Dec. 14, 1954 J. A. AILEO 2,696,959

PARACHUTE CANOPY STRUCTURE

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Fig. 1

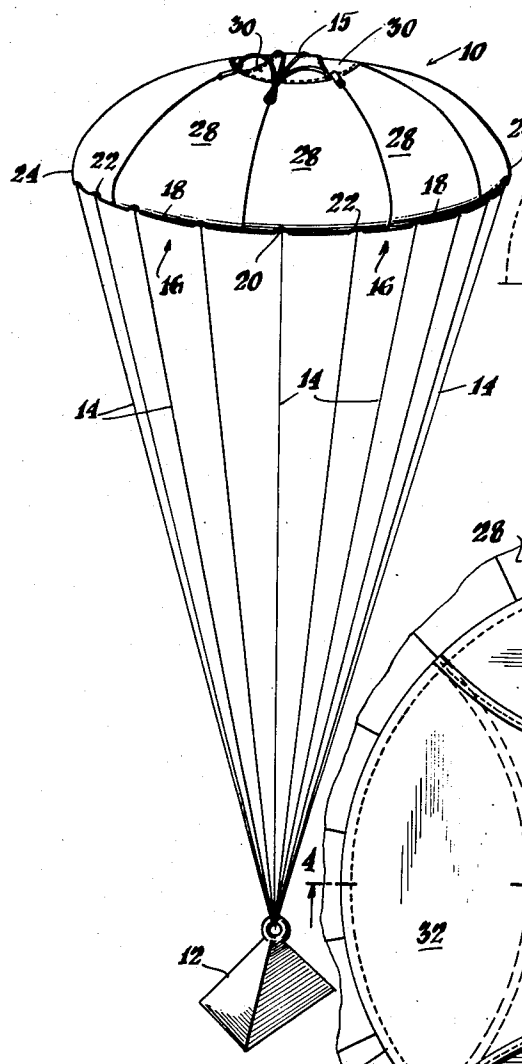


Fig. 2

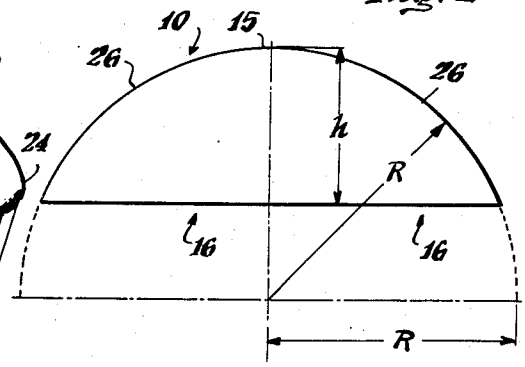


Fig. 3

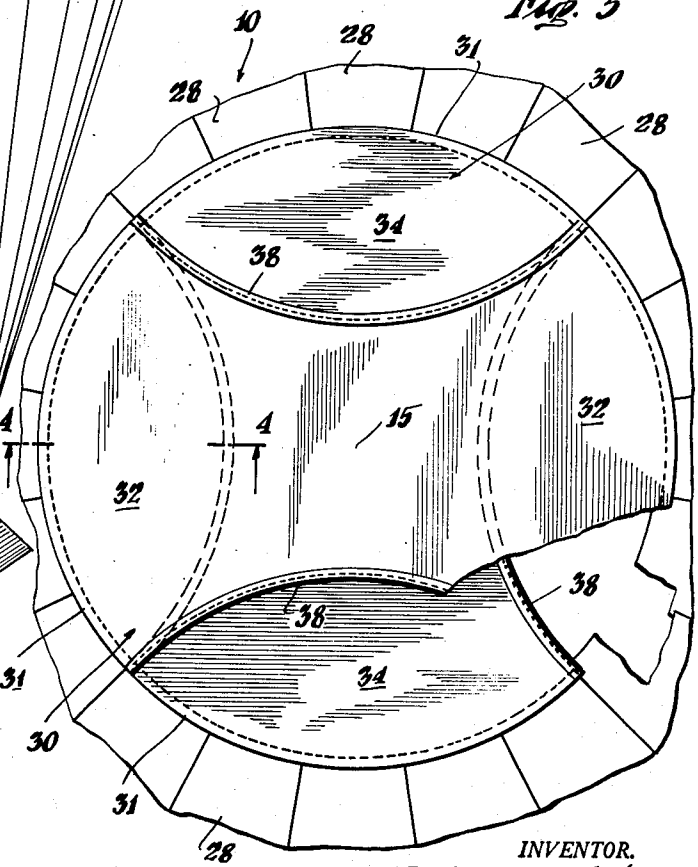
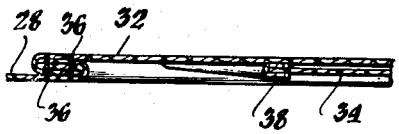


