United States Patent

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[54] **MULTICURVED REFLECTOR**
4 Claims, 4 Drawing Figs.

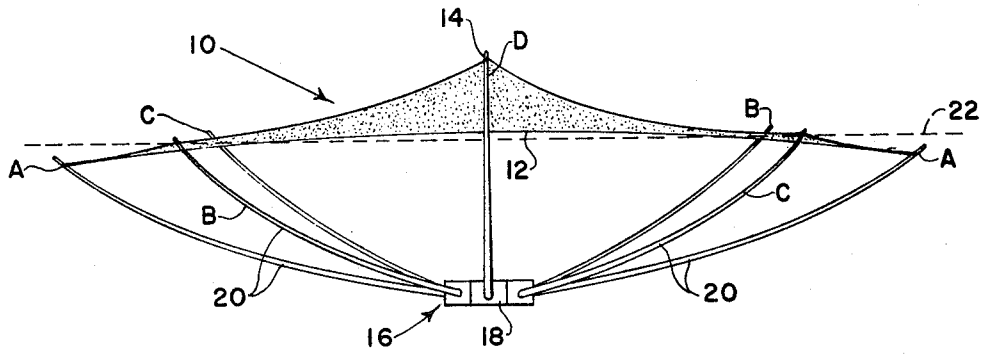
[52] **U.S. Cl.** **350/293,**
350/288, 350/295
[51] **Int. Cl.** **G02b 5/10**
[50] **Field of Search** 350/293-
-295, 288, 109; 343/817, 894

[56] **References Cited**
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ABSTRACT: The invention relates to a reflecting surface with a prescribed complex curvature achieved without the use of internal pressurization-, inflation-, or rigidization-dependent techniques. The reflector is a one-sheet hyperboloid or some other similar smoothly varying curved sheet containing both convex and concave elements at every point on its surface. The surface is achieved by the proper tensioning and positioning of the sheet around its periphery.



