United States Patent [19]

Pinnell

[11] **3,780,970**

[45] **Dec. 25, 1973**

[54] **PARACHUTE APPARATUS**

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[73] Assignee: **The United states of America as represented by the Secretary of the Air Force,** Washington, D.C.

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[21] Appl. No.: **266,788**

[52] **U.S. Cl.** **244/152,** 244/142
[51] **Int. Cl.** **B64d 17/34,** B64d 17/06
[58] **Field of Search** ..... 244/152, 142, 138 R, 244/149, 147

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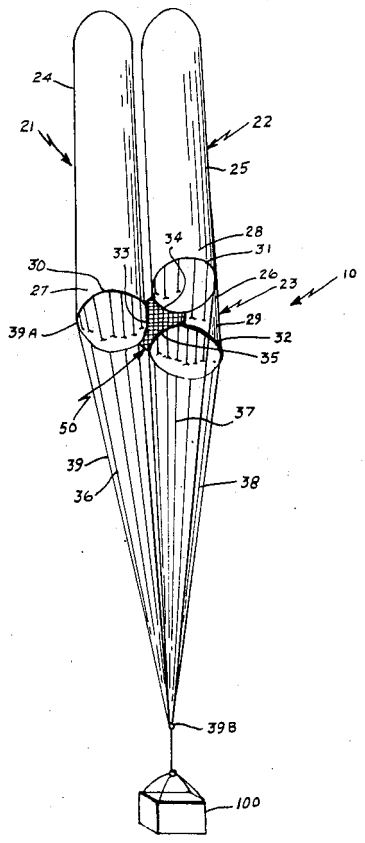
Assistant Examiner—Randolph A. Reese
Attorney—Harry A. Herbert, Jr. et al.

[57] **ABSTRACT**

A parachute apparatus which includes a plurality of identical parachutes, each of which has a canopy, with the parachutes releasably connected together by a clustering web assembly. When the parachute apparatus is deployed with a common payload, the parachutes, with the clustering web assembly releasably connected thereto, form a cluster and carry the common payload. The web assembly holds a portion of the canopy of each of the parachutes in a reefed condition. At a preselected time, or at a preselected atmospheric pressure (or altitude), during descent of the clustered parachutes, the web assembly permits the simultaneous disreefing of all of the parachute canopies. As a result, all of the canopies simultaneously open; then they spread; and, then they inflate to the fully open position, simultaneously. Therefore, none of the canopies need be designed to withstand the overload which normally occurs because of the frequent non-simultaneous opening, and subsequent non-simultaneous inflating, of the canopies in a cluster of parachutes during descent. Further, the current need for the use of additional (and redundant) parachutes in a cluster to assure payload recovery when one or more canopies of the parachutes, which are normally in the cluster, fail to open and/or to inflate to the fully open position during descent, is obviated. The common payload is, thereby, safely delivered.

4 Claims, 8 Drawing Figures



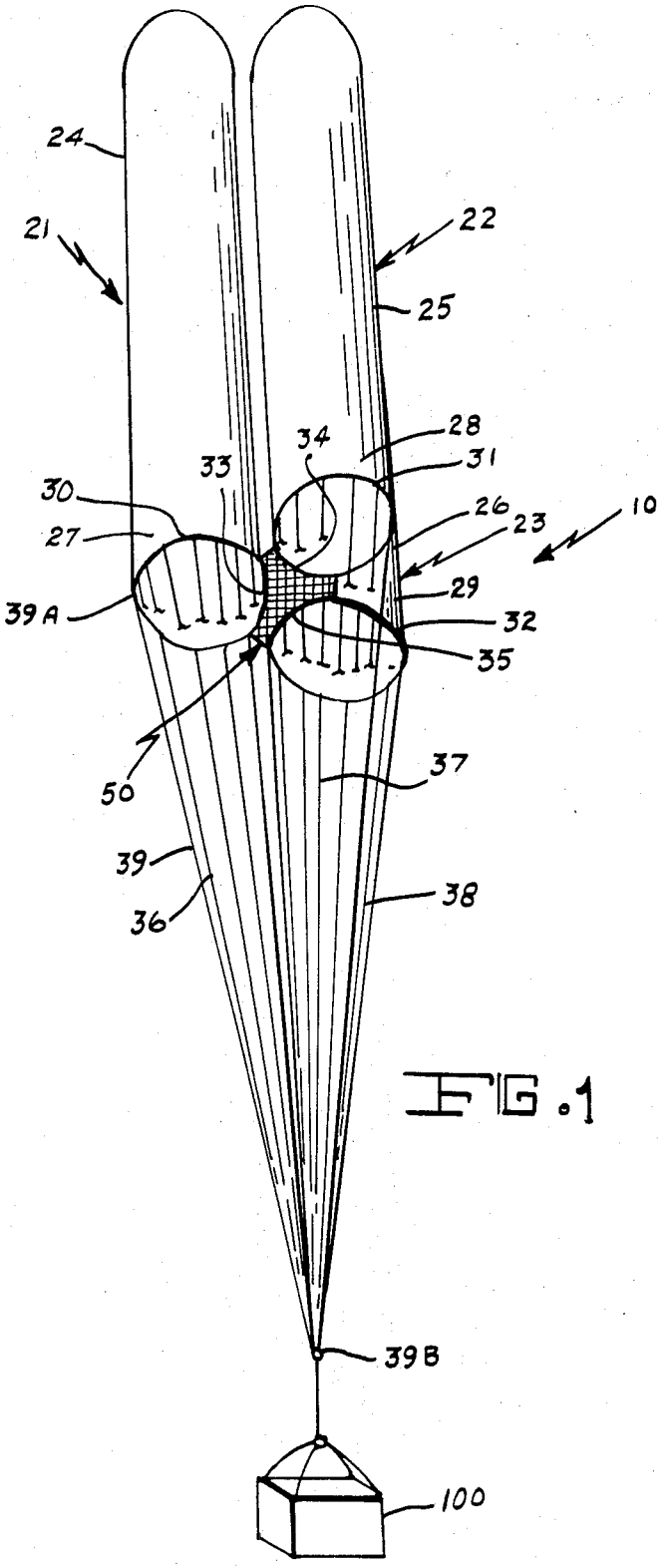
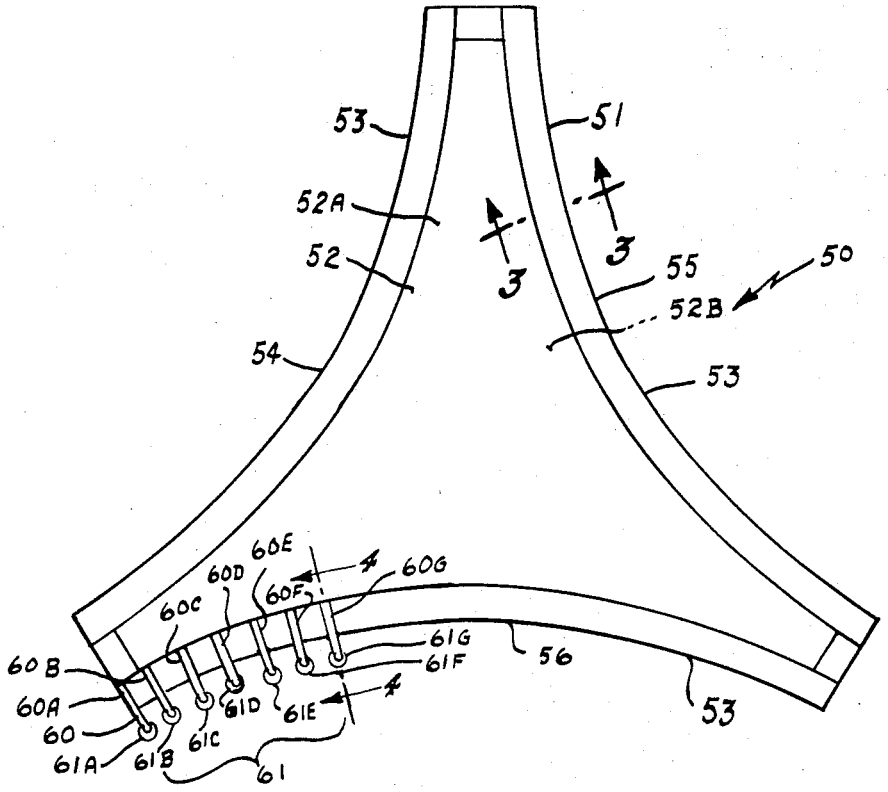