Fig. 4



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Fig. 5

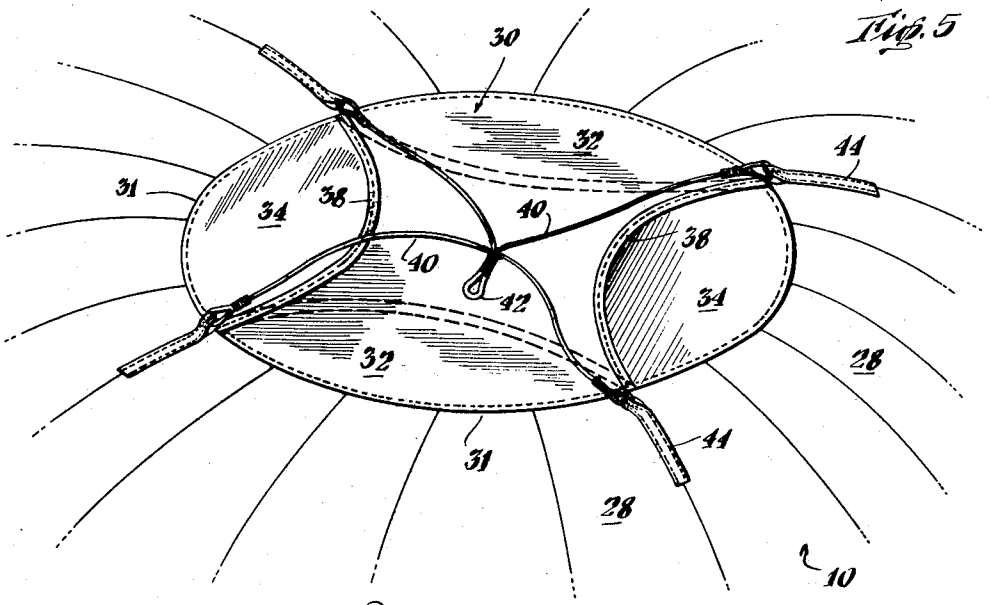
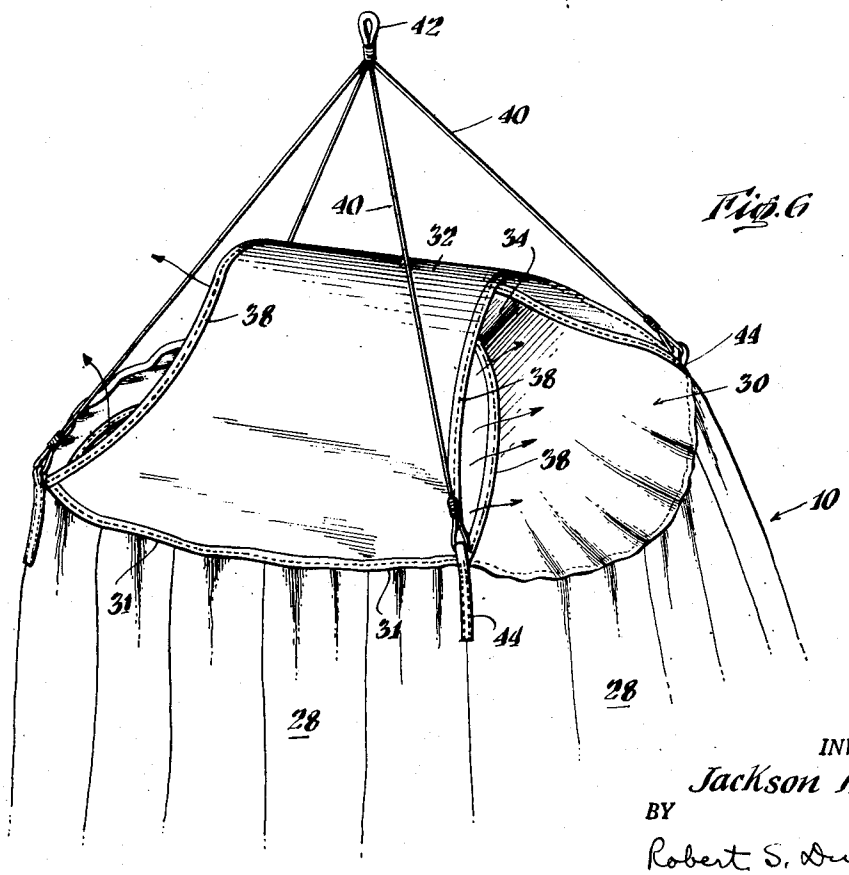


