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

REPLY TO ATTN OF: GP

March 29, 1971

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 contained in the Code GP to Code USI memorandum on this subject, dated June 8, 1970, 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. : 3,373,430

Corporate Source : Langley Research Center

Supplementary Corporate Source : ______

NASA Patent Case No.: XLA-03114

Gayle Parker

Enclosure:
Copy of Patent

NASA-HQ

N71-22888

March 12, 1968 W. F. CROSWELL ETAL 3,373,430

OMNIDIRECTIONAL MICROWAVE SPACECRAFT ANTENNA

Filed March 15, 1965 2 Sheets-Sheet 1

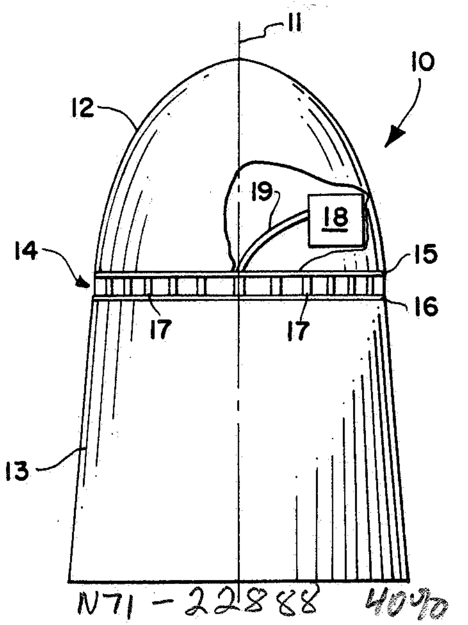

FIG. 1

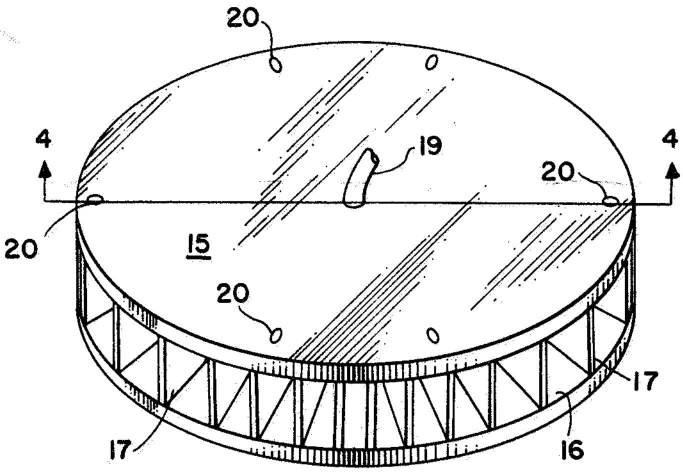

FIG. 2

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March 12, 1968 W. F. CROSWELL ET AL **3,373,430**

