May 8, 1962 H. B. RIBLET 3,034,121

BROAD BAND SPHERICAL ANTENNA

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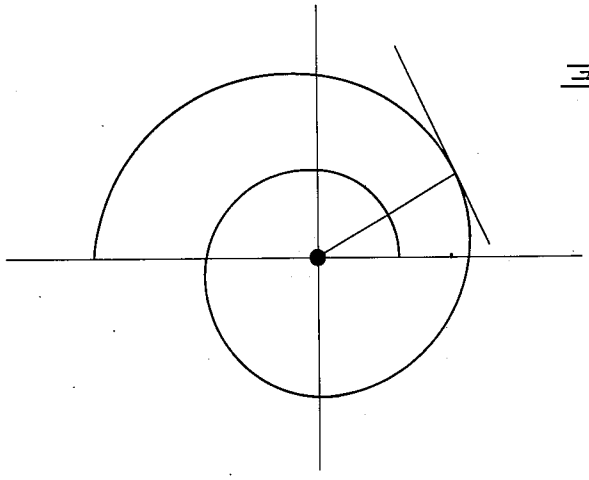


FIG. 1.

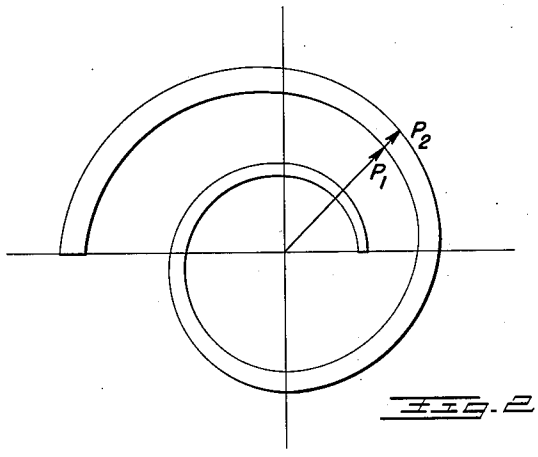
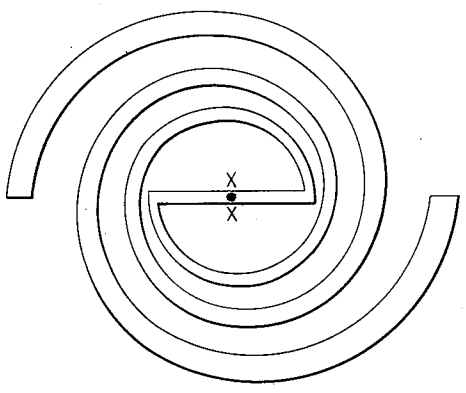


FIG. 2.

FIG. 3.



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FIG. 4.

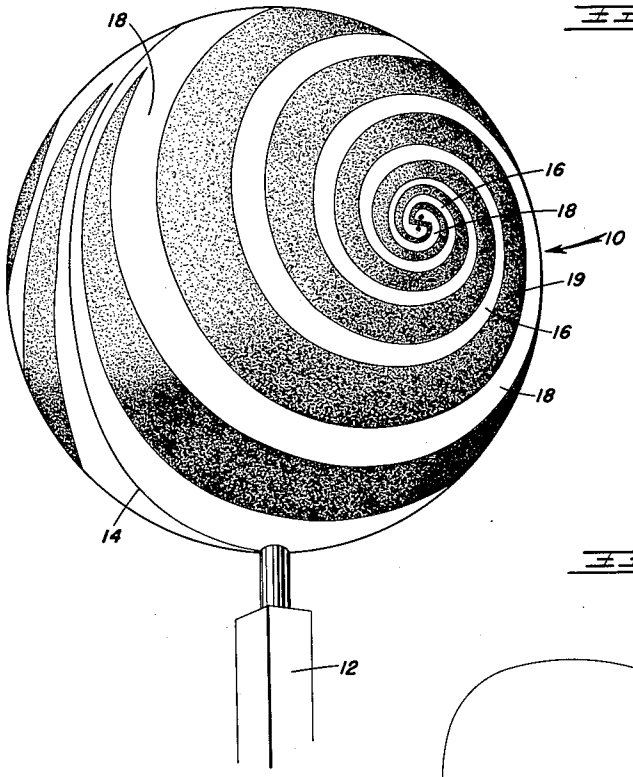


FIG. 7.

