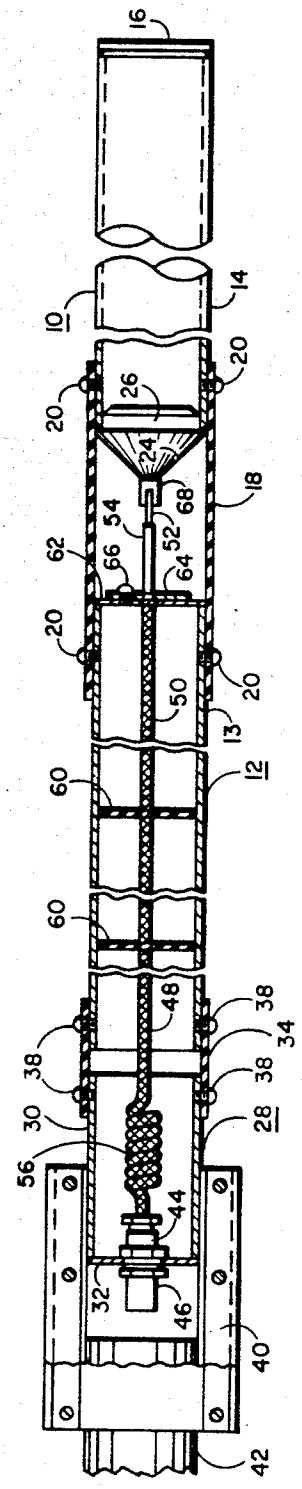
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CENTER FED VERTICAL DIPOLE ANTENNA

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INVENTOR.
JOHN A. KUECKEN

BY

ATTORNEY

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# CENTER FED VERTICAL DIPOLE ANTENNA

John A. Kuecken, Pittsford, N.Y., assignor to General Dynamics Corporation, a corporation of Delaware

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## ABSTRACT OF THE DISCLOSURE

A vertical dipole antenna suitable for installation on a vehicle is disclosed. The antenna is center fed by means of a coaxial cable which extends along the axis of the cylindrical parts thereof. The antenna is ground independent by virtue of a cylindrically shaped control section containing a helically wound coil of the same coaxial cable as feeds the radiating sections of the antenna.

This invention relates to communication antennas, and particularly to VHF and UHF antennas.

Antennas provided by the present invention are especially suitable for use in mobile service and mast mounted applications for either transmitting or receiving purposes.

VHF and UHF antennas of the type known in the art have several disadvantages, particularly when used in mobile service. For example, the current distribution in the usual antenna has a current maximum at the antenna base and the current is coupled to ground or to the structure of the vehicle or craft on which the antenna is mounted. Such coupling wastes power thereby making the antenna inefficient. The coupling also usually is non-uniform about the antenna axis, particularly when the antenna is mounted on an irregular surface, such as a vehicle. Such non-uniform coupling results in a distorted radiation pattern. Various attempts to prevent coupling to ground has lead to simulated ground plane structures, such as wire arrays, disks, or cones which are cumbersome, fragile, or otherwise unsuited for mobile service.

It is an object of the present invention to provide an improved antenna which is independent of ground and the structure on which the antenna is mounted.

It is another object of the present invention to provide an antenna which is small in size, rugged in construction, and low in cost, and which is especially suitable for vehicular or any mobile service.

It is a further object of the present invention to provide an antenna having a radiation pattern, distortion of which by structures adjacent to the antenna is minimized.

It is a still further object of the present invention to provide a communication antenna which is operative over a broad band of frequencies, such as a substantial portion of either the UHF or VHF bands.

It is a still further object of the present invention to provide an improved antenna having radiation pattern, the orientation of which may be selected, say to have a desired orientation with respect to a plane perpendicular to the plane of the antenna.

Briefly described, an antenna in accordance with the present invention includes two radiator sections and a control section which are spaced from each other. A coaxial cable which feeds power to the antenna extends along the sections. The cable is helically wound into a solenoid section which is coupled to the control section. At the upper end of the cable, the inner conductor is connected to one of the radiator sections and the outer conductor is connected to the other of the radiating sections. The control section provides a choke having a higher impedance than the radiator section adjacent thereto. By virtue of the construction and location of the control section, the coupling from the radiating sections to ground or other structure on which the antenna may be mounted is minimized; thus minimizing radiation pattern distortion and enhancing efficiency. Since such coupling is minimized, attendant band width reduction is also minimized and the antenna is operative over a broad band of frequencies. By adjustment of the impedance of the control section, or of its position with respect to the radiator sections, the radiation pattern of the antenna in the vertical plane may be adjusted.



The invention itself, both as to its organization and method of operation, as well as additional objects and advantages thereof will become more readily apparent from a reading of the following description in connection with the accompanying drawing, in which the sole figure is a cross-sectional view of an antenna in accordance with the invention.

