May 20, 1952 R. M. SILLIMAN 2,597,392

ANTENNA

Filed Jan. 7, 1946

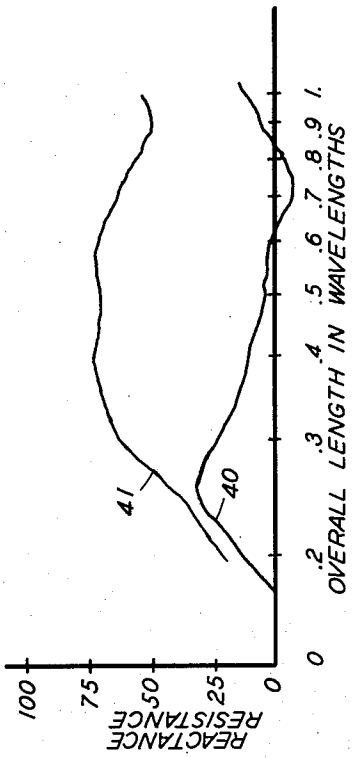


FIG. 3

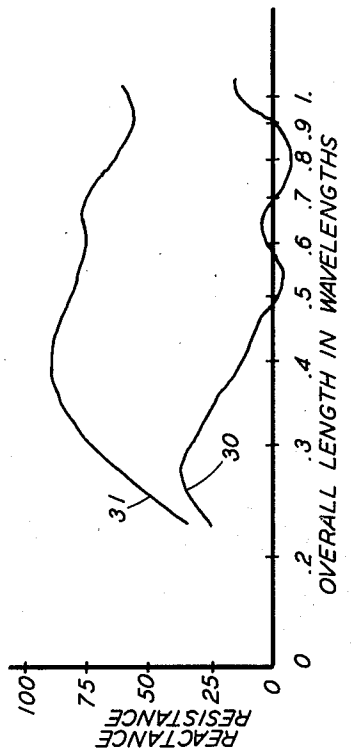


FIG. 2

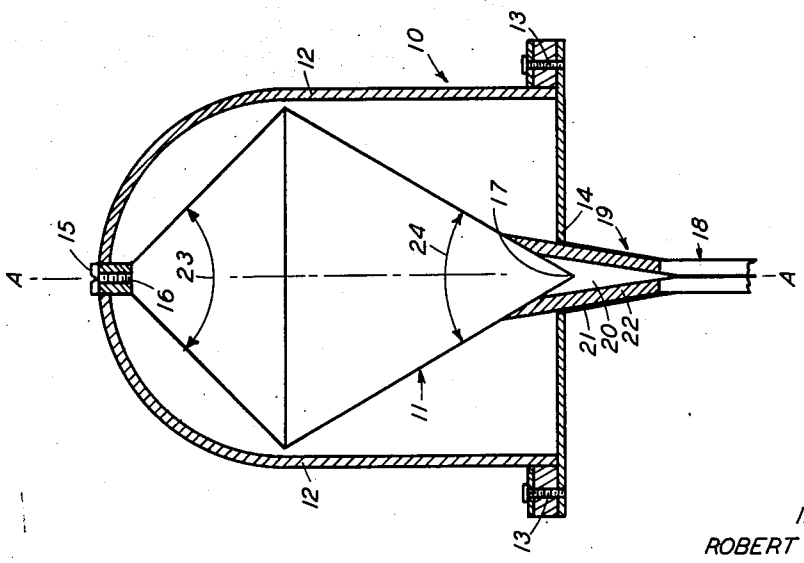


FIG. 1

INVENTOR
ROBERT M. SILLIMAN

By William D. Hall
ATTORNEY

Patented May 20, 1952 2,597,392

UNITED STATES PATENT OFFICE

2,597,392

ANTENNA

Robert M. Silliman, Silver Spring, Md., assignor to the United States of America as represented by the Secretary of War

Application January 7, 1946, Serial No. 639,648

5 Claims. (Cl. 250—33)

1

This invention relates to apparatus for the transmission and reception of electrical energy. More particularly it relates to conical antennas adapted for use at very high frequencies.