OMNIDIRECTIONAL MICROWAVE SPACECRAFT ANTENNA

Filed March 15, 1965 2 Sheets-Sheet 2

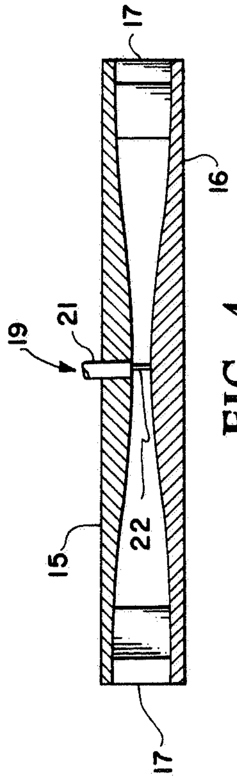

FIG. 4

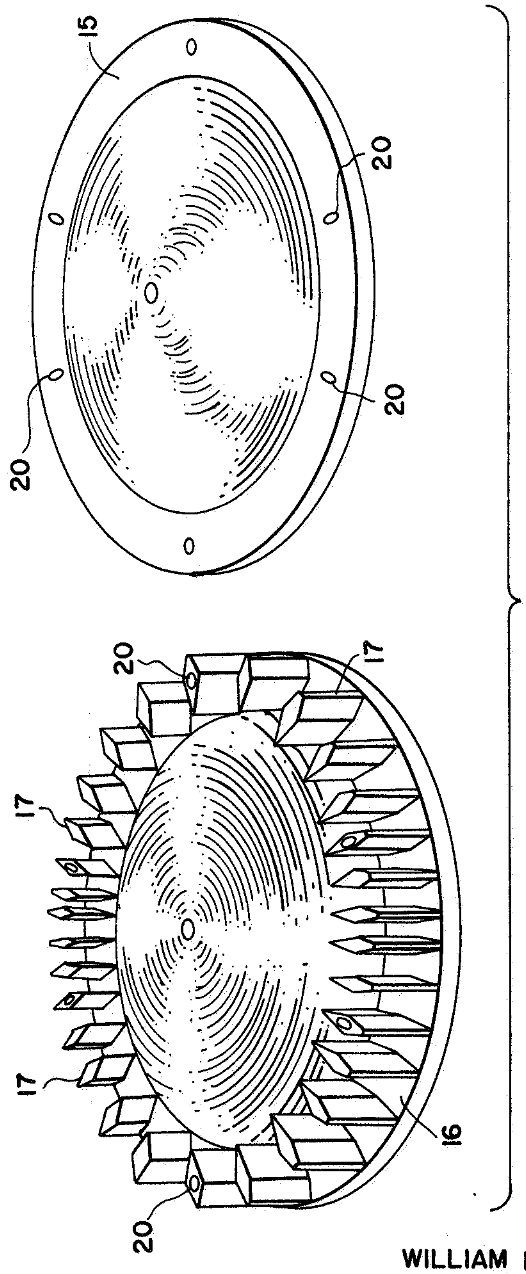

FIG. 3

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3,373,430

OMNIDIRECTIONAL MICROWAVE SPACECRAFT ANTENNA

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Filed Mar. 15, 1965, Ser. No. 440,039
12 Claims. (Cl. 343—708)

ABSTRACT OF THE DISCLOSURE

An omnidirectional antenna utilized with a spacecraft. The antenna is a biconical horn placed between segments of the spacecraft. The antenna halves are connected by wedge-shaped scattering obstacles which offer minimum interference to a wave, and re-radiate obstructed portions of the wave.

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

This invention relates to antennas and more particularly concerns a microwave omnidirectional antenna for use on a spacecraft.

In a spin stabilized spacecraft, nearly omnidirectional antenna patterns, in a plane orthogonal to the spin axis, are required to provide continuous communications from the spacecraft. A partial solution to this problem for spacecraft of circular cross section is to array a number of discrete sources around the circumference of the spacecraft. At commonly used VHF telemetry frequencies, typical spacecraft dimensions are in the order of a wavelength, so that only a few sources are needed to obtain satisfactory patterns. However, at microwave frequencies many sources are required since typical spacecraft dimensions are many wavelengths. Since a large number of sources becomes impractical on a spacecraft because of additional volume, weight and feed loss, a new solution is desirable.

A simple solution to the problem of producing an omnidirectional antenna pattern in a plane orthogonal to the spin axis of a spacecraft would be to split the spacecraft in half and place a biconical horn, fed in the TEM Mode, between the two halves. However, if this is done the two halves of the spacecraft have to be attached together by means extending through the biconical horn. Also electrical connections have to be made through the biconical horn. These attaching means and electrical connections seriously disturb the antenna patterns.

It is therefore an object of this invention to provide a microwave omnidirectional antenna for use on a spacecraft.

Another object of this invention is to provide an antenna that produces omnidirectional antenna patterns in a plane orthogonal to the spin axis of a spacecraft.

A further object of this invention is to provide an omnidirectional antenna that separates two portions of a spacecraft wherein the structural and electrical connections through the antenna will not seriously disturb the antenna patterns.

A still further object of this invention is to provide an omnidirectional antenna having only one feed source for use on a spacecraft.

Still another object of this invention is to provide a modified biconical horn antenna for use on a spin stabilized spacecraft.

