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Fujimoto et al.

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[45] **Apr. 16, 1974**

[54] **DIVERSE TYPE DIPOLE ANTENNAS ON COMMON MOUNT**

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[21] Appl. No.: **261,973**

[30] **Foreign Application Priority Data**

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June 14, 1971 Japan 46-50484
June 14, 1971 Japan 46-50487

[52] **U.S. Cl.** **343/794,** 343/802
[51] **Int. Cl.** **H01q 9/16**
[58] **Field of Search** 343/802, 806, 828, 794

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Attorney, Agent, or Firm—Stevens, Davis, Miller & Mosher

[57] **ABSTRACT**

An antenna means comprising a linear element of a conductor having a length sufficiently shorter than a half wavelength and a plurality of parallel two-wire type distributed constants transmission lines short-circuited at the free end thereof, said transmission lines being sequentially arranged along the linear conductor element and connected to the same element, whereby compensation of the impedance characteristics of the antenna is achieved without decreasing the antenna efficiency.

1 Claim, 14 Drawing Figures

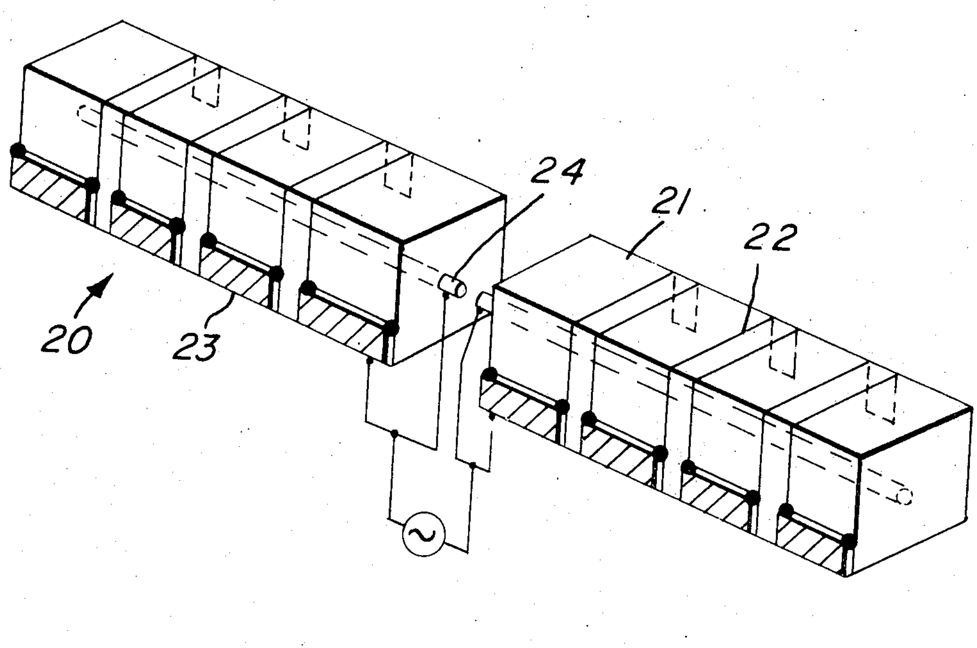


FIG. 1

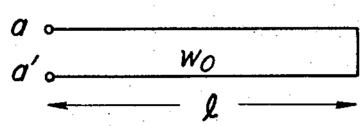


FIG. 2

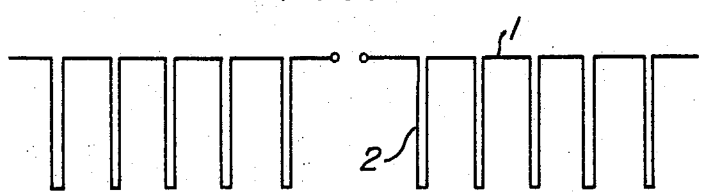


FIG. 3

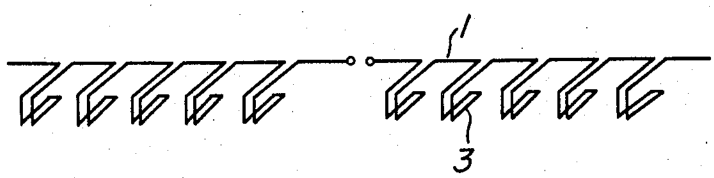
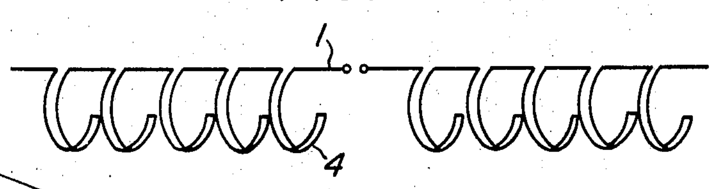


