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ANTENNA SLEET MELTING APPARATUS

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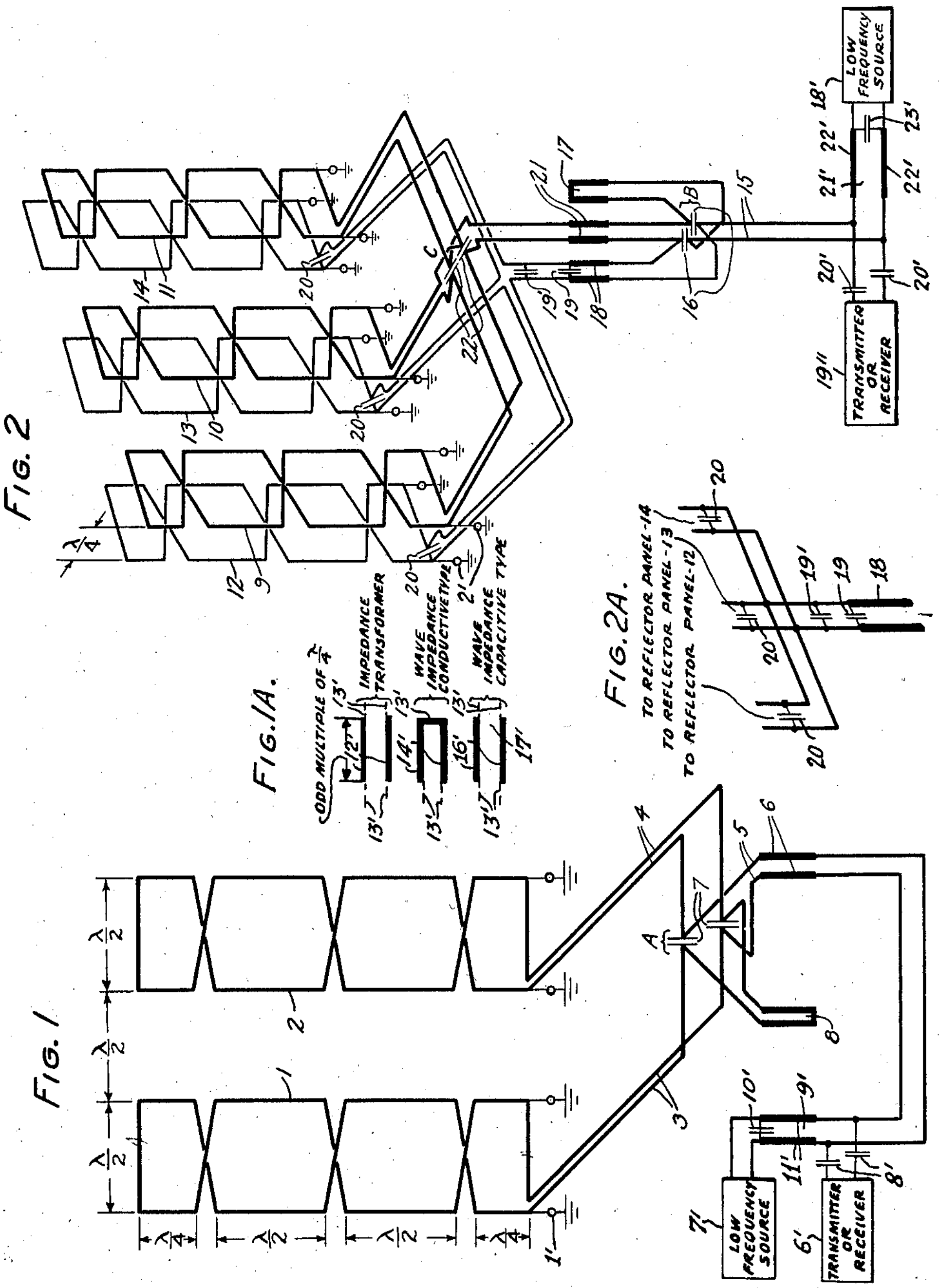

