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Multi-function valve assemblies

Abstract

Multi-function valve assemblies are provided for use in automotive components, such as traction battery packs, for example. An exemplary multi-function valve assembly may include a valve housing, a first valve body movably positioned within the valve housing, and a second valve body movably positioned within the valve housing. The first and second valve bodies may be moved between positions in which the valve bodies are seated against one another and other positions in which the valve bodies are unseated relative to one another to provide various valve functions. The multi-function valve assembly may be configured to provide functions such as degassing, pressure equalization, leak testing, etc.

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Background/Summary

TECHNICAL FIELD

(1) This disclosure relates to multi-function valve assemblies for use within automotive

components.

BACKGROUND

(2) Many automotive components require a gas-tight housing design. The components may also require pressure equalization due to temperature fluctuations.

SUMMARY

(3) A multi-function valve assembly according to an exemplary aspect of the present disclosure includes, among other things, a valve housing, a first valve body movably positioned within the valve housing, and a second valve body movably positioned within the valve housing. The first valve body is seated against the second valve body in a default position of the multi-function valve assembly and is unseated relative to the second valve body in an additional position of the multi-function valve assembly.

(4) In a further non-limiting embodiment of the foregoing multi-function valve assembly, the first valve body is degassing valve body, and the second valve body is a pressure equalization valve body.

(5) In a further non-limiting embodiment of either of the foregoing multi-function valve assemblies, a biasing member is configured to bias the second valve body against the first valve body during the default position.

(6) In a further non-limiting embodiment of any of the foregoing multi-function valve assemblies, a biasing member is configured to bias the first valve body against the valve housing during the default position.

(7) In a further non-limiting embodiment of any of the foregoing multi-function valve assemblies, the additional position is a degassing position of the multi-function valve assembly.

(8) In a further non-limiting embodiment of any of the foregoing multi-function valve assemblies, during the degassing position, the first valve body is configured to move apart from the second valve body to establish a gas path through the valve housing.

(9) In a further non-limiting embodiment of any of the foregoing multi-function valve assemblies, the additional position is a leak test position of the multi-function valve assembly.

(10) In a further non-limiting embodiment of any of the foregoing multi-function valve assemblies, during the leak test position, the second valve body is configured to move apart from the first valve body.

(11) In a further non-limiting embodiment of any of the foregoing multi-function valve assemblies, a water-impermeable membrane is secured to the second valve body.

(12) In a further non-limiting embodiment of any of the foregoing multi-function valve assemblies, the water-impermeable membrane is configured to perform a pressure equalization function of the multi-function valve assembly during the default position.

(13) In a further non-limiting embodiment of any of the foregoing multi-function valve assemblies, a seal is arranged to seal an interface between the first valve body and the second valve body during the default position.

(14) In a further non-limiting embodiment of any of the foregoing multi-function valve assemblies, the seal is received within a groove formed in an outer flange of the first valve body.

(15) An automotive component according to another exemplary aspect of the present disclosure includes, among other things, an enclosure wall, and a multi-function valve assembly received within an opening of the enclosure wall. The multi-function valve assembly is configurable in a default position in which a pressure is equalized between an interior of the automotive component and an atmosphere outside the automotive component, a degassing position in which a gaseous mixture is dischargeable from the interior to the atmosphere, and a leak test position for leak testing the automotive component without removing the multi-function valve assembly from the enclosure wall.

(16) In a further non-limiting embodiment of the foregoing automotive component, the automotive component is a traction battery pack.