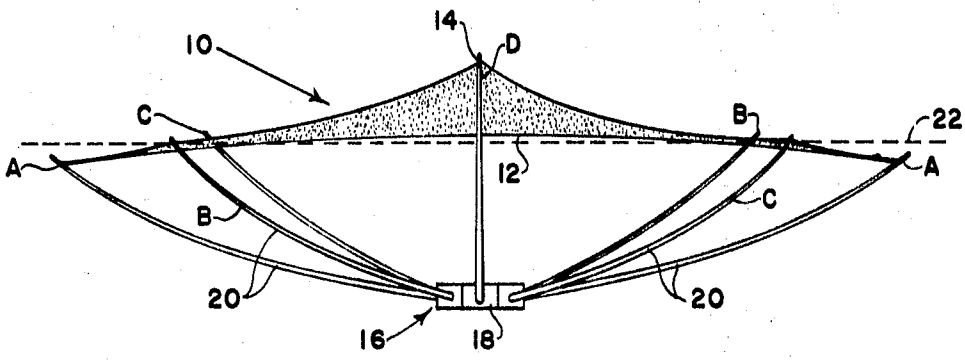


FIG. - 1

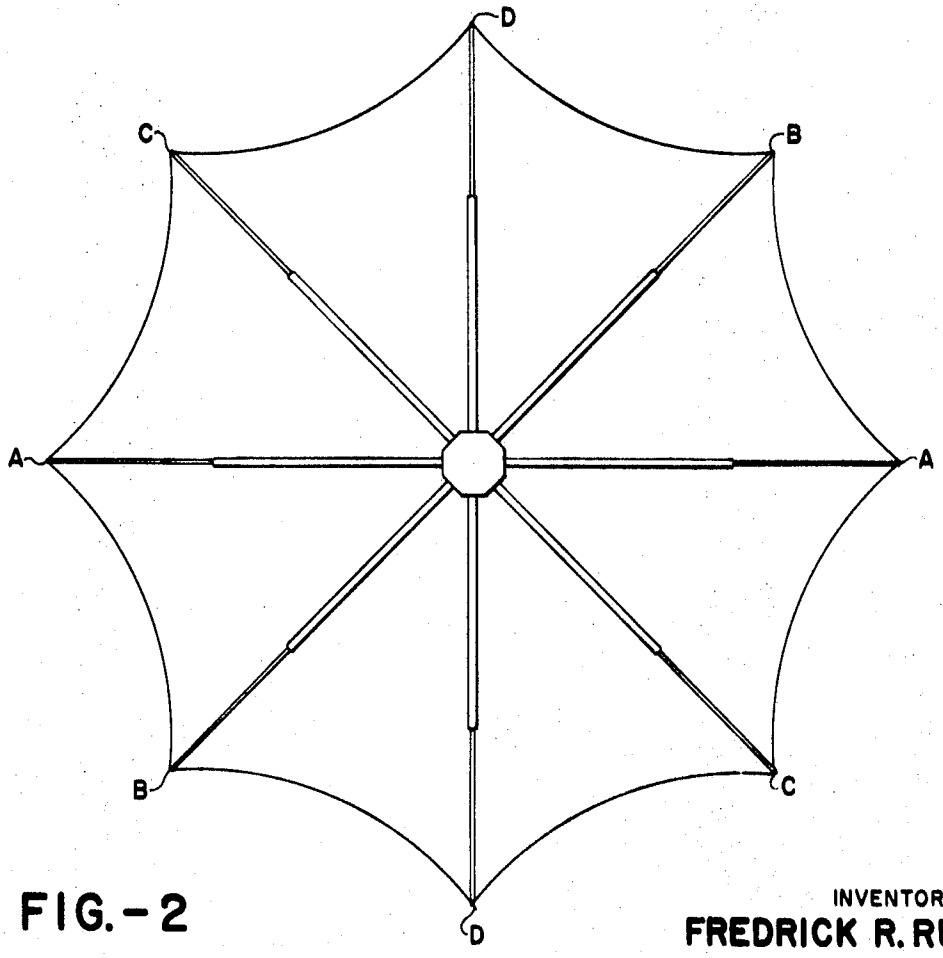


FIG. - 2

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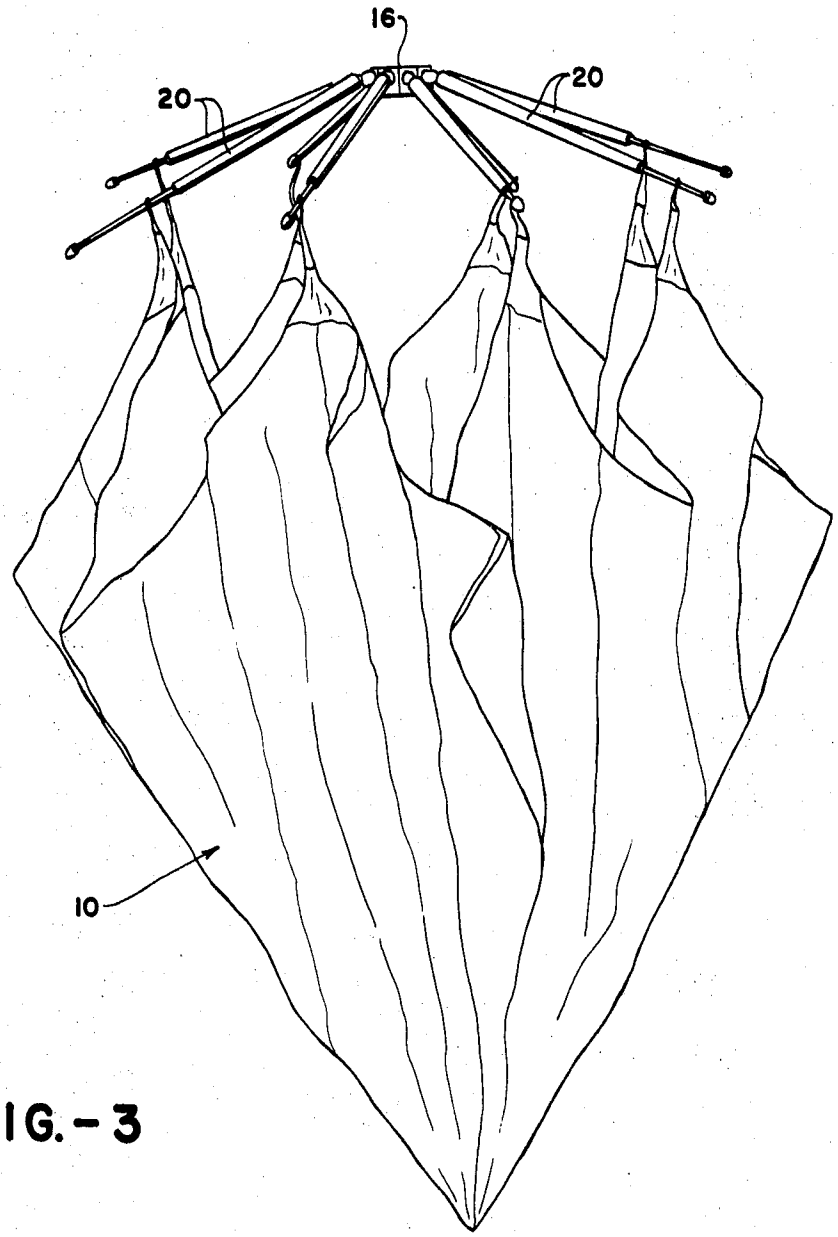


