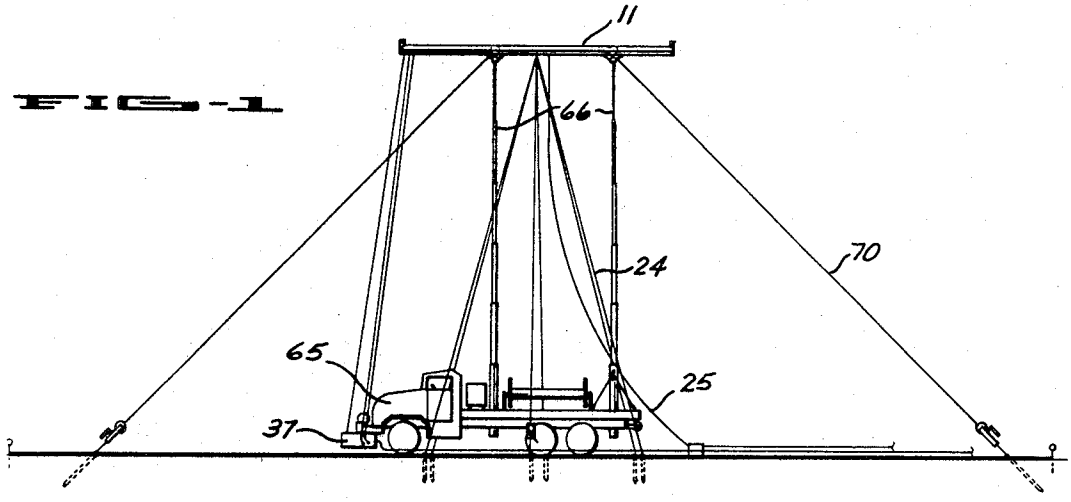
May 21, 1968 K. H. KRIZ 3,384,896

VERTICAL MONOPOLE WITH SPIRAL-SHAPED TOP LOADING

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FIG. 1



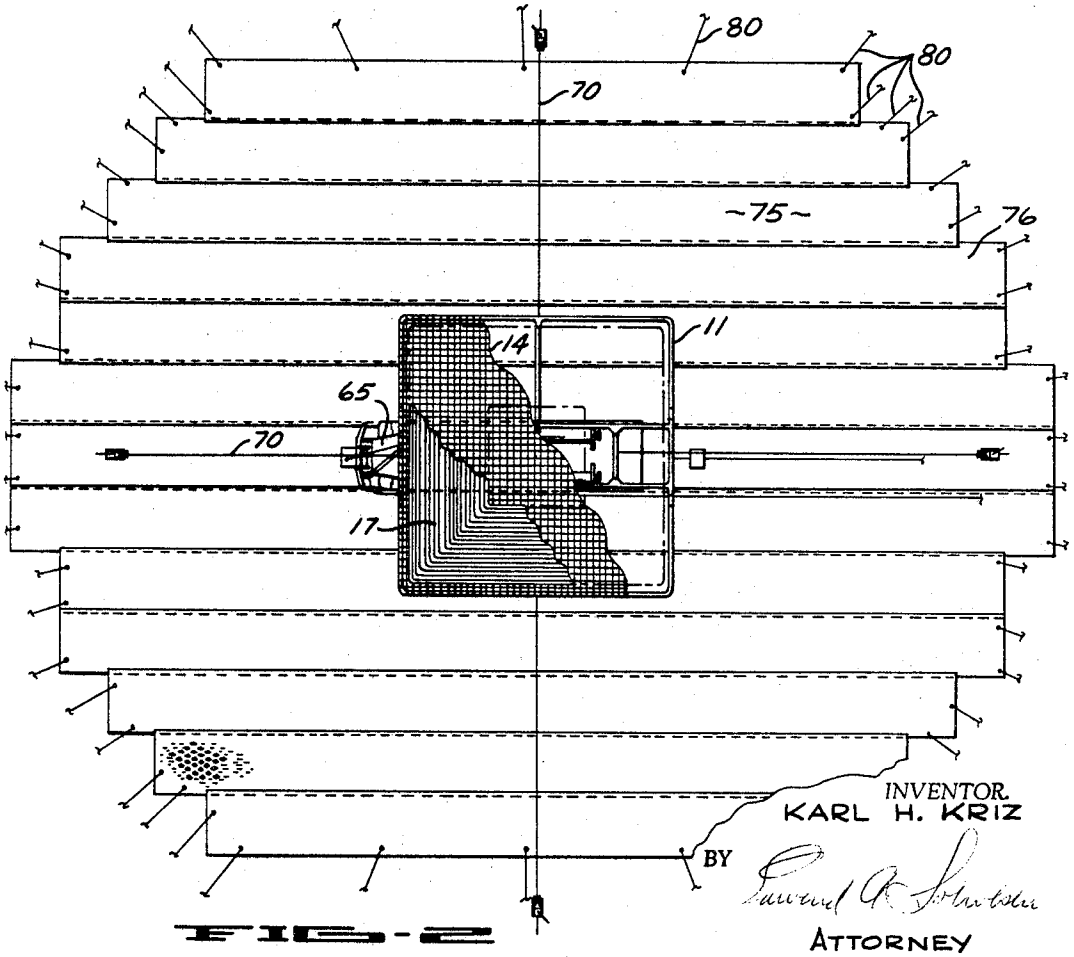