In accomplishing these and other objects this invention consists of a biconical horn antenna located between two portions of a spin stabilized spacecraft. Each of the two

contoured plates of the biconical horn antenna is attached to one of the two portions of the spacecraft; and the two plates of the biconical horn antenna are attached together by a number of scattering obstacles evenly spaced around the circumference of the plates. Each of these scattering obstacles is tapered in a wedge shape that points toward the center of the antenna. The scattering obstacles, because of their shapes, disturb the antenna patterns very little. The scattering obstacles perform two useful functions; they attach the two portions of the spacecraft together and they provide a location where electrical connections can be made between the two portions of the spacecraft without disturbing the antenna patterns.

Other objects and advantages of this invention will further become apparent hereinafter and in the drawings, in which:

FIG. 1 is a schematic drawing showing the relationship of a spin stabilized spacecraft and the antenna that constitutes this invention;

FIG. 2 is a perspective view of the antenna that constitutes this invention;

FIG. 3 is a perspective view of the antenna in FIG. 1 disassembled; and

FIG. 4 is a cross-sectional view taken along section lines 4—4 in FIG. 2.

In describing the preferred embodiment, of the invention illustrated in the drawings, specific terminology will be resorted to for the sake of clarity. However, it is not intended to be limited to the specific terms so selected, and it is to be understood that each specific term includes all technical equivalents which operate in a similar manner to accomplish a similar purpose.

Turning now to the specific embodiment of the invention selected for illustration in the drawings, the number **10** in FIG. 1 designates generally a spacecraft that is spin stabilized about an axis **11**. Spacecraft **10** is divided into two parts **12** and **13**. The two parts are separated by a modified biconical antenna **14** including two electrically conductive plates **15** and **16**. Plate **15** is attached to spacecraft part **12** by any suitable means such as welding or bolting; and plate **16** is attached to spacecraft part **13** by any like suitable means. Plates **15** and **16** are connected together by means of a number of electrically conductive scattering obstacles **17**. Scattering obstacles **17** are attached to plates **15** and **16** by suitable means such as welding or bolting. Antenna **14** is fed from a transmitter **18** by means of a coaxial cable **19**.

Referring now to FIG. 2 there is shown a perspective view of the antenna **14** in FIG. 1. As is shown, there are several holes **20** in plate **15**. Each of these holes **20** goes through plate **15**, a scattering obstacle **17** and plate **16**. These holes provide openings through which electrical connections can be made from spacecraft part **12** to spacecraft part **13**. Any number of these holes **20** can be made up to the number of scattering obstacles **17**.

FIG. 3 shows the antenna in FIG. 2 disassembled. Plate **15** is shown flipped over on its back. As can be seen, plates **15** and **16** are flat on their outer edges and are contoured in their center portions. Scattering obstacles **17** are equally spaced around the flat portions of plates **15** and **16**. All of the scattering obstacles **17** are the same size and have the same wedge shape that points in the direction of the center of the antenna. Each of the scattering obstacles **17** measures approximately one wavelength from its tip or sharp end to its widest part and measures approximately one-half a wavelength from its widest part to its blunt end. It is necessary that a scattering obstacle be at least one wavelength long.

A cross-sectional view of the antenna taken along section lines 4—4 in FIG. 2 is shown in FIG. 4. Plates **15** and **16** are contoured so that at their centers they are less than a half wavelength apart and at their outer edges they are a wavelength or greater apart. Coaxial cable **19** consists of an outer conductor **21** and an inner conductor **22**. Outer conductor **21** is electrically connected to plate **15** and inner conductor **22** is electrically connected to plate **16**. Other types of omnidirectional radiating means, such as dipoles, could be fed by coaxial cable **19** without departing from the spirit or scope of the invention.

In operation the coaxial feed **19** is used to excite a voltage across plates **15** and **16**. These plates are spaced so that a uniform circular TEM wave is launched which propagates outwardly. The parts of the wave that go between the scattering obstacles **17** travel on into space unaltered by the scattering obstacles. The parts of the wave that strike the scattering obstacles induce current in them causing them to re-radiate. The re-radiation patterns of the scattering obstacles are influenced by their shapes. For the shapes shown, that is wedge shapes, practically all of the re-radiation will be in a direction away from the center of the antenna. Very little re-radiation will be in the direction of the center of the antenna. Consequently, re-radiation patterns from the scattering obstacles will add to the circular TEM wave resulting in an omnidirectional pattern from the antenna. If scattering obstacles **17** had shapes other than wedge shapes, they would re-radiate substantially in the direction of the center of the antenna. This would result in deep nulls in the antenna patterns. With the scattering obstacles having wedge shapes these nulls are very shallow.

