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Moody

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[54] **ANTENNA STRUCTURE**

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Related U.S. Application Data

[63] Continuation of Ser. No. 777,596, Nov. 21, 1968, abandoned.

[52] **U.S. Cl.** **343/802,** 343/803, 343/806, 343/818

[51] **Int. Cl.** **H01q 9/16**

[58] **Field of Search**..343/700 A, 793, 795, 802, 803, 343/806, 818, 897, 908

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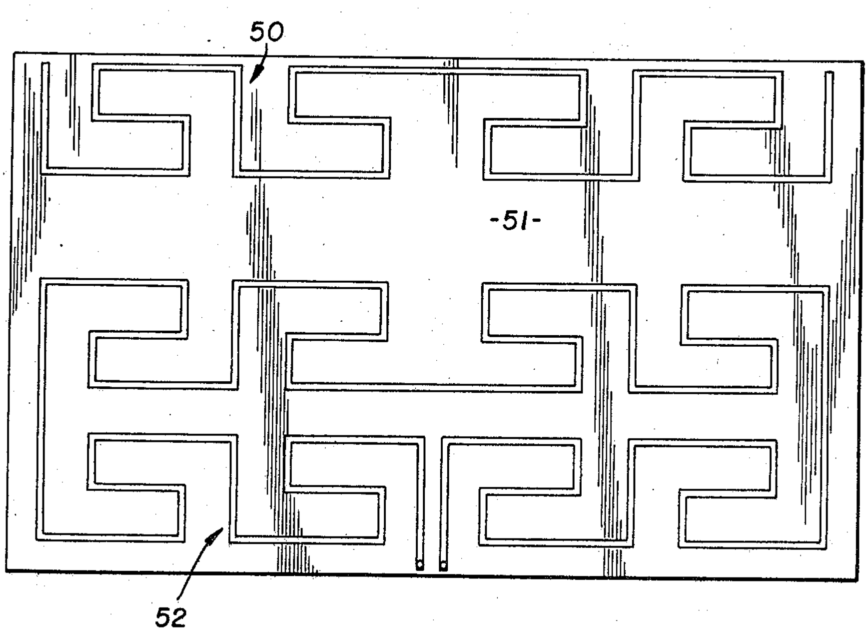
[57] **ABSTRACT**

This antenna structure designed primarily for the V.H.F. and U.H.F. radio and television frequency spectrums, either transmitting or receiving, comprises a thin-film, electrically conductive element formed on a surface of a relatively thin, flexible supporting substrate with the conductive element being a relatively narrow, elongated strip arranged in a "Greek-Key" configuration. This design configuration of the conductive element results in an antenna structure having a physical length which is relatively compressed while maintaining a desired effective electrical length and electromagnetic wave response characteristic. The antenna may be fabricated with a parasitic element for enhanced response with the parasitic element also being of the "Greek-Key" design configuration.

2 Claims, 3 Drawing Figures



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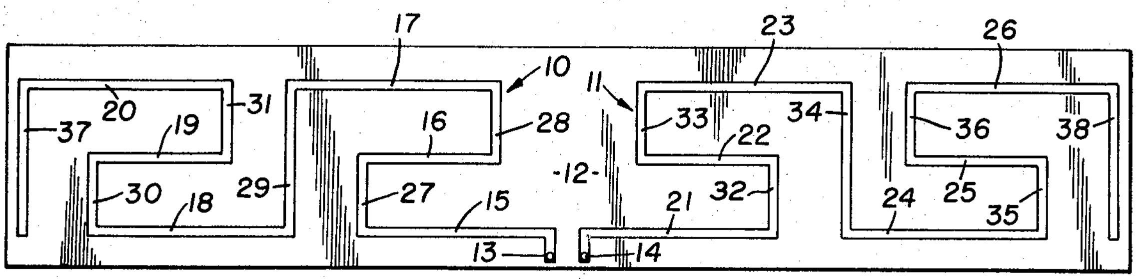

