Dec. 14, 1937. G. W. FYLER 2,102,410

ANTENNA SYSTEM

Filed April 20, 1935

Fig. 1.

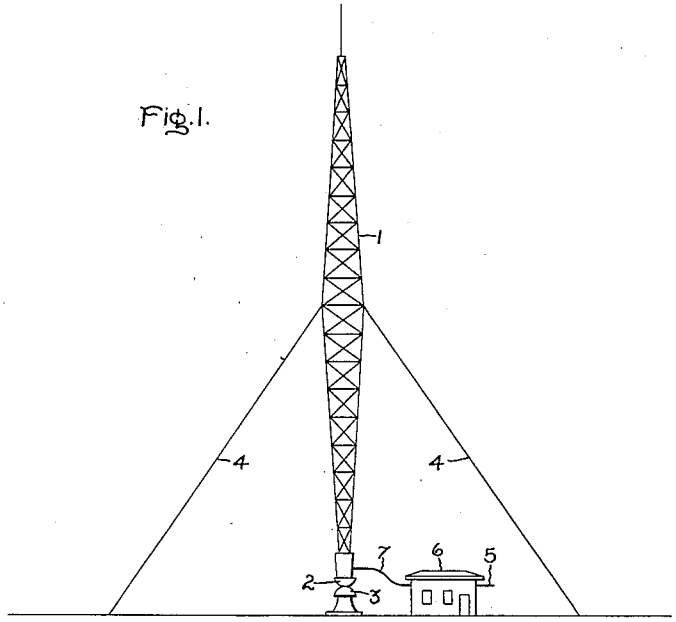


Fig. 2.

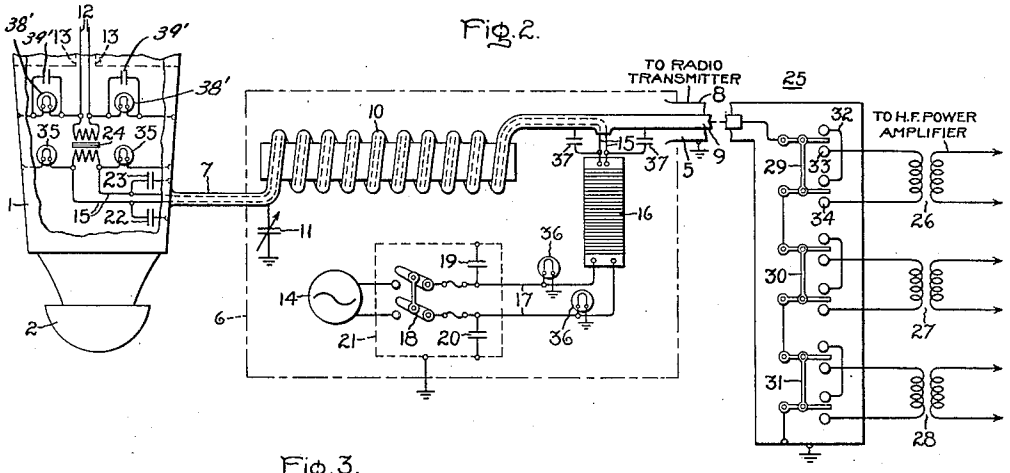
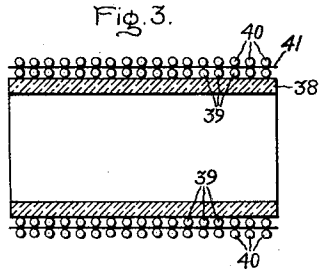


Fig. 3.



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2,102,410

ANTENNA SYSTEM

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Application April 20, 1935, Serial No. 17,451

4 Claims. (Cl. 250—33)

My invention relates to antenna systems and more particulary to that type of system which has for its purpose to supply current to the lighting system of a tower type antenna. The use of a tower which is suitably insulated as a vertical antenna has introduced a problem in providing a suitable system for lighting the tower at night so that its location may be visible to aircraft. One of the methods by which such towers have been lighted involves the use of a motor-generator set which has a generator so mounted and insulated that the generator may be operated at the radio frequency potential of the antenna tower. Such generators are mounted on special insulators and the driving shafts of the motor and generator are insulated from each other. It has been found, however, that such motor-generator sets become very expensive when the radio transmitter is of considerable power and when the lighting load is of some magnitude.