The problem of making an antenna to operate at very high frequencies and to cover a very wide frequency range has presented problems to the prior art. This is especially true of antennas adapted for use on aircraft, since the smallness of the antenna used becomes a necessary and important factor. The electrical characteristics of an antenna are, among other things, dependent upon the size and shape of that antenna. This means that when the physical size of an antenna is limited by the use to which it is put, the design for optimum electrical performance becomes a compromise between the physical size and optimum electrical performance.

It is an object of the present invention to provide an antenna which will operate satisfactorily over a frequency range exceeding a three to one ratio.

It is also an object of the present invention to provide an antenna which represents the best compromise between physical size and electrical performance.

It is a further object of the present invention to provide a connection from a coaxial transmission line to the antenna which is capable of mechanically supporting the conical antenna structure.

It is another object of the present invention to provide a tapered connection from a coaxial transmission line to an antenna which does not introduce unwanted electrical reflections.

It is a further object of the present invention to provide a method of ruggedly mounting and solidly supporting a conical antenna on a moving craft without the introduction of unwanted electrical reflections.

Generally this invention comprises the making of an antenna, consisting of two conical portions having bases of equal dimensions which are joined together, which is adapted to be mounted on structures, such as aircraft, within a housing of insulating material. A coaxial transmission line conveys radio frequency energy to the antenna through the apex of the conical portion of greater altitude. This apex is electrically joined to the coaxial transmission line by use of a tapered section of coaxial transmission line commonly known as the transformer. The characteristic impedance of this transformer where it joins the apex is equal to the characteristic impedance of the conical antenna at this apex and the characteristic impedance of the transformer

2

where it joins the coaxial transmission line is equal to the characteristic impedance of that line. The transformer is filled with a solid dielectric material which lends rigidity and support to the conical antenna structure.

Other objects, features and advantages of this invention will suggest themselves to those skilled in the art and will become apparent from the following description of the invention taken in connection with the accompanying drawings in which:

Fig. 1 is a diagrammatic sketch of a conical antenna built in accordance with the principles of this invention;

Fig. 2 is a diagram showing the electrical characteristics of an antenna constructed in accordance with the principles of the present invention; and

Fig. 3 is a diagram showing the characteristics of another antenna constructed in accordance with the principles of the present invention.

Referring more particularly to Fig. 1, the antenna and its associated structure are generally designated by 10. The structure may be more fully appreciated by visualizing it as a figure of revolution about its longitudinal axis A—A. The housing 12 made of insulating material encloses the antenna 11. Screws 13 fasten housing 12 to the skin 14 of the aircraft. The screw connection 15 fastens antenna 11 at its upper apex 16 to the housing 12.

Radio frequency energy is conveyed to antenna 11 through its lower apex 17 which is connected to coaxial transmission line 18 by the coaxial transmission line transformer 19. The inner conductor 20 of transformer 19 is connected directly from coaxial transmission line 18 to apex 17 and outer conductor 21 of transformer 19 is electrically connected directly from coaxial transmission line 18 to the skin 14 of the aircraft, which is the ground potential.

Since the characteristic impedance of a coaxial transmission line is determined principally by the ratio of the outer diameter of the inner conductor to the inner diameter of the outer conductor the transformer section 19 is constructed with a diameter ratio which will give a characteristic impedance equal to that of the coaxial transmission line 18 where it is connected to it and a characteristic impedance equal to the antenna 11 where it is connected to it. Dielectric material 22 is placed between outer conductor 21 of transformer 19 and its inner conductor 20. The transformer section 19 prevents the introduction of radio frequency reflections despite the placing of

the dielectric material between its conductors. The primary function of the length of tapered dielectric material **22** is to aid in the mechanical support of antenna **11**. This dielectric material in combination with screw connection **15** solidly supports and securely holds the antenna **11** in position.

Experiments have been conducted to determine the best compromise between the allowable physical size and electrical operation of the antenna **11**. The results obtained by experiment have been substantiated and it has been found that the angle **23** at apex **16** should be substantially 90 degrees and the angle **24** at apex **17** in the neighborhood of 60 degrees to 70 degrees.

