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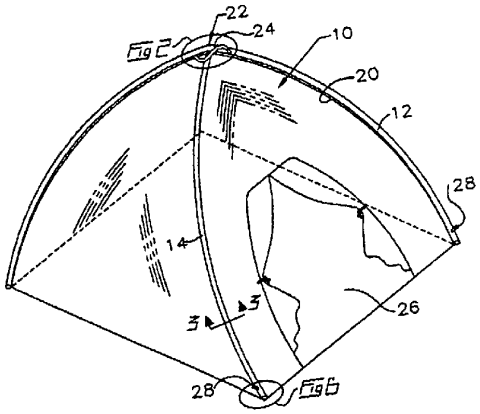

Fig 2 Fig 6

(57) Abstract

One or more inflatable tubes are used to support a self–erecting tent. If two or more tubes then they may have at least one cross over criss–crossed in the manner of conventional domed tent poles. The tube or tubes are secured or releasably secured to the tent so that the tent is self–erecting as the tube or tubes are inflated. When two or more tubes are employed, the tubes may be connected by an auxiliary tube so that forcing pressurized air into one tube results in all tubes inflating simultaneously. The ends of the tubes are self–sealing so as to accommodate relatively high air pressure within the tube, in the order of 20–30 pounds per square inch inflated pressure, thereby providing a significantly rigid structure from which the tent is suspended.

INFLATABLE SELF-ERECTING TENT

Field of the Invention

This invention relates to inflatable tent supports for erecting and supporting light weight shelters such as awnings and tents or other lightweight portable structures.

Background of the Invention

Tents commonly utilize a semi-rigid, segmented pole. Segmented fibreglass or aluminium poles are commonly used to support, for example, dome tents.

The inflatable tent supports of the present invention overcome several difficulties associated with commonly utilized tent supporting structures. For example, they require no assembly prior to use. They are not normally subject to loss by being misplaced. They are easily used by those persons unfamiliar with the erecting of tents or those persons lacking sufficient strength or manual dexterity for such an undertaking and may be rapidly and easily used during inclement weather or at night.

As opposed to most other prior art involving inflatable tents, there are no manifolds at the apex, or apexes. Instead inflatable tubes criss-cross one another to provide for uplifting self-erecting of the tent, and, once erected, to provide structural integrity to the tent.

In particular, in the prior art applicant is aware of United States Patent Number 5,205,086 which issued to Heim on April 27, 1993 for an inflatable tent. Heim teaches a tent having a flexible canopy, floor and a series of inflatable tubes serving as frame hoops which, according to the teaching of Heim do not criss-cross in the manner of conventional domed tent supports. The tubes of Heim are fastened removably to the tent using sleeves that open along a longitudinal slit. Hook and loop releasable fasteners are employed for closing the sleeves

onto the tubes. The tubes of Heim are taught to be made of thermal plastics or vinyl and are the same diameter as the corresponding sleeves. Rigid boot cups are provided at the ends of the tubes for supporting the tube ends therein. Each of the tubes are independently inflated. Thus, the tent of Heim is not self-erecting as the tubes are inflated as is the case in the present invention.

Applicant is aware of United Kingdom patent specification numbers 358,094 and 448,129 which both issued to Dixon for a tent which is supported by a number of curved or bowed pneumatic tubes. The tubes are of flexible material which, when inflated, form a bowed framework and are so shaped that they assume the form or outline of the fabric which is super imposed to form the tent. The shaping of the pneumatic tubes is effected by making the tubes or the covers of the tubes less extensible or of less length on the interior surfaces of the bends. The walls, gores or panels of the tent are attached to the inflatable ribs or tubes, again, the ribs or tubes being less extensible along their longitudinal portions presented inwardly of the structure or being naturally curved in the deflated condition. The inflation of such ribs or tubes causes them to become bowed and to impart trim shape, tautness and rigidity to the structure. The tubes inter communication where they intersect, as at the head of the tent, so that inflation from a single source is possible. In the latter specification of Dixon, he teaches improved connections for the inner tubes of the inflatable ribs and an improved construction of an outer cover for such tubes.

Applicant is also aware of United States patent number 4,068,418 which issued to Masse. Masse discloses using inflatable structural members so as to support a tent. Each structural member has an inner, air-impermeable inflatable tube and an outer flexible sheath restraining the inner tube when it is inflated. The sheath is constructed to shape the tube to a desired curve shape conforming to the desired shape of the tent in a manner similar to the teaching of Dixon.

