

Jan. 21, 1969

F. B. STENCEL

3,423,054

BALLISTICALLY SPREAD MULTIPLE CANOPY PARACHUTE APPARATUS

Filed Dec. 27, 1967

Sheet 1 of 3

Fig. 1.

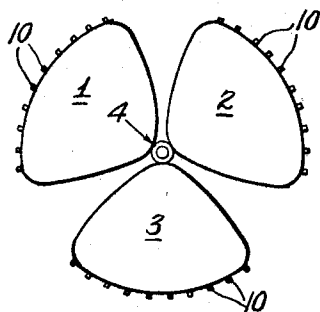
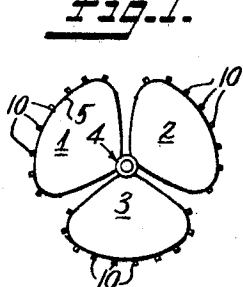


Fig. 1A.

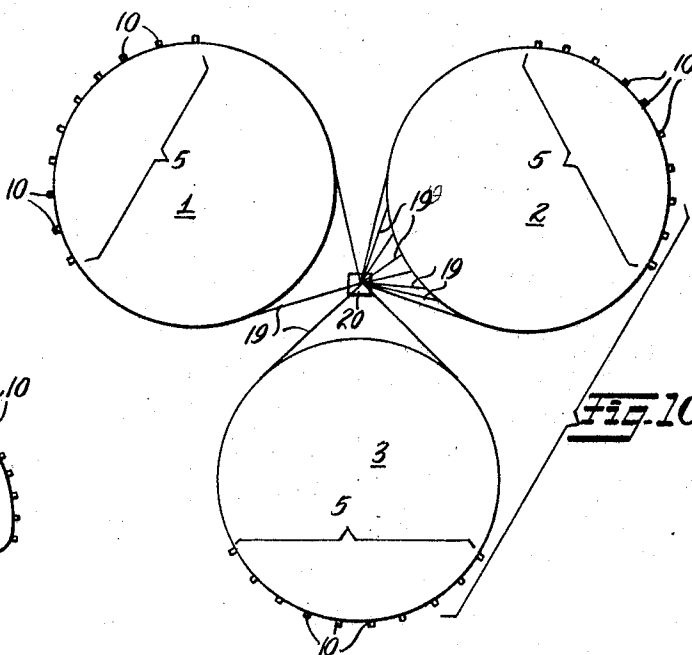


Fig. 1C.

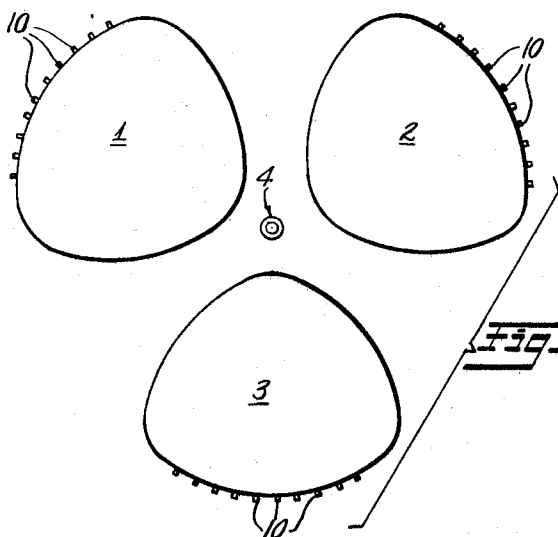


Fig. 1B.

