March 30, 1965 H. HOLLAND 3,176,303

COLLAPSIBLE ANTENNA WITH PLURALITY OF FLEXIBLE REFLECTOR PETALS RELEASABLY RETAINED

Filed Feb. 21, 1962 2 Sheets-Sheet 1

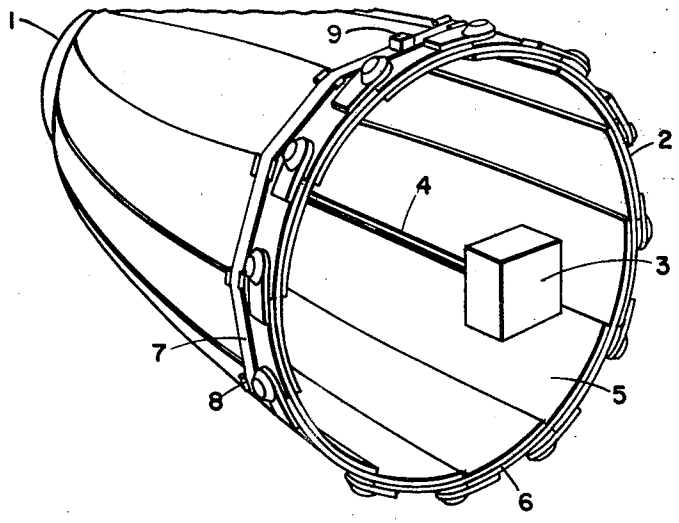


FIG. 1.

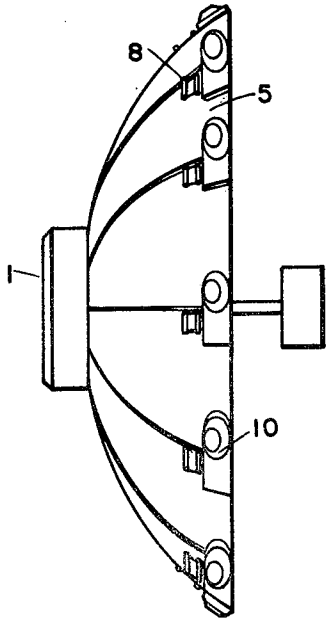


FIG. 2.

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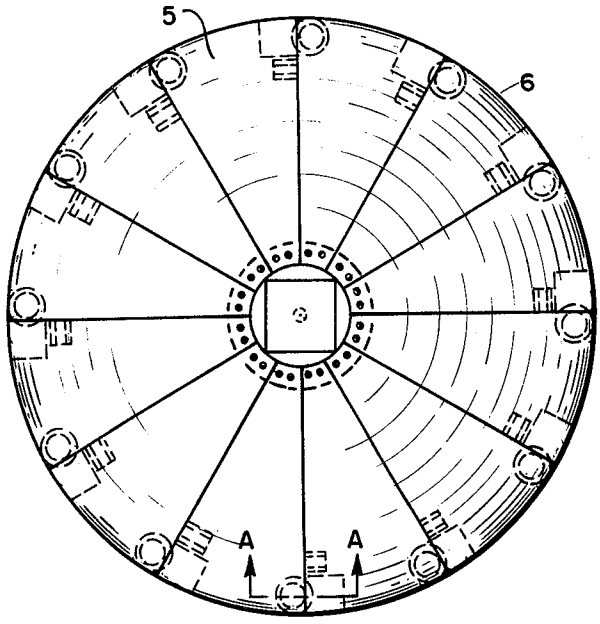
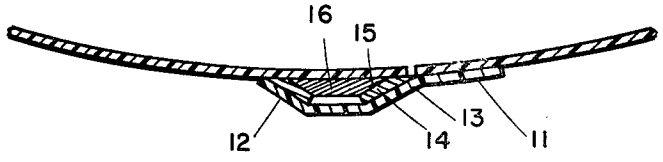


FIG. 3.