24
21
22
25
28
34
31
33
30
26
23
10
27
29
39A
32
35
50
37
39
38
36
39B
100

FIG. 1

FIG. 2



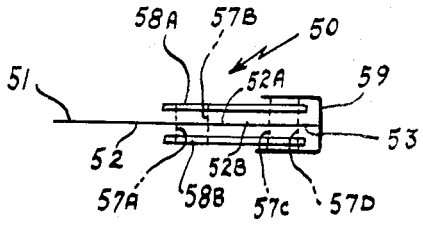


FIG. 3

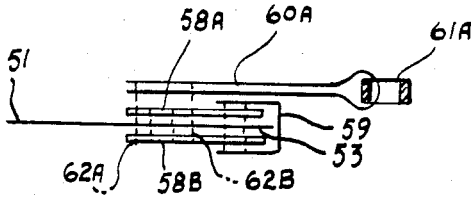


FIG. 4

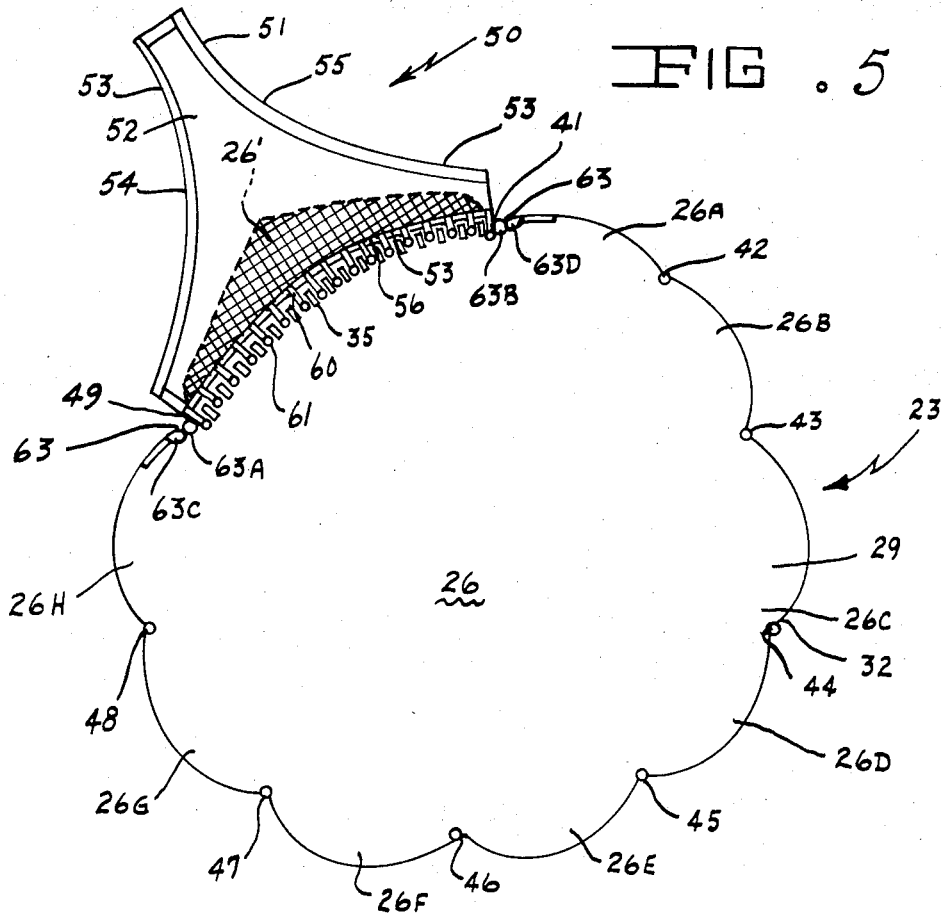

51
50
55
53
52
54
26'
53
41
63
26A
42
63D
53
56
63B
35
26B
60
61
49
43
23
63
63A
63C
29
26
26H
26C
32
44
48
26D
26G
45
47
26E
46
26F