INVENTOR

FRED B. STENCEL

BY *Arnold, Roylance, Kruger & Durkin*
ATTORNEYS

Jan. 21, 1969

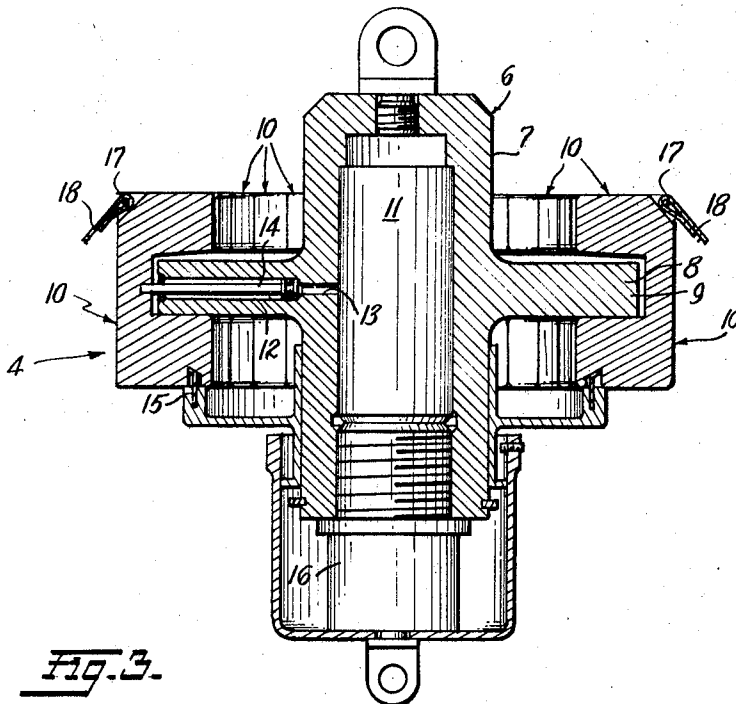
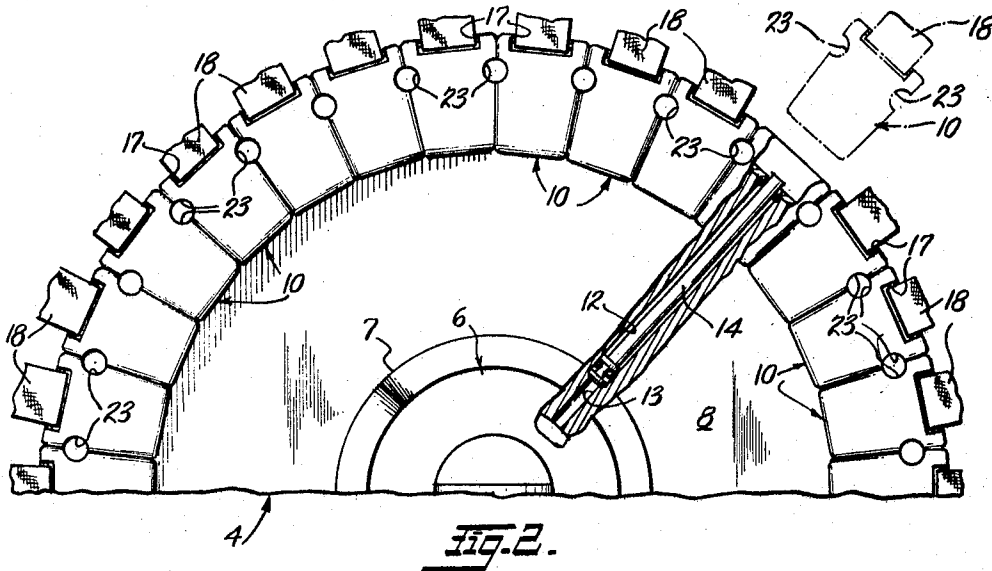
F. B. STENCEL

