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[54] SPIRAL ANTENNA WITH DIELECTRIC COVER

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[51] Int. Cl. H01q 1/36

[58] Field of Search 343/872, 873, 895, 343/915

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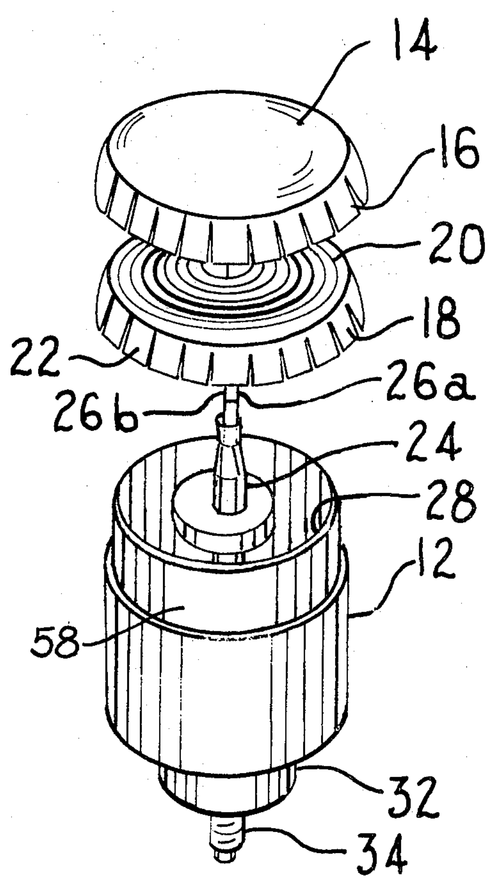
[57] ABSTRACT

A radar antenna and method of constructing the same, the antenna having a cup-like support base, a printed antenna circuit on a thin flexible dielectric blank, and an impervious cover, the antenna being constructed by stretching the dielectric blank across the open end of the support using a jig having means to engage a plurality of radially projecting tabs on the dielectric blank and drawing the tabs down against the side of the support to which they are secured before being severed from the jig, and covering the dielectric blank with the impervious cover to hermetically seal the printed antenna circuit from adverse environmental conditions.