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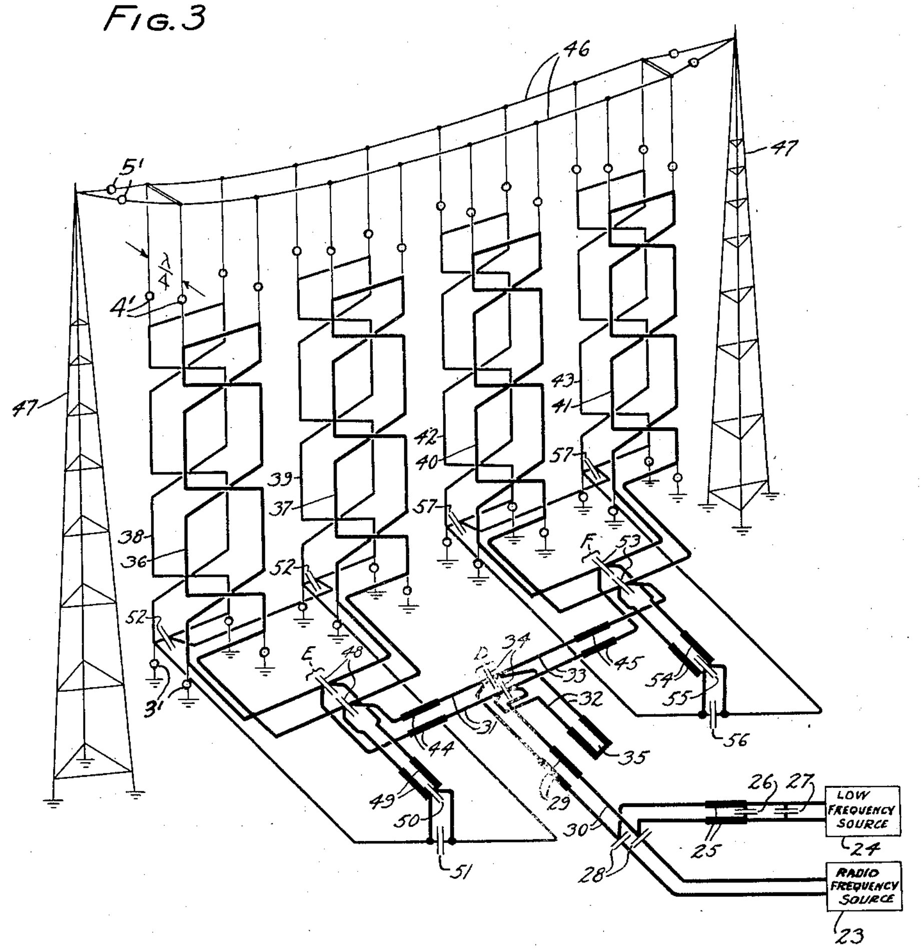
FIG. 3



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ANTENNA SLEET MELTING APPARATUS

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Application August 1, 1929, Serial No. 382,702

21 Claims. (Cl. 250—33)

This invention relates to aerial systems and more particularly to such systems as are equipped with means for removing sleet therefrom.

In the operation and maintenance of both transmitting and receiving antenna systems located in sections of the country which are subject to sleet storms, considerable trouble is at present experienced because of the formation and the presence of sleet and ice on the radiating members of the system. The added weight of the ice tends to detune aerial systems as a result of the change in the dielectric constant of the medium surrounding the wires, the ice having a constant of 80. It also frequently causes an actual severence of the radiating elements which usually results in a complete interruption of the operation of the system.

Practically all of the schemes at present employed for removing the sleet possess the disadvantage that it is usually necessary, unless relatively expensive filter apparatus is employed, to disconnect the radio frequency apparatus from the system during the time the low frequency or direct current is being applied to heat the wires.

It is an object of this invention to supply low frequency energy to a plurality of conductors and, at the same time to supply energy of a higher frequency in parallel to either the whole plurality of the conductors or a portion thereof.

It is another object of this invention to simultaneously energize a radiating system with direct or low frequency current for heating and high frequency current for radiation.

It is another object of this invention to arrange a plurality of antennæ units or groups of units in series for the sleet melting current and, at the same time, in parallel for the radio frequency current.

