

Aug. 6, 1957

W. BERNDT

2,802,210

TUNED DIPOLE TYPE ANTENNA

Filed May 23, 1955

2 Sheets-Sheet 1

FIG. 1 FIG. 2

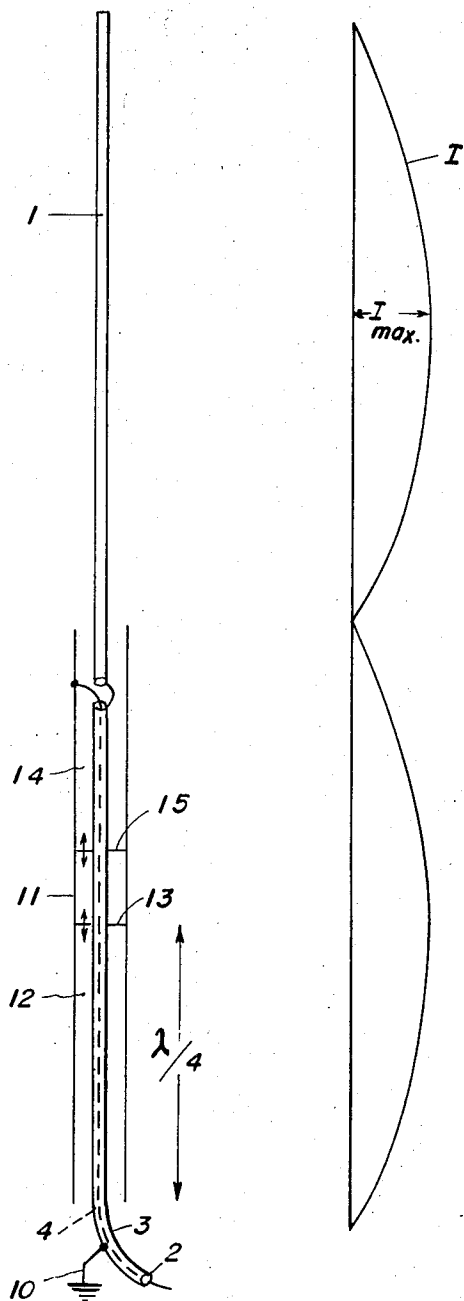
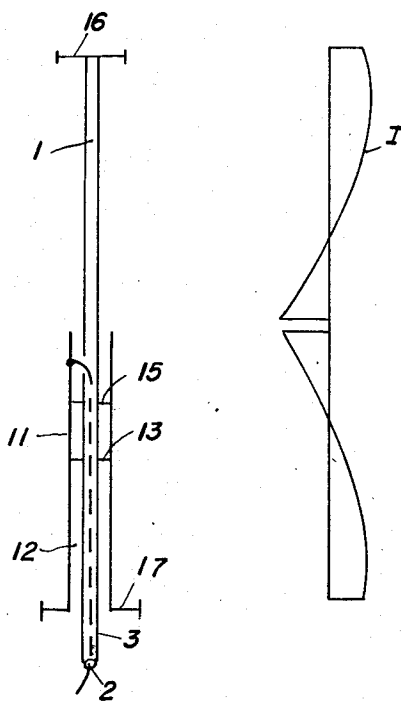