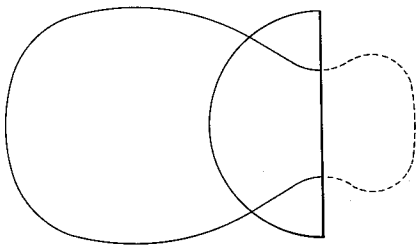
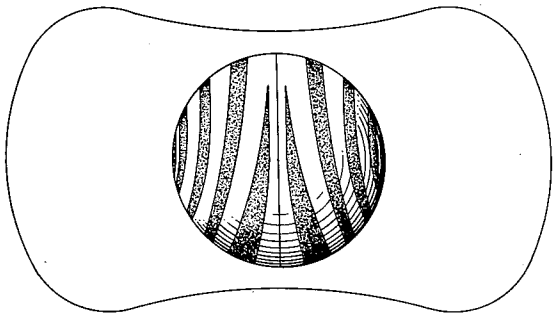


FIG. 8.



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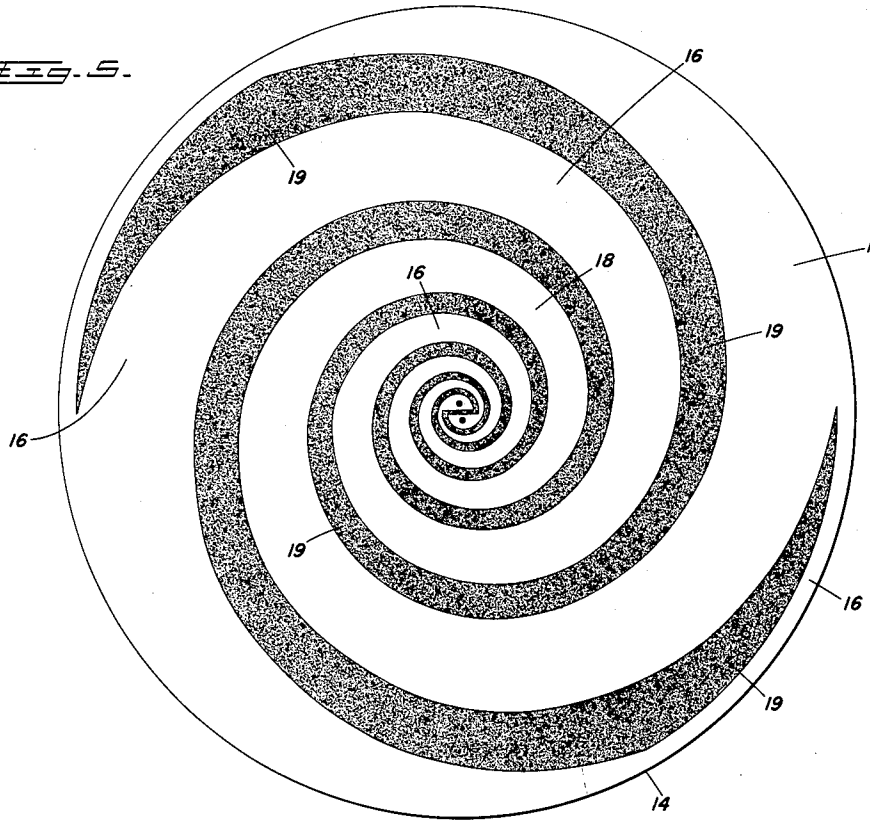
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Fig. 5.



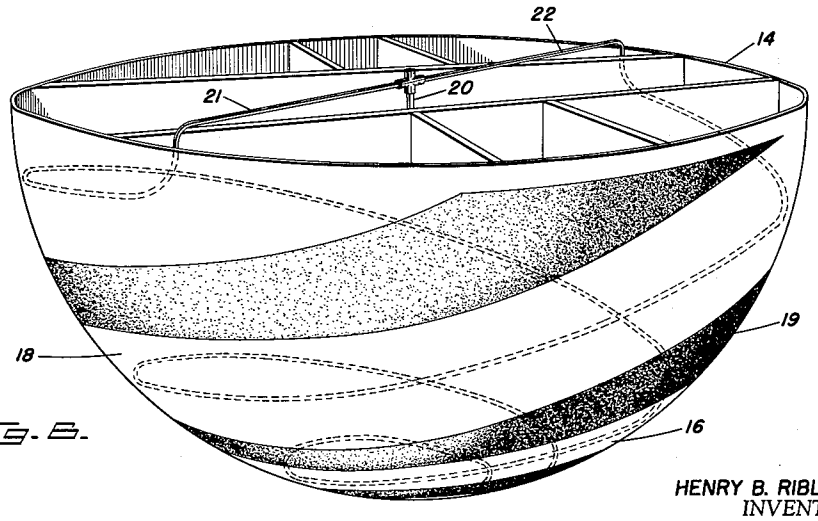


Fig. 6.