It is still another object of this invention to supply sleet melting current to all of the panels of an exciter or exciter-reflector system, such as disclosed in my copending application Serial No. 382,103, filed July 30, 1929, and radio frequency current in parallel to the panels of the exciter only, using simple and inexpensive apparatus for doing the same.

One feature of the invention resides in the use of a wave impedance comprising a line, an odd multiple of a quarter wave length long short-circuited at one end for the radio frequency current, as a means of providing a path for the sleet melting current and also as a means of preventing the flow of the high frequency current to certain parts of the radiating system. Since one end of the quarter wave length is short-circuited, in a manner such that the load impedance at the given frequency becomes substantially equal to zero, the sending impedance becomes practically infinite for waves of the given frequency; and consequently the wave impedance acts as a low pass filter for separating the paths of the sleet melting and radio frequency currents. Under certain conditions it has been found practicable to utilize a portion of the aerial system connected in a two-fold circuit relationship with the remaining portion of the system, as a means of obtaining the desired distribution of the high frequency and sleet melting current. The above feature and other features will be more apparent from the following description taken in connection with the drawings in which;

Fig. 1 represents one embodiment of the invention in a wave antenna system comprising an even number of units or panels;

Fig. 1A shows, symbolically, the impedance transformer and wave impedances;

Fig. 2 represents another specific embodiment of the invention in a uni-laterally directive antenna system consisting of an odd number of exciter-reflector panels;

Fig. 2A shows the manner of connecting the reflector panels of Fig. 2 in parallel with each other; and

Fig. 3 shows still another application of the invention in a four-panel uni-laterally directive antenna and associated transmission system.

In Fig. 1 reference numerals 1 and 2 designate any suitable type of closed antenna unit or panel as, for example, the panels described in my copending application referred to above. In that particular system the vertical elements serve as radiating members and the horizontal elements as transmission lines. All elements except the top and bottom vertical elements are one-half wave length long and the panels are one-half wave length apart. The horizontal elements are so inter-related that radiation therefrom is effectively suppressed. The panels are insulated from the ground by means of insulators 1′.

Reference numerals 3 and 4 represent feeder lines directly connected at one end to panels 1 and 2, respectively, and connected at junction A to the main line 5. The other end of line 5 is connected through an impedance transformer 6 to any type of radio frequency translation apparatus 6′ such as a receiver or transmitter and also to the source of power 7′ for melting the sleet. The impedance transformer is shown in more detail in Fig. 1A and is similar in construction to that disclosed in my copending application referred to above. The current for melting the sleet will hereinafter be referred to as low frequency current and it should be understood that direct current is thereby included since the latter has zero frequency.

Condensers 7 are inserted at junction A in the feeder lines for the purpose of connecting panels 1 and 2 in parallel for the high frequency energy, that is, their capacity is such that low frequency currents are effectively blocked and only high or radio frequency currents are passed. Line 5 is connected to the proper terminals of the two condensers for placing each of condensers 7 effectively in series with a different side of the line and a different panel of the antennæ.

The reference numeral 8 designates a wave impedance, each terminal of which is connected to one side of the line 5 through one of condensers 7. This impedance is symbolically shown in Fig. 1A. It comprises two parallel conductors, preferably copper tubing, an odd multiple of a quarter wave length long and short circuited at the far end hereinafter referred to as the receiver end by means of a solid metallic bar or other suitable connection. Such a line offers substantially infinite impedance to waves of the given frequency, since as pointed out in the above mentioned application, the sending impedance of a quarter wave line is equal to the square of the line surge impedance divided by the terminating or receiver impedance. In the arrangement utilized here the terminating impedance is practically zero and therefore the sending impedance is substantially infinite.

The translation apparatus 6′ is connected through low frequency blocking condensers 8′ to line 5; and low frequency source 7′ is connected to line 5 through a capacitive wave impedance 9′ comprising condenser 10′ and conductors 11′. This wave impedance is similar to that denoted by numeral 8 mentioned above except that its receiver end is short circuited with respect to high frequency energy by means of a condenser instead of a conductive bar.

