

1 A BALLONET SYSTEM FOR A LIGHTER-THAN-AIR VEHICLE ✓

2

3 BACKGROUND OF THE INVENTION

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5 Field of the Invention

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7 The invention relates to the field of lighter-than-air vehicles and, in
8 particular, to an improved ballonets and a system for pressurizing same.

9

10 Description of Related Art

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12 There are three general types of non-rigid vehicles: those comprising a
13 single gas filled bag; several gasbags joined together in series; and, of course,
14 those having a multiple number of gasbags within a non-rigid envelope.

15 One of the major problems with non-rigid lighter-than-air vehicles is keeping the
16 bag from bursting as the ambient pressure decreases with altitude or from
17 collapsing when descending from altitude. The main method of preventing such
18 events is to incorporate ballonets in the vehicle, which are inflatable gasbags
19 within the Helium bag. The vehicle is designed to fly with partially inflated
20 ballonets that can be inflated with air, causing the Helium volume to contract or,
21 deflated, causing the Helium volume to expand. Thus, at altitude, the ballonets
22 may be almost collapsed, providing the necessary "room" for the Helium to
23 expand as ambient air pressure has decreased. As the vehicle descends into
24 denser atmosphere, the ballonets are inflated to insure that the Helium gasbag
25 does not collapse or even locally sag. Additionally, ballonets can play a roll in
26 altitude control. An example of ballonets installed on a lighter-than-air vehicle
27 can be found in U.S. Patent No. 5,143,322, "Ground Handling, Altitude Control
28 And Longitudinal Stability Of Airships" by E. W. Mason.

29

30 Prior art methods of pressurizing and filling the ballonets typically involved
31 the use of ram air scoops. Examples of this type system can be found in U.S.

1 Patent Nos. 1,475,210, "Airship" by R. H. Upson and 2,331,404, "Airship" by H.
2 R. Liebert. In the Liebert design, the ram air scoops are located behind the
3 propellers and thus less dependent upon the speed of the airship. However, if
4 the ship were at very low speeds filling, of course, would be proportionally
5 slower. This would be true even with the Liebert design, because the speed of
6 the airship is proportional to the rotational speed of the propeller.

7
8 In U.S. Patent Nos. 1,580,004, "Airship" by A. Bradford and 1,797,502,
9 "Airship" by C. S. Hall separate pumps are used for pressurizing the ballonets.
10 Additionally, the Hall design provide heaters to heat the pressurized air. Since
11 the ballonet is located in the middle of the main Helium filled gasbag, heating of
12 the Helium could also be accomplished. The problem with these designs is that
13 the ballonets are located centrally and fill valves and lines are, necessarily, co-
14 located. Thus they are difficult to reach for maintenance and repair or removal.
15 Additionally, the need for such fill valves and lines add weight.

16
17 Thus, it is a primary object of the invention to provide a ballonet system
18 for a lighter-than-air vehicle.

19
20 It is another primary object of the invention to provide a ballonet system
21 for a lighter-than-air-vehicle that is independent from other systems of the
22 vehicle.

23
24 It is a further object of the invention to provide a ballonet system for a
25 lighter-than-air vehicle that allows the volume of air in each ballonet to be
26 individually varied.

27
28 A still further object of the invention is to provide a ballonet system for a
29 lighter-than-air vehicle that provides rapid filling and venting of the individual
30 ballonets.

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1 SUMMARY OF THE INVENTION

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3 The invention is a ballonnet system for a lighter-than-air-vehicle, the vehicle
4 having a lift producing gasbag and a longitudinal, vertical and lateral axis. In
5 detail, the ballonnet system includes a plurality of ballonnets located within the
6 gasbag positioned along the longitudinal axis and on each side of the vertical
7 axis of the vehicle in equal numbers. Each of the ballonnets is made up of a
8 flexible sheet joined at the periphery thereof to a portion of the wall of the
9 gasbag.

