

METHOD AND APPARATUS FOR SHAPING AND SUPPORTING LARGE REFLECTORS

The invention described herein is directed toward the art of support structures for reflectors, and more particularly concerns a support structure for large parabolic reflectors intended primarily for use as solar concentrators and which are comprised of a large number of relatively small, essentially identical reflecting sections arranged into a paraboloid or a section thereof.

Background

Traditionally, large parabolic reflectors, particularly ones measuring ten feet in width and larger have been used in a variety of applications, including as insolation concentrators. The cost of these however has always been high, which has limited their use to a subset of special, well-funded applications.

Material science, design and manufacturing process are three factors dictating such high production costs. Usually, the support structure is designed for the particular reflector, and is not suitable for other reflector applications. For example, support structures designed for reflectors deployed in protected environments will not be able to withstand weather, including wind, precipitation and temperature swings, without damage to either themselves or the reflector.

To reduce production costs, various large reflector structures of various forms have been built using relatively small reflective elements. An example of so built spherical reflector is described in U.S. Patent 2,978,794 (Random Structural Devices), a parabolic reflector support structure is described in Canadian Patent 1,140,823 (Apparatus for Supporting Large-Dimension Curved Reflectors). Though decreasing overall production costs, this construction technique does not necessarily solve the need for adequate support for the individual reflective elements in weather, nor does it completely standardize the size of the used construction elements.

To provide the required level of service, the supporting structure of large reflectors built for outdoor use and comprised of relatively small sections must provide adequate support under normal operating conditions (for example when repositioning) and protection under inclement weather without measurable deviation from the overall reflector shape. In addition, such a support structure must be easily and inexpensively manufactured and assembled on site, without the use of a specialized tools or knowledge.



Consequently, a general object of the invention described herein is to provide a support structure for such large reflectors, which overcomes at least one of the disadvantages of the aforementioned prior art. Thus, it is an object of the present invention to provide such an apparatus which:

- is equally suitable to shaping and supporting such a reflector generally described by any usable geometric curve, without modification to its elements;
- is comprised of a plurality of essentially identical components, therefore easy and inexpensive to manufacture;
- is relatively easy to install and operate without the use of specialized tools or knowledge;
- is capable of withstanding the stress of inclement weather exposure while protecting the reflective elements for the duration of its design lifetime;
- is capable of supporting the plurality of individual reflecting elements comprising such a large reflector of any practical size;
- allows said individual reflecting elements to be structurally weaker, without compromising the overall reflector shape or strength;
- is capable of supporting the plurality of reflective sections comprising such a large reflector of any practical size;

Summary of the Invention

Accordingly, there is provided a structure for shaping and supporting large reflectors which generally present a geometrical curved surface, such as parabolic reflectors. Such reflectors are indeed a composition of individual essentially identical reflective elements of rectangular shape, arranged in a manner such as to generally conform to said reflector's curve, and each attached to a supporting section comprised of a plurality of base elements interlocked as to allow limited relative movement only in a plane perpendicular to the plane of its attached reflective element. A suitably shaped profile threaded through a corresponding opening in each said base element determines the contour defined by the reflective element attached to the front of the interlocked base elements of each such section.

Further, to yield the final shape and size of the reflector, as many sections as necessary are interconnected in a similar fashion and their relative position determined and fixed by a suitably shaped profile threaded perpendicularly through corresponding openings in said base structure elements. The structure in its entirety is connected to the load bearing structure used to manage the position of the reflector by way of standoff elements and bolt-nut assemblies.

Description of Preferred Embodiments

The main object of the present invention is attained through the employment of a plurality of substantially identical Basic Structural Blocks [BSB] made of a material with suitable characteristics and shape similar to the one shown in Fig.1. With reference to the same, the main elements of the BSB are the Body (1), Working Surface (2) and Interconnectors (3). The BSB Body serves the purpose of transferring mechanical loads and stress across, and its size and shape are designed accordingly. In the preferred embodiment the material of choice is polymer, but any material with sufficient performance in the target environment can be used. The Working Surface, which may be essentially flat or curved as per design requirements, provides both mechanical support and general attitude to the Reflective Element (4), a unit section of the reflector (5). The Interconnectors (3) establish a firm connection between two adjacent BSBs in such a way as, in the absence of the Contour Profile (6) and Reflective Element (4), to allow them to rotate about each other within a range generally limited to eighty degrees or less (Fig.2). It is this degree of freedom, resulting in flexibility of the train of so interconnected BSBs that allows the Working Surfaces to essentially approximate the required curve of the reflector, while simultaneously providing lateral mechanical support. To complete the assembly, a Contour Profile (6) is inserted through the corresponding openings (7) in each BSB, thus preventing them from further relative movement and forcing the plane defined by the plurality of Working Surfaces (2) to approximate its shape (i.e. the design shape of the reflector).

