Sept. 24, 1963

T. W. KNACKE ETAL

3,104,857

GLIDE PARACHUTE

Filed Sept. 1, 1961

4 Sheets-Sheet 1

Fig. 1

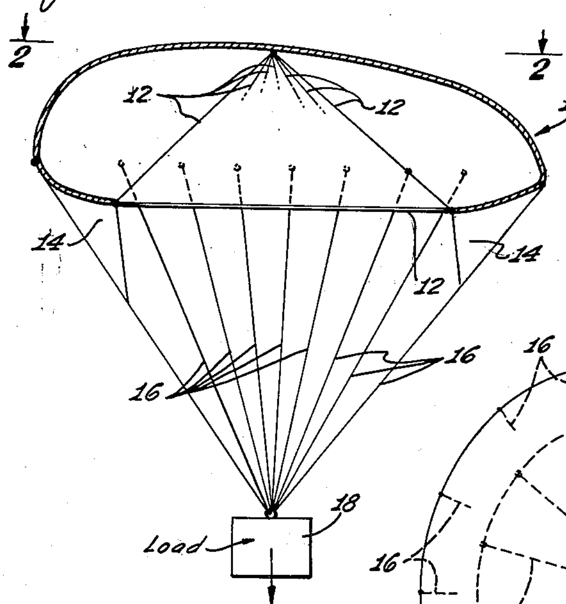

Fig. 2

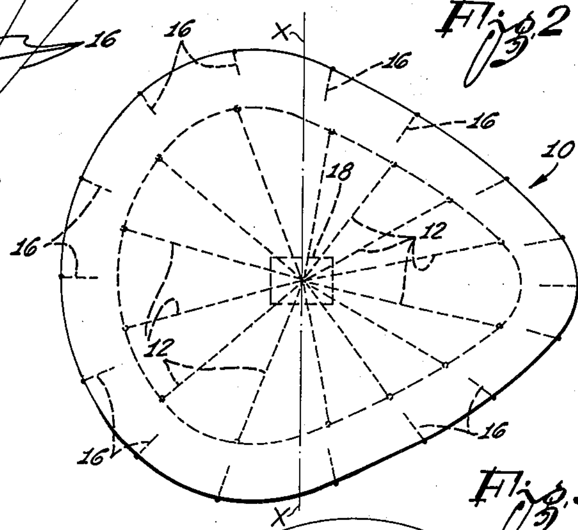

Fig. 4

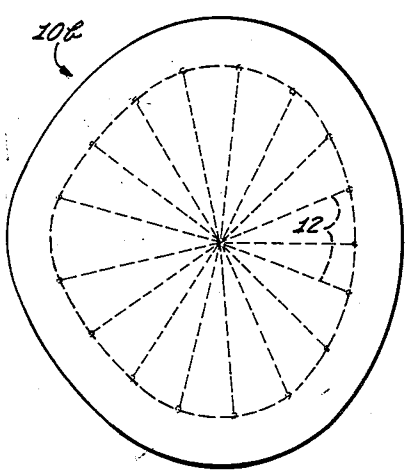

Fig. 3

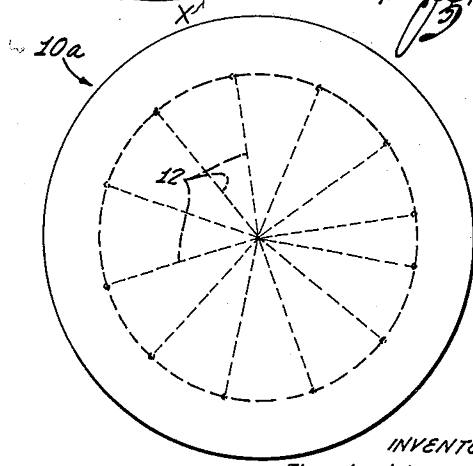

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Fig. 5

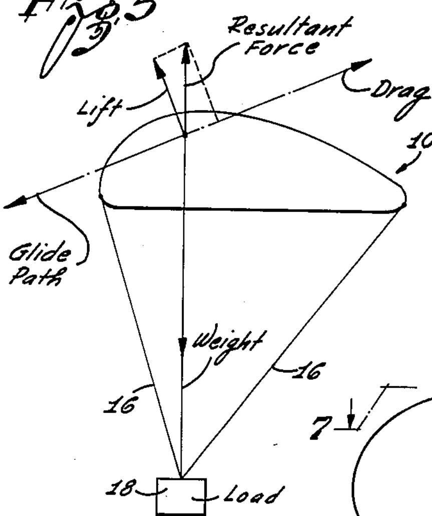

Fig. 6

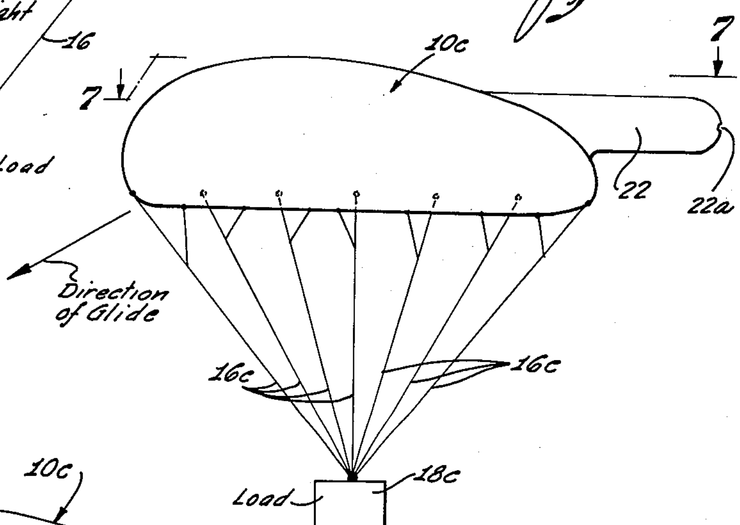

Fig. 7

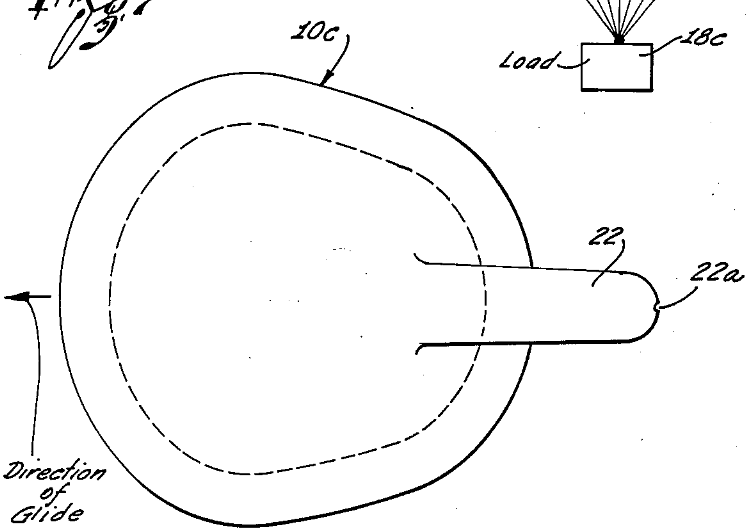

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Fig. 8

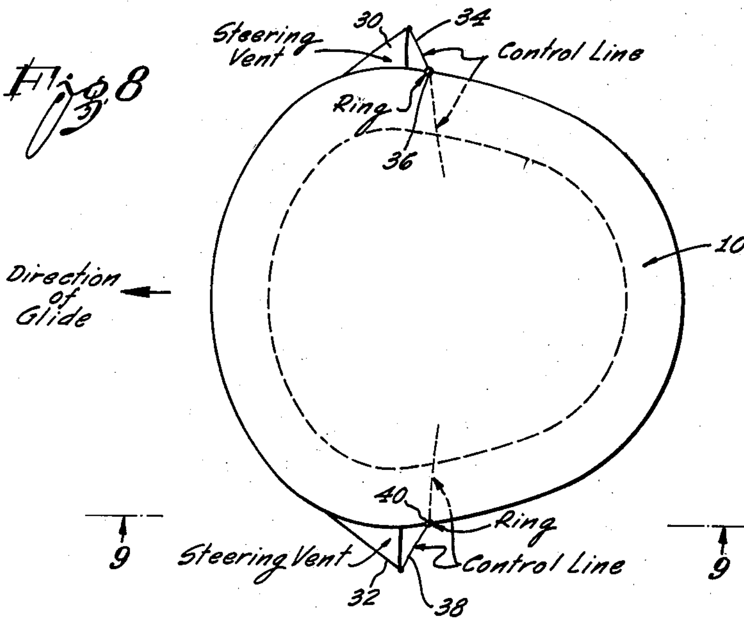

Fig. 9

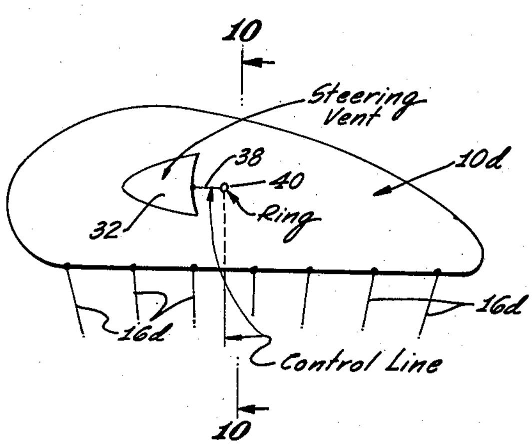

Fig. 10

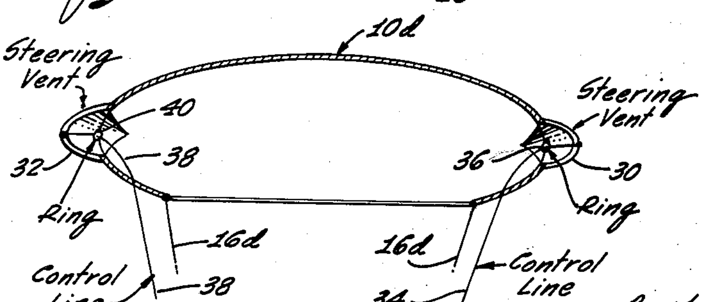

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Fig. 11

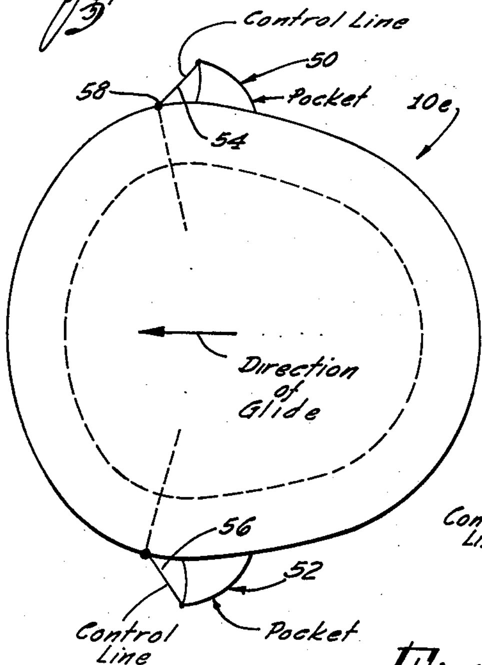


Fig. 12

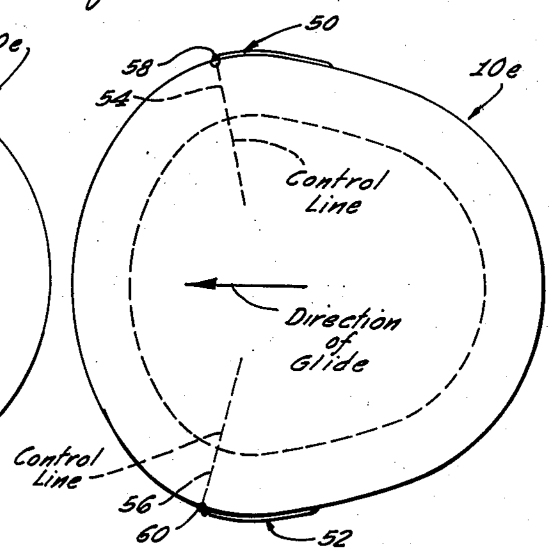