FIG. 5

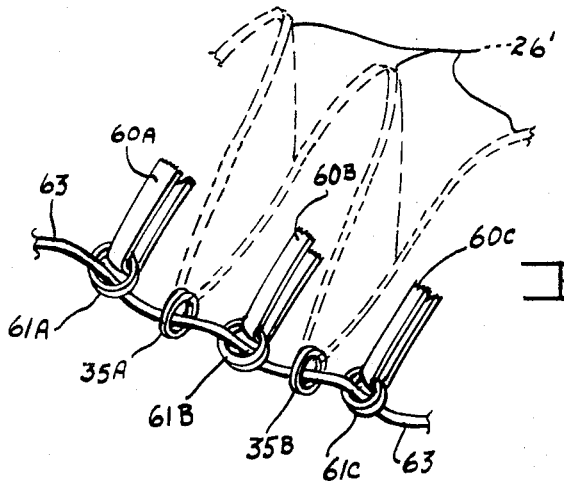

26'
60A
63
60B
60C
61A
35A
61B
35B
61C
63

FIG. 6

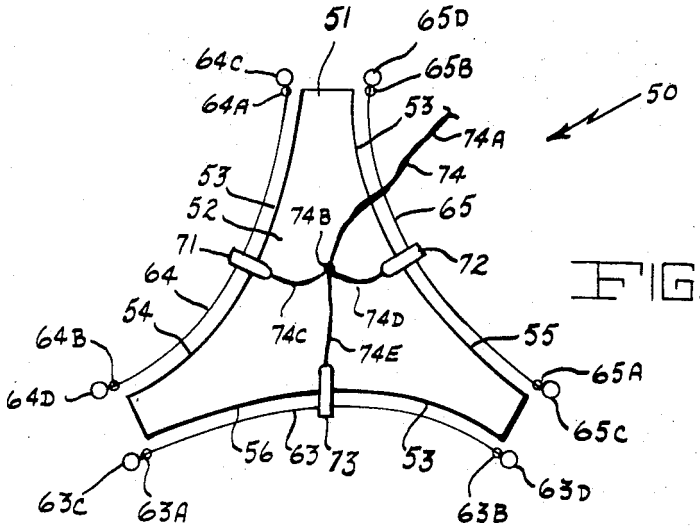

51
65D
64C
65B
64A
53
50
74A
53
74
52
74B
65
71
72
64
54
74C
74D
55
64B
74E
65A
64D
65C
56
63
73
53
63C
63A
63B
63D

FIG. 7

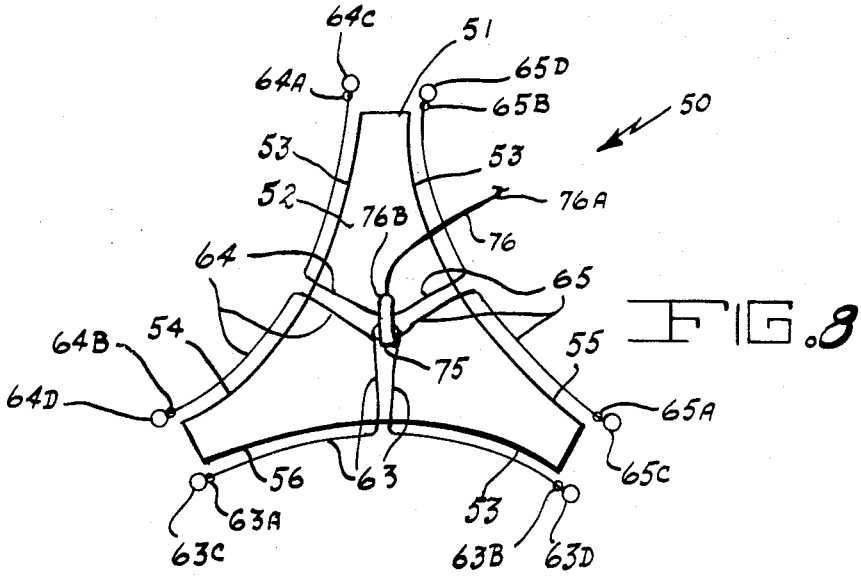

64C
51
64A
65D
65B
50
53
53
52
76B
76A
76
64
65
64B
54
75
55
64D
65A
65C
56
63
53
63A
63C
63B
63D

FIG. 8

PARACHUTE APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to the parachute art and, more particularly, to a parachute apparatus which includes a cluster of parachutes.

Parachute clusters, as such, are not new in the art. They are well known; and, it is fair and accurate to say, that it is equally well known in the art that, during descent, the operation of clustered parachutes is characterized, at best, by some degree of non-simultaneity during the opening-spreading-inflating sequential process which hopefully leads to the fully open position of the canopies in the cluster of parachutes. Often a canopy (or some of the canopies) in a cluster will open and inflate to the fully open position more rapidly than the other canopies in the cluster, thereby causing structural overloads on the early opening canopy (or canopies), and aerodynamic and mechanical interference, which result in excessive filling times for the total cluster, or even inflation failure in the late-opening canopy (or canopies). Therefore, it has been found necessary to construct the parachutes, and of course the canopy of each parachute, of a cluster, so that any one parachute can withstand the entire impact of the payload and can control the payload. Further, since, despite the best efforts and intentions of scientists, engineers, designers, technicians and the like, one or more of the parachute canopies which are normally in the cluster may fail to open, or may open but may fail to fully inflate, it is customary in some situations in the art to include additional (i.e., and redundant or "back-up") parachutes in the cluster to assure safe recovery of the payload.

