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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO ATTN OF: GP

November 6, 1970

TO: USI/Scientific & Technical Information Division
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned U. S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code USI, the attached NASA-owned U. S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U. S. Patent No. : 3,509,570

Government or Corporate Employee : U.S. Government

Supplementary Corporate Source (if applicable) : NA

NASA Patent Case No. : MSC-12101

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

Yes ☐ No ☒

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of Column No. 1 of the Specification, following the words ". . . with respect to an invention of . . ."

Elizabeth A. Carter

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Enclosure
Copy of Patent cited above

FACILITY FORM 602

N71-18720 (ACCESSION NUMBER)
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N71-18720

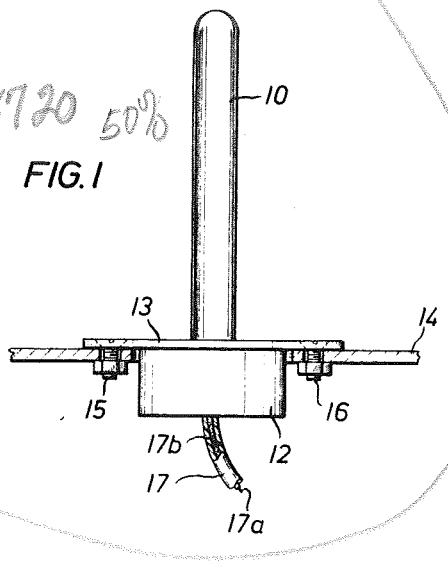
April 28, 1970 J. F. LINDSEY III, ETAL 3,509,570

FLEXIBLE BLADE ANTENNA

Filed Sept. 30, 1968

N71-18720 50%

FIG. 1



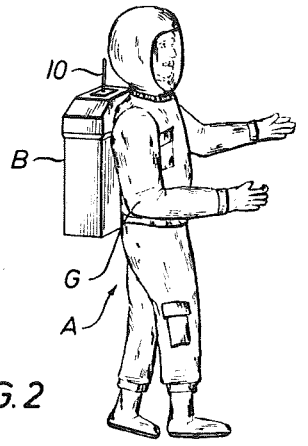


FIG. 2

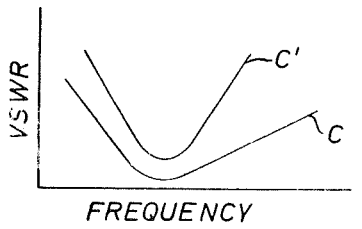


FIG. 5

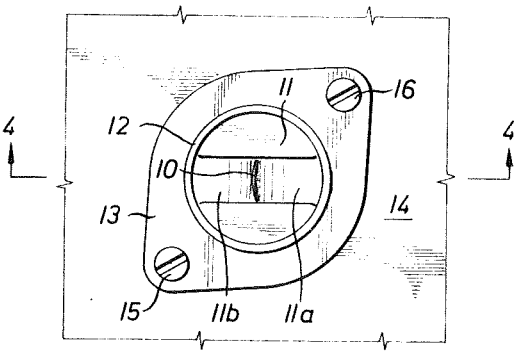


FIG. 3

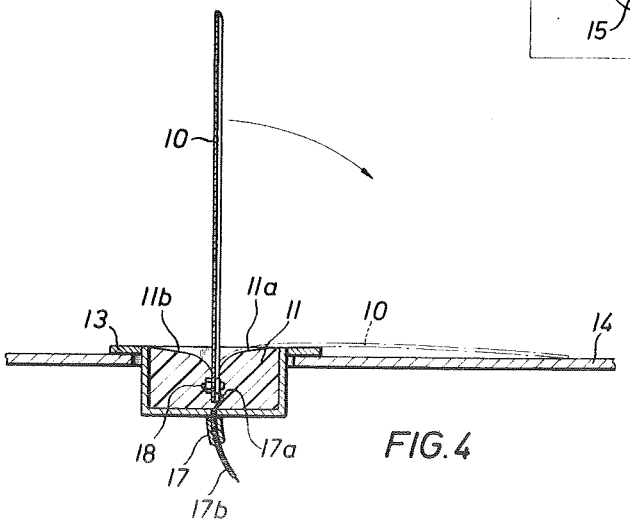


FIG. 4

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FLEXIBLE BLADE ANTENNA

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Int. Cl. H01q 1/12
U.S. Cl. 343—718 10 Claims

ABSTRACT OF THE DISCLOSURE

A flexible, resilient metallic blade is perpendicularly mounted from the surface of a solid dielectric material held in a metallic cup with the cup in turn being mounted in a flat metallic plate. A metallic shielded electrical conductor extends into the cup and through the dielectric material with the central conductor being electrically connected to the blade and the shield being electrically connected to the cup. The surface of the dielectric material is depressed to permit the blade to be bent flat and the blade is curved laterally to prevent it from kinking when bent and to increase its rigidity when erect.