15 Claims, 6 Drawing Figures



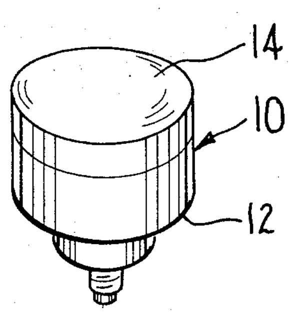


FIG. 1

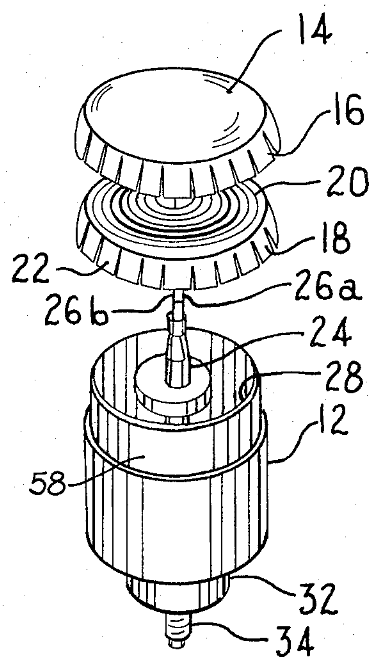


FIG. 2

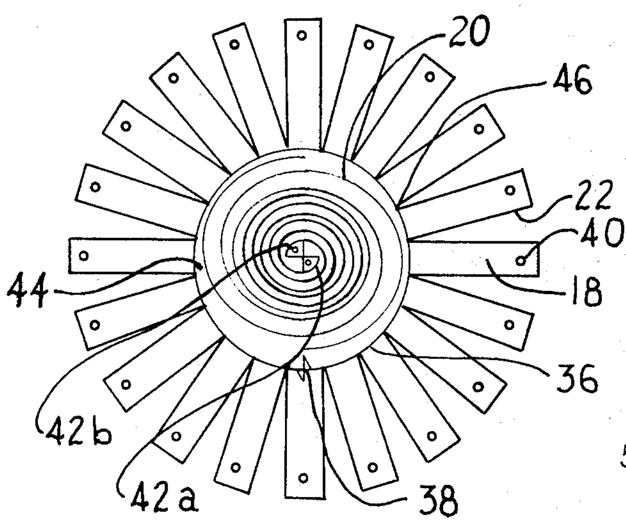


FIG. 3

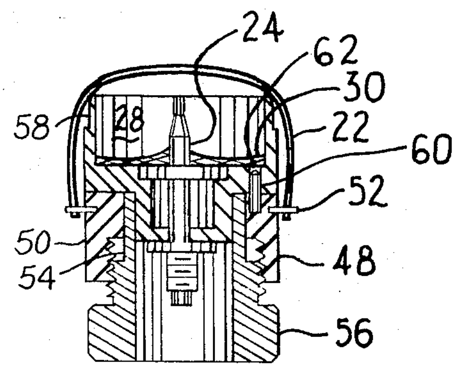


FIG. 4

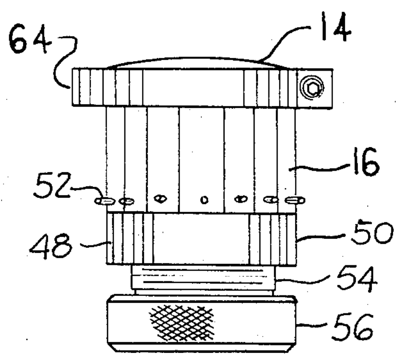


FIG. 5

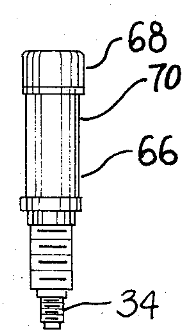


FIG. 6

SPIRAL ANTENNA WITH DIELECTRIC COVER

BACKGROUND OF THE INVENTION

Small highly directional antennas have been developed which are employed largely on aircraft for directional finders and warning devices for collision avoidance. To obtain accurate directional information, the antennas are arranged in phased arrays of generally three or more units. Furthermore, to avoid signal interference with the electrical equipment on board the aircraft, the antennas are arranged on the outside of the aircraft and are therefore subjected to the hostile environmental conditions of extreme changes in temperature, pressure and humidity, and intense structural vibrations.

Previous antenna constructions for cavity-backed systems employed a printed antenna circuit on a thick dielectric blank or plug which was fixed to the end of a cup-like base having a notched rim at the open end of the base in which the plug was seated and secured by an adhesive. However, vibrations and other environmental conditions loosen the adhesive and cause the plug to pop out of the base during sudden changes in atmospheric pressure.

In addition to structural problems, antenna circuits printed on thick dielectric plugs fail to perform within the narrow specification tolerances necessary to obtain uniformly responsive units for matched arrays.

It is a principal object of this invention to provide an antenna suitable for use in aircraft which is not adversely affected by the extremes in environmental conditions and which can be fabricated in a manner that provides uniform response characteristics when used in arrays.

SUMMARY OF THE INVENTION

This invention relates to miniature radar antennas, principally for aircraft use, and a method for constructing the same providing both uniformity and high performance. The antenna and construction method of this invention are particularly adaptable to cavity backed antenna systems. The additional problems created by an air chamber behind an antenna circuit support, creating pressure differentials on atmospheric pressure changes, are solved. However, the antenna and method may be employed in other systems lacking an air cavity with excellent results and it is not intended to restrict this invention to air cavity systems.

To employ the cavity backed system as a preferred embodiment, an antenna circuit is printed on a thin flexible dielectric blank and stretched tautly across the open end of a cup-like support base and covered. This is accomplished by die cutting an oversized blank with a plurality of radially projecting tabs each with a hole at the distal end of the tab. The cup-like support is held by a jig having an outer sleeve with a plurality of projecting pins around its periphery. The upper edge of the sides is coated with an adhesive, and the dielectric blank is placed over the open end of the cup-like support. The plurality of projecting tabs are folded down the side of the support and the holes at their ends are engaged with the pins on the jig. The outer sleeve is forced away from the support base to draw the tabs uniformly down the sides of the support, thereby tautening the portion of the blank covering the open end of the support base. The tabs are then secured to the side of the support base by an annular collar clamp which encirlces the upper edge of the support clamping the tabs to the adhesive. The remaining portion of the tabs are severed, releasing the jig, and the support base and blank are cured before the clamp is removed.

