Feb. 9, 1971 G. A. BONADIO 3,562,755

THREE DIMENTIONAL ANTENNA SYSTEM

Filed July 5, 1968 3 Sheets-Sheet 1

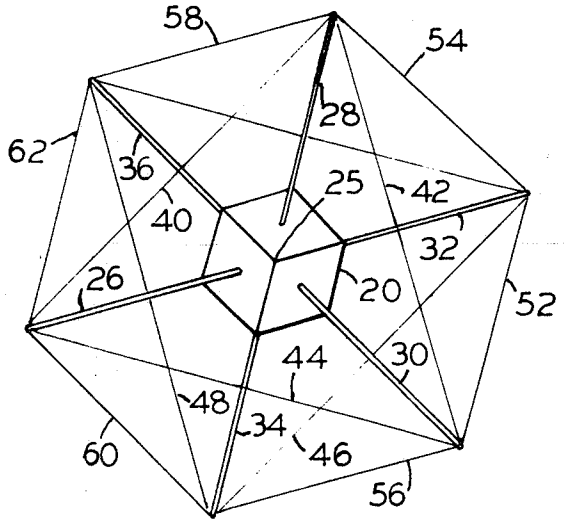


FIG. 1

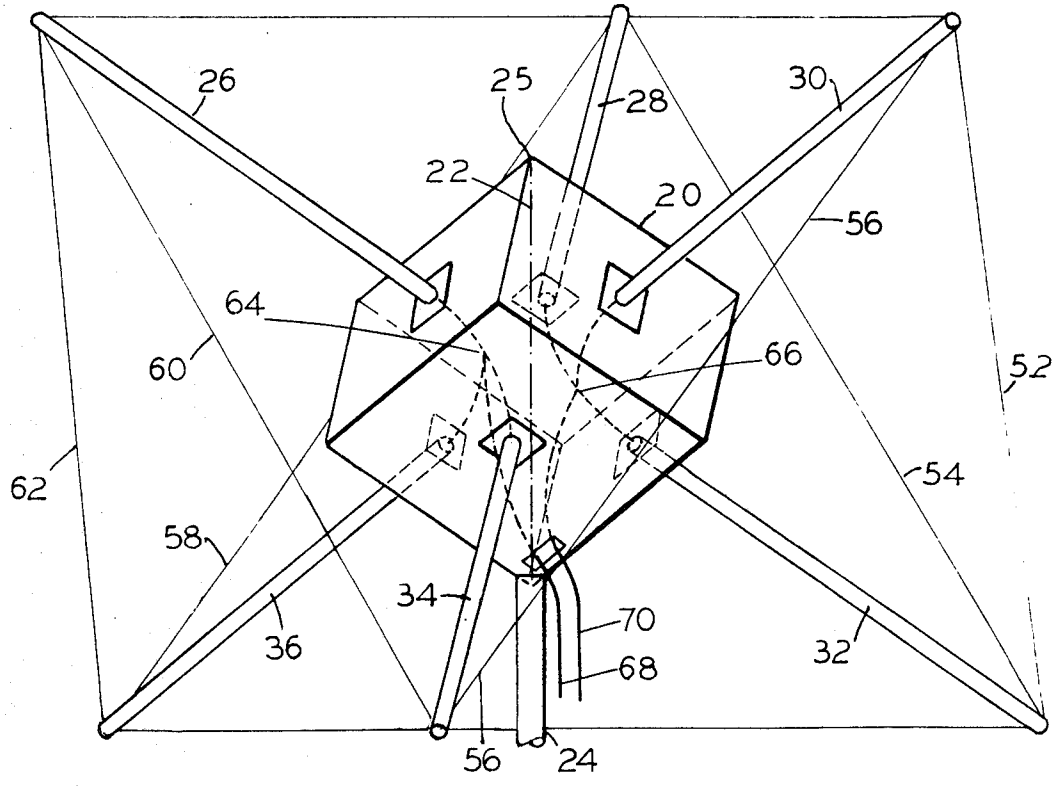


FIG. 2

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THREE DIMENTIONAL ANTENNA SYSTEM