FIG.-3

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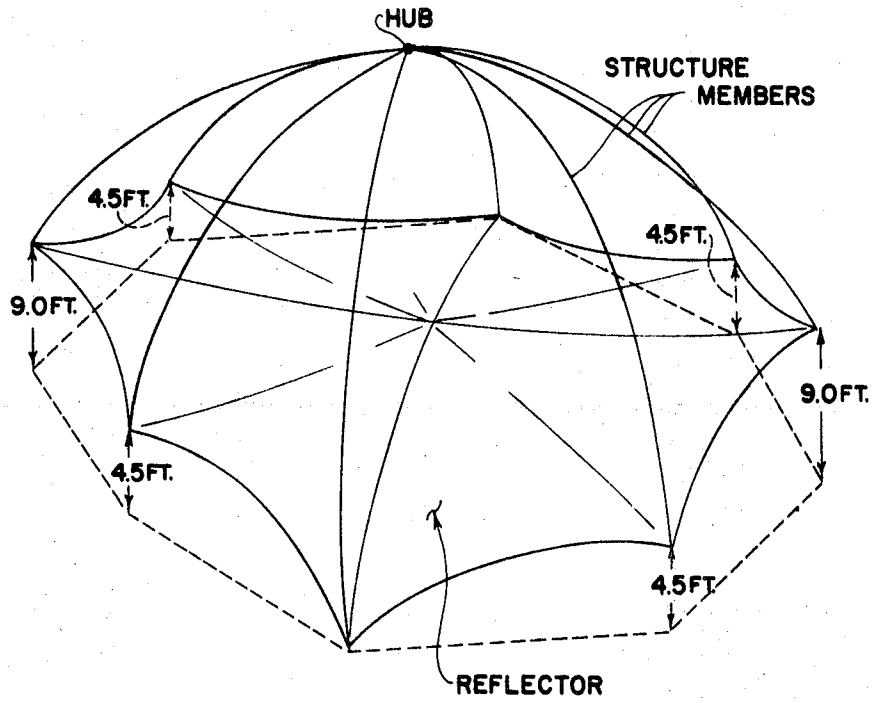


FIG.-4

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MULTICURVED REFLECTOR

PRIOR ART

Heretofore, attempts have been made in large spaced deployable reflecting surfaces to obtain a prescribed curvature with minimum weight requirement. These attempts have included internal pressurization or rigidization dependent techniques. These techniques are subject to distortion, are particularly characterized by being highly dependent upon maintaining proper pressure or rigidization, and have not proved to be reliable in a space environment. The extreme temperature changes which take place very greatly effect this type of structure. Further, structures of this type are not readily packaged for deployment in a space environment.

Therefore, it is the general object of the present invention to overcome the foregoing and other difficulties of and objections to the prior art practices by providing a large space deployable tensioned reflecting surface with a prescribed curvature which is a one-sheet hyberboloid or some other similar smoothly varying curved sheet containing both convex and concave elements at every point on its surface. This surface is achieved by the proper tensioning and positioning of the sheet at its periphery.

For better understanding of the invention, reference should be had to the accompanying drawings wherein:

FIG. **1** is a side elevational view of a preferred embodiment of the invention;

FIG. **2** is a plan view of the reflector of FIG. **1**;

FIG. **3** is a view of the reflector of FIG. **1** in the nearly collapsed condition showing how ready packaging can be incorporated for deployment purposes; and

FIG. **4** is a schematic perspective illustration showing the multicurved configuration to the surface of the reflector.

With reference to the form of the invention illustrated in FIG. **1** of the drawings, the numeral **10** indicates generally a reflector which is formed in a one-sheet hyperboloid containing both convex and concave elements at every point on its surface. Essentially, the surface line **12** represents the convex surface running from left to right across in FIG. **1**, while the line **14** running into the paper represents the concave configuration. The particular configuration to the reflective surface **10** is achieved by any suitable supporting frame, which is indicated generally by numeral **16**. The frame comprises a hub **18** and radiating spokes **20** which connect to the periphery of the reflector **10** and hold it in tension to a desired configuration, as more fully defined hereinbelow.

