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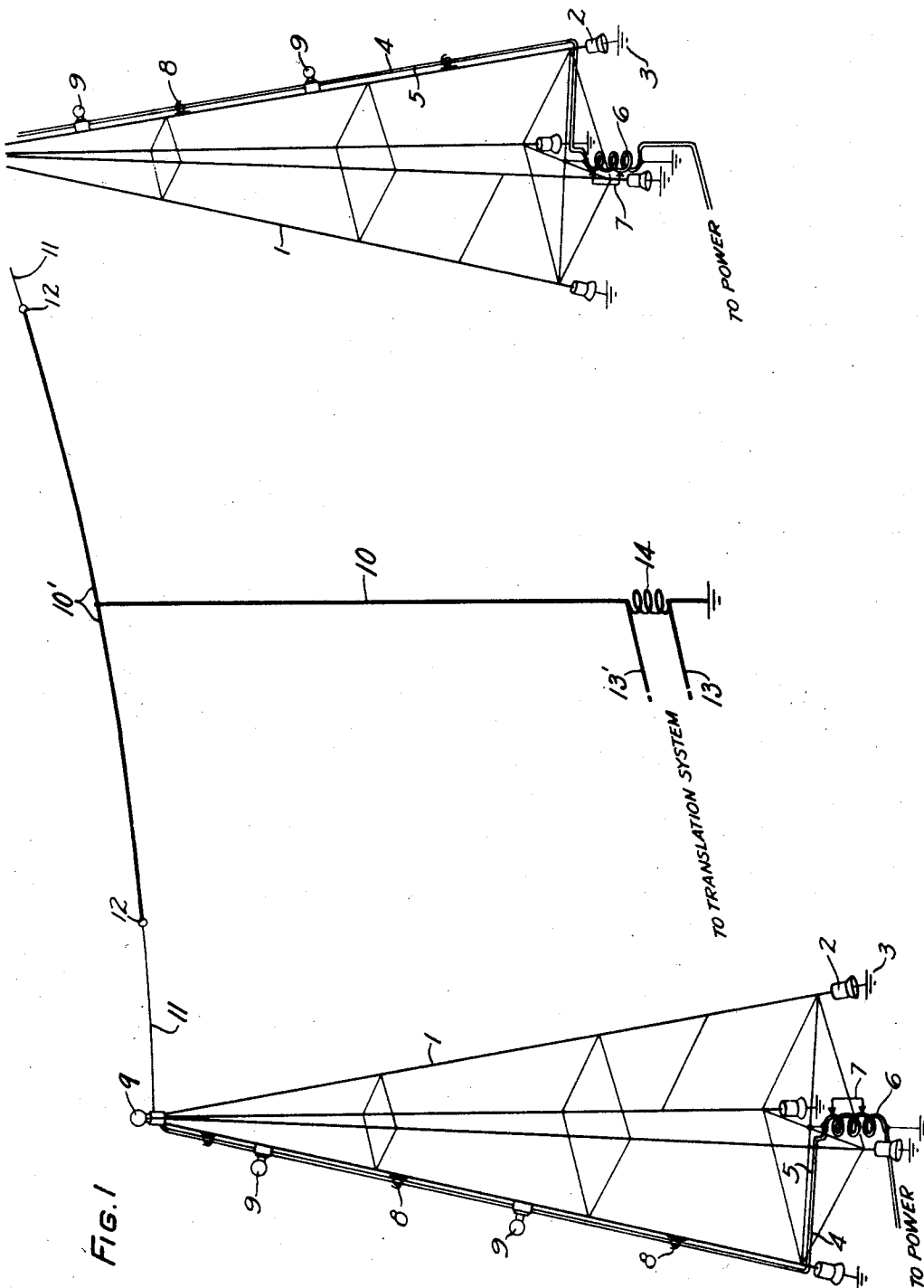
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RADIO ANTENNA SUPPORTING AND ACCESSORY STRUCTURE

