United States Patent [19]

Williams

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[54] **PITOT TUBE DIELECTRIC ANTENNA SYSTEM**

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[52] **U.S. Cl.** **343/708,** 343/785, 343/853

[51] **Int. Cl.** **H01q 1/28**

[58] **Field of Search** 343/705, 708, 785, 853

[56] **References Cited**

UNITED STATES PATENTS

3,245,080	4/1966	Beuvain	343/708
2,814,800	11/1957	Martin et al.	343/708
2,820,964	1/1958	Lyle	343/708

FOREIGN PATENTS OR APPLICATIONS

867,356	5/1961	Great Britain	343/785

Primary Examiner—Eli Lieberman

[57] **ABSTRACT**

A metallic conductor protruding from a surface, for example, a pitot tube protruding from an aircraft surface is coated on its periphery with a low loss dielectric in order to form an antenna. Functions of the pitot tube and antenna are combined in one structure, and the need for a radome is eliminated. Monopulse feed may be provided to the dielectric rod comprising the antenna.

2 Claims, 4 Drawing Figures

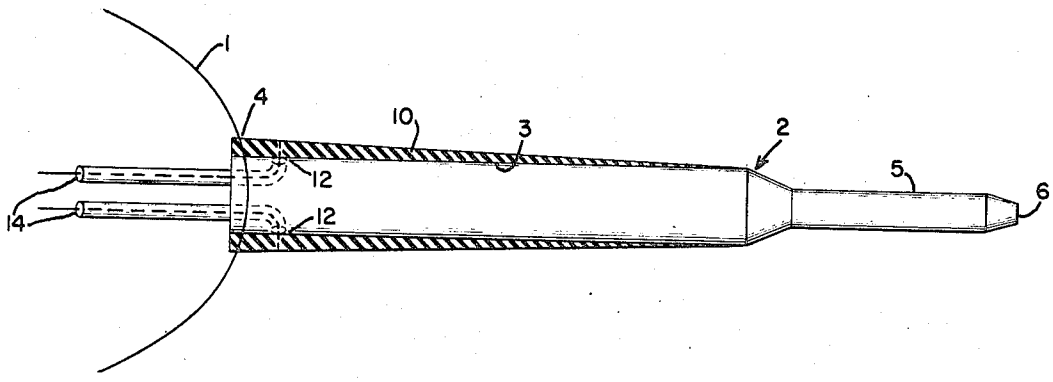


Fig. 1

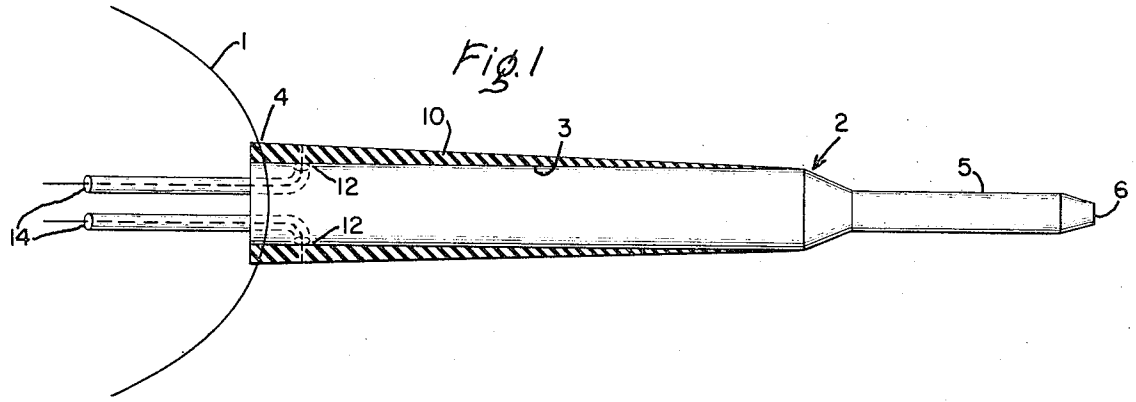


Fig. 2a

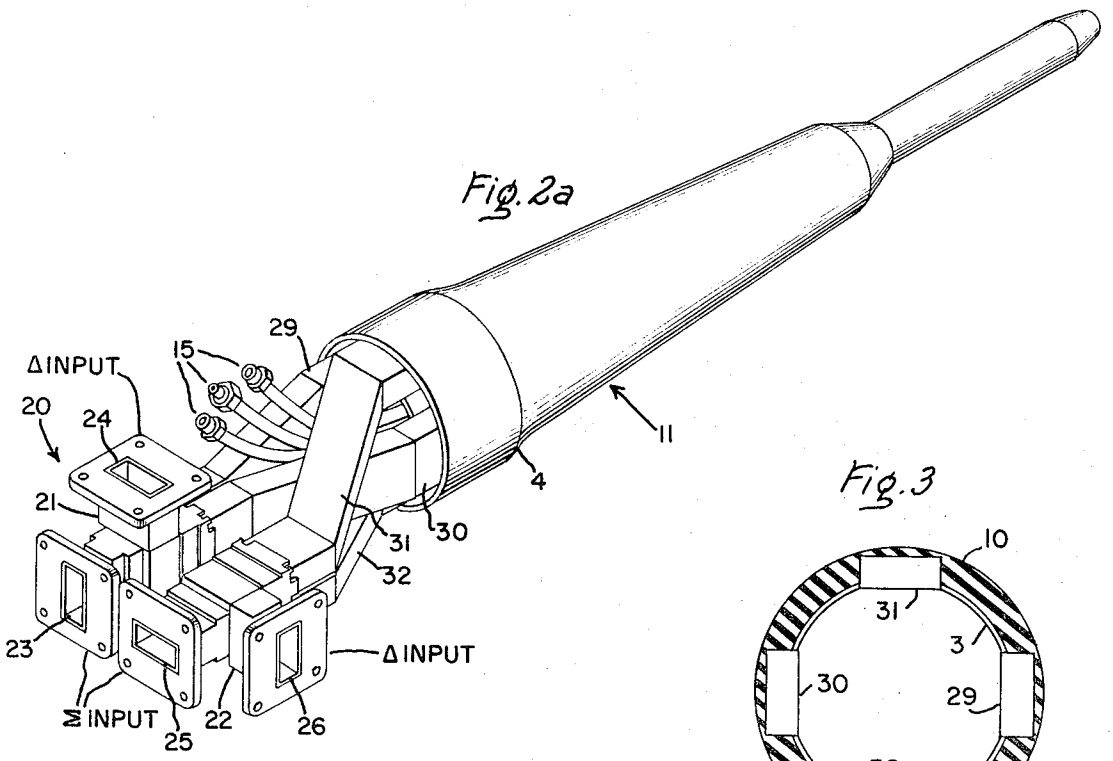
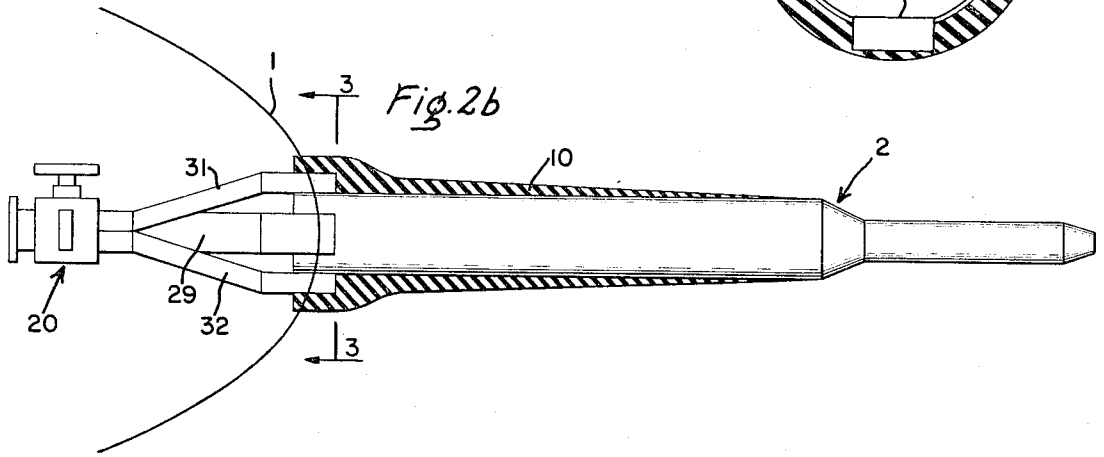


Fig. 3

Fig. 2b



PITOT TUBE DIELECTRIC ANTENNA SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to radio wave antennas, and more particularly to an active antenna which is preferably part of an aircraft.

