A damping mechanism that includes a housing having fluid disposed therein and an inner circumferential surface, an axle shaft that is rotatable with respect to the housing, and a first vane having a distal end and being pivotally associated with the axle shaft. When the axle shaft rotates in a first direction, the first vane pivots to a deployed position, and when the axle shaft rotates in a second direction, the first vane pivots to a stowed position. A first clearance is defined between the distal end of the first vane and the inner circumferential surface of the housing when the first vane is in the deployed position, and a second clearance is defined between the distal end of the first vane and the inner circumferential surface of the housing when the first vane is in the stowed position. The second clearance is greater than the first clearance.
ROTARY DAMPING MECHANISM WITH PIVOTAL VANES

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Provisional Application No. 61/598,846, filed Feb. 14, 2012, which is herein incorporated by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates generally to rotary damping mechanisms, and, more particularly, to a rotary damping mechanism with pivotal vanes.

BACKGROUND OF THE INVENTION

[0003] Conventional damping mechanisms provide resistance in the opening direction for a controlled descent of a pivoting overhead stowage bin bucket when loaded with luggage. However, prior art damping mechanisms in commercial aircraft overhead stowage bins are often bulky and take up a large amount of space. Furthermore, prior art damping mechanisms typically have an angular working range that is less than 360°.

SUMMARY OF THE PREFERRED EMBODIMENTS

[0004] In accordance with a first aspect of the present invention there is provided a damping mechanism that includes a housing having a volume of fluid disposed therein and an inner circumferential surface, an axle shaft that is rotatable with respect to the housing, and at least a first vane having a distal end and being pivotally associated with the axle shaft and positioned within the volume of fluid. When the axle shaft and first vane rotate in a first direction, the first vane pivots to a deployed position, and when the axle shaft and first vane rotate in a second direction, the first vane pivots to a stowed position. A first clearance is defined between the distal end of the first vane and the inner circumferential surface of the housing when the first vane is in the deployed position, and a second clearance is defined between the distal end of the first vane and the inner circumferential surface of the housing when the first vane is in the stowed position. The second clearance is greater than the first clearance. In a preferred embodiment, the housing has an opening defined therein through which the axle shaft extends and the axle shaft includes a hub member mounted thereon to which the first vane is pivotally mounted. Preferably, the first vane includes opposing concave and convex surfaces such that when the hub member rotates in the first direction, the concave surface of the first vane leads and the convex surface trails, and when the hub member rotates in the second direction, the convex surface of the first vane leads and the concave surface trails. In a preferred embodiment, the damping mechanism includes a second vane positioned approximately 180° apart from the first vane on the hub member. Preferably, the damping mechanism includes a flange extending radially outwardly from the housing. The flange includes at least one attachment opening defined therein. Preferably, the first vane includes a stop member that prevents the first vane from pivoting beyond the deployed position.

[0005] In accordance with another aspect of the present invention there is provided a damping mechanism that includes a housing, an axle shaft that extends through an axial opening in the housing, a hub member mounted on the axle shaft, and first and second vanes pivotally mounted to the hub member approximately 180° apart and extending radially outwardly therefrom. The housing defines a housing interior that includes a volume of fluid disposed therein and includes an inner circumferential surface. The first and second vanes each include a distal end and are positioned in the housing interior and within the volume of fluid. When the axle shaft rotates in a first direction, the first and second vanes pivot to a deployed position. When the axle shaft rotates in a second direction, the first and second vanes pivot to a stowed position. The distance in a radial direction between the distal ends of the first and second vanes and the inner circumferential surface of the housing is greater when the first and second vanes are in the stowed position than when the first and second vanes are in the deployed position.

[0006] In accordance with yet another aspect of the present invention there is provided a method that includes obtaining a damping mechanism that includes a housing that defines a housing interior that includes an inner circumferential surface and a volume of fluid disposed therein, rotating an axle shaft in a first direction such that a first vane that is positioned within the volume of fluid and has a distal end pivots to a deployed position and a first clearance is defined between the distal end and the inner circumferential surface of the housing, rotating the axle shaft in a second direction such that the first vane pivots to a stowed position and a second clearance is defined between the distal end and the inner circumferential surface of the housing. The second clearance is greater than the first clearance. In a preferred embodiment, the housing is affixed to a first object and the axle shaft is affixed to a second object. The first and second objects are pivotal with respect to one another. Preferably, the first object is stationary and the second object pivots with respect to the first object.