Summary of the Invention

In the inflatable tent of the present invention, one or more inflatable tubes are used to support a self-erecting tent. If two or more tubes are used, they may have at least one cross over criss-crossed at each juncture in the manner of conventional domed tent poles. The tube or tubes are secured or releasably secured to the tent so that the tent is self-erecting as the tube or tubes are inflated. When two or more tubes are employed, the tubes are pneumatically connected by an auxiliary tube so that forcing pressurized air into one tube results in all tubes inflating simultaneously. The ends of the tubes are self-sealing so as to accommodate relatively high air pressure within the tube, in the order of 20-30 pounds per square inch inflated pressure, thereby providing a significantly rigid structure from which the tent is suspended. Advantageously, the auxiliary tube extends between the two criss-crossing tubes in airflow communication therebetween at approximately the apex of the dome shape defined by the tubes. The ends of the tubes and along the length of the tubes are attached or mounted to the tent, advantageously along corresponding seams between tent panels. The tubes may, in one embodiment, be releasably mounted onto the tent by means of releasable fasteners such as zippers. The end result is that, once the tent of the present invention has been erected, it does not need to be held up by auxiliary structures such as guy wires as is the case in the Heim teaching.

The tubes comprise outer non-resilient sleeves containing inner resilient bladders, for example, rubber inner-tubes. This is not intended to be limiting as it may be reasonably foreseen to use a tubeless sleeve, where the sleeve itself is air-tight and an inner bladder is not required. The ends of the inner rubber bladder coincide with the ends of the non-resilient sleeves and are self-sealing by means of the ends of the inner-tubes being folded over onto themselves within the sleeve so that inflation of the inner-tube sandwiches the folded over end between the inflated inner-tube and the inner non-resilient surface of the sleeve. Folding over the end of inner bladder, combined with the use of conventional adhesives to seal the open ends of the bladder provides for an airtight seal even at high inflated pressure. The ends of the tubes therefore have no rigid parts which may become crushed or distorted in use as in the case of the Heim device. The rubber bladder is sewn into the sleeve

so as to trap the folded over portion of the bladder within the ends of the sleeve. Increasing the air pressure within the inner-tube merely forms a stronger airtight seal at the ends of the bladder by increasing the compressive force applied to the folded over end sandwiched between the inflated bladder and the sleeve.

In the embodiment of the present invention in which the tubes are releasably mounted to the tent by means of releasable fasteners such as zippers, the tubes may be unzipped from the tent in the case of puncture of the bladder within a tube. The tubes may be unfastened at their ends from the bottom corners of the tent, for example by undoing snaps or other releasable fasteners holding the ends of the tubes securely fastened to the bottom corners of the tent. A punctured tube may thus be replaced with an identical spare tube. This may be quickly accomplished. Since all tubes used to support the tent are identical, only one spare tube need be carried.

The criss-cross between the tubes at the apex of the tent support structure does not result in interference between the two tubes. This is because adjustments are made to the circumferential profile of the corresponding tent seams over which the tubes pass. Whether or not the tubes pass over seams between tent panels, the circumferential portions of the tent over which the tubes pass are adjusted, by adjusting the circumferential length of segments of the corresponding circumferential profiles, so that one tube crosses over the apex at higher elevation than the other tube.

Thus, in one preferred embodiment, first and second criss-crossing inflatable tubes are mounted or mountable to corresponding criss-crossing first and second circumferential profiles wherein the first and second circumferential profiles may correspond to the seams between tent panels making up the tent. In any event, the first and second circumferential profiles are differently shaped when view in cross-section in first and second corresponding planes containing correspondingly the first and second circumferential profiles, the first circumferential profile having a shorter circumferential distance than the second circumferential profile. Thus, when the first and second tubes are mounted along their corresponding first and second circumferential profiles along segments of those profiles not

including segments at the apex of the tent, and in view of the fact that both the first and second tubes are identical in length, the first tube forms an arch at the apex of the tent which extends a higher vertical distance above the tent apex than does the corresponding portion of the second tube. The first tube therefore crosses over the second tube at the apex of the tent by reason of its higher arched profile.

In summary, the inflatable self-erecting tent of the present invention includes, when erect, substantially vertical circumferential first and second profiles intersecting, at corresponding first and second vertices thereof, a common vertical axis. The first and second profiles are radially spaced apart about the common vertical axis. A first inflatable tube is mounted or mountable to the first profile. A second inflatable tube is mounted or mountable to the second profile. The first and second profiles extend circumferentially over the fabric panels of the tent from opposite ground engaging edges of the tent.