It is clear, therefore, that there is a genuine and critical need for a parachute apparatus that includes a cluster of parachutes of which all the individual or respective canopies thereof will simultaneously, and reliably, open; will then spread; and will, thereafter inflate to the fully open position simultaneously.

I have invented such a parachute apparatus; and, thereby, I have significantly advanced the state-of-the-art.

This invention pertains to a novel parachute apparatus which includes, but is not limited to, a cluster of parachutes and a clustering web assembly.

As a preliminary matter, it is to be noted and understood that the word "open," as used herein, is intended to mean the initial opening of the canopy of a parachute, and not the fully open position thereof, and that the term "deploy" or the like, as used herein, is intended to mean, in addition to its usual meaning, the in-flight use of a parachute apparatus, parachute, canopy, or the like.

The principal object of this invention is to provide a cluster of parachutes, the canopies of which will open, spread, and inflate to the fully open position simultaneously, and, thereby, will provide the necessary reliability and operational confidence to the user of the cluster, without the present art-conceded needs: (1) of designing each canopy of each parachute to withstand the overload due to non-simultaneity in attaining the full opening of the canopies; and (2) of using additional (i.e., redundant) parachutes in the cluster to assure payload recovery, when one or more of the canopies of the parachutes in the cluster, which canopies would normally and numerically be sufficient for the purpose, fail to inflate to the fully open position.

The principal object, and other equally important and related objects (such as providing a simple, reliable, and unique clustering web assembly), of this invention will become readily apparent after a consideration of the description of my invention and reference to the drawings.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view, partially in schematic form, of a preferred embodiment of my invention while it is in the initial stage of deployment;

FIG. **2** is a top plan view, in schematic form, of a major component, i.e., the clustering web assembly, of my invention;

FIG. **3** is a side elevation view, in cross-section and in simplified schematic form, of a portion of the major component shown in FIG. **2**, taken along line **3—3** of FIG. **2**;

FIG. **4** is a side elevation view, in cross-section and in simplified schematic form, of another portion of the major component shown in FIG. **2**, taken along line **4—4** of FIG. **2**;

FIG. **5** is a top plan view, in simplified schematic form, of the clustering web assembly component of my invention, and of one of the canopies, a representative canopy, of a parachute of the plurality of parachutes of my invention, showing how the clustering web assembly is connected to the representative canopy, and showing how a portion of the canopy is reefed, and also showing in phantom how the reefed portion of the canopy is stowed;

FIG. **6** is a perspective view, in simplified schematic form, showing enlarged and in detail, a portion of my inventive means for reefing a representative canopy of a parachute of my plurality of parachutes, and also showing in phantom the relative position of a portion of the reefed canopy;

FIG. **7** is a top plan view, in schematic form, of a preferred embodiment of my inventive means for simultaneously disreefing the reefed canopies of my parachute cluster; and,

FIG. **8** is a top plan view, in schematic form, of another preferred embodiment of my inventive means for simultaneously disreefing the reefed canopies of my parachute cluster.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to FIG. **1**, therein is shown a perspective view, partially in schematic form, of a preferred embodiment **10** of my invention while it is in the initial stage of deployment.

It is here to be noted that my invention can be adapted by persons of ordinary skill in the art for any one or more of many uses. However, in the interest of simplicity, and solely by way of illustration, and not by way of any limitation, my invention will be described as structured in a preferred embodiment **10** for use in the aerial delivery of a payload.

Again, with reference to FIG. **1**, my preferred embodiment **10** includes a plurality of parachutes, preferably three, such as **21, 22** and **23.** For illustrative purposes, the parachutes **21, 22** and **23,** are, but need not be, identical. Each of the parachutes has a canopy, such as **24** for parachute **21, 25** for parachute **22,** and **26** for parachute **23.** As a matter of preference and not of limitation, each canopy is of the gore type, although

of course it need not be. Each canopy, such as **24, 25** and **26,** has, respectively, a canopy skirt such as **27, 28** and **29,** and each canopy skirt has a periphery, such as **30** for canopy skirt **27, 31** for canopy skirt **28,** and **32** for canopy skirt **29.** Each canopy has a first plurality of reefing rings, designated generally as **33** for canopy **24, 34** for canopy **25,** and **35** for canopy **26,** attached to, and evenly spaced along, a selected portion of the periphery of the particular canopy skirt.

Again with reference to FIG. **1,** my preferred embodiment **10** also includes means, leading from each canopy skirt, for removably securing each canopy to a payload, such as **100,** which said payload is common to all of the parachutes, such as **21, 22** and **23,** of the plurality of parachutes and, of course, to the canopy of each parachute. The common payload **100** removably securing means includes, as to each parachute, and to the canopy thereof, a plurality of suspension lines, generally designated as **36** for canopy **24, 37** for canopy **25,** and **38** for canopy **26,** which lead from the skirt of each canopy to the common payload **100.** Each suspension line, such as representative suspension line **39,** of each plurality of suspension lines, such as **36,** has two ends, such as **39A** and **39B,** with one end, such as **39A,** attached to its respective canopy, such as **24,** at the skirt thereof, such as **30,** and evenly spaced along the skirt, and with the other end, such as **39B,** leading from the skirt to the common payload **100.** In this adaptation, each suspension line, such as **39,** of each plurality of suspension lines, such as **36,** is of equal length.