The invention described herein was made by employees of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates generally to the field of antennas and more particularly to a flexible monopole antenna exhibiting a broad bandwidth characteristic and low voltage standing wave ratio over a selected frequency range.

Brief description of the prior art

The prior art discloses a variety of antennas which are designed to be mounted on the surface of a vehicle or other moving body. In some instances, the primary consideration is to provide a flexible antenna which is less likely to be damaged when it is struck or bent. One such prior art antenna includes simply a thin, wire-like antenna element carried within a supporting rubber mounting.

In other areas, the primary concern may be for reducing the induced air drag of the antenna where it is employed on rapidly moving bodies such as air craft. In such cases, the radiating element of the antenna may assume the form of an air foil to reduce induced air drag. U.S. Patent No. 2,484,817 to De Armond discloses an antenna having a radiating element in the form of a slightly curved metal blade which may be raised into or retracted from a streamlined housing. The antenna resembles a steel tape measure and is in fact coiled and uncoiled from a storage container in a fashion similar to such tape measure.

While the described prior art devices include certain desirable physical attributes, their electrical characteristics are relatively limited, partially due to the manner by which they are mounted and partially due to their overall design. Improved antenna designs have been suggested by the prior art with attendant improvement in operating characteristics. For example, U.S. Patents No. 2,505,751 and 2,449,562 to Bolljahn and Meier respectively, disclose improvement in mounting and design of antenna elements. The Bolljahn reference discloses a streamlined sleeve type antenna with a specific dimensional relationship between antenna components. The antenna is also adapted for effective cooperation with the surface upon

which it is mounted which is employed as a ground plane. The Meier antenna is of the whip type and includes a mounting assembly which is also designed to employ the mounting surface as a ground plane. Both the Bolljahn and Meier antennas employ a driven element which is mechanically mounted within a grounded parasitic element. The radiating element is in each case electrically insulated from the parasitic element by dielectric mounting means.

While the Bolljahn and Meier antennas afford improved operating characteristics as compared with other prior art antennas, they are relatively bulky, are difficult to mount and include a large number of separate components. Moreover, the driven elements disclosed in the latter two references are relatively large and cannot be collapsed for storage where limited space is available.

SUMMARY OF THE INVENTION

The blade monopole antenna of the present invention includes a single spring-metal blade which is mounted vertically in a suitable dielectric material carried in a cup-like structure with the cup in turn being countersunk in a metal plate. The center conductor of a suitable coaxial line is electrically connected to the embedded end of the blade while the outer shielding of the coaxial line is electrically connected to the cup. The plate acts as a mechanical mounting structure and also as a ground plane.

The blade is slightly curved laterally along its length to be self-supporting and the face of the dielectric material is depressed adjacent the blade mounting to permit the blade to be bent flat. When not in use, the blade of the antenna may be folded against its supporting structure or ground plane to reduce the space required for storing the antenna and associated equipment.

The antenna of the present invention is capable of broad application but it is particularly advantageous for use in radio frequency communication between astronauts during extravehicular activities in space. The components employed in fabricating the antenna are dependable and sturdy and, more importantly, have small dimensions and thus require only a small volume for storage.

The dimensions and configuration of the blade and cup are designed for optimum performance on the particular equipment with which they are mounted and employed. In the case of space application, the ground plane for the blade monopole may include the metallic portions of an astronaut's back pack as well as his metallized garments.

