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Czerwinski

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[54] **TRIPLEX ANTENNA**

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[52] **U.S. Cl.** **343/790;** 343/822; 343/872

[51] **Int. Cl.**[2] **H01Q 9/04**

[58] **Field of Search** 343/790, 791, 792, 822, 343/872

[56] **References Cited**

UNITED STATES PATENTS

2,199,375 4/1940 Lindenblad 343/790

Primary Examiner—Eli Lieberman

Attorney, Agent, or Firm—Nathan Edelberg; Robert P. Gibson; Arthur L. Bowers

[57] **ABSTRACT**

An antenna system for operation in the UHF and VHF band comprising at least three individually excited tubular dipole antennas vertically oriented in an in-line configuration inside of a tubular radome and being spaced approximately one wavelength apart. Each tubular radiation element is excited by means of a Gamma Match feed (DC grounded) for protection against lightning and destructive effects from high level electromagnetic pulses. A coaxial sleeve approximately a quarter wavelength long is additionally mounted exteriorly of and is associated with each tubular radiating element inside of the radome for broadbanding the feed-point impedance of the respective dipole antennas.

14 Claims, 3 Drawing Figures

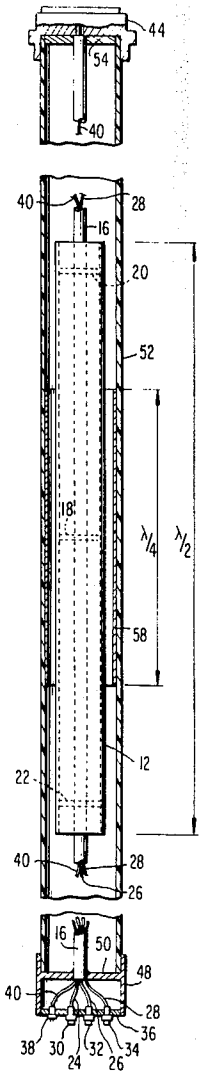


FIG. 1

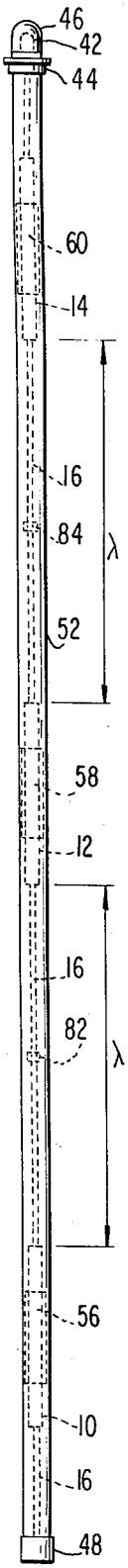


FIG. 2

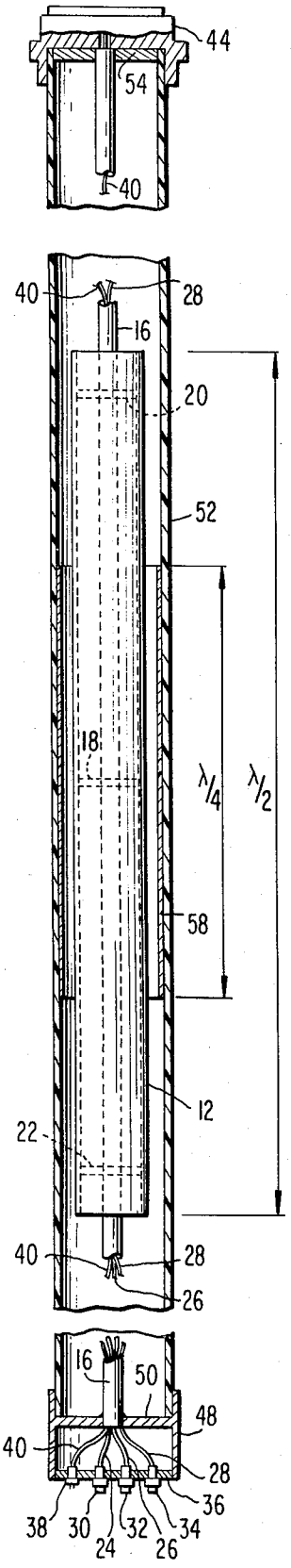
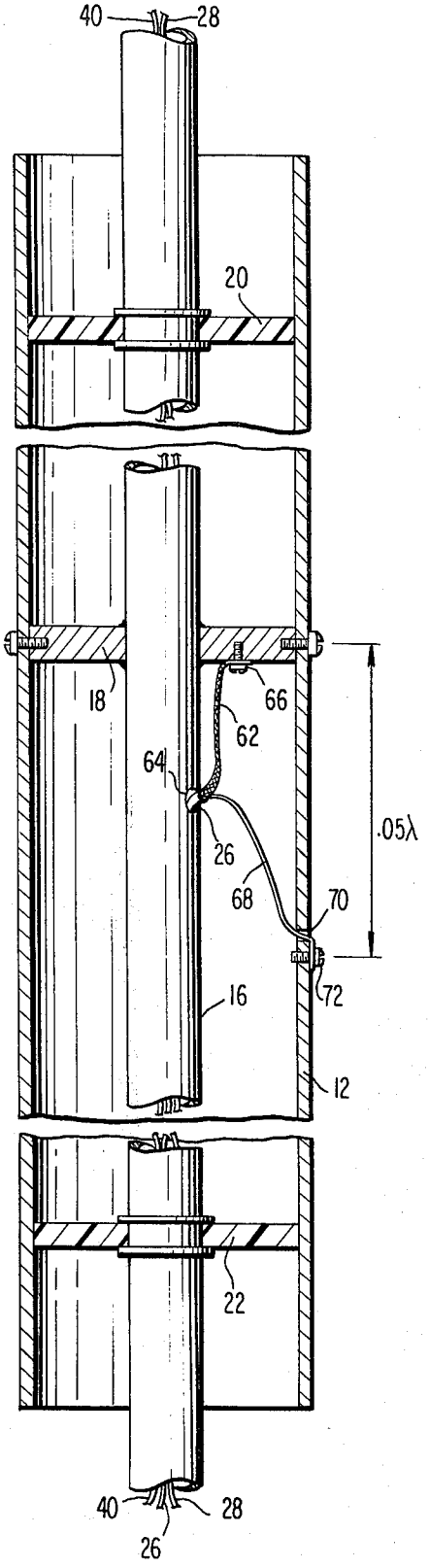


FIG. 3



TRIPLEX ANTENNA

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

The present invention relates generally to antenna systems for radiating and intercepting electromagnetic energy and more particularly to a vertical dipole antenna array for permitting simultaneous operation of a plurality of radio apparatus in the same frequency band.