Referring to Fig. 2, the driving point impedance of a conical antenna having an angle **23** equal to 90 degrees and an angle **24** equal to 60 degrees is plotted against the overall length in wavelengths of the antenna (the distance between the apexes of the two cones). The former is plotted on the ordinate and the latter on the abscissa. The driving point impedance is divided into two components represented by curves **30** and **31**. The curve **30** represents the reactive component of the impedance and the curve **31** represents the resistive component. The reactance is negative when the curve falls below the base line. It is obvious from inspection of curves **30** and **31** that they are of material assistance in arriving at the best compromise between physical size and electrical operation for any given set of conditions.

Referring to Fig. 3 the driving point impedance of a conical antenna having an angle **23** equal to 90 degrees and an angle **24** equal to 70 degrees is plotted against the overall length in wavelengths of the antenna (the distance between the apexes of the two cones). As in Fig. 2 the driving point impedance is plotted on the ordinate and the overall length in wavelengths on the abscissa. The curve **40** represents the reactive component of the characteristic impedance and the curve **41** represents its resistive component. The reactance is negative when the curve falls below the base line. These curves are utilized in the same manner as the curves shown in Fig. 2.

While there has been here described what is at present considered to be 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 scope of the invention.

What is claimed is:

1. A wide-band antenna comprising a pair of electrically conductive cones extending in opposite directions and mounted base-to-base with their axes colinear and electrically and mechanically connected at their bases, one of said cones having an apex angle of 90°, the other of said cones having an apex angle of between 60° and 70°, said cones having bases of the same area and being of different lengths, the distance between the apices of said cones being between substantially .3 of one wavelength and one wavelength of the frequencies in the operating frequency band, and a coaxial impedance transformer electrically connected to said other cone and serving as a mechanical support for said cones.

2. A wide band antenna comprising a pair of electrically conducting cones extending in opposite directions and mounted base-to-base with their axes colinear and electrically and mechanically connected at their bases, one of said cones having an apex angle of 90°, the other of said cones having an apex angle of between 60° and 70°, said cones having bases of the same area and being of different lengths, the distance between the apices of said cones being between substantially .3 of one wavelength and one wavelength of the frequencies in the operating frequency band, a coaxial transmission line for feeding ultra-high frequency energy to said cones, and impedance matching means coupling said line to the apex of one of said cones.

3. A wide band antenna for operation at ultra-high frequencies comprising a pair of electrically conducting cones mounted base-to-base with their axes colinear, said cones extending in opposite directions and having bases of the same area and different apex angles and being of different lengths, the distance between the apices of the cones being between substantially .3 of one wavelength and one wavelength of the frequencies in the operating frequency band.

4. A wide band antenna for operation at ultra-high frequencies comprising a pair of electrically conducting cones mounted base-to-base with their axes colinear and extending in opposite directions, said cones having bases of the same area and different apex angles and being of different lengths, the distance between the apices of said cones being between substantially .3 of one wavelength and one wavelength of the frequencies in the operating frequency band, a coaxial transmission line for feeding ultra-high frequency energy to said cones, and impedance matching means coupling said line to the apex of one of said cones.

5. An antenna according to claim 4 in which said impedance matching means comprises linearly tapered inner and outer coaxial conductors, the ratio of inner-to-outer conductor diameter at the ends of said matching means being such that the impedances of said matching means at said ends are equal respectively to the impedance of said line and to that of said one cone.

ROBERT M. SILLIMAN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,639,727	Fraser	Aug. 23, 1927
2,237,778	Carter	Apr. 8, 1941
2,267,889	Aubert	Dec. 30, 1941
2,275,646	Peterson	Mar. 10, 1942
2,313,046	Bruce	Mar. 9, 1943
2,433,698	Hurst	Dec. 30, 1947

FOREIGN PATENTS

Number	Country	Date
114,368	Australia	Dec. 24, 1941
469,366	Great Britain	July 23, 1937
633,148	France	Jan. 21, 1928