3,423,054

BALLISTICALLY SPREAD MULTIPLE CANOPY PARACHUTE APPARATUS

Filed Dec. 27, 1967

Sheet 2 of 3



INVENTOR
FRED B. STENCEL

BY *Arnold, Roylance, Kruger & Durkee*
ATTORNEYS

Jan. 21, 1969

F. B. STENCEL

3,423,054

BALLISTICALLY SPREAD MULTIPLE CANOPY PARACHUTE APPARATUS

Filed Dec. 27, 1967

Sheet 3 of 3

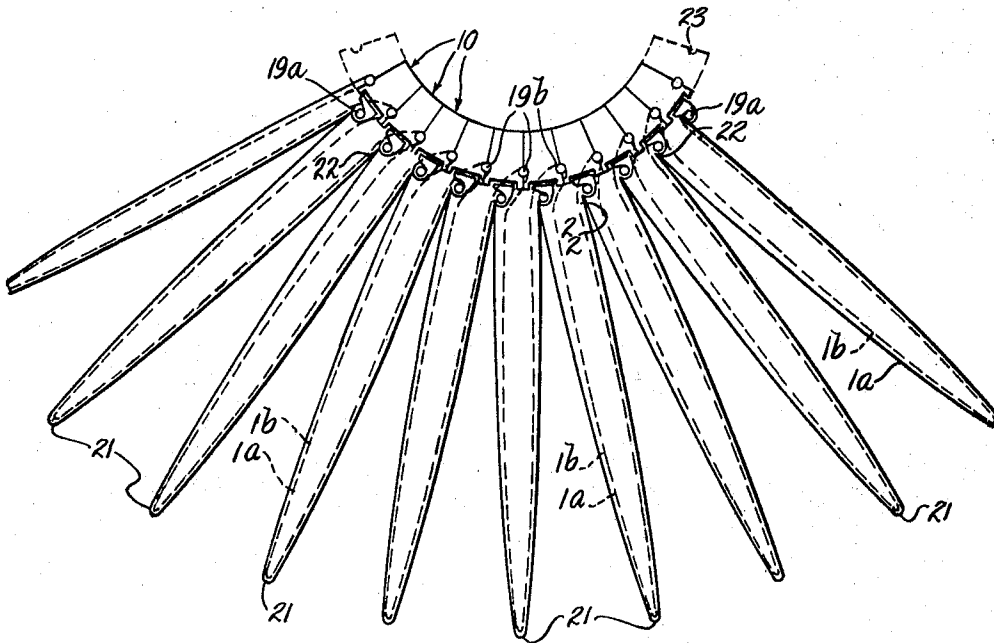


Fig. 4.

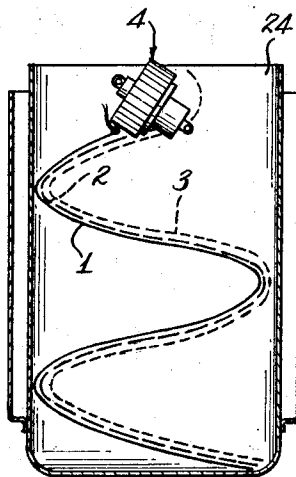


Fig. 5.

INVENTOR

FRED B. STENCEL

BY
Arnold, Roylance, Kruger & Durkee
ATTORNEYS

1

3,423,054

**BALLISTICALLY SPREAD MULTIPLE CANOPY
PARACHUTE APPARATUS**

Fred B. Stencel, Asheville, N.C., assignor to Stencel Aero
Engineering Corporation, Arden, N.C., a corporation
of North Carolina

Filed Dec. 27, 1967, Ser. No. 693,790

U.S. Cl. 244-149

7 Claims

Int. Cl. B64d 17/04, 17/54, 17/72

ABSTRACT OF THE DISCLOSURE

In parachute apparatus including a plurality of canopies, a single power-operated spreading device is employed to spread all of the canopies simultaneously. A spreading device including an annular series of spreading projectiles is used, the series including groups of projectiles and the projectiles of each group being attached to a portion of the skirt of a different one of the canopies. For each canopy, that skirt portion to which the respective group of projectiles is attached is positively driven outwardly when the spreading device is actuated, the remainder of the skirt and the body of the canopy being spread as a result of the powered travel of the projectile-equipped skirt portion.

This invention relates to parachute apparatus and particularly to multic canopy parachute apparatus in which the canopies are spread ballistically.