Still with reference to FIG. **1,** my preferred embodiment **10** also includes means, common to the canopy of each parachute of the plurality of parachutes, such as **21, 22** and **23,** for connecting each parachute of the plurality to each other, i.e., together, and thereby forming a cluster of parachutes. Said common connecting means is designated generally as **50** in FIG. **1** and, as a matter of preference and not of limitation, permits in this adaptation the releasable connection, rather than fixed or permanent connection, of each parachute, and the respective canopy thereof, to each other. Said common releasable connecting means **50** may comprise, or may include, a clustering web assembly, which will be shown in detail in other Figures, which will be discussed and described immediately hereinafter, and which will be designated as **50,** since for the purpose of this adaptation, i.e., preferred embodiment **10,** it (i.e., the clustering web assembly) is, in fact, the common releasable connecting means.

Now, with reference to FIG. **2,** therein is shown, in a top plan view and in schematic form, my clustering web assembly **50** (i.e., the common releasable connecting means), which includes a web **51,** which further includes a panel **52** having a perimeter **53,** and a panel top surface **52A** and a panel bottom surface **52B.** Panel **52** is preferably made of nylon duck cloth. Perimeter **53** of panel **52** has portions thereof, three in this adaptation, such as **54, 55** and **56,** each of which is suitably shaped and sized to accept and to abut with the canopy, such as **24, 25** and **26,** of a different one of the parachutes, such as **21, 22** and **23,** when each said canopy, or a portion thereof, is reefed. In this adaptation, the perimeter **53** of panel **52** is substantially triangular in form, with each side of the triangle shaped in the form of an outwardly facing arc, such as **54, 55** and **56,** with said arc being of the same length, and also with each said arc being circumferential portions of circles of the same radius. These arcs **54, 55** and **56** are suitably shaped and sized to accept and to abut with, respectively, canopies **24, 25** and **26,** when each canopy, or a portion thereof, is in a reefed condition. In other words, arcs **54, 55** and **56** are, respectively, complementary to the correspondingly selected portion of the reefed periphery of the particular canopy skirt which the particular arc abuts, and vice versa.

With reference to FIG. **3,** therein is shown a side elevation view, in cross-section and in simplified schematic form, of the clustering web assembly **50** shown in FIG. **2,** taken along line **3—3** of FIG. **2.** Panel **52** of web **51** of clustering web **50** has attached thereto, preferably with nylon thread(s), represented by **57A, 57B, 57C** and **57D,** and by stitching, reinforcement webbing **58A** and **58B,** at panel perimeter **53,** on, respectively, panel top surface **52A** and panel bottom surface **52B.** Said webbing **58A** and **58B** reinforces said panel **52.** Binding tape **59** is attached to panel **52** and to reinforcement webbing **58A** and **58B,** at the perimeter **53** of panel **52,** thereby further reinforcing panel **53.** The attachment of binding tape **59** is preferably with nylon thread(s) such as **57C** and **57D** and by stitching thereof.

With reference to FIG. **4,** therein is shown a side elevation view, in cross-section and in simplified schematic form, of the clustering web assembly **50,** shown in FIG. **2,** taken along line **4—4** of FIG. **2.** Panel perimeter **53** of panel **52** of web **51** of clustering web assembly **50** has attached thereto, preferably by nylon thread(s), such as represented by **62A** and **62B,** and by stitching, a plurality of tubular nylon webbing loops (such as represented in part in FIG. **2** by reference numerals **60A–60G,** inclusive, and collectively by **60,** and in FIG. **4** by reference numeral **60A** for a representative loop). Each of the plurality **60** of the tubular nylon webbing loops, such as **60A,** FIGS. **2** and **4,** is evenly spaced along perimeter **53** of panel **52;** and, in this adaptation, is also attached to reinforcing webbing **58A** and **58B** and binding tape **59.** Additionally, each tubular nylon webbing loop, such as **60A,** FIGS. **2** and **4,** captively holds a reefing ring, such as **61A.** There is, of course, a plurality **61** (hereinafter referred to a second plurality) of such reefing rings, and part of said second plurality of pictorially represented in FIG. **2** as **61A-61G,** inclusive. Of course, the tubular nylon webbing loops, such as **60A,** FIGS. **2** and **4,** with their respective reefing rings, such as **61A,** FIGS. **2** and **4,** are positioned at and on perimeter **53** of panel **52** and, in this adaptation, along arcs **54, 55** and **56,** FIG. **2.**

With reference to FIG. **5,** therein is shown a top plan view, in simplified schematic form, of the clustering web assembly **50** of my invention and of one of the canopies **26,** (a representative canopy) of one of the parachutes **23** (A representative parachute) of the plurality of parachutes, such as **21, 22** and **23** of my invention, showing how the clustering web assembly **50** is connected (removably in this adaptation) to the representative canopy **26** and how a portion **26'** of canopy **26** is reefed, and also showing in phantom how the reefed portion **26'** of canopy **26** is stowed. Also shown in FIG. **5:** are representative unreefed gores **26A–26H,** inclusive, of canopy **26** of representative parachute **23;** representative suspension lines **41–49** of representative parachute **23;** canopy skirt **29** of canopy **26;** periphery **32** of canopy skirt **29;** and representative reefing line **63,** of a plurality of reefing lines, with one reefing line

for each parachute, such as **23**, of the plurality of parachutes, such as **21**, **22** and **23**, and with each reefing line, such as **63**, having two ends, such as **63A** and **63B**, with each of the two ends attached to the respective parachute, such as **23**, of said reefing line, such as **63**. In this adaptation, one reefing line end **63A** is attached, preferably by tieing, to canopy reefing line loop **63C** which, in turn, is attached preferably by sewing, to canopy skirt **29** of canopy **26** of parachute **23**. The other reefing line end **63B** is similarly attached to canopy reefing line loop **63D**. The other reefing lines are similarly attached to their respective parachutes. The canopy reefing line loops, such as **63C** and **63D**, are attached, preferably by sewing, near the seam of each first unreefed gore, such as **26A** and **26H**.