The first and second profiles have corresponding circumferential first and second distances. The first and second distances are substantially the same. The first and second inflatable tubes are of substantially the same length when mounted to the first and second profiles. The corresponding first and second tubes do not intersect each other. The first vertex, that is, the vertex of the first profile is above the second vertex, that is, the vertex of the second profile.

Advantageously, the first and second inflatable tubes are, when mounted to the tent's panels along the first and second profiles, pneumatically interconnected by a flexible air conduit extending between the tubes.

In one aspect of the present invention, the first and second inflatable tubes are resilient tubes, and the first and second profiles include corresponding non-resilient sleeves. The sleeves extend circumferentially along the profiles for sliding mounting of the inflatable tubes in journalled relation through the sleeves.

In a further aspect, the invention may provide an inflatable, pegged, self-erecting tent including at least one inflatable support mounted to a canopy of said tent along corresponding ridge-lines thereof, said canopy having circumferential ground-engaging edges adapted for pegged anchoring of said edges to a ground surface, said ridge-lines extending over said canopy from one of said edges to an opposite edge of said edges,

wherein said inflatable support includes an inner resilient tube snugly mounted within an outer non-resilient sleeve,

wherein said sleeve of said outer non-resilient straight sleeve has a seam extending linearly along its length, said seam being in opposed facing relation to said ridge-line of said canopy, said seam being an overlapped seam having an overlapped portion within said sleeve due to inversion of said sleeve following forming of said seam, said overlapped portion folded over so as to be disposed perpendicular to a curvature of said seam when said at least one inflatable support is inflated.

In another aspect, the invention may provide an inflatable, pegged, self-erecting tent including at least one inflatable support mountable to a canopy of said tent along corresponding ridge-lines thereof, said canopy having circumferential ground-engaging edges adapted for pegged anchoring of said edges to a ground surface, said ridge-lines extending over said canopy from one of said edges to an opposite edge of said edges,

wherein said at least one inflatable support includes an inner resilient tube snugly mounted within an outer non-resilient sleeve,

wherein said sleeve of said outer non-resilient straight sleeve has a seam extending linearly along its length, said seam being in opposed facing relation to said ridge-line of said canopy when said at least one inflatable support is mounted to said canopy, said seam being an overlapped seam having an overlapped portion within said sleeve due to inversion of said sleeve following forming of said seam, said overlapped portion folded over so as to be disposed perpendicular to a curvature of said seam when said at least one inflatable support is inflated.

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In a second aspect, the first and second tubes are self-sealing by self-sealing ends of the tubes. The ends are folded over onto themselves and mounted within the non-resilient sleeves. The ends of the sleeves may form corresponding flap hinges when the ends of the sleeves are mounted to the tent panels.

In a further aspect, the first profile is an arch and the second profile approximates a semi-circle. The first and second profiles may be mountable to the seams between panels of the tent or circumferentially over any arc of the tent canopy.

Each end of the tube may have a flexible flap hinge mounted thereto oriented so that a lower flap of the flap hinge is mounted to the canopy, disposed below and adjacent each end of the tube. The flap hinge is directed inwardly towards a center of the tent. Inflation of the tube urges rotation of each end of the tube upwardly about the flap hinge relative to the lower flap.

Brief Description of the Drawings

Figure 1 is, in perspective view, one embodiment of the inflatable tent of the present invention.

Figure 1a is, in perspective view, a single tube embodiment of the present invention.

Figure 1b is, in elevation view, the embodiment of Figure 1 showing arched tube profiles overlaid.

Figure 2 is a partially cut-away enlarged view of a portion of Figure 1.

Figure 3 is a cross-sectional view along line 3-3 in Figure 1, additionally showing a ply-sheet mounted over the tube structure.

Figure 4 is a partially cut-away cross-sectional view along an end of a resilient tube bladder according to the present invention.

Figure 5 is, in partially cut-away cross-sectional view, an end of the non-resilient tube sleeve of the present invention.

Figure 6 is, in partially cut-away cross-sectional view, an enlarged portion of the view of Figure 1.

Figure 6a is the view of Figure 6 showing the upward pivoting of the tube as the tube is inflated.

Figure 7 is a partially cut-away cross-sectional view along line 7-7 in Figure 6.

Figure 8 is, in side elevation view, an alternative use of an inflatable tube according to the present invention for suspending a tent fly above a tent.

Figure 9 is a cross-sectional view along line 9-9 in Figure 8.

Figure 10 is, in perspective view, an alternative embodiment wherein a vestibule tube supports a tent vestibule.