Difficulties have heretofore been encountered when a plurality of canopies have been used in a single "cluster" parachute system because one or more of the several canopies tends to inflate more slowly, lagging the other canopy or canopies by an appreciable time, with the result that the overall drag force is distributed unequally, frequently to such an extent that canopy damage results.

It is accordingly a general object of the invention to devise a multiple canopy parachute apparatus characterized by simultaneous and essentially equal spreading and inflation of all of the canopies.

Another object is to achieve positive spreading and inflation of all of the canopies simultaneously when a plurality of canopies are employed in a single parachute apparatus, as when the canopies are used in a "cluster" to support a single load.

A further object is to provide, in parachute apparatus of the type described, an improved disposition of the canopy material, in the parachute pack, which assures better extraction of the canopies from the pack.

Yet another object is to devise a way to arrange the suspension lines, in a packed multiple canopy parachute apparatus, so as to assure positive and even extraction and spreading of the canopies.

Stated generally, the invention employs a single ballistic spreading device which is operatively arranged to accomplish simultaneous power spreading of two or more parachute canopies. The spreading device employs an annular series of spreading projectiles which are all projected radially outwardly from the device simultaneously by the action of a single power source, such as an explosive charge. A particular portion of the skirt of each canopy is initially arranged adjacent a different arcuate portion of the annular series of projectiles, and thus adjacent a particular group of the projectiles. The projectiles of each such group are all connected to the adjacent canopy skirt portion. Upon simultaneous projection of the projectiles, the particular skirt portions of the canopies are each positively driven outwardly by the group of projectiles connected thereto, each such skirt portion thus moving outwardly within its own field of travel which is defined by the initial disposition and

2

radial flight paths of the group of projectiles connected to that skirt portion. The remainder of each canopy skirt is spread progressively as a result of the positive travel of the projectile-attached skirt portion. As a result, all of the canopies attain a fully spread condition, and positions spaced outwardly from the spreading device, essentially simultaneously.

In order that the manner in which the foregoing and other objects are attained in accordance with the invention can be understood in detail, particularly advantageous embodiments thereof will be described with reference to the accompanying drawings, which form a part of this specification, and wherein:

FIGS. 1-1C are diagrams illustrating successive stages of operation of a parachute apparatus according to the invention;

FIG. 2 is an end elevational view of a spreading gun employed in the parachute apparatus of FIG. 1;

FIG. 3 is a longitudinal sectional view of the spreading gun of FIG. 2;

FIG. 4 is a semi-diagrammatic illustration of a manner in which the parachute canopies can be folded and connected to the spreading gun; and

FIG. 5 is a semi-diagrammatic view illustrating the manner in which the parachute apparatus can be packed.

Turning now to the drawings in detail, the embodiment of the invention illustrated is a three-canopy "cluster" parachute apparatus comprising identical conventional fabric parachute canopies 1, 2 and 3 and a single explosively operated spreading gun 4 shown in detail in FIGS. 2 and 3 and constructed generally in accordance with U.S. Patent 3,281,098, issued Oct. 25, 1966, to Fred B. Stencel et al. Each canopy 1-3 has the usual skirt which extends circularly when the canopy has been successfully spread and inflated. The three canopies are packed in a suitable container, as hereinafter described in detail, and are so arranged that at least a particular portion 5, FIG. 1C, of the skirt of each canopy is disposed adjacent the mouth of the container for the pack, each such skirt portion 5 being disposed in a different 120° portion of the space defined by the canopy container adjacent the mouth thereof.

Spreading gun 4 comprises a housing 6, FIGS. 2 and 3, including a hollow cylindrical body 7 and a transverse outwardly extending annular flat flange 8, the flange having a circular peripheral wall 9 concentric with body 7. Thirty spreading projectiles 10 are initially supported on flange 8, each projectile being of such generally U-shaped cross section as to be capable of slidably embracing flange 8, the base of the U of the projectile extending adjacent to the peripheral wall 9. The internal bore of body 7 accommodates a cylindrical explosive cartridge 11. Flange 8 is provided with thirty equally spaced, radially disposed cylindrical bores 12, and each such bore communicates with the interior of body 7 via a port 13.