The antenna that constitutes this invention has several advantages. It produces an omnidirectional pattern in one plane; it has a simple feed system requiring only one connection; it allows for attaching its two plates together and for electrical interconnections through its two plates without influencing the antenna characteristics; and it exhibits broadband impedance characteristics over waveguide bandwidths.

It is to be understood that the form of the invention herewith shown and described is to be taken as a preferred embodiment. Various changes may be made in the shape, size and arrangement of parts. For example, equivalent elements may be substituted for those illustrated and described herein, parts may be reversed, and certain features of the invention may be utilized independently of the use of other features, all without departing from the spirit or scope of the invention as defined in the following claims.

What is claimed is:

1. An omnidirectional microwave antenna for use on a satellite comprising: a biconical antenna located between two sections of the satellite with each of the two plates of said antenna securely attached to one of said two sections of the satellite; a number of wedge-shaped scattering obstacles located between said two plates at their outer edges and attached thereto for holding the two plates together and thereby holding the two sections of the satellite together; and means for feeding said biconical antenna at its center to cause it to launch a uniform circular wave outwardly in the direction of the scattering obstacles whereby parts of the wave pass through the scattering obstacles unchanged and the other parts generate currents in the scattering obstacles which reradiate to cause a resultant omnidirectional pattern.

2. An omnidirectional microwave antenna in accordance with claim **1** wherein the pointed ends of said wedge-shaped scattering obstacles are all pointed toward the center of said biconical antenna.

3. An omnidirectional microwave antenna in accordance with claim **1** wherein said wedge-shaped scattering obstacles are equally spaced around the two plates.

4. An omnidirectional microwave antenna in accordance with claim **1** wherein said wedge-shaped scattering obstacles are each at least one wavelength long.

5. An omnidirectional microwave antenna in accordance with claim **1** wherein said two plates and said scattering obstacles have holes in them to provide for electrical connections between said two sections of the satellite.

6. An omnidirectional microwave antenna comprising: first and second electrically conductive circular plates that are flat around their circumference and inwardly toward their centers for at least a wavelength, and that are then contoured toward their centers on one of their sides; a number of electrically conductive wedge-shaped scattering obstacles for connecting said first and second circular plates together around their circumferences such that the contoured surfaces of the plates face each other; and means for applying a voltage between said two plates at their centers to cause a uniform circular wave to be launched outwardly in the direction of the scattering obstacles whereby parts of the wave pass through the scattering obstacles unchanged and the other parts generate currents in the scattering obstacles which re-radiate to cause a resultant omnidirectional pattern.

7. An omnidirectional microwave antenna in accordance with claim **6** wherein the pointed ends of said wedge-shaped scattering obstacles are all pointed toward the centers of said two plates.

8. An omnidirectional microwave antenna in accordance with claim **6** wherein said wedge-shaped scattering obstacles are equally spaced around the two plates.

9. An omnidirectional microwave antenna in accordance with claim **6** wherein said two plates are less than a half wavelength apart at their centers and greater than a wavelength apart at their outer edges.

10. An omnidirectional microwave antenna comprising: first and second electrically conductive plates; a number of electrically conductive wedge-shaped scattering obstacles for connecting said first and second plates together around their outer edges; and means for applying electrical signals between said two plates to cause a uniform circular wave to be launched outwardly in the direction of the scattering obstacles whereby the interference of the wave by said scattering obstacles is minimized because of the shapes of the scattering obstacles.

11. An omnidirectional microwave antenna in accordance with claim **10** wherein said scattering obstacles are equally spaced around the outer edges of said two plates and all point in the direction of the centers of the two plates.

12. An omnidirectional microwave antenna in accordance with claim **10** wherein the two plates and the scattering obstacles have holes in them whereby electrical connections can be made through the scattering obstacles without interfering with said uniform circular wave.

References Cited

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