

1     **A CARGO COMPARTMENT FOR A LIGHTER-THAN-AIR VEHICLE**

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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  
8 vehicles and, in particular, to cargo compartments for such  
9 vehicles.

10

11    **Description of Related Art**

12

13            Lighter-than-air vehicles have either non-rigid or  
14 rigid gasbags. There are three general types of non-rigid  
15 vehicles: those comprising a single gas filled bag; several  
16 gasbags joined together in series; and, of course, those  
17 having a multiple number gasbags within a non-rigid  
18 envelope. Rigid airships have an internal structure  
19 defining the shape of the vehicle containing a plurality of  
20 gasbags with an aerodynamic cover there over. One of the  
21 problems with both rigid and non-rigid lighter-than-air  
22 vehicles is their limited ability to station keep and/or  
23 maneuver when docking, especially if there are any  
24 significant cross-winds. This is primarily due to their  
25 large cross-sectional area, which causes the vehicle to  
26 "weather vane" and "wave" with the wind. They are  
27 particularly difficult to control if the wind is gusting or  
28 when there are significant up or down drafts. In fact,  
29 docking has proven to be the most difficult portion of a  
30 flight for a lighter-than-air-vehicle. Thus the most  
31 common docking procedure is moor the vehicle by its nose and  
32 let it weather vane.

33

34            In non-rigid designs the cargo flight station and cargo  
35 compartments are suspended from the bottom of the vehicle in  
36 what is most often referred to as a gondola. In rigid  
37 designs, it is also common practice to mount the flight

1 station/passenger and cargo compartments under the gasbag.  
2 Unlike a conventional aircraft, the lift forces developed by  
3 the gasbag remains when docked. Thus as cargo is unloaded,  
4 the net lift force increases. In the past, this increase in  
5 net lift has been absorbed by docking restraints, for  
6 example mooring lines. If the cargo weight is very large,  
7 the force exerted on the mooring lines also becomes large  
8 and "station keeping" when docked becomes even more  
9 difficult. Therefore, unloading and reloading of cargo  
10 sometimes must wait until any winds have sufficiently died  
11 down or additional mooring lines must be used to "lock" the  
12 vehicle in one position. It is therefore obvious that it is  
13 always important to minimize the time spent in such  
14 operations.

15  
16 Thus conventional loading of cargo containers and the  
17 like through doors located on the side of the vehicle is too  
18 slow and it would be difficult to simultaneously load and  
19 unload cargo in order to maintain the gross weight of the  
20 vehicle constant. Cargo aircraft, such as the C-5 military  
21 transport, have front and rear opening doors to the cargo  
22 compartment. However, moving the cargo simultaneously in the  
23 front and out the rear of a large lighter-than-air vehicle  
24 would still be a difficult and time consuming operation,  
25 especially if the cargo compartment is some 600 to 800 feet  
26 long. In addition, requiring an uninterrupted passageway  
27 over such a length would greatly complicate the design of  
28 the gondola. The use of individual cargo compartments  
29 located along either side of the vehicle can reduce the  
30 cargo loading and unloading time, but does not address the  
31 need to maintain a constant payload weight on the vehicle.  
32 In U.S. Patent No. 5,143,323, "Airship Handling System" by  
33 F. Husain, et al. a vehicle is disclosed having a  
34 cargo/passenger module that is secured in a recess in the  
35 gondola. However, properly securing such a module to the  
36 gondola is believed to complicate the design of the gondola.  
37 In addition, the cargo module would have to be flight

1 certified increasing its cost. In fact, no prior art cargo  
2 compartment design has addressed the need to maintain a  
3 constant payload weight during loading and unloading of  
4 cargo and/or to provide a cargo loading system that  
5 minimizes the docking time for unloading and loading cargo.  
6

7  
8 Therefore, it is a primary object of the invention to  
9 provide a cargo compartment for a lighter-than-air vehicle  
10 that allows a constant neutral buoyancy to be maintained on  
11 the vehicle during loading and unloading thereof.  
12

13 It is another primary object of the invention to  
14 provide a cargo compartment for a lighter-than-air vehicle  
15 that provides for simultaneous loading and unloading of  
16 cargo while maintaining a constant neutral buoyancy on the  
17 vehicle.  
18

19 It is a further object of the invention to provide a  
20 cargo compartment for a lighter-than-air vehicle wherein  
21 the cargo can be loaded and unloaded using individual cargo  
22 containers.  
23

#### 24 SUMMARY OF THE INVENTION

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26 The invention is a cargo compartment for a lighter-  
27 than-air vehicle, the vehicle having a longitudinal,  
28 vertical and lateral axis. The cargo compartment includes  
29 a cargo carrying structure mounted to the bottom of the  
30 vehicle and which extends along at least a portion of the  
31 longitudinal axis thereof. The cargo compartment has a  
32 plurality of passageways extending along the longitudinal  
33 axis of the vehicle. Each of the passageways is aligned  
34 with the lateral axis of the vehicle and extends completely  
35 through the cargo compartment, and is adapted to receive at  
36 least one cargo container.  
37