Filed April 12, 1930

2 Sheets-Sheet 1



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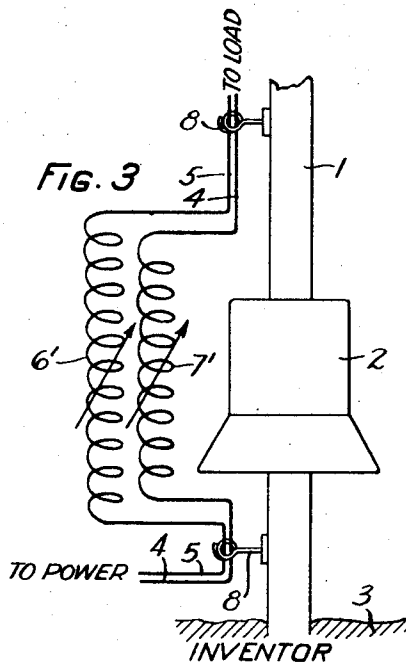
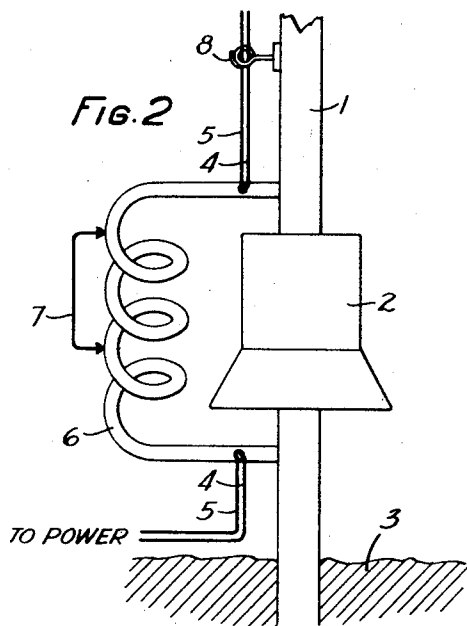
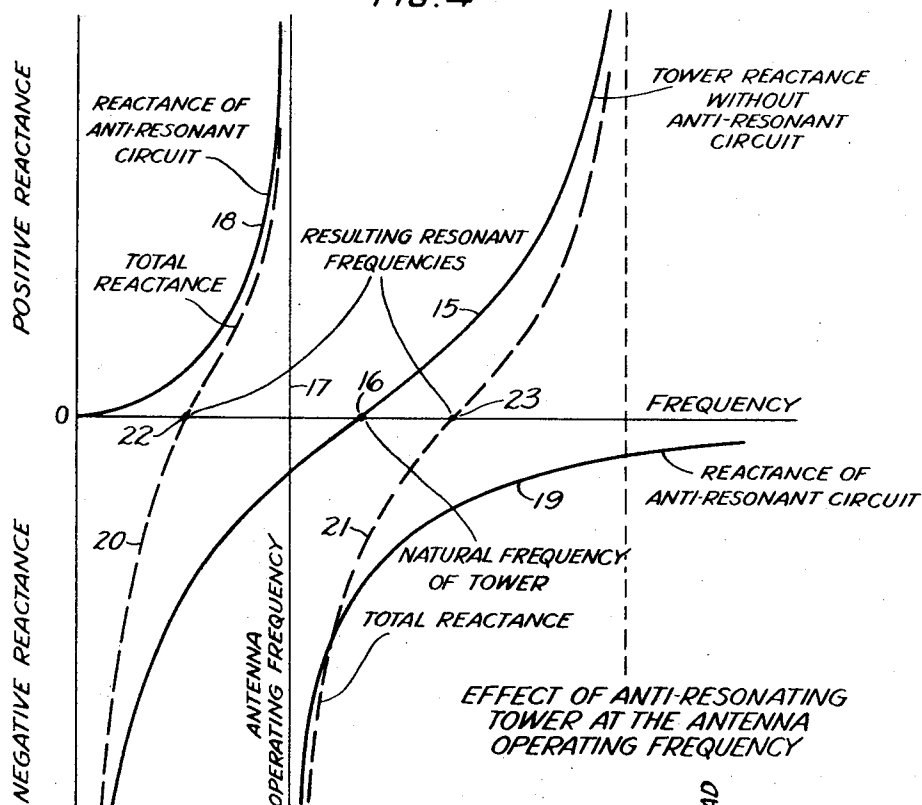
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RADIO ANTENNA SUPPORTING AND ACCESSORY STRUCTURE

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2 Sheets-Sheet 2

Fig. 4



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RADIO ANTENNA SUPPORTING AND
ACCESSORY STRUCTUREFrancis M. Ryan, East Orange, N. J., assignor to
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12 Claims. (Cl. 250—33)

This invention relates to radio antenna systems and more particularly to the towers employed in supporting such antenna systems.

Heretofore, insulators of low capacity have been inserted between the ground and the antenna towers ordinarily associated with broadcast and other large transmitting or receiving antenna, for the purpose of minimizing the flow of tower current which occurs as a result of the electromotive force induced therein by the transmitted or received waves. If tower current having a frequency corresponding to that of the antenna is reduced to a minimum the modification of the antenna field by undesirable radiation from or absorption by, the tower becomes negligible, and in directive antenna the overall directional characteristic of the system will remain unaffected.