Each bore 12 slidably accommodates a different one of thirty projectile-driving pistons 14. When the gun is assembled ready for use, each piston 14 projects beyond the periphery of flange 8 and has its tip engaged in a suitable recess in the base of the U of the corresponding one of projectiles 10. The projectiles are initially retained on flange 8 by an annular shear band 15 which can either be sheared away as a result of firing of the gun or slidably disengaged from the projectiles, as described in the aforesaid patent 3,281,098.

Explosive cartridge 11 and its associated firing line-operated actuator 16 can be constructed according to U.S. Patent No. 3,356,025, issued Dec. 5, 1967 to James W. Duncan. When the cartridge 11 is ignited, the resulting expanding combustion gases are delivered to all of the bores 12 essentially simultaneously via the respective ports 13.

3

Accordingly, all of the thirty pistons 14 are driven outwardly essentially simultaneously, each with essentially the same driving force. Since the outer tip of each piston 14 directly engages one of the projectiles 10, the projectiles are accelerated radially outwardly in conformance with movement of the pistons 14.

At its outer or leading end, each projectile 10 is notched and provided with a pin 17, FIG. 3, and a tape or like connecting element 18 has one of its ends looped about the pin 17. The other end of tape 18 is connected in any suitable fashion to the skirt portion 5 of one of canopies 1-3. Tapes 18 being short, the radial outward movement of projectiles 10 is substantially immediately imparted to the canopy skirt portions 5.

As seen in FIG. 1, ten of the thirty projectiles 10 are connected to the skirt portion 5 of canopy 1, the projectiles of a second group of ten are connected to the skirt portion 5 of canopy 2, and the remaining ten projectiles are connected to the skirt portion 5 of canopy 3. For each canopy, the group of ten projectiles occupies a particular 120° arcuate portion of the annular series of projectiles in the spreading gun, and the projectiles of that group constitute an uninterrupted portion of the annular series, that is, no projectile not connected to the respective canopy is present in the group. The ten projectiles connected to each canopy skirt portion 5 are evenly spaced along the arcuate extent of the skirt portion (considering the canopy as in its inflated condition). Though the projectiles 10 are close together in the assembled spreading gun, advantageously in side-to-side contact as seen in FIG. 2, each projectile is constrained to travel its own projection path, and that path is radial with respect to the longitudinal axis of the spreading gun. Accordingly, once the spreading gun has been fired, the thirty projectiles 10 define a circle of increasing diameter, which circle is centered on the spreading gun.

For each canopy, skirt portion 5 can extend for an arcuate distance which is less than half of the full circular extent of the skirt when the canopy is fully inflated. Thus, in FIGS. 1-1C, the arcuate extent of skirt portion 5 for each canopy is 120°. Alternatively as hereinafter described with reference to FIG. 4, the particular skirt portion 5 which is equipped with spreading projectiles can extend for a full 180° of the circular extent of the canopy skirt.

The action of each group of ten projectiles 10 is thus to drive the canopy skirt portion 5 to which the projectiles are attached by tapes 18 outwardly away from the spreading gun, the remainder of the skirt being progressively spread as a result of the powered travel of the projectile-equipped skirt portion 5. In usual applications, the spreading gun 4 is fired after canopies 1-3 have been extracted from the canopy bag or other container and attain a full stretch condition, extraction being accomplished by conventional aerodynamic, mechanical or ballistic means (not shown). With the canopy thus fully extracted, and with partial spreading resulting from the action of the projectiles, full spreading and inflation occurs aerodynamically. FIGS. 1 and 1A illustrate successive conditions of the three canopies at relatively early stages (typically 0.1 sec. and 0.81 sec. after firing, respectively) in the flight of the projectiles. FIG. 1B shows typical conditions and positions of canopies 1-3 at approximately 1.3 sec. after firing of the spreading gun. FIG. 1C illustrates the canopies in their final, fully spread and inflated condition, typically attained 1.8 sec. after firing of the spreading gun. While FIGS. 1-1B omit the suspension lines for simplicity of illustration, the suspension lines are illustrated diagrammatically at 19 in FIG. 1C as extending downwardly and inwardly to a single load 20 disposed generally centrally relative to the cluster of parachutes, the spreading gun and canopy container having fallen away.

