Aug. 16, 1949. E. N. GILBERT 2,479,227

DUAL FREQUENCY ANTENNA

Filed Nov. 6, 1945

FIG. 1

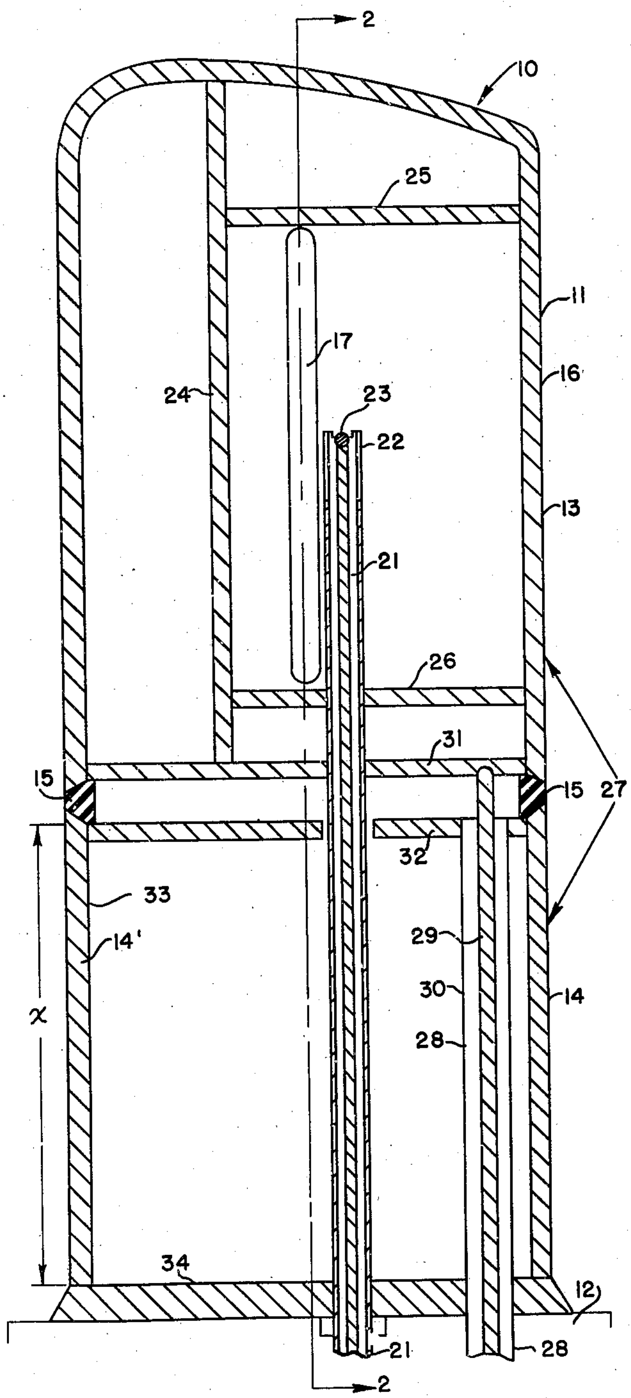


FIG. 2

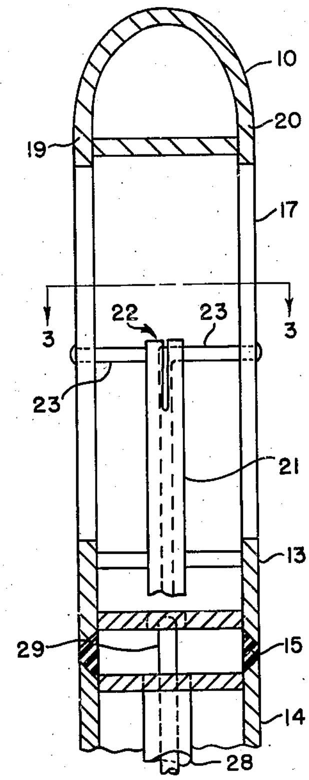
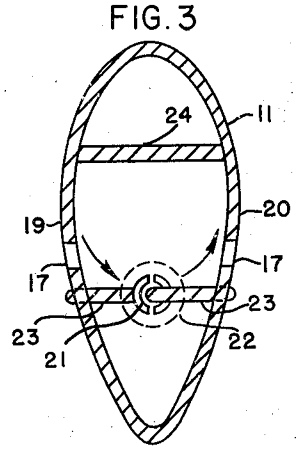


FIG. 3



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DUAL FREQUENCY ANTENNA

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Application November 6, 1945, Serial No. 627,042

6 Claims. (Cl. 250—33)

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This invention relates to antennas for communication systems and more particularly to an antenna for use as a beacon in connection with radio object-locating systems.

In certain radio object locating systems, it is desirable to utilize a "friend or foe" interrogation (IFF) with a target search indication. It is also desired to obtain substantially uniform omnidirectional radiation of energy. Heretofore, it has been considered necessary that a beacon antenna for obtaining uniform omnidirectional radiation be radially symmetrical in cross-section and that separate antennas be used as a beacon and for IFF interrogation.