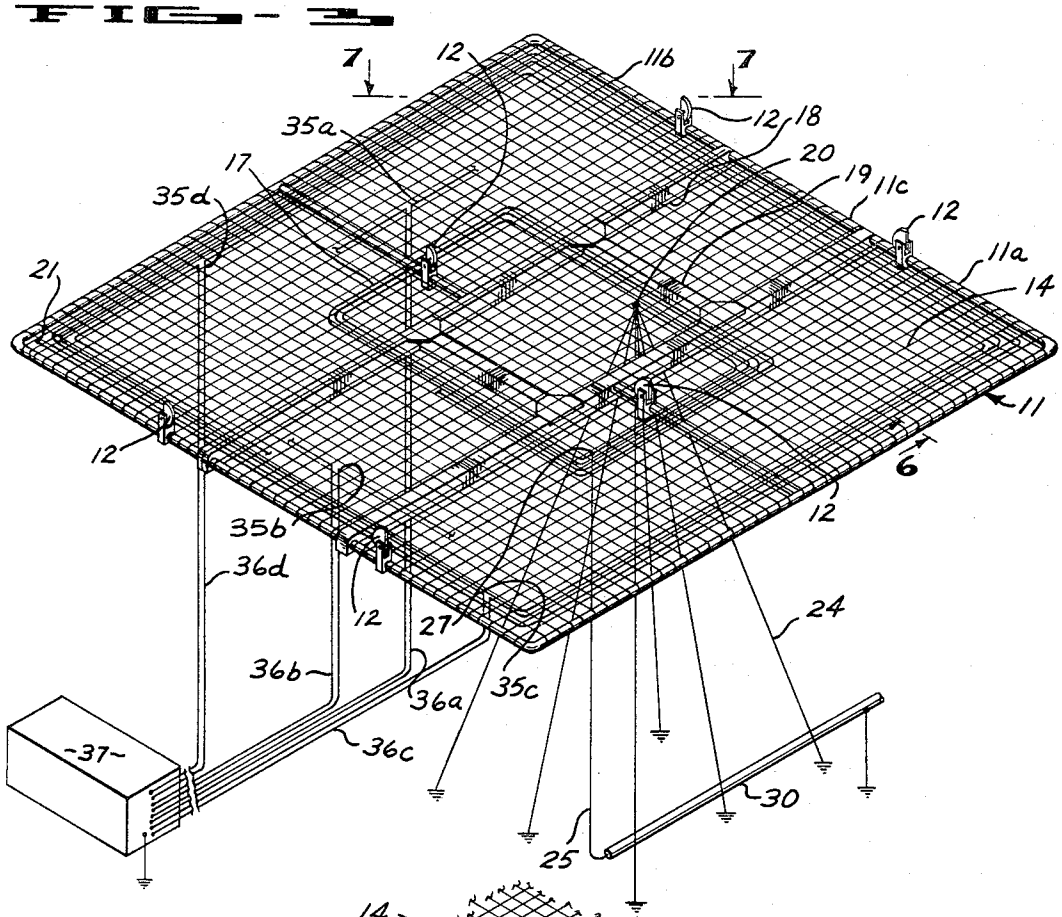
FIG. 2

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VERTICAL MONOPOLE WITH SPIRAL-SHAPED TOP LOADING

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FIG. 3