The present invention is directed toward an antenna for inclusion on a pitot tube projecting from the nose of an aircraft. The pitot tube takes in air, and the air flow therethrough is used for sensing airspeed. It should also be realized that other protrusions from a surface may be equivalent. Antennas may be placed at the front of an aircraft for many applications: for example, range only radar, angle tracking radar, navigation, or for countermeasures purposes. In the past, dielectric rod antennas have been provided. However, this type of antenna is not suited for inclusion at the nose of an aircraft on a pitot tube. Also, structures have been provided which include both a dipole antenna and a pitot tube in different portions of the structure. However, the construction may affect the aerodynamics of a pitot tube, or require the use of a longer pitot tube to reach air undisturbed by the dipole antenna. However, in the past an antenna has not been provided integrally with a pitot tube. Also, prior dielectric rod antennas have been excitable in only one mode of radiation. Consequently, they could not be used for monopulse radar.

SUMMARY OF THE INVENTION

It is therefore a particular object of the present invention to provide a unitary pitot tube-antenna structure for airborne use.

It is a more general object of the present invention to provide an antenna structure for incorporation with a projection from a surface.

It is another object of the present invention to provide an airborne antenna of minimum bulk.

It is a further object of the present invention to further provide an airborne antenna, the performance of which is not degraded by the presence of a radome and the radiation pattern of which is not effected by blockage due to objects such as a pitot tube.

It is also an object of the present invention to provide a dielectric antenna of the type described particularly suited for forward looking radar applications.

It is yet another object to provide a dielectric antenna of the type described which may be excited in more than one mode of radiation.

It is a particular object in one form of the present invention to provide an antenna of the type described for monopulse radar.

Briefly stated, in accordance with the present invention there is provided an antenna for incorporation on an object such as a pitot tube.

In the preferred embodiment, a pitot tube at the nose of an aircraft is coated with a low loss dielectric, and radio frequency energy is coupled to or from the tube by means of a waveguide transducer or a coaxial transducer. Alternatively, means are provided for exciting the antenna in more than one mode of radiation.

BRIEF DESCRIPTION OF THE DRAWINGS

The means by which the foregoing objects and features of novelty are achieved are pointed out with particularity in the claims forming the concluding portion of the specification. The invention, both as to its operation and manner of organization, may be further understood by reference to the following description taken in connection with the following drawings.

Of the drawings:

FIG. 1 is an illustration of an embodiment of the present invention having a balanced feed.

FIGS. 2*a* and 2*b* are respectively isometric illustrations of a further embodiment of the present invention.

FIG. 3 is a cross-section view taken along line 3—3 of FIG. 2*b*.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, there is illustrated the nose 1 of an aircraft having a pitot tube 2 projecting therefrom. The pitot tube 2 in the present embodiment includes a rear portion 3, which is preferably a right circular cylinder communicating with the nose of the aircraft at a base 4. The other end of the rear portion 3 has a forward portion 5 projecting therefrom which terminates in an air inlet port 6. Conventional air tubes and heater wires 15 (FIG. 2*a*) run through the pitot tube 2 for connection to sensing means (not shown) in the aircraft.

In accordance with the present invention, the pitot tube 2 is made into an antenna by forming a dielectric layer 10 on the base portion 3. The dielectric thickness in terms of wavelength L is dictated by the gain to beamwidth desired. In a preferred embodiment, the thickness of dielectric coating at the base 4 of the pitot tube 2 is 0.15 inch and is tapered to approximately 0.01 inch at the forward end of the rear portion 3. The thickness is also a function of the overall wavelength of the rear portion 3. The above described dimensions are particularly useful for forming an antenna providing an end fired slow wave. In this manner, a narrow, forward looking lobe is provided. By well-known theory, antenna geometry, i.e., the shape and thickness of the dielectric coating, may be changed to modify the radiated beam. For example, see Henry Jasik, Antenna Engineering Handbook, First Edition (McGraw Hill Book Company, Inc., New York, 1961) Chapter 16. In the present embodiment, by tapering the thickness of the dielectric layer 10 from the maximum thickness at the base 4 to the minimum thickness at the forward end of the rear portion 3, antenna gain is maximized and pattern side lobes are minimized.