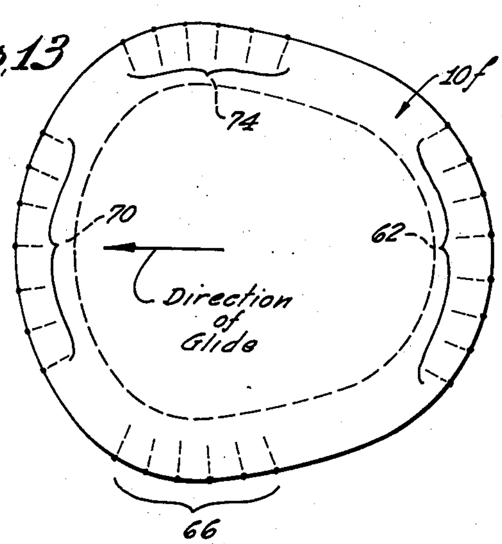


Fig. 13



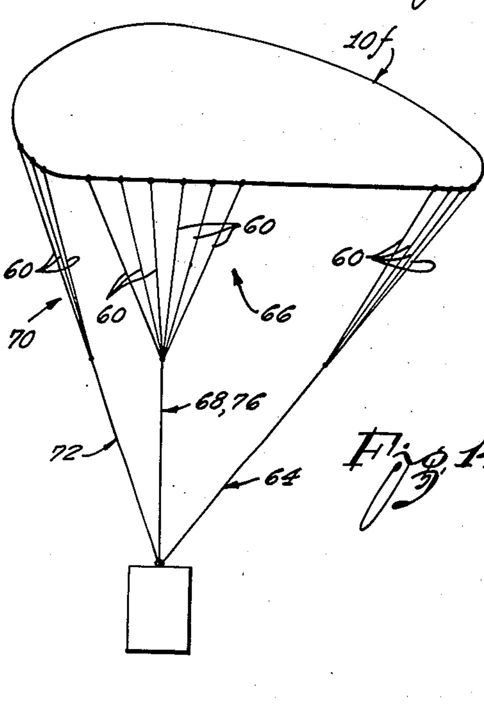


Fig. 14

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GLIDE PARACHUTE

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8 Claims. (Cl. 244—145)

The present invention relates to parachutes, and it relates more particularly to a new and improved type of parachute having the ability to glide along a determined course.

Glide parachutes, per se, are known, and such parachutes have been used in the past. The well-known types of prior art glide parachutes include those designated the Hart Paratchute, the Derrick Parachute, the Tojo Parachute, and different types of blank-gore parachutes.

The prior art glide parachutes referred to in the preceding paragraph all operate on the same principle of reaction forces. In these prior art glide parachutes, one or more openings are provided in