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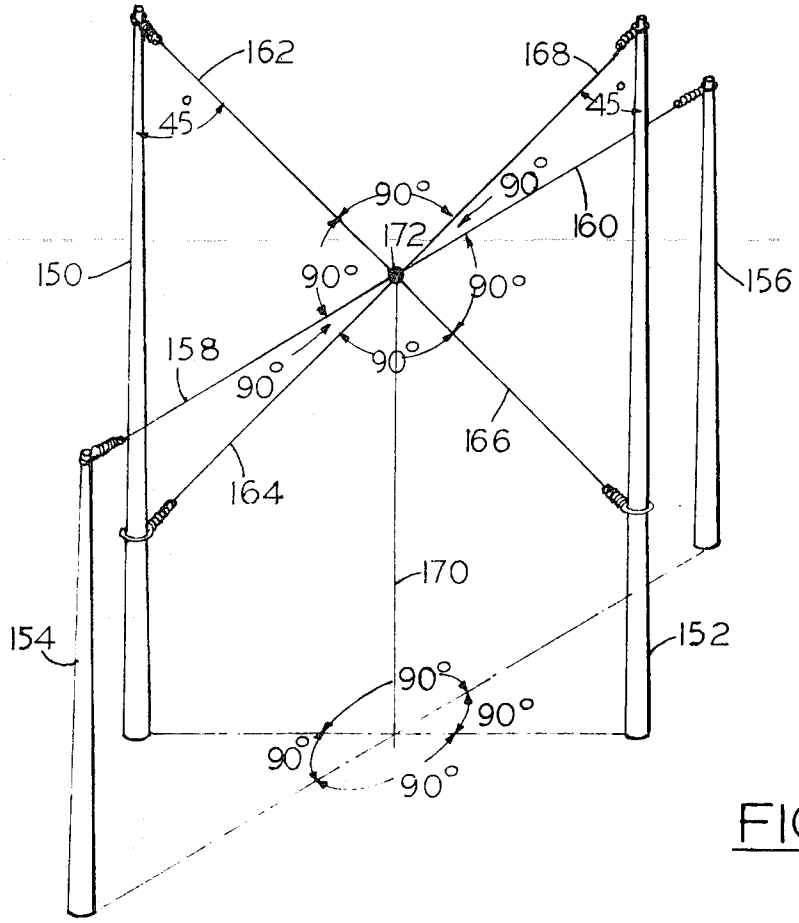


FIG. 3

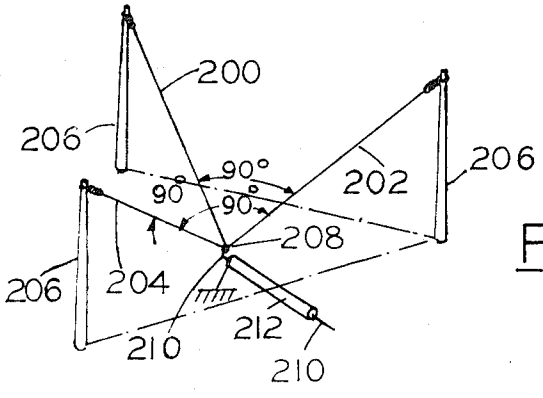


FIG. 4

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THREE DIMENTIONAL ANTENNA SYSTEM

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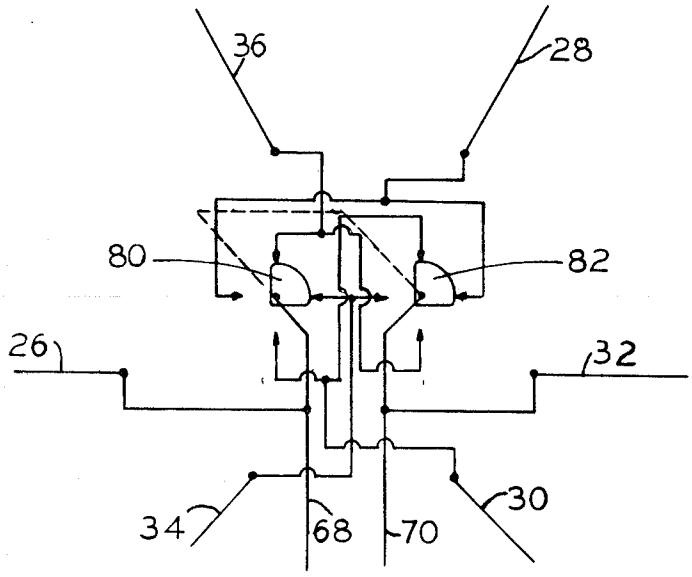