Fig 1

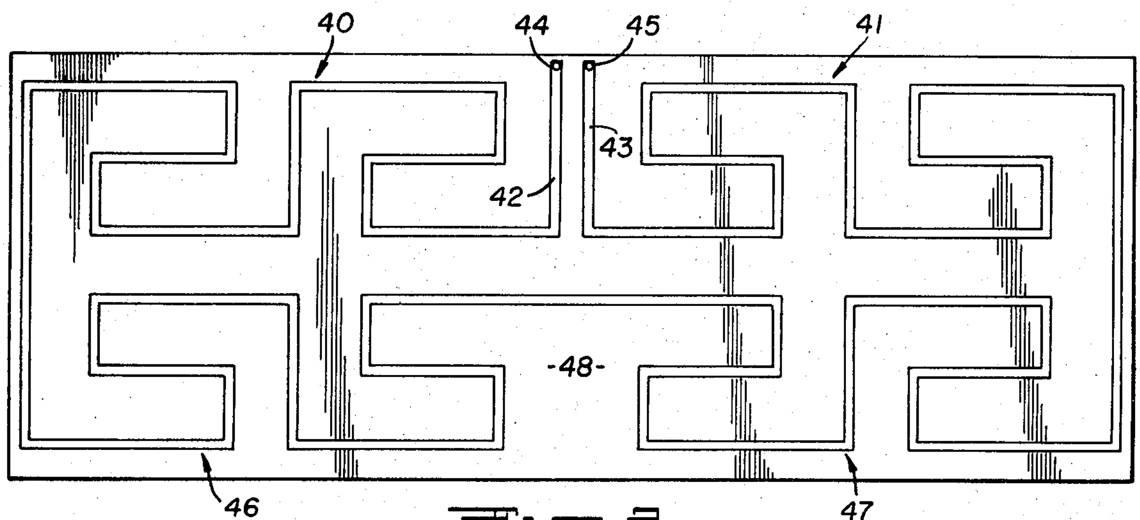

Fig 2

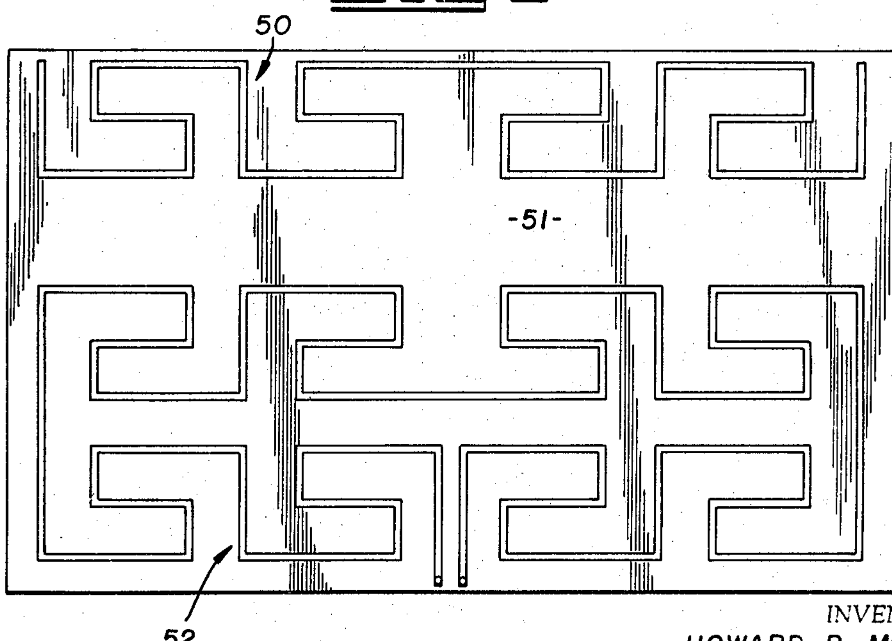

Fig 3

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ANTENNA STRUCTURE

GENERAL DESCRIPTION OF PRIOR ART

Antenna structures designed for utilization in the V.H.F. and U.H.F. spectrum such as for television reception have generally been fabricated from elongated metal stock of tubular form. The known prior art antenna structures are generally of the dipole or the folded-dipole type or other multielement types and often include parasitic elements with the physical length of the elements generally equivalent to a predetermined fraction of an electrical wavelength such as one-fourth or one-half. Because of the design requirements for the standard broadcast frequencies, these prior art structures have generally been of relatively large physical dimensions and, consequently, are difficult to install as they must normally be installed exteriorly of the building housing the receiver. Other types or prior art antenna structures include the relatively small type normally positioned on the receiver itself such as the well known pair of relatively divergent electrically conductive elements. These elements are also normally fabricated from tubular metal stock and are not as large in physical structure as the previously described type, but are not decoratively appealing nor are they as effective in receiving electromagnetic wave signals.

