There is provided an opening assembly for an extended end of a stressed membrane structure having a fixed part, said opening assembly comprising: at least a part of said end separated from said fixed part and moveable relative to said fixed part; a pivot assembly for permitting movement of said at least a part of said extended end between an open and a closed position relative to said structure; a support frame for maintaining the integrity of said part in stressed membrane condition at all times during said movement and when in said open and closed position; rolling transport means for supporting said frame and said assembly during said movement.
FIG. 9
DOOR ARRANGEMENT FOR TENSIONED MEMBRANE STRUCTURE

FIELD OF THE INVENTION

[0001] This application relates to stressed membrane structures and to opening or door assemblies for such enclosures.

BACKGROUND OF THE INVENTION

[0002] Stressed membrane structures have been in use for many years and, in many situations, offer advantages over conventional structures. One area where such structures are very attractive is for use as aircraft hangars.

[0003] In order to function effectively as aircraft hangars, it is necessary that wide opening doors be provided for ingress and egress of aircraft.

[0004] There has been an ongoing need for doors which will meet this objective of wide opening doors for hangers and many other applications within the structural limitations of stressed membrane structures. It is preferable that such doors retain the relocatability which has been the hallmark of tensioned membrane structures, while meeting structural criteria such as wind resistance.

[0005] The present invention arises against this background.

PRIOR ART

[0006] Applicant’s prior U.S. Pat. No. 5,283,993 illustrates a door arrangement for tensioned membrane structures.

SUMMARY AND OBJECTS OF THE INVENTION

[0007] The present invention provides an opening or a door arrangement whereby an end of a stressed membrane structure can be partly or fully opened while maintaining a tensioned condition of the membrane of the opened part.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] In the drawings which illustrate embodiments of the invention:

[0009] FIG. 1 is a plan view, partially cut away, of a stressed membrane structure, showing an airplane in ghost lines;

[0010] FIG. 2 is a plan view of the structure of FIG. 1 with an opening assembly in an open position;

[0011] FIG. 3 is a plan view of the structure of claim 1 with the opening assembly in a partially opened condition;

[0012] FIG. 4 is a cross-section through the opening assembly of FIG. 1 with the tensioned membrane removed;

[0013] FIG. 5 is a perspective view illustrating a support frame for the opening assembly;

[0014] FIG. 6 illustrates detail of braiding for a part of the support frame of FIG. 5;

[0015] FIG. 7 is an elevation of a pivot assembly for the opening assembly;

[0016] FIG. 8 is a plan view of the pivot assembly of FIG. 7;

[0017] FIG. 9 illustrates an inner tie-down for securing the opening assembly;

[0018] FIG. 10 illustrates an outer tie-down for securing the opening assembly;

[0019] FIG. 11 illustrates a closure lock plate for securing a pair of opening assemblies in a closed position;

[0020] FIG. 12 illustrates the closure plate of FIG. 11 in a partially opened position;

[0021] FIG. 13 is a plan view of a skid plate and alignment pipes for aligning a pair of opening assemblies during closing; and

[0022] FIG. 14 is an elevation of the skid plate and alignment pipes of FIG. 13.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] Stressed membrane structure 10 comprises a framework including structural members 12 which support tensioned membrane 14.

[0024] Various bracing arrangements, such as cable bracing 16, may be utilized where required in structure 10.

[0025] Structure 10 may be provided with doors such as personnel doors 18 and sliding door 20. Various other features, such as skylight 22, may be included.

[0026] Structure 10 will generally have a substantially semi-circular end 34, and it is desirable that at least a part of end 34 can be opened to allow access to the structure for large objects. Thus end 34 is divided into two end parts 24 and 26. In the preferred case, both end parts 24 and 26 are rotatable so that the entire end 34 of structure 10 can be opened to the full width of the structure 10. For this purpose, end parts 24 and 26 are pivotally associated with but separated from structure 10 by pivot assemblies 28 and 30.

[0027] Stressed membrane structures normally have rounded or arcuate ends or ends which extend outwardly of the plate across the end of the normal full width of the structure. While this is not always true for these structures, the present invention is applicable to those which do have at least one such end.

[0028] The rounded or arcuate end part has a number of advantages which include the ability to stress the membrane continuously around the structure without substantial special attention to the end treatment. As well, such end structures contribute to the very important ability of the structure to withstand wind and associated environmental effects.

[0029] It is possible that other shapes might be used but all such protruding or extended ends are considered to be under the general heading of extended ends. Such extended shapes are to be contrasted specifically with a normal flat door configuration.

[0030] In guiding the opening and closing of end parts 24 and 26, pivot assemblies 28 and 30 are preferably positioning and guiding pivots only and are not intended to support any part of the weight of the associated end part.
FIG. 3 illustrates the positioning of the main frame members 36 that would normally be a part of an end 34 of a structure 10.

The door arrangement of the present invention preferably provides a support structure 38 associated with each structural member 36. As illustrated in FIG. 4, the support structure 38 comprises horizontal beam 40, vertical beam 42 and diagonal beams 44 and 46.

Each support structure 38 is preferably provided with transport members which may be in the form of rollers which are preferably wheel assemblies and preferably at least two wheel assemblies 48 and 50 for each horizontal beam 40.

It is the combination of the support structures 38 and wheels 48 and 50 which support the weight of end parts 24 and 26 in opening and closing the end parts. Pivot assemblies 28 and 30 are non-weight bearing.

FIG. 5 illustrates an essentially complete frame for each of end parts 24 and 26. This consists of the normal structural members 36 of structure 10 and, as well, usual structural members 52, extending between structural members 36.

