United States Patent Application Publication 20250256831
Kind Code A1
Publication Date August 14, 2025
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Drain Mast

Abstract

A drain mast includes a mast section. The mast section includes a drain line. The drain line routes a liquid from an upper portion of the mast section to a lower portion of the mast section. The drain mast also includes a body section attached to the mast section. The body section has a convex-curved surface that includes one or more outlet holes. The convex-curved surface of the body section creates a low-pressure area proximate to the one or more outlet holes to enable the liquid from the lower portion of the mast section to drain through the one or more outlet holes.

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Family ID: **96661587**

Appl. No.: **18/439772**

Filed: **February 13, 2024**

Publication Classification

Int. Cl.: **B64C1/14** (20060101)

U.S. Cl.:

CPC **B64C1/1453** (20130101);

Background/Summary

FIELD
[0001] The present disclosure generally relates to a drain mast, and more particularly, to a drain mast that provides outlet suction.

BACKGROUND

[0002] This background description is provided for the purpose of generally presenting the context of the disclosure. Unless otherwise indicated herein, material described in this section is neither expressly nor impliedly admitted to be prior art to the present disclosure or the appended claims.

[0003] An aircraft can use a drain mast to eject fluid from itself during flight. The fluid travels though the drain tube and is ejected into a surrounding airflow stream during flight via a cavity in the drain mast. In particular, the fluid may be drained from a region of low pressure in the cavity to a region of high pressure outside of the aircraft.

[0004] However, in some scenarios, the force of gravity is not strong enough to move the fluid against the pressure gradient, causing backflow in the drain tube. For example, a traditional drain mast may not create strong enough suction forces at the drain outlet to force the fluid outside of the aircraft.

SUMMARY

[0005] The present application is directed to an improved drain mast for an aircraft. In particular, the present application is directed to a drain mast that has low pressure region proximate to a drain outlet to enable liquid (e.g., water waste) to be ejected via the drain outlet. For example, the drain mast may include a body section that has a convex-curved surface that includes one or more drain outlet holes. The convex-curved surface of the body section creates a low-pressure area proximate to the one or more drain outlet holes. As a result, the low pressure created on the surface of the body section proximate to the one or more drain outlet holes is lower than the pressure volume from which the liquid is being drained. As a result, a forward pressure gradient is created which drives the liquid out of the aircraft. The drain outlet holes are used to vent the liquid out of the aircraft and into the airstream. The body section is mounted on a mast to (i) position the body section outside an aerodynamic boundary layer of the aircraft and (ii) separate the fluid being drained from the exterior surface of the aircraft.

[0006] In one aspect, the present application discloses a drain mast. The drain mast includes a mast section. The mast section includes a drain line. The drain line routes a liquid from an upper portion of the mast section to a lower portion of the mast section. The drain mast also includes a body section attached to the mast section. The body section has a convex-curved surface that includes one or more outlet holes. The convex-curved surface of the body section creates a low-pressure area proximate to the one or more outlet holes to enable the liquid from the lower portion of the mast section to drain through the one or more outlet holes.

[0007] In another aspect, the present application discloses an aircraft. The aircraft includes an aircraft component and a drain mast coupled to the aircraft component. The drain mast includes a mast section. The mast section includes a drain line. The drain line routes a liquid from an upper portion of the mast section to a lower portion of the mast section. The drain mast also includes a body section attached to the mast section. The body section has a convex-curved surface that includes one or more outlet holes. The convex-curved surface of the body section creates a low-pressure area proximate to the one or more outlet holes to enable the liquid from the lower portion of the mast section to drain through the one or more outlet holes.

[0008] In another aspect, the present application discloses a method of manufacturing a drain mast. The method includes manufacturing a mast section of the drain mast. The mast section includes a drain line. The drain line routes a liquid from an upper portion of the mast section to a lower portion of the mast section. The drain mast also includes a body section attached to the mast section. The method also includes manufacturing a body section of the drain mast that is attached to the mast section. The body section has a convex-curved surface that includes one or more outlet holes. The convex-curved surface of the body section creates a low-pressure area proximate to the one or more outlet holes to enable the liquid from the lower portion of the mast section to drain through the one or more outlet holes.

[0009] The foregoing summary is illustrative only and is not intended to be in any way limiting. In

addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the figures and the following detailed description.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] A more complete understanding of embodiments of the present application may be derived by referring to the detailed description and claims when considered in conjunction with the following figures, wherein like reference numbers may refer to similar elements throughout the figures. The figures are provided to facilitate understanding of the disclosure without limiting the breadth, scope, scale, or applicability of the disclosure. The drawings are not necessarily made to scale.

