

[54] **GROUND INDEPENDENT ANTENNA**
 [75] Inventor: **John A. Kuecken, Pittsford, N.Y.**
 [73] Assignee: **Radionics, Incorporated, Webster, N.Y.**
 [22] Filed: **Sept. 7, 1971**
 [21] Appl. No.: **178,042**

3,358,286 12/1967 Heins 343/898 X
 3,438,042 4/1969 Kuecken 343/792

FOREIGN PATENTS OR APPLICATIONS

929,562 6/1963 Great Britain 343/792
 19,550 7/1956 Germany 343/792
 1,013,723 8/1957 Germany 343/792
 675,096 7/1952 Great Britain 343/860
 494,572 5/1954 Italy 343/831

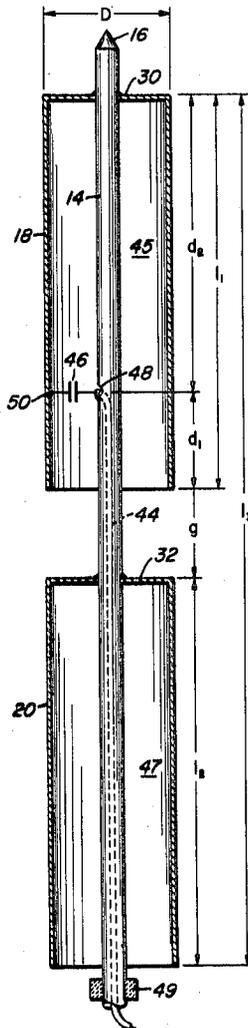
[52] U.S. Cl. **343/790, 343/860**
 [51] Int. Cl. **H01q 9/20, H01q 1/50**
 [58] Field of Search **343/898, 831, 769, 343/790, 791, 792, 722; 333/12**

Primary Examiner—Eli Lieberman
Assistant Examiner—Wm. H. Punter
Attorney—Samuel R. Genca and Raymond L. Owens

[56] **References Cited**
UNITED STATES PATENTS
 2,199,375 4/1940 Lindenblad 343/790
 2,440,081 4/1948 Fick 343/860 X
 2,945,232 7/1960 Vasik 343/769 X
 2,239,909 4/1941 Buschbeck et al. 343/861 X
 2,322,971 6/1943 Roosenstein 333/12
 2,412,640 12/1946 Varian et al. 333/12
 2,624,844 1/1953 Nelson et al. 343/831 X
 2,284,434 5/1942 Lindenblad 343/831 X

[57] **ABSTRACT**
 A ground independent UHF antenna is described which has upper and lower coaxial radiators. The upper radiator provides a coaxial feed cavity presenting both inductance and capacitance so as to provide a broad bandwidth of operation. The lower radiator defines a choke cavity which affords ground independent operation.