Detailed Description of the Preferred Embodiment

Figure 1 is a perspective view of a typical dome-style tent incorporating the present invention, with the tent's fly removed for clarity. Figure 1a is a perspective view of an inflatable self-erecting tent according to the present invention wherein only one inflatable tube is used, the result being a modified "pup" tent. The pup tent is self-erecting, once the ground edges or corners are pegged to the ground, by inflating the single tube which extends from opposite edges.

Inflatable tent supports are illustrated in use with both dome-type tent 10 and the pup tent. In Figure 1 the inflatable tent supports comprise identical elongate inflatable tubes 12 and 14. One such tube is used in the pup tent embodiment of Figure 1a. The tubes are sealed at their ends and each is enclosed within a non-resilient fabric sleeve 16 as better seen in Figures 2 and 3. Each sleeve 16 may be formed by sewing a rectangular piece of material into a straight sleeve having a folded-over or foldable overlapping seam 17 as seen in Figure 7. Folding over of the seam within an inverted sleeve allows for ease of bending of the combination sleeve and tube once inflated, to conform to the shape of the tent canopy. Each sleeve 16 is also closed at its terminal ends as better seen in Figures 4 and 6. Sleeve 16 may in one embodiment be formed as an integral part of the tent fabric during manufacture of the tent. However, when retrofitting to existing tent structures, a projecting flexible flange or seam 18 is left on one side of the sleeve so that it may be sewn or releasably mounted, for example by zippers 19, to a corresponding flexible flange or seam 20 on the side of the tent.

In the illustrated example of Figure 1, the inflatable tubes cross at the apex 22 of the tent. A pneumatic airway connection is provided between both tubes by a flexible connecting tube 24. Tube 24 may be of smaller diameter than tubes 12 and 14. Stem 28 is advantageously located near a corner of tent 10 or near the access door 26, or any other easily accessible location. Stem 28 contains a one-way valve 30 and projects from each inflatable tube through the fabric of sleeve 16 for inflation of the tubes. When two or more tubes are used, the inner core of a second valve stem, for example valve stem 28a, is removed so that by removing the valve stem cap, air is allowed to escape through valve stem 28a thereby releasing the air pressure and deflating the tubes when taking down the tent.

Tubes 12 and 14 are advantageously identical so that only a single replacement or spare tube need be carried. Tubes 12 and 14, once mounted onto the tent, may be inflated through the one-way valve 30. The tubes are inflated by way of a hand pump, or compressed air (for example from a portable tank), or compressor or CO_2 cartridges or the like. The tent is self-erecting, that is, may be erected without additional effort other than inflation of the tubes. As the air pressure in the tubes is increased, the tubes attempt to straighten out. They are constrained by the shape of their corresponding profiles as better seen in Figure 1b, the

profiles themselves defined by the corresponding tensioned shape of the tent or tent panels along seam 20.

The profiles, namely profiles 32 and 34, correspond respectively to tubes 12 and 14. In Figure 1b, cross sections along each tube in Figure 1 are overlaid for ease of comparison. Thus it may be seen that profile 34, which corresponds to tube 14, may for example approximate a semi-circle having constant radius R1. In this case, in order to cross tube 12 over tube 14 at apex 22, keeping in mind that tubes 12 and 14 are identical in length, shape and construction, profile 32 is not of constant radius but rather has side profile distances D1 (measured from common centroid 36) which are less than radius R1 so that tube 12 is forced upwardly into an arch having a vertical distance D2 above centroid 36 at apex 22.

With tubes 12 and 14 secured to seams 20, and seams 20 tailored, whether by adapting a conventional symmetrically domed tent by additional stitching or the like, or by manufacturing tent 10 with seams 20 already tailored, to force the tubes into profiles 32 and 34 respectively, as the tubes are inflated through one of the one-way valves 30 to 20-30 pounds pressure, the criss-crossed tubes support one another and constrain the direction of bowing of the tubes to a direction generally along centroidal axis A. Tent 10 is thus self-erecting and self-stabilizing as it is erected. Apex 22 is elevated upwardly along axis A urged by the uplifting forces resultant of the constrainment provided by the profile or profiles of the tent shell, and the uplifting urging resultant of the design of the ends of the tubes as better described below. Criss-cross does indeed help the self-erecting feature, although such a self-erecting also occurs in the one-support pup tent, which involves the lifting force provided at the end of the tubes plus the restrictions placed on the straightening support by the profile of the tent.

When maximum inflation is achieved the tubes are held in relatively stable crossed juxtaposition to support the tent.