Tactical military aircraft control centrals are known to operate up to three radio sets (transceivers) simultaneously on the same UHF (220–400MHz) and/or VHF (115–150MHz) frequency bands. Presently, these units utilize a separate but identical antenna for each of the radio transceivers in both the transmit and receive modes. These antennas, however, are mounted in a cluster laterally spaced with respect to one another, having a separation of one wavelength which for an operating frequency of 300MHz is in the order of 40 inches. Experience has shown, however, that when one antenna is operating in the transmit mode, sufficient energy is coupled into the other antenna(s) to render its (their) respective receiver(s) inoperable due to high level of cross-talk and receiver desensitization. Therefore, due to this limitation, it is current practice to use only one transmission link at a time. Such practice, however, has been found to be unsatisfactory when air traffic becomes relatively dense due to the fact that more than one link is necessary in order to insure safety against collision between incoming and outgoing aircrafts.

Additionally, it is well known that electrical isolation between two dipole antennas fed from separate radio signal sources is significantly greater when the dipoles are mounted one above the other on the same axis as opposed to being arranged in a broadside relationship with the same relative spacing between feed points. The following references are known to constitute prior art arrangements of such vertical in-line antenna systems:

U.S. Pat. No. 2,115,761, A. D. Blumlein;
U.S. Pat. No. 2,158,376, W. Mosher, et al.; and
U.S. Pat. No. 2,425,585, H. A. Wheeler.