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BROAD BAND SPHERICAL ANTENNA

Henry B. Riblet, Kensington, Md., assignor to the United States of America as represented by the Secretary of the Navy

Filed Dec. 23, 1959, Ser. No. 861,722
8 Claims. (Cl. 343—770)

The present invention relates generally to antennas; more particularly it relates to an improved double hemispherical concentric spiral antenna which is especially adapted for use with spherical aerial vehicles.

The principal object of the invention is to provide an antenna having broad band characteristics and a pattern approaching the isotropic (zero null).

Another object of the invention is to provide an antenna which may be flush mounted on the vehicle, so that the aerodynamic stability of said vehicle will be maintained.

A further object of the invention resides in the provision of an antenna that may be conveniently arranged on the surface of a sphere, said antenna consisting of pairs of concentric logarithmic spirals placed back to back on the sphere and having such radiation characteristics that received signal amplitude changes would not be greater than 10 db due to antenna pattern variations, regardless of the attitude in space of the sphere.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. 1 is a diagram showing a logarithmic spiral;

FIG. 2 is a diagram showing the evolution of a logarithmic spiral slot;

FIG. 3 is a diagram showing a double spiral slot, the two slots being positioned 180 degrees with respect to each other;

FIG. 4 is a perspective view of the improved spherical antenna;

FIG. 5 is a plan view showing a pair of concentric spiral antenna elements as they would appear if arranged in a plane;

FIG. 6 is a perspective view of a hemisphere with one pair of the concentric spiral antenna elements thereon;

FIG. 7 is a diagram showing a basic pattern obtained with a spiral antenna arranged on the surface of a hemisphere; and

FIG. 8 is a diagram showing the pattern obtained by placing two pairs of hemispheric spiral antennas back to back on a sphere, it being assumed that feed point phasing and orientation of the spiral pairs with respect to each other are correct.

The requirement for a broad band antenna, covering a frequency range of at least four to one and providing radiation characteristics which would produce no nulls greater than —10 db with respect to the maximum in any plane, and at any angle with respect to the antenna within a spherical boundary, was generated by the development of a special spherical aerial vehicle. This requirement was so imposed that regardless of the attitude of the vehicle in space, the received signal variation would not be greater than 10 db due to antenna pattern changes.

The design of the antenna constituting the present invention is based on the established properties of the class of broad band antennas using equiangular spiral slots or conductors. Such an antenna has the property that its shape is specified entirely by angles, so that its performance is independent of wavelength. A familiar example of such an antenna is the infinite biconical horn.

The logarithmic spiral has the property that an angle between the tangent to the curve and its radius vector is

a constant and greater than 90 degrees. Such a spiral is shown in FIG. 1. A spiral slot antenna can be constructed by plotting two spirals slipped in angle with respect to each other, as shown in FIG. 2. Similarly, as shown in FIG. 3, a double spiral slot can be produced by plotting two spirals (FIG. 2) 180 degrees with respect to each other. In FIG. 3 the feed points are shown at X—X.

The present invention contemplates the application of a logarithmic spiral antenna to the surface of a hemisphere rather than to a flat surface or sheet as in conventional practice. More specifically, and as shown in FIG. 4 of the drawings, the present invention utilizes a pair of concentric logarithmic spiral antennas applied back to back on the surface of a sphere. The sphere is shown at **10** and is mounted on a suitable support **12** which also carries the feed line, to be described hereinafter. The support **12** passes through the equator of the sphere, indicated at **14**, and is thus positioned normal to the polar axis of the sphere. Suitably secured to or formed on each half of the sphere is a pair of concentric spiral logarithmic antenna elements **16** and **18** separated by dielectric filled slots **19** which are formed in the manner described in FIG. 3. The antenna is then fed in the conventional manner for slot antennas across the slot **19** as shown at X—X in FIG. 3. In the alternative, surfaces **19** could be made conductive and elements **16** and **18** could be changed to dielectric filled slots. In this complementary embodiment the surfaces **19** are opened at the poles of the sphere and the feed means connected to them across the slot as shown in FIG. 3. Since either embodiment is the complement of the other the radiation characteristics will be essentially the same for each case.