The spokes **20** because of their respective positions and tensioning features with respect to hub **18** actually form the reflector **10** to the complex curvatures formed by lines **12** and **14** defined above. This is accomplished by diametrically opposite spokes **20** lying at the same level with respect to hub **18**. Thus, for example, those spokes labeled A support the diametrically opposite ends below what would be considered the normal or mean level of the reflector **10** which is indicated by dotted line **22**. The frame **16** indicated in FIG. **1** of the drawings actually has eight spokes connected to hub **18**. Spoke pairs BB and CC both have their supporting and tensioning ends lying substantially on the median plane line **22**. However, spokes DD actually support the periphery of the reflector **10** at a point substantially the same distance above the median plane line **22** as the spokes AA support the periphery below the median plane line. The spokes DD are spaced substantially 90° from spokes AA.

The form or configuration of the periphery of reflector **10** is not critical to the variable level support to achieve the concave-convex surfaces illustrated in FIG. **1**, nor is the actual support structure to achieve the peripheral tensioning necessarily limited to the spoked arrangement shown in FIG. **1**. However, FIG. **2** does show that the periphery might be formed to terminate with a loaded catenary having its concentrated load reaction points at eight points to cooperate with the hub and spoke configuration shown in FIG. **1**, for example. In this catenary arrangement, the minimum number of periphery catenary reaction points required to achieve the desired convex-concave surface is four. More reaction points can be used to accomplish variations in the planned form shape or to achieve three-dimensional concave multiple envelope surfaces. Naturally, the more catenary reaction points, and the more levels of the supporting spokes, will produce a more complex surface. The desired number of reaction points can be fixed in position many ways, with the one shown in FIGS. **1** and **2** utilizing adjustable telescopic spokes, beams, or bows. The beam, column, or bow structural elements in the proposed reloaded arrangement results in the reflector surface being maintained at a relatively constant tension in configuration somewhat insensitive to reasonable surface elongations and temperature extremes or differentials that might be experienced across the overall structure. The character of the surface, as, for example, a solid wire grid, aluminized Mylar, etc. can be selected and employed to reflect energy in the visual and/or microwave region. The beam pattern of the reflected energy can be varied, by properly controlling the curvature to the surface, and such reflection is predictable, controllable, and highly acceptable.

FIG. **3** illustrates the embodiment of FIGS. **1** and **2** in a partially collapsed condition showing the telescopic relationship of spokes **20** and how the reflector **10** actually folds down in somewhat of an accordion shape to be readily packaged for deployment by any suitable means. The invention contemplates the spokes **20** will be telescopic by a hydraulic or other suitable pressure drive means so as to extend and position themselves in the configuration somewhat similar to that shown in FIG. **1**. Naturally, as the spokes position themselves to the configuration shown in FIG. **1**, they tend to bow so as to provide the desired and necessary tensioned relationship to achieve the stretch and desired contour configuration to reflector **10**. The particular construction of the spokes **20** and the method to deploy same does not comprise a part of the invention.

FIG. **4** is a schematic perspective illustration showing the convex and concave curved configuration of the reflective surface **10** of FIG. **1** showing specifically how the dimensions might be adjusted to achieve the surface configuration desired. This provides a surface containing both concave and convex elements at every point thereon. Naturally, as indicated above, this surface could contain multiple curves dependent upon the relationship of the supporting ends of the spokes with reference to the median plane **22**. Naturally, the more curves that are present in the reflector surface, the harder it is to predict the actual beam pattern of the reflected energy.

While in accordance with the Patent Statutes, only the best known embodiment of the invention has been illustrated and described in detail, and it is to be particularly understood that the invention is not limited thereto or thereby, but that the inventive scope is defined in the appended claims.

I claim:

1. A reflector which comprises:

a large reflective surface of generally hyperbolic configuration; and

a frame to support and stretch the surface by attachment only at points on the periphery of the surface, where the majority of attachment points are at a given level and at least a pair of substantially opposed points is above said level and at least a pair of substantially opposed points is below said level, whereby the surface is stretched to form a single sheet which has both concave and convex elements at every point.

2. A reflector according to claim **1** where the reflective surface is formed with a catenary between each point of attachment to the frame.

3. A reflector according to claim **1** where the attachment points are opposite to each other and the majority of opposite attachment points are at the same level, with respect to the frame, but where at least one pair of opposite points is above and another pair of opposite points is below such level.

4. A reflector according to claim **3** where the pairs of points above and below such level are at 90° spacing from each other.