FIG. 3

FIG. 4



WALTER BERNDT INVENTOR

BY *Emil D. Munkel*
PATENT AGENT

Aug. 6, 1957

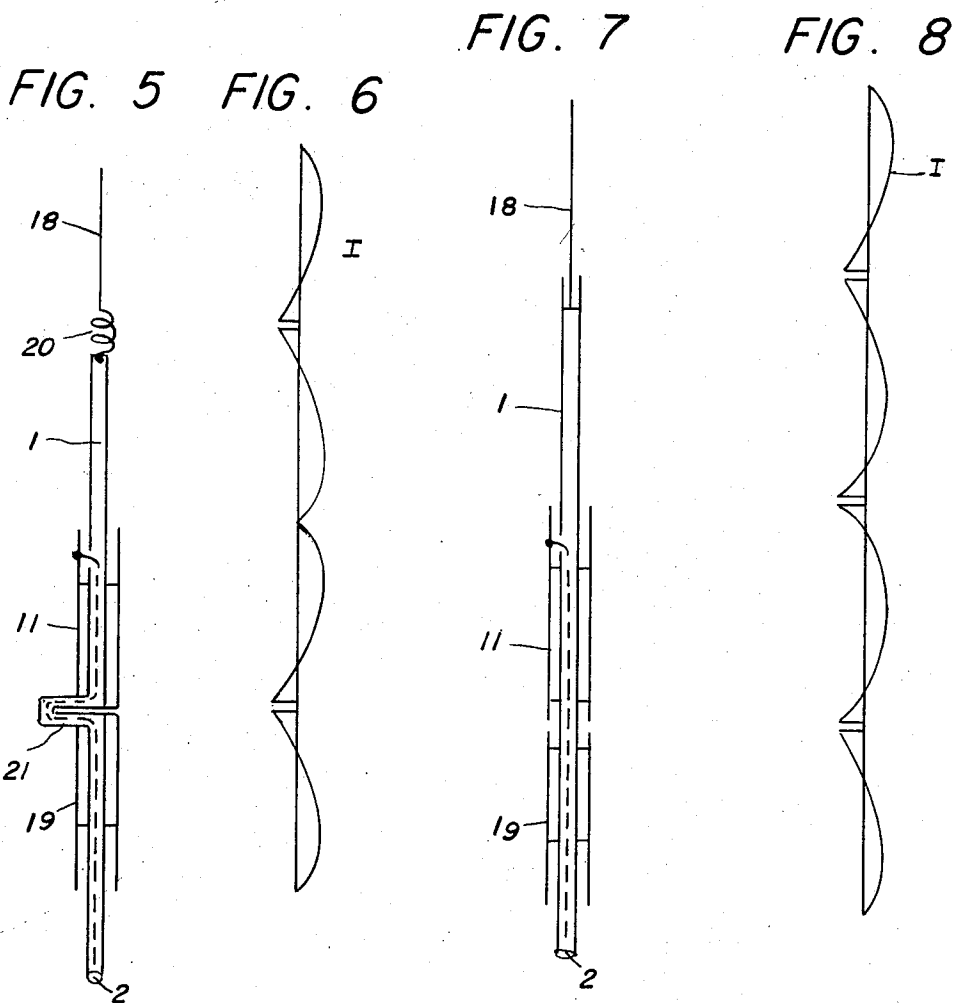
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INVENTOR

WALTER BERNDT

BY

John D. Munkel

PATENT AGENT

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TUNED DIPOLE TYPE ANTENNA

Walter Berndt, Berlin, Germany, assignor to Telefunken G. m. b. H., Berlin, Germany

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Claims priority, application Germany August 19, 1949

8 Claims. (Cl. 343—792)

The present invention relates to an antenna for transmitting or receiving electro-magnetic waves, said antenna being connected to electronic transmitting or receiving apparatus by means of a coaxial cable. Such antennas are often exposed to lightning, or they might be charged by other atmospheric electricity. To prevent damage to the electronic apparatus and cables connected to the antenna, it has been previously known to connect the outer conductor of the coaxial cable to a vertical radiator and the inner conductor of the coaxial cable to a balance member. However, the safety with respect to lightning of this arrangement is not satisfactory. Experience has shown that discharges by lightning do not necessarily strike the highest points of the antenna installations. Also, the parts which are located at lower levels are endangered by the lightning if they have an appreciable height above ground. Therefore, in case of the known prior art arrangement, a passage of discharges or, at least, partial discharges to the balance member connected to the inner conductor of the cable has to be taken into account. This is particularly true in antenna installations for short waves which antennas have correspondingly short radiator elements in which the lower radiator element is located relatively close to the grounded upper element.