Referring to Fig. 1A the symbols representing the impedance transformer and the two types of wave impedances discussed above are shown in detail. The impedance transformer is illustrated by means of heavy lines 12′ which represent conductors an odd multiple of a quarter wave length long to the terminals of which are connected the conductors of a transmission line.

When the system shown in Fig. 1 is employed in conjunction with a transmitter, both the low frequency sleet melting current and the radio frequency current are supplied over the main line 5 simultaneously to the system. Assuming that direct current is employed for the sleet melting current it will be seen that the current from source 7′ coming in over one side of the line that is, the side at the right in the figure flows through wave impedance 9′ transformer 6 and thence through one panel, wave impedance 8, the other panel, again through wave transformer 6 and finally back to the source through wave transformer 9′. The blocking condensers 7 prevent it from flowing through the two panels in parallel and condensers 8′ prevent it from flowing to source 6′. The radio frequency current passes through the condensers 8′ and 7 and thence through the two panels in parallel. Because of the infinite impedance of the wave impedance at the frequency employed, practically none of this latter energy passes through impedance 8. Similarly, none of this high frequency energy passes through wave impedance 9′ to source 7′. Obviously, substantially the same distribution of energy is present when the system is utilized for receiving purposes and when the ordinary commercial low frequency current is used for sleet melting purposes.

In Fig. 2 an exciter-reflector three-panel unidirectional antenna system and associated transmission system are shown in which are incorporated other features of the invention. Reference numerals 9, 10 and 11 denote three exciter panels and numerals 12, 13 and 14 the associated reflector panels, which are similar in design to the radiating panels described in connection with Fig. 1. The panels are separated from the ground electrically by means of insulators 2. The reflector is one fourth of a wave length to the rear of and parallel with the exciter. Since it is desirable to supply the same amount of sleet melting energy to all antenna elements and the transmission line a convenient method of effecting this purpose is to connect the panels in series for this type of current, as explained below, although any proper shunt arrangement may be utilized. Similarly, the reflector panels may be connected in parallel as shown in Fig. 2A which is self explanatory, although the preferable manner is in series as shown in Fig. 2. In Figs. 2 and 2A like reference numerals designate elements of similar function.

The main transmission line from the sleet melting power source 18′ and radio frequency transmitting or receiving apparatus 19″ is designated by numeral 15. Numeral 20′ designates low frequency blocking condensers and numeral 21′ a wave impedance comprising conductors 22′ and condenser 23′. At junction B the two condensers 16, one in each side of the line, serve as low frequency blocking condensers. One wave impedance 17 provides a direct current or low frequency path for connecting the reflector panels, which are in series with each other, with the exciter panels which, as explained hereinafter, are also in series with each other. The reference numeral 18 designates a quarter wave line located an even quarter wave length away from junction B and forming in cooperation with high pass condensers 19, 19′ and 20 an anti-resonant circuit for preventing high frequency current from entering the reflector curtain. The distances between impedance 18 and condenser 19′, and between condenser 19′ and each of condensers 20 are each equal to an odd multiple of a quarter wave length, since this is the optimum anti-resonant arrangement. It should be noted here that the wave impedances of the type such as 17, or of the type such as that comprising line 18 and condensers 19, 19′ and 20, are both in series with the active or exciter panels and in shunt to the inactive or reflector panels.

Reference numeral 21 designates a quarter wave line impedance transformer and is utilized here for transforming the parallel load impedance of the exciter panels into the proper surge impedance for terminating the main line 15. The distance between transformer 21 and junction B is an even multiple of a quarter wave length so that the impedance at the sending end of transformer 21 is transferred to junction B without substantial change.

At junction C panels 9, 10 and 11 are connected through condensers 22 in parallel for the radio frequency current and in series for the sleet melting current in a manner similar to that employed in the arrangement of Fig. 1. Panel 10, the odd panel, is used in one sense in place of the wave impedance 8 of Fig. 1, that is, unlike the wave impedance it, of course, does not offer infinite impedance to the high frequency current, although it does provide a means of connecting panels 9 and 11 in series for the sleet melting current. It is obvious that additional exciter panels may be connected to panels 9 and 11, in parallel for both types of current; and that additional reflector panels may be associated in shunt or in series with reflector panels 12, 13 and 14.