It has now been found that substantially uniform omnidirectional radiation may be obtained with an antenna asymmetrical in cross-section such as of streamlined, tear drop or even rectangular cross-section. Such an antenna has been disclosed in the copending application of Henry J. Riblet, Serial No. 627,040, filed November 6, 1945, entitled "Antenna." This invention contemplates an improvement of the invention of the aforesaid copending application and combines therewith means for simultaneously radiating energy of two different frequencies.

Thus, one of the objects of the present invention is to utilize a single antenna adapted to transmit and receive energy at two different ranges of frequencies simultaneously, such as a microwave frequency range having wavelengths of the order of centimeters for use as a beacon in connection with radio object-locating systems, and a longer wave frequency range having wavelengths of the order of meters or longer for the IFF.

It is another object of the invention to provide a beacon antenna having a streamlined, tear drop or other non-circular shape in cross-section capable of radiating energy of two different ranges of frequencies in substantially uniform omnidirectional radiation patterns.

For a better understanding of the invention together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing, in which:

Fig. 1 is a longitudinal side sectional view of the antenna according to the present invention;

Fig. 2 is a longitudinal front sectional view, partly broken away, of the same, taken substantially along the line 2—2 of Fig. 1; and

Fig. 3 is a transverse sectional view of the antenna of Figs. 1 and 2 taken substantially along the line 3—3 of Fig. 2.

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In the drawing, 10 designates the antenna according to the invention comprising a substantially hollow pipe 11 of electrically conductive material and of non-circular cross-section. Preferably, pipe 11 has its cross-sectional shape streamlined or, in other words, in the form of a tear drop to provide minimum wind resistance. Pipe 11 is supported by, and is mounted on, any suitable base 12 such as the skin surface of an aircraft, and may be disposed either horizontally, vertically, or angularly to said base. For the present description, it is assumed that antenna 10 including pipe 11 extends upwardly and vertically from base or support 12 and is closed at its upper end.

Pipe 11 is divided transversely into two sections, an upper section 13 and a lower section 14 spaced from each other by a ring of dielectric material 15 having the same cross-sectional shape as pipe 11. The upper portion 13 generally includes the radiating element 16 for radiating energy in one range of frequencies, preferably of the microwave frequency range.

Radiating element 16 is constructed in the manner described in the aforesaid copending application of Henry J. Riblet and more particularly as described with reference to Figs. 6 and 7 of this copending application. Thus, radiating element 16 is of streamlined or tear drop shape having a slot 17 disposed longitudinally along the approximate center line of each of the opposite sides 19 and 20. Energy is fed to slots 17 by means of a coaxial conductor line 21 which terminates in a balanced dipole 22, the dipole sections 23 of which connect the inner and outer conductors of line 21 to a point substantially midway of the length of the edge portions of slots 17 respectively. As shown, the upper pipe section 13 is provided with internal partitions 24, 25, and 26 which serve to reduce the interior region of propagation of energy of pipe section 13 to support the proper moding of the microwave energy excited in pipe section 13. As thus far described, it will be understood that the radiating element 16 is adapted to radiate substantially uniform omnidirectional radiation in the microwave frequency range as disclosed in the aforesaid copending application.

As will be understood, it is contemplated that antenna 10, according to this invention, be adapted to radiate energy of a lower frequency than the microwave range of frequencies. For longer wave radiation, the entire length of pipe 11 is utilized, the upper section 13 becoming, in effect, one section and the lower section 14 becoming the other section of a dipole radiator. Energy is fed to the long wave dipole radiating element 27 comprising sections 13 and 14 by means of a coaxial conductor transmission line 28 connected to a source of lower frequency energy not shown. The center conductor 29 of coaxial line 28 extends beyond the end of the outer conductor 30 and is connected to the upper dipole section 13, for example, through a transverse partition member 31 connected to the wall of dipole section 13. The outer conductor 30 is connected to the lower pipe or dipole section 14 by means of a transverse partition member 32. It will thus be understood that the pipe or dipole sections 13 and 14 comprising the long wave radiating element 27 is excited by means of the coaxial line 28 and is adapted to radiate energy of longer wave lengths than, or of lower frequencies than, that of the microwave energy. Also such longer wave energy is radiated in a substantially uniform omnidirectional pattern. With the antenna in its contemplated vertical position, radiations of both frequencies will therefore have approximately uniform azimuth patterns.

In order to prevent any lower frequency excitation from interfering with the high frequency transmission through antenna 10, and particularly to keep the low frequency or long wave signals from being carried along the outside surface of line 21 inside of the aircraft, the long wave dipole 27 is shorted by a stub 33. Stub 33 comprises the inner surfaces of partition 32, and of lower pipe section 14′ which is shorted at the junction of antenna 10 with the base 12 by means of a plate 34, the inner conductor of the stub 33 being the outer surface of coaxial line 21 extending longitudinally therethrough. Inasmuch as the outer conductor 14′ of this stub is large compared with the outer surface of the coaxial line 21, the characteristic impedance of the stub 33 will be large and the admittance will be reasonably small even though the length X of the stub 33 is only, for example, of the order of ⅛ wavelength of the longer wave energy. The overall length of antenna 10 and the length of the bottom pipe or dipole section 14 are so chosen as to obtain proper impedance matching for the long wave dipole radiating element 27 comprising the sections 13 and 14. It has beeen found that even though the currents of both the higher and lower frequency ranges of energy both exist on the upper section 13, the polarization is such that no interference exists between energy of one frequency with that of the other and that radiation of both frequency ranges can simultaneously be emitted from antenna 10 without interference.