SECT. A-A

FIG. 4.

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3,176,303

COLLAPSIBLE ANTENNA WITH PLURALITY OF FLEXIBLE REFLECTOR PETALS RELEASABLY RETAINED

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This invention relates to a collapsible antenna and more particularly to an antenna which is maintained in a collapsed position, taking up a relatively small space, and, when needed, is rapidly expanded into operative position.

In present day space applications, a need exists to make everything which is to be carried aloft by a missile, such as the components of a satellite, as lightweight and compact as possible. Any decrease in the weight of a device carried aloft will necessarily result in a corresponding increase in the payload capacity of the missile. The space within a satellite is also limited, and, accordingly, it is desirable to have all devices contained in the satellite in as compact a shape as possible.

Most satellites now include at least one antenna. An antenna generally has a radiator or collector and a reflector. The reflector is an element which ordinarily takes up more space than any other component of the antenna. It would be desirable to provide an antenna which has a reflector capable of being packaged in a compact shape and which when needed for use as a reflector could be expanded to the desired operative shape. Heretofore, no practical means has been provided to achieve this result.

This invention provides an antenna which employs a reflector consisting of a plurality of petals, each petal being made of a flexible material. Because of the resilient characteristic of the petals, the petals can be compacted to a relatively small area and maintained in this position by a retaining means. Release of the retaining means permits the petals to assume their respective original positions, thereby forming an operative reflector surface.

An object of the invention is to provide an antenna which is compact.

Another object of the invention is to provide an antenna having a reflector which can be collapsed into a compact position when not in use.

A further object of the invention is to provide an antenna which has a reflector capable of being collapsed when not in use, and, upon remote activation, can be expanded into an operative position.

A still further object of the invention is to provide a collapsible antenna which is simple in construction and operation and at the same time, is reliable in operation.

Other objects and advantages will be apparent from the detailed description of the invention and from the appended drawings and claims.

In the drawings:

FIGURE 1 is a showing of the reflector in a collapsed, compact condition.

FIGURE 2 is a side view of the antenna in an expanded condition.

FIGURE 3 is a front view of the antenna in the full open position.

FIGURE 4 is a sectional view of the antenna substantially on the line of A—A of FIGURE 3, illustrating a form of locking means employed for maintaining the petals of the reflector in place.

A general showing of the antenna in the collapsed position is shown in FIGURE 1. A mounting base 1 is provided to support the antenna structure generally shown at 2. A radiator 3 with its associated support 4 is attached to the mounting base by suitable means and extends in a longitudinal direction from the mounting base 1. A plurality of petals 5 are attached to the mounting base by suitable means such as screws 6. The respective petals 5 are made from a flexible material capable of being distorted and returning to an original position after the distorting means is removed. Any fiberglass or other reinforced plastic materials could be used. A metal can also be used therein if it has a high modulus of elasticity. Fiberglass is especially good since it has an inherently low flexural modulus. Large deflections are possible with fiberglass materials without consequent permanent deformations occurring since the yield stress of fiberglass is close to its ultimate stress.

The respective petals 5 are bent over from their original poistion to form a cup-like structure around the collector means as shown in FIGURE 1, thereby decreasing the total space taken up by the antenna. The petals are restrained in this position by suitable retaining means. In this embodiment, a strap 7 is employed to retain the petals 5 in their flexed position. The strap 7 is held in place relative to the petals 5 by a plurality of clips 8 attached to the petals 5. The strap 7 itself is held in a locked position by a destructive link 9. Unless the link 9 is destroyed, the strap 7 serves to hold the petals 5 in their folded position.

The destructible link 9 can take any of a plurality of forms. A squib could be provided wherein, by utilizing a remotely controlled actuating apparatus (not shown), the link 9 can be destroyed, whereby the flexed petals 5 spring out to their normal position and form an operative reflector surface.