In accordance with my invention I obviate the above-noted disadvantages by providing an antenna lighting system in which the lighting circuit conductors are led to the antenna tower through a hollow radio frequency transmission line conductor which connects the tower with the transmitting apparatus. With the above arrangement and during the operation of the transmitter, the hollow transmission line conductor is at a high radio frequency potential with respect to ground while the power generator for the lighting circuit is normally at ground potential. It has been found that it is necessary to provide a suitable means for absorbing the high radio frequency potential drop between the transmission line conductor and ground. In accordance with my invention, a radio frequency choke is interposed in the lighting circuit, which choke is designed to offer an exceedingly high impedance to the high radio frequency currents and a relatively low impedance to the lower frequency currents generated by the lighting circuit power source. The above described arrangement of my improved system is completely described in my copending application, Serial No. 695,636, filed October 28, 1933, of which the present application is a continuation in part.

It is an object of my invention to provide an improved economical system for supplying currents to the lighting and power circuit of a tower or vertical type antenna.

It is a further object of my invention to provide a system for supplying current to the antenna lighting and power circuit which does not require any insulating means between the source of commercial current from which energy for the antenna power and light current is derived, and the tower lighting and power circuit.

In the normal operation of certain types of radio transmitting systems it is necessary to interrupt at times the radio frequency transmission line circuit and thereby leave the antenna tower isolated from ground. During such interrupting periods severe static charges accumulate on the antenna tower and thereby create a high potential difference, which may assume a value of several thousand volts, between the tower and ground. In my improved antenna lighting circuit, the lighting circuit conductors are at ground potential during such isolation periods and the high potential difference noted above is therefore imposed directly across the insulation of these conductors. This high voltage causes failure of the insulation of the conductors which results in a grounding of the conductors on the radio frequency parts of the antenna system and short circuits between the conductors. In order to obviate this difficulty, a static charge drain circuit is provided, this circuit including the lighting circuit conductors and resistance means connected between each of the conductors and the radiating tower and between the conductors and ground. In this manner, a low resistance path to ground is furnished for the static charges which prevents the accumulation of a high potential difference between the tower and ground.

It is, therefore, an additional object of my invention to provide in an improved antenna lighting circuit of the type described above a static drain circuit for conducting the static charges to ground during the switching periods when the antenna tower is disconnected from ground.

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 be understood best by reference to the following description taken in connection with the accompanying drawing, in which Fig. 1 is a pictorial representation of the type of antenna which is to be lighted, Fig. 2 discloses schematically the embodiment of my invention, Fig. 3 shows the construction of an inductance used in the system.

Referring to Fig. 1 of the drawing, I have shown therein a vertical antenna comprising a steel tower 1 which is mounted upon a suitable

insulating base having the insulators 2 and 3. The tower is maintained in position by a plurality of guy-wires 4—4 which may be divided into suitable non-resonant sections by means of strain insulators (not shown). Radio energy from a radio transmitter (not shown) is transmitted over a concentric transmission line 5 which leads into an antenna house 6 containing an antenna loading inductor 10 and the tuning capacitor 11. The radio energy is then transmitted to the antenna 1 by means of a conductor 7.

In Fig. 2, the dotted line 6 forming a rectangle indicates the apparatus which is housed within the antenna house 6. The concentric transmission line 5 which connects the radio transmitter to the antenna house is composed of an outer cylindrical member 8 which is at ground potential and a conductor 9 which is at a high radio frequency potential with respect to ground. The conductor 9 is connected to the antenna inductor 10 which in turn is connected to the conductor 7. The conductor 7 is connected to the lower portion of the antenna 1 which is shown in part in this figure. In order to adjust the transmission line terminal impedance to a value equal to the line surge impedance, a tuning capacitor 11 is connected between ground and the inductor 10 adjacent to the conductor 7.