Up to the present time the desirable condition of minimum tower current has not been fully realized since the footing insulators employed necessarily possess some undesired capacity. Moreover, in tower systems equipped with low frequency or direct current apparatus such as aircraft warning lights, sleet melting and similar circuits, the advantage secured in using footing insulators becomes nullified by the presence of ground on such low frequency or direct current power leads obtained, for example, from the power source. On account of the capacity between the leads and tower, this ground completes a high frequency path from the tower to ground in shunt to the insulators and causes the tower to simulate an antenna. Similarly the leads themselves have an antenna effect.

It is an object of this invention to improve the operating efficiency of antenna systems.

It is another object of this invention to improve the effectiveness of the tower footing insulators.

It is a further object of this invention to electrically isolate the antenna tower from ground at the operating frequency of the associated antenna.

It is still another object of this invention to impede the flow of current having a frequency substantially equal to that of the antenna current in antenna towers and associated power leads.

One feature of the invention resides in the use of a coil comprising an outer tubular conductor conductively connected in shunt to the tower insulators and enclosing several separately insulated conductors, each of which is connected in series with one of the power leads mounted on the tower. The coil is so designed electrically that each of the enclosed conductors, as well as the outer conductor, when separately considered, is in effect a radio frequency choke coil at the operating frequency of the antenna.

The tubular conductor and enclosed conductors may also be considered, on account of the large distributed capacity and mutual inductance existing between these elements, as a unitary choke coil connected in series with the tower and power leads. A short-circuiting bar is associated with the tubular conductor for varying its inductance and, incidentally, for varying the inductance of the unitary coil.

According to another feature of the invention each of the enclosed conductors of the coil is connected, through the distributed capacity between itself and the outer conductor, in shunt to the tower insulators so that an effective anti-resonant circuit comprising one of the enclosed conductors and the capacity of the insulators is included in the associated power leads; similarly, the outer conductor of the coil is conductively connected in shunt to the tower insulators so as to form an effective anti-resonant circuit in series with the tower proper. As above, the outer and inner coil conductors may be considered, because of the mutual capacitive and inductive coupling, as a single conductor connected in shunt to the tower insulators and when so considered the anti-resonant circuit so formed is obviously in series with both the power leads and the tower. The adjusting bar associated with the tower conductor performs, in addition to the function mentioned above, the further function of adjusting the anti-resonant value of the shunt combination. Thus, the tower and leads are effectively isolated from ground and the antenna characteristic remains unimpaired.

The nature of this invention will be better understood from the following detailed description and accompanying drawings, in which;

Fig. 1 represents a tower equipped with footing insulators for the purpose of eliminating undesired currents in the towers and associated power leads;

Fig. 2 illustrates an embodiment of the invention employed for anti-resonating at the antenna operating frequency an antenna tower having a single footing insulator and the associated leads;

Fig. 3 illustrates another embodiment of the invention employed for impeding the flow of undesired current in the power leads associated with an antenna tower; and

Fig. 4 is a set of curves showing the effect produced on the resonant frequency of the tower by inserting the anti-resonant circuit in series with the tower.

In each of the figures of the drawings, like reference numerals designate similar elements.

In Fig. 1 reference numeral 1 designates the towers of an antenna system constructed of metal and supported by insulators 2 which may

or may not be of low capacity value and which are positioned directly on or relatively close to the ground 3. Numerals 4 and 5 denote the conductors of a low frequency or direct current power line employed for supplying energy to the upper portions of the towers. Numerals 6 designate inductance coils each formed from a tubular conductor of relatively small internal diameter, each coil being conductively connected in shunt to insulators 2 and enclosing the associated conductors 4 and 5 throughout its length. The inductance of each coil is varied by manipulating adjustable bar 7. The power leads are either enclosed in metal conduit supported on the towers 1, or mounted directly on the towers by means of insulators 8 as shown on the drawings. These leads are connected to a load circuit such as the aircraft warning lights 9 mounted on the upper portions of the towers.

The antenna illustrated in Fig. 1 is a T type antenna and comprises a vertical element 10 and a horizontal element 10' supported by means of guy wires 11 attached to the towers 1. The antenna is insulated from the guy wires and towers by means of insulators 12. Reference numerals 13 and 13' designate the conductors of a transmission line terminated in an impedance 14 and employed for connecting the antenna with a translation system which is not shown on the drawing and which may be either a transmitter or receiver. Any type of antenna or of electrically conducting tower may, of course, be employed in place of those shown without affecting the results secured by the invention.