Also shown in FIG. **5** are: web **51**, web panel **52**; panel perimeter **53**; panel perimeter arc (or curved) portions **54**, **55** and **56**, with each panel perimeter portion, such as **56**, shaped and sized to accept and to abut with the reefed portion (i.e., the correspondingly selected portion which is complementary), such as **26'**, of its respective canopy, such as **26**, of its respective parachute, such as **23**; a representative plurality of reefing rings, such as **35**, for its respective canopy, such as **26**; and, a representative plurality of tubular nylon webbing loops, such as **60**, for its respective web panel perimeter portion, such as **56**, with each tubular nylon webbing loop captively holding its respective reefing ring of a second plurality of reefing rings which are general designated as **61** in FIG. **5**. In the interest of not unnecessarily encumbering FIG. **5**, the other parachutes, such as **21** and **22**, FIG. **1**, and their respective canopies, gores, canopy skirts, peripheries, canopy reefing rings, and suspension lines are not shown in FIG. **5**. Additionally, also in the interest of avoiding confusion with regard to the drawing, the plurality of tubular nylon webbing loops, and the second plurality of reefing rings for said loops, for the other panel perimeter are portions, such as **54** and **55**, are also not shown in FIG. **5**. However, in this adaptation, all comparable components not shown in FIG. **5** are identical to the components shown therein. It is to be particularly noted that each of the canopy reefing rings, shown as a representative plurality by **35**, FIGS. **1** and **5**, and each of the webb panel loop reefing rings, shown as a representative plurality by **61**, FIGS. **2** and **5**, positionally alternate (e.g., web panel reefing ring-canopy reefing ring-web panel reefing ring-etc.); and that they, the web panel reefing rings and the canopy reefing rings, are in juxtaposed relationship to each other, and that the particular or appropriate reefing line, such as represented by **63**, FIG. **5**, passes through each of the reefing rings, such as **35**, FIGS. **1** and **5**, and **61**, FIGS. **2** and **5**.

With reference to FIG. **6**, therein is shown, in simplified schematic form, enlarged and in detail, a portion of my inventive means for reefing a representative canopy of a parachute of my plurality of parachutes, and in phantom, the relative position of a portion of the reefed canopy. More specifically, shown are: representative tubular nylon webbing loops **60A**, **60B**, and **60C**, with their respective captively held reefing rings **61A**, **61B**, and **61C**; representative reefing rings **35A** and **35B** of representative reefed gores portion **26'** of representative canopy **26**; and representative reefing line **63**. The webbing loop reefing rings, such as **61A**, **61B** and **61C**, and the canopy reefing rings, such as **35A** and **35B**, are positioned and disposed alternately with, and in juxtaposed relation to, each other. The appropriate and representative reefing line, such as **63**, passes through all of the rings, alternately.

With reference to FIG. **7**, therein is shown, in a top plan view and in schematic form, a preferred embodiment of my inventive means for simultaneously disreefing the reefed canopies of my cluster of parachutes. Shown are: web **51** with panel **52**; panel perimeter **53**; panel perimeter arc (or curved) portions or sides **54**, **55** and **56**, for respectively, canopy **24** of parachute **21**, FIG. **1**, canopy **25** of parachute **22**, FIG. **1**, and canopy **26** of parachute **23**, FIGS. **1** and **5** of my preferred embodiment **10**, FIG. **1**; reefing lines **63**, **64** and **65**, for, respectively, parachute **23**, FIGS. **1** and **5**, parachute **21**, FIG. **1**, and parachute **22**, FIG. **1**, with said reefing line **63** having two ends, **63A** and **63B**, and said reefing line **64** having two ends, **64A** and **64B**, and with said reefing line **65** having two ends, **65A** and **65B**; canopy skirt reefing loops **63C** and **63D**, FIG. **5**, of canopy **26** of parachute **23**, FIGS. **1** and **5**, with end **63A** of reefing line **63** tied to loop **63C**, and with end **63B** of reefing line **63** tied to loop **63D**; canopy skirt reefing loops **64C** and **64D**, of canopy **24** of parachute **21**, FIG. **1**, with end **64A** of reefing line **64** tied to loop **64C**, and with end **64B** of reefing line **64** tied to loop **64D**; canopy skirt reefing loops **65C** and **65D**, of canopy **25** of parachute **22**, FIG. **1**, with end **65A** of reefing line **65** tied to loop **65C**, and with end **65B** of reefing line **65** tied to loop **65D**; and suitably positioned conventional reefing line cutters **71**, **72** and **73** for cutting, respectively, reefing lines **64**, **65** and **63**, with said reefing line cutters having a common arming lanyard **74** having two ends, **74A** and **74B**, with one end **74A** leading to and attached to a suitable pulling means, such as a suspension line of one of the plurality of suspension lines of one of the plurality of parachutes, as is conventionally done and with the other end **74B** having branches or leads therefrom and thereof, such as **74C** connected to cutter **71**, **74D** connected to cutter **72**, and **74E** connected to cutter **73**, thereby permitting the simultaneous activation of cutters **71**, **72** and **73** and the resultant simultaneous cutting of reefing line **64** by cutter **71**, of reefing line **65** by cutter **72**, and of reefing line **63** by cutter **73**, and the subsequent resultant simultaneous disreefing, respectively, of canopy **24** of parachute **21**, FIG. **1**, of canopy **25** of parachute **22**, FIG. **1**, and of canopy **26** of parachute **23**, FIGS. **1** and **5**. As previously stated, reefing line cutters **71**, **72** and **73** (and, of course, arming lanyard **74**) are conventional. The simultaneous cutting of the reefing lines by their respective cutters may be made to occur at a preselected time, or at a preselected atmospheric pressure (or altitude), during descent (i.e., deployment) of the clustered parachutes. As a related matter, it is to be noted that, for redundancy, two cutters (and their associated cooperative components thereof) may be incorporated at each location, i.e., the location of cutter **71**, the location of cutter **72**, and the location of cutter **73**. Additionally, as a matter of maintaining simplicity of FIG. **7**, the canopy reefing rings, such as **35**, FIGS. **1**, **5** and **6**, the web panel tubular nylon webbing loops, such as **60**, FIGS. **2**, **4**, **5** and **6**, and the reefing rings thereof, such as **61**, FIGS. **2**, **4**, **5** and **6**, and other related components are not shown in FIG. **7**.