[0007] In accordance with another aspect of the present invention, there is provided an overhead stowage bin that includes an upper portion and a bucket that cooperate to define a bin interior, and at least one damping mechanism. The axle shaft of the damping mechanism is secured to one of the upper portion or the bucket, and the housing of the damping mechanism is secured to the other of the upper portion or the bucket. The bucket can pivot with respect to the upper portion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1 is a perspective view of rotary damping mechanism in accordance with a preferred embodiment of the present invention;

[0009] FIG. 2 is a cross-sectional elevational view of the rotary damping mechanism of FIG. 1 showing the vanes mounted on a side of the hub member and in a deployed position; and

[0010] FIG. 3 is a cross-sectional elevational view of the rotary damping mechanism of FIG. 1 showing the vanes mounted on a side of the hub member and it stowed position.

[0011] FIG. 4 is a cross-sectional elevational view of another embodiment of the rotary damping mechanism of FIG. 1 showing the vanes mounted on an outer circumferential surface of the hub member and in a deployed position;

[0012] FIG. 5 is a cross-sectional elevational view of the rotary damping mechanism of FIG. 1 showing the vanes mounted on an outer circumferential surface of the hub member and in a stowed position;
FIG. 6 is a side elevational view of the rotary damping mechanism of FIG. 1 secured to a first object and a second object such that it can provide damping of the rotation of the second object when it rotates in the first direction.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following description and drawings are illustrative and are not to be construed as limiting. Numerous specific details are described to provide a thorough understanding of the disclosure. However, in certain instances, well-known or conventional details are not described in order to avoid obscuring the description. References to one or an embodiment in the present disclosure can be, but not necessarily are references to the same embodiment; and, such references mean at least one of the embodiments.

Reference in this specification to “one embodiment” or “an embodiment” means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the disclosure. The appearances of the phrase “one embodiment” in various places in the specification are not necessarily all referring to the same embodiment, nor are separate or alternative embodiments mutually exclusive of other embodiments. Moreover, various features are described which may be exhibited by some embodiments and not by others. Similarly, various requirements are described which may be requirements for some embodiments but not other embodiments.

The terms used in this specification generally have their ordinary meanings in the art, within the context of the disclosure, and in the specific context where each term is used. Certain terms that are used to describe the disclosure are discussed below, or elsewhere in the specification, to provide additional guidance to the practitioner regarding the description of the disclosure. For convenience, certain terms may be highlighted, for example using italics and/or quotation marks: The use of highlighting has no influence on the scope and meaning of a term; the scope and meaning of a term is the same, in the same context, whether or not it is highlighted.

It will be appreciated that the same thing can be said in more than one way. Consequently, alternative language and synonyms may be used for any one or more of the terms discussed herein. No special significance is to be placed upon whether or not a term is elaborated or discussed herein. Synonyms for certain terms are provided. A recital of one or more synonyms does not exclude the use of other synonyms. The use of examples anywhere in this specification including examples of any terms discussed herein is illustrative only, and is not intended to further limit the scope and meaning of the disclosure or of any exemplified term. Likewise, the disclosure is not limited to various embodiments given in this specification.

Without intent to further limit the scope of the disclosure, examples of instruments, apparatus, methods and their related results according to the embodiments of the present disclosure are given below. Note that titles or subtitles may be used in the examples for convenience of a reader, which in no way should limit the scope of the disclosure. Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure pertains. In the case of conflict, the present document, including definitions, will control.

It will be appreciated that terms such as “front,” “back,” “top,” “bottom,” “side,” “short,” “long,” “up,” “down,” “aft,” “forward,” “inboard,” “outboard” and “below” used herein are merely for ease of description and refer to the orientation of the components as shown in the figures. It should be understood that any orientation of the components described herein is within the scope of the present invention.