the canopy of the parachute, and the air escaping through these openings creates reaction forces which propels the parachute in a direction opposite to the direction of the escaping air.

Unlike the prior art glide parachutes mentioned above, the glide parachute of the present invention uses the principle of lift mainly, but combines reaction for directional control, as will be described. The glide parachute of the invention is constructed to have the shape and characteristics of an air foil, in that it is shaped to obtain a lift force on its surface from the atmosphere through which is moves.

As is well known, "lift" is the force which counteracts gravity, and this force is caused by the motion of air over and under an air foil as it moves through the atmosphere. Lift is produced, as enunciated by the Bernoulli priciple, because the air foil is shaped such that the speed of air over its top surface is greater than the speed of air over its lower surface. To achieve this condition, the top surface of the air foil is curved, and the air has a further path to travel over the top surface than over the lower surface. This, in accordance with Bernoulli's principle, creates a condition such that the pressure of air below the air foil is greater than the pressure of air above, and this pressure differential causes the air foil to "rise" or "lift."

As is also well known, "drag" is the force which resists the forward motion of an object through the air. A first type of drag of an air foil section, known as "profile" drag, depends largely on the shape of the air foil. Another type of drag is directly caused by the lift and is called "induced" drag. The total drag of the air foil is the combination of the profile drag and the induced drag.