GENERAL DESCRIPTION OF THIS INVENTION

The antenna structure of this invention provides the dual advantages of size reduction while retaining effectiveness as to electromagnetic wave reception and relative ease and simplicity of mounting. Forming the active element as a thin film of electrically conductive material on a flexible, sheet form substrate provides a physical structure which may be readily positioned in a convenient, unnoticeable place such as under a carpet or in an attic and easily connected with the receiver by the conventional transmission line. Forming the active element in a "Greek-Key" configuration results in a substantial reduction in actual physical size without degradation of the electrical effectiveness.

These and other objects and advantages of this invention will be readily apparent from the following detailed description of embodiments thereof and the accompanying drawings.

In the drawings:

FIG. **1** is a plan view of an antenna structure of the dipole-type embodying this invention.

FIG. **2** is a plan view of an antenna structure of the folded dipole-type embodying this invention.

FIG. **3** is a plan view of an antenna structure embodying this invention having an active element of the folded dipole-type and a parasitic element of the dipole-type.

Referring to the drawing, a basic antenna structure of the dipole-type is illustrated in FIG. **1** which is constructed in accordance with the principles of this invention. This antenna structure comprises two allochiral, electrically conductive units **10** and **11** which are formed on a structurally supporting substrate **12**. In the preferred embodiment, this substrate **12** is formed from a relatively thin flexible sheet of polymeric material such as polyvinyl chloride. The specific material utilized is selected to have the desired dielectric characteristics and is essentially electrically nonconductive at the particular design or operating frequency.

Bonded onto a surface of the substrate **12** are the units **10** and **11** which form the active electrical element of the antenna structure. The units **10** and **11** are symmetrically alike but oriented on the substrate reversed in position and arrangement as in a right and lefthanded or allochiral relationship and are formed from an electrically conductive metal, aluminum for example, which is deposited in a thin film by a well known processes onto a surface of the substrate. Each unit **10** or **11** comprises an elongated, relatively narrow strip of conductive material which is folded upon itself in a predetermined pattern. In accordance with this invention, the conductive units **10** and **11**, which extend in longitudinally aligned but opposite directions from a mutual center point with the ends provided with respective connector terminals **13** and **14**, each comprise a plurality of longitudinally oriented sections **15, 16, 17, 18, 19, 20** and **21, 22, 23, 24, 25, 26**, respectively, which are interconnected by transversely oriented sections. In the case of left unit **10**, the longitudinal sections are interconnected by the transverse sections designated by the numerals **27, 28, 29, 30** and **31** while the longitudinal sections of the right unit are interconnected by the transverse sections **32, 33, 34, 35**, and **36**. The endmost longitudinal sections **20** and **26** of each unit **10** and **11** connects with and terminates in a respective transverse section **37** and **38**. As can be seen in the drawing, the several sections of each unit are arranged in a pattern closely resembling what is known as a "Greek-Key" design.

It is this "Greek-Key" design which permits a reduction in the physical length of the antenna structure without a reduction in performance at a selected design frequency. The of a dipole antenna structure utilizing the straight elements in accordance with prior art design practice is normally equal to one half wavelength of the design frequency and each half of the antenna would be equal in length to one quarter of this wavelength with the length being determined from the mathematical relationship $\lambda = c/f$ where λ is the wavelength, c is the speed of light and f is the design frequency. Utilizing the design of this invention, the actual lineal length of each unit **10** or **11** may be determined from the mathematical relationship $L = 2220/f$ where L is the length in inches, f is the design frequency expressed in MHz and the numerical constant 2220 has been determined by empirical means. As an example of the length reduction which can be effected by this invention, it will be seen from the equation that for a design frequency of 69MHz, the actual half-wavelength and antenna length according to prior art design would be of the order of 88 inches whereas the length of each unit **10** or **11** of the present design is of the order of 48 inches. While a substantial size reduction is effected utilizing the design criteria of this invention, the performance or electrical response to electromagnetic radiation remains substantially equivalent to that of an antenna structure of conventional design, a fact which has been substantiated by tests.

In the illustrated embodiment, for the design frequency of 69 MHz, the longitudinal sections in the outer two of the three longitudinal rows in each unit are of the order of 6 inches whereas the longitudinal sections in the center row are of the order of four inches while the longer transverse sections are of the order of four inches. The conductive strip in one-half inch wide and the centerline, transverse spacing of adjacent rows of the longitudinal sections is of the order of 2 inches with the longitudinal spacing as between the transverse sections **27** and **29** or **29** and **31** also being of the order of 2 inches. Consequently, the overall physical dimension of a unit of the active element of an antenna structure fabricated in accordance with this invention for a design frequency of 69 MHz will be rectangular planar surface dimension of about 4 inches wide and 16 inches long. Utilizing a longitudinal spacing of 2 inches between the connector terminals **13** and **14**, it can be seen that the substrate **12** may be of the order of 6 inches by 36 inches. This thus provides a relatively small physical size antenna structure which, when combined with the advantages of a flexible substrate, enables the antenna to be readily and easily installed within a building such as a personal residence.