As seen in Figures 2 and 3, sleeves 16, which are non-resilient, advantageously made of fabric or the like, contain snugly therein resilient tubes 38. Resilient tubes 38 may be

made of rubber. As better seen in Figure 4, the ends of resilient tubes 38 have a folded section 40 folded over and laid back against the adjacent portion of the resilient tube and secured thereto by adhesive layer 42. An adhesive layer 44 adheres the sides of the tube forming folded section 40 together. Cavity 46 within resilient tubes 38 thus extends along side folded section 40 and terminates at fold line 48.

The ends of resilient tubes 38 above described, are positioned within corresponding ends of sleeves 16, one of which is better depicted in Figure 6. As seen in Figures 5 and 6, in one preferred embodiment, a resilient cylindrical sleeve or boot 52 is used to encapsulate the end of resilient tube 38 and folded section 40 within tubular cavity 54. The end of resilient tube 38 adjacent folded section 40, and folded section 40 are secured within tubular cavity 54 by adhesive layer 56, where it is understood that adhesive layers 42, 44 and 56 are of an appropriate adhesive which remains resilient when cured.

Resilient boot 52 may have extending from an end thereof a resilient flange 58. Flange 58 serves to anchor resilient boot 52 within the end of sleeve 16 by sandwiching resilient flange 58 between the sides of the stitched closed end 16a of sleeve 16 as better seen in Figure 6. The end 16a of sleeve 16 may be stitched closed and folded over so that it may be releasably secured to a corner of the material of tent floor 10a by means of releasable fasteners such as the button snap 60 illustrated.

The above-described inflatable supports may thus exhibit an important characteristic, namely, that when inflation begins, as air flow reaches the ends of the supports, the result is an uplifting. Since the ends are sealed and air pressure is introduced, and since the bottom part of the sleeve is secured to the tent floor at the very end and with the tent floor advantageously pegged down, the sleeve, as it begins to inflate, begins to push against the tent floor as seen in Figure 6a. By so pushing, the inflatable support is urged so as to pivot about sleeve end 16a upwardly. Sleeve end 16a functions as a flap hinge. This assists in self-erecting of the tent. The more air pressure is added, the more the resultant force "F" helps the tent to self-erect. Further, the greater the maximum air pressure, the greater the rigidity of the tent structure. Since the design of the rubber bladder is made so that the end of the supports

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become stronger with more pressure, the uppermost limit of the air pressure that the inflatable support will sustain is primarily only limited by the tensile strength of the sleeve material, rather than the pressure at which the sealed ends of the inflatable tube will fail.

Figures 8 and 9 illustrate how an inflatable tent fly 62 may be suspended over tubes 12 and 14 and tent 10. A single inflatable ridge pole tube 64 (shown in dotted outline in Figure 8), identical in construction to tubes 12 and 14 is fastened at about its mid-length to fly 62 or to tube 12 at apex 22. When inflated, tube 64 rises at both ends to form a ridge pole. Tube 64 thus elevates fly 62 facilitating entry into the tent while providing an air space which, in turn, allows a free flow of air between the tent wall and the fly, just as a fly does with conventional rigid tent poles. The corners of the fly may be attached to the tent corners, just as they are with conventional rigid tent poles, or otherwise secured to the ground by lines or pegs. As seen in Figure 10, fly 62 may be modified to provide a vestibule or extension 66. Vestibule 66 may be supported by an inflatable auxiliary vestibule tube 68 shown in dotted outline. Vestibule tube 68 extends around a vestibule doorway 70. Vestibule tube 68 may be maintained upright by means of mounting tube 68 to a ridge pole tube 64 or the like or by means of a conventional pegged guy wire 72.

In the preferred embodiment, each resilient tube 38 is an elongate unitary resilient tube.

As will be apparent to those skilled in the art in the light of the foregoing disclosure, many alterations and modifications are possible in the practice of this invention without departing from the spirit or scope thereof. Accordingly, the scope of the invention is to be construed in accordance with the substance defined by the following claims.

When used in this specification and claims, the terms "comprises" and "comprising" and variations thereof mean that the specified features, steps or integers are included. The terms are not to be interpreted to exclude the presence of other features, steps or components.