The improved glide parachute of the present invention is constructed to have an air foil configuration, and the glide characteristics thereof are produced by a combination of lift and drag, rather than by drag and reaction forces as is the case in the prior art type of glide parachutes referred to above.

An object of the invention, therefore, is to provide an improved type of glide parachute which is capable of gliding along a determined glide path.

Another object is to provide such an improved type of glide parachute which is capable of gliding along the determined glide path with a high degree of directional stability. This object is achieved, for example, in a second embodiment of the invention by the provision of one or more stabilizing fins.

Yet another object is to provide such an improved type

of glide parachute which is capable of being guided along a desired glide path. This latter object is achieved, for example, in a further embodiment by the provision of controllable vents in the canopy of the parachute, or pockets, as will be described.

Other objects and advantages will become apparent from a consideration of the following specification in conjunction with the accompanying drawings, in which:

FIGURE 1 is a side sectional view of a parachute constructed in accordance with one embodiment of the invention to have an air foil configuration;

FIGURE 2 is a top view of the assembly of FIGURE 1 and illustrating the particular plane configuration of the canopy;

FIGURES 3 and 4 represent other suitable plane configurations for the canopy;

FIGURE 5 is a schematic representation of the parachute of FIGURE 1 and illustrating the forces involved in the assembly;

FIGURE 6 is a side elevational view of a parachute similar to the parachute of FIGURE 1 and which includes a stabilizing fin formed in the canopy of the parachute;

FIGURE 7 is a top plan view of the parachute of FIGURE 6;

FIGURE 8 is a top plan view of a parachute constructed in accordance with the concepts of the invention and further including controllable steering vents in the canopy;

FIGURE 9 is a side view of the parachute of FIGURE 8, substantially on the line 9—9 of FIGURE 8;

FIGURE 10 is an end view of the parachute substantially on the line 10—10 of FIGURE 9;

FIGURES 11 and 12 are top plan view of a parachute constructed in accordance with the concepts of the invention and further including controllable steering pockets in the canopy;

FIGURE 13 is a top plan view of a parachute constructed in accordance with the concepts of the invention and including controllable steering means; and

FIGURE 14 is a side view of the parachute of FIGURE 13.

As shown, for example, in FIGURES 1 and 2, the parachute of the first embodiment of the invention includes a canopy 10. The canopy 10 is shaped to have an air foil configuration, as best shown in FIGURE 1, when the parachute is in an inflated condition. The canopy 10 achieves the air foil configuration in the embodiment of FIGURES 1 and 2, by appropriately shaping the canopy and by turning in its peripheral rim portion towards the open underside of the air foil section formed thereby.

It will be apparent from an examination of the presentation of FIGURE 1, that the cross-section through the parachute is similar to a thick air foil with a high camber and an open underside. The camber may, for example, be of the order of 10%.

The air foil shape may be maintained, for example, by internal and external anchor lines, such as the anchor lines 12 of FIGURES 1 and 2 and by gusset-like ribs 14, as shown in FIGURE 1. The anchor lines 12 and the members 14 maintain a desired balance between aerodynamic and stress forces. A tension line may also be provided at the lower opening to keep the proper tension on all parts of the parachute.

A plurality of suspension lines 16 are secured to the canopy at angular positions around the periphery thereof. In the embodiment of FIGURE 1, these suspension lines 16 are spaced radially outwardly from the inner peripheral edge of the turned in rim portion, so that the anchor lines **12** may maintain the canopy in its air foil shape.

The canopy **10** may be self-inflating; or it may include inflatable tubes or inflation rigging for the purpose of preventing deflation or flutter of parts of the canopy, or to maintain the desired airfoil shape of the canopy.

The material used for the canopy **10** should preferably be of low porosity. However, any suitable material, such as organic textiles, synthetic textiles, plastics, glass fiber, wire mesh and the like, may be used. As illustrated in FIGURE 1, an appropriate load **18** is suspended from the lower end of the suspension lines **16**.

The embodiment of the invention shown in FIGURES 1 and 2 has a canopy whose plane configuration resembles an ellipse on one side of a transverse axis X—X, and a parabola on the other side, as shown in FIGURE 2.