10

11 A ballonnet pressurization system is coupled to each ballonnet for
12 pressurizing the ballonnet with air that includes the portion of the wall of the
13 gasbag forming the ballonnet having a plurality of holes therethrough. A manifold
14 having at least one inlet port is joined to the wall covering the holes therein and
15 adapted to diffuse the pressurized air entering therein. The manifold is,
16 preferably, structurally ridged with the inlet port thereof made of a flexible
17 material. At least one fan having an inlet port is coupled to ambient atmosphere
18 and an outlet port coupled to the at least one inlet port of the manifold and
19 provides pressurized air to the interior thereof. If the vehicle is of the type that
20 includes a gondola suspended under the gasbag, the fan is, preferably, mounted
21 thereon, with the relative movement between the manifold and the fan absorbed
22 by the flexible inlet.

23

24 A check valve is located in the outlet port of the fan for preventing air
25 from flowing from the interior of the manifold out of the inlet port of the fan. A
26 ballonnet venting system, preferably in the form of one or butterfly valves is
27 mounted on the manifold for venting the interior of the ballonnet to ambient
28 atmosphere. Finally, the ballonnet system includes a means to drain the ballonnet
29 of liquids contained therein, which takes the form of a drain tube coupled to the
30 bottom of the ballonnet with a valve mounted in the drain tube and pump means
31 to drain the ballonnet.

1 The novel features which are believed to be characteristic of the invention,
2 both as to its organization and method of operation, together with further objects
3 and advantages thereof, will be better understood from the following description
4 in connection with the accompanying drawings in which the presently preferred
5 embodiment of the invention is illustrated by way of example. It is to be
6 expressly understood, however, that the drawings are for purposes of illustration
7 and description only and are not intended as a definition of the limits of the
8 invention.

9 10 **BRIEF DESCRIPTION OF THE DRAWINGS**

11
12 Figure 1 is a side view of the lighter-than-air vehicle incorporating the
13 subject ballonnet system.

14
15 Figure 2 is a bottom view of the vehicle illustrated in Figure 1

16
17 Figure 3 is a partial cross-sectional view of the vehicle shown in Figure 1
18 taken along the line 3-3.

19
20 Figure 4 is an enlarged view of a portion of Figure 3, particularly
21 illustrating the pressurization system for the ballonnet system.

22
23 Figure 5 is a partial cross-section view of Figure 4 particularly illustrating
24 the holes in the wall of the gasbag for pressurizing and de-pressurizing an
25 individual ballonnet.

26 27 **DESCRIPTION OF THE PREFERRED EMBODIMENT**

28
29 Referring to Figure 1 through 3, a lighter-than-air vehicle, generally
30 referred to by numeral 10 is illustrated that includes a gasbag 12 and gondola
31 (cargo compartment) 14 suspended therebelow by a cable suspension system

1 15. The gondola 14 includes a flight station 16 and a plurality of propulsion
2 systems 17 mounted thereon. The gasbag includes a longitudinal axis 18,
3 vertical axis 19 and lateral axis 20. The vehicle 10, as shown, is a non-ridged
4 design; however, the subject invention could be used on ridged designs as well.
5 Thus the vehicle depicted is for purposes of illustration only. Disposed within the
6 gasbag 12, from the nose 22 to tail 24, are a plurality of ballonets located on
7 either side of the longitudinal axis 16 in equal numbers and indicated by
8 numerals 30A and B, 32A and B, 34A and B, 36A and B, and 38A and B. Each
9 ballonet is formed from a flexible sheet 40 joined at its periphery 43 to a portion
10 of the wall 44 of the gasbag 12, thus making the wall part of each ballonet.
11 Referring particularly to Figure 3 it can be seen that the ballonet 34A is illustrated
12 in various stages of inflation. Note that such a placement of ballonets eliminates
13 interference with the cargo compartment suspension system 15.

14
15 Still referring to Figures 1-3 and additionally to Figures 4 and 5, each
16 ballonet includes a ballonet pressurization system 45. The pressurization system
17 45, for example, for the ballonet 34A, includes a plurality of fans 46 mounted by
18 stands 48 to the cargo compartment 14. The inlet port 50 is coupled to ambient
19 atmosphere and the outlet port 51 incorporates a one way check valve 52. A
20 plurality of holes 54 are provided in the wall 44 that are in communication with
21 the interior of the ballonet 34A. A manifold 60 having a structurally ridged
22 diffuser portion 62 is coupled to the wall 44 covering the holes 54. The manifold
23 60 includes a plurality of flexible inlet ducts 64 that couple to the outlet ports 51
24 of the fans 46. Butterfly valves 70 are mounted in the diffuser portion 62 that are
25 opened for de-pressurizing the ballonet 34A. A porous screen 72 extends from
26 the manifold 60 to the cargo compartment 14 that, while providing a cover,
27 allows for the free flow of air into the fans 46.