[0011] FIG. **1** illustrates an architecture that includes an aircraft drain mast, according to an exemplary embodiment;

[0012] FIG. **2** illustrates another architecture that includes an aircraft drain mast, according to an exemplary embodiment;

[0013] FIG. **3** illustrates an aircraft that includes a drain mast, according to an exemplary embodiment;

[0014] FIG. **4** illustrates an aircraft drain mast, according to an exemplary embodiment; and

[0015] FIG. **5** is a flowchart of an example of an implementation of a method, according to an exemplary embodiment.

DETAILED DESCRIPTION

[0016] The figures and the following description illustrate specific exemplary embodiments. It will be appreciated that those skilled in the art will be able to devise various arrangements that, although not explicitly described or shown herein, embody the principles described herein and are included within the scope of the claims that follow this description. Furthermore, any examples described herein are intended to aid in understanding the principles of the disclosure and are to be construed as being without limitation. As a result, this disclosure is not limited to the specific embodiments or examples described below, but by the claims and their equivalents.

[0017] Particular implementations are described herein with reference to the drawings. In the description, common features may be designated by common reference numbers throughout the drawings. In some drawings, multiple instances of a particular type of feature are used. Although these features are physically and/or logically distinct, the same reference number is used for each, and the different instances are distinguished by addition of a letter to the reference number. When the features as a group or a type are referred to herein (e.g., when no particular one of the features is being referenced), the reference number is used without a distinguishing letter. However, when one particular feature of multiple features of the same type is referred to herein, the reference number is used with the distinguishing letter. For example, referring to FIG. **1**, outlet holes are illustrated and associated with reference number **124**. When referring to a particular one of the outlet holes, such as the outlet hole **124**A, the distinguishing letter “A” is used. However, when referring to any arbitrary one of the outlet holes or to the outlet holes as a group, the reference number **124** may be used without a distinguishing letter.

[0018] As used herein, various terminology is used for the purpose of describing particular implementations only and is not intended to be limiting. For example, the singular forms “a,” “an,” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. Further, the terms “comprise,” “comprises,” and “comprising” are used interchangeably with “include,” “includes,” or “including.” Additionally, the term “wherein” is used interchangeably with the term “where.” As used herein, “exemplary” indicates an example, an

implementation, and/or an aspect, and should not be construed as limiting or as indicating a preference or a preferred implementation. As used herein, an ordinal term (e.g., “first,” “second,” “third,” etc.) used to modify an element, such as a structure, a component, an operation, etc., does not by itself indicate any priority or order of the element with respect to another element, but rather merely distinguishes the element from another element having a same name (but for use of the ordinal term). As used herein, the term “set” refers to a grouping of one or more elements, and the term “plurality” refers to multiple elements.

[0019] Referring to FIG. **1**, an architecture **100** that includes an aircraft drain mast is illustrated, in accordance with an exemplary embodiment. The architecture **100** includes a fuselage **102** of an aircraft and a drain mast **110** coupled to the fuselage **102**. Although the drain mast **110** is depicted as being coupled to the fuselage **102**, in other implementations, the drain mast **110** can be coupled to other components of an aircraft. As a non-limiting example, in some implementations, the drain mast **110** can be coupled to a lower surface of an aircraft wing, an engine nacelle, etc.

[0020] The drain mast **110** includes a mast section **110**A and a body section **110**B that is attached to the mast section **110**A. The mast section **110**A of the drain mast **110** includes a drain line **112** (e.g., a drain tube) that routes a liquid from an upper portion of the mast section **110**A to a lower portion of the mast section **110**A. According to one implementation, the liquid includes water. According to another implementation, the liquid includes fuel. According to another implementation, the liquid includes hydraulic fluid. It should be understood that water, fuel, and hydraulic fluid are merely non-limiting examples of liquids that can be drained from the drain mast **110**. In other implementations, different liquids can be drained from the drain mast **110**. As illustrated in FIG. **1**, an outlet **114** of the drain line **112** is located in the lower portion of the mast section **110**A. However, in some implementations, the outlet **114** of the drain line **112** may extend into the body section **110**B of the drain mast **110**, as depicted in FIG. **2**.

[0021] In some embodiments, the drain mast **110** can include a continuous section (e.g., a single piece). For example, the mast section **110**A and the body section **110**B can be manufactured as a continuous section, as opposed to two separate sections that are attached.