The blade monopole of the present invention is characterized by a very low voltage standing wave ratio over a relatively wide frequency band. These advantageous operating characteristics are also present when the antenna is employed with the theoretically imperfect ground plane afforded by the back pack and garments employed by astronauts.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 of the drawings is a front elevation, partially broken away, of the blade monopole of the present invention;

FIG. 2 of the drawings illustrates the blade monopole of the present invention mounted on the back pack of a fully suited apollo astronaut;

FIG. 3 is a plan view of the blade monopole of the present invention;

FIG. 4 is a cross section of the blade monopole of the present invention taken along the line 4—4 of FIG. 3; and

FIG. 5 of the drawings is a graph illustrating the improved operating characteristics of the blade monopole of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to FIGS. 1, 3 and 4 of the drawings, it may be seen that the antenna of the present invention includes a single, spring-steel blade **10** mounted in a suitable dielectric potting material **11** contained in a cylindrical metallic cup **12** which is in turn counter sunk in a metallic mounting plate **13**. The plate **13** is secured to a metallic mounting surface **14** by any means such as the threaded bolts and nuts **15** and **16**. The surface **14** may comprise a portion of an astronaut's back-pack or other associated or similar equipment.

As best illustrated in FIG. 4 of the drawings, a coaxial line **17** having a center conductor **17***a* and a metal shield **17***b* extends through the base of the cup **12** and connects the antenna to its associated electronic system (not illustrated). The shield **17***b* is D.C. coupled to the cup **12** by any suitable means, such as soldering, while the center conductor **17***a* is D.C. coupled to the base of the antenna blade **10** by means of nut and bolt assembly **18** which extends through an appropriate bore in the blade. The assembly **18** also acts as an anchoring means for improving the mounting of the blade **10** within the potting material **11**.

As best illustrated in FIGS. 3 and 4 of the drawings, the blade **10** is laterally curved along its lengthwise axial development. The curvature in the body of the blade **10** assists in holding the blade in an erect position and also prevents it from kinking when it is forcibly bent. As a further measure to permit forcible bending of the antenna without damage, the potting material **11** is depressed as indicated at **11***a* and **11***b*. By virtue of the described structure, the antenna blade **10** may be bent and folded into the dotted line position illustrated in FIG. 4 of the drawings. When thus bent for storage or otherwise, the blade is allowed to follow the smoothly curving contour of the potting surface at **11***a* which prevents the elastic limit of the blade material from being exceeded. When the bending force is released, the resiliency of the blade **10** causes it to spring back into its erect, operative position.

In one specific embodiment of the antenna, designed for use in the 259.7 mHz. to 296.8 mHz. frequency range, the blade **10** was made approximately 11⅛ inches in length measured from the top of the cup **12**, ½ inch in width and 0.005 inch in thickness, with the curve in the blade having a 0.5 inch radius. The dielectric material employed for the potting **11** was Stycast 1090SI manufactured by Emerson & Cuming, Inc. The dimensions of the cup **12** were designed to best match the characteristics of the blade **10** and included an inside diameter of 1⅛ inches and a height of $^{27}/_{32}$ inch. The spacing between the bottom of the blade and the inside surface of the bottom on the cup **12** was ⅛ inch, and the metallic ground plate **13** was in the form of a 2½ by 2½ inch square. The antenna was mounted on the back pack B carried by a suited apollo astronaut A as illustrated in FIG. 2 of the drawings. In this mounting, the ground plate made radio frequency contact with metallic portions of the equipment carried within the back pack B and the ground plane for the blade monopole was formed by aluminum honeycomb (not illustrated) in the cover of the back pack B and aluminized mylar in the astronaut's thermal garments G.

When thus mounted, and operating as an asymetric dipole by virtue of the irregular ground plane, a 1.2:1 voltage standing wave ratio (VSWR) was achieved at the intermediate frequency of 279.0 mHz. with a 50 ohm resistive impedance being used as a reference for the VSWR. Distinctly improved characteristics, as compared with other antenna designs, were observed for the monopole antenna of the present invention through all changes in orientation of the astronaut A and associated ground plane of back B and garments G. The antenna having the stated dimensions is generally characterized by an unusually broad band width characteristic over the 259.7 mHz. to 296.8 mHz. frequency range with a 1.5:1 or less voltage standing wave ratio at 259.7 mHz. and 1.6:1 VSWR at 296.8 mHz.