1       A cargo container moving system is mounted in the floor  
2 of each passageway for moving the at least one cargo  
3 container in one end and out the opposite end of the  
4 passageway and to intermediate positions therebetween. The  
5 container moving system includes a plurality of powered  
6 rollers mounted in the floor of each of the passageways. In  
7 addition, the cargo container moving system further includes  
8 a plurality of non-powered (passive) rollers mounted in the  
9 floor of each of the passageways for movably supporting the  
10 at least one cargo container therein.

11

12       A cargo container securing system is provided for  
13 releasable securing the at least one cargo container within  
14 the passageway. The cargo container is provided with a  
15 flange along the bottom of the front and rear ends thereof.  
16 The cargo securing system further includes a pair of guide  
17 rails mounted in a spaced relationship on the floor of the  
18 passageway. Thus as the cargo containers are moved into and  
19 out of the passageway and to intermediate positions  
20 therebetween, the rails engage the flanges on the cargo  
21 containers and restrain them from movement along the  
22 longitudinal axis of the vehicle. The cargo container  
23 securing system further includes a locking system to  
24 releasable secure the cargo containers in the intermediate  
25 positions along the floor of the passageway preventing  
26 movement along the vertical and lateral axis. Although the  
27 above described cargo moving and securing systems are  
28 preferred, other systems are useable. For example cargo  
29 pallets restrained by cargo nets tied down to the passageway  
30 floor in combination or air cushion systems for movably  
31 supporting the pallets instead of a passive roller system.

32

33

34       The novel features which are believed to be char-  
35 acteristic of the invention, both as to its organization and  
36 method of operation, together with further objects and  
37 advantages thereof, will be better understood from the

1 following description in connection with the accompanying  
2 drawings in which the presently preferred embodiment of the  
3 invention is illustrated by way of example. It is to be  
4 expressly understood, however, that the drawings are for  
5 purposes of illustration and description only and are not  
6 intended as a definition of the limits of the invention.

7

#### 8 **BRIEF DESCRIPTION OF THE DRAWINGS**

9

10 Figure 1 is a perspective view of a lighter-than-air  
11 vehicle, incorporating the subject cargo compartment, shown  
12 in the docked position.

13

14 Figure 2 is partial perspective view partially broken  
15 away of the vehicle shown in Figure 1 providing an interior  
16 view of the subject cargo compartment.

17

18 Figure 3 is partial cross-sectional view of the vehicle  
19 shown in Figure 1 taken along the line 3-3, providing a side  
20 view of the subject cargo compartment.

21

22 Figure 4 is a view similar to Figure 3 illustrating the  
23 loading and unloading of cargo containers.

24

25 Figure 5 is an enlarged perspective view of a cargo  
26 container tie down device used to secure cargo containers  
27 with the cargo compartment.

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#### 30 **DESCRIPTION OF THE PREFERRED EMBODIMENT**

31

32 Illustrated in Figure 1 is a lighter-than-air vehicle  
33 incorporating the subject cargo compartment. The vehicle,  
34 designated by numeral 10, is a non-rigid design having a  
35 longitudinal axis 12, vertical axis 14, and lateral axis 16  
36 and includes a helium bag 18 with a gondola 20, mounted at  
37 the bottom. The vehicle 10 is shown in a docked position

1 tethered by its nose 22 to a tower 24. Thus it is free to  
2 weather vane in the wind. The gondola 20 includes a flight  
3 station 26, and cargo compartment 28 upon which are mounted  
4 propulsion systems 30. Whereas a gondola type cargo  
5 compartment (suspended cargo compartment) is necessary on a  
6 non-rigid vehicle, it is certainly not required on a rigid  
7 design. Thus a gondola style cargo compartment is also for  
8 purposes of illustration only. A movable platform 32  
9 mounted on a plurality of circularly configured rails 33 is  
10 positioned under the vehicle 10 and is movable in a circle  
11 about the tower 24. A plurality of cargo containers 34,  
12 mounted on a portable loading cart 36, are positioned to be  
13 loaded into the cargo compartment 28. Thus the platform 32,  
14 with cargo containers 34 thereon, can rotate under power  
15 with the vehicle 10, if it "weather vanes".  
16