FIG. 4



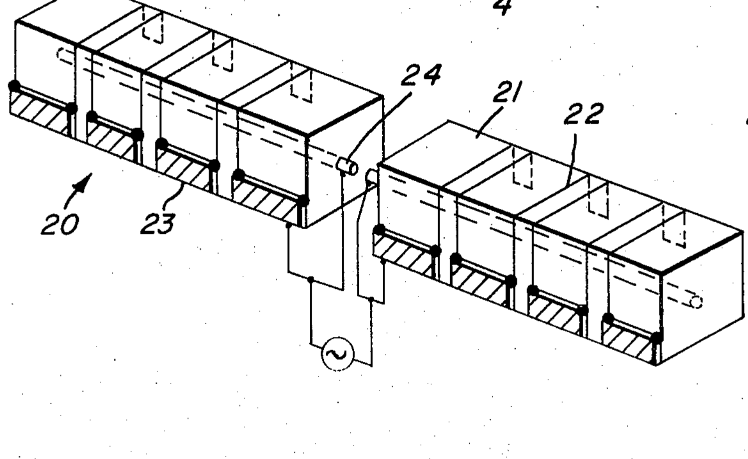


FIG. 12

FIG. 5

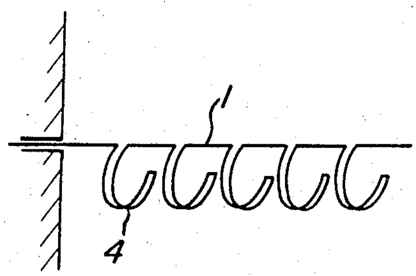


FIG. 6

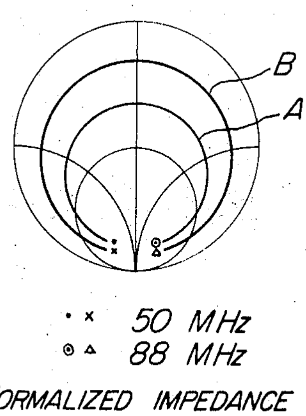


FIG. 7

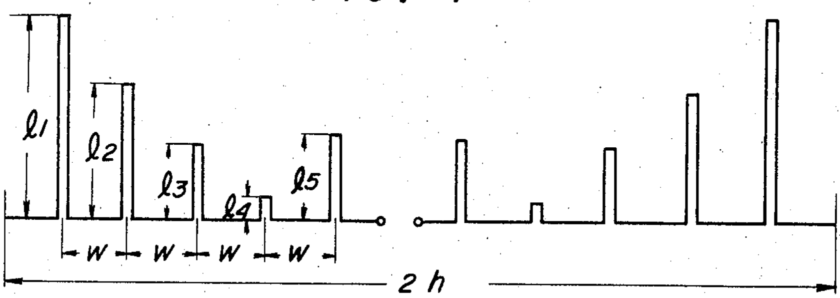


FIG. 8

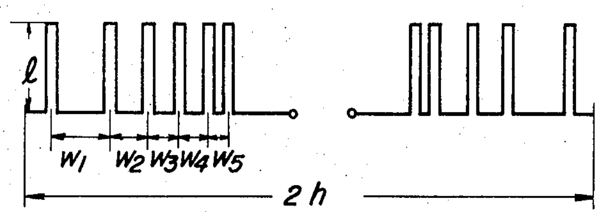


FIG. 9

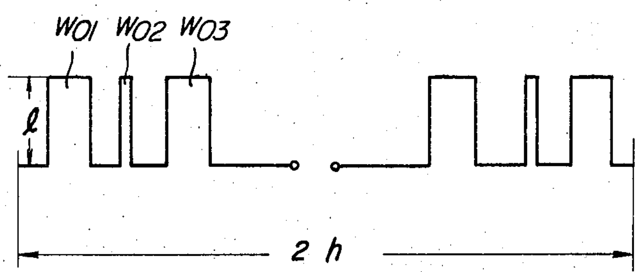


FIG. 10a

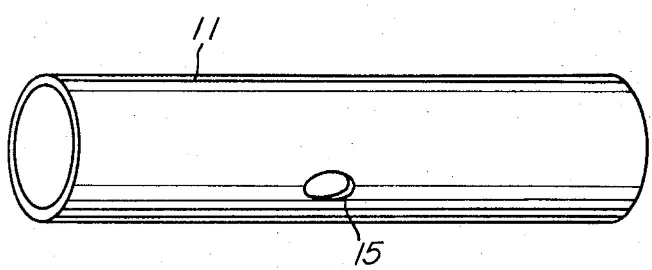


FIG. 10b

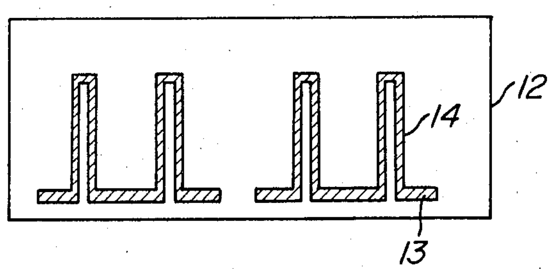


FIG. 10c

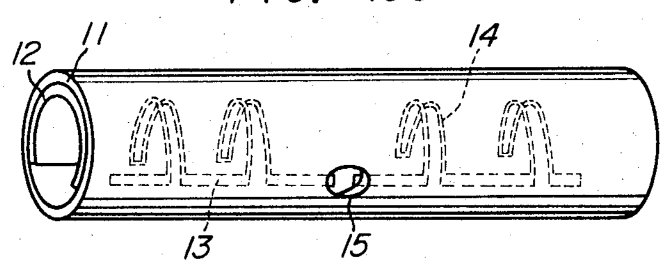
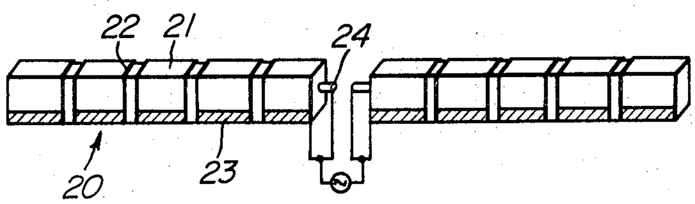


FIG. 11



DIVERSE TYPE DIPOLE ANTENNAS ON COMMON MOUNT

This invention relates to an antenna means of comparatively small size, particularly to such a means designed to have well compensated impedance characteristics and yet to maintain good antenna efficiency.

Generally, small linear antennas the length of which is sufficiently shorter than a half wavelength, have an impedance characteristics in which the resistive component is comparatively small and the capacitive component iis comparatively large. Therefore, the mismatch loss with a receiver is accordingly large.

Hitherto, in order to compensate such an impedance characteristic, an inductance of concentrated constants (or a coil) has been attached to the antenna at the intermediate portion or at the driving terminals thereof. Such a loading has caused a decrease in the antenna efficiency due to a loss in the inductance (coil). Further, the radiation impedance of the antenna is usually small.

An object of this invention is to remove the above-mentioned drawbacks of a small antenna by loading it with inductances of distributed constants.

Another object of this invention is to provide a small antenna which has a long life and can be easily handled.

A further object of this invention is to provide a small antenna which can be easily formed as a composite antenna.

In order to achieve the above objects, the antenna of this invention comprises an aligned series of linear conductors the total length of which is substantially shorter than a half wavelength in the operating frequency band and a plurality of parallel two-wire type distributed constants transmission lines short-circuited at one end thereof, said transmission lines being connected between two adjacent conductors of said series of linear conductors at the other end thereof.