28
29 The ballonets at the nose 22 (ballonets 34A and 34B) and at the tail
30 (ballonets 38A and 38B) are larger than the interior ballonets. Thus a larger
31 number of fans are required. Note that, on the vehicle illustrated, more than one

1 fan is required for each ballonnet; however, on smaller vehicles one fan may be
2 sufficient as well as only one butterfly valve for venting. Furthermore, a single
3 manifold was illustrated coupled to a plurality of fans. However, a series of
4 manifolds, each coupled to a signal fan could be used, but the former approach
5 is preferred.

6
7 Because water is likely to collect in the ballonets, a drain system is
8 provided. As illustrated in Figure 4, such a capability is provided by a line 80
9 located at the bottom of the ballonnet. A valve 83, in conjunction with a pump 84,
10 provide such a system.

11
12 The advantages of the subject ballonnet system are numerous. First of all,
13 by providing holes in the wall of the gasbag in conjunction with a manifold, large
14 internal ducting coupling the fans to individual ballonets is eliminated saving
15 weight and cost. Also illustrated are large inlet ducts that would be required if the
16 fans were located within the cargo compartment. Additionally, it allows the
17 pressurization fans and vent valves to be positioned in very accessible locations
18 allowing rapid repair or replacement.

19
20 While the invention has been described with reference to a particular
21 embodiment, it should be understood that the embodiment is merely illustrative
22 as there are numerous variations and modifications which may be made by
23 those skilled in the art. Thus, the invention is to be construed as being limited
24 only by the spirit and scope of the appended claims.

25 26 **INDUSTRIAL APPLICABILITY**

27 The invention has applicability to the aircraft industry and, in particular, to
28 those industries manufacturing lighter-than-air vehicles.



CLAIMS

- 1 1. A ballonnet system for a lighter-than-air-vehicle, the vehicle having a lift
2 producing gasbag having a longitudinal, vertical and lateral axis, the ballonnet
3 system comprising:
 - 4 a plurality of ballonnets located within the gasbag positioned along the
5 longitudinal axis and on each side of the vertical axis in equal numbers, each of
6 said ballonnets comprising a flexible sheet joined at its periphery thereof to a
7 portion of the wall of the gasbag;
 - 8 a ballonnet pressurization system coupled to each ballonnet for pressurizing
9 said ballonnets with air, said pressurization system comprising;
 - 10 said portion of the wall of the gasbag forming said ballonnet having
11 a plurality of holes therethrough;
 - 12 a manifold having an inlet port, said manifold joined to said wall
13 covering said holes therein and adapted to diffuse the pressurized air entering
14 therein;
 - 15 at least one fan having an inlet port coupled to ambient
16 atmosphere and an outlet port coupled to said inlet port of said manifold
17 for providing pressurized air to the interior thereof; and
 - 18 a check valve located in said outlet port of said fan for preventing
19 air from flowing from said interior of said manifold out said inlet port of said
20 fan; and
 - 21 a ballonnet venting system for venting the interior of said ballonnet to
22 ambient atmosphere.



1 2. The ballonnet system as set forth in Claim 1 wherein the vehicle includes a
2 cargo compartment suspended underneath the gasbag, said ballonnet system
3 further comprising:

4 said manifold is structurally ridged with said inlet port thereof made of a
5 flexible material;

6 said fan mounted on said cargo compartment and said outlet of said fan
7 coupled to said flexible inlet port of said manifold;

8 such that relative movement between said manifold and said fan is
9 absorbed by said flexible inlet.

1 3. The ballonnet system as set forth in Claim 2 wherein said venting system is
2 located in said manifold.

1 4. The ballonnet system as set forth in Claim 3 wherein said venting system
2 comprises a butterfly valve.

1 5. The ballonnet system as set forth in Claim 4 further comprising means to
2 drain said ballonnet of liquids contained therein.

1 6. The ballonnet system as set forth in Claim 5 wherein said means to drain
2 said ballonnet of liquids contained therein comprises:

3 a drain tube coupled to the bottom of the ballonnet;

4 a valve mounted in said drain tube; and

5 pump means to drain said ballonnet.