FIGS. 4 and 5 illustrate semi-diagrammatically a particularly advantageous manner in which the three cano-

4

pies 1-3 can be folded and packed with the spreading gun 4. In the arrangement here illustrated, each canopy consists of twenty generally triangular gores connected edge-to-edge in conventional fashion, and twenty suspension lines each connected to the canopy along the seam between two of the gores. The spreading gun 4 of FIGS. 2 and 3, equipped with thirty of the projectiles 10, is used so that each of the three canopies can be equipped with ten of the projectiles, each of the ten projectiles being connected by its tape 18 to a different one of the suspension lines 19a at a point on the suspension line immediately adjacent the edge of the skirt. Accordingly, the skirt portion to which the projectiles are connected constitutes one-half of the full skirt, and is directly associated with one-half of the twenty suspension lines.

In packing each canopy, the canopy is first folded in pleated fashion, involving a fold 21 along the center of each gore and a fold 22 at each edge of each gore, as seen in FIG. 4. The material of the canopy half to which the projectiles 10 are not directly attached is similarly pleated, with the material of each gore of that half of the canopy being enclosed within the fold of a matching gore of the canopy half to which the projectiles 10 are directly connected. Thus, in FIG. 4, the solid lines 1a indicate the material of the canopy half to which the projectiles are directly connected, and the broken lines 1b indicate the material of the canopy half not equipped with projectiles.

The suspension lines 19a, connected to the projectile-equipped canopy half, are simply run from the skirt of the canopy past the outer end of the corresponding projectile 10, being connected thereto by the tape 18 for that projectile. The canopy half which is not equipped with projectiles is provided with suspension lines 19b. In order to maintain the two sets of suspension lines 19a and 19b separate, the lines 19b are run from the canopy skirt through cylindrical bores extending generally axially of the gun, each bore being defined by matching grooves 23, FIG. 2, of semicircular transverse cross section, in the side faces of the projectiles 10. When the projectiles are assembled in the gun, each cooperating pair of grooves 23 effectively retains one of the suspension lines 19b. After the gun has been fired, the radial travel of the projectiles causes the projectiles to be spaced apart, so that the suspension lines 19b are immediately freed and can pay out freely as the canopy is spread.

Pleating of the gores of the canopy allows each folded canopy to be spread out on a work surface as, in effect, a stack of pleats. So spread out, the stacks can be piled one on another in coextensive relation, providing a stack having the plan shape of the gores, the spreading gun 4 being located at the wider end of this stack, and the apices of the three canopies at the other. The stack of the three canopies is then folded transversely in Z-fashion, as illustrated in FIG. 5, and the thus-folded canopies inserted into a canopy bag 24, FIG. 5, with the apices of the canopies at the bottom of the bag and the skirt portions and the spreading gun at the top end of the bag, the latter end being openable in any conventional fashion preparatory to firing of the spreading gun.