FIG. 5

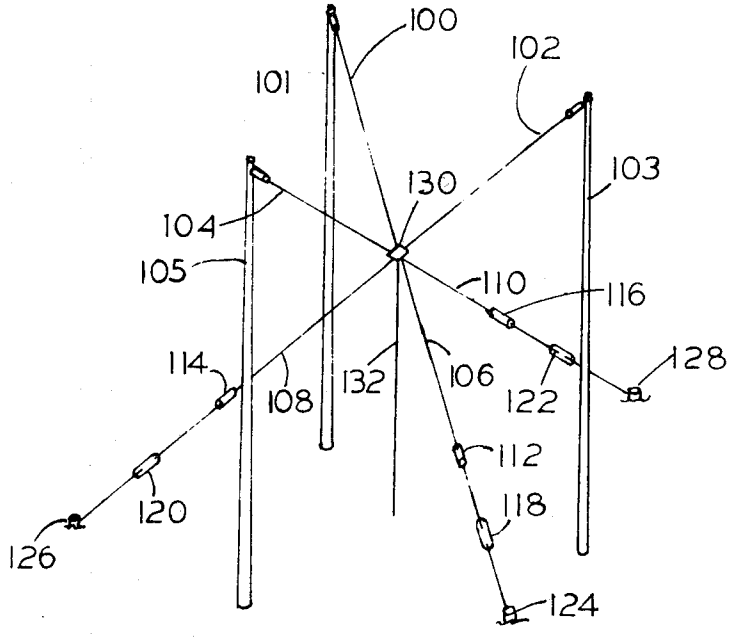


FIG. 6

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United States Patent Office

3,562,755
Patented Feb. 9, 1971

3,562,755

THREE DIMENSIONAL ANTENNA SYSTEM

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Filed July 5, 1968, Ser. No. 742,663
Int. Cl. H01q 21/00, 21/24
U.S. Cl. 343—853 7 Claims

ABSTRACT OF THE DISCLOSURE

Antenna system comprising six like lineal conductors of equal length and disposed on axes radiating from a common center, each conductor being at an angle of 90 degrees from the adjacent four elements, and switching means in the center area to connect combinations of three adjacent conductors to one lead-in and the remaining conductors to the other lead-in.

This invention relates to antenna system for radio and television use and adapted to radiate electromagnetic radio waves simultaneously in three dimensions.

Radio antenna systems generally radiate primarily in one dimension represented by the radiating element as in the Hertz dipole for example. While there are some variations, such as the quad, rhombic or conical types, none provide two dimensions as disclosed in my Pat. No. 3,274,606 issued Sept. 20, 1966. In my Pat. No. 3,453,635 issued July 1, 1969, there is shown a four element antenna to provide a three dimensional system, with certain switching advantages.

The present invention is directed to an antenna system wherein three elements are employed, so disposed as to effect the maximum separation of 90 degrees between any two of the three elements whereby to effect the maximum possible three dimensional diversity of propogation and reception. In one form, the three elements are fed at the ground plane, while variations employ two sets of three elements adapted to be fed against each other instead of against the ground. Where two sets are employed, the six elements are disposed so that any one element extends at a right angle to four of the other elements and is aligned with the remaining element. Thus with suitable switching, four differently directed three dimensional effects may be obtained.

The above and other novel features of the invention will appear more fully hereinafter from the following detailed description when taken in conjunction with the accompanying drawings. It is expressly understood that the drawings are employed for purposes of illustration only and are not designed as a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawings, wherein like reference characters indicate like parts:

FIG. 1 is a top plan view of a six element antenna according to the invention, with the elements radiating from a central support;

FIG. 2 is an enlarged side view of the antenna of FIG. 1 with elements considerably shortened;

FIG. 3 is a similar antenna with the elements supported from masts, but without vertical polarization;

FIG. 4 is a three element antenna with the elements fed at the ground plane;

FIG. 5 is a schematic illustration of switching means for any of the six element forms; and

FIG. 6 is a further mast supported variation and like FIG. 3 is adapted to longer wavelengths, but like FIGS. 1 and 2 with vertical polarization.

Referring to FIGS. 1 and 2, there is shown a switching relay housing, which for illustrative purposes is in the form of a cube **20** mounted with one of the cubes internal space diagonals **22** disposed on a vertical axis and supported on a vertical pole or mast **24**, in alignment with the diagonal **22**. Such diagonal extends from the pole to the apex **25** of the cube housing. Extending from the center of each of the six faces of the cube, and normal thereto, are conductors, each of which may be in the form of a whip antenna and all of identical length. The conductors are indicated at **26**, **28** and **30**, and **32**, **34** and **36**. It will be seen that the angle between each pair of adjacent conductors, measured in the common plane of the adjacent pair of conductors is 90°, while the horizontal angle between the three vertical planes in which the conductors **26** and **32**, and **28** with **34**, and **30** with **36** lie is 60°, and the angle between the three vertical planes in which the conductors **26**, **28** and **30** lie is 120°, as is also the angle between the three vertical planes in which the conductors **32**, **34** and **36** lie.