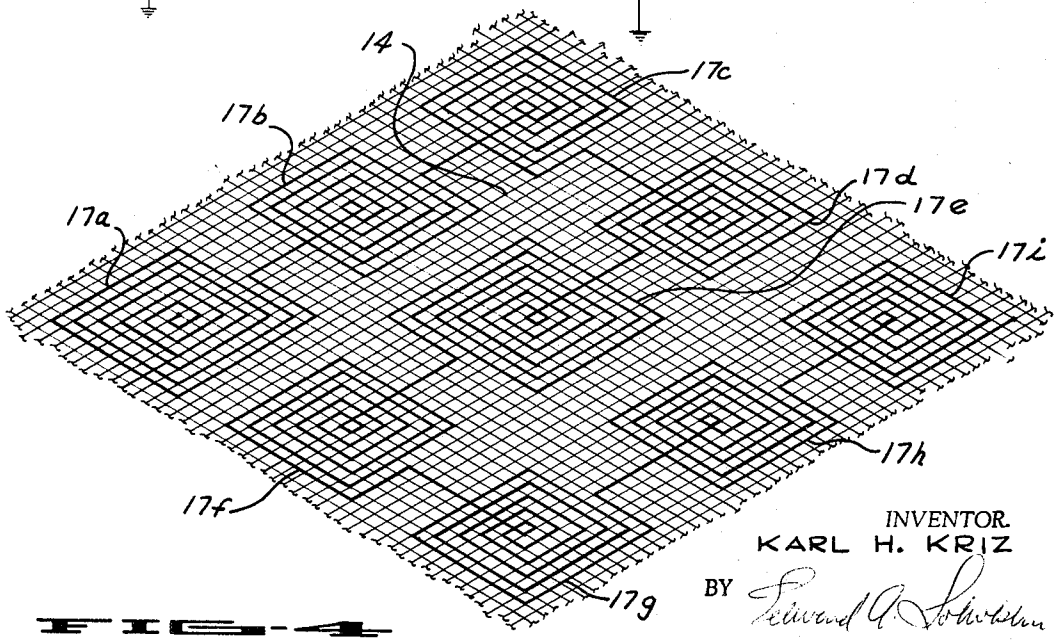


FIG. 4

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VERTICAL MONOPOLE WITH SPIRAL-SHAPED TOP LOADING

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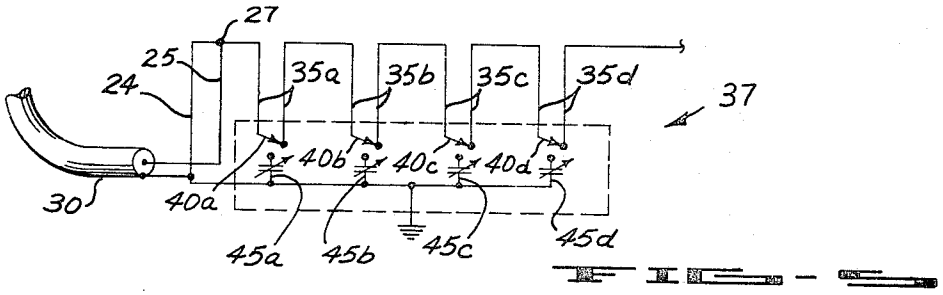