SUMMARY

Briefly, the subject invention comprises at least a three bay vertically stacked dipole antenna assembly having individually excited tubular dipole radiating elements axially aligned along a common vertical central axis and being respectively fed from separate radio apparatus operable in the same frequency band and being fed by what is generally referred to as a Gamma Match by coaxial cables fed through a relatively small diameter metallic tubular support conduit running up inside of the radiating elements. A tubular broadbanding element having a length shorter than the respective radiating element is arranged coaxially with and exteriorally of the respective tubular dipole radiating element, being held in place by the inner surface of a tubular radome. Each of the dipole radiating elements are separated by substantially one wavelength and the tubular support conduit containing the coaxial feeds are adapted to include lossy coating and ferrite rings on the conduit's outer surface for limiting unwanted circulating currents and to increase the desired electrical isolation between bays.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view illustrative of the preferred embodiment of the subject invention;

FIG. 2 is an enlarged fragmentary view of a longitudinal cross section of the embodiment shown in FIG. 1, being illustrative of one bay of the antenna array; and

FIG. 3 is a still further fragmentary view of the embodiment shown in FIG. 1, being further illustrative of the bay shown in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An antenna is a conductor so constructed as to either radiate or collect electromagnetic energy or to do both. A transmitting antenna converts electrical energy from a source into electromagnetic waves called radio waves which radiate away from the antenna at speeds near the velocity of light. A receiving antenna on the other hand converts electromagnetic waves which it intercepts into electrical energy and applies this energy to radio receiver apparatus for interpretation. Some antennas such as that forming the subject invention are adapted to serve both functions being coupled to transceiver apparatus which is adapted to both send and receive communication signals.

A halfwave dipole antenna is not only a fundamental element of an antenna system, it is particularly adapted for communications for use in applications above 2MHz (2×10^6Hertz). Basically, the halfwave dipole antenna is comprised of two quarterwave conductors linearly aligned and having the inner extremities thereof excited by an RF generator. Such apparatus is well known to those skilled in the art and is well documented in the literature.

The subject invention is directed to the problem of operating a plurality, for example, three sets of radio apparatus simultaneously on the same frequency band while being in relatively close proximity to one another but sufficiently decoupled to permit operation of each without interference from the others. Referring now to the drawings and more particularly to FIG. 1, the antenna system comprising the subject invention includes, for purposes of illustration, three tubular halfwave dipole radiation elements **10, 12** and **14** mounted on a common support conduit **16** in the form of a grounded metal pipe or the like by means of respective metal support plates or grounding discs, not shown. The dipole elements **10, 12** and **14** are axially aligned with the metal support conduit **16** thus having a common central axis which is vertically oriented. The spacing between adjacent dipole elements **10, 12** and **14** is in the order of one wavelength (λ) of a predetermined center frequency of operation, which includes both the UHF band (220–400MHz) as well as the VHF band (115–150MHz).

The three bay configuration shown in FIG. 1 includes tubular dipole antenna elements which have substantially the same overall physical dimensions inasmuch as they are adapted to operate in combination with respective radio apparatus operating in the same frequency band. Therefore only one of the three dipole elements i.e. the middle element **12** is shown in FIGS. **2** and **3** for the purposes of further illustrating the de-

tails of the subject invention. For operation in the region of 300MHz, the dipole elements **10, 12** and **14** consist of aluminum tubing typically having an outer diameter in the order of 2 inches and a length ($\lambda/2$) in the order of 20 inches. Referring now to FIG. **2,** the support conduit **16** is of a relatively smaller diameter grounded metal pipe and is hollow so as to act as a passageway for the respective coaxial dipole element feedlines **24, 26** and **28,** which respectively terminate in three coaxial connectors **30, 32** and **34** mounted on a first or lower base plate **36.** These coaxial connectors are adapted to be coupled to separate aforementioned radio apparatus, now shown. A fourth connector **38** is also located in the base plate **30** for the connection of AC line potential thereto from a source not shown. An AC line cord **40** coupled to the connector **38** is adapted to travel up through the conduit **16** to the top of the entire antenna assembly for lighting one or more hazard lights **42** located on a sub-assembly including a support member **44** having a globe **46** attached thereto as shown in FIG. **1.** The purpose of the hazard lights **42** is due to the fact that the overall height of the antenna system is in the order of 25–30 feet for operation in the VHF band and in the order of 15–20 feet for operation in the UHF band and since the primary use of such apparatus is for aircraft control, being located in close proximity to an airstrip.