It was discovered that these favorable operating characteristics are attributable to the use of the blade monopole design described herein in combination with a cup having an inside diameter which is correlated with the blade length and width. In the described example, the inside diameter of the cup is $^{9}/_{89}$ the length of the blade measured from the top of the cup and 2¼ times the width of the blade. These ratios of cup diameter to the blade width and height are larger than analogous ratios found in prior art antennas.

FIG. 5 of the drawings illustrates the relationship between frequency and voltage standing wave ratio (VSWR) for two antennas with the curve C generally representing the performance of an antenna incorporating the features of the present invention and the curve C′ representing the performance of an antenna which was of similar construction but without a cup. As is clearly indicated by the curves, the operating characteristics of the antenna of the present invention are markedly superior to those of the antenna having no cup.

It will be understood that various materials are suitable for use in constructing the antenna of the present invention. By way of example rather than limitation, the potting compound **11** may be any suitable dielectric material having the desired structural strength when cured, and preferably having a dielectric constant in the range of 1.8 and a dissipation factor of 0.015 or less. Suitable potting materials in addition to Stycast 109051 include polytetrafluoroethylene, sold under the trademark "Teflon" or R.T.V. 560, 90 or 60 made by the General Electric Company. The blade **10** may be constructed of Havar Steel which is sold by the Hamilton Watch Company, Simmonds Precision Sara Beacon Material made by the Simmonds Precision Company, or any other suitable metal such as stainless steel or beryllium copper. The cup **12** and plate **13** may be constructed of any suitable, conducting metal.

It will also be understood that various modifications may be made in the illustrated form of the invention without departing therefrom. By way of example rather than limitation, the single blade element **10** may be replaced with a series of similar blades which are laminated to each other to increase their rigidity. The plate **13** may also assume a variety of shapes and is not limited to the configuration illustrated in the drawings. If desirable, the base of the cup **12** may be omitted and the shield conductor **17***b* may be connected directly to the cylindrical wall of the cup. Various modifications may also be made in the anchoring and attachment assembly carried at the bottom of the blade **10**.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof, and various changes in the size, shape, and materials as well as in the details of the illustrated construction may be made within the scope of the appended claims without departing from the spirit of the invention.

We claim:

1. A blade monopole antenna comprising:

(a) an elongated metallic blade means having first and second axial ends;

(b) a dielectric means for supporting said first axial end of said blade means;

(c) an axially extending annular metallic shield means completely encircling said first axial end and a portion of the axial length of said blade means and separated from said blade means by said dielectric means; and

(d) a metallic ground plate means carried externally of said annular metallic shield means and extending laterally from said shield means.

2. The blade monopole antenna as defined in claim 1 wherein said blade curves laterally along its axial length.

3. The blade monopole antenna as defined in claim 1 or 2 above wherein said dielectric material includes a concave surface which extends toward said first axial end of said blade.

4. The blade monopole antenna as defined in claim 1 or 2 above wherein said shield means includes cylindrical walls and is concentrically disposed about said blade.

5. The blade monopole antenna as defined in claims 1 or 2 above wherein:

(a) said shield means includes a cup-shaped body having cylindrical sidewalls; and

(b) said dielectric material includes a concave surface which extends toward said first axial end of said blade.

6. The monopole blade antenna as defined in claim 1 above wherein:

(a) said blade curves laterally along its axial length;

(b) said dielectric material includes a concave surface which extends toward said first axial end of said blade;

(c) said shield means includes cylindrical walls and is concentrically disposed about said blade; and

(d) shield means further includes a metal base extending between said cylindrical walls.

7. The blade monopole antenna as defined in claim 1, 2 or 6 further including a coaxial conductor having an inner conductor and an outer conductor with said inner conductor connected to said first axial end of said blade and said outer conductor connected to said shield means.

8. The blade monopole antenna as defined in claim 1, 2 or 6 wherein said metallic ground plate means is electrically associated with a metallic mounting surface for forming a ground plane.

9. The blade monopole antenna as defined in claim 1, 2 or 6 including a ground plane of metallized garments.

10. The blade monopole antenna as defined in claim 1, 2 or 6 wherein said metallic ground plate means is electrically associated with a metallic mounting surface for forming a ground plane and including a further ground plane area comprising metalized garments.

References Cited

FOREIGN PATENTS

873,521 3/1942 France.

ELI LIEBERMAN, Primary Examiner

U.S. Cl. X.R.

343—829. 888