The claims defining the invention are as follows:

1. An inflatable, pegged, self-erecting tent including at least one inflatable support mounted to a canopy of said tent along corresponding ridge-lines thereof, said canopy having circumferential ground-engaging edges adapted for pegged anchoring of said edges to a ground surface, said ridge-lines extending over said canopy from one of said edges to an opposite edge of said edges,

wherein said inflatable support includes an inner resilient tube snugly mounted within an outer non-resilient sleeve,

wherein said sleeve of said outer non-resilient straight sleeve has a seam extending linearly along its length, said seam being in opposed facing relation to said ridge-line of said canopy, said seam being an overlapped seam having an overlapped portion within said sleeve due to inversion of said sleeve following forming of said seam, said overlapped portion folded over so as to be disposed perpendicular to a curvature of said seam when said at least one inflatable support is inflated.

2. The tent of claim 1 wherein said support has sealed ends, said sealed ends positioned within corresponding ends of said sleeve, wherein said ends of said sleeve are stitched closed, and said sealed ends are closely adjacent said ends.

3. The tent of claim 1 wherein said at least one inflatable support is self-sealing by self-sealing means at ends of said at least one inflatable support, said self-sealing means comprising ends of said inner resilient tubes which are folded over onto themselves, said ends of said tubes anchored by anchoring means to said ends of said at least one inflatable support, said ends of said at least one inflatable support each formed as a flap hinge when said ends are mounted to said tent canopy.

4. The tent of any one of the preceding claims further including an inflatable vestibule support mounted around an opening of an aperture of a tent vestibule of said tent canopy.

5. The tent of any one of the preceding claims wherein each said ridge-line approximates a semi-circle.

6. The tent of any one of the preceding claims wherein said at least one inflatable support is mounted by releasable fasteners to said canopy.

7. An inflatable, pegged, self-erecting tent including at least one inflatable support mountable to a canopy of said tent along corresponding ridge-lines thereof, said canopy having circumferential ground-engaging edges adapted for pegged anchoring of said edges to a ground surface, said ridge-lines extending over said canopy from one of said edges to an opposite edge of said edges,

wherein said at least one inflatable support includes an inner resilient tube snugly mounted within an outer non-resilient sleeve,

wherein said sleeve of said outer non-resilient straight sleeve has a seam extending linearly along its length, said seam being in opposed facing relation to said ridge-line of said canopy when said at least one inflatable support is mounted to said canopy, said seam being an overlapped seam having an overlapped portion within said sleeve due to inversion of said sleeve following forming of said seam, said overlapped portion folded over so as to be disposed perpendicular to a curvature of said seam when said at least one inflatable support is inflated.

8. The tent of claim 7 wherein said support has sealed ends, said sealed ends positioned within corresponding ends of said sleeve, wherein said ends of said sleeve are stitched closed, and said sealed ends are closely adjacent said ends.

9. The tent of claim 7 wherein said at least one inflatable support is self-sealing by self-sealing means at ends of said at least one inflatable support, said self-sealing means comprising ends of said inner resilient tubes which are folded over onto themselves, said ends of said tubes anchored by anchoring means to said ends of said at least one inflatable support, said ends of said at least one inflatable support each formed as a flap hinge when said ends are mounted to said tent canopy.

10. The tent of any one of claims 7 to 9 further including an inflatable vestibule support mounted around an opening of an aperture of a tent vestibule of said tent canopy.

11. The tent of any one of claims 7 to 10 wherein each said ridge-line approximates a semi-circle.

12. The tent of any one of claims 7 to 11 wherein said at least one inflatable support is mountable to said canopy by releasable fasteners.

13. An inflatable, pegged, self-erecting tent substantially as hereinbefore described with reference to Figures 1 to 10.

Dated this 20th day of April 2004
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JEAN MARC DANIEL TURCOT & JOHN ROBERT TURCOT

