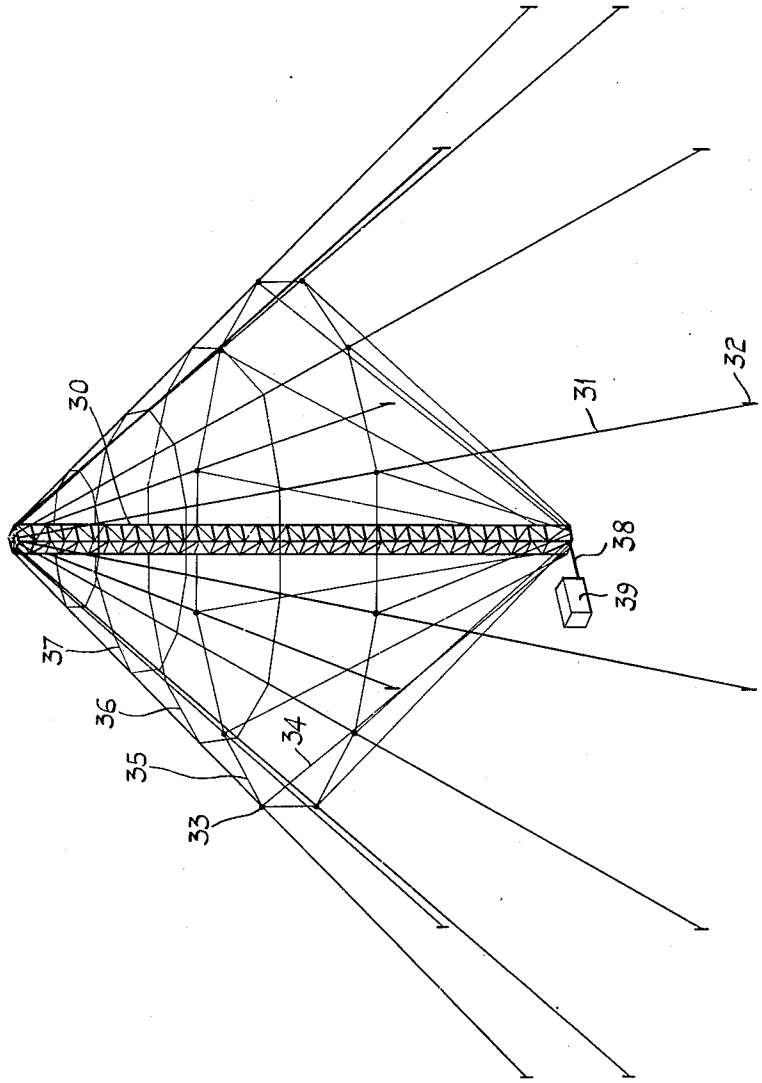
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AERIAL SYSTEM

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AERIAL SYSTEM

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This invention relates to aerial systems and has particular reference to aerial or antenna constructions which find particular utility when employed as radiators of radio frequency energy of relatively long wavelength.

In the radio transmitting art, great difficulty has been experienced in the past in obtaining a reasonably high radiation efficiency. This is for the reason that with antenna constructions employed prior to this invention, it was difficult, if not impossible, to obtain a relatively high radiation resistance. As is well known, the radiation efficiency is equal to the ratio of the radiation resistance to the sum of the radiation resistance, ground resistance and circuit resistance. Since the radiation resistance is proportional to the square of the effective height of the antennae in wavelengths, and since at low frequencies it is impossible to erect a mast or tower which is comparable to a quarter wavelength in height, it becomes impossible with conventional constructions to erect an antenna in which the radiation resistance bears a favourable ratio to the ground resistance. Accordingly, at best, the radiation efficiency of conventional installations is much lower than is desired.

Furthermore, since at low frequencies the height of conventional installations is low as compared with the wavelength of the signals transmitted, the inductance and capacity of the radiator are too low for resonance and a series loading coil must be included in the circuit. This adds additional resistance to the non-radiating parts of the circuit and further reduces the radiation efficiency.

Many prior attempts have been made to improve the radiation efficiency at low frequencies and these attempts have generally taken the form of flat top antennae where a considerable length of radiator is disposed parallel to the surface of the ground. The cost of such constructions is considerably increased, due to the necessity for erecting two supporting towers instead of one. Furthermore, the two towers, not forming part of the radiating structure, absorb energy radiated from the antenna and tend to offset the gains in efficiency to be expected from the flat top construction. Also, where the radiations are to be used for navigational or direction finding purposes, further disadvantages of the flat top construction are found in the non-circular radiation pattern produced, and in the horizontal polarization of the radiation which tends to increase the sky wave difficulties, particularly at night.

It is, therefore, an object of this invention to provide an antenna or radiator for use at relatively low frequencies which overcomes the above noted disadvantages by providing a higher radiation resistance and lower ground resistance than is found in smiple vertical radiators of the same height.

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It is also an object of this invention to provide an antenna of the character described in the preceding paragraph in which an array of radiators is so arranged that the cross-section area of the array increases away from the transmitter.

It is another object of this invention to provide an antenna of the character referred to in the preceding paragraphs which comprises a group of radiating conductors so disposed as to define a conical shape positioned with the apex thereof nearest the ground.

It is a still further object of this invention to provide an aerial system of the character hereinbefore referred to which has a large radiating surface to thereby provide an antenna having high capacity.