As shown in FIGURES 3 and 4, the canopy may have other plane forms. For example, the canopy **10***a* in FIGURE 3 has a circular-shaped plane form; and the canopy **10***b* of FIGURE 4 has an oval plane form. The plane form of the canopy may have any other appropriate configuration.

As shown in FIGURE 5, as the parachute of FIGURE 1 moves through the atmosphere, various forces are created. First there is the downward force, as represented by the vector "weight" created by the force of gravity on the load **18**. The resulting motion of the parachute through the atmosphere creates a lift force, due to the air foil shape of the canopy **10**. This lift force is represented by the vector "lift" in the diagram of FIGURE 5. The resultant of the two forces "weight" and "lift" causes the assembly to move along the path designated "glide path." Motion along the glide path is opposed by the drag force discussed above. This latter force is represented by the vector "drag" in FIGURE 5. An examination of FIGURE 5 will reveal, therefore, that the glide parachute assembly of the present invention, instead of proceeding directly downwardly towards earth, is caused to move along a particular glide path during its downward descent.

The parachute of FIGURES 6 and 7 is similar in most respects to the glide parachute of FIGURE 1. The parachute of FIGURE 6 includes a canopy **10***c* which may have a configuration similar to any of the canopies described above. A plurality of suspension lines **16***c* suspend a load **18***c* from the canopy **10***c*. During the downward descent of the parachute of FIGURE 6, the parachute is caused to glide along the path indicated by the arrow in FIGURE 6.

As a further feature of the embodiment of the invention shown in FIGURES 6 and 7; one or more fins, such as the extension, or fin, **22** is formed on the canopy **10***c*. The fin **22** protrudes from the canopy as illustrated in FIGURES 6 and 7. This fin has a tubular configuration, and it communicates with the interior of the canopy **10***c*. The fin **22** is inflated by the ram pressure inside the parachute. A small exit hole **22***a* may be provided at the end of the extension **22**.

The cross-section of the tubular fin **22** may be circular, oval, polygonal, or other suitable shape. One or more of the fins, such as the fins **22** in FIGURES 6 and 7 may be provided. These fins extend from the rear of the canopy in a direction opposite to the direction of flight. The purpose of the fins is to provide the glide parachute with directional stability, and hold its glide path in the direction of the wind.

The parachute illustrated in FIGURES 8–10 is similar in most respects to the parachute embodiments described above. The latter parachute includes a canopy **10***d* of any desired plane form and configured as an air foil in accordance with the teachings of the invention.

The parachute of FIGURES 8–10 includes a plurality of suspension lines **16***d*. In this embodiment, the suspension lines are shown as attached to the turned-in inner rim of the canopy. The canopy itself is cut and configured to have its air foil shape when inflated.

The parachute of FIGURES 8–10 is provided with a pair of vents **30** and **32**. These vents are positioned on opposite sides of the canopy **10***d*, as shown. The vents **30** and **32** function as a steering means for the parachute to cause it to glide down along a desired path.

The steering vent **30** is provided with a control line **34** which extends down through a ring **36** to a position where it can be manipulated by a person suspended from the parachute. The steering vent **32** is, likewise, provided with a control line **38** which extends down through a ring **40** to a position where it also can be manipulated by the person.

The manipulation of the control lines **34** and **38** causes the cowl portions of the vents **30** and **32** to be moved in and out with respect to the canopy. This, in turn, controls the cross-section area of the vents and the amount of air passing therethrough. This control of the air passage controls the reaction forces so that effective steering of the parachute may be realized.

The parachute of FIGURES 11 and 12 is provided with controllable air-brake pockets for steering purposes. These pockets are designated **50** and **52** in FIGURES 11 and 12. The pockets are positioned on opposite sides of the canopy **10***e* of the parachute, and they open in the direction of glide, as shown. The pockets inflate as the parachute proceeds along its glide path; and act as air brakes.

The amount of opening of the individual pockets is controlled by lines **54** and **56**. These lines, like the lines **34** and **38** in FIGURES 8, 9 and 10, run through appropriately positioned rings **58** and **60** and down to a position in which they can be manipulated by the person suspended from the parachute. The pockets **50** and **52** in FIGURE 11 are shown in the open, inflated position. The pockets in FIGURE 12 are shown closed, under the control of the lines **54** and **56**.