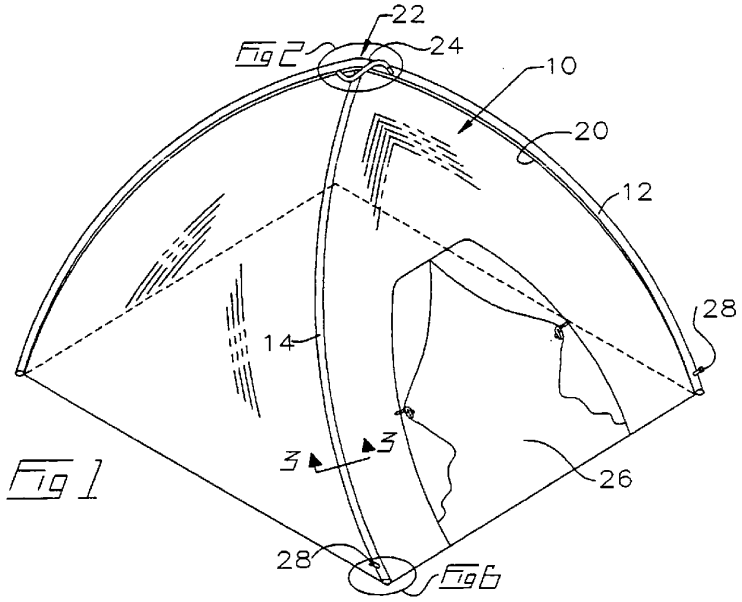

Fig 1

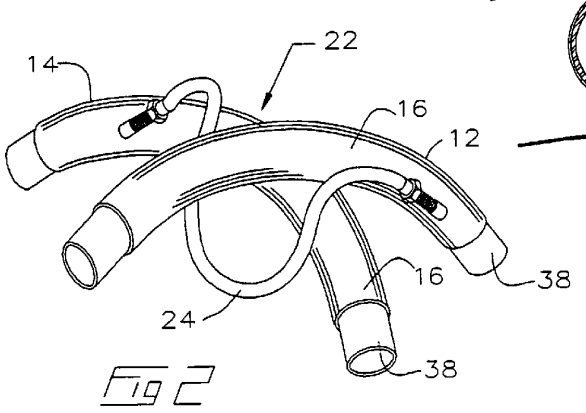

Fig 2

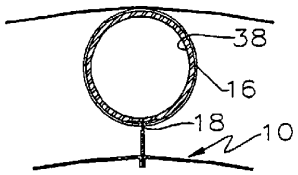

Fig 3

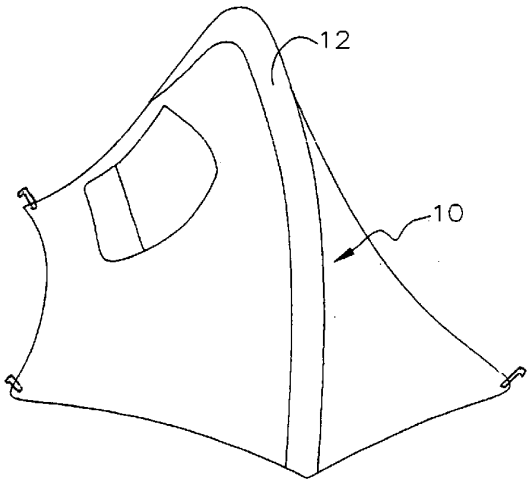

Fig 1a

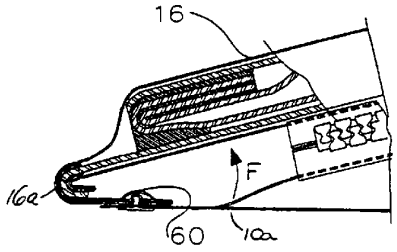

Fig 6a

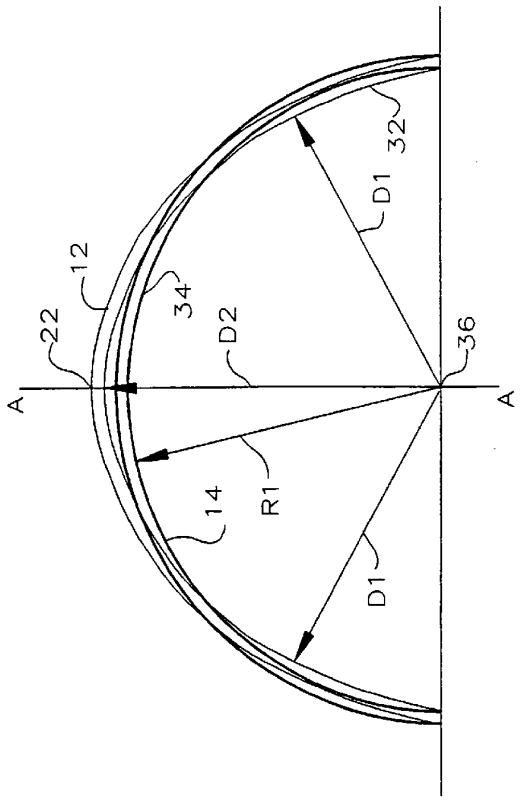

Fig 1b

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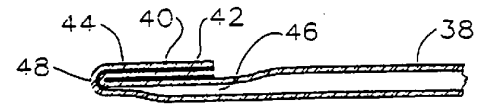