FIG. 1

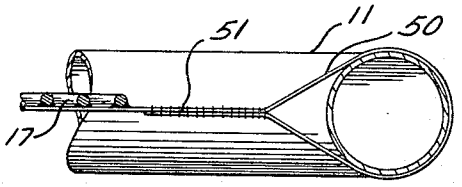


FIG. 3

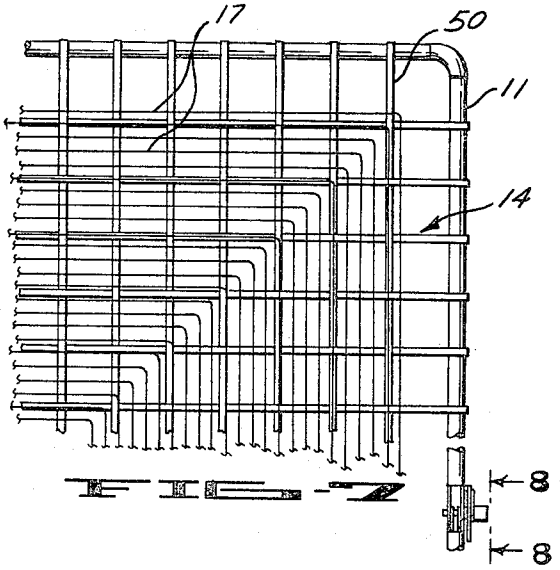


FIG. 2

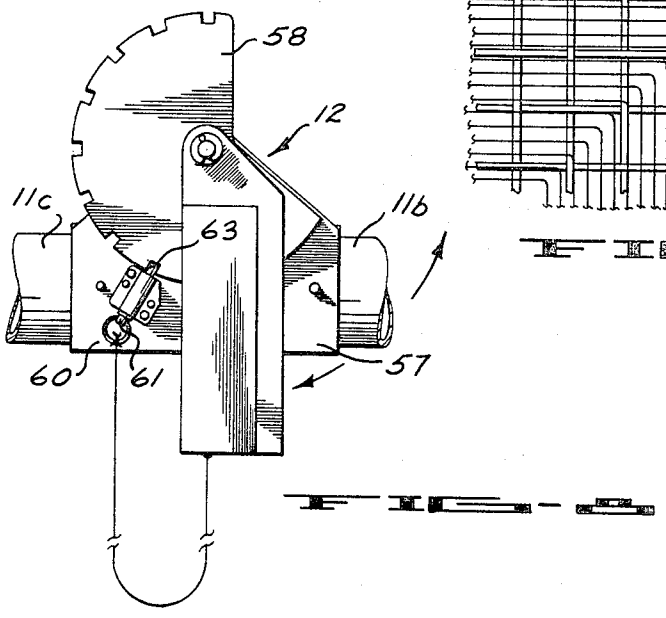


FIG. 4

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United States Patent Office 3,384,896 Patented May 21, 1968

3,384,896

VERTICAL MONOPOLE WITH SPIRAL-SHAPED TOP LOADING

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Filed June 28, 1965, Ser. No. 467,399
14 Claims. (Cl. 343—713)

This invention relates to a top-loaded spiral radio antenna, and more particularly to such an antenna which is readily transportable for field installation.

In receiving and transmitting radio waves at relatively low frequencies, vertical antennas are generally utilized in conjunction with their ground images to generate a strong ground wave which provides the most efficient type of transmission at such frequencies. For optimum results, the vertical antenna should be a quarter-wave length at the operational frequency. Where very low frequencies are involved, the dimensions of a quarter-wave length become so great as to make it impractical to provide a vertical antenna section of such proportions. This problem is especially difficult in situations where the antenna must be set up temporarily in the field and then moved to a subsequent location, as is often the case where field military communication installations are involved. In order to lessen the amount of vertical antenna section that is required, top loading is often utilized in antennas of the prior art. Such techniques sometimes involve the utilization of horizontal sections of antenna which may be folded back on each other so that the total antenna length including the vertical section is equal to the desired quarter wave length. These horizontally oriented antenna sections provide horizontally polarized radiation which does not contribute to the ground wave and therefore provides no useful radiation, all of the effective radiation being provided by the vertical section. The use of the top-loading section, however, brings about a desirable current condition in the vertical section of the antenna and thus provides effective radiation of power therefrom.