With reference to FIG. **8**, therein is shown, in a top plan view and in schematic form, another preferred

embodiment of my inventive means for simultaneously disreefing the reefed canopies of my cluster of parachutes. Shown are: web **51** with panel **52**; panel perimeter **53**; panel perimeter arc (or curved) portions or sides **54, 55** and **56**, for, respectively, canopy **24** of parachute **21**, FIG. **1**, canopy **25** of parachute **22**, FIG. **1**, and canopy **26** of parachute **23**, FIGS. **1** and **5**, of my preferred embodiment **10**, FIG. **1**; reefing lines **63, 64** and **65**, for, respectively, parachute **23**, FIGS. **1** and **5**, parachute **21**, FIG. **1**, and parachute **22**, FIG. **1**, with said reefing line **63** having two ends, **63A** and **63B**, and said reefing line **64** having two ends, **64A** and **64B**, and with said reefing line **65** having two ends, **65A** and **65B**; canopy skirt reefing loops **63C** and **63D**, FIG. **5**, of canopy **26** of parachute **23**, FIGS. **1** and **5**, with end **63A** of reefing line **63** tied to loop **63C**, and with end **63B** of reefing line **63** tied to loop **63D**; canopy skirt reefing loops **64C** and **64D**, of canopy **24** of parachute **21**, FIG. **1**, with end **64A** of reefing line **64** tied to loop **64C**, and with end **64B** of reefing line **64** tied to loop **64D**; canopy skirt reefing loops **65C** and **65D**, of canopy **25** of parachute **22**, FIG. **1**, with end **65A** of reefing line **65** tied to loop **65C**, and with end **65B** of reefing line **65** tied to loop **65D**; and suitably positioned conventional reefing line cutter **75**, common to reefing lines **64, 65** and **63**, with said common reefing line cutter **75** having an arming lanyard **76** having two ends, **76A** and **76B**, with one end **76A** attached to a suitable pulling means, such as a suspension line of one of the plurality of suspension lines of one of the plurality of parachutes, as is conventionally done, and with the other end **76B** connected to the common reefing line cutter **75**, thereby permitting the activation of reefing line cutter **75**, and the resultant simultaneous cutting by cutter **75** of reefing lines **63, 64** and **65**, and the subsequent resultant simultaneous disreefing, respectively, of canopy **24** of parachute **21**, FIG. **1**, of canopy **25** of parachute **22**, FIG. **1**, and of canopy **26** of parachute **23**, FIGS. **1** and **5**. The simultaneous cutting of reefing lines **63, 64** and **65** by common cutter **75** may be made to occur at a preselected time, or at a preselected atmospheric pressure (or altitude), during descent (i.e., deployment) of the clustered parachutes. As in the embodiment which includes a plurality of reefing line cutters, FIG. **7**, the embodiment in FIG. **8** may incorporate, at the location of cutter **75**, two or more cutters (and their associated cooperative components thereof), for redundancy. Also, similarly to FIG. **7**, in the interest of maintaining simplicity of FIG. **8**, the canopy reefing rings, the web panel tubular nylon webbing loops and the reefing rings thereof, and other related components are not shown in FIG. **8**.

MODE OF OPERATION OF THE PREFERRED EMBODIMENT

The mode of operation of my preferred embodiment **10**, FIG. **1**, may be easily and rapidly ascertained by a person of ordinary skill in the art from the hereinabove description of the preferred embodiment, coupled with an examination of my FIGS. **1–8**, herein. A detailed description of said operation is, therefore, not believed necessary. However, for the benefit of those not skilled in the art, the mode of operation of my preferred embodiment is succintly and, in essence, as follows:

When the parachute apparatus **10**, FIG. **1**, is deployed with its common payload **100**, FIG. **1**, the parachutes **21, 22** and **23**, FIG. **1**, with the clustering web assembly **50**, FIGS. **1–8**, releasably connected thereto, form a cluster and carry the common payload. The reefing line cutter **75**, FIG. **8**, is (or the reefing line cutters **71, 72** and **73**, FIG. **7** are) automatically activated by the deployment. The web assembly is flat and holds a portion of the canopy of each of the parachutes in a reefed condition, as is shown in FIG. **5**, without alteration of the length of the curved portions **54, 55** and **56**, FIGS. **2, 5, 7** and **8**, of the web assembly, and without slack in the reefing lines **63, 64** and **65**, FIGS. **5–8**. At a preselected time, or at a preselected atmospheric pressure (or altitude), during descent of the clustered parachutes, the reefing line cutter (or cutters) simultaneously cuts the reefing lines, thereby permitting and accomplishing the subsequent simultaneous disreefing of all of the canopies. As a result, all of the canopies simultaneously open, FIG. **1**; then they spread; and, then they inflate to the fully open position, simultaneously. Thereby, the common payload is safely delivered.

In addition to the basic structural novelity of my inventive parachute apparatus, my invention attains the new, useful and unobvious result of reliability, a goal which has been long sought in the parachute art. Experimental tests of my parachute apparatus establish its reliability. Because of my teachings, it is, therefore, no longer necessary in the parachute art either to overdesign each parachute (and canopy thereof), or to provide additional (and redundant or "back-up") parachutes, to insure safe delivery of the payload.