17 Still referring to Figure 1 and additionally to Figures  
18 2 through 5, it can be seen that the cargo compartment 28  
19 includes a plurality of passageways 40A-F extending along  
20 the longitudinal axis 12. The passageway 40A-F are aligned  
21 with the lateral axis 16 and extend completely through the  
22 cargo compartment with first and second ends 42 and 44,  
23 respectively, having fold up doors 45 attached thereto. The  
24 passageways are configured to receive and hold one or more  
25 of the cargo containers 34. Because all the passageways  
26 40A-F are basically identical the following remarks shall be  
27 directed at just one, 40A. The floor 46 of the passageway  
28 40A contains a plurality of roller assemblies 50 that allow  
29 the cargo containers 34 to be "rolled" on to the floor 46  
30 and, in fact, in end 42 when loading and out end 44 when  
31 unloading. Although the cargo containers 34 can be pushed  
32 or pulled by hand, a plurality of powered roller assemblies  
33 52 are provided in the floor 46 to assist in the movement of  
34 the cargo containers 34 in and out of the passageway 40A and  
35 intermediate positions therebetween. A suitable powered  
36 roller assembly is manufactured by Lucus Western,  
37 Incorporated, Electric Systems Division, Brea, California.

1           Referring to Figure 5, to lock the cargo container 34  
2 within the passageway 46A, the container is provided with  
3 flanges 60 on the ends thereof. These flanges 60 are  
4 adapted to slidably engage guide rails 62 mounted on the  
5 floor 46. Thus once the flanges 60 engage the rails 62, the  
6 cargo container is restrained from moving along the  
7 longitudinal axis 14 of the vehicle (forwards and  
8 backwards). Additionally, retractable cargo restraints 66  
9 are provided to restrain the containers 34 movement along  
10 the vertical and lateral axis, 14 and 16, respectively  
11 (upwards, downwards and from side to side). A suitable  
12 cargo restraints 66 can be obtained from Ancra, Corporation,  
13 El Segundo, California. a combination passive roller tray  
14 and cargo restraint is manufactured by Pemco Engineering,  
15 Stanton, California. Referring particularly to Figure 5 it  
16 can be seen that the cargo restraint 66 includes two  
17 restraining "hooks" 68 that engage the flanges 60 on two  
18 adjacent cargo containers 34. Note again that this  
19 particular restraint is only illustrative and there are  
20 numerous other types that may be used in this application.

21  
22           Referring back to figures 1-4, in operation, the  
23 vehicle 10 is first docked with the nose 22 moored to the  
24 tower 24 and positioned over the platform 32. The vehicle  
25 10 is secured to the platform 32 by mooring lines (not  
26 shown). Cargo containers 34A-D are positioned on a cart 36  
27 in proximity to the end 42 of the passageway. The cart 36  
28 includes cargo moving systems similar to those found in the  
29 passageways 40. An empty cart 72 is shown positioned on the  
30 opposite end 44 of the passageway 40. With the doors 45  
31 opened, the cargo containers 34A-D are moved off the cart 36  
32 into the passageway 40, while cargo containers 34E-H are  
33 simultaneously removed from the passageway onto cart 72.  
34 Note that, while only one cart 36 is shown, it is envisioned  
35 that all the passageways 40A-F would be simultaneously  
36 unloaded and loaded. Thus a constant payload weight is  
37 always maintained, balancing the lift forces generated by

1 the airbag 18. Of course, the individual weight of the  
2 loaded cargo containers must be known so that they can be  
3 matched with the container being unloaded. In addition,  
4 the normal center of gravity shifts must be considered, as  
5 in the case of conventional aircraft. If the total weight  
6 of the new cargo is dramatically different from that being  
7 off loaded, then containers loaded with ballast (not shown)  
8 may have to be used. Such a case would occur if the cargo  
9 being unloaded were automobiles and cut flowers were being  
10 loaded.

11  
12 While the invention has been described with reference  
13 to a particular embodiment, it should be understood that the  
14 embodiment is merely illustrative as there are numerous  
15 variations and modifications which may be made by those  
16 skilled in the art. Thus, the invention is to be construed  
17 as being limited only by the spirit and scope of the  
18 appended claims.

19  
20 **INDUSTRIAL APPLICABILITY**

21  
22 The invention has applicability to the aircraft  
23 industry and, in particular to manufactures of lighter-than-  
24 air vehicles.



## Claims

- 1        1.        A cargo compartment for a lighter-than-air vehicle, the vehicle having a  
2        longitudinal, vertical and lateral axis, the cargo compartment comprising:  
3                a cargo carrying structure mounted to the bottom of the vehicle, said  
4        structure extending along at least a portion of the longitudinal axis of the vehicle  
5        and having a plurality of open ended passageways, each having a floor, and  
6        extending along the longitudinal axis of the vehicle, each of said passageways  
7        aligned with the lateral axis of the vehicle and extending completely through said  
8        structure, said passageways adapted to simultaneously off load cargo from one  
9        end of said passageway and to on load cargo from the opposite end;  
10              first means mounted in each passageway for moving the cargo in one end  
11        and out the opposite end of said passageway and intermediate positions  
12        therebetween; and  
13              second means for releasably securing the cargo within said passageway.
- 14        2.        The cargo compartment as set forth in claim 1 wherein the cargo is  
15        mounted within at least one cargo container, said compartment further  
16        comprising:  
17              -        said first means adapted to move said at least one cargo container in one  
18        end and out the opposite end of said passageway and intermediate positions  
19        therebetween; and  
20              said second means adapted to releasably secure the cargo container within  
21        said passageway.
- 22        3.        The cargo compartment as set forth in claim 2 wherein said first means is  
23        mounted on said floor of each passageway.



