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[54] **DUPLEXED ANTENNA FOR RETRANSMISSION DEVICES**

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[52] **U.S. Cl.** **343/729,** 343/791, 343/830, 343/853

[51] **Int. Cl.** **H01q 1/00**

[58] **Field of Search** 343/722, 725, 727, 343/729, 730, 790, 791, 792, 830, 853

[56] **References Cited**

UNITED STATES PATENTS

3,579,244	5/1971	Dempsey	343/846
3,139,620	6/1964	Leidy et al.	343/730
3,541,556	11/1970	Cheillan	343/727
2,648,771	8/1953	Cork	343/722
2,096,782	10/1937	Brown	343/722
3,259,901	7/1966	Bykerk	343/848

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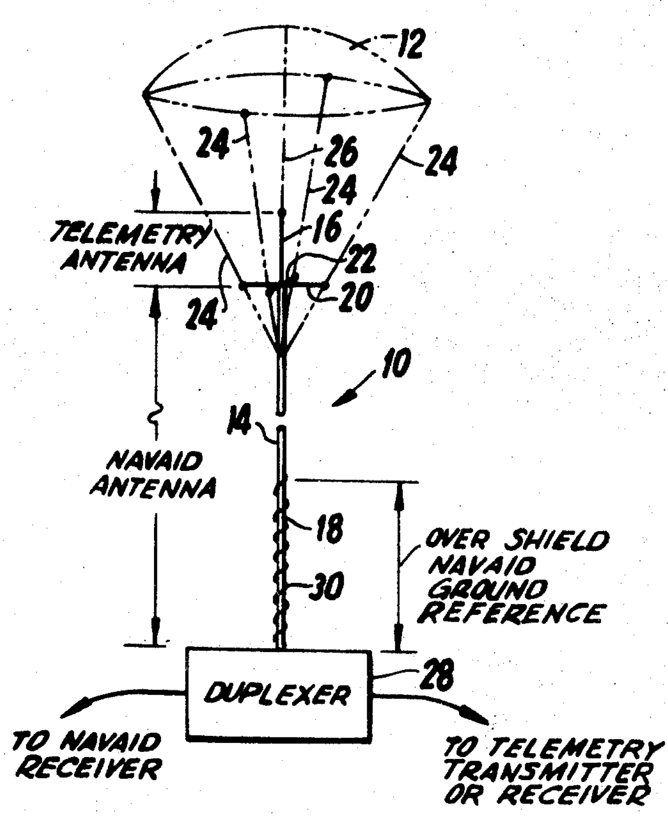
[57] **ABSTRACT**

A dual antenna system formed on a common structure includes two antennas operating within different frequency ranges. In one embodiment of the invention the central conductor of a coaxial line defines the receiving element of one antenna and the shield of the coaxial line is employed as the receiving element of the second antenna. A ground plane for the first antenna is coupled to the coaxial shield. In a second embodiment of the invention the central conductor of the coaxial line is electrically divided to serve as the receiving element of both antennas, and the shield of the coaxial line forms a part of the ground element of one of the antennas. Duplexing circuitry connected to the antenna separates the signals received at the two antennas and applied the separated signals to the appropriate receiver or transmitter.