As shown in FIG. 6, a central coaxial feed line **20**, which is passed upwardly through the support **12**, transfers energy between a transmitter or a receiver and the antenna elements **16** and **18**, branch feed lines **21** and **22** connecting the central line to said elements. The branch feed lines **21** and **22** are, as shown in dotted lines, arranged in spiral formation within the hemisphere and beneath, or inside, the antenna elements.

When the spiral antenna is formed on the surface of a hemisphere, a radiation component is available normal to the polar axis of the hemisphere, giving some side radiation. Such radiation is similar to the null fill-in obtained by a bent dipole or a V-shaped dipole. FIG. 7 is illustrative of this result. The dotted back lobe illustrates the back radiation if the cavity within the hemiphere is not infinite or not fully shielded.

If two hemispheres are placed back to back to form a sphere and the orientation of the spiral and the feed point phasing are correct, the radiation components at the equator can be made to be in phase. In this situation the radiation components normal to the polar axis (i.e., equator) add to reinforce the side nulls already filled in by the bending of the spiral slot or conductor antenna elements over the spherical surface. FIG. 8 shows the arrangement.

When the two spirals which are fed independently at the poles are fed in phase, by equal length lines, from a common point and the radiation components are in phase all around the equator, the radiation pattern is a figure of revolution about the polar axis. By another phasing arrangement (i.e., out of phase 180 degrees) a null of revolution will be obtained about the equator and a pattern equivalent to that produced by the open flat plane spiral slot and spiral conductor will be obtained. By winding the spirals in the same screw sense rather than opposite, the phasing will vary from in phase in one plane to out of phase in a plane normal thereto, creating zero nulls in one plane and fill-in of the nulls in the plane 90 degrees removed.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In an antenna, a pair of hemispherical body members of dielectric material forming a sphere, a support for the sphere, said support extending normal to the axis of said sphere, electromagnetic field producing means on the sphere and comprising pairs of elements arranged with respect to a diameter of said sphere as concentric logarithmic spirals at the surface of the sphere, one pair of the elements being located on one of the hemispherical body members with the inner ends of said elements adjacent the polar axis of the sphere and the other pair of said elements being positioned on the other of the body members in back to back relation to the first pair of elements.

2. An antenna as recited in claim 1, including additionally means for transferring electrical energy between the center of the sphere and a point remote from the sphere, and means connecting said last-mentioned means to the inner ends of the elements of each pair of elements.

3. In an antenna, a sphere of dielectric material, a pair of conductors arranged with respect to a diameter of said sphere in concentric logarithmic spirals on each half of the sphere, the pair of conductors on one half of the sphere being positioned back to back with respect to the pair of conductors on the other half of the sphere, and means for transferring electrical energy between feed points on the pairs of spiral conductors and a point remote from the antenna.

4. In an antenna, a sphere, electromagnetic field producing means, said means comprising pairs of substantially concentric equiangular spiral elements arranged on the surface of the sphere so that the inner ends of said elements are positioned on the axis of the sphere and the outer ends of said elements are positioned in juxtaposed

relationship to each other and to the equator of said sphere, whereby the radiation components will be in phase around the equator of the sphere, and feed lines connected between a common point and the inner ends of said elements.

5. An omnidirectional antenna comprising a sphere, and electromagnetic field producing means, said means comprising pairs of substantially concentric equitriangu- said sphere are in phase.

6. An antenna as defined in claim 1 wherein said hemispherical body members are oriented with respect to each other so that the radiation components at the equator of said spheres are in phase.

7. An antenna as defined in claim 3 wherein said hemispheres are oriented with respect to one another so that the radiation components at the equator of said sphere are in phase.

8. An omnidirectional antenna comprising a sphere, and electromagnetic field producing means, said means comprising pairs of substantially concentric equiangular spiral elements arranged on each of the hemispheres defining said sphere so that the radiation components from said elements are in phase around the entire equator of said sphere.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

May 8, 1962

Patent No. 3,034,121

Henry B. Riblet

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, lines 8 and 9, for "equitriangusaid sphere are in phase" read -- equiangular spiral elements arranged on each of the hemispheres defining said sphere --.

Signed and sealed this 13th day of November 1962.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents