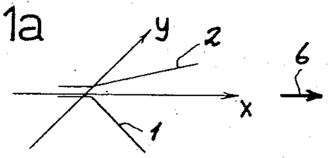
Aug. 22, 1967 K. E. CASSEL 3,337,873

DIRECTIONAL ANTENNA COMPRISING AN INCLINED NONREFLECTING RADIATING ELEMENT AND VERTICAL COUNTERPOISE

Filed March 20, 1964

Fig. 1a



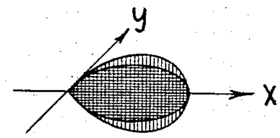
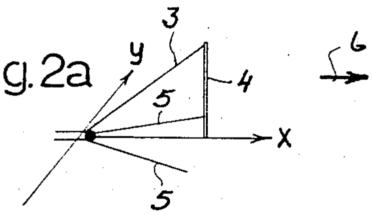


Fig. 1b

Fig. 2a



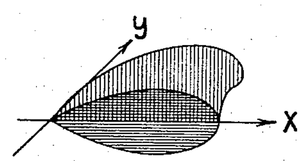
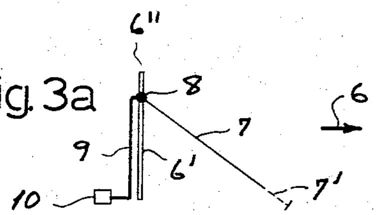


Fig. 2b

Fig. 3a



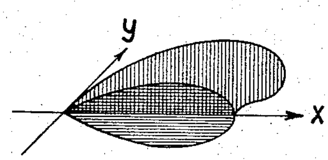


Fig. 3b

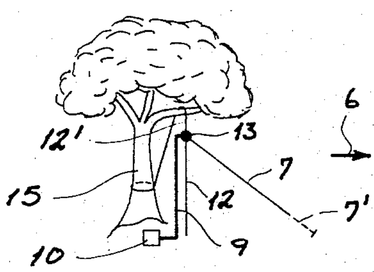


Fig. 4a

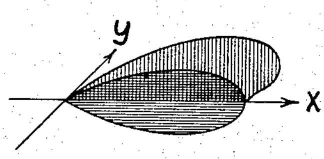


Fig. 4b

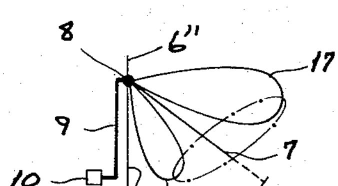


Fig. 5a

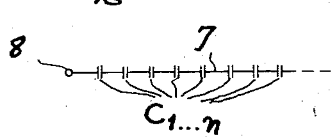


Fig. 7

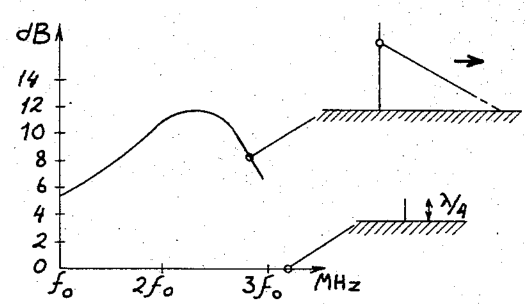


Fig. 6

Knut E. Cassel
INVENTOR.

BY

Karl G. Ross
Attorney

United States Patent Office

3,337,873
Patented Aug. 22, 1967

3,337,873
DIRECTIONAL ANTENNA COMPRISING AN INCLINED NONREFLECTING RADIATING ELEMENT AND VERTICAL COUNTERPOISE

Knut Erland Cassel, Djursholm, Sweden, assignor to Allgon Antennspecialisten A/B., Akersberga, Sweden, a corporation of Sweden

Filed Mar. 20, 1964, Ser. No. 353,460
Claims priority, application Sweden, Mar. 22, 1963, 3,131/63
5 Claims. (Cl. 343—731)

My present invention relates to a directional antenna, either a stationary antenna or one adapted to be used with portable equipment for the transmission or reception of radio waves.

The general object of this invention is to provide an antenna of this description which has a well-defined directive pattern and an exceptional large bandwidth.

Another object of this invention is to provide an easily mountable antenna which, in addition to satisfying the aforestated requirements, can be rapidly assembled or disassembled at selected locations and can be readily stored in a compact, wrapped-up state.

A more specific object of my invention is to provide an antenna of this character which does not require any ground system.

I have found, in accordance with the instant invention, that the foregoing objects can be realized by a simple antenna consisting essentially of a downwardly inclined antenna conductor of a type which is substantially reflection free and a feeding point at a location whose height above the lowest point of the antenna conductor exceeds half a wavelength of the high-frequency energy to be radiated or picked up by the antenna. The antenna conductor is inclined to the horizontal at an angle ranging between 25° and 45° and is arranged in a vertical plane which is directed to a conjugate (e.g. receiving) station.