Referring now to the drawings, wherein the drawings are for purposes of illustrating the present invention and not for purposes of limiting the same. FIGS. 1-6 show embodiments of a rotary damping mechanism 10. In particular, the invention can be used on commercial passenger aircraft as a part of an overhead stowage bin. However, this is not a limitation on the present invention and the rotary damping mechanism 10 can be used elsewhere.

In a preferred embodiment, the rotary damping mechanism 10 provides damping in one rotational direction (the first direction) (see FIG. 2), while providing little to no damping in the other rotational direction (the second direction) (see FIG. 3). As shown in FIGS. 1-5, the rotary damping mechanism 10 includes a housing 12, an axle shaft 14, and at least one pivotal vane 16 that is mounted on a hub member 18 that is mounted on axle shaft 14. In a preferred embodiment, the rotary damping mechanism includes a pair of pivotal vanes 16. However, more pivotal vanes 16 can be included as desired. In another embodiment, the vanes 16 can be pivotally mounted directly on the axle shaft 14 and the hub member can be omitted. Housing 12 includes a first portion 20 and a second portion 22 that cooperate to define a housing interior 24 that houses the hub member 18, pivotal vanes 16 and a volume of damping fluid 26. The first portion 20 and second portion 22 can be unitary or be separate pieces. In a preferred embodiment, the second portion 22 of the housing 12 includes a flange 22a with openings therein for connecting the housing 12 to an object. However, this is not a limitation on the present invention and the housing 12 can be connected to an object in other ways. For example, the housing 12 can be glued within an opening.

In use, axle shaft 14 and hub member 18 are rotatable within housing interior 24, which causes the pivotal vanes 16 to rotate within fluid 26 because the vanes 16 are operationally coupled to the axle shaft 14 via the hub member 18. The hub member 18 can include a ring 18a and pivot pins 18b, or the like on which the vanes 16 are mounted. FIGS. 2-3 show the vanes 16 (and associated pivot pins 28) mounted on a side of the hub member and FIGS. 4-5 show the vanes 16 (and associated pivot pins 28) mounted on an outer circumferential surface of the hub member.

As a result of the friction placed on the vanes 16 by the fluid 26, when the axle shaft 14 rotates in the first direction D1, the vanes 16 pivot to the in the deployed position (see FIG. 2), such that they extend radially outwardly, thereby providing a first level of resistance. The distal ends of the vanes 16 define a restriction space or first clearance C1 in a radial direction between the distal end of the vane 16 and the inside surface of the housing 12. The first clearance C1 allows fluid 26 to pass therethrough, but, due to the small clearance provides damping. Damping can also be controlled by making the vanes 16 thicker or thinner in a direction parallel to the axis of axle shaft 14.

When the axle shaft 14 rotates in the second direction D2, the vanes 16 pivot to the stowed position (see FIG. 3) thereby providing a second level of resistance that is less than the first level of resistance. In the stowed position, the dis-
The rotary damping mechanism 10 can be applied to any axis that requires different damping rates in either direction (lateral doors, overhead stowage bin doors/buckets for example). It will be appreciated by those of ordinary skill in the art that varying the fluid viscosity can provide greater or lesser damping. Varying the vane length and/or the gap between the distal free end of the vane and the inner circumferential surface of the housing can also provide greater or lesser damping. Varying the number of vanes can also affect the damping.

Unless the context clearly requires otherwise throughout the description and the claims, the words “comprise,” “comprising,” and the like are to be construed in an inclusive sense, as opposed to an exclusive or exhaustive sense; that is to say, in the sense of “including, but not limited to.” As used herein, the terms “connected,” “coupled,” or any variant thereof, means any connection or coupling, either direct or indirect, between two or more elements; the coupling of connection between the elements can be physical, logical, or a combination thereof. Additionally, the words “herein,” “above,” “below,” and words of similar import, when used in this application, shall refer to this application as a whole and not to any particular portions of this application.