In addition, FIG. 5 illustrates transverse bracing arrangements 54 between vertical beams 42 and shown consisting of horizontal members 56 and diagonal structure 58. Diagonals 58 may comprise cables and the cables may be adjustable in tension.

End parts 24 and 26 are thus each self-supporting structures and each maintains its membrane in a stressed condition at all times.

It is noted that bracing structure is required to provide rigidity and tension to the end parts 24 and 26, and variations on the support structure are therefore permissible so long as those criteria are maintained. Thus the bracing structure may vary for different environments.

FIGS. 7 and 8 illustrate details of pivot assemblies 28, 30. Pivot post 60 comprises pipe 62 which passes through the structure’s concrete pad 64 and is embedded in concrete pile 66. Pipe 62 may be filled with concrete 68.

Brackets 74 and 76 are fixed to structure member 36. Each bracket includes a cylindrical sleeve 78.

In assemblies structure 10, the sleeves 78 are slid over post 60 to form the pivot.

Each horizontal structural beam 40 is provided with wheel assemblies 48 and 50. The wheel assemblies support the weight of the end parts so that the pivot assemblies do not carry the weight of the end parts. Additional wheel assemblies may be used if required.

Connecting and/or sealing means (not shown) are preferably provided between beams 39 and 41 in the closed position and between beams 37 and 43 and beam 45 main part 32 of structure 10 when the end parts are in the closed position.

In order to actually activate opening or closing of the assemblies 24 and 26 around pivot assemblies 28 and 30, tow-bar attachments are provided at the bases 80 and 82 of the central arches 39 and 41, which are the arches which will be adjacent when the door is in the closed position. An aircraft tug or other small motorized vehicle may then be used to open and close the assemblies.

As well, an integral drive arrangement (not shown) may be mounted on the opening assemblies for opening and closing parts 24 and 26.

FIGS. 13 and 14 illustrate alignment pipe and skid plate assemblies 84 and 85. The assemblies are mounted at selected locations between the arches 39 and 41, which are located adjacent each other when the opening assemblies are in the closed position, and also between the end rib 45 of the stationary part of the stressed membrane structure and the adjacent ribs 37 and 43 of the opening assemblies when in the closed position.

Assemblies 84 and 85 comprise skid plates 86 and 88 and respective pairs of alignment pipes 90 and 92. As the opening assembly is moved into the closed position, the camming angles 94 on pairs of pipes 90 and 92 ride along skid plates 86 and 88 to align the adjacent beams.

The effect of the alignment is to transfer some of the load from the rolling sections of the assemblies to the overall structure to thus provide greater structural stability of the system. The skid plates also provide some friction between the opening assemblies and the stressed membrane structure to further facilitate load transfer from the opening assembly to the stationary structure.

FIGS. 11 and 12 illustrate a lock plate assembly 96 for holding doors in a locked position. The assembly 96 comprises fixed plates 98 and 100 from which project pins 102 and 104. Lock plate 106 rotates on pin 104. Lock plate 106 includes camming surface 108 which, during closing of the assemblies, rides up and over pin 102. Recess 110 at the end of surface 108 then drops over pin 102 to lock the assemblies in the closed position.

Parts 24 and 26 are preferably additionally stabilized in the open and closed positions by the use of conventional aircraft tie-down systems.

FIGS. 9 and 10 illustrate inner and outer tie-down assemblies 112 and 114 respectively. Tie-down assemblies 112 and 114 include earth anchors 116 and 118 implanted below surface 119. Cables 120 and 122 project from earth anchors 116 and 118 above surface 119. The opening assemblies are provided with brackets 124 and 126 to correspond in positioning with projecting cables 120 and 122 respectively. When the opening assemblies are in position and ready for tie down in either the open or the closed position, load binders 128 or 130 are installed between the brackets and the projecting cable ends.

The inner tie-down is intended for installation on interior beam members while the outer tie-down is intended for installation on the outer arches.

Clearly, the tie-downs will vary in size, type, location, and quantity depending on door size and environmental conditions. In short, any kind of tie-down may be used depending on circumstances.

Suitable flashing will be installed along the line where the two halves of the opening assembly meet in the closed position and along the line between the two parts of the opening assembly and the stationary structure in the closed position.
What is claimed is:

1. An opening assembly for an extended end of a stressed membrane structure having a fixed part, said opening assembly comprising:
   a pivot assembly for permitting movement of said at least a part of said extended end between an open and a closed position relative to said structure;
   a support frame for maintaining the integrity of said part in stressed membrane condition at all times during said movement and when in said open and closed position; and
   rolling transport means for supporting said frame and said assembly during said movement.

2. The opening assembly of claim 1 wherein said extended end is generally of arcuate outer plan.

3. The opening assembly of claim 2 wherein said assembly comprises two parts, each of which includes one said pivot assembly.

4. The opening assembly of claim 1 wherein said pivot assembly is independent of said fixed part of said structure.

5. The opening assembly of claim 4 wherein said pivot assembly comprises a first part anchored beneath the surface upon which the structure rests and a second part fixed to said at least a part of said end.

6. The opening assembly of claim 5 wherein said first part comprises a post and said second part comprises at least one collar for engagement around said post.

7. The opening assembly of claim 1 wherein said transport means comprises a group of wheels mounted on said frame.

8. The opening assembly of claim 1 including alignment means for aligning said at least one part of said end with said fixed part of said structure when said assembly is moved from said open to said closed position.

9. The opening assembly of claim 3 including alignment means for aligning said two parts with each other and with said fixed part when said two parts are moved from said open to said closed position.

10. The opening assembly of claim 1 wherein said support frame is in part comprised of adjustable cables whereby said frame is adjustable.