When the antenna elements 10 and 10' in Fig. 1 are energized either by means of incoming waves or by energy transmitted from the translation system, high frequency potential is induced in the towers 1 and in conductors 4 and 5 in the case of transmission, as a result of the radiation from the antenna; in the case of reception, by direct absorption from the incoming waves. Ordinarily if the natural frequency of the tower be relatively close to that of the frequency of the induced potentials the tower current will be large and whether by reason of the absorption itself from the antenna field or by reason of reradiation of the absorbed energy, will unfavorably affect the antenna operating characteristic. If the antenna is directional, the directivity will, of course, be lessened. Current of the antenna operating frequency is prevented from flowing in the tower, however, in accordance with this invention, by the insertion of the anti-resonant circuit in series with the tower, this circuit comprising inductance 6 in shunt with the insulators 2. The bar 7 associated with coil 6 is adjusted until the proper inductance for anti-resonance is secured. As will be explained in connection with Fig. 4 one of the effects of introducing the anti-resonant circuit in series with the tower is to change the resonant frequency of the tower to a value substantially different from that of the operating frequency of the antenna, the new resonant frequency of the tower being above or below that of the antenna frequency. Of course an anti-resonating coil may, alternatively, be used with each insulator, its inductance being changed accordingly from that appropriate to the situation illustrated.

The power leads mounted on the tower tend to function with respect to the antenna similarly as the tower, and currents of the antenna

frequency are prevented from flowing in these leads, that is, in conductors 4 and 5, by means of the radio frequency choke coils formed within each of coils 6. Moreover, as already explained each radio frequency choke coil is effectively connected in shunt with the insulators 2 through the large distributed capacity and mutual inductance between the outside conductor and each associated inner conductor so that an anti-resonant circuit at the antenna frequency is included in series with each lead, and this circuit still further impedes the flow of these undesired currents. The flow of low frequency or direct current energy is, of course, unimpeded in the radio frequency choke coils.

In Fig. 2 the reference numeral 1 represents a tower which may be used in place of either of the towers 1 shown in Fig. 1. This tower contains a single footing insulator preferably located on or relatively close to the ground 3. As in Fig. 1, the insulator is shunted conductively by means of tubular coil 6 having an adjustable bar 7. Power conductors 4 and 5 are enclosed by the coil 6, the spacing between the conductors 4 and 5 and the tubular coil 6 being relatively small so that the distributed capacity between each inner conductor and coil 6 is relatively large and the mutual inductance relatively high.

The anti-resonant device shown in Fig. 2 functions in a manner similar to that explained in connection with the system of Fig. 1. The flow of undesired high frequency current will be impeded in the tower circuit by the anti-resonant circuit arrangement comprising coil 6 and insulator 2. Similarly the flow of undesired high frequency current in power conductors 4 and 5 will be impeded by the radio frequency choke coil formed within tube 6 in each of conductors 4 and 5.

In Fig. 3 a means for impeding the flow of undesired current in the power leads only is shown. Numerals 1, 2 and 3 designate the tower, footing insulator, and ground respectively as in Figs. 1 and 2. Power conductors 4 and 5 each contain an adjustable radio frequency choke coil designated 6' and 7', respectively. These coils are adjusted to a value suitable for impeding current having a frequency substantially equal to that of the antenna current. In this embodiment of the invention, no anti-resonant circuit is shown although each of conductors 4 and 5 may be located relatively close to tower 1, for the purpose of obtaining a large distributed capacity between the terminals of the insulators and each lead, which capacity effectively connects the insulator and coils in shunt to form an anti-resonant circuit in each power lead.

The curves of Fig. 4 indicate the change produced in the resonant frequency of the tower as a result of inserting the anti-resonant circuit. The curve designated by reference numeral 15 represents the impedance of the tower and numeral 16 designates the natural frequency of the tower. This natural frequency, it will be seen, is relatively close to the operating frequency of the antenna represented by the straight line 17. The impedance of the anti-resonant circuit comprising the tubular coil and the footing insulator is shown by curves 18 and 19 taken together, the anti-resonant circuit being adjusted for maximum impedance at the frequency of the antenna current. Curves 20 and 21 together represent the total impedance

of the tower and anti-resonant circuit. It will be noted that the total impedance is infinite at the antenna operating frequency and that the two new resonant frequencies 22 and 23 are farther away from the antenna frequency, on the frequency axis, than the original resonant frequency 16.