A remotely actuated solenoid could also serve as the actuating means to release the latching means (not shown) linking the respective ends of the strap 7 together. In fact, any type of well-known triggering mechanisms could be used to release the strap 7.

The surface area of the collapsed reflector, shown in FIGURE 1, necessarily is less than the surface area of the reflector in its open position. The decrease in size of the reflector surface upon collapse is made possible by having the petals 5 overlap each other as is clearly shown in FIGURE 1. The degree of overlap is necessarily proportionate to the decrease in the reflector surface area.

Release of the strap retainer 7 upon activation of the destructible link 9 results in the petals 5 snapping out into their operative position. An important feature of the invention resides in the fact that the energy for expanding the collapsed reflector structure is inherently contained in the reflector structure itself. The energy is stored up in the flexed petals 5 and this energy alone is used to expand the reflector structure. The open operative reflector surface can be parabolic, spherical, flat, or any other design, the operative form depending solely on how the respective petals 5 had been originally molded or preformed.

Locking means 10 are provided near the edge of each petal to maintain the individual petals 5 in a desired relationship. One type of locking means 10 which could be employed is a complementary pair of permanent magnets, as is clearly shown in FIGURE 4. A brace 11 is attached to a first edge of each petal 5 on its backside and includes an extension 12 which protrudes over the edge of the petal 5. The extension 12 is formed in such a manner so as to provide a recessed area 13 to support a magnet. A first magnet 14 having a recess 15 therein is inserted in the recessed area 13 of the extension 12 and attached thereto with a suitable adhesive. The opposite edge of each petal has a second magnet 16 attached thereto by suitable adhesive means. The second magnet 16 has a convex form which is capable of fitting snugly into

the recess **15** of the adjoining first magnet **14**. The magnets **14** and **16** are aligned so as to match up with each other when the reflector is in its fully opened position. The attractive force between the respective pairs of magnets **14** and **16** serves to prevent separation of the individual petals **5** and helps to maintain the predetermined surface contour of the reflector and provide rim stiffness ties.

Other and different locking means, such as complementary latching means could be used without departing from the scope of the invention.

The petal folding operation automatically stores energy in the form of material flexural stress. It is this flexural stress energy which is utilized to accomplish the unfolding action. This energy storage capability obviates the necessity of including with the antenna various mechaanisms, control devices, or other extraneous hardware to effect the expansion of the reflector. The only power necessary to expand the reflector is that energy necessary to trigger the release of the link **9** holding the ends of the strap **7** together. Since no extraneous structure is necessary to provide the motive power for expanding the reflector, a significant decrease in the overall weight of the antenna structure results. The absence of complicated mechanisms results in an increase in reliability of the antenna.

Because fiberglass plastic materials do not reflect electro-magnetic radiations, a metallic surface must be provided if the petals **5** are made of fiberglass. This can be achieved by vapor depositing, metal spraying, or metal bonding gold, silver, copper or aluminum to the fiberglass petals **5**. Of course, this would not be necessary if the petals **5** themselves are constructed from a flexible metal.

Although this invention has been disclosed and illustrated with reference to particular applications, the principles involved are susceptible of numerous other applications which will be apparent to persons skilled in the art. The invention is, therefore, to be limited only as indicated by the scope of the appended claims.

I claim:

1. A collapsible reflector assembly essentially comprising a base member, a plurality of independent petals attached to said base member and extending radially therefrom, each of said petals being composed of a flexible solid material, said petals in an unflexed state being capable of presenting a unitary reflector surface, releasable retainer means for holding said petals in a flexed, overlapping position, means for deactivating said retainer means, whereby the energy utilized to expand said reflector assembly is supplied solely by the petals.

2. The reflector assembly set forth in claim 1 including locking means for maintaining the petals in an aligned position while in an unflexed state.

3. The reflector assembly set forth in claim 2 wherein said locking means are permanent magnets.

4. The reflector assembly set forth in claim 1 wherein said releasable retainer means are remotely activated.

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