2 Claims, 6 Drawing Figures



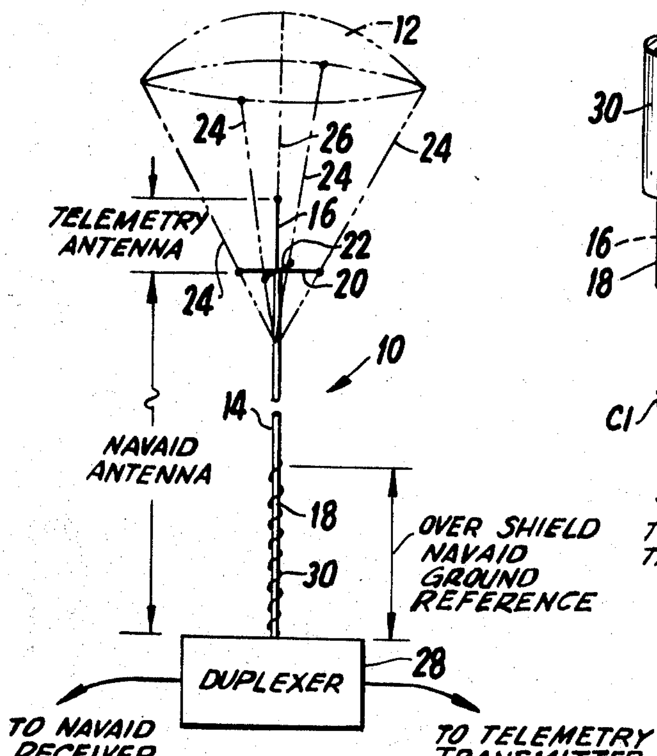


FIG. 1

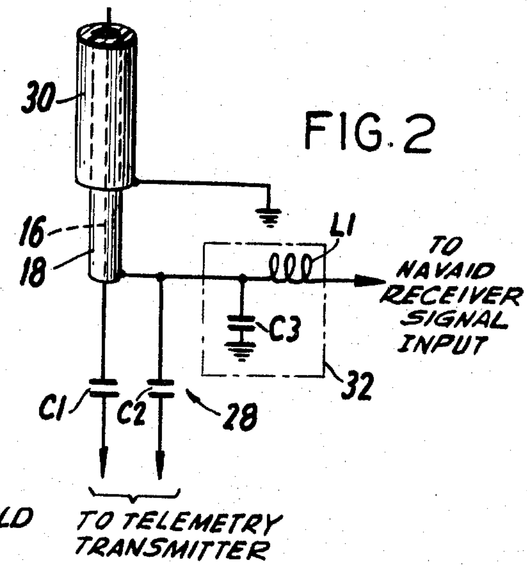


FIG. 2

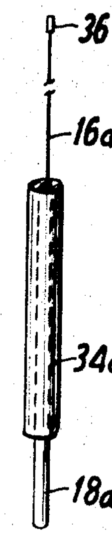


FIG. 6

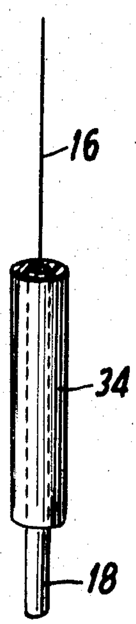


FIG. 3

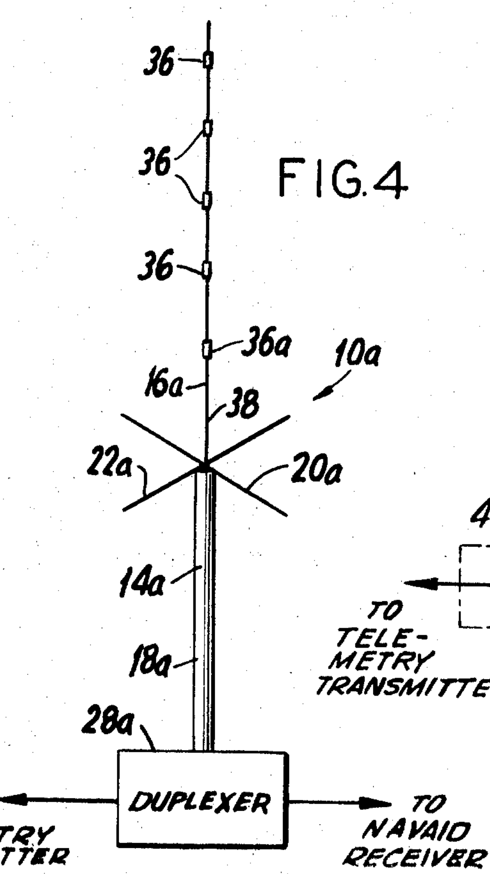


FIG. 4

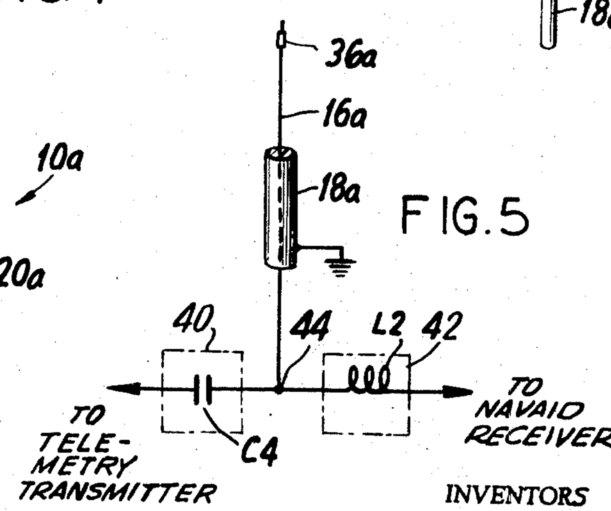


FIG. 5

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DUPLEXED ANTENNA FOR RETRANSMISSION DEVICES

The present invention relates generally to antennas, and more particularly to an improved dual antenna system capable of operating within two distinct frequency ranges.

There are a great number of applications in which two antennas capable of operating at distinct frequency ranges are employed. One such system is described in a co-pending application Ser. No. 873,590, now U.S. Pat. No. 3,683,377 entitled Navigation System for a Meteorological Telemetry System, and assigned to the assignee of this application. The system disclosed in said co-pending application is a meteorological sensing and data transmitting system including a balloon-carried radiosonde. The system further includes a telemetry antenna coupled to a transmitter operating in the VHF or UHF range. A carrier modulated by sensed meteorologic data is impressed onto the antenna for transmission to a ground data receiving station. To enable the determination of the position of the radiosonde at the remote receiving station, the radiosonde disclosed in said application is additionally provided with a navigation or Navaid receiver and transmitter and a separate antenna, which may be a Loran-C or Omega system, or the like, operating at frequencies in the range of 10 – 100KHz.

Where possible, it is desirable to separate the telemetry and navigation antennas to ensure maximum isolation and thus minimum interference between the two antennas. For example, in the system disclosed in said co-pending application, one of the antennas extends upwardly from one surface of the radiosonde while the other antennas extends downwardly from an opposite surface of the radiosonde housing. There are, however, many system applications requiring the use of two or more antennas in which the configuration of the antenna support structure or the manner in which the antenna system is to be employed, makes it desirable if not imperative to deploy at least two of the antennas from a common surface of the antenna structure. For example, in a dropsonde, the antenna system is dropped from an aircraft and held aloft for a period of time by a parachute. For optimum operation of the system, the two antennas should both radiate in a common direction such as toward an aircraft in which the tracking and data receiving systems are located. Other applications in which the deployment of two antennas from a common surface is desirable include the use of a dual antenna system on buoys, sonobuoys, manpacks, helicopters, boats and ships, and fixed wing aircraft.

To deploy two antennas from a common surface in a side-by-side relation usually causes an intolerable level of interaction between the two antenna systems. Moreover, it is highly desirable that the combined antenna system should be light in weight particularly in applications in which the system is adapted to be carried aloft by a balloon or parachute. Moreover, for optimum practicality the antenna system should be economical and yet reliable, particularly in those applications in which the antenna system is expendible.

It is thus an object of the invention to provide an improved dual antenna system which can be mounted on and extended from a common surface of a support without the introduction of significant interference between the two antennas.

It is a further object of the invention to provide a dual antenna system of the type described which can be fabricated as a unitary assembly.

It is another object of the invention to provide a dual antenna system of the type described in which certain elements are common to both antennas and which is thus relatively economical and light-weight.

The antenna system of the present invention as broadly conceived comprises a coaxial cable including a central conductor and a surrounding coaxial outer or shield conductor. A single element of the coaxial cable performs a common role for the two antennas. For example, as in one embodiment herein specifically described, one of the antennas utilizes the central conductor to define a monopole above a ground plane fed by the outer conductor, the latter in turn defining the receiving element of the second antenna. A shield arranged about and insulated from the lower end of the coaxial outer shield defines the ground reference for the second antenna. The ground plane for the first antenna may be as herein shown in the form of radial conductors coupled to and extending from the upper end of the coaxial shield which have the desirable, added result of increasing the effective electrical length of the second antenna.

In another version of the dual antenna system of the invention the central conductor of the coaxial line serves as the receiving element for both of the antennas, suitable means being provided therein to electrically divide the electrical length of the central conductor to enable it to operate at the distinct frequencies of the two antennas. The outer coaxial shield serves as the ground reference for one of the antennas, and means coupled to the coaxial shield establishes a ground plane for the other of the antennas.

Also disclosed herein is a duplexer circuit for connection to the common dual antenna structure for selectively coupling the signals at the two frequencies associated with each of the antennas to the desired receiver or transmitter with minimum interference or interaction between the two signals.

To the accomplishment of the above and to such further objects as may hereinafter appear, the present invention relates to an improved dual antenna system, substantially as defined in the appended claims and as described in the following specification taken together with the accompanying drawings in which:

FIG. 1 is a perspective view in schematic form of the dual antenna system according to one embodiment of the invention as deployed from a parachute;

FIG. 2 is a schematic diagram of the duplexer of the system of FIG. 1;

FIG. 3 is a fragmentary perspective view of a possible variation in the dual antenna system of FIG. 1;

FIG. 4 is a perspective view in schematic form of a second embodiment of the invention;

FIG. 5 is a schematic diagram similar to FIG. 2 of the duplexer for use with the antenna system of FIG. 4; and

FIG. 6 is a view similar to FIG. 3 of a possible variation of the antenna system of FIG. 4.

While the dual antenna system of the invention may be employed to considerable advantage in a great variety of applications in which two or more antennas are to operate at distinct frequencies, the invention is herein described with reference to a dual antenna system for use in providing telemetry and navigation information. In a typical application of this type, the telemetry data is transmitted over a VHF or UHF carrier which is in the mega-or gigaherz range, while the navigation aid (navaid) system, which may be a Loran-C or Omega system, transmits and receives information over a 10 – 100KHz carrier. In the description that follows these antennas are respectively referred to as the telemetry and navigation antennas.

Referring first to the embodiment of the invention illustrated in FIG. **1**, the dual antenna system of the invention generally designated **10** is held aloft by means of a parachute **12**. Antenna system **10**, which includes separate antennas for telemetry and navigation signals, is in the form of a coaxial cable **14** including a central conductor **16** surrounded and insulated from a coaxial outer shield or conductor **18**. A pair of orthogonal radial conductors **20** and **22** are attached to and electrically connected at their approximate centers to the upper end of coaxial shield **18**, and the ends of radial conductors **20** and **22** are secured to opposing pairs of parachute support lines **24**. The upper end of central conductor **16** is secured to an axial support line **26** of the parachute. The attachement of the central and radial conductors to the parachute support lines **24** and **26** permits the parachute to securely and reliably support and carry the antenna system **10**. A grounded concentric shield **30** is arranged about the lower section of coaxial shield **18** for reasons set forth below.

As is more completely described below with reference to FIG. **2**, central conductor **16** and coaxial shield **18** are coupled at their respective lower ends to a duplexer **28** which separates and then guides the signals from the two sections of antenna system **10** to the corresponding transmitter and/or receiver (not shown). Means in duplexer **28** are coupled to outer conductor **18** to establish an effective ground at one of the signal frequencies, and to electrically couple signals at the other frequency to the appropriate (telemetry or navaid) receiver or transmitter.

As seen in FIG. **1**, central conductor **16** extends axially by a distance approximately equal to one-quarter wavelength of the telemetry frequency beyond the upper end of outer conductor **18**. The extending portion of the central conductor **16** defines a quarter-wave monopole telemetry antenna over a ground plane defined by the intersecting radial conductors **20** and **22**.

The navigation antenna has its conducting element defined primarily by the length of outer coaxial conductor **18** and its ground reference is established by the outer shield **30**. The radial conductors **20** and **22**, which define the ground plane for the telemetry antenna, serve as loading for the navigation conducting element (conductor **18**), to thereby effectively increase the electrical length of the navigation antenna. This feature is generally highly desirable since navigation frequencies (Loran) are relatively low, in the range of 10 – 100KHz, so that optimum reception and transmission at those frequencies is obtained by increasing the length of the navigation antenna as much as is practical.

The manner in which duplexer **28** serves to selectively separate and guide telemetry and navigation signals from the dual antenna system to the proper receiver or transmitter is shown in FIG. **2**. As therein shown center conductor **16** is coupled through parallel capacitor C1 to the output of the telemetry receiver. Outer conductor **18**, which acts as a ground plane for the telemetry antenna and as a signal conducting element for the navigation antennas, is coupled through a capacitor C2 to the ground terminal of the telemetry transmitter, and through a filter network **32** consisting of inductor L1 and capacitor C3 to the signal input of the navigation transceiver.

Inductor L1 provides a relatively high impedance to the telemetry signals and a relatively low impedance to the lower frequency navigation signals, while capacitor C3 acts respectively as a low impedance and a high impedance to ground for the telemetry and navigation signals, to thereby conduct essentially only low frequency navigation signals to the navigation transceiver, while conducting the telemetry signals to ground as is desired.

Capacitors C1 and C2 are in operative series relationship with the equivalent capacitance established between center conductor **16** and outer conductor **18**, and thus lowers the effective input capacitance to the telemetry transmitter. This in turn has the beneficial effect of increasing the impedance to the low-frequency navigation signals at the input of the telemetry transmitter. Moreover, the provision of capacitors C1 and C2 lowers the net input capacitance to the navigation transceiver established by the coaxial cable capacitance which appears in parallel with the input of that transceiver. For optimum operation the values of capacitors C1 and C2 are selected such that their series value present a low impedance at telemetry frequencies.

If desired to achieve a dipole radiation pattern rather than a monopole radiation pattern for the telemetry signals, as in the embodiment of FIG. **1**, the dual antenna system of the invention may be modified by utilizing, as shown in FIG. **3**, a conducting sleeve **34** connected to the outer conductor **18** in place of the radial conductors ground plane of the FIG. **1** embodiment. Sleeve **34** preferably has an axial length equal to a quarter-wavelength at the telemetry frequencies so as to define along with the quarter-wavelength extension of central conductor **16**, a half-wave dipole antenna for the telemetry signals.