While other methods are available for securing the cover to the support base, it has been found that the same method that is employed for securing blank to the support may be employed for securing the cover to the support. However, the cover must be impervious to hermetically seal the printed circuit from the environment. The antenna blank, on the other hand, is air pervious either inherently or by the addition of vent holes therein. In this manner pressure differences on either side of the blank are immediately equalized preventing any signal distortions from deflections of the blank. When using a cover secured in the manner described, the antenna blank may alternately, but not preferably assume a more conventional configuration and comprise a plug seated in the end of a cup-like base. If the blank is air pervious, the cover will adequately secure and protect the antenna blank from adverse environmental conditions and provide a low profile radome for a radar circuit on the covered blank.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the radar antenna.

FIG. 2 is an exploded view of the antenna of FIG. 1.

FIG. 3 is a plan view of the antenna circuit blank for the antenna of FIG. 1.

FIG. 4 is a sectional view of the antenna circuit blank and support mounted on a fabricating jig.

FIG. 5 is an elevational view of the antenna cover and support mounted on the fabricating jig of FIG. 4.

FIG. 6 is an elevational view of an alternate embodiment of the radar antenna.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1 the preferred embodiment of the radar antenna **10** is shown fully assembled and ready for mounting. The antenna shown has a support base **12** constructed of an anodized aluminum, and an impervious cover **14** which hermetically seals the antenna and protects the internal components.

The construction of the completed antenna is shown most clearly in the exploded view of FIG. 2. In FIG. 2 the cover **14** is shown with its plurality of trimmed tabs **16** which enable the cover to be secured to the support base **12**. Below the cover is a similar antenna blank **18** on which is printed a spiral antenna circuit **20**. The antenna blank **18** also has a plurality of trimmed tabs **22** which enable the blank **18** to be secured to the support base **12**. Below the antenna blank **18** and centered in the support base **12** is a conduit **24** containing two balun leads **26***a* and **26***b* which attach to the antenna circuit **20**. While the conduit **24** is not necessary to the functioning of the antenna, it nevertheless assists in protecting an antenna signal in the balun leads **26***a* and **26***b* from picking up any stray interference signals.

The conduit **24** is fixed in the center of the cup-like support base **12** and extends to the antenna blank **18**. The support base **12** is constructed with an open backing chamber **28** over which the antenna blank **18** is extended. The backing chamber **28** has a depth greater than one-half the operating wave length and has a foam absorber **30** at the chamber floor which inhibits reflected interference waves. The support base **12** has a mounting stem **32** and a coaxial cable connection **34** for electrically connecting a coaxial cable to the leads *26a* and *26b*.

Considering FIGS. 3, 4 and 5, the preferred method of constructing the antenna is shown. Referring to FIG. 3, a large antenna blank 18 fabricated from a Teflon impregnated fiberglass is printed with a spiral antenna circuit 20 by conventional methods. The blank is aligned by a printed guide circle 36 and orientation point 38 and die cut to form a plurality of centrally radiating tabs 22, each having a small hole 40 at their distal end. The antenna blank is fabricated from a Teflon impregnated fiberglass and has a thickness of 10 mils. It has been discovered that the thickness of the dielectric support for the antenna circuit has a substantial effect on the performance characteristics of the circuit. It is preferred that the support be as thin as possible and approximate the impedance characteristics of air. Thus with due consideration for structural limitation, the antenna blank should be as thin as possible and in many cases can be substantially thinner than 10 mils. Where structural considerations permit use of very thin dielectric blanks, cutting radial tabs may be dispensed with and the blank secured by overlapping the periphery of the blank and pleating the overlap to the sides of the support base. This alternate method of securing the blank is otherwise the same as that described for the preferred embodiment, but will not provide as trim an appearance or as uniform a tension to the secured blank as the preferred embodiment for thicker dielectrics. To obtain uniformity, strict quality control of materials must be enforced.