12 Claims, 3 Drawing Figures



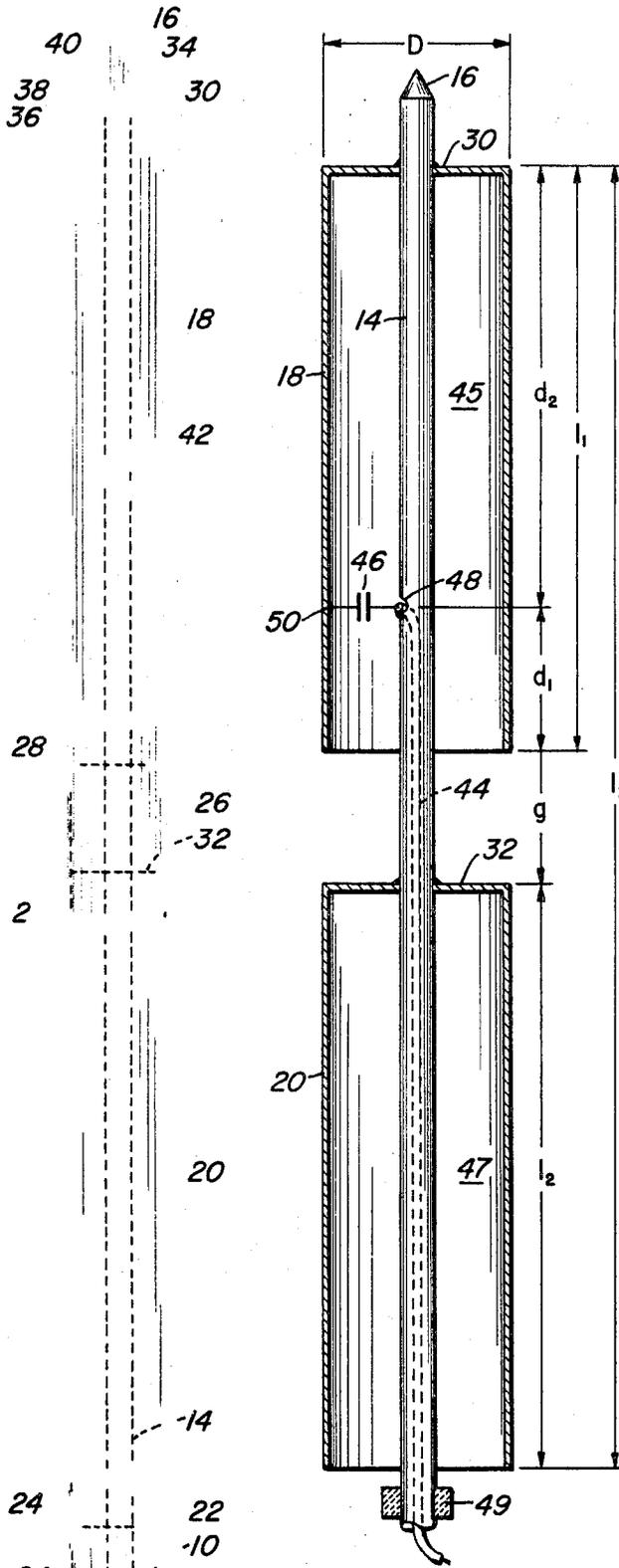


FIG. 1.

FIG. 2.

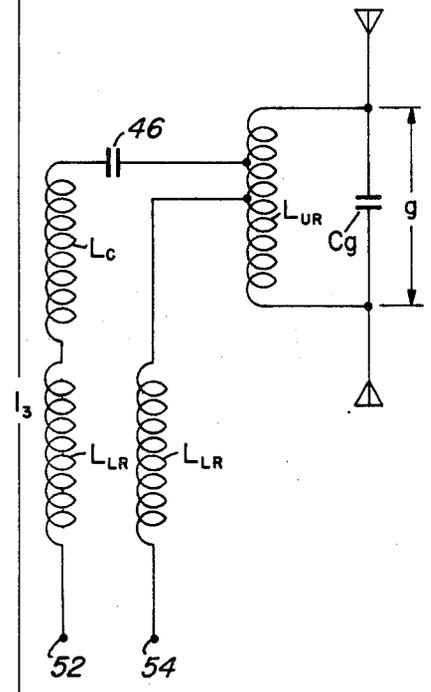


FIG. 3.

INVENTOR.
JOHN A. KUECKEN

GROUND INDEPENDENT ANTENNA

The present invention relates to radio antennas and particularly to an improved ground independent antenna which is operable over a broad band of frequencies.

The invention is especially suitable for use in vertical antennas in the UHF and VHF band for portable and fixed installations. Features of the invention provide means for controlling the frequency band of operation and especially the center frequency of the band so as to optimize performance over desired segments of the band. Thus features of the invention will be found applicable for various antenna designs.

A ground independent antenna has the capability of decoupling the antenna from the ground on which it is mounted, say a feed cable, tower or vehicle, such that the shape of the ground does not substantially affect the radiation pattern of the antenna. Reference may be had to U. S. Pat. Nos. 2,913,722 and 3,438,042 for antennas of the type previously mentioned. Additional features are desired however, without sacrificing the structure of the antenna which affords its ground independent operation. Such features include broad band of operation, lightning or static grounding and facilities for providing lighting and other forms of obstruction warning on the antenna itself. By broad band of operation is meant that the antenna provides a good impedance match and a corresponding low voltage standing wave ratio (VSWR) over a large bandwidth.

