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IMAGE LOOP ANTENNA

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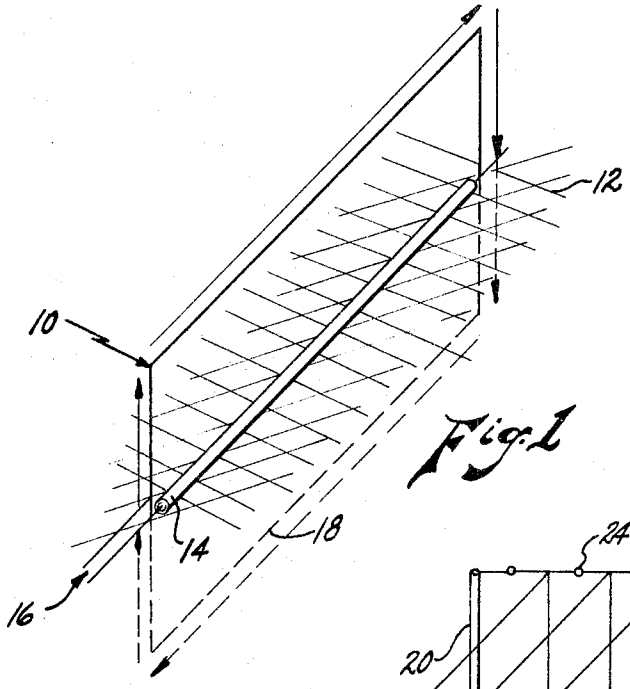


Fig. 1

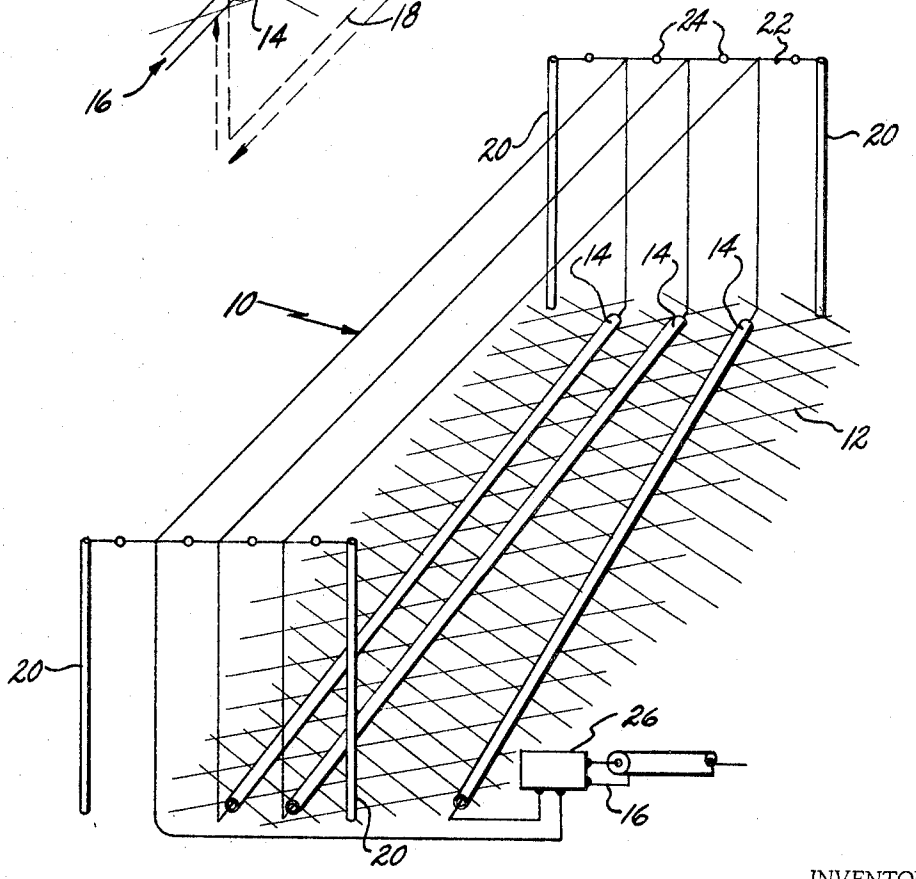


Fig. 2

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IMAGE LOOP ANTENNA

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2 Claims. (Cl. 343—742)

The invention described herein may be manufactured and used by or for the United States Government for governmental purposes without payment to me of any royalty thereon.

This invention relates generally to loop antennas which use the method of images to increase radiation pattern effectiveness and more particularly to a loop antenna which utilizes coaxial conductors bonded to a ground plane for parts of the turns of the loop.

The term "loop antenna" does not ordinarily have a precise definition in that the many, so called, loop antennas, because of their dimensions and arrangement, are now known as slot or transmission line antennas. Present day loop antennas for effectiveness depend, among other things, on the area enclosed by the loop; therefore for maximization of these areas, a circular, square or rectcangular shape is commonly used.

An objective of the loop antenna of this invention is to double the effective area of the antenna, and therefore the gain or aperture by using as parts of the loop the images of the conductors which are above ground. The fourth side of the loop is embedded in a coaxial transmission line in the ground plane of the antenna to shield it from the volume of the antenna field, thereby negating its effectiveness as a radiator, while supplying a continuous circuit for the real antenna current.

Accordingly, it is the primary object of this invention to provide an image loop antenna which has a series of coaxial lines embedded in a conducting ground plane with effectively constant current maintained in the antenna system.