The operation of the system shown in Fig. 2 may be described as follows. Both sleet melting current and high frequency energy are conducted over the main line 15. If direct current is employed the sleet melting current from source 18' passes, for instance, through one side of impedance 21', over the left conductor of line 15, through one side of impedance 18, reflector panels 12, 13 and 14, successively, in the order named, through the other side of impedance 18, one side of transformer 21, exciter panels 9, 10 and 11 serially, the other side of transformer 21, wave impedance 17, right conductor of line 15, other side of impedance 21' and thence to source 18'. The radio frequency energy passes through condensers 20' and 16, transformer 21, condensers 22 and then to the exciter panels 9, 10 and 11 in parallel. Practically none of this latter energy reaches the reflector panels because of the anti-resonant circuit in the reflector feeder lines.

In Fig. 3 a uni-laterally directive antenna and transmission arrangement is shown which illustrates one method of employing the invention in a four-panel system. In this figure the source of the radio frequency energy and the source of low-frequency sleet melting current are designated by the reference numerals 23 and 24, respectively. In practice a direct current generator supplying 150 amperes at 1,000 volts has been found suitable for sleet melting purposes in a system such as shown in this figure. The quarter wave line 25 and condensers 26 and 27, the latter condenser being a quarter wave length from the source 24 and from condenser 26, comprise an anti-resonant circuit at the frequency of the energy supplied by source 23. Condenser 27 merely insures a better capacity short-circuit for the radio frequency energy, that is, currents of this frequency leaking past condenser 26 pass through condenser 27. Because of the quarter wave length spacing from condenser 26 condenser 27 is located at the point of maximum leak current flow. Condensers 28 are low frequency blocking condensers which prevent energy from source 24 from interfering with that supplied by source 23 or with the transmitting apparatus.

The reference numeral 29 denotes an impedance transformer employed to obtain the proper terminating impedance for line 30. At junction D three branch lines 31, 32 and 33 are connected to the main line 30, one conductor of each of lines 31 and 33 being conductively connected to opposite conductors of the main line 30, and the other conductor of these lines being associated through one of the low frequency blocking condensers 34 to the remaining opposite main line conductor. Each of the conductors of line 32 is connected to the main line 30 through one of condensers 34.

The branch line 31 serves as a means of supplying radio frequency and sleet melting energy to the exciter panels 36 and 37 and sleet melting energy to the associated reflector panels 38 and 39; in a symmetrical manner branch line 33 supplies energy to exciter panels 40 and 41 and reflector panels 42 and 43. Line 32 is terminated in a wave impedance 35. Reference numerals 44 and 45 designate additional impedance transformers employed for transforming the load impedance at the points indicated into any desired impedance. The panels are supported by messenger wires 46 suspended between antenna towers 47. Insulators 3' and 4' serve to insulate the panels from the ground and messenger wires respectively; and insulators 5' electrically separate the messenger wires from the towers.

In a manner similar to that shown in Figs. 1 and 2 panels 36 and 37 are connected in parallel to each other for high frequency distribution through high-pass condensers 48 and in series with each other and with the serially connected reflector panels 38 and 39 for the distribution of the sleet melting current. It should be noted that the reflector panels are utilized here in place of a wave impedance such as designated 8 in Fig. 1, or an odd panel such as 10 in Fig. 2, as a means of connecting the active panels in series for the sleet melting current. The branch line 31 is connected to condensers 48 in the manner described in connection with Fig. 1. Quarter wave line 49 is shorted by condensers 50, 51 and 52 to form an anti-resonant circuit for the high frequency waves. Condensers 50 and 51, and 51 and 52, are an odd multiple of a quarter wave length apart as explained in connection with the anti-resonant circuit comprising line 25 and condensers 26 and 27, the additional condensers 51 and 52 merely provide a path for the high frequency energy leaking past condenser 50.