Accordingly, it is an object of the present invention to provide an improved antenna.

It is a further object of the present invention to provide an improved ground independent antenna.

It is a still further object of the present invention to provide an improved ground independent antenna which is operable over a broad band of frequencies.

It is a still further object of the present invention to provide an improved antenna which may be constructed or modified to provide a desired center frequency of operation (i.e., a frequency where the impedance presented by the antenna is equal to a certain impedance at the center of its band of operation).

It is a still further object of the present invention to provide an improved ground independent antenna which also serves as a lightning arrester or otherwise for static grounding purposes.

It is a still further object of the present invention to provide an improved antenna readily adaptable to carry lighting fixtures as for warning or obstruction illumination or for carrying other structures above the antenna itself.

It is a still further object of the present invention to provide an improved ground independent antenna which is operable over a large portion of the VHF band or UHF band.

It is a still further object of the present invention to provide an improved ground independent antenna which is sturdy in construction and therefore adapted for portable and vehicular application.

Briefly described, an antenna embodying the invention is of coaxial construction and has a pipe of conductive material which extends the entire length of the antenna. Upper and lower radiators, as in the form of coaxial sleeves, encompass the pipe and form upper and lower coaxial cavities. A signal carrying line, such as a coaxial cable extends upward along the inside of the pipe and through an opening within the confines of the

upper cavity. The line extends across the cavity and into contact with the upper radiator. The upper cavity thereby forms a feed cavity presenting both capacitance and inductance (viz. a parallel resonant circuit).

Signals fed through the line excite antenna radiation currents which are radiated by the upper and lower radiators. The design center frequency is readily selectable by the location of the feed point (viz. where the line emanates from the pipe and extends across the cavity to contact the upper radiator. The upper radiator forms a choke which is effectively shunted across the antenna feed point. The antenna is capacitive below the design center frequency (the first resonance of the cavity). Inasmuch as the cavity is inductive at frequencies below resonance and the antenna is capacitive, while the antenna becomes inductive and the cavity capacitive at frequencies above resonance, the impedance of the antenna as presented to the transmitter or other device which feeds signals to it tends to remain constant over a broad bandwidth. Thus the antenna has a broad band of operation. Other features are also provided by the structure. Specifically, the central pipe can be grounded and forms a static ground suitable for a lightning arrester. Also power cables can be extended through the pipe for lighting such as where warning or obstruction lights are desired at the top of the antenna. The entire antenna is structurally rigid and the central pipe can afford a base for other devices, such as other antennas which may be mounted on top of it or even below it.

The following foregoing other object, advantages and features of the invention will become more readily apparent from the reading of the following description in connection with the accompanying drawings in which:

FIG. 1 is an elevational view of an antenna embodying the invention;

FIG. 2 is a simplified sectional view of the antenna shown in FIG. 1; and

FIG. 3 is a schematic diagram of a equivalent circuit of the antenna shown in FIGS. 1 and 2.

Referring more particularly to FIG. 1, the antenna there shown has a base 10 in the form of a flanged ring. The flange 12 on the ring provides a suitable means for mounting the antenna on a ground plane which may for example be the body of a vehicle or a tower. A pipe 14 extends vertically upward to a pointed upper end 16. This pipe serves as the conduit for the antenna feed cable as well as a lightning arrester. In addition, power cables may be extended through the pipe for obstacle warning or other lighting purposes. The pipe also may serve as a mast for supporting other antennas and the like.