Fig. 6



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PARACHUTE CANOPY STRUCTURE

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Application January 26, 1952, Serial No. 268,401

4 Claims. (Cl. 244—142)

This invention pertains to load-carrying canopies and more particularly relates to a novel and improved parachute canopy structure in which the canopy is preformed substantially in the shape of the polar zone of a hemisphere, the altitude of the polar zone being less than the spherical radius. Such a canopy will be often referred to herein as a polar zone canopy.

Reference herein to the "preformed shape" of a canopy signifies that if properly supported (but without inflation), the canopy will assume the described special configuration even when there is essentially no tension in the fabric at any place.

The most widely used type of parachute (at least until very recently) has involved a so-called flat canopy, i. e. preformed to a flat shape. The assembly usually has a circular edge to which shroud lines are connected, for convergence to the point of load attachment. When such a parachute blooms in use, the downward pull of the shroud lines and the upward or inward force of air cup the fabric into a shallow, more or less parabolic shape.

More recently, use has been made of canopies preformed to a hemispherical shape, for example as described in the prior U. S. Patents No. 2,412,392, granted December 10, 1946, on the application of Walter S. Finken, and No. 2,426,926, granted September 2, 1947, on the application of Leonard P. Frieder and Walter S. Finken. Hemispherical canopies have been found specially advantageous, particularly in having much greater stability in flight than the older flat type parachutes which have a strong tendency to oscillate during descent; the hemispherical canopies also generally exhibit improved strength, especially against the sudden shock of opening at high speeds. Furthermore, in the case of a flat-type canopy, large and unequal stresses are developed in the fabric to pull the canopy into the desired, shallow parabolic contour. To avoid undue strain on the fabric and to promote some degree of stability, a crown or polar opening is usually provided (in a flat-type canopy) to relieve a considerable part of the so-called velocity head of air entering the mouth of the canopy and moving upward against the fabric.

A parachute having a canopy of the hemispherical type provides a much more stable descent than where a flat-type canopy is used, and the fabric in the hemispherical canopy is not subjected to any unequal stresses and other forces.

The present invention embraces the discovery that a canopy having the above-described novel, polar zone configuration affords several marked advantages over either or both of the flat and the hemispherical canopies. For example, the polar zone canopy: is faster opening than the hemispherical canopy; is more stable than the flat canopy, i. e. does not oscillate as much during descent; produces less unequal fabric strains and stresses than the flat canopy; requires considerably less cloth area than the hemispherical canopy to support a given load; and is relatively easy to manufacture, i. e. in that the gores or other sections making up the canopy may conveniently be made of the same shape as for a hemispherical canopy, but of shorter dimension toward the hemline or mouth opening. The retarding effect of the polar zone canopy is good, because of the fairly large low-pressure area which is found to be present above the crown during flight.

Important objects of this invention are therefore to attain the above-mentioned advantages, and generally, to provide improved parachute and like structures.

A further feature of the invention is the discovery that

it is advantageous to provide a polar zone canopy (and in some cases, other types of canopies) with an arrangement in the crown area for relieving internal pressure to ease the initial shock of inflation. Such an arrangement may most conveniently comprise a venting crown of overlapping flaps or panels, which will permit air to pass therethrough as the parachute is being inflated, but which will be closed and so held by the velocity head of air as and after the canopy is fully opened. Such improved structure thus advantageously differs from the parachutes of the prior art which have been equipped with crown holes that remain open in flight, e. g. as in the case of the flat-type canopies described above.