When operating at very low frequencies (of the order of 10–2,000 kilocycles) the horizontally oriented top loading section can take on enormous proportions, where vertical lengths which are of the order of only 30–50 feet are permissible. The device of this invention provides a radio antenna particularly suitable for utilization at low and very low frequencies which is readily transportable for erection in the field in a minimum amount of time and with a minimum effort. This end result is achieved by utilizing a top-loading section which is wound in the general configuration of a tight spiral and which is supported on a frame which is foldable for ready transportation. In a preferred embodiment of the invention, the frame is supported on a vertical jacking device which is mounted on a truck and the top loading section may thus be folded and mounted on the truck and then rapidly installed in the field. Means are further provided in the device of the invention to utilize various lengths of the top loading spiral section to make for quarter wave resonance at various frequencies, thus enabling rapid changes of resonant frequency as operational requirements may dictate.

The device of this invention thus enables efficient low frequency antenna operation in the form of a portable type installation, suitable for ready assembly and disassembly in the field.

It is therefore an object of this invention to provide an improved radio antenna utilizing top loading in the form of a generally spiral wound horizontal section.

It is still a further object of this invention to enable more efficient transmission of low frequency radio waves in portable installations.

It is still another object of this invention to provide an efficient low frequency antenna which is suitable for mounting on a vehicle.

It is still another object of this invention to provide a top loaded antenna having relatively high efficiency which is particularly suitable for temporary installations.

Other objects of this invention will become apparent from the following description taken in connection with the accompanying drawings, of which:

FIG. 1 is an elevation view illustrating the device of the invention as installed on a truck,

FIG. 2 is a top plan view of the installation shown in FIG. 1,

FIG. 3 is a perspective view illustrating a preferred embodiment of the device of the invention,

FIG. 4 is a perspective view showing an alternative spiral top loading section which may be utilized in the device of the invention,

FIG. 5 is a schematic view illustrating a tuning device that may be utilized in the device of the invention,

FIG. 6 is a cross-sectional view as taken along the plane indicated by 6—6 in FIG. 3,

FIG. 7 is a partial top plan view illustrating the details of construction of the top-loading member shown in FIG. 3, and

FIG. 8 is a view of the bracket assembly of the support member shown in FIG. 7 as taken along the plane indicated by 8—8 in FIG. 7.

Referring now to FIGS. 3 and 6–8, a first embodiment of the device of the invention is illustrated. Frame member **11**, which is preferably fabricated of a material having a high strength to weight ratio, such as Fiberglas, includes two end portions **11***a* and **11***b* and a central portion **11***c*. End portions **11***a* and **11***b* are pivotally joined to central portion **11***c* by means of hinge members **12**. End portions **11***a* and **11***b* are shorter in width than central portion **11***c* so that they may be folded over on top of the central portion to make for a more readily transportable package.

Strung on frame **11** is web **14** fabricated of a flexible insulating material, such as glass cloth. Wound on webbing **14** and attached thereto by suitable means, such as, for example, nylon stitching or cementing, is top loading antenna section **17** which is wound in the general form of a spiral. The spiral form may be in the general form of a square or rectangle, as shown in FIGS. 3 and 7, or may be in the curved shape of a true spiral. Top loading section **17** thus starts at a point **20** near the center of web portion **14** and winds outwardly in one direction toward the outer portion of web **14** where it finally terminates at point **21**. The wire portions of top loading section **17** are fabricated of a highly conductive electrically conductive material such as copper and are attached to web portion **14** so that the individual windings thereof are adequately insulated from each other to assure that the electrical path formed thereby follows the spiral windings. This end result may be achieved by utilizing wire having an insulated covering thereon.

The starting point **20** of the spiral winding is grounded by means of lines **24**, which provide the vertical section from which the effective radiation occurs. Feed line **25** which couples the antenna to the transmitter or receiver is connected to the spiral windings at point **27**. Point **27** is spaced from point **20** a distance which provides an optimum impedance match which is determined experimentally for each antenna design by techniques known to those skilled in the art. Transmitting and receiving equipment (not shown) is coupled to feed line **25** by means of coaxial cable **30**.

For illustrative purposes, a shunt feeding technique is shown in FIG. 3, i.e., with point **20** connected to lines **24** which are grounded, and feed line **25** connected at a point

27 spaced from point 20. If so desired, however, a series feed can be utilized with feed line 25 connected directly to central point 20 and line 24 eliminated. In this case, of course, feed line 25 will form the radiating element.

