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(54) **ION FILTER**

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(52) **U.S. Cl.**

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(57) **ABSTRACT**

An ion filter for circulating coolant in a fuel cell stack of a fuel cell vehicle includes a housing including an inlet configured so that a fluid is introduced and an outlet configured so that the fluid is discharged, a filter element accommodated in the housing to filter the fluid, a valve assembly provided on the inlet and configured to operate the flow of the fluid introduced into the housing through the inlet to be allowed or blocked, and a gate member provided in the housing and configured to adjust an operation of the valve assembly.

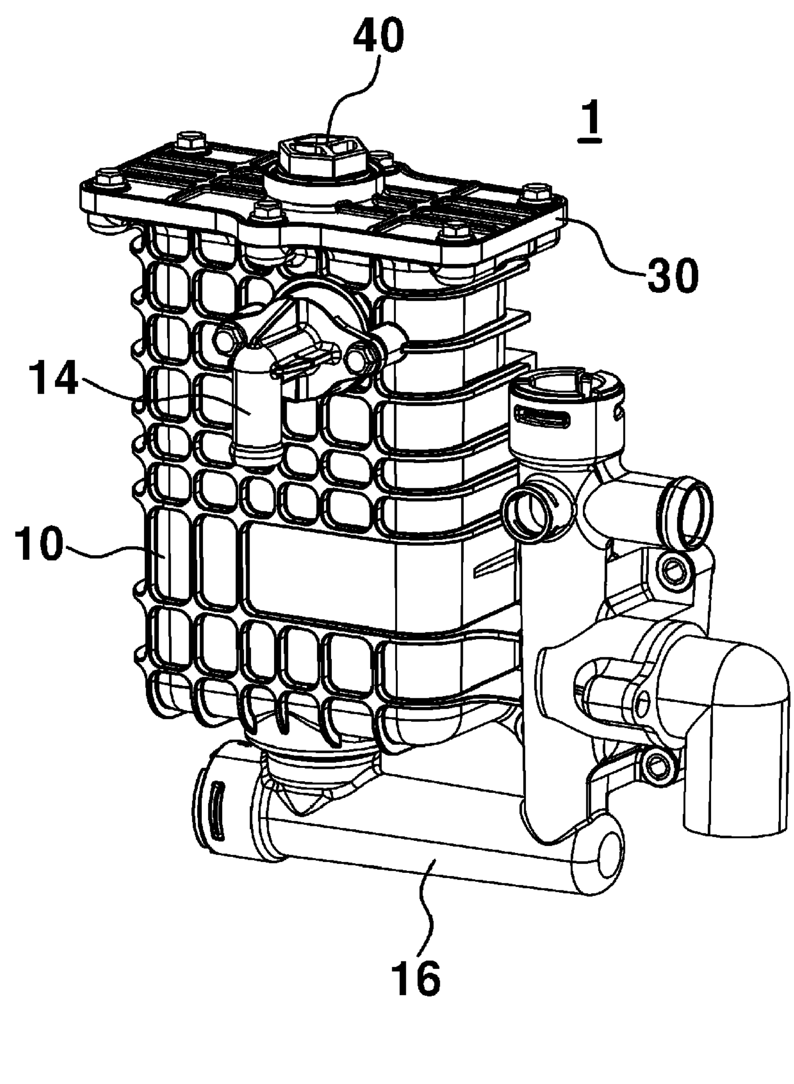


FIG. 1("Related Art")

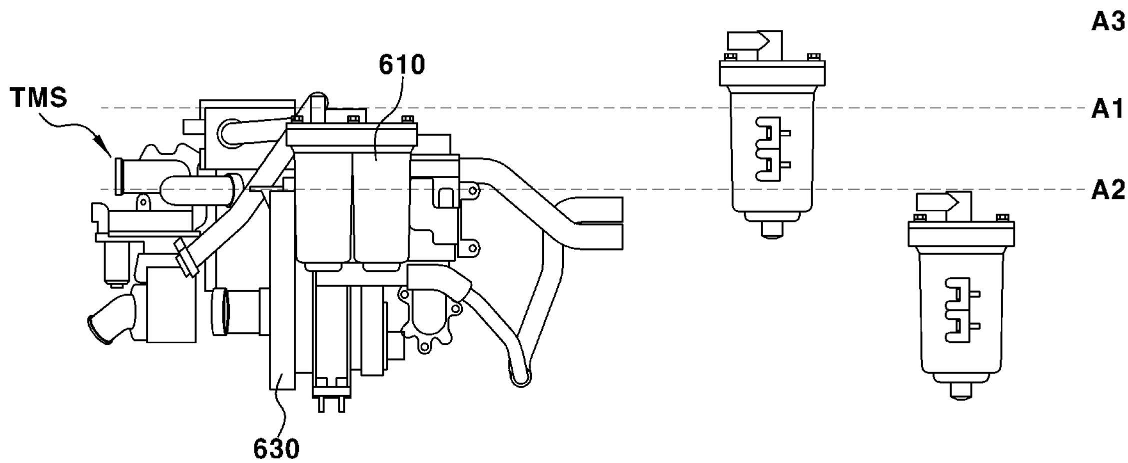


FIG. 2A