In order to permit the conductors to be constructed as light as possible, and to utilize whip antenna for the purpose, the tips of the conductors may be interconnected by nylon thread or other strong insulating cord, whereby to eliminate vibration and to maintain the conductors rigid against away and droop and in the desired angular relation to one another. Such cords as **40**, **42** and **44** will connect the ends of the conductors **26**, **28** and **30** together, while cords **46**, **48** and **50** will connect conductors **32**, **34** and **36** together. Further, cords **52**, **54**, **56**, **58**, **60** and **62** as indicated will complete the interconnection between the conductor tips to provide a rigid, but light structure, with conductors of relatively small diameter, and hence offering little obstruction to air currents. While in FIG. 2, cords are shown, they may be omitted if the individual elements have sufficient stiffness to maintain their relative positions without deflection.

Each conductor is insulated from the others. For lead in connections, any three adjacent conductors, such as **26**, **36** and **34** may be connected together within the housing **20**, as at **64** and the remaining conductors **28**, **30** and **32** connected together within the housing as at **66**, and the connections **64** and **66** connected to a lead in comprising feeders **68** and **70**. If desired remote controlled switching may be disposed in the housing **20** to vary the connections. In practice feeder **68** may be permanently connected to conductor **26**, and feeder **70** permanently connected to conductor **32**, which is aligned with conductor **26**. The connections shown, that is feeder **68** connected with conductors **26**, **34** and **36**, and feeder **70** connected with conductors **28**, **30** and **32** may be altered to three other sets of connections while retaining the fixed connection of the feeder **68** and **70** to conductors **26** and **32**. The other connections would then be feeder **68** and conductors **26**, **30**, **34**, or **26**, **28**, **30**, or **26**, **28** and **36**, while

feeder **70** would be connected to conductors **28**, **32**, **36**, or **32**, **34** and **36**, or **30**, **32** and **34** respectively.

For this purpose a ganged rotary switch as diagrammatically illustrated in FIG. 5 may be provided, the switch having two sets of four contacts, and rotary fan blades such as **80** and **82** being ganged together, the fan blades being connected to feeders **68** and **70** respectively and conductors **26** and **32** while the switch points are connected as shown to the conductors **28**, **30**, **34** and **36**.

In practice the housing **20** may be an 8 inch cube and the conductors **26**, **28**, **30**, **32**, **34** and **36** each 9 feet or 108 inches in length, and the transmission line may comprise feeders **68** and **70** of #4 wire spaced apart by the diameter of one strand. Such an antenna is highly suitable for frequency modulation, television, amateur, military and commercial short waves, and civilian broadcast, and is suitable for rooftop mounting, an optimum elevation of the center being approximately 20 meters, or 66 feet, above surrounding land. It may be furnished with a given transmission line and precalibrated tuner for any wavelengths.

Another version of the antenna using longer conductors may utilize three masts of equal height disposed at the apices of an equilateral triangle as indicated in FIG. 6. In such case a similar cube housing **20** enclosing suitable switching is provided with six conductors affixed to and extending through the center of each side of the housing and normal thereto. The conductors **100**, **102** and **104** extend to insulators at the upper end of the masts **101**, **103** and **105**, while conductors **106**, **108** and **110** of like length are connected to strain insulators **112**, **114** and **116**, and guy wires of nylon cords **118**, **120** and **122** extending to ground anchors at **124**, **126** and **128**. The angle between the conductors **100**, **102**, and **104**, and their respective masts **101**, **103** and **105** will be approximately 54.8 degrees and as before, adjacent conductors will be at 90 degrees, as measured in the common plane of the conductors. With masts 99 feet high and the strain insulators located 33 feet above ground, the length of each of the conductors, using an 8" cube housing for switching, will be about 56.9 feet to achieve the 90° angle between adjacent conductors, or such lesser length as may be necessary to accommodate strain insulators. The masts for such an installation would be disposed at the apices of an equilateral triangle, each side of which would be approximately 81.2 feet. As before, the switching by relays and connections to the transmission line indicated at **130** and **132** respectively, may be the same as in FIGS. 1 and 2.