In order to enable resonant operation of the antenna at several operating frequencies, the spiral top loading windings 17 are interrupted at points 35*a*–35*d* by dual lines 36*a*–36*d* which run to control box 37. Referring to FIG. 5, control box 37 includes a plurality of switches 40*a*–40*d*, by means of which the total effective electrical length of the spiral top loading section 17 can be changed to provide resonance at various operating frequencies. Control box 37 also has tuning capacitors 45*a*–45*d* for precise tuning of each of the antenna sections. Thus, for example, with all of the switches in the positions indicated, the entire length of the top loading section is utilized providing resonance at the lowest operating frequency. The highest resonant frequency is obtained by closing switch 40*a*, while other operating frequencies may be achieved by means of switches 40*b*, 40*c* and 40*d*. Shunt tuning capacitors 45*a*–45*d* may be utilized to tune the antenna. If so desired, a series tuning capacitor may be added in the top-loading spiral section, such modification being within the capabilities of one skilled in the art.

Central support frame section 11*c* includes beefed up members 18 and 19 to assure proper strength and rigidity of the overall structure.

Referring now to FIGS. 6 and 7, details of structure of the support frame and web portion are illustrated. Web portion 14 includes web strands 50, the ends of which are looped around frame 11 and are stretched on the frame and attached thereto by means of stitching 51. The spiral wire portion 17 is wound on webbing 14 and attached thereto by means of nylon thread, cementing or any other suitable means. It is essential, however, that the individual wires be adequately separated or otherwise insulated from each other so that no short circuiting can occur between adjacent wire sections. This problem may be completely avoided by utilizing insulated wire.

Referring now to FIG. 8, a hinge mechanism utilized in the first embodiment of the device of the invention is shown. Locking plate 58 is fixedly attached to hinge plate 57 which in turn is fixedly attached to frame section 11*b*, while locking pin 61 is fixedly attached to hinge plate 60, which in turn is fixedly attached to frame section 11*c*. Thus, with locking pin 61 released, frame section 11*b* can be folded over onto frame section 11*c*. With frame section 11*b* out in its extended position, the two frame sections are locked in this position by means of locking pin 61 which engages an appropriate slot 63 formed in locking plate 58.

Referring now to FIG. 4, a second embodiment of the device of the invention utilizing a plurality of spiral top loading sections rather than a single such section is illustrated. In this embodiment, rather than utilizing a single spiral section 17, a plurality of small spiral sections 17*a*–17*i* connected in series are utilized. These spiral sections are attached to web portion 14 in the same fashion as single spiral section 17, and may utilize a similar tuning mechanism and coupling to the vertical section as described in connection with FIG. 3. While the single spiral configuration shown in FIG. 3 operates to effectively cancel out horizontally polarized energy, thus assuring that most of the radiation occurs from vertical lines 24, at certain operating frequencies a resonant condition may be set up in this single spiral section which may result in undesirable losses therein. In such instances, the utilization of a plurality of small spiral sections, each of which tends to have a high resonant frequency, as compared to the operational frequency, minimizes the chances of such undesirable resonant effects occurring in the top-loading section.

Referring now to FIGS. 1 and 2, a typical installation of the device of the invention is shown. Frame 11 is mounted on telescoping supports 66. Supports 66 are mounted on truck 65. Hydraulic jacking means (not shown) are utilized to raise and lower support sections 66 so that frame 11 may be lowered down on to truck 65 for transportation. In the installed position, as shown, frame 11 is guyed by means of guy wires 70. A ground plane is provided by means of ground mat 75, over which the antenna frame 11 is positioned. Ground mat 75 may include a series of overlapping strip portions 76 fabricated of copper wire mesh, these strip portions being rolled out so that they overlap each other. The ground mat 75, which forms a ground plane for the antenna, is effectively extended and connected to the earth by means of radially extending wires 80 which are staked into the ground. Thus, as can be seen, a transportable installation is provided which can readily be dismantled and moved to a new location as the situation may demand.

The device of the invention thus provides a comparatively efficient radio antenna which is relatively compact in configuration. This antenna, while ideally suited for use at low operation frequencies, can also be used to advantages on higher frequencies where space and size is a factor. The antenna of the invention is particularly adaptable for a mobile field installation, in which case it can be moved to a new location in a minimum amount of time and with a minimum amount of effort.