The pipe is made of conductive material, such as steel, and is supported at its lower end in the ring portion of the base 10. A pair of sleeves 18 and 20 are disposed coaxially with the pipe 14. These sleeves may be of conductive material, such as copper. The lower sleeve 20 is connected to the base by a cylinder 22 of insulating material which may be fastened to the sleeve by rivets or screws 24. Rivets or screws similarly fasten the cylinder 22 to the base 10. The cylinder is desirably a strong insulating material, such as nylon. The upper and lower sleeves 18 and 20 are supported in spaced relationship by another cylinder 26 which is fastened to the sleeves 18 and 20 by means of screws or rivets 28. The upper ends 30 and 32 of the upper and lower sleeves 18 and 20, respectively, are closed and may

have tabs 34 extending therefrom which are held tightly against the pipe 14 by means of a clamp 36; a hose type clamp being suitable. A similar clamping arrangement may be provided in case of the top 32 of the lower sleeve 20. In order to provide further support for the sleeves, a bracket 38 which may be welded to the upper sleeve 18, extends upwardly from the top of the upper sleeve. A rod 40 extends between these brackets through the top 16 of the pipe 14 to provide further lateral support for the sleeves.

A cover or bore 42 in the upper sleeve 18 provides access to a region of the pipe 14 from which the feed cable extends (viz. to the feed point of the antenna).

The antenna is shown more diagrammatically in FIG. 2 with the supporting cylinders and brackets and base removed to simplify the illustration. The upper sleeve 18 provides the upper radiator of the antenna while the lower sleeve 20 provides the lower radiator. In addition, the upper and lower sleeves provide coaxial cavities when taken together with the pipe 14. The cavity 45 is formed between the pipe and the upper sleeve 18, and the lower cavity 47 is formed between the pipe and the lower sleeve 20.

The lower cavity provides a choke which affords ground independent operation for the antenna. The upper cavity 45 is a feed cavity. In order to feed the antenna, a coaxial cable 44 having an inner conductor surrounded by a conductive sleeve or shell, preferably a flexible coaxial cable, is extended through the pipe and out of an opening 48 in the pipe. The conductor then extends across the cavity into contact with the outer sleeve or radiator at the feed point 50. A capacitor 46 is included in this connection to the feed point 50 for tuning purposes, as will be explained more fully hereinafter.

The dimensions of the antenna are also depicted in FIG. 2. The gap g is the space between the upper and lower cavities (viz. between the top 32 of the lower sleeve and the open lower end of the upper sleeve 18). The overall length from the bottom of the lower sleeve to the top 30 of the upper sleeve is l_3 . The lengths of the upper and lower sleeves are l_1 and l_2 respectively. The distance from the bottom of the upper sleeve to the feed point is d_1 . The distance from the feed point to the top 30 of the upper sleeve is d_2 . The diameter of the sleeves is D .

It is a feature of this invention that D is relatively large as compared to the diameter of typical antennas, such as whip antennas and the like. D is also large as compared to the diameter of the pipe 14. It is found that D is desirably 0.035 times the wave length at the lower design frequency of the antenna (viz. the lowest frequency of the band over which the antenna is designed to operate). l_1 and l_2 are desirably equal to each other. The ratio d_2/l_1 controls the design center impedance of the antenna. By changing the location of the feed point 50, the design center (or nominal) impedance may be readily varied. The gap g tends to control the upper frequency limit of the band over which the antenna may operate while the overall length l_3 controls the lower frequency limit of the band. By virtue of the large diameter D , the end impedance of the antenna is relatively low thereby enhancing the depth of the current minimum at the lower end of the antenna and making the antenna more ground independent. If desired, a ferrite ring 49 may be located below the lower end of the sleeve 20, to further reduce the end

impedance and enhance ground independent operation.

Inasmuch as the diameter D is large, the inductance of the center conductor extended across the cavity 45 is relatively high and is desirably tuned out through the use of the capacitor 46.