While there have been shown and described the fundamental features of my invention, as applied to a preferred embodiment and as adapted for a particular use and purpose, it is to be understood that various substitutions, omissions, additions, and adaptations can be made by those of ordinary skill in the art without departing from the spirit of my invention. For example, among other variations, the number of parachutes, the canopy size thereof, the degree or amount of reefing of each canopy, the configuration of the web panel, and the like, may be varied or otherwise changed. In addition, my inventive parachute apparatus can be used, or can be adapted to be used, for other applications and uses other than as shown and described with regard to the preferred embodiment, including, but not limited to: deceleration of aircraft, drones, missiles and the like; recovery of aircraft escape capsules; restriction of rate of descent of bombs, mines, flares, and the like; and, use by humans, such as pilots, paratroopers, and sky divers.

What is claimed is:

1. A parachute apparatus, comprising:

a. a plurality of parachutes, with each said parachute having:

1. a canopy, with said canopy having a canopy skirt with a periphery, and with said canopy having a first plurality of reefing rings attached to, and evenly spaced along, a selected portion of said periphery of said canopy skirt;

2. and, means, leading from said canopy skirt, for removably securing said canopy to a payload which, when secured to said canopy, is common to all said parachutes of said plurality of parachutes;

b. and, means, common to the said canopy of each parachute of said plurality of parachutes, for releasably connecting each said parachute of said plurality of parachutes to each other, thereby form-

ing a cluster of parachutes, wherein said releasable connecting means comprises a clustering web assembly which includes:

1. a web, which further includes a panel having a perimeter, with said perimeter having selected portions thereof, each of which is suitably shaped and sized to accept and to abut with a correspondingly selected portion of said canopy of a different parachute of said plurality of parachutes, when each said selected portion of said canopy is in a reefed condition;

2. and, means for releasably connecting said canopy of each parachute of said plurality of parachutes to said panel of said web, wherein said means includes:

a. means for reefing a portion of said canopy of each parachute of said plurality of parachutes, thereby forming a reefed portion of said canopy;

b. and, means for simultaneously disreefing said reefed portion of said canopy of each parachute of said plurality of parachutes.

whereby each said canopy of each of parachute of said plurality, and of said cluster, of parachutes opens, spreads, and inflates to the fully open position simultaneously, with reference to each said canopy, when said parachute apparatus is deployed.

2. A clustering web assembly, as set forth in claim **1**, wherein said panel of said web of said web assembly:

a. is made of nylon duck cloth;

b. has a top surface and a bottom surface;

c. has attached thereto, with nylon thread, reinforcement webbing at said perimeter of said panel on both said top surface and said bottom surface of said panel, thereby reinforcing said panel;

d. and, has attached thereto and to said reinforcement webbing, with nylon thread, binding tape at said perimeter of said panel, thereby further reinforcing said panel.

3. A clustering web assembly, as set forth in claim **1**, wherein:

a. said means for reefing a portion of said canopy of each parachute of said plurality of parachutes includes:

1. a plurality of tubular nylon webbing loops attached to, and evenly spaced along, a selected portion of said perimeter of said panel of said web;

2. a second plurality of reefing rings, with a different ring of said second plurality of reefing rings captively held, respectively, within and by a different tubular nylon webbing loop of said plurality of tubular nylon webbing loops;

3. and, a plurality of reefing lines, one reefing line for each parachute of said plurality of parachutes, with each said reefing line having two ends and with each end of said two ends attached to the respective parachute of said reefing line, and with each said reefing line passing through each of said reefing rings of said second plurality of reefing rings which is captively held, respectively, within and by a different tubular nylon webbing loop of said plurality of tubular nylon webbing loops, and with each said reefing line also passing through each reefing ring of said first plurality of reefing rings which are attached to, and are evenly spaced along, a correspondingly selected portion of the periphery of said canopy skirt of said canopy of said respective parachute, and with said reefing rings of said first plurality and with said reefing rings of said second plurality positionally located, with reference to each other, such that said reefing rings of said first plurality alternate with, and are in juxtaposed relation to, said reefing rings of said second plurality;

b. and, said means for simultaneously disreefing said reefed portion of said canopy of each parachute of said plurality of parachutes includes a plurality reefing line cutters, with one cutter for each reefing line of said plurality of reefing lines, with each said cutter suitably positioned to cut its respective reefing line simultaneously.

4. A clustering web assembly, as set forth in claim **1**, wherein:

a. said means for reefing a portion of said canopy of each parachute of said plurality of parachutes includes:

1. a plurality of tubular nylon webbing loops attached to, and evenly spaced along, a selected portion of said perimeter of said panel of said web;

2. a second plurality of reefing rings, with a different ring of said second plurality of reefing rings captively held, respectively, within and by a different tubular nylon webbing loop of said plurality of tubular nylon webbing loops;

3. and, a plurality of reefing lines, one reefing line for each parachute of said plurality of parachutes, with each said reefing line having two ends and with each end of said two ends attached to the respective parachute of said reefing line, and with each said reefing line passing through each of said reefing rings of said second plurality of reefing rings which is captively held, respectively, within and by a different tubular nylon webbing loop of said plurality of tubular nylon webbing loops, and with each said reefing line also passing through each reefing ring of said first plurality of reefing rings which are attached to, and are evenly spaced along, a correspondingly selected portion of the periphery of said canopy skirt of said canopy of said respective parachute, and with said reefing rings of said first plurality and with said reefing rings of said second plurality positionally located, with reference to each other, such that said reefing rings of said first plurality alternate with, and are in juxtaposed relation to, said reefing rings of said second plurality;

b. and, said means for simultaneously disreefing said reefed portion of said canopy of each parachute of said plurality of parachutes includes one reefing line cutter which is common to, and is suitably positioned to cut, each of said plurality of reefing lines simultaneously.

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