When the left pocket **50** alone is opened, the parachute will be caused to turn to the left. On the other hand, when the right pocket **52** alone is opened, the parachute will be caused to turn to the right. Opening both pockets **50** and **52** will air brake the forward motion of the parachute and change its glide slope.

The parachute of FIGURES 13 and 14 includes a canopy **10***f* which has an airfoil configuration in accordance with the teachings of the invention. The parachute of FIGURES 13 and 14 also includes a plurality of suspension lines **60**.

A first group **62** of the suspension lines **60** is connected to a riser **64**. A second group **66** of the suspension lines **60** is connected to a riser **68**. A third group **70** of the suspension lines is connected to a riser **72**. A fourth group **74** of the suspension lines is connected to a riser **76**, not shown.

Additional fixed risers may be used for other groups of the suspension lines, if so desired. The risers **64**, **68**, **72**, **76**, however, are controllable in that they may be lengthened or shortened. If the riser **68**, for example, is lengthened and the riser **76** is shortened, the canopy **10***f* will execute a right hand bank and the parachute will turn right.

Likewise, if the riser **68** is shortened and the riser **76** is lengthened, the canoyp **10***f* will execute a left bank and the parachute will turn left. On the other hand, if the riser **72** is lengthened and the riser **64** is shortened, or vice versa, the pitch of the canopy will change and a glide path control is provided.

The risers illustrated in FIGURE 14 provide, therefore, a convenient attitude control for the parachute. Manipulation of the various risers provides a complete control over the parachute.

The invention provides, therefore, an improved and eminently simple glide parachute. The glide parachute of the invention is advantageous in that it is constructed to glide with a high degree of directional stability along a glide path in its descent to earth, and which in some of its embodiments is capable of a full convenient attitude control.

While particular embodiments of the invention have been shown and described, it is evident that modifications may be made. The present invention is intended to cover all such modifications as fall within the spirit and scope of the invention.

What is claimed is:

1. A deployable glide parachute assembly comprising:
- an upper flexible inflated canopy member having a circumferential edge;
- a lower, dish shaped member, partially enclosing the underside of the canopy member, having an inner peripheral edge defining an aperture and having an outer peripheral edge attached to the circumferential edge of the canopy member;
- when deployed, the parachute assembly generating an air foil configuration with leading and trailing edges having a predetermined camber line in a plane of symmetry extending between the leading and trailing edges;
- the distance between the canopy member and the lower member normal to the camber line and in the plane of symmetry continuously increasing at a first rate from the leading edge to a maximum intermediate the leading and trailing edges and thereafter decreasing at a second rate to the trailing edge;
- means extending between the inner peripheral edge of the lower member and the canopy to maintain the air foil configuration when the parachute is deployed; and
- a plurality of suspension lines secured to the canopy at spaced angular positions disposed about the perimeter of the canopy for supporting a load.

2. The parachute assembly of claim 1 wherein the means for maintaining the air foil configuration further comprises gusset-like ribs, one end of which is connected to the lower member and the other end of which is connected to the load bearing suspension lines.

3. The parachute assembly of claim 1 wherein the canopy further comprises at least one extension projecting therefrom for providing directional stability along the glide path of the parachute.

4. The parachute assembly of claim 3 wherein the extension has a tubular fin-like configuration and is inflated by the ram pressure inside the canopy.

5. The parachute assembly of claim 1 wherein the canopy member further comprises at least one vent formed therein to control the movement of the parachute along its glide path.

6. The parachute assembly of claim 5 wherein the canopy has at least a pair of vents formed therein to control the movement of the parachute along its glide path;
- each of the vents having a cowl associated therewith; and
- a corresponding pair of control lines attached to respective ones of the cowls to control the passage of air through the vents thereby controlling the movement of the parachute along its glide path.

7. The parachute assembly of claim 1 wherein the canopy further comprises at least a pair of pockets attached thereto at diametrically opposite positions and opening in the direction of movement of the parachute to control the movement of the parachute along its glide path.

8. The parachute assembly of claim 7 further including a pair of control lines attached to respective ones of the pockets to control the amount of opening of the pockets.

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