[0022] As illustrated in FIG. **1**, the body section **110**B of the drain mast **110** has a convex-curved surface that includes one or more outlet holes **124**. The convex-curved surface of the body surface of the body section **110**B creates a low-pressure area **122** that is proximate to the one or more outlet holes **124**. For example, in FIG. **1**, the low-pressure area **122** of the body section **110**B includes two outlet holes **124**A, **124**B. Although two (2) outlet holes **124**A, **124**B are depicted in the low-pressure area **122**, in other implementations, additional (or fewer) outlet holes **124** can be included in the low-pressure area **122**. As a non-limiting example, in some scenarios, the low-pressure area **122** can include five (5) outlet holes **124**. As another non-limiting example, in some scenarios, the low-pressure area **122** can include a single outlet hole. In some implementations, the outlet holes **124** are located at a bottom portion of the body section **110**B.

[0023] The low-pressure area **122** enables the liquid from the lower portion of mast section **110**A to drain through the outlet holes **124**A, **124**B. For example, the low pressure created on the surface of the body section **110**B proximate to the outlet holes **124** (e.g., created at the low-pressure area **122**) is lower than the pressure volume from which the liquid is being drained. As a result, a forward pressure gradient is created which drives the liquid out of the aircraft. The outlet holes **124** are used to vent the liquid out of the aircraft and into the airstream. The body section **110**B may be positioned outside an aerodynamic boundary layer of the aircraft to prevent the liquid from draining on an exterior surface of the aircraft.

[0024] Referring to FIG. **2**, another architecture **200** that includes an aircraft drain mast is illustrated, in accordance with an exemplary embodiment. The architecture **200** includes the fuselage **102** of an aircraft and a drain mast **210** coupled to the fuselage **102**.

[0025] The drain mast **210** is substantially similar to the drain mast **110** of FIG. **1**. For example, the drain mast **210** includes a mast section **210**A and a body section **210**B attached to the mast section

210A. The mast section **210**A of the drain mast **210** includes a drain line **212** that routes a liquid from an upper portion of the mast section **210**A to an upper portion of the body section **210**B. Thus, in the architecture of FIG. **2**, an outlet **214** of the drain line **212** may extend into the body section **210**B of the drain mast **210**.

[0026] Similar to the architecture **100** of FIG. **1**, the body section **210**B of the drain mast **210** has a convex-curved surface that includes the one or more outlet holes **124**. The convex-curved surface of the body surface of the body section **210**B creates the low-pressure area **122** that is proximate to the one or more outlet holes **124**.

[0027] The low-pressure area **122** enables the liquid from the lower portion of mast section **210**A to drain through the outlet holes **124**A, **124**B. For example, the low pressure created on the surface of the body section **210**B proximate to the outlet holes **124** (e.g., created at the low-pressure area **122**) is lower than the pressure volume from which the liquid is being drained. As a result, a forward pressure gradient is created which drives the liquid out of the aircraft. The outlet holes **124** are used to vent the liquid out of the aircraft and into the airstream. The body section **210**B may be positioned outside an aerodynamic boundary layer of the aircraft to prevent the liquid from draining on an exterior surface of the aircraft.

[0028] Referring to FIG. **3**, an aircraft **300** that includes an aircraft drain mast is illustrated, in accordance with an exemplary embodiment.

[0029] The aircraft **300** includes the fuselage **102** and a drain mast **310** that is coupled to the fuselage. According to some implementations, the drain mast **310** corresponds to the drain mast **110** of FIG. **1**. According to other implementations, the drain mast **310** corresponds to the drain mast **210** of FIG. **2**. As depicted in FIG. **3**, a body section (e.g., the body section **110**B or the body section **210**B) of the drain mast **310** is outside an aerodynamic boundary layer of the aircraft **300** to prevent liquid from draining on an exterior surface of the aircraft **300**.

[0030] Referring to FIG. **4**, the drain mast **310** is illustrated, in accordance with an exemplary embodiment.

[0031] The drain mast **310** includes a mast section **310**A and a body section **310**B that is attached to the mast section **310**A. The mast section **310**A of the drain mast **310** includes a drain line **312** that routes a liquid from an upper portion of the mast section **310**A to a lower portion of the mast section **310**A.

[0032] As illustrated in FIG. **4**, the body section **310**B of the drain mast **310** has a convex-curved surface that includes one or more outlet holes (not shown in FIG. **4**). The convex-curved surface of the body surface of the body section **410**B creates a low-pressure area **322** that is proximate to the one or more outlet holes.

[0033] The low-pressure area **322** enables the liquid, from the drain line **312**, to drain through the outlet holes. For example, the low pressure created on the surface of the body section **310**B proximate to the outlet holes (e.g., created at the low-pressure area **322**) is lower than the pressure volume from which the liquid is being drained. As a result, a forward pressure gradient is created which drives the liquid out of the body section **310**B.