The same design criteria of this invention as previously described may also be utilized for design of a folded-dipole type antenna structure to effect a further reduction in physical dimensions. A folded-dipole antenna embodying this invention is illustrated in FIG. **2** and is seen to comprise two units **40** and **41** of the same configuration as the dipole of FIG. **1** with the adjacent inner ends attached to respective transverse sections **42** and **43** which are each provided with a connector terminal **44** and **45**. Disposed in spaced, parallel relationship to the units **40** and **41** are respective mirror image units **46** and **47** that are interconnected at their adjacent inner ends and are connected with the units **40** and **41** to form a single, continuous electrically conductive path. All units are formed by depositing a thin film of electrically conductive material on a flexible substrate **48** of suitable polymeric material.

As a further example of antenna structures which may be fabricated utilizing the design criteria of this invention, it will be seen in FIG. **3** that an antenna structure of the folded-dipole type as illustrated in FIG. **2** may also be provided with a parasitic element designated in its entirety by the numeral **50.** This parasitic element **50** is formed on a substrate **51** in spaced parallel relationship to the folded-dipole structure designated generally by the numeral **52.** Spacing of the parasitic element **50** to the dipole **52** is determined in accordance with conventional design practice with the spacing being of the order of 0.2 to 0.25 of the wavelength of the design frequency with the spacing being relative to the respective longitudinal center axis and the parasitic element may either by utilized as a reflector or a director.

It will be understood from the foregoing detailed description of the several embodiments of this invention that a novel and improved antenna structure is provided which is of substantially reduced physical size compared to conventionally designed antennas. This size reduction is effected through utilization of the "-Greek-Key" design configuration. In addition to size reduction, the formation of the electrically conductive elements as thin films on a flexible substrate greatly enhances the ease and versatility of installation.

Having thus described this invention, what is claimed is:

1. An antenna structure comprising an active element having a first "S" shaped conductive unit electrically connected to a second "S" shaped electrically conductive unit, a first terminal, a 4 inch electrical conductive member connecting said first "S" shaped conductive unit to said terminal, a first backward "S" shaped electrically conductive unit electrically connected to said second "S" shaped conductive unit, a second backward "S" shaped electrically conductive unit electrically connected to said first backward "S" shaped electrically conductive unit, a third "S" shaped electrically conductive unit electrically connected to said second backward "S" shaped electrically conductive unit, a fourth "S" shaped electrically conductive unit electrically connected to said third "S" shaped electrically conductive unit, a third backward "S" shaped electrically conductive unit connected to said fourth "S" shaped electrically conductive unit, a fourth backward "S" shaped electrically conductive unit electrically connected to said third backward "S" shaped electrically conductive unit, a second terminal, a second 4 inch electrical conductive member connecting said second terminal to said fourth backward "S" shaped conductive unit, each of said first, second, third and fourth "S" shaped conductive units and each of said first, second, third and fourth backward "S" shaped conductive units having a first long leg being 6 inches connected to a first short leg being two inches long, an intermediate length leg being four inches connected to said first two inch short leg, a second two inch leg connected to said intermediate length four inch leg and a second long leg being six inches long connected to said second short leg, a flexible sheet of dielectric material, having a first surface, said first, second, third and fourth "S" shaped conductive units and said first, second, third and fourth backward "S" shaped conductive units all being mounted on said first surface of said flexible dielectric sheet, the combined linear length of said interconnected first, second, third and fourth "S" shaped conductive units and said first, second, third and fourth backward "S" shaped conductive units being approximated by the mathematical relationship $L = 2220/f$ where L is the length in inches and f is the design frequency in MHz, said first and second "S" shaped conductive unit lying in the same horizontal line as said third and fourth backward "S" shaped conductive units, and said third and fourth "S" shaped conductive units lying in the same horizontal line as said first and second backward "S" shaped conductive units.

2. An antenna structure according to claim **1**, which includes a parasitic element disposed in spaced parallel relationship to said active element and which includes a first and second "S" shaped conductive unit connected to each other and first and second backward "S" shaped conductive unit connected to each other and said second "S" shaped conductive unit being connected to said first backward "S" shaped conductive unit.

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