The spiral antenna circuit has two center located printed terminals *42a* and *42b*, each having a small hole through which the ends of the balun leads *26a* and *26b* are inserted and soldered to each respective terminal.

A similar Teflon impregnated blank (not shown) is cut for the cover 14 from a similar material which has a thickness of approximately 10 mils. The cover thickness is not critical and may be thicker than the antenna blank 18 since only structural considerations are controlling. While the tabless center portion 44 on the antenna blank 18 can have a diameter the same as or even less than the diameter of the backing chamber 28 in the support base, the tabless center portion of the cover blank must have a diameter sufficiently large to hermetically seal the center portion of the antenna blank and the backing chamber. Since the antenna blank must not seal the backing chamber, small air holes may be required if the center portion 44 of the antenna blank is designed to be the same size or larger than the diameter of the backing chamber and is fabricated from an impervious material. These air holes provide a pressure relief for pressure differences between antenna blank and cover, and antenna blank and chamber.

Referring to FIGS. 4 and 5, the method of assembling the antenna blank to the support base is illustrated. In the sectional view of FIG. 4 the support base 12 is shown seated in a jig 48 which is used to stretch the antenna blank 18 tautly across the top of the support base 12.

The jig 48 is of simple construction comprising an outer sleeve 50 with a plurality of radially projecting pins 52 around the top periphery of the sleeve. The outer sleeve 50 is threaded to an inner sleeve 54 on which the support base 12 is seated such that the sleeves can be displaced with respect to each other in telescoping fashion by rotating the flanged portion 56 of the inner sleeve 54.

In assembling the antenna, the support base 12 is first prepared by coating the top outside periphery 58 of the base support with an epoxy adhesive. This portion of the support base in the preferred embodiment is chamfered with a plurality of grooves to enhance adhesion. The antenna blank 18 is then placed on top of the base support 12, which is seated in the jig. The plurality of tabs 22 on the blank are folded down the sides of the base support and attached to the jig by inserting the pins 52 on the jig through the holes 40 at the ends of the tabs 22. When all of the tabs 22 have been attached to a corresponding pin 52, then the flanged portion 56 of the inner sleeve is rotated driving the seated support base away from the outer sleeve 50. The plurality of tabs are thereby drawn down the side of the support base tautly stretching the center portion of the antenna blank across the top of the support base. To insure that the outer sleeve 48 and support base 12 are not rotationally displaced with respect to one another, a locating pin 60 in the top of the outer sleeve 48 engages a locating hole 62 in the bottom of the support base. The locating pin 60 also provides a reference point for orienting the orientation point 38 on the printed antenna circuit 20 with respect to the support base.

The degree of tautness can be determined most easily by tapping the stretched antenna blank and comparing the audible tone. While the antenna blank should be taut to provide a necessary flat antenna circuit, the precise degree of tautness is not important except to establish a uniformity between one antenna and another which is critical to uniform performance.

When the antenna blank is stretched to the desired degree, an annular collar clamp 64 is placed over the tabs and around the top outside periphery 58 of the support base 12 in the manner shown in FIG. 5. The collar clamp 64 is tightened and the tabs trimmed at the base of the collar clamp 64. The support base 12 and antenna blank are then removed from the jig 48 and oven cured to harden the epoxy adhesive.

At this time, the two wire leads *26a* and *26b* in FIG. 2 are connected to the antenna circuit 20. Alternatively, the leads may be connected to the antenna circuit 20 prior to fastening the circuit to the support base 12.