(17) In a further non-limiting embodiment of either of the foregoing automotive components, a degassing valve body of the multi-function valve assembly is seated against a pressure equalization valve body of the multi-function valve assembly during the default position.
(18) In a further non-limiting embodiment of any of the foregoing automotive components, the degassing valve body is unseated from the pressure equalization valve body during the degassing position.
(19) In a further non-limiting embodiment of any of the foregoing automotive components, the degassing valve body is movable in a direction away from the interior to configure the multi-function valve assembly in the degassing position.
(20) In a further non-limiting embodiment of any of the foregoing automotive components, the pressure equalization valve body is unseated from the degassing valve body during the leak test position.
(21) In a further non-limiting embodiment of any of the foregoing automotive components, the pressure equalization valve body is movable in a direction toward the interior to configure the multi-function valve assembly in the leak test position.
(22) In a further non-limiting embodiment of any of the foregoing automotive components, the multi-function valve assembly includes a water-impermeable membrane configured to equalize the pressure between the interior and the atmosphere during the default position.
(23) The embodiments, examples, and alternatives of the preceding paragraphs, the claims, or the following description and drawings, including any of their various aspects or respective individual features, may be taken independently or in any combination. Features described in connection with one embodiment are applicable to all embodiments, unless such features are incompatible.
(24) The various features and advantages of this disclosure will become apparent to those skilled in the art from the following detailed description. The drawings that accompany the detailed description can be briefly described as follows.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) FIG. **1** illustrates a first exemplary position of a multi-function valve assembly.
(2) FIG. **2** illustrates a second exemplary position of the multi-function valve assembly of FIG. **1**.
(3) FIG. **3** illustrates a third exemplary position of the multi-function valve assembly of FIG. **1**.
(4) FIG. **4** illustrates a traction battery pack that includes a multi-function valve assembly.
(5) FIG. **5** is a cross-sectional view of the traction battery pack of FIG. **4**.
(6) FIG. **6** illustrates an electrified vehicle that includes the traction battery pack of FIGS. **4** and **5**.
DETAILED DESCRIPTION
(7) This disclosure details exemplary multi-function valve assemblies for use in automotive components, such as traction battery packs, for example. An exemplary multi-function valve assembly may include a valve housing; a first valve body movably positioned within the valve housing, and a second valve body movably positioned within the valve housing. The first and second valve bodies may be moved between positions in which the valve bodies are seated against one another and other positions in which the valve bodies are unseated relative to one another to provide various functions. The multi-function valve assembly may be configured to provide a functions such as degassing, pressure equalization, leak testing, etc. These and other features are discussed in greater detail in the following paragraphs of this detailed description.
(8) FIGS. **1**, **2**, and **3** illustrate a multi-function valve assembly **10** (hereinafter “valve assembly”) according to an embodiment of this disclosure. The valve assembly **10** may be disposed within an opening **15** of an enclosure wall **12** of an automotive component C, such as a traction battery pack, a transmission component, a degas function component, a brake component, a fuel tank, a

differential box, or any other automotive component in which it is desirable to fill or evacuate any fluid (e.g., air, liquid, or Gas) and also provide pressure equalization and/or other functionalities at a single location of the component. The valve assemblies of this disclose could also be utilized in certain medical components and thus are not limited to automotive applications.

(9) Although a single valve assembly **10** is provided in the enclosure wall **12** in the illustrated embodiments, the automotive component C could include a greater number of valve assemblies **10** within the scope of this disclosure. The valve assembly **10** may be secured within the enclosure wall **12** in any known manner.

(10) Among other components, the valve assembly **10** may include a valve housing **14**, a water-impermeable membrane **16**, a degassing valve body **18**, and a pressure equalization valve body **20**. The valve housing **14** may be a plastic component or a metallic component and may include a single-piece structure or a multi-piece structure. The size and shape of the valve housing **14** are not intended to limit this disclosure.

(11) The valve housing **14** may include an internal bore **22** that extends along a longitudinal centerline axis A between an inner section **28** and an outer section **30**. The inner section **28** interfaces with the enclosure wall **12**, and the outer section **30** protrudes outward of the enclosure wall **12**. The outer section **30** is therefore located further away from an interior I of the automotive component C compared to the inner section **28**.

(12) The degassing valve body **18** and the pressure equalization valve body **20** may each be accommodated within the internal bore **22** of the valve housing **14**. In an embodiment, the pressure equalization valve body **20** is positioned to extend coaxially along the longitudinal centerline axis A, and the degassing valve body **18** may circumscribe the pressure equalization valve body **20** within the internal bore **22**. Thus, the degassing valve body **18** may be radially outward of the pressure equalization valve body **20**.

(13) The water-impermeable membrane **16** may be secured to an outer flange **24** of the pressure equalization valve body **20**. The water-impermeable membrane **16** may therefore be arranged to substantially cover an internal bore **26** of the pressure equalization valve body **20**. The water-impermeable membrane **16** may be a patch, filter, or some other porous membrane.

(14) A groove **32** may be formed in a circumferential wall **34** of the degassing valve body **18**. A first seal **36** may be received within the groove **32**. The first seal **36** may be configured to seal an interface between the degassing valve body **18** and the outer section **30** of the valve housing **14**. The first seal **36** could be a bore seal, an adhesive seal, a press-in-place seal, a carrier gasket, a form in place sealant, or any other suitable sealing device/agent.