This invention will be described in detail with reference to the accompanying drawings, in which:

FIG. 1 is a diagram of a fundamental two-wire distributed constants transmission line;

FIGS. 2, 3, 4 and 5 are schematic diagrams of the antenna of this invention shown in various forms;

FIG. 6 is a chart showing comparison of the impedance relations between the antennas of this invention and of the conventional one;

FIGS. 7, 8 and 9 are schematic diagram of modified forms of the antenna of this invention;

FIGS. 10*a*, 10*b* and 10*c* are views relating to a practical embodiment of this invention; and

FIGS. 11 and 12 are views of another embodiment of this invention.

Referring to FIG. 1 which shows a distributed constnnts transmision line of parallel two-wire type short-circuited at the load end, the impedance of the line at the sending end *a,a'* contains an inductive component Z expressed by the following formula:

$$Z = jW_0 \tan \beta l \quad (1)$$

where

W_o is the characteristic impedance of the line,
β is the phase constant, and
l is the length of the line.

FIG. 2 schematically shows an embodiment of the antenna of this invention, in which a plurality of short-circuited transmission lines 2 as shown in FIG. 1 are successively loaded to an antenna element 1.

with this formation, the inductive component of each transmission line 2 is added in series to the impedance of the antenna element 1 which has a large capacitive component. Further, the radiation current is superposed to the transmission lines 2.

FIGS. 3 and 4 are schematic diagrams of other embodiments of this invention. The embodiment shown in FIG. 3 has a plurality of folded transmission lines 3, while the one shown in FIG. 4 has curved transmission lines 4.

Though dipole antennas are shown in the above embodiments, it will be understood that this invention is also applicable with similar effects to monopole antennas as shown in FIG. 5.