To illuminate the antenna 1 so that it may be visible at night to aircraft, the antenna tower 1 is provided with a lighting and power circuit comprising a pair of conductors 12 enclosed within suitable conduit which is denoted by the dotted lines 13. The antenna 1 operates at a very high radio frequency potential with respect to ground. In one instance, for example, this potential had a value of 14,000 volts R. M. S. for the radio frequency carrier current and the energy radiated from the antenna was 500 kilowatts. This is by reason of the fact that the coil has inductive reactance, which together with the reactance of the antenna and condenser 11 forms a resonant circuit, whereby a portion of the high voltage of the resonant circuit appears on the inductance 10. In order to supply the lighting and power circuit 12 with energy from a source of commercial current 14, it is necessary to provide some means for producing a potential gradient between the source 14 and the lighting and power circuit 12.

It was found that while one end of the inductor 10 was at a very high potential with respect to ground, the other end of the inductor nearest the concentric transmission line 5 had a potential which was only about one-half of the radio frequency potential of the antenna tower 1. By placing a pair of conductors 15 within the hollow conductor comprising the antenna inductor 10 and the conductor 7, the inductor 10 operates as a coupling means to apply to the pair of conductors 15 a voltage gradient which ranges from a relatively low value to the high radio frequency potential of the antenna and its lighting and power circuit. A radio frequency choke inductor 16 connected between the conductors 15 at the low potential end of the inductor 10 and the source of commercial current 14, serves to operate as a means for producing a voltage gradient ranging from the value present at the low potential end of the inductor to the ground potential of the commercial current source. The radio frequency choke inductor 16 also operates to prevent radio frequency energy from the transmission line, and also energy received by the antenna from other transmitters in the vicinity from being impressed upon the source of current 14. By placing the choke inductor 16 at the low potential end of the inductor 10, the antenna inductor 10 and capacitor 11 operate to shield the choke inductor 16 from the effects of lightning and other radio frequency energy received by the antenna. The radio frequency choke inductor 16 is connected through a pair of conductors 17 to the switch 18 which is connected to the source of current 14. At the switch the conductors 17 are connected through capacitors 19, 20 to ground through the shield 21 which encloses the switch 18, suitable fuses and capacitors 19 and 20. The capacitors 19 and 20 operate to remove any radio frequency currents from the conductors 17 which may have passed through the radio frequency choke inductor 16. At the point of entry of the conductors 15 into the antenna structure 1, the conductors are connected capacitively to the antenna structure through capacitors 22 and 23 so that any radio frequency energy picked up by the pair of conductors 15 is impressed upon the antenna structure. In addition, a pair of condensers 37 are provided which are connected at the low radio frequency potential end of the inductor 10 between the conductor 9 and the two conductors 15. The condensers 37 serve to maintain the portion of the conductors 15 entering the inductor 10 at the relatively low radio frequency potential existing at the point of entry. The conductors 15 are connected to a transformer 24 which is connected to the lighting and power circuit 12.

It will be observed that the power supply conductors 15 are arranged in close proximity to each other throughout their length and that they carry current in opposite directions. Thus, they not only have the radio frequency potential gradient existing between the two ends of the conductor 10 distributed along their length, but they offer substantially zero inductance to currents of the power source. In this manner the reactance drop of the power frequency in these conductors is minimized.

In Fig. 3, I have shown the radio frequency choke inductance 16 as comprising a glass or other nonconducting, nonmagnetic core 38 having the conductors 39 and 40 wound in the same direction around the surface thereof in close proximity to each other. As indicated, the conductors 39 and 40, respectively, form two separate layers of turns which are separated by a layer 41 of a suitable insulating material such as varnished cambric, or the like. Adjacent ends of each of the conductors 39 and 40 are connected to the pair of conductors 15 and each of the two opposite ends are connected respectively to one of the pair of low frequency supply current conductors 17. The low frequency power current flows in opposite directions in the conductors 39 and 40 and by arranging the conductors in close proximity to each other throughout their length they offer substantially zero inductance to this current. Thus the reactance drop of the power frequency in these conductors is reduced to a minimum. However, the conductors 39 and 40 are effectively tied together at radio frequencies by the distributed capacity between the turns thereof and the condensers 19, 20, and 37, and accordingly may be accurately considered to be a single conductor coil for computing the radio frequency reactance. The physical characteristics of the equivalent single conductor radio frequency inductance coil thus formed are so selected that the coil is resonant to the carrier current frequency at which the

transmitting apparatus is to be operated. By constructing the coil to resonate at the operating radio frequency a very high radio frequency impedance is obtained which effectively absorbs the high radio frequency potential gradient between the transmission line conductor 9 and ground without detracting from the efficiency of the antenna system. Thus, the conductors 39 and 40 form an inductance which efficiently carries the low frequency power currents from the conductors 17 to the conductors 15 and at the same time blocks the high radio frequency voltage from the low frequency current power source.