(15) Another groove **38** may be formed in an inner surface **40** of an outer flange **42** of the degassing valve body **18**. The outer flange **42** may protrude outwardly of the outer section **30** of the valve housing **14** in a default position (shown in FIG. **1**) of the valve assembly **10**.

(16) A second seal **44** may be received within the groove **38**. The second seal **44** may be configured to seal an interface between the degassing valve body **18** and the pressure equalization valve body **20**. The second seal **44** could be a bore seal, an adhesive seal, a press-in-place seal, a carrier gasket, a form in place sealant, or any other suitable sealing device/agent.

(17) A first biasing member **46** may be arranged to extend between the inner section **28** of the valve housing **14** and the outer flange **24** of the pressure equalization valve body **20**. In a default position of the valve assembly **10**, the first biasing member **46** may bias the pressure equalization valve body **20** in a direction away from the interior I to seat the outer flange **24** against the inner surface **40** of the outer flange **42** of the degassing valve body **18**. The first biasing member **46** could be a spring, a resilient insert (e.g., rubber grommet, etc.), or any other suitable biasing device.

(18) A second biasing member **50** may be arranged to extend between an inner flange **52** of the degassing valve body **18** and the outer section **30** of the valve housing **14**. In a default position of the valve assembly **10**, the second biasing member **50** may bias the degassing valve body **18** in a direction toward the interior I to seat the inner flange **52** against an inner surface **54** (see FIG. **2**) of

the inner section **28** of the valve housing **14**. The second biasing member **50** could be a spring, a resilient insert (e.g., rubber grommet, etc.), or any other suitable biasing device.

(19) A cylindrical wall **56** may protrude from the inner surface **54** of the inner section **28** of the valve housing **14**. The cylindrical wall **56** may help locate the degassing valve body **18** within the valve housing **14**. The cylindrical wall **56** may further help separate the first biasing member **46** from the degassing valve body **18**.

(20) FIG. **1** shows a first or default position P**1** of the valve assembly **10**. In this position, the water-impermeable membrane **16** of the valve assembly **10** is configured to allow gases to flow in and out of the automotive component C while preventing moisture, particle contaminants, etc. from entering an interior I of the automotive component C during normal operating conditions. The water-impermeable membrane **16** may therefore provide pressure equalization between the interior I of the automotive component C and an atmosphere AT outside the enclosure wall **12** of the automotive component C.

(21) FIG. **2** shows a second or degassing position P**2** of the valve assembly **10**. The degassing valve body **18** may be configured to move (e.g., in a direction parallel to the longitudinal centerline axis A) from the default position P**1** shown in FIG. **1** to the degassing position P**2** shown in FIG. **2** during a thermal event of the automotive component C. For example, during a thermal event, a gaseous mixture **58** (e.g., gases, effluent particles, and/or other byproducts) can increase the pressure inside the interior I of the automotive component C. When the increased pressure exceeds a predefined threshold, the pressure may overcome the biasing force of the second biasing member **50**, thereby forcing the degassing valve body **18** to move in a direction away from the interior I and unseat itself relative to the pressure equalization valve body **20** and the inner section of the valve housing **14**. The gaseous mixture **58** may then enter the internal bore **22** of the valve housing **14** prior to being discharged from the valve housing **14**. The gaseous mixture **58** may be discharged from the valve assembly **10** through a now opened space **99** between the degassing valve body **18** and the pressure equalization valve body **20** and/or through multiple vent passages **60** formed in the valve housing **14**.

(22) FIG. **3** shows a third or leak test position P**3** of the valve assembly **10**. The pressure equalization valve body **20** may be configured to move (e.g., in a direction parallel to the longitudinal centerline axis A) from the default position P**1** of FIG. **1** to the leak teat position P**3** of FIG. **3** when leak testing the automotive component C. For example, during a leak test, a block-off plate **62** may be secured over top of the water-impermeable membrane **16**, and a leak test device **64** may be attached to the valve assembly **10** (e.g., to the outer flange **42** of the degassing valve body **18**). The leak test device **64** may be configured to either introduce air into the interior I or apply a vacuum to the interior I as part of a procedure for leak testing the automotive component C.