FIGS. **4–6** illustrate a second embodiment of the dual antenna system of the invention in which, as in the embodiment of FIG. **1**, the elements of a coaxial cable are employed to define the elements of two antenna systems operating at two distinct frequency ranges. Where elements of the system of FIG. **4** corresponds to elements of the system of FIG. **1**, they are identified in FIGS. **4–6** by corresponding reference numerals with the suffix a being appended thereto.

Thus, the antenna system of FIG. **4** generally designated **10*a*** comprises a coaxial cable **14*a*** which in turn includes an elongated central conductor **16*a*** enclosed and insulated from an outer coaxial conductor or shield **18*a***. The upper end of conductor **18*a*** is electrically connected to a pair of intersecting radial conducting elements **20*a*** and **22*a*** which, as in FIG. **1**, define a ground plane for the monopole telemetry antenna. Central conductor **16*a*** is coupled to a duplexer **28*a*** which is more completely described below with reference to FIG. **5**.

In the embodiment of FIG. **4**, central conductor **16*a***, the entire length of which defines the conducting element of the navigation antenna, is electrically divided into a number of section by the provision of a series of axially spaced chokes (or resistors) **36** along its exposed length. The length **38** of central conductor **16*a*** between the ground plane radial conductors **20a** and **22a** and the first choke **36a** defines the monopole of the telemetry antenna and is of a length equal to between one-quarter and three-eighths of a wavelength at telemetry frequencies depending on the radiation pattern desired for the telemetry signals. The spacing between all adjacent other chokes **36** along central conductor **16a** from forming parasitic radiators of telemetry signals which would adversely affect the impedance and radiation pattern of the telemetry antenna.

The outer conductor **18a** of the coaxial cable serves as the ground return for both the telemetry and navigation antennas, and the center conductor **16a** contains signals at both the navigation and telemetry frequencies. The center conductor **16a**, as shown in FIG. **5**, is connected to duplexer **28a** which separates the navigation and telemetry signals and applies these signals to the appropriate receiver and/or transmitter. Duplexer **28a** includes two networks **40** and **42** connected to conductor **16a** at a point **44**. Network **40** as shown consists of a capacitor C4 having a value of capacitance that presents a high impedance at the navigation frequencies while providing a low impedance path between the telemetry transmitter and telemetry antenna, that is, conductor **16a**. Network **42** includes an inductor L2 which provides a high impedance path to the telemetry frequencies while providing a low impedance path for navigation frequencies.

As shown in FIG. **6**, the radial conductor ground plane for the telemetry antenna in FIG. **4** may be replaced by a sleeve **34a** connected to the outer conductor **18a** to obtain a dipole radiation pattern for the telemetry signals.

The antenna system of the invention thus provides an efficient antenna system having a common antenna structure and capable of reliable operation at two distinct frequency ranges. Individual elements of the dual antenna system serve as elements of each antenna, and yet interference between the two antennas is negligible. The antenna system of the invention is particularly useful in those applications in which it is required to implement two separate antennas on a single antenna structure which is to be mounted on a common surfaces.

While the two antennas of the system herein described have been designated for use in transmitting and receiving telemetry and navigation signals, the dual antenna system of the invention could be used to equal advantage in other applications requiring the transmission and reception of signals of two different frequencies by a common antenna structure.

Thus while several embodiments of the present invention have been herein specifically described it will be apparent that modifications may be made therein without departing from the spirit and the scope of the invention.

We claim:

1. A dual antenna system including first and second antennas respectively capable of operating at first and second distinct frequency ranges, said antenna system comprising a coaxial transmission line having a central conductor and an outer conductor surrounding and insulated from said central conductor, said central conductor having a section extending axially beyond said outer conductor, at least a portion of said extending section defining a radiating element of said first antenna, a pair of intersecting conductors coupled to said outer conductor and extending radially therefrom for defining a first reference element for said first antenna, said outer conductor also defining a radiating element of said second antenna, said pair of intersecting conductors serving as a load element for said outer element, thereby increasing the effective electrical length of said second antenna, a grounded sleeve surrounding and insulated from said outer conductor and defining a second reference element for said second antenna, and means coupled to said coaxial line for separating signals at said first and second frequencies for selective external coupling of said signals.

2. The dual antenna system of claim **1**, in which said signal separating means comprises first and second networks respectively coupled to said central conductor and said outer conductor, said first and second networks respectively exhibiting high and low impedances to signals at said first frequency, and low and high impedances at signals at said second frequency.

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