Moreover, the antenna according to a more specific feature of my invention should be provided with a counterpoise represented by a linear conductor which extends substantially vertically from the ground upwardly to the feeding point.

A further embodiment of the invention comprises an extension of the counterpoise beyond the feeding point. This extension can have a length equaling a fraction of the height of the feeding point above ground, e.g. one-fifth of this height or more. This upward extension of the counterpoise, I have found, is useful for influencing the horizontal directive pattern in a vertical plane.

The invention will be described in greater detail with reference to the accompanying drawing in which:

FIG. 1*a* is a perspective view of an antenna of V type;

FIG. 1*b* is a perspective radiation pattern of the antenna of FIG. 1*a*;

FIG. 2*a* is a perspective view of an antenna of half V type;

FIG. 2*b* is a perspective radiation pattern of the antenna of FIG. 2*a*;

FIG. 3*a* is a partly diagrammatical elevational view of a directional antenna representing a first embodiment;

FIG. 3*b* is a perspective radiation pattern of the antenna of FIG. 3*a* in the presence of a ground surface;

FIG. 4*a* is a view similar to FIG. 3*a*, illustrating a second embodiment;

FIG. 4*b* is a perspective radiation pattern of the antenna of FIG. 4*a*;

FIG. 5*a* shows a free-space radiation pattern of the antenna of FIG. 3*a* in a vertical plane;

FIG. 6 is a graph showing the antenna gain of the antenna FIG. 3*a*; and

FIG. 7 diagrammatically illustrates a nonreflective antenna conductor to be used in the antennas of the preceding figures.

In FIG. 1*a* I have shown an antenna of known construction of so-called V type having two antenna elements **1** and **2** forming an angle with each other and arranged in a horizontal plane. The antenna elements **1**, **2** are reflection free, i.e. their impedance value increases progressively in the direction from the feeding point to the outer end of the element.

The radiation patten of the antenna of FIG. 1*a* in the direction of the arrow **6**, shown in FIG. 1*b*, closely conform to a lobe that is approximately symmetrical with respect to the X-axis of the pattern. This antenna, however, has the disadvantage that it must be mounted at three points high enough above ground, i.e. the antenna in most cases needs three support masts.

In another known antenna construction as shown in FIG. 2*a*, the so-called half-V type, a non-reflecting antenna element **3** is inclined upwardly from a feeding point on the ground to an elevated fastening point at the upper end of a mast **4**. A grounding system consisting of three conductors **5** is placed on the soil under the antenna elements **3**.

The radiation pattern of this antenna, as shown in FIG. 2*b*, can be regarded as a lobe halved by the ground plane. This antenna already represents an essential improvement compared with the antenna of FIG. 1*a* but the antenna still suffers from heavy drawbacks by reason of the fact that the mast **4** must not influence the radiation field of the antenna element, i.e. that the mast is to be constructed of insulating material of a low dielectric constant and, moreover, that a special ground system is needed.

In FIG. 3*a* I have shown a transportable transmitting or receiving station with a directional antenna comprising a preferably grounded mast **6'**, e.g. of steel, which at an elevated location is provided with a feeding point **8** for feeding a downwardly inclined antenna conductor. Mast **6'**, acting as a counterpoise for the conductor **7**, has an extension **6''** rising above feeding point **8** for a distance equal to about one-fifth of the height of point **8** above ground. A transducer for high-frequency waves, i.e. a radio transmitter or receiver **10**, is connected to the feeding point **8** via a nonradiating feeder **9**, e.g. a coaxial cable. The lower end of conductor **7** lies at a level whose distance from the level of point **8** is greater than $\lambda/2$ where λ is the operating wavelength. Conductor **7** is anchored to the soil by any suitable means, e.g. with the aid of a nonconductive rope **7'** fastened to the conductor end and secured to the ground by any suitable means.

The conductor **7**, which is free from reflection, has an impedance which increases progressively from junction point **8** to the outer end of conductor **7**. Such a conductor may comprise, e.g. as disclosed in Swedish Patents Nos. 133,888 and 137,026, a series of built-in condensers $C_{1 \ldots n}$ of progressively decreasing capacitance, as illustrated in FIG. 7.

FIG. 5*a* shows the radiation pattern of antenna **7** in the vertical plane. This pattern will exist when the antenna arrangement of FIG. 3*a* is located in free space, i.e. remote from ground. It will be seen that the vertical-plane aspect of the pattern comprises a major lobe **17** and a minor lobe **16** on opposite sides of conductor **7**, the lobe **17** being generally horizontally directed whereas the lobe **16** is directed downwards. The presence of counterpoise extension **6''** causes a lengthening of lobe **17** and a foreshortening of lobe **16**. The entire pattern in the space naturally has roughly the shape of a beveled hollow cone with a generally conical inner surface whose axis substantially coincides with the conductor **7**.