(23) During the leak test, a force **66** may be applied to the block-off plate **62**. The force **66** may be applied by the leak test device **64** or some other device. When the force **66** exceeds a predefined threshold, the force **66** may overcome the biasing force of the first biasing member **46**, thereby forcing the pressure equalization valve body **20** to move in a direction toward the interior I and unseat itself relative to the degassing valve body **18**. The air/vacuum may then be applied to the interior I as part of the procedure for leak testing the automotive component C. The leak test can therefore be performed without first removing the valve assembly **10** from the enclosure wall **12**.

(24) Notably, the pressure equalization valve body **20** remains stationary and in its default position relative to the valve housing **14** during the degassing position P**2**, and the degassing valve body **18** remains stationary and in its default position relative to the valve housing **14** during the leak test position P**3**.

(25) In an embodiment, the degassing valve body **18** and the pressure equalization valve body **20** are each configured as poppet-type valves. However, these valve bodies could embody other configurations within the scope of this disclosure.

(26) FIGS. **4**, **5**, and **6** illustrate an exemplary automotive component within which the valve

assembly **10** described above may be employed. In this implementation, the valve assembly **10** is part of a traction battery pack **68** of an electrified vehicle **70** (see FIG. **6**). Again, however, other automotive implementations could benefit from use of the valve assembly **10** within the scope of this disclosure.

(27) The electrified vehicle **70** may include any type of electrified powertrain. In the illustrated embodiment, the electrified vehicle **70** is a full electric vehicle propelled solely through electric power, such as by one or more electric machines **72**, without assistance from an internal combustion engine. The electric machine **72** may operate as an electric motor, an electric generator, or both. The electric machine **72** receives electrical power and can convert the electrical power to torque for driving one or more wheels **86** of the electrified vehicle **70**. A voltage bus **88** may electrically couple the electric machine **72** to the traction battery pack **68**.

(28) The traction battery pack **68** may be secured to an underbody **90** of the electrified vehicle **70**. However, the traction battery pack **68** could be located elsewhere on the electrified vehicle **70** within the scope of this disclosure

(29) The traction battery pack **68** may be a high voltage traction battery pack system that includes one or more battery arrays **74** (e.g., battery assemblies or groupings of rechargeable battery cells **76**) capable of outputting electrical power to power an electric machine **72** and/or other electrical loads of the electrified vehicle **70**. Other types of energy storage devices and/or output devices could alternatively or additionally be used to electrically power the electrified vehicle **70**.

(30) The battery cells **76** may be stacked side-by-side along a stack axis to construct a grouping of battery cells **76**, sometimes referred to as a "cell stack." In the highly schematic depiction of FIG. **5**, the battery cells **76** are stacked in a direction into the page to construct each battery array **74**, and thus the battery arrays **74** may extend in cross-car direction. However, other configurations may also be possible. The total number of battery arrays **74** and battery cells **76** provided within the traction battery pack **68** is not intended to limit this disclosure.

(31) In an embodiment, the battery cells **76** of each battery array **74** are prismatic, lithium-ion cells. However, battery cells having other geometries (cylindrical, pouch, etc.), other chemistries (nickel-metal hydride, lead-acid, etc.), or both could alternatively be utilized within the scope of this disclosure.

(32) The battery arrays **74** and various other battery internal components (e.g., bussed electrical center, battery electric control module, wiring, connectors, etc.) may be housed within an interior area **78** of an enclosure assembly **80**. The enclosure assembly **80** may include an enclosure cover **82** and an enclosure tray **84**. The enclosure cover **82** may be secured (e.g., bolted, welded, adhered, etc.) to the enclosure tray **84** to provide the interior area **78**. The size, shape, and overall configuration of the enclosure assembly **80** is not intended to limit this disclosure.

(33) The traction battery pack **68** may include one or more of the valve assemblies **10**. The valve assembly **10** may be disposed within an enclosure wall **12** of the enclosure assembly **80**. The enclosure wall **12** may be part of the enclosure cover **82**, the enclosure tray **84**, or both. The exact mounting location of each valve assembly **10** could vary and is therefore not intended to limit this disclosure.

(34) Each battery cell **76** of the traction battery pack **68** may include a vent port **92** (see FIG. **5**). The vent ports **92** are configured to expel battery vent byproducts V, such as gases, effluent particles, and/or other vent byproducts, from the battery cells **76** during certain battery thermal events. A battery thermal event may occur, for example, during over-charging conditions, over-discharging conditions, or during other conditions.