Fig 4

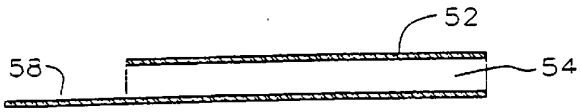

Fig 5

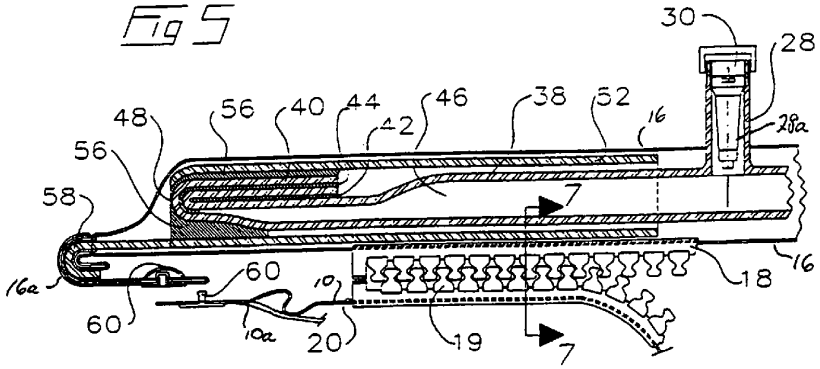

Fig 6

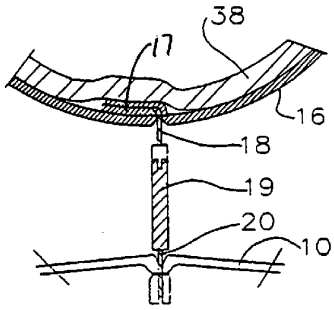

Fig 7

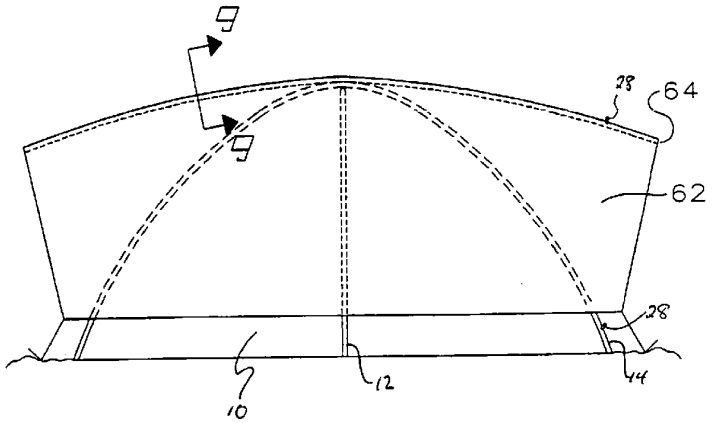

Fig 8

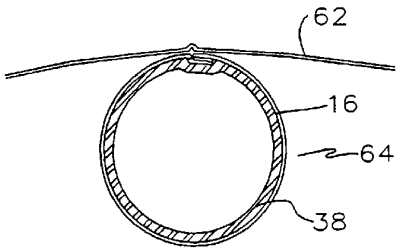

Fig 9

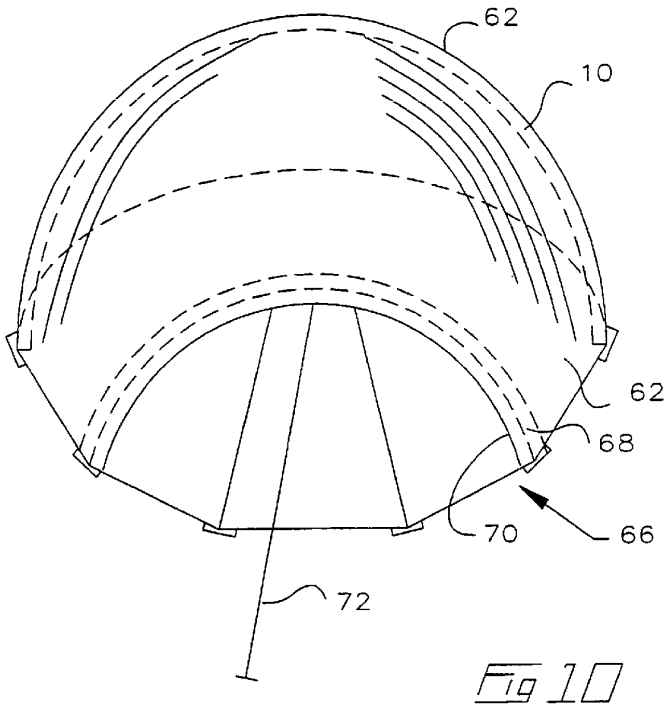

Fig 10