What is claimed is:

1. In a multiple canopy parachute apparatus, the combination of
 - a ballistic spreading device comprising
 - a body means,
 - a plurality of projectiles supported by said body means in an annular series, and
 - power means carried by said body means and constructed and arranged to project said projectiles simultaneously radially outwardly from said body means;
 - a plurality of parachute canopies each including a skirt;
 - a plurality of groups of suspension lines, each group of said suspension lines being operatively attached to a different one of said canopies,

5

6

said spreading gun and said canopies being arranged in such fashion that a portion of the skirt of each canopy is adjacent a different arcuate portion of said annular series of projectiles; and a plurality of connecting elements each connecting a different one of said projectiles to that one of said canopy skirt portions which is adjacent such projectile,

the ones of said projectiles occupying each of said arcuate portions of said annular series all being connected to the same one of said canopy skirt portions and each group of said projectiles which occupies one of said arcuate portions of said annular series thus being operatively associated with a different one of said canopies, actuation of said power means to cause simultaneous projection of said projectiles resulting in said canopies being simultaneously and substantially equally spread, said canopy skirt portions being driven positively outwardly and the remainder of the skirt of each canopy being spread as a result of the positive travel of the corresponding one of said skirt portions.

2. A parachute apparatus according to claim 1, wherein said canopy skirt portions do not exceed one-half of the full circle of the canopy skirt, and said projectiles of each group are connected to points on the corresponding one of said canopy skirt portions which are spaced apart equally when the canopy is fully spread and inflated.

3. A parachute apparatus according to claim 1, wherein for each of said canopies, said suspension lines join the skirt of the canopy at points which are equally spaced along the canopy skirt, the portion of the canopy to which said projectiles are connected is folded into pleats with the folds for each pleat being along lines which extend from the skirt to the apex at two adjacent ones of said suspension lines and at a location therebetween, the remaining portion of the canopy is similarly folded into pleats, and the pleats of said remaining portion being respectively enclosed by the pleats of said canopy portion to which said projectiles are connected.

4. A parachute apparatus according to claim 3, wherein each of said projectiles is provided with a pair of laterally opening grooves, one of said grooves being on each side of the projectile, said grooves extending at least generally longitudinally of the gun when said projectiles are assembled on the gun, said projectiles being in side-to-side contact when assembled on the gun, said grooves being so dimensioned and arranged that, between each adjacent pair of projectiles, the corresponding two grooves cooperate to define a bore, the ones of said suspension lines which are joined to the portion of the canopy not equipped with projectiles each passing through one of said bores.

5. A parachute apparatus according to claim 1 and further comprising

a canopy container having a closed end and a second end via which canopies can be extracted, said plurality of canopies each being folded into an elongated flat shape with the skirt of the canopy at one end and the apex thereof at the other end, said folded canopies being arranged in a stack and the stack being accordion folded,

the accordion folded canopies being disposed in said canopy container with the apices of the canopies at said closed end and the skirts of the canopies at said second end.

6. In a parachute apparatus, the combination of a ballistic spreading device comprising

body means,

a plurality of projectiles supported on said body means side-by-side in an annular series transverse to the central axis of the spreading device, said projectiles having cooperating side portions defining a bore between each adjacent pair of projectiles, said bores extending generally axially of the spreading device, and

power means for projecting said projectiles simultaneously radially outwardly from said body means; and

a parachute comprising a canopy and a plurality of suspension lines operatively connected to said canopy, some of said suspension lines being connected each to a different one of said projectiles, others of said suspension lines extending each through a different one of said bores, radial projection of said projectiles, with attendant increasing space therebetween, resulting in freeing of said other suspension lines.

7. In a parachute apparatus, the combination of

a plurality of parachute canopies each including a skirt;

a plurality of groups of suspension lines, each of said groups of suspension lines being operatively attached to a different one of said canopies, said suspension lines all being connectable to a load to be suspended from said canopies when said canopies are inflated; and

ballistic spreading means connected only to a portion of the skirt of each of said canopies and operative to drive said skirt portions simultaneously outwardly from a common central point to effect substantially uniform and simultaneous spreading of said canopies.

References Cited

UNITED STATES PATENTS

3,281,098	10/1966	Stencel et al.	244—149
3,315,921	4/1967	Riley et al.	244—152

MILTON BUCHLER, *Primary Examiner*.

R. A. DORNON, *Assistant Examiner*.