In certain transmitting circuit arrangements it is necessary to interrupt the normal connection between the transmission line conductor and ground. Thus, at 25 I have shown a switching device interposed in the transmission line for connecting one or more of several output circuits to the antenna system. The outputs from several high frequency power amplifiers (not shown) are coupled to the antenna circuit by the coupling devices indicated at 26, 27 and 28. The respective secondaries of the coupling devices are connected to the individual switches 29, 30, and 31 respectively. As shown, when the switch 29, for example, is in the upper position, the antenna circuit is completed by the connection 32 and the secondary of the coupling device 26 is excluded from the antenna circuit. With the movable switch members of the switch 29 in the upper position, if it is desired to connect the secondary of the coupling device 26 in the antenna circuit, it is only necessary to throw the movable switch members to the lower position to engage the contacts 33 and 34. In like manner, the secondaries of the coupling devices 27 and 28 may be connected in, or excluded from, the antenna circuit by operating the switches 30 and 31.

During a switching interval when any one of the switches 29, 30 and 31 is open extremely heavy static charges accumulate on the antenna 1 which cause a high potential difference to exist between the antenna and ground. Since, during these intervals, the antenna lighting circuit including the conductors 15 is the only portion of the system which is at ground potential, it will be seen that a high voltage exists directly across the insulation of these conductors. I have found that this high potential difference is of sufficient magnitude to puncture the insulation and cause short circuits between the conductors 15 through the points of contact between the conductors 15 and the parts of the radio frequency circuit.

In order to obviate the above difficulty, a static drain circuit is provided. This circuit includes the conductors 15 and 17 and resistance 35 and 36 connected respectively between the conductors 15 and the antenna, and between the conductors 17 and ground. I have shown the resistances 35 and 36 as incandescent lamps for a purpose to be described hereinafter. With the above circuit arrangement, during the switching interval when the transmission line is open circuited, static charges have a low resistance path to ground which includes the resistances 35, the conductors 15, the choke impedance 16, the conductor 17 and the resistances 36. Thus the antenna is maintained at substantially ground potential during the switching periods when the antenna is isolated from ground and the lighting circuit conductor insulation is protected. In order to prevent the accumulation of static charges on the load conductors 12, a pair of lamps 38' are provided which are connected between the conductors 12 and the antenna 1. Preferably, each of the lamps 38' is shunted by a high frequency by-pass condenser 39', which condensers function to remove radio frequency currents from the conductors 12. It will be observed that the lamps 38' provide a conductive path between the conductors 12 and the antenna 1 which prevents the accumulation of static potentials on the conductors when the high frequency antenna supply circuit is interrupted.

By employing incandescent lamps as the resistance means 35 and 36 in the manner described above, an indication may be obtained during normal operation, when the transmitter is operating, for determining the location of faults in the lighting circuit conductors. It will be observed that the lamps 35 connected to the conductors 15 are in series across the primary of the transformer 24. These lamps have a normal voltage rating equal to the potential between the conductors 15 so that, with the circuit in ungrounded condition, the lamps burn at less than normal brilliance. However, if a short circuit occurs between a portion of the radio frequency circuit and one of the conductors 15, the lamp 35 connected between that conductor and the antenna 1 will be extinguished and the other lamp 35 connected between the other conductor 15 and the antenna 1 will burn at full brilliance. In like manner, if one of the conductors 17 becomes grounded, the lamp 36 connected thereto will be extinguished and the lamp 36 connected to the other conductor 17 will burn at full brilliance. The lamps 38' connected between the antenna 1 and conductors 12 operate in a manner similar to that described above to indicate faults on the conductors 12. By this arrangement the conductor upon which the fault occurs may be detected and the approximate location of the fault may be determined with little difficulty.