Although the invention has been described in connection with certain specific embodiments it is to be understood that the invention is not to be limited to the systems described herein. Any type of antenna, or any tower constructed of conducting material may be employed; and the anti-resonant circuit may satisfactorily be located at a point in the tower other than that shown in the drawings.

What is claimed is:

1. In combination, an antenna supporting structure comprising a metallic tower having a resonant frequency not appreciably different from the operating frequency of the antenna supported thereby and an insulator supporting said tower and constituting with the adjacent conductive surfaces a condenser, a coil connected in shunt to the condenser so constituted and forming therewith a circuit anti-resonant at the antenna operating frequency, whereby each resultant resonant frequency of the supporting structure is substantially different from that of the antenna operating frequency.

2. In combination, an antenna tower, a conductor, a portion of which is positioned relatively close to said tower and a circuit anti-resonant at a particular frequency connected conductively in series with said tower and inductively and capacitively in series with said conductor.

3. In combination, an antenna tower, a conductor substantially parallel thereto, a circuit anti-resonant at the antenna operating frequency comprising an insulator included between two conductive surfaces and a coil connected in shunt thereto, said circuit being electrically connected in series with said tower and conductor.

4. In combination, an antenna tower, a plurality of conductors mounted thereon, means for anti-resonating said tower and conductors at the operating frequency of the antenna, said means comprising a tubular coil and an insulator, the insulator being connected in series with the tower and in shunt with the coil and the conductors being enclosed by the tubular coil.

5. In combination, an antenna tower, at least one conductor mounted thereon and substantially parallel thereto, an insulator in series with the tower and means for anti-resonating said tower and conductors at the antenna operating frequency, said means comprising a tubular coil of small interior diameter connected in shunt to said insulator, the conductor being contained within the tubular coil.

6. In combination, an antenna tower, a plurality of conductors mounted thereon and substantially parallel thereto, an insulator in series with the tower and means for anti-resonating said tower and conductors at the antenna operating frequency, said means comprising a tubular coil connected in shunt to said insulator, the conductors being contained within the tubular coil so that the magnetic coupling between each conductor and the coil is relatively close.

7. In combination, an antenna tower, a footing insulator therefor, a conductor at least one part of which is positioned relatively close to said

tower, an inductance included in said conductor, said insulator and inductance being connected in shunt for high frequency currents so as to form an anti-resonant circuit at the frequency of the potential induced in said tower and conductor.

8. In combination, an antenna tower, an antenna supported thereon, a low capacity insulator included between said tower and the ground, a plurality of conductors positioned above the earth relatively close to said tower, an adjustable inductance inserted in each of said conductors, said insulator and each inductance being capacitively connected in shunt, and each inductance being adjusted to form with the insulator an antenna resonant circuit at the antenna frequency.

9. In combination, an antenna, a tower, an insulator included in series with said tower and conductively connected to the ground, a plurality of insulated conductors mounted on the tower, a tubular coil connected in shunt to said insulator, each of the said conductors being included within said coil so as to form separate inductance coils, the distributed capacity between said tubular coil and each inductance coil being relatively large, and the reactance of each inductance coil being of the same magnitude as that of the insulator at the operating frequency of the antenna.

10. In combination, a plurality of towers, an antenna supported thereon, a source of potential of high frequency associated with said antenna, a low capacity insulator included between each tower and the ground, a tubular coil connected in shunt to said insulator, a plurality of separately insulated conductors positioned substantially parallel and relatively close to one of the said towers, each of said conductors being enclosed by said coil throughout said length so as to form a high impedance at said frequency, and the inductance of said tubular coil and capacity of said insulators being such that the flow of current of said frequency is impeded in said towers.

11. In combination, a tower, an antenna supported thereon, a plurality of grounded insulators supporting said tower, a plurality of low frequency conductors positioned relatively close to said tower, means associated with said antenna for causing high frequency current to flow therein, a plurality of inductances comprising an adjustable tubular coil enclosing one or more insulated coiled conductors positioned closely adjacent to said coil and to each other, each of the low frequency conductors being connected to ground through one of the coiled conductors, the tubular coil being conductively connected in shunt to the insulators, and the inductance value of the tubular coil and each of the coiled conductors being such that they each form with the insulators separate antenna resonant circuits at the frequency of the above current.

12. In combination, a tower, an antenna supported by said tower, means for producing high frequency current in said antenna, a plurality of low capacity insulators included between the tower and the ground, low frequency power leads mounted on said tower, means for impeding the flow of current of substantially the same frequency as the antenna current included in series with the tower and the power leads, said means comprising a tubular coil connected in shunt to the insulators and containing coiled conductors one of which is included in each power lead.

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