Continuing with the structural details, the base plate **36** containing the coax connectors **30, 32** and **34** as well as the AC connector **38** is attached to the lower portion of a metal sleeve **48** which has a second base plate **50** attached to the upper portion thereof. The base plate **50** includes a mounting hole at the center to which the lower end of the support conduit **16** is secured. A radome **52** comprising a tubular structure formed of fiberglass or the like is fitted to the inside surface of the sleeve **48,** coming to rest on the base plate **50** as shown in FIG. **2.** The sub-assembly for the hazard lights **42** and including the support member **44** is adapted to fit over the other end of the radome **52.** Additionally, a third or upper base plate **54** is fitted inside the upper portion of the radome **52** and includes a hole at its center whereupon the top portion of the conduit **16** is inserted therein and secured. Thus what is obtained is a relatively tall, thin, tubular type assembly adapted to include at least three dipole tubular radiators **10, 12** and **14,** spaced approximately one wavelength apart inside of the radome **52** and being attached to the inner support conduit pipe **16** by means of respective metallic spacers, for example element **18** shown in FIGS. **2** and **3.** Dielectric spacers **20** and **22** are additionally included near both ends of the radiating dipole element for providing added support.

Each of the dipole elements **10, 12** and **14,** moreover, has a respective impedance broadband element **56, 58** and **60** associated with it which is shown comprising a quarter wavelength $\lambda/4$ section of thin wall aluminum tubing or aluminum foil of relatively larger diameter than the elements themselves and being fitted and held stationary inside of the radome **52** by the fact that the outer diameter of the sections **56, 58** and **60** is made equal to the inner diameter of the radome **52.** This is shown in greater detail in FIG. **2** with respect to element **58.** The broadbanding sections **56, 58** and **60,** moreover, are arranged such that they are substantially midway between the lengths of the respective radiators thus providing a symmetrical arrangement.

Since the excitation connection of the respective coaxial cable to each dipole element is the same for all three bays, only one will be considered in detail. Referring now to FIG. **3** and the bay including the dipole element **12,** the braid or outer conductor **62** of the coaxial cable **26** is grounded to the metal support disc **18** after being fed out of a hole or port **64** in the conduit **16** near the disc **18.** This ground connection is shown for example by means of a set screw **66.** It should be noted, however, that any type of electrical connection can be made such as by soldering and could be to the conduit **16** itself near the port **64** when desired. The inner conductor **68** of the coax **26** is fed across the inner diameter and through a hole or opening **70** in the dipole element **12** and connected to the outer surface thereof by means of another set screw **72.** The location of the connection of the inner conductor **68** to the outer wall surface of the dipole element **12** is significant, being at a point of minimum VSWR in the coaxial feed cable **26.** This comprises a distance $L = 0.05\lambda$ away from the grounding point of the outer conductor **62** i.e. at the location of the metal support disc **18.** At 300MHz, this distance is typically 2 inches. This type of feed to a dipole antenna is generally referred to as a Gamma Match. Such a feed connection is selected because it results in a DC grounded antenna desirable for protection against lightning and destructive effects from high-level electromagnetic pulses (EMP).

Undesired antenna current which would normally be coupled to the surface of the support pipe **16** and having a tendency to limit the level of electrical isolation obtainable between adjacent dipole elements **10, 12** and **14** is dissipated by coating the outside surface of the conduit **16** with a lossy ferrite material. Additionally, lossy ferrite rings shown schematically by reference numerals **82** and **84** in FIG. **1** are affixed to the outer surface of the pipe **16** intermediate the lower and middle dipole elements **10** and **12** and the middle and upper dipole elements **12** and **14,** respectively.