The impervious cover 14 is attached in the same manner as the antenna blank. The support base 12 and attached antenna blank 18 are returned to the jig 48 and epoxied around the top periphery over the trimmed antenna blank tabs 22 shown in FIG. 2. The cover tabs 16 are attached to the pins 52 on the jig and drawn taut. Because of the greater allowed thickness and larger diameter of the center portion of the cover, a slight curvature is imparted to the cover 14 as shown in FIG. 5. This curvature displaces the cover from the antenna circuit on the tautly drawn antenna blank and permits a degree of flexure to the cover without affecting the antenna circuit. The cover 14 is secured by the collar clamp 64 and the tabs 16 are trimmed. The assembled antenna is then removed from the jig and oven cured before the clamp is removed. The completed antenna is then tested for service.

The antenna 10 heretofore described has a diameter of approximately two inches. However, the same construction and method of assembly can be applied to an antenna substantially smaller in size as shown in FIG.

6. The antenna 66 shown therein includes essentially the same type of antenna blank (not visible) cover 68, support base 70 and cable connector 34 as the antenna above described and is shown as an alternate embodiment to illustrate the various configurations that the invented antenna can assume. With the smaller span across the support base in the alternate embodiment, the dielectric antenna blank can be fabricated from a thinner material than used for the larger antenna and can more readily employ the alternate method of pleating a peripheral overlap rather than die cutting radial tabs for securing the blank to the support base.

I claim:

1. An antenna comprising a support base and a thin, flexible dielectric blank having a spiral antenna circuit thereon and having further a plurality of integral tabs, said blank being stretched over said support base and secured thereto by said plurality of tabs.

2. The antenna of claim 1 comprising further a cover on the support base which covers the antenna circuit.

3. The antenna of claim 2 wherein said cover comprises an impervious dielectric blank having a plurality of tabs, said cover being stretched over said antenna circuit and over said support base and secured thereto by said plurality of tabs.

4. An antenna comprising: a cup-like support base having an open end and a cylindrical side, and

a thin, flexible dielectric antenna blank having a spiral antenna circuit printed thereon and a plurality of radially projecting integral tabs, said blank being stretched across the open end of the support base and secured thereto by the plurality of radially projecting tabs which are fastened to the side of the support base.

5. The antenna of claim 4 comprising further a cover on said support base which covers said antenna circuit.

6. The antenna of claim 5 wherein said cover comprises an impervious dielectric antenna blank having a plurality of tabs, said cover being stretched over said antenna circuit and over said support base and secured thereto by said plurality of tabs.

7. The antenna of claim 6 wherein said thin dielectric blank on which said antenna circuit is printed is air pervious to relieve pressure differences on either side of the blank.

8. The antenna of claim 1 wherein said cylindrical side adjacent said open end is chamfered with a plurality of grooves to insure that the tabs are fastened securely to the side of the support base.

9. The antenna of claim 8 wherein said tabs are fastened with an epoxy adhesive.

10. An antenna comprising a support base and a thin, flexible dielectric blank having a spiral antenna circuit thereon and having further a peripheral overlap, said blank being stretched over said support base and secured thereto by said peripheral overlap.

11. The antenna of claim 10 comprising further a cover on the support base which covers the antenna circuit, wherein said cover comprises an impervious dielectric blank having a peripheral overlap, said cover being stretched over said antenna circuit and over said support base and secured thereto by said peripheral overlap.

12. The antenna of claim 11 wherein said dielectric blank on which said antenna circuit is printed is air pervious to relieve pressure differences on either side of the blank.

13. An antenna comprising:

a support base;

a dielectric blank having an antenna circuit thereon and having further a plurality of integral tabs, said blank being stretched over said support base and secured thereto by said plurality of tabs; and

a cover on the support base which covers the antenna circuit, said cover comprising an impervious dielectric blank having a plurality of tabs, said cover being stretched over said antenna circuit and over said support base and secured thereto by said plurality of tabs.

14. An antenna comprising:

a support base;

a dielectric blank having an antenna circuit thereon and having further a peripheral overlap, said blank being stretched over said support base and secured thereto by said peripheral overlap; and

a cover on the support base which covers the antenna circuit, said cover comprising an impervious dielectric blank having a peripheral overlap, said cover being stretched over said support base and secured thereto by said peripheral overlap.

15. The antenna of claim 14 wherein said dielectric blank on which said antenna circuit is printed is air pervious to relieve pressure differences on either side of the blank, and is displaced from said cover.

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