It is also an object of this invention to provide an antenna construction of the character hereinbefore referred to which includes a single supporting mast.

It is a still further object of this invention to provide an antenna construction of the character set forth in the preceding paragraphs which is symmetrical in horizontal cross-section to provide a circular radiation pattern.

It is another object of this invention to provide an antenna of the character hereinbefore described in which the current is fed to the radiators in such manner as to provide an effective height greatly exceeding one half of the actual height.

Other objects and advantages of this invention will be apparent from a study of the following specifications, read in conjunction with the accompanying drawings, wherein the single figure is a perspective view of the preferred embodiment of this invention.

Referring to the drawings, there is illustrated an antenna constructed in accordance with the principles of this invention and characterized particularly by the employment of a single mast or tower as the principal element of the supporting structure. This tower, which is shown at **30**, may be of any suitable or conventional construction and is preferably disposed vertically and insulated from ground as by means of suitable tower insulators (not shown), placed between the lower ends of the tower legs and the base structure upon which the tower is erected.

From the top of the tower there are extended a plurality of guys **31**, which are anchored at their outer ends as by means of ground stakes or anchors **32**. Each of the guys **31** is interrupted at approximately the mid point by means of strain insulators **33** so that the upper half only of each of the guy members is associated with the

radiating structure. Auxiliary conductors or feeder lines 34 may be connected to the upper half of each of the guy members 31 at or near the location of the strain insulators 33, each of the conductors 34 being extended to and connected to the lower end of the tower 30. Additional capacity may be provided by means of a plurality of circumferentially extending conductors 35, 36, 37, etc., which are secured to the upper halves of the guys 31 and which are arranged in generally circular form as viewed in plan.

The antenna may be fed by a single lead 38 connected to the base of the mast 30 and extended from a suitable transmitter house or shelter 39 disposed a convenient distance away from the tower.

It will be noted that the invention described herein embodies the principle of providing an array of radiating conductors which are so disposed as to define a conical or semi-conical shape in which the apex of the cone is located nearest the ground. As will be understood, a single vertical wire antenna which is short compared to the wavelengths of the signal to be radiated therefrom has neither sufficient capacity nor inductance to resonate at the frequency desired to be resonated. Such an antenna may be tuned by the addition of a series loading coil, but this reduces the radiation efficiency. Each of the antennae described herein substitutes additional capacity for the series loading inductors, the additional capacity being achieved through the use of a large number of radiating conductors so as to provide a larger surface area. Preferably to increase the surface area and to reduce the resistance due to skin effect, each of the radiating conductors is formed of multi-strand cable or similar high efficiency radio frequency conductor. Additional capacity is included by employing the supporting structure as part of the radiating array. Furthermore, by concentrating a great part of the surface area of the radiating array in that area which is located high above the ground, the effective height of the antenna is increased so as to increase the radiation resistance.

It has been found that with antennae constructed as described herein wherein a large number of paths are provided for the flow of radio frequency current to the high capacity elements of the structure, the current concentration in each of the conductors is such as to place the effective height of the antenna well above the mid point of the actual height. Furthermore the distribution of the lines of force about the structure as a whole appears to be such as to reduce the ground resistance to a value materially lower than that associated with a simple vertical conductor of the same height. The ground resistance is further reduced by using a network of ground conductors which are buried a convenient distance below the surface of the ground and extended radially away from the base of the antenna a distance which is comparable to the height of the structure.

Thus, through an increase in the ratio of radiation resistance to ground resistance, an improvement in radiation efficiency by a factor of six or more is readily obtainable.

It should also be noted that the elimination (or the reduction in size) of the series loading coil required for a single vertical radiator materially reduces the circuit losses and also provides a lower ratio of antenna reactance to transmission resistance, thereby providing a relatively broad tuning antenna. A broadly tuned antenna will efficiently radiate a wider band of frequencies and will also produce smaller phase changes as the result of varying external conditions, an item of considerable importance when the antenna is used in radio navigation and beacon systems operating on the phase comparison principle.

From the foregoing it will be observed that this invention provides a new aerial system which is characterized by high capacity, high radiation resistance, low ground resistance, and low ratio of antenna reactance to radiation resistance. It will also be noted that the construction employed is such as to reduce to a minimum the amount of structure which must be erected, thus providing a definite advantage over the conventional flat top constructions which require a minimum of two supporting towers. It should also be noted that the structure disclosed herein is symmetrical about a vertical centre line and therefore operates to radiate a truly circular field strength pattern.

While there has been shown and described the preferred embodiment of the invention, the invention is not to be limited to any of the details shown or described herein except as defined in the appended claims.

I claim:

1. In an antenna system, the combination of: a supporting tower extending upwardly from the ground surface; a plurality of radiating conductors extending upwardly and outwardly from the lower end of said tower, said conductors being disposed outside of said tower for their entire length; means connected to said tower for holding the upper portions of said conductors spaced from each other and spaced from said tower; means connecting the upper ends of said conductors to the top of said tower; means insulating said tower from ground; and means electrically interconnecting said conductors with said tower.

2. In an antenna system, the combination of: a supporting tower extending upwardly from the ground surface; means insulating said tower from ground; a plurality of circumferentially spaced guys extending from the top of said tower to the ground at points spaced from said tower; an insulator in each of said guys electrically dividing the same into an upper portion and a lower portion; and a plurality of radiating conductors, each extending upwardly and outwardly from the lower end of said tower and each electrically connected to the upper portion of a different one of said guys.

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