With the arrangement as described hereinbefore, the antenna has several advantages over known types of beacon antennas. In the first place because the microwave radiating element comprises slots rather than dipoles and because of the streamlined nature of the entire assembly, a tight fitting housing may be used which may be small and streamlined for low wind drag effect. Also, since the microwave frequency antenna is mounted at the upper end of the longer wave radiating element rather than in the bottom section, the nulls in the elevation pattern due to reflections from the skin surface of the aircraft are less likely to occur and are less serious than would otherwise occur. Also, the antenna as thus described provides a more compact, light-weight easily constructed and easily mountable structure than heretofore known.

While there has been described what is at present considered the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention.

What is claimed is:

1. An antenna for radiating electromagnetic energy of two different ranges of frequencies, comprising a hollow pipe of electrically conductive material and of streamlined shape in cross-section, said pipe comprising two aligned pipe sections forming upper and lower pipe sections when said pipe is in its contemplated vertical position, a ring of dielectric material separating said upper and lower sections, whereby said sections comprise the two poles of a dipole radiating element, a coaxial transmission line disposed within said pipe and longitudinally thereof adapted to transmit energy of one range of frequencies, means for coupling said coaxial line to each of said pipe sections whereby said sections are adapted to be excited by and to radiate said energy, the walls of said upper pipe sections on opposite sides of the major axis of the cross-section thereof each having a slot disposed longitudinally of said upper section and along the approximate centerline of each of said walls whereby said slots are directly opposite each other, said upper pipe section including said slots comprising a second radiating element adapted to radiate energy of a different range of frequencies than said dipole radiating element, and means for feeding energy of said different range of frequencies to and for exciting said second radiating element, said means including a second coaxial line extending longitudinally through said hollow pipe, and means for coupling said second coaxial line to the edge portions of said slots, said dipole radiating element and second radiating element being adapted to be excited by and to radiate energy of both said ranges of frequencies simultaneously without interference of one with the other in substantially uniform omnidirectional radiation patterns in planes perpendicular to said pipe sections.

2. An antenna as claimed in claim 1 wherein said second radiating element is adapted to be excited and to radiate energy within the microwave range of frequencies and said dipole radiating element is adapted to be excited by and to radiate energy within a range of lower frequencies than said microwave energy.

3. An antenna as claimed in claim 1 wherein means are provided for shorting said lower pipe section at the base thereof whereby said lower pipe section forms a stub to prevent energy currents being carried on the outer surface of said second coaxial line.

4. An antenna as claimed in claim 1 wherein the outer conductor of said first-mentioned coaxial line extends upwardly substantially to the upper end of said lower section and the inner conductor thereof extends beyond said outer conductor, said means for coupling said first coaxial line to said pipe sections comprising a member connecting said outer conductor to said lower section and a member connecting said inner conductor to said upper section, and wherein said means for coupling said second coaxial line to said slots comprises a balanced dipole termination of said second coaxial line, one element of said dipole termination connecting the inner conductor of said second coaxial line to the midpoint of the edge portion of one of said slots, the other element of said dipole termination connecting

the outer conductor of said second coaxial line to the midpoint of the edge portion of the opposite slot, said coaxial lines being disposed substantially parallel to each other within said pipe.

5. An antenna for radiating electromagnetic energy of two different ranges of frequencies simultaneously in substantially uniform omnidirectional radiation patterns in planes perpendicular to the axis of said antenna comprising a substantially hollow pipe of electrically conductive material and of non-circular cross-section, said pipe comprising two aligned pipe sections affording upper and lower pipe sections when said pipe is in its contemplated vertical position, a member of dielectric material separating said sections whereby said sections form the two poles of a dipole radiating element, means for transmitting energy of one range of frequencies to and energizing said two poles, said upper section having at least one slot in each of two opposed sides thereof said slots being disposed longitudinally of said upper section and means for feeding energy of a different range of frequencies to said slots whereby said upper section is adapted to radiate said last-mentioned energy.

6. An antenna for radiating electromagnetic energy of two different ranges of frequencies simultaneously in substantially uniform omnidirectional radiation patterns in planes perpendicular to the axis of the antenna comprising a substantially hollow pipe of electrically conductive material and of non-circular cross-section, said pipe comprising two aligned pipe sections affording upper and lower pipe sections when said pipe is in its contemplated vertical position, said sections forming two poles of a dipole radiating element, means for transmitting energy of one range of frequencies to and energizing said two poles, said upper section having at least one slot in each of two opposed sides thereof said slots being disposed longitudinally of said upper section and means for feeding energy of a different range of frequencies to said slots whereby said upper section is adapted to radiate said last mentioned energy.

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