The above-detailed description of embodiments of the disclosure is not intended to be exhaustive or to limit the teachings to the precise form disclosed above. While specific embodiments and examples for the disclosure are described above for illustrative purposes, various equivalent modifications are possible within the scope of the disclosure, as those skilled in the relevant art will recognize. Further, any specific numbers noted herein are only examples; alternative implementations may employ differing values, measurements or ranges.

The teachings of the disclosure provided herein can be applied to other systems, not necessarily the system described above. The elements and acts of the various embodiments described above can be combined to provide further embodiments. Any measurements described or used herein are merely exemplary and not a limitation on the present invention. Other measurements can be used.

Any patents and applications and other references noted above, including any that may be listed in accompanying filing papers, are incorporated herein by reference in their entirety. Aspects of the disclosure can be modified, if necessary, to employ the systems, functions, and concepts of the various references described above to provide yet further embodiments of the disclosure.
disclosure should not be taken to imply that the terminology is being redefined herein to be restricted to any specific characteristics, features or aspects of the disclosure with which that terminology is associated. In general, the terms used in the following claims should not be construed to limit the disclosures to the specific embodiments disclosed in the specification unless the above Detailed Description of the Preferred Embodiments section explicitly defines such terms. Accordingly, the actual scope of the disclosure encompasses not only the disclosed embodiments, but also all equivalent ways of practicing or implementing the disclosure under the claims.

While certain aspects of the disclosure are presented below in certain claim forms, the inventors contemplate the various aspects of the disclosure in any number of claim forms. For example, while only one aspect of the disclosure is recited as a means-plus-function claim under 35 U.S.C. §112, ¶6, other aspects may likewise be embodied as a means-plus-function claim, or in other forms, such as being embodied in a computer-readable medium. (Any claims intended to be treated under 35 U.S.C. §112, ¶6 will include the words "means for"). Accordingly, the applicant reserves the right to add additional claims after filing the application to pursue such additional claim forms for other aspects of the disclosure.

Accordingly, although exemplary embodiments of the invention have been shown and described, it is to be understood that all the terms used herein are descriptive rather than limiting, and that many changes, modifications, and substitutions may be made by one having ordinary skill in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A damping mechanism comprising:
   a housing that defines a housing interior that includes a volume of fluid disposed therein, wherein the housing includes an inner circumferential surface, an axle shaft that is rotatable with respect to the housing, and at least a first vane having a distal end and being pivotally associated with the axle shaft and positioned in the housing interior and within the volume of fluid, wherein when the axle shaft and first vane rotate in a first direction, the first vane pivots to a deployed position, and wherein when the axle shaft and first vane rotate in a second direction, the first vane pivots to a stowed position, wherein a first clearance is defined between the distal end of the first vane and the inner circumferential surface of the housing when the first vane is in the deployed position, wherein a second clearance is defined between the distal end of the first vane and the inner circumferential surface of the housing when the first vane is in the stowed position, and wherein the second clearance is greater than the first clearance.

2. The damping mechanism of claim 1 wherein the housing has an opening defined therein through which the axle shaft extends.

3. The damping mechanism of claim 2 wherein the axle shaft includes a hub member mounted thereon, and wherein the first vane is pivotally mounted to the hub member.

4. The damping mechanism of claim 3 wherein the first vane includes opposing concave and convex surfaces.

5. The damping mechanism of claim 4 wherein when the hub member rotates in the first direction, the concave surface of the first vane leads and the convex surface trails, and wherein when the hub member rotates in the second direction, the convex surface of the first vane leads and the concave surface trails.

6. The damping mechanism of claim 5 further comprising at least a second vane having a distal end, wherein the second vane is pivotally mounted to the hub member and is positioned in the housing interior and within the volume of fluid, wherein when the axle shaft and second vane rotate in a first direction, the second vane pivots to a deployed position, and wherein when the axle shaft and second vane rotate in a second direction, the second vane pivots to a stowed position, wherein a first clearance is defined between the distal end of the second vane and the inner circumferential surface of the housing when the second vane is in the deployed position, wherein a second clearance is defined between the distal end of the second vane and the inner circumferential surface of the housing when the second vane is in the stowed position, and wherein the second clearance is greater than the first clearance.