The equivalent circuit of the antenna as shown in FIG. 3 is viewed from the driving or output terminals 52 and 54 of the transmitter which drives the antenna. The coil L_{LR} represents the inductance seen at the driving terminals and presented by the lower cavity 47. This inductance L_{LR} is shown connected to the outer conductor or shell of the cable, inasmuch as the cable outer shell is conductively connected to the pipe 14 as at the opening 48. The inductance L_C across the upper cavity 45 is tuned out by the capacitor 46. The upper cavity or upper radiator provides a choke represented by the inductance L_{UR} . The feed is effectively connected across this choke; the center conductor being effectively connected at one tap on the choke (the outer sleeve or radiator 18) while the outer conductor is connected to another tap point on the choke (at the feed pipe opening 48). The choke or upper cavity is shunted across the antenna feed point and is represented by the parallel circuit L_{UR} and C_σ . The antenna is capacitive below the design center frequency (viz. frequency where the cavity is in resonance). As noted above the impedance presented by the cavity and by the antenna changes above and below the design center frequency. The cavity becomes capacitive above the design center frequency and stays inductive below the design center frequency. The impedance presented by the antenna varies conversely. Therefore, over which the antenna can operate with reasonably good match to the driving circuits is relatively broad.

For example, a UHF antenna provided in accordance with the invention had a VSWR of less than 2.5:1 from 300 MHz to 800 MHz and a VSWR of less than 3:1 from 200 MHz to 900 MHz. The dimensions of this exemplary antenna are as follows: l_3 was $17\frac{1}{4}$ inches ($0.438 \times$ the wave length at the 300 MHz); D is 1.375 inches or ($0.035 \times$ the wave length at the 300 MHz); g is 1.25 inches; d_1 is 1.625 inches and l_1 and l_2 are 8 inches. The impedance at the design center frequency is 50 ohms.

From the foregoing description it will become apparent that there has been provided an improved antenna which affords ground independent operation as well as features of broad bandwidth, flexibility of impedance matching, sturdy construction, and facilities for lightning arresting and illumination. Variations and modifications in the herein described antenna will undoubtedly suggest themselves to those skilled in the art. Accordingly, the foregoing description should be taken merely as illustrative and not in any limiting sense.

What is claimed is:

1. In a ground independent UHF antenna, the combination comprising:
 - a. a conductive pipe;
 - b. upper and lower radiators disposed around said pipe and spaced from each other to form upper and lower coaxial cavities and defining upper radiator inductance and lower radiator inductance L_r respectively;
 - c. a line for carrying signals, said line being disposed inside said pipe and extending upwardly along said pipe into said upper cavity, said line also extending

5

6

across said upper cavity and being connected to said upper radiator and defining an unbalance inductor Lc said line connection being selected to obtain a desired characteristic impedance for the antenna and

d. a capacitor disposed in said line and coupling said upper cavity and having a capacitance selected to substantially tune out said unbalance inductance Lc of said line.

2. The invention as set forth in claim 1 wherein the connection to said upper radiator is at a point along the length of said upper radiator such that the ratio of the distance between said point and the upper end of said upper radiator and the length of said upper radiator corresponds to the desired impedance of said antenna at the center of its operating band.

3. The invention as set forth in claim 1 wherein said line is a coaxial cable.

4. The invention as set forth in claim 3 wherein said cable has an inner and outer conductor, and opening in said pipe out of which the center conductor of said cable extends across said cavity to said upper radiator, said outer conductor being connected to said pipe.

5. The invention as set forth in claim 4 wherein the

connection between said outer conductor of said cable and said pipe is at said opening.

6. The invention as set forth in claim 1 wherein said radiators are sleeves of conductive material coaxial with said pipe and having a disc shaped upper ends connected to said pipe.

7. The invention as set forth in claim 6 wherein said pipe extends through the disc at the upper end of said upper radiator sleeve.

8. The invention as set forth in claim 1 wherein the spacing between said upper and lower radiator defines a feed gap for said antenna.

9. The invention as set forth in claim 8 wherein said feed gap is approximately one-fifth the length of said individual radiators.

10. The invention as set forth in claim 9 wherein said radiators are of equal length.

11. The invention as set forth in claim 1 wherein the diameter of said radiators is relatively large.

12. The invention as set forth in claim 11 wherein said radiator diameter is approximately 0.035 times the wave length at the lower end of the band of frequency over which the antenna operates.

* * * * *

25

30

35

40

45

50

55

60

65