Thus what has been shown and described is a multiple dipole array in the form of light weight one-piece adapted to operate a plurality of radio sets simultaneously within the same frequency band while being electrically isolated from one another. Each dipole moreover is capable of broadband operation with a VSWR less than 3:1 by virtue of the broadbanding effects of elements **56, 58** and **60** and is adapted to provide an omnidirectional radiation pattern. By proper phasing of the feed between each dipole, high gain operation as a single radiation source is easily obtainable. Since all members are grounded to DC, automatic protection against lightning is obtained.

Having thus described what is at present considered to be the preferred embodiment of the subject invention, I claim as my invention:

1. A broadband antenna system for a plurality of radio apparatus adapted to operate simultaneously in the same frequency band, comprising in combination:

a generally vertically oriented electrically conductive and grounded support conduit of predetermined length;

a respective plurality of in-line tubular dipole radiating elements, one for each of said plural radio apparatus, axially mounted on said support conduit, the inner surface of said tubular radiating elements being grounded to said conduit substantially midway along their respective lengths;

a port in the sidewall of said support conduit at the location of each of said radiating element;

a respective coaxial cable, having an inner and outer conductor, coupling each radiating element to a respective radio apparatus of said plurality of radio apparatus, running through support conduit and out of a respective port, said outer conductor being electrically grounded in the vicinity of said port;

each said tubular radiating element having an opening to the outer wall surface thereof wherein the inner conductor of the respective coaxial cable passes therethrough and is electrically connected to said outer surface; and

respective impedance broadbanding means for each of said dipole radiating elements disposed exteriorally of each of said radiating elements.

2. The antenna system as defined by claim **1** wherein each said respective broadbanding means comprises quarter wavelength tubular elements coaxially disposed outside of the respective tubular radiating element and positioned intermediate the length of said tubular radiating element.

3. The antenna system as defined by claim **2** wherein said coaxial tubular broadbanding element is disposed substantially mid-way along the length of the respective tubular radiating element.

4. The antenna system as defined by claim **3** and additionally including a tubular radome coaxially oriented with respect to said plurality of tubular radiating elements and their respective tubular broadbanding elements, said radome having an inner surface which is adapted to hold the broadbanding tubular elements in position relative to the respective radiating elements.

5. The antenna system as defined by claim **4** wherein said support conduit comprises a tubular member of a relatively small cross sectional dimension with respect to said tubular radiating elements and having the outer surface coated with lossy material for providing electrical isolation between adjacent radiating elements.

6. The antenna system as defined by claim **5** and additionally including at least one ring of lossy material disposed on the outer surface of said tubular member located intermediate said plurality of radiating elements for providing additional electrical isolation between adjacent radiating elements.

7. The antenna system as defined by claim **1** wherein said opening in each said tubular member is located approximately 0.05 wavelength of a predetermined operating frequency distance away from the point along the length of said radiating element wherein the inner surface of said element is grounded to said support conduit.

8. The antenna system as defined by claim **1** and additionally including respective electrically conductive support and grounding means attaching each tubular radiating element to said support conduit, said means being disposed normal to the common central axis of said support conduit and said plurality of tubular radiating elements.

9. The antenna system as defined by claim **8** wherein the outer conductor of each coaxial cable is electrically connected to said support and grounding means.

10. The antenna system as defined by claim **1** and additionally including means located at the upper end of said support conduit for mounting at least one hazard light thereon, and electrical conductor means for operating said hazard light running through said support conduit.

11. The antenna system as defined by claim **1** wherein said plurality of radiating elements comprises at least three substantially identical tubular radiating elements having a mutual separation of approximately one wavelength of a predetermined operating frequency.

12. The antenna system as defined by claim **1** and additionally including a mounting sleeve and a first base plate attached to the lower portion thereof, said plate including a respective plurality of coaxial cable connectors mounted thereon and being respectively connected to each coaxial cable, a second base plate attached to the upper portion of said sleeve, said support conduit being mounted on said second base plate.

13. The antenna system as defined by claim **12** and additionally including a tubular radome fitted to said mounting sleeve.

14. The antenna system as defined by claim **13** wherein said impedance broadbanding means comprises quarter wavelength tubular sections, and wherein said support member, said plurality of tubular radiating elements and respective tubular broadbanding elements as well as said tubular radome are circular in cross section.

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