As shown in the drawing, the antenna is a vertical dipole having an upper radiating section **10** and a lower radiating section **12**. The upper radiating section **10** is made up of a tube **14** of conductive material, such as aluminum, the top of which is closed by a disk **16**. The disk, which is also of conductive material such as aluminum, may be soldered, staked, or otherwise suitably attached to the tube **14**. In the drawing, the upper end of the tube **14** is chamfered and the disk **16** is soldered to the upper end; the solder filling the gap formed by the chamfer.

The lower section is also a tube **13** of conductive material, such as aluminum. The tubes are separated from, and mechanically coupled to each other by another tube **18** of dielectric material, such as fiberglass or ceramic. The radiating sections **10** and **12**, and the dielectric tube **18** are fastened together by means of screws **20**. As fastened, the sections **10** and **12** are coaxial with each other along a common vertical axis. A conical connector **24** having a cylindrical boss **26** is inserted into the lower end of the tube **14** prior to the assembly of the upper section **10** with the dielectric tube **18**. Fastening techniques, such as soldering, similar to that used to fasten the disk **16** to the tube **14**, may be used to connect the connector **24** to the lower end of the tube **14**.

The antenna also includes a control section **28** which is located below the lower radiator section **12**. A conductive tube **30** of aluminum having a disk **32** fastened to the lower end thereof provides the control section **28**. A tube **34** of dielectric material is disposed in overlapping relation between the opposing ends of the control sections **30** and the lower radiator section tube **13**. Screws **38** fasten the dielectric tube **34** to the tubes **13** and **28**, so as to locate these tubes in coaxial relation along the common vertical axis of the antenna. A clamp type bracket **40** may be used to mount the antenna on a post or mast **42** which may project from a vehicle or other mobile craft or structure on which the antenna is to be used.

Radio frequency power is supplied to the antenna by way of a standard coaxial connector **44** which has an inner conductor insulated from the outer portions **46** thereof. This inner conductor is insulated from the outer portion of the connector **44** which is in contact with the disk **32**. It will be appreciated, of course, that the outer conductor is electrically connected to the mast, and therefore to the vehicle by way of the bracket **40**. Accordingly, the lead or ground side of the transmitter may be connected to the vehicle, while the output terminals of the transmitter are connected through a conventional coaxial cable to connector **44**.

A coaxial cable **48** serves to connect the connector **46** to the feed point of the antenna which is located between the opposing ends of the upper and lower radiating sections **10** and **12**. The coaxial cable **48** may be of conventional design having an outer braid **50** of conductive material and a center conductor **52** which is insulated from the outer braid **50** by a flexible insulating sleeve **54**.

At the lower end of the coaxial cable 48, the outer braid 50 is connected to the outer portion 46 of the connector 44 and the center conductor is connected through the central terminal. After leaving the connector 44, the cable 48 is wound in a plurality of helical turns into a cylindrical solenoid section 56 which is encompassed by the tube 30 of the control section 28 and which is coaxial with the tube 30 along the common vertical axis of the antenna. The control section 56 provides an auxiliary choke of higher impedance than the lower radiating section which effectively isolates the radiating sections 12 and 14 from the mounting structures and ground thereby making the antenna independent of such structures ground and of the disadvantageous coupling effects mentioned above.

The solenoid cable section 56 in the control section provides the advantage of increasing the characteristic impedances of the control choke, since the solenoid has a relatively large inductance per unit length. Since the characteristic impedance is approximately equal to the square root of the ratio of the inductance per unit length to the capacitance per unit length of the cable, the increase of inductance by virtue of the solenoid section 56 increases the characteristic impedance of the control section 28 and therefore of the control choke. Also, the velocity of propagation of the signals through the control section is decreased by such increase in inductance, since the velocity of propagation is proportional to the reciprocal to the square root of inductance per unit length multiplied by the capacitance per unit length of the antenna. Since the velocity of propagation in the control section 28 is decreased, the section may be relatively small in size.

The coaxial cable 48 extends through the lower radiator section 12 and is positioned along the vertical axis by disks 60 of dielectric material. The upper end of the tube 13 is closed by a disk 62 which may be fastened thereto in a manner similar to the manner in which the disk 16 is fastened to the tube 14. The braid 50 is clamped to this disk 62 by means of another disk 64 which is removeably secured to the disk 62 by means of screws 66. The center conductor 52 and its insulating sleeve 54 projects through the disks 62 and 64 and the conductor is connected to the upper radiating section by way of a tab 68 which depends from the conical connector 44. Both the lower radiating section 12 and the upper radiating section 10 may be approximately one quarter wave length long as measured at the center of the band over which the antenna is designed to operate. For example, the sections 12 and 14 may each be twenty inches in length when the antenna is designed to operate over the VHF band. A further advantage of the antenna is that it is broadhanded (i.e., operative over a wide range of frequencies). This broadhanded characteristic is obtained, in part, because of the control section which presents a choke of a high impedance, and of high Q. Thus, energy which would otherwise leak to ground from the radiating portions of the antenna is prevented from so leaking, especially at the resonant frequency of the choke. Since leakage affects over operating frequency range are diminished, the antenna effectively is broadhanded. The operative band is also increased by virtue of the use of relative large diameter tubes which decrease the distributed inductance of the antenna sections and thereby decrease the impedance of the antenna.