A further version of the antenna may take the form indicated in FIG. 3, wherein masts **150** and **152** are provided which may be 100 feet high and spaced 70.70 feet, and masts 154 and 156 about 64.65 feet high are provided at a spacing of 100 feet, the masts **150** and **152** lying in a plane at right angles to the plane of the masts **154** and **156**. Stretched between masts **154** and **156** are two aligned horizontal conductors **158** and **160**, each 50 feet long, and stretched between positions at the upper end and 29.3 feet above ground of masts **150** and **152** are conductors **162**, **164**, **166** and **168**, each 50 feet long and extending 45° from horizontal, and all lying in a single vertical plane. Again the trigonometrical dimensions are chosen such that each of the six conductors are at an angle of 90 degrees to any adjacent conductor. Each of the two feeders of a transmission line **170** may be connected to the conductors such that one feeder is connected to any three adjacent conductors and the other feeder connected to the remaining conductors, the two sets being electrically insulated from each other at the center **172** of the array. If switching is desired, a relay switch housing such as **20** may be interposed at **172**, and if cubical as before, the cube is oriented to allow each conductor to extend normal to and from the center of one face of the cube.

A further version of the antenna is illustrated in FIG. 4 wherein three conductors **200**, **202** and **204** of equal length, and disposed in vertical planes 120 degrees apart, and set at an angle so that adjacent conductors are 90 degrees apart as measured in the plane of the adjacent conductors are provided. The upper ends of the conductors may be supported on three like masts **206** disposed at the apices of an equilateral triangle. All conductors are joined as at **208** at ground level and the lead-in may consist of a central conductor **210** of a coaxial conductor cable, the outer shell **212** of which is grounded. Each wire will bear an angle of 35.2 degrees to the horizontal.

It will be understood that the antennas of FIGS. 1 and 2 and 4 and 6 may be said to use vertical polarization by reason of the vertical axis forming in effect an axis for the elements **26**, **28** and **30**, whereas in FIG. 3, while the six elements are all of the same length, and bear the same 90 degree relationship between adjacent elements, no axis about which any three adjacent elements may be said to be disposed, is vertical. If desired a switching relay housing may be supported at the convergence of the six elements as at **172**, having the circuitry of FIG. 5. The arrangement is for fixed station use or short medium or long wave transmission or reception, and not using vertical polarization.

The arrangement of FIG. 4 is suitable for broadcasting bands, and alleviates the annoyance of transistor receivers having to be oriented to prevent signal neutralization or nulls.

The arrangement of FIG. 6 is adapted for a fixed station which can use the vertical polarization mode as one of its possible switching modes, in which the upper three elements are on one feeder and the lower three on the other feeder.

While a single embodiment with variations of the invention has been illustrated and described, it is to be understood that the invention is not limited thereto. As various changes in the construction and arrangement may be made without departing from the spirit of the invention, as will be apparent to those skilled in the art, reference will be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. An antenna system comprising three like lineal elements of equal length with each element disposed entirely on an axis radiating from a common center, and each element having its inner end disposed at the same distance from the common center, and each element being at an angle of substantially 90 degrees from the adjacent two elements, and each element bearing an angle of approximately 54.8 degrees from an exis extending through the center and centrally with respect to the three elements.

2. An antenna system according to claim **1** wherein a second set of three like elements are provided extending on axis radiating from the center in directions substantially opposite from each of the first three elements and three adjacent elements are connected together and insulated from the remaining elements.

3. An antenna system according to claim **2** wherein each of the six elements is at an angle of substantially 90 degrees from each of four adjacent elements, and wherein switching means are provided in the center area to connect combinations of three adjacent elements to one lead-in and the remaining elements to the other lead-in.

4. An antenna system according to claim **1** wherein the common center is at approximately ground level and the central axis substantially perpendicular thereto, and a single lead-in from the three elements is provided in the form of the central conductor of a coaxial cable, the outer sheath of which is grounded.

5. An antenna system according to claim **3** wherein the switching means is disposed in a central housing of cubical shape having six square faces, and in which the six elements each radiate from the center of a housing face normal to the face, whereby any one element bears an angle of substantially ninety degrees to four adjacent elements and is in substantial alignment with the remaining element, extending oppositely.

6. A antenna system according to claim 5 wherein the housing is disposed with a long diagonal passing through the cube center extending substantially vertically.

7. An antenna system according to claim 3 wherein each of the elements are relatively resilient and unsupported at their outer ends, and in which insulating stays connect the adjacent elements adjacent their outer ends whereby to hold the elements on their respective axes.

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