In a manner similar to that outlined above exciter panels 40 and 41 are connected to the branch line 33 through condensers 53. These panels are likewise in parallel for the high frequency current and in series with each other and with reflector panels 42 and 43, for the sleet melting current. The reflector panels 42 and 43 are in series with each other. The anti-resonant circuit comprising quarter wave length line 54 and condensers 55, 56 and 57 effectively prevent high frequency current from passing to the reflector and, as in the other anti-resonant circuits described herein, the condensers are preferably an odd multiple of a quarter wave length apart.

The operation of the complete system is obvious from the description given in connection with Figs. 1 and 2 and need not be repeated here in detail. Briefly stated sleet melting direct current from source 24 flows over the bottom side of line 30 shown in the figure, through transformers 29 and 44, panels 37, 39, 38 and 36 in the order named, transformer 44, wave impedance 35, transformer 45, panels 41, 43, 42 and 40 serially, transformer 45 and thence to the opposite side of both transformer 29 and line 30 to source 24. High frequency current flows through condensers at junction D, E and F in parallel to panels 36, 37, 40 and 41, the high frequency energy being effectively prevented from entering the reflector panels.

Although the various features of the invention have been described in connection with one type of wave antenna, it should be understood that the invention is applicable to any transmitting or receiving aerial system including both wave antennæ and other forms of antennæ arrangements and that the invention is not to be limited to the specific embodiments described herein.

It should also be understood that either direct current or alternating current of a frequency lower than the radio frequency current may be successfully used for melting or preventing the formation of sleet on the members of the aerial system.

What is claimed is:

1. In combination, a transmission line, means for supplying high and low frequency currents connected thereto, a plurality of antenna elements connected in parallel across said line, a plurality of low frequency blocking impedances one of which is included between a terminal of one element and one side of the line and another of which is included between a terminal of another element and the other side of the line, and a high frequency blocking impedance included between said terminals.

2. In combination, a transmission line, means for supplying high and low frequency currents connected thereto, a plurality of antenna elements connected across the line, a plurality of low frequency blocking impedances one of which is included in one side of the line between said elements and another of which is included in the other side of the line between said elements and said means, and a plurality of high frequency blocking impedances one of which is included between at least one of the elements and the line and another of which is included conductively in series with said elements and said means.

3. In combination, a plurality of antenna conductors, a source of energy, a second source of energy, the frequency of the energy from the second source being higher than that from the first mentioned source, said conductors being in series circuit with said low frequency source and at least a portion of said conductors being in parallel with each other and in circuit with said second source.

4. In combination, a plurality of antenna conductors, a source of low frequency energy, a translation device, said source being conductively connected to the conductors, said device being connected in circuit with two of these said conductors arranged in parallel with each other, and means for preventing high frequency energy from flowing through the remaining antenna conductors.

5. In combination, a plurality of aerial conductors, a source of low frequency energy, a relatively high frequency translation device, said source being conductively connected to said conductors, said device connected in circuit with at least two of said conductors in parallel and means for preventing high frequency energy from flowing through the remaining conductors comprising a capacitively short-circuited quarter wave length line inserted between the first mentioned and the last mentioned aerial conductors.

6. In combination, a plurality of aerial units, each terminal of each of the said units being connected to the corresponding terminals of the other units through at least one low frequency impedance, a series circuit comprising said units connected in series with each other through at least one high frequency impedance, a high frequency translation device, a source of low frequency power, said device and source connected in series with said series circuit.

7. In combination, an even plurality of antenna panels, a plurality of low frequency blocking condensers, the terminals of each panel being connected through a separate condenser to the terminal of another panel, a high frequency impedance comprising a quarter wave length line whose conductors are conductively joined at one end, a source of low frequency energy, and a source of high frequency energy, said impedance being connected to each panel through one of the said condensers, and said sources being connected to the condensers at opposite points from the impedance.

8. In combination, an even plurality of antenna panels, a plurality of low frequency impedances, the terminals of each panel being connected through a separate impedance to the terminals of another panel, an odd antenna panel being connected directly to one terminal of each of the panels and through one of the impedances to the other terminal of each panel, a source of radio frequency energy, and a source of low frequency energy, said sources being connected to said impedances at points opposite from the odd panel.