As described above, the antenna element is loaded with inductive components of small loss and the antenna efficiency is not deteriorated. Further, as the radiation current is superposed to the loading transmission lines, the effective length of the antenna is equivalently increased, the radiation resistance being thereby multiplied eight to ten-fold. Thus, a small antenna with which the loss due to the mismatching thereof with the receiver in the resonant state is minimized, is realized.

Further, according to this invention, broad-band characteristics equal to or even better than those of a normal mode helical antenna of corresponding length are achieved.

The chart of FIG. 6 shows impedance characteristics (A) for an antenna of this invention of 60 cm in length characteristics (B) for a helical antenna of corresponding length.

Further, the antenna efficiency can be increased by changing the length or the characteristic impedance of the loading transmission lines according to the respective loading positions, or by changing the spaces between adjacent transmission lines. Namely, as seen from the hereinbefore shown formula (1), impedance Z can be changed by varying the value of the characteristic impedance W_o or the length l of the line. In the embodiment shown in FIG. 7, the lengths ($l_1 \ldots l_5$) of respective transmission lines are changed while the spaces (w) are equal. The embodiment shown in FIG. 8 is loaded with transmission lines of the same length (l) but differently spaced ($w_1 \ldots w_5$). On the other hand, FIG. 9 shows an embodiment in which the characteristic impedances (W_{01} W_{03}) of the loading transmission lines are varied depending on the loading position along The antenna. In FIGS. 7 to 9, distance $2h$ represents the total length of the antenna.

It is important for the antenna of this invention to be provided in such a form that simple construction, stable characteristics and easy handling of the antenna are ensured. An example of such an antenna is described hereunder.

Referring to FIGS. 10*a*, 10*b* and 10*c*, a supporting cylinder 11 is made of a dielectric material and provided with a hole 15 which serves as the outlet for feeders. A conductive material in the pattern of antenna elements 13 loaded with short-circuited transmission lines 14 are deposited, by known printed-circuit technique, on an elastic sheet 12 of an insulating material. This elastic sheet 12 with the conductive pattern of the antenna deposited thereon is placed within the supporting cylinder **11** so that the sheet **12** is pressed against the inner wall of the cylinder **11** by its own elasticity. Thus, the sheet **22** is assuredly held by the cylinder **11** as shown in FIG. **10***c*. Though a cylindrical tube is used in the above embodiment, it will be understood that similar effects are achieved using a tube having a square section.

The antenna of this invention fabricated in such a form as described above has the following advantages. Namely, antennas of any complicated pattern can be easily fabricated in mass-production scale with very accurate dimensions and good uniformness. Further, as the antenna element is protected by the dielectric cylinder, it is little affected by weather or salty wind and also hardly suffers mechanical damage. Thus, a long operation life can be expected. Moreover, the antenna assembly described is very simple in construction, as the printed sheet is certainly within the supporting cylinder with its own elasticity and no fixing means is required. Thus, the prduction cost is accordingly low.

Another embodiment of this invention is shown in FIGS. **11** and **12.** In the illustrated arrangement, the antenna **20** according to this invention constitutes a part of a composite antenna, the other part being a rod antenna **24.** The antenna **20** comprises support **21** which may be, for example, a square bar of a dielectric material such as polystyrole, an antenna element **23** which may be a series of conductive strips, for example, of metal foil attached to the support **21** along a longitudinal edge thereof, and compensating elements **22** which are a plurality of parallel two lines of conductor attached to the support **21,** one end of the two lines being connected with the antenna element and the other end being short-circuited. The support **21** is provided with a hole along the longitudinal axis thereof at the center portion of the square section. This hole serves to support the rod antenna **24** which operates at a frequency band different from that for the first antenna **20.** Further, as both antennas can be driven through a common feeding point, a composite antenna of reduced size which may appear to be a single antenna is obtained. Moreover, the second or rod antenna **24** contributes to increase the mechanical strength of the composite antenna.

What we claim is:

1. An antenna means comprising two sets of linear conductors aligned in a plain dipole antenna fashion and having the total length substantially shorter than a half wavelength in the operation frequency band, the linear conductors of each set of said two sets of linear conductors being spaced at intervals corresponding to a fraction of the operating wavelength,

a plurality of parallel two-wire type distributed constants transmission lines having one end thereof short-circuited, said transmission lines being connected between two adjacent conductors of each set of said two sets of linear conductors at the other end of said transmission lines, said plurality of parallel two-wire type transmission lines being perpendicular to the axis of said two sets of linear conductors and having a predetermined impedance characteristic,

a bar of dielectric material, said bar having on the surface thereof said two sets of linear conductors and said plurality of parallel two-wire type distributed constants transmission lines, and

a rod of conductor along the longitudinal axis of said dielectric bar, said rod being designed to serve as another antenna which operates at another frequency band, the feeding point for both antennas being common, whereby said antenna means constitutes a part of a composite antenna.

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