[0034] FIG. **5** illustrates a flow chart of a method **500**, according to an exemplary embodiment.

[0035] The method **500** includes manufacturing a mast section of a drain mast, at block **502**. The mast section includes a drain line, and the drain line is configured to route a liquid from an upper portion of the mast section to a lower portion of the mast section. For example, referring to FIG. **1**, the mast section **110**A of the drain mast **110** may be manufactured. The mast section **110**A includes the drain line **112**, and the drain line **112** is configured to route a liquid from the upper portion of the mast section **110**A to the lower portion of the mast section **110**A.

[0036] The method **500** also includes manufacturing a body section of the drain mast that is attached to the mast section, at block **504**. The body section has a convex-curved surface that includes one or more outlet holes. The convex-curved surface of the body section creates a low-pressure area proximate to the one or more outlet holes to enable the liquid from the lower portion

of the mast section to drain through the one or more outlet holes. For example, referring to FIG. **1**, the body section **110**B of the drain mast **110** that is attached to the mast section **110**A may be manufactured. The body section **110**B has a convex-curved surface that includes the outlet holes **124**A, **124**B. The convex-curved surface of the body section **110**B creates the low-pressure area **122** proximate to the outlet holes **124**A, **124**B to enable the liquid from the lower portion of the mast section **110**A to drain through the outlet holes **124**A, **124**B.

[0037] According to one implementation of the method **500**, an outlet of the drain line extends into the body section. For example, referring to FIG. **2**, the outlet **214** of the drain line **212** extends into the body section **210**B of the drain mast **210**.

[0038] According to one implementation of the method **500**, an outlet of the drain line is located in the lower portion of the mast section. For example, referring to FIG. **1**, the outlet **114** of the drain line **112** is located in the lower portion of the mast section **110**A.

[0039] According to one implementation of the method **500**, an outlet of the drain line is positioned proximate to the one or more outlet holes. For example, referring to FIG. **2**, the outlet **214** of the drain line **212** is positioned proximate to the outlet holes **124**A, **124**B. In some implementations of the method **500**, an outlet of the drain line is coupled to the one or more outlet holes.

[0040] According to one implementation of the method **500**, the one or more outlet holes are located at a bottom portion of the body section. For example, referring to FIG. **1**, the outlet holes **124**A, **124**B are located at the bottom portion of the body section **110**B of the drain mast **110**.

[0041] According to one implementation of the method **500**, the body section is positioned outside an aerodynamic boundary layer of an aircraft to prevent the liquid from draining on an exterior surface of the aircraft. The low pressure created on the surface of the body section **110**B proximate to the outlet holes **124** (e.g., created at the low-pressure area **122**) is lower than the pressure volume from which the liquid is being drained. As a result, a forward pressure gradient is created which drives the liquid out of the aircraft. The outlet holes **124** are used to vent the liquid out of the aircraft and into the airstream.

[0042] Although the systems are described herein with specific reference to aircraft systems or aerospace vehicles, in other embodiments, the system can be a vehicle other than an aircraft without departing from the essence of the present disclosure.

[0043] Additionally, instances in this specification where one element is “coupled” to another element can include direct and indirect coupling. Direct coupling can be defined as one element coupled to and in some contact with another element. Indirect coupling can be defined as coupling between two elements not in direct contact with each other, but having one or more additional elements between the coupled elements. Further, as used herein, securing one element to another element can include direct securing and indirect securing. Additionally, as used herein, “adjacent” does not necessarily denote contact. For example, one element can be adjacent another element without being in contact with that element.

[0044] As used herein, a system, apparatus, structure, article, element, component, or hardware “configured to” perform a specified function is indeed capable of performing the specified function without any alteration, rather than merely having potential to perform the specified function after further modification. In other words, the system, apparatus, structure, article, element, component, or hardware “configured to” perform a specified function is specifically selected, created, implemented, utilized, programmed, and/or designed for the purpose of performing the specified function. As used herein, “configured to” denotes existing characteristics of a system, apparatus, structure, article, element, component, or hardware which enable the system, apparatus, structure, article, element, component, or hardware to perform the specified function without further modification. For purposes of this disclosure, a system, apparatus, structure, article, element, component, or hardware described as being “configured to” perform a particular function may additionally or alternatively be described as being “adapted to” and/or as being “operative to” perform that function.