Still another advantage of the antenna is that the directivity of the radiation pattern and specifically the pattern in the plane of the E vector may be controlled or steered. The maximum E vector field strength is in the region of the feed point of the antenna. It is desirable that the pattern be steered or tilted somewhat in an upward direction in order to enhance the ability of the communication system to communicate over obstacles and with airborne vehicles (aircraft). In order to steer the pattern, the phase or position of the current standing wave on the lower radiator section 12 may be shifted somewhat by changing



either the number of turns in the solenoid section 56 or by changing the spacing between the lower radiator section 12 and the control section 28, so as to obtain the desired orientation of the radiating pattern with respect to a horizontal plane perpendicular to the vertical plane of the antenna.

From the foregoing description it will be apparent that there has been provided an improved antenna for use in communication systems, particularly in the UHF and VHF bands. The illustrated antenna is made up of relatively large diameter tubular sections, none of which is much more than one quarter wave length long at a frequency in the band in which the antenna is designed to be operated. Accordingly, the antenna is both small in size and rugged, and especially adapted for mobile service. Modifications in the illustrated antenna within the scope of the invention will, of course, become apparent to those skilled in the art. For example, in the event that the illustrated antenna is designed to operate VHF bands, a UHF antenna of design similar to the VHF antenna may be disposed within the confines of the upper radiator section 24. Suitable connections may be made to the upper radiating sections, so that both VHF and UHF energy may be supplied by the coaxial cable 48 and simultaneously to both the UHF and VHF antennas, so that both UHF and VHF signals may be simultaneously transmitted or received by such a combined antenna.

What is claimed is:

1. An antenna adapted to be supported above a grounded structure comprising:
   (a) a radiator portion and a control section physically spaced from said radiator portion, said portion and said section being disposed above said grounded structure,
   (b) a coaxial cable extending from said control section to said radiating section for coupling energy with respect to said radiator portion, and
   (c) said coaxial cable including a solenoid section in the portion thereof disposed within said control section.

2. The invention as set forth in claim 1 wherein said radiator portion and said control section are cylindrical structures spaced from each other and coaxial with each other.

3. The invention as set forth in claim 2 wherein said control portion is a conductive tube and wherein said solenoid section comprises a plurality of turns of said cable and is encompassed by said tube.

4. The invention as set forth in claim 1 wherein said antenna is a vertical dipole, said radiator portion includes a pair of radiator sections spaced from each other and disposed along a common axis, and wherein said cable extends along said axis through said control section and the lower one of said radiator sections, and is connected both to the upper one of said radiator sections and to the lower one of said radiator sections.

5. The invention as set forth in claim 4 wherein said cable is a coaxial cable having an inner conductor and an outer conductor, and wherein said inner conductor is connected to one of said radiating sections and said outer conductor is connected to the other of said radiating sections.

6. The invention as set forth in claim 5 wherein said radiator sections are provided by tubes of conductive material, said upper radiator section being closed by a conductive member at the end thereof which is opposed to said lower radiator section, said lower radiator section being closed at the end thereof opposed to said control section and open at the end thereof which is opposed to said upper section, and said control section being closed by a conductive member at the end thereof opposite from said lower radiator section.

7. The invention as set forth in claim 6 wherein said control and radiator sections are all of the same diameter.

8. The invention as set forth in claim 7 wherein the radiator sections are each approximately one quarter wave length at a frequency in the operating band of said antenna, and wherein said control section is smaller than said one quarter wave length.

9. The invention as set forth in claim 1 wherein said solenoid section has a predetermined number of turns whereby to provide a current maximum in the standing wave pattern on said radiator portion at a predetermined point thereon.

10. The invention as set forth in claim 4 wherein said solenoid section has a predetermined number of turns so that said control section presents a significantly higher impedance than the impedance of the one of radiator sections adjacent thereto.




**References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,059,186 | 10/1936 | Brown | 343—752 |
| 2,580,798 | 1/1952 | Kolster | 343—807 |
| 3,100,893 | 8/1963 | Brueckmann | 343—792 |
| 3,268,903 | 8/1966 | Kuecken et al. | 343—791 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 690,113 | 5/1951 | Great Britain. |
| 1,154,159 | 9/1963 | Germany. |


ELI LIEBERMAN, *Primary Examiner.*

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