7. The damping mechanism of claim 6 wherein the first and second vanes are positioned approximately 180° apart on the hub member.

8. The damping mechanism of claim 7 further comprising a flange extending radially outwardly from the housing, wherein the flange includes at least one attachment opening defined therein.

9. The damping mechanism of claim 3 wherein the first vane is pivotally mounted to the hub member by a pivot pin.

10. The damping mechanism of claim 1 wherein the first vane includes a stop member that prevents the first vane from pivoting beyond the deployed position.

11. A damping mechanism comprising:
   a housing that defines a housing interior that includes a volume of fluid disposed therein, wherein the housing includes an inner circumferential surface, an axle shaft that extends through an axial opening in the housing, a hub member mounted on the axle shaft, and first and second vanes pivotally mounted to the hub member approximately 180° apart and extending radially outwardly therefrom, wherein the first and second vanes each include a distal end and are positioned in the housing interior and within the volume of fluid, wherein when the axle shaft rotates in a first direction, the first and second vanes pivot to a deployed position, and wherein when the axle shaft rotates in a second direction, the first and second vanes pivot to a stowed position, wherein the distance in a radial direction between the distal ends of the first and second vanes and the inner circumferential surface of the housing is greater when the first and second vanes are in the stowed position than when the first and second vanes are in the deployed position.

12. The damping mechanism of claim 11 wherein the first and second vanes each include opposing concave and convex surfaces.

13. The damping mechanism of claim 12 wherein when the axle shaft rotates in the first direction, the concave surfaces of the first and second vanes lead and the convex surfaces trail, and wherein when the hub member rotates in the second
direction, the convex surfaces of the first and second vanes lead and the concave surfaces trail.

14. A method comprising the steps of:
- obtaining a damping mechanism that includes
  - a housing that defines a housing interior that includes an inner circumferential surface and a volume of fluid disposed therein,
- rotating an axle shaft in a first direction, wherein a first vane that is positioned within the volume of fluid and has a distal end pivots to a deployed position and a first clearance is defined between the distal end and the inner circumferential surface of the housing, and
- rotating the axle shaft in a second direction, wherein the first vane pivots to a stowed position and a second clearance is defined between the distal end and the inner circumferential surface of the housing, wherein the second clearance is greater than the first clearance.

15. The method of claim 14 wherein the housing is affixed to a first object and the axle shaft is affixed to a second object, and wherein the first and second objects are pivotal with respect to one another.

16. The method of claim 15 wherein the first object is stationary and the second object pivots with respect to the first object.

17. The method of claim 14 wherein the first vane includes opposing concave and convex surfaces, wherein when the axle shaft rotates in the first direction, the concave surface of the first vane leads and the convex surface trails, and wherein when the axle shaft rotates in the second direction, the convex surface of the first vane leads and the concave surface trails.

18. An overhead stowage bin comprising:
- an upper portion,
- a bucket, wherein the bucket and the upper portion combine to define a bin interior, and
- at least one damping mechanism that includes
  - a housing that defines a housing interior that includes a volume of fluid disposed therein, wherein the housing includes an inner circumferential surface,
  - an axle shaft that is rotatable with respect to the housing, and
- at least a first vane having a distal end and being pivotally associated with the axle shaft and positioned in the housing interior and within the volume of fluid, wherein when the axle shaft and first vane rotate in a first direction, the first vane pivots to a deployed position, and wherein when the axle shaft and first vane rotate in a second direction, the first vane pivots to a stowed position, wherein a first clearance is defined between the distal end of the first vane and the inner circumferential surface of the housing when the first vane is in the deployed position, wherein a second clearance is defined between the distal end of the first vane and the inner circumferential surface of the housing when the first vane is in the stowed position, and wherein the second clearance is greater than the first clearance, wherein the axle shaft is secured to one of the upper portion or the bucket, and wherein the housing is secured to the other of the upper portion or the bucket, whereby the bucket can pivot with respect to the upper portion.

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