While the device of the invention has been described and illustrated in detail, it is to be clearly understood that this is intended by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of this invention being limited only by the terms of the following claims.

I claim:

1. A radio antenna comprising

a vertical antenna section,

a top-loading antenna section connected to one end of said vertical antenna section, comprising a substantially horizontally oriented generally spirally wound wire portion,

means for supporting said top-loading section comprising a frame member, a webbing fabricated of electrically insulating material strung on said frame member, means for attaching said top-loading antenna section to said webbing portion, and means for supporting said frame member substantially horizontally over the ground, and

means for coupling said antenna to a radio frequency device,

whereby said vertical antenna section and said top-loading section as combined resonate at a predetermined operating frequency with substantially all the electromagnetic radiation of said antenna being radiated from said vertical antenna section.

2. The antenna as recited in claim 1 wherein said top-loading wire portion and said webbing are flexible and said frame member is foldable.

3. The antenna as recited in claim 1 wherein said vertical antenna section comprises wire means connected at one end thereof to the internal end of said spirally wound wire portion, the other end of said wire means being connected to the ground.

4. The antenna as recited in claim 3 wherein said wire means comprises a plurality of radially and downwardly extending wires.

5. The antenna as recited in claim 1 and further including means for changing the effective length of said top-loading section.

6. The antenna as recited in claim 5, wherein said means for changing the effective length of said top-loading section includes a plurality of dual wire lines for interrupting said loading section at predetermined points and switch means for selectively connecting the wires of preselected ones of said dual lines together.

7. The antenna as recited in claim 1, wherein said means for supporting said frame member comprises a vehicle and support means mounted on said vehicle for

raising said frame member above said vehicle and lowering said frame member onto said vehicle for transportation.

8. The antenna as recited in claim 1 and further including a wire mesh mat laid on the ground beneath said top-loading section to form a ground plane.

9. The antenna as recited in claim 3, wherein said means for coupling said antenna to a radio frequency device comprises an electrically conductive feed line attached to the spirally wound wire portion at a point which is a predetermined distance from the internal end of said wire portion.

10. A radio antenna comprising

a vertical antenna section,

a top-loading antenna section connected to one end of said vertical antenna section, comprising a substantially horizontally oriented generally spirally wound flexible wire portion,

means for supporting said top-loading section comprising a foldable frame member, a flexible webbing fabricated of electrically insulating material strung on said frame member, means for attaching said top-loading antenna section to said webbing portion, and means for supporting said frame member substantially horizontally over the ground, said frame member including three sections, and hinge means for joining said three sections together in foldable relationship, and

means for coupling said antenna to a radio frequency device,

whereby said vertical antenna section and said top-loading section as combined resonate at a predetermined operating frequency with substantially all the electromagnetic radiation of said antenna being radiated from said vertical antenna section.

11. The antenna as recited in claim 10, wherein said vertical antenna section includes a plurality of radially extending wires attached at one end thereof to the internal end of said spirally wound wire portion and at the other end thereof to the ground.

12. The antenna as recited in claim 11 wherein said means for coupling said antenna to a radio frequency device comprises a feed line connected to said spirally wound wire portion at a point which is a predetermined distance from the internal end thereof.

13. A radio antenna comprising

a vertical antenna section,

a top-loading antenna section connected to one end of said vertical antenna section, comprising a plurality of substantially horizontally oriented generally spirally wound antenna portions, said top-loading antenna portions being connected in series, and

means for supporting said top-loading section comprising a frame member, a flexible webbing fabricated of electrically insulating material strung on said frame member, means for attaching said top-loading antenna portions to said webbing portion, and means for supporting said frame member substantially horizontally over the ground, said frame member including three sections, and hinge means for joining said three sections together in foldable relationship,

whereby said vertical antenna section and said top-loading section as combined resonate at a predetermined operating frequency with substantially all the electromagnetic radiation of said antenna being radiated from said vertical antenna section.

14. The antenna as recited in claim 13 wherein said vertical antenna section comprises a plurality of downwardly and radially extending wire members, one end of each of said wire members being connected to the internal end of said top-loading section, the other ends of said wire members being grounded.

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