It is accordingly a further object of the invention to provide a canopy having novel means for relieving the initial shock occasioned by the sudden opening of the parachute.

The above and other objects and advantages will appear more clearly from the following description, taken with the accompanying drawings in which:

Fig. 1 is a somewhat diagrammatic perspective view of an example of a parachute having the improved polar zone canopy, shown in expanded form, as for support of a load;

Fig. 2 is a diagram showing the preformed canopy of Fig. 1 in vertical section, with certain geometric relationships;

Fig. 3 is a top view of a self-sealing crown vent, with portions broken away;

Fig. 4 is a sectional view on line 4—4 of Fig. 3;

Fig. 5 is a perspective view of the vent arrangement with the canopy fully opened; and

Fig. 6 is a perspective view of the vent arrangement with the canopy partially opened.

Like reference numerals denote like parts in the various views.

Fig. 1 shows diagrammatically a parachute having a polar zone canopy **10** in expanded form, supporting a load **12** by means of a plurality of shroud lines **14**. The canopy **10** has a crown section **15** and a circular mouth or hem edge **16** circumferentially terminated by a hemmed sleeve **18** looped over a running cord **20**, which may if desired be bartacked at suitable localities to limit its movement relative to the hem. The sleeve **18** is provided with evenly spaced holes **22** (there being as many holes **22** as there are shroud lines **14**), and the upper end of each shroud line **14** is passed through one of the holes **22** and looped around the cord **20**, thus to connect the lines **14** to the canopy **10**. Hem cord arrangements of this type are now well known and need not here be described in greater detail.

The canopy **10** is composed essentially of flexible sheet material, preferably woven textile fabric. Its configuration, i. e. as a polar zone canopy, can be best seen in and understood from Fig. 2, which is a diagram showing the preformed canopy in vertical section, i. e. in a section perpendicular to the mouth **16** and passing through the top or crown **15**. In this section, the canopy **10** appears as a circular arc **26** of radius R extending outward and downward an equal distance on each side of the top **15** of the canopy **10** and being terminated by the mouth **16**. The dimensions are such that the depth *h* of the arc **26** is less than R. More specifically, a canopy having satisfactory characteristics of stability, load-retarding effect, and minimum weight of fabric is believed to result where *h* is substantially in the range from 30% to 80% of R. At present it is greatly preferred to limit the range to from 40% to 70%, a particularly useful arrangement being one in which *h* has a value about 60% of R.

As shown, the canopy **10** is made up (except at its crown area) of gores **28**, which, as will now be apparent, are readily cut in essentially the same way as for true hemispherical canopies, with the exception that for this polar zone canopy, the gores **28** are shorter at the bottom. The amount by which they are shorter is essentially determined by the desired ratio of *h* to R.

It is further preferred to provide the top **15** of the polar zone canopy **10** with a venting arrangement **30**, designed and adapted to provide an air escape to ease the initial shock which occurs when the canopy **10** opens. This shock is particularly severe when the parachute is re-

leased at very high speed (e. g. from high speed aircraft); under such circumstances the initial velocity head of air entering the canopy **10** through its mouth **16** is abnormally large. Although providing the initial relief of shock, the arrangement **30** is also self-sealing after the canopy **10** is fully opened, so that in effect no more air can pass therethrough.

In the example of crown structure shown, the arrangement **30** is substantially circular at its outer boundary **31**, with its center corresponding to the top **15** of the canopy **10**, and may conveniently be constituted by two pieces of fabric **32** and **34**. The ends of the pieces **32** and **34** are substantially circular arcs, each corresponding to and embracing approximately 90° of the circle **31**. The pieces **32** and **34**, which are preferably considerably narrower at their central portions than at their ends, are affixed to the gores **28**, for instance by suitable stitching such as shown at **36** (Fig. 4), with the lengthwise center lines of the pieces **32** and **34** intersecting each other at right angles. Thus the piece **32** lies above the piece **34**, and the pieces **32** and **34** cooperate in overlapping relationship to cover the crown area of the canopy **10** completely, when the canopy is in its deployed or open condition.