The problem of matching the radiation resistance of the antenna to the impedance of the coaxial feed cable has not yet been solved in a satisfactory manner in the prior art antenna arrangement. In the known arrangements, an open balanced conductor section of wave length $\lambda/4$ has been used for this purpose, the individual conductors of this balanced conductor section forming continuations of the two conductors of the coaxial cable. The ungrounded radiator of such an antenna is connected with the outer cable conductor via one of the balanced conductors of the matching section, and is thereby electrically grounded. However, the risk that the installation might be hit by lightning is not essentially decreased, because the open balanced matching conductors might be hit by lightning just as easily as the radiator which is located only slightly higher.

In the antenna arrangement according to the present invention, a safe by-passing of the atmospheric electricity to the ground is assured.

It is an object of the invention to provide in an antenna system two individual radiators arranged one above the other, each of said radiators being of about one half wave length, and a coaxial feed cable, the electrically grounded outer casing of which is connected to the upper radiator, while the inner conductor of this feed cable is connected with the lower radiator, whereby the lower radiator is made in the form of a tube enclosing the coaxial feed cable.

It is another object of the invention to provide in one part of the tubular radiator, preferably the lower part, a blocking filter to present to the tuned frequency of the antenna a high impedance to ground, and it is a further object to provide within the upper part of the

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tubular radiator an impedance matching transformation section.

In an antenna according to the present invention, the upper radiator is electrically grounded via a connection known per se, to the cable outer conductor. In case of the use of individual radiators of length $\lambda/2$ there is sufficient space in the lower tubular radiator to receive the transformation matching section in the inner chamber of this radiator and simultaneously the blocking filter for suppressing standing waves. In this construction, both of these parts required for good operation are completely protected against damaging influence of atmospheric electricity, whereby the short-circuit bridge of the $\lambda/4$ blocking filter and also of the transformation matching section are preferably designed as coaxial tubular conductor elements connecting electrically the lower radiator to the cable outer conductor and thereby to ground. In this manner a superior antenna design of a compact and simple construction is obtained, assuring a safe discharge path to ground for atmospheric electricity at all points of the outer surface of the antenna.

It has been known to provide a blocking filter in the interior of a radiator of length $\lambda/4$ surrounding the feed cable. However, in this known antenna design no space for the transformation matching section is available within the radiator due to the considerable length of the radiator. In this prior art structure the upper radiator is connected to the inner conductor of the cable so that no safety with respect to lightning is obtained. In another prior art antenna design a single vertical radiator is mounted on a standing pipe, said radiator being connected to the inner conductor of a coaxial cable without insertion of a transformation matching section. A blocking filter is built into the interior of this single radiator. However, this known antenna is neither safe with regard to lightning nor can the matching of the radiation resistance of the antenna to the impedance of the cable be considered satisfactory.

These and other important objects and advantageous features of this invention will be apparent from the following detailed description and drawings appended thereto wherein, merely for the purposes of disclosure, non-limitative embodiments of the invention are set forth.

Fig. 1 of the drawing shows one embodiment of the invention.

Fig. 2 is a diagram of the current distribution in the antenna of Fig. 1.

Figs. 3, 5 and 7 are further embodiments of the invention, the corresponding current distribution diagrams in the antennas of these figures being shown in Figs. 4, 6 and 8, respectively.

In Figure 1 of the drawing, 1 and 11 denote two single radiators arranged one above the other, each of said radiators being of half wave length and being connected to a transmitter or to a receiver, not shown. The coaxial cable comprises an outer conductor 3 grounded at 10 and an inner conductor 4. To the high frequency current flowing along the inner conductor 4 there corresponds a high frequency current of equal intensity directed in opposite direction, said latter current flowing on the inner side of the outer conductor of the cable. This current is fed to the upper radiator 1 so that this radiator is electrically connected to the outer cable conductor, as shown in Figure 1. The high frequency current flowing on the inner conductor is supplied to the lower radiator 11 which forms with the upper radiator 1 the two members of a balanced dipole.