In the circuit arrangement described, the use of the transformer 24 provides several advantages which, while desirable, are not essential to the invention. The transformer 24 permits the use of a higher voltage current from the commercial source of supply 14, thereby reducing the current flowing through the inductor 10 and also reducing the physical size of the choke inductor 16 due to the smaller conductors utilized. Because the transformer 24 isolates the lighting and power circuit 12 from the other circuits, one wire of the circuit 12 may become grounded without causing failure to the lighting circuit. It is evident, however, that where desirable the antenna tower could serve as a return circuit for the lighting circuit.

While I have shown the source of commercial lighting current 14 as being alternating in nature, thereby utilizing the transformer 24, it is to be understood that a source of direct current of suitable voltage could be used to supply energy to the lighting and power circuit 12 of the antenna 1. It is furthermore evident that any other arrangement could be used in place of the inductor 10 and the radio frequency choke 16 which would operate to produce the necessary voltage gradient along the length of the conductors between the antenna lighting and power circuit and the source of commercial current 14. It is evident of course that the source of commercial current 14 must be protected from the radio frequency currents in order to prevent any disturbance on the lines of the commercial source of current as well as to confine radio energy received at the antenna house to the transmission medium between the

transmitter and the antenna so as to obtain the maximum efficiency of the entire arrangement.

While I have shown a particular embodiment of my invention, it will, of course, be understood that I do not wish to be limited thereto, since it is apparent that the principles disclosed herein are susceptible of numerous other applications, and modifications may be made in the circuit arrangements and in the instrumentalities employed without departing from the spirit and scope of my invention as set forth in the appended claims.

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

1. In combination, an antenna tower insulated from ground except through capacitance, a source of oscillations connected between ground and said antenna tower, an inductance coil connected in series between said tower and said source, the inductance of said coil being so proportioned relative to said capacitance that the voltage on said tower is substantially greater than that of said source, a power load arranged on said tower, a power source, a conductor extending from said load to said source along the turns of said coil throughout the length of said turns, and a drainage connection for static charges on said tower, said connection comprising said conductor, a connection from the tower end thereof to said tower and a connection from the source end thereof to ground.

2. In combination, an antenna tower insulated from ground except through capacitance, a source of oscillations having one terminal connected to ground, an inductance having one end permanently connected to said tower and the other end connected to ground through said source and a switch, the inductance of said coil being so proportioned relative to said capacitance that the voltage on said tower is substantially greater than that of said source, a power load arranged on said tower, a power source, a pair of conductors extending along the turns of said coil throughout the length thereof in close proximity to said turns and to each other, said conductors being connected in opposite sides respectively of a power circuit including said source and load, whereby said conductors offer substantially no inductance to power current flowing therethrough, and means to drain static charges on said antenna to ground when said switch is open, said means comprising a drainage connection complete from said tower to ground through one of said conductors irrespective of the position of said switch.

3. In combination, an antenna tower insulated from ground except through capacitance, a source of oscillations connected between ground and said antenna tower, an inductance coil connected in series between said tower and said source, the inductance of said coil being so proportioned relative to said capacitance that the voltage on said tower is substantially greater than that of said source, a power load arranged on said tower, a power source, a pair of conductors extending along the turns of said coil throughout the length thereof in close proximity to said turns and to each other and insulated from said turns, said conductors being connected in opposite sides respectively of a power circuit including said source and load whereby the inductance of said conductors is neutralized, and signal devices connected respectively between the tower end of each conductor and said tower and additional signal devices connected respectively between the source ends of said conductors and ground whereby said signal devices and conductors constitute drainage paths to ground for static charges on said antenna and said signal devices respond to break down of insulation between either of said conductors and said inductance coil.

4. In a lighting and power system for an antenna, the combination of an antenna, a radio frequency supply circuit for said antenna, said circuit including a single tuning coil having a high radio frequency potential end connected to said antenna and a relatively low radio frequency potential end, a power circuit for said antenna, a source of commercial current, a circuit for transferring energy from said source to said power circuit, said last-named circuit including the conductors of a double wound radio frequency choke coil and a second pair of conductors connected in opposite sides of said circuit thereby to carry current in opposite directions, said second pair of conductors having turns adjacent to the turns of said tuning coil and adjacent to each other whereby the potential difference between the ends of said tuning coil is distributed along the length of said conductors and the inductance of said conductors to currents from said power source is minimized, and means including said tuning coil and a condenser connected between said high radio frequency potential end of said tuning coil and ground for shielding said choke coil against high potential difference between said antenna and ground.

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