When the antenna system **7**, **6'**, **6''** is disposed directly above ground, as in FIG. 3*a*, the result is a pattern as shown in FIG. 3*b*. The vertical pattern appears lengthened in conformity with the lengthening of the lobe **17** in FIG. 5*a*.

In FIG. 6 I have shown the amount of antenna gain of antenna **7**, in decibels, plotted against frequency. The reference value of 0 db represents the signal of a gauging oscillator provided with a pole antenna in the form of a vertical quarter-wavelength conductor extending from a ground plate. It will be seen that the antenna gain amounts to about 5.5 db at the frequency f_0, rises to approximately 12 db in the region of the frequency $2.3f_0$ and returns to about 6 db near the frequency $3f_0$, the bandwidth thus extending over 1½ octaves.

The modified antenna system shown in FIG. 4*a* will be particularly useful for the temporary installation of an aerial on terrain providing a support such as a tree. The conductor **7** is anchored to the soil in the same manner as before and is connected to a feeding point **13** which in turn is connected to a feeder **9**. The mast **6'** of FIG. 3*a* has been replaced by a grounded wire **12** representing the counterpoise and having an upward extension **12**; the wire being attached to a nonconductive rope **15** slung over a supporting branch of the tree and tied to the trunk thereof while feeder **9** again leads to transmitter or receiver **10** from feeding point **13**.

The pattern of the antenna of FIG. 4*a* is shown in FIG. 4*b* and will be seen to differ only slightly from the pattern of FIG. 3*b*, the difference being due to the reflecting action of the tree. The deviation of the two patterns from each other is small.

The antenna of the invention has the following advantages. The mast **6'** or the counterpoise wire **12** as well as the feeder **9** will not be influenced by the radiation of the antenna, thus making it possible to use a mast of steel or a tree as a support without risk of disadvantageously affecting the radiation pattern of the antenna. As the mast **6'** or the counterpoise wire **12** serves as grounding means for the transmitter or receiver, a special ground system or an additional grounding is not necessary. Moreover, as the center of the current area of antenna conductor **7** will be nearer to the feeding point **8** or **13** than to the outer end point of conductor **7**, especially at lower frequencies within the bandwidth of the antenna, the antenna will have a greater effective antenna height or, in other words, the height of the mast will be better utilized. Moreover, the center of radiation lies at an approximately constant level above ground for all frequencies within the bandwidth. Thus, the antenna will vary but slightly with frequency.

Modifications of the specific embodiments described and illustrated are possible; for instance, the counterpoise

12 of FIG. 4*a* can be omitted, thereby impairing the efficiency and the radiation pattern of the antenna according to the invention only to a minor extent. Moreover, the transmitter or receiver can be placed at the feeding point, thus eliminating the feeder.

I claim:

1. A directional antenna associated with a transducer for high-frequency wave energy, comprising a substantially nonreflecting elongated conductor extending inclinedly downwardly, at an angle of 25° to 45° with reference to the horizontal, from a location elevated above ground by more than half a wavelength at the operating frequency of said transducer, shielded conductor means forming a junction with said conductor at said elevated location and extending from said junction to said transducer, insulating anchor means for the lower end of said nonreflecting conductor, and an elongated conductive counterpoise extending substantially vertically upwardly from ground to said junction and coupled thereat to said nonreflecting conductor to form therewith an asymmetrical structure.

2. An antenna as defined in claim **1** wherein said counterpoise extends upwardly beyond said junction for a distance of at least one-fifth of the height of said elevated location above ground.

3. An antenna as defined in claim **2** wherein said counterpoise comprises a wire mechanically linking said conductor with an overhead support.

4. An antenna as defined in claim **1** wherein said counterpoise is a mast.

5. An antenna as defined in claim **1** wherein said nonreflecting conductor includes a series of spaced-apart condensers whose capacitance progressively decreases from said junction.

References Cited

UNITED STATES PATENTS

2,208,749	7/1940	Cork et al.	343—731
2,239,724	4/1941	Lindenblad	343—791 X
2,712,602	7/1955	Hallen	343—731 X
2,998,604	8/1961	Seely	343—875 X
3,189,906	6/1965	Kulik et al.	343—890 X
3,191,177	6/1965	Parzen	343—873 X

OTHER REFERENCES

The A.R.R.L. Antenna Book, The American Radio Relay League, Inc. Connecticut, 1956, pp. 104–105.

ELI LIEBERMAN, *Primary Examiner.*

HERMAN KARL SAALBACH, *Examiner.*

M. NUSSBAUM, *Assistant Examiner.*