A sufficient number of so built reflective segments are interconnected in a similar fashion to form reflective banks which in turn are connected to the base structure of the reflector as shown in Fig.3, to form its general outline. In this example, a bank of six reflective segments is comprised of six reflective elements each attached to a train of BSBs assembled as described herein, and each such assembly attached in turn to the one next to it using its integral Interconnectors, and all segments are fixed in the desired reflective surface shape by Contour Profiles inserted in the corresponding BSB openings perpendicularly to the Profiles used in the earlier assembly of BSB trains.

Using this method one can easily achieve any practical curve without having to redesign its structural components, the Contour Profile being the sole custom-made shape defining element of the structure. It may have a circular, triangular, rectangular or polygonal cross section, depending on the specific application and material used. In the preferred embodiment the Contour Profile is a rectangular-shaped thick wall profile of a 2:1 ratio of length over width.

Generally, the size and proportions of BSBs are so chosen as to provide sufficient, balanced mechanical support to the reflective elements. Practically, an integer number of BSBs would be interconnected in the above described manner so that the overall dimensions of the assembly are equal or slightly larger than the dimensions of the reflective element,

which is then affixed to said assembly by mechanical means including but not necessarily limited to channels, brackets, adhesives, etc.

Banks of reflective segments are further attached to the main reflector structure (with means of deployment, positioning, etc., Fig. 4) so their general shape is not altered by way of common structural elements such as brackets, bolt-nut assemblies, welds and other suitable fastening technology as per design requirements, to form the reflector. The use of non-permanent fasteners allows structure disassembly, if needed at any time thereafter.

In another embodiment, shown on Fig. 5, the reflective segments banks are attached to the main reflector structure in a staggered formation, allowing portion of the oncoming wind to pass through small gaps formed by offset mounting of every other bank so that it lies essentially in a plane behind or in front of the plane of its immediate neighbor. This arrangement results in reduced overall wind load borne by the reflector. It should be noted however that the shapes of the Contour Profiles for such staggered reflective banks differs in its target focal distance, aimed at ensuring the focal points of all staggered reflective banks coincide. In the case of a reflector exhibiting a general parabolic shape this stipulation means that the reflector is essentially comprised of two separate paraboloids with coinciding foci.

Yet another embodiment, having reflective segments staggered instead is shown on Fig.6. The goal of this arrangement is the same as above, decreasing the wind load borne by the reflector.

Although the illustrative embodiments of the present invention have been described herein with reference to the accompanying drawings, it is to be understood that the invention is not limited to those precise embodiments, and that various other changes and modifications may be effected therein by one skilled in that art without departing from the scope or spirit of the invention.

Claims

The embodiments of the invention in which an exclusive property or privilege is claimed are described as follows:

1. A support structure for large reflectors formed by a plurality of smaller, rectangle-shaped reflective elements, which comprises of a plurality of essentially identical, relatively small, when compared to the size of said reflective elements, support members so made that they:
 - exhibit one working surface, which mechanically supports at least a portion of an individual reflecting element, and to which said portion of a reflecting element is affixed by way of integral retaining channels, snap-on

brackets, adhesive, screws, bolt-and-nut assemblies or any other mechanical means;

- exhibit protrusions designed to interconnect with same on the adjacent member in a manner so as to form a firm, hinge-like junction, allowing two adjacent members so interconnected to turn about each other within a limited range and generally only in the direction in front of the reflector, and restricting relative motion in any other plane or direction;
- exhibit specially designed openings in their body in which a suitably chosen lengths of a profile can be inserted and installed in a manner so that said lengths of profile remain perpendicular to each other, with at least one of them having a tangent laying in a plane parallel to the member's working surface, and
- are capable of distributing and transferring design loads from their working surface across the body and interconnectors without mechanical failure and without substantially deviating from their intended shape;

and said profile, suitably made to be of sufficient length and cross section such as to fit in said member openings in a manner that when so inserted through several such openings it substantially forces said members to assume and retain the general curve of the profile, which by virtue of the members' design is replicated at the plurality of working surfaces, thus defining the curvature of at least a section of the reflector.

2. An apparatus of claim 1 wherein each reflective element is supported and attached to at least one of said support members.