Within the lower tubular radiator there is housed a quarter wave length ($\lambda/4$) blocking filter 12, the tuning of which is controlled by the position of the short circuit bridge 13 which is conveniently adjustable. The blocking filter prevents the formation of standing waves

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on the outer cable conductor 3. To obtain a reflection-free match of the radiation resistance of the antenna to the impedance of the high frequency cable 2, the upper part 14 of the interior of the tubular radiator 11 is designed to be a transformation matching section, the impedance of which can be adjusted by means of a slidable short circuit bridge 15.

It can readily be seen that dangerous electric charges from the radiator 1 and from the radiator 11 can always be directly discharged to ground via a continuous metallic circuit path, because the radiators are effectively grounded for all frequencies, including direct current, deviating from the frequency for which the antenna system is tuned, while for this tuned frequency an effective high frequency resistance in the form of a tuned blocking filter 12 is provided between the point of grounding of the outer conductor 3 and its connecting point to the radiator 1.

Fig. 2 illustrates adjacent to the radiators 1 and 11 a current (I) distribution diagram for the case of a radiator of length λ .

In the example of Figures 3 and 4, the radiators have an effective length which is somewhat longer than one half wave length ($\lambda/2$), for example the radiator length can be made $5/8\lambda$. By providing end loading capacities 16 and 17 at the upper and lower radiator ends, respectively, the structural height of the total antenna is made smaller while the same electrical length is retained. Also in this embodiment, the chamber formed by the tubular lower radiator 11 is utilized to house the blocking filter 12 and the transformation matching section.

The new antenna is advantageously designed in such a manner that the part of the outer conductor of the coaxial cable which is directly connected to the radiator 1 is a solid pipe supporting the antenna structure. This new construction can be employed in stationary and in portable radio installations.

In the embodiments of the invention according to Figs. 5 to 8, an antenna construction similar to Fig. 1 is extended at both the top and the bottom by radiators 18 and 19, respectively, having a length of $\lambda/2$ in Figs. 5 and 6, and $5/8\lambda$ in Figs. 7 and 8. Connecting numbers 20 and 21, well known in the prior art, are used to suppress an undesirable portion of the negative half wave as shown in Figs. 5 and 6. These embodiments are likewise safe with respect to lightning.

Although in accordance with the provisions of the patent statutes this invention is described as embodied in concrete forms and the principle of the invention has been explained together with the best modes in which it is now contemplated applying that principle, it will be

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understood that the elements and combinations shown and described are merely illustrative and that the invention is not limited thereto, since alterations and modifications will readily suggest themselves to persons skilled in the art without departing from the true spirit of the invention or from the scope of the annexed claims.

I claim:

1. A tuned dipole type antenna having two single radiators one above the other, each radiator being of half wave length, said antenna having a coaxial feed cable, the grounded outer conductor of which is connected to the upper radiator and the inner conductor of which is connected to the lower radiator, characterized in that the lower radiator is made in the form of a tube, surrounding and coaxial with the feed cable, further characterized in that a part of said tube is provided with a short circuiting bridge to the said outer conductor to provide a high frequency impedance to ground for the tuned operating frequency currents flowing on the outside of the outer conductor, and further characterized in that another part of the tubular radiator is provided with a second short-circuiting bridge to said outer conductor, said second bridge serving as a matching section to match the antenna resistance to the cable impedance.

2. An antenna according to claim 1, said part being the lower part and said other part being the upper part of the said tubular radiator.

3. An antenna according to claim 1, said part being the lower part and said other part being the part of the tubular radiator facing said upper radiator.

4. An antenna according to claim 1, wherein the said short-circuiting bridges are axially positionable within said tubular radiator.

5. An antenna according to claim 1, characterized in that further radiator extensions are connected by inductive loading means to the tubular radiator and the upper radiator respectively, at the ends thereof.

6. An antenna according to claim 1, characterized in that the tubular radiator and upper radiator projecting therefrom are provided with end loading capacities.

7. An antenna according to claim 1, characterized in that the electrical length of the single radiators is longer than half a wave length.

8. An antenna according to claim 7, said single radiators having an electric length of $5/8\lambda$.

References Cited in the file of this patent

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