The pitot tube 2 is metallic. Coaxial cavities 12 are provided near the base for coupling of a balanced coaxial feed 14 to the antenna 11. The cavities 12 in the preferred embodiment are in diametrically opposed portions of the pitot tube 2, and a balanced feed is provided. The antenna system is operative if fed at only one side, but an optimal radiation pattern is not provided. Due to the use of a balanced feed, the metallic portion 3 in the center of the antenna 11 does not adversely affect radiation by the dielectric portion 10.

The dielectric layer 10 is a low loss dielectric. The prime criteria for the choice of material of which the layer 10 is formed are radio frequency performance requirements and aircraft environment. Choice of the material will dictate a well-known method of application. The prime environmental considerations are thermal capabilities and erosion. It is noted that at the nose of an aircraft travelling at mach II, the temperature of a pitot tube may reach 1,075°F. A low loss radio fre-

quency material such as polytetrafaluoroethylene, a quartz fibre reinforced resin, or a boron nitride reinforced material are suitable for supersonic applications. For low speed and low temperature applications, many well-known plastics are known to be suitable.

FIGS. 2*a* and *b* respectively represent a further embodiment of the present invention of isometric and cross section form. The same reference numerals are used to denote elements corresponding to those of FIG. 1. In the embodiment of FIG. 2, the coaxial feed 14 of FIG. 1 is replaced by a multimode waveguide feed **20.** The feed **20** consists of first and second E plane hybrids **21** and **22.** The E plane hybrid **21** has a sum input port **23** and a difference input port **24,** while the E plane hybrid **22** has a sum input port **25** and a difference input port **26.** First and second waveguides **29** and **30** are coupled from the E plane hybrid **21** to diametrically opposite portions of the base **4.** First and second waveguides **31** and **32** are coupled from the E plane hybrid **22** to diametrically opposed portions of the base **4** and are spaced 90° from the waveguides **29** and **30.**

FIG. **3** shows the arrangement of the four waveguides in the required 90° spacing about the perifery of the tube **3.** The end of the tube may be slotted to receive the ends of the waveguides and the latter may be secured in the slots by conventional techniques such as brazing. The E plane hybrids **21** and **22** can be fed with radiation having a phased difference of 90° to radiate a circularly polarized wave. When only one E plane hybrid is fed, either horizontal or vertical polarization is radiated and a sum and a difference pattern is generated in both planes. Consequently, more than one mode of radiation may be radiated by the antenna **11.** The antenna **11** is thus useful for monopulse radar. Other well-known waveguide arrangements can be provided.

What is thus provided is a pitot tube antenna and a dielectric antenna excited in more than one mode of radiation. Due to the construction of the present invention, aerodynamics of the pitot tube are not adversely affected. Further, the construction of the antenna does not interfer with apparatus such as air tubes and heater wires which must extend through the center of a pitot tube. The above teachings will enable those skilled in the art to construct many forms of antenna in accordance with the present invention, including embodiments having different hybrid and waveguide feed arrangements.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A radio frequency antenna for use on an aircraft comprising, in combination:

a metallic cylindrical tube forming a part of a pitot tube mounted at the nose of said aircraft;

RF feed means for coupling RF energy to said tube, said feed means including an E plane hybrid with first and second waveguides branching from said hybrid and connected to opposed sides of said tube at the end thereof adjacent the nose of said aircraft; and

a layer of low loss dielectric material covering the outer surface of said tube, said layer tapering from a maximum thickness near the nose of said aircraft to a minimum thickness at the end of said tube farthest from said nose, said layer acting to minimize side lobes in the energy pattern radiated by said tube.

2. The antenna set forth in claim **1** wherein said RF feed means further comprises:

a second E plane hybrid with third and fourth waveguides branching therefrom and connecting to opposed sides of said tube between said first and second waveguides; and

means for feeding said first and second E plane hybrids with RF signals having the same frequency and a **90** degree relative phase difference whereby said antenna radiates a circularly polarized wave pattern.

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