[0045] The flow chart diagrams included herein are generally set forth as logical flow chart diagrams. As such, the depicted order and labeled steps are indicative of one embodiment of the presented method. Other steps and methods may be conceived that are equivalent in function, logic, or effect to one or more steps, or portions thereof, of the illustrated method. Additionally, the format and symbols employed are provided to explain the logical steps of the method and are understood not to limit the scope of the method. Although various arrow types and line types may be employed in the flow chart diagrams, they are understood not to limit the scope of the corresponding method. Indeed, some arrows or other connectors may be used to indicate only the logical flow of the method. For instance, an arrow may indicate a waiting or monitoring period of unspecified duration between enumerated steps of the depicted method. Additionally, the order in which a particular method occurs may or may not strictly adhere to the order of the corresponding steps shown.
[0046] Unless otherwise indicated, the terms “first,” “second,” etc. are used herein merely as labels, and are not intended to impose ordinal, positional, or hierarchical requirements on the items to which these terms refer. Moreover, reference to, e.g., a “second” item does not require or preclude the existence of, e.g., a “first” or lower-numbered item, and/or, e.g., a “third” or higher-numbered item.
[0047] While the systems and methods of operation have been described with reference to certain examples, it will be understood by those skilled in the art that various changes can be made and equivalents can be substituted without departing from the scope of the claims. Therefore, it is intended that the present methods and systems not be limited to the particular examples disclosed, but that the disclosed methods and systems include all embodiments falling within the scope of the appended claims.

Claims

1. A drain mast comprising: a mast section that includes a drain line, wherein the drain line routes a liquid from an upper portion of the mast section to a lower portion of the mast section; and a body section attached to the mast section, wherein the body section has a convex-curved surface that includes one or more outlet holes, and wherein the convex-curved surface of the body section creates a low-pressure area proximate to the one or more outlet holes to enable the liquid from the lower portion of the mast section to drain through the one or more outlet holes.
2. The drain mast of claim 1, wherein an outlet of the drain line extends into the body section.
3. The drain mast of claim 1, wherein an outlet of the drain line is located in the lower portion of the mast section.
4. The drain mast of claim 1, wherein an outlet of the drain line is positioned proximate to the one or more outlet holes.
5. The drain mast of claim 1, wherein an outlet of the drain line is coupled to the one or more outlet holes.
6. The drain mast of claim 1, wherein the one or more outlet holes are located at a bottom portion of the body section.
7. The drain mast of claim 1, wherein the body section is positioned outside an aerodynamic boundary layer of an aircraft to prevent the liquid from draining on an exterior surface of the aircraft.
8. The drain mast of claim 1, wherein the liquid includes water, fuel, or hydraulic fluid.
9. An aircraft comprising: an aircraft component; and a drain mast coupled to the aircraft component, the drain mast comprising: a mast section that includes a drain line, wherein the drain line routes a liquid from an upper portion of the mast section to a lower portion of the mast section; and a body section attached to the mast section, wherein the body section has a convex-curved surface that includes one or more outlet holes, and wherein the convex-curved surface of the body

section creates a low-pressure area proximate to the one or more outlet holes to enable the liquid from the lower portion of the mast section to drain through the one or more outlet holes.

10. The aircraft of claim 9, wherein an outlet of the drain line extends into the body section.

11. The aircraft of claim 9, wherein an outlet of the drain line is located in the lower portion of the mast section.

12. The aircraft of claim 9, wherein an outlet of the drain line is coupled to the one or more outlet holes.

13. The aircraft of claim 9, wherein the one or more outlet holes are located at a bottom portion of the body section.

14. The aircraft of claim 9, wherein the body section is positioned outside an aerodynamic boundary layer of the aircraft to prevent the liquid from draining on an exterior surface of the aircraft.

15. The aircraft of claim 9, wherein the liquid includes water, fuel, or hydraulic fluid.

16. A method of manufacturing a drain mast, the method comprising: manufacturing a mast section of the drain mast, wherein the mast section includes a drain line, and wherein the drain line is configured to route a liquid from an upper portion of the mast section to a lower portion of the mast section; and manufacturing a body section of the drain mast that is attached to the mast section, wherein the body section has a convex-curved surface that includes one or more outlet holes, and wherein the convex-curved surface of the body section creates a low-pressure area proximate to the one or more outlet holes to enable the liquid from the lower portion of the mast section to drain through the one or more outlet holes.

17. The method of claim 16, wherein an outlet of the drain line extends into the body section.

18. The method of claim 16, wherein an outlet of the drain line is located in the lower portion of the mast section.

19. The method of claim 16, wherein the one or more outlet holes are located at a bottom portion of the body section.

20. The method of claim 16, further comprising mounting the body section on a mast to position the body section outside an aerodynamic boundary layer of an aircraft.