It is another object of this invention to provide an image loop antenna which provides for prevention of conduction of feed current across the ground plane.

It is still another object of this invention to provide an image loop antenna having a number of half-loop turns with a conducting ground plane in order to provide radiation patterns equivalent to those of a loop antenna in free space.

It is a further object of this invention to provide an image loop antenna of relatively small physical size with some directivity in azimuth and with radiation at both low and high angles.

It is a still further object of this invention to provide an image loop antenna with an effective aperture of twice the physical aperture, the antenna being capable of use at very low frequencies with long wavelength.

Another object of this invention is to provide an image loop antenna which is easy and economical to produce of conventional, currently available materials that lend themselves to standard mass production manufacturing techniques.

These and other advantages, features and objects of the invention will become more apparent from the following description taken in connection with the illustrative embodiments in the accompanying drawings, wherein:

FIG. 1 is a schematic representation of a half-loop over a ground plane with the current being shown by arrows and the image loop illustrated by means of a dashed line.

FIG. 2 is a schematic illustration of a practical embodiment of a typical multi-turn image loop antenna for use at frequencies below 100K cycles per second.

For the purpose of demonstrating the theory of the multiple turn loop antenna of this invention, reference may be had to FIG. 1, wherein a single half-loop **10** is shown, which is small in physical extent with respect to a half wavelength of the energy radiated or received and has a far field radiation pattern of toroidal shape with polarization of the radiation parallel to the major circumference of the torus, if the current in the loop is maintained constant throughout its length.

The half-loop antenna, shown in FIG. 1, is placed over a ground plane **12**, and constant current in the loop is aided by the use of a coaxial transmission line **14** on the base leg. The outer conductor of the coaxial transmission line **14** is embedded in or bonded to the conducting ground plane **12**. A terminal at **16** provides for the insertion of energy when the loop **10** acts as a radiator and as a coupler to other circuitry when the antenna is used to receive energy. Doubling of the effective area of the antenna is achieved by utilizing as parts of the loop the images of the above ground conductors. The image loop, illustrated at **18**, forms a part of the entire loop antenna system. The base side of the physical loop, embedded in the coaxial transmission line **14** and the ground plane **12**, is shielded from the volume of the antenna field thereby negating its effectiveness as a radiator. The embedded side of the physical loop also functions to supply a continuous circuit for the real antenna current which is illustrated in the schematic representation of the loop with solid lined arrowheads.

Because of the ground plane **12** and the image **18**, the antenna appears to be a loop consisting of three conductors above ground and three image conductors. The free space radiation then consists effectively of that which results from a loop whose area or aperture is twice the real, physical aperture with current in the same direction with reference to the conductors in all the legs of the real and image loop.

Effectiveness of a loop antenna is increased by using more than one turn for the loop. The same holds true for the image-loop antenna, where any number of radiators may be used as loop turns, provided only that the total loop length is small with respect to a half wavelength. A multiple-turn image loop is depicted in FIG. 2 and includes a practical embodiment of a typical image-loop antenna for use at frequencies below 100K cycles per second. Three turns are shown for illustration purposes, although the number of turns may be varied, the number being limited by the aforementioned parameters. The antenna will result in a far-field radiation pattern which is vertically polarized in azimuth, with relative maxima in both senses in the direction of the plane of the loop, and with pattern nulls perpendicular to the plane of the loop. Radiation overhead is horizontally polarized, in a direction parallel to the plane of the loop.

In the case of the Image Loop Antenna of more than one turn, separate coaxial lines are required between adjacent loops to permit the perpendicular disposition of two legs of the loops with respect to the ground plane, and to transfer the current from one turn to the next. In addition, all coaxial lines are required to be bonded to the ground plane thereby aiding in the maintenance of constant current in the loop and eliminating interference with stray currents.

In FIGURE 2 there are shown four posts **20** which are utilized to support the turns of the rectangular loop **10**. A segmented guy wire **22** extends between the pairs of posts adjacent the vertical legs of the loop and insulators **24** are placed between segments of the guy wire **22** in order to avoid the shorting of one turn of the loop to another. A matching transformer **26** is applied between the feed terminals **16** and the device to be connected to

the loop. For the purpose of illustration only, the height of the posts would be 30 feet from the ground screen **12**, and the length of the longer side of the loop would be 60 feet for operation at a frequency below 100K cycles per second.

Although the invention has been described with reference to a particular embodiment, it will be understood to those skilled in the art that the invention is capable of a variety of alternative embodiments within the spirit and scope of the appended claims.

I claim:

1. A multiple turn image loop antenna capable of use at low frequencies with long wavelengths comprising a series of turns of wire forming a rectangular shaped loop, the length of said loop being small with respect to a half-wavesength, a ground plane, outer coaxial conductors bonded to said ground plane, each of said outer coaxial conductors being disposed around and along a separate

one of the longer legs of each rectangular turn, insulating means insulating said legs of each rectangular turn within said outer coaxial conductor from said conductor, and means for supporting said loop such that the shorter legs of said turns are perpendicularly disposed with respect to said ground plane.

2. An antenna as defined in claim **1** wherein said means for supporting comprises a pair of posts adjacent each end of said rectangle and means secured to said posts and each of said turns for maintaining said turns in a fixed orientation, said last-mentioned means including insulation for electrically insulating said turns from said posts and each other.

No references cited.

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