The pieces **32** and **34** are preferably hemmed at their sides as shown at **38**, and may if desired be cut to have a little fullness across the circular area bounded by the upper ends of the gores **28**; specifically, the crown assembly can thus be preformed to constitute (when the piece **32** smoothly and fully overlies the piece **34**) a part of the polar zone shape of Fig. 2.

Fig. 5 shows, in perspective, the vent arrangement **30** with the canopy **10** in its fully deployed or opened position. Under these conditions, the air velocity head inside the canopy **10** exerts upward and outward pressure to force the pieces **32** and **34** together in smoothly abutting relation and thus to prevent outward passage of air through the vent arrangement **30**.

Fig. 6 shows, also in perspective, the arrangement **30** with the canopy **10** part way open, as it will be during the opening of the parachute and before the fabric of the gore assembly has assumed full, uniform tension. It will be apparent that when this condition prevails (during the opening of the canopy **10**) air can freely pass between the pieces **32**, **34**, from the inside of the canopy as shown by the arrows, to ease the initial shock of the opening.

Suitable means, such as lines **40** which are joined together at an eye **42** at the top and at their lower ends are joined by suitable loops to tabs **44** on the canopy at the crown boundary, are adapted for attaching a pilot parachute (not shown) to the top of the canopy **10**; it will be understood that other pilot chute attachments may be employed if desired, as well as further structural features sometimes found advantageous, such as a hem zone of relatively low porosity thereby providing the intermediate zone between hem zone and crown as by a region of comparatively high porosity.

It may be explained, i. e. in further detail, that by reason of the novel crown construction, the velocity head of incoming air, in conjunction with an increasing effect of canopy expansion by volumetric displacement of air into and within the canopy, results in effective ballooning of the parachute, so that it inflates promptly and positively but in a cushioned manner. That is to say, at the outset as the parachute falls under the weight of its load, and as it then commences to expand, the mouth or open end of the canopy tends to scoop up a greater amount of air than will pass through the valve-like crown. In consequence, the enlarging volume of air expands the canopy more rapidly; as such expansion progresses to maximum radius, the fabric is increasingly stressed, and indeed sufficiently stressed to tighten the overlaps of the crown to

the point where further escape of air is prevented. Thereafter, the parachute continues its descent as a completely closed canopy, with full retarding force.

As illustrated in Figs. 1 and 2, and conveniently as embodying the flap crown construction of Figs. 3 to 6, the polar zone canopy provides effective load-retarding action and accomplishes the several objects set forth above. To some special advantage, notably of stability, the parachute preferably is such that when fully deployed, its hem region is pulled slightly inward (at **24**, Fig. 1), i. e. in a slightly incurving distortion from the shape as actually preformed.

It is to be understood that the invention is not limited to the specific details herein shown and described, but may be embodied in other forms without departure from its spirit.

What is claimed is:

1. A load carrying canopy having a crown region and including a crown vent structure occupying the crown region and effective to ease the initial shock when said canopy is opened, said crown vent structure including overlapping pieces of flexible material extending across said crown region and having ends shaped to conform to the boundary of said crown region and affixed thereto, said pieces being arranged and constructed so that when said canopy is fully opened, said pieces will seal said crown region in substantially air-tight relationship, and when said canopy is not fully opened, said pieces will permit air to escape between them.

2. A canopy as described in claim 1, wherein said crown region is circular, and the ends of said pieces are circular arcs of radii substantially equal to the radius of said crown region.

3. A vent structure as described in claim 1, wherein said crown region is circular, the ends of said pieces are circular 90° arcs of radii substantially equal to the radius of said crown region, the sides of the pieces are similar 90° arcs, and the lengthwise center lines of said pieces intersect each other at right angles.

4. A load-carrying canopy having a crown region and a peripheral portion encircling said crown region, including crown vent means to ease the initial shock when the canopy opens, said vent means including overlapping pieces of flexible material extending generally diametrically across said crown region and fixed only at their ends to said peripheral portion, said pieces having longitudinal dimensions substantially equal to the diameter of said crown region when the canopy is fully open, so that the pieces are slack during the opening of the canopy until the peripheral portion is fully open, said pieces when slack providing pressure-relieving vent openings between them, said pieces being placed under tension only by said full opening, said pieces having lateral dimensions sufficient so that when all the pieces are under tension, the pieces cooperate to close the crown region substantially completely.

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