(35) The valve assemblies **10** may operate in the manner illustrated in FIG. **1** to provide pressure equalization between the interior area **78** of the traction battery pack **68** and atmosphere AT outside of the traction battery pack **68**. The valve assemblies **10** may operate in the manner illustrated in FIG. **2** to degas the battery vent byproducts V during a battery thermal event. The valve assemblies **10** may operate in the manner illustrated in FIG. **3** to leak test the enclosure assembly **80** of the

traction battery pack **68**.
(36) The exemplary valve assemblies of this disclosure provide a multi-functional design (e.g., capable of degassing, providing pressure equalization, and/or providing leak testing) for addressing fluid and gaseous management of certain automotive components. The valve assembles are relatively simply to assemble and manufacture and do not require complex modifications to the automotive component sealing strategy.
(37) Although the different non-limiting embodiments are illustrated as having specific components or steps, the embodiments of this disclosure are not limited to those particular combinations. It is possible to use some of the components or features from any of the non-limiting embodiments in combination with features or components from any of the other non-limiting embodiments.
(38) It should be understood that like reference numerals identify corresponding or similar elements throughout the several drawings. It should be understood that although a particular component arrangement is disclosed and illustrated in these exemplary embodiments, other arrangements could also benefit from the teachings of this disclosure.
(39) The foregoing description shall be interpreted as illustrative and not in any limiting sense. A worker of ordinary skill in the art would understand that certain modifications could come within the scope of this disclosure. For these reasons, the following claims should be studied to determine the true scope and content of this disclosure.

Claims

1. A multi-function valve assembly, comprising: a valve housing; a first valve body movably positioned within the valve housing; a second valve body movably positioned within the valve housing, wherein the first valve body is seated against the second valve body in a default position of the multi-function valve assembly and is unseated relative to the second valve body in an additional position of the multi-function valve assembly; and a water-impermeable membrane secured to the second valve body.
2. The multi-function valve assembly as recited in claim 1, wherein the first valve body is degassing valve body, and the second valve body is a pressure equalization valve body.
3. The multi-function valve assembly as recited in claim 1, comprising a biasing member configured to bias the second valve body against the first valve body during the default position.
4. The multi-function valve assembly as recited in claim 1, comprising a biasing member configured to bias the first valve body against the valve housing during the default position.
5. The multi-function valve assembly as recited in claim 1, wherein the additional position is a degassing position of the multi-function valve assembly.
6. The multi-function valve assembly as recited in claim 5, wherein during the degassing position, the first valve body is configured to move apart from the second valve body to establish a gas path through the valve housing.
7. The multi-function valve assembly as recited in claim 1, wherein the additional position is a leak test position of the multi-function valve assembly.
8. The multi-function valve assembly as recited in claim 7, wherein during the leak test position, the second valve body is configured to move apart from the first valve body.
9. The multi-function valve assembly as recited in claim 1, wherein the water-impermeable membrane is configured to perform a pressure equalization function of the multi-function valve assembly during the default position.
10. The multi-function valve assembly as recited in claim 1, comprising a seal arranged to seal an interface between the first valve body and the second valve body during the default position.
11. The multi-function valve assembly as recited in claim 10, wherein the seal is received within a groove formed in an outer flange of the first valve body.
12. The multi-function valve assembly as recited in claim 11, comprising a second seal arranged to

seal an interface between the first valve body and the valve housing.
13. The multi-function valve assembly as recited in claim 12, wherein the second seal is received within a second groove formed in a circumferential wall of the first valve body.
14. The multi-function valve assembly as recited in claim 1, wherein the first valve body circumscribes an outer flange of the second valve body in both the default position and the additional position.
15. The multi-function valve assembly as recited in claim 1, wherein the first valve body and the second valve body are both poppet-type valves.
16. An automotive component comprising the multi-function valve assembly as recited in claim 1.
17. The automotive component as recited in claim 16, wherein the automotive component is a traction battery pack.
18. The automotive component as recited in claim 16, wherein the multi-function valve assembly is received within an opening of an enclosure wall of the automotive component such that a first portion of the multi-function valve assembly extends within an interior of the automotive component and a second portion of the multi-function valve assembly extends outside the interior and thus interfaces with an atmosphere outside the automotive component.