1       4.     The cargo compartment as set forth in claim 3 wherein said second means  
2       is mounted on said floor of each passageway.

3       5.     The cargo compartment as set forth in claim 4 wherein said first means  
4       includes a plurality of powered rollers mounted in said floor of each of said  
5       passageways for moving the at least one cargo container in one end and out the  
6       other end of said passageway and intermediate positions therebetween.

7       6.     The cargo compartment as set forth in claim 5 wherein said first means  
8       further comprises a plurality of non-powered rollers mounted in said floor of each  
9       of said passageways for movably supporting the at least one cargo container.

10      7.     The cargo compartment as set forth in claim 2, or 3, or 4, or 5, or 6  
11      further comprising said second means including a pair of guide rails mounted in a  
12      spaced relationship on said floor of said passageway, such that at least one cargo  
13      container is moved into and out of said passageway and to said intermediate  
14      positions therein, said rails engage said at least one cargo container and restrain it  
15      from movement along the longitudinal axis of the vehicle.

16      8.     The cargo compartment as set forth in claim 7 further comprising said  
17      second means including locking means to releasably secure at least one cargo  
18      container in said intermediate positions along said floor of said passageway from  
19      movement along the vertical and lateral axis of the vehicle.

20      9.     The cargo compartment as set forth in claim 8 further comprising doors  
21      mounted on each end of said passageways for sealing of the interior thereof.

22      10.    A cargo compartment for a lighter-than-air vehicle, the vehicle having a  
23      longitudinal, vertical and lateral axis, the cargo compartment comprising:

24           a cargo carrying structure mounted to the bottom of the vehicle, said



1 structure extending along at least a portion of the longitudinal axis of the vehicle  
2 and having a plurality of open ended passageways, each having a floor, and  
3 extending along the longitudinal axis of the vehicle, each of said passageways  
4 aligned with the lateral axis of the vehicle and extending completely through said  
5 structure, said passageways adapted to simultaneously off load cargo from one  
6 end of said passageway and to on load cargo from the opposite end.

7 11. The cargo compartment as set forth in claim 10 comprising first means  
8 mounted in each passageway for moving the cargo in one end and out the  
9 opposite end of said passageway and intermediate positions therebetween.

10 12. The cargo compartment as set forth in claim 11 comprising second means  
11 for releasably securing the cargo within said passageway.

12 13. The cargo compartment as set forth in claim 12 wherein the cargo is  
13 mounted within at least one container, said compartment further comprising:

14 said first means adapted to move the at least one cargo container in one  
15 end and out the opposite end of said passageway and intermediate positions  
16 therebetween; and

17 said second means adapted to releasable secure the at least one cargo  
18 container within said passageway.

19 14. The cargo system as set forth in claim 13 wherein said first means is  
20 mounted on the floor of each passageway.

21 15. The cargo compartment as set forth in claim 14 wherein said second  
22 means is mounted on the floor of each passageway.

23 16. The cargo compartment as set forth in claim 15 wherein said first means  
24 includes a plurality of powered rollers mounted in said floor of each of said



1 passageways for moving the at least one cargo container in one end and out the  
2 other end of said passageway and intermediate positions therebetween.

3 17. The cargo compartment as set forth in claim 16 wherein said first means  
4 further comprises a plurality of non-powered rollers mounted in said floor of each  
5 of said passageways for movably supporting the at least one cargo container.

6 18. The cargo compartment as set forth in claim 13, or 14, or 15, or 16, or  
7 17 further comprising said second means including a pair of guide rails mounted  
8 in a spaced relationship on said floor of said passageway, such that, as the at  
9 least one cargo container is moved into and out of said passageway and to said  
10 intermediate positions therein, said rails engage the at least one cargo container  
11 and restrain it from movement along the longitudinal axis of the vehicle.

12 19. The cargo compartment as set forth in claim 18 further comprising said  
13 second means including locking means to releasably secure the at least one cargo  
14 container in said intermediate positions along said floor of said passageway from  
15 movement along the vertical and lateral axis of the vehicle.

16 20. The cargo compartment as set forth in claim 19 further comprising doors  
17 mounted on each end of said passageways for sealing of the interior thereof.