9. In combination, an antenna system comprising an exciter and a reflector each comprising a plurality of panels conductively joined, a source of low frequency current, a first circuit conductively connecting said source with the exciter and reflector, a source of high frequency current, a second circuit connecting the exciter panels in parallel with each other and to the last mentioned source, a wave impedance or filter comprising a quarter wave length line having substantially zero terminating impedance being included in series with the exciter panels and in shunt to the reflector panels, and a low frequency blocking condenser included in the second circuit between each two adjacent panels so that the exciter panels are serially connected for low frequency current.

10. In combination, means for removing sleet from an antenna system comprising a low frequency impedance in circuit with a radio transmitter and a wave impedance in circuit with a source of low frequency power, a portion of the antenna being connected through the wave impedance to the source and through the low frequency impedance to the radio transmitter.

11. In combination, a wave antenna system comprising an exciter having an even plurality of closed panels and a reflector, leads connecting the panels in parallel and each including a low frequency impedance element, a lead connecting each terminal of the reflector to a relatively opposite terminal of a different element, a high frequency impedance included in the reflector leads and comprising a quarter wave line capacitatively short-circuited at the end toward the reflector, a transmitter, a source of low frequency power, and common leads from said transmitter and said source each connected to opposite reflector terminals through one of the said elements.

12. In combination, an antenna, a source of high frequency alternating current for energizing said antenna, a source of heating energy for said antenna, means for coupling both of said sources simultaneously to said antenna comprising wire connections, and means for preventing flow of radio frequency current in the connections to the heating source.

13. In combination, an antenna, a translation device, a source of heating energy, means for simultaneously coupling said device and source to said antenna, and means for preventing the flow of radio frequency current in the connections to the heating source when said antenna and source are coupled.

14. In combination, an antenna, a source of radio frequency current therefor, feeders for cou-

pling said source to said antenna, means for neutralizing radiation from said feeders, a source of heating energy, and connections between said last mentioned source and the antenna for supplying heating energy thereto simultaneously with the application of said radio frequency current.

15. In combination, an antenna, a source of radio frequency current therefor, feeders for coupling said source to said antenna, means for neutralizing radiation from said feeders, a source of heating energy, connections between said last mentioned source and the antenna for supplying heating energy thereto simultaneous with the application of said radio frequency current, and means for preventing the flow of high frequency currents in said connections.

16. In combination, an antenna, a source of high frequency energy therefor, feeders coupling the source and the antenna, neutralizers for neutralizing radiation from the feeders, a source of heating energy, and means for connecting the source of heating energy to the antenna and neutralizers for removing frozen deposits therefrom.

17. In an antenna system, a radiating element comprising a pair of radiators, each radiator comprising a pair of wires paralleled for radio frequency currents and serially connected for heating energy, and means for supplying radio frequency energy and heating energy at the same time to the wires.

18. In an antenna system, a source of heating energy, a source of radio frequency energy, a radiating element comprising a pair of radiators, each radiator comprising a pair of wires adapted for simultaneous association with both said sources of energy, said wires being effectively connected in parallel for radio frequency energy and serially connected for heating energy, feeders between said source and said wires, said feeders being arranged so that there is mutual radiation cancelation therefrom.

19. A radio signalling system having, in combination, high frequency apparatus, a plurality of antenna conductors, a source of relatively low frequency heating energy, said conductors being directly connected with said low frequency source, and at least a portion of said conductors being in parallel with each other and in circuit with said high frequency apparatus, and means for preventing the flow of high frequency current in the conductors to the heating source.

20. In combination, high frequency apparatus, a plurality of antenna conductors, a source of heating energy, said conductors being electrically connected to both said high frequency apparatus and said source, and means for preventing the flow of high frequency current in the conductors to the heating source.

21. In combination, two pairs of antenna conductors, a source of heating energy, and a source of high frequency alternating current, said first source being directly connected to said pairs of conductors, said second source being connected in circuit with said conductors arranged in parallel with respect to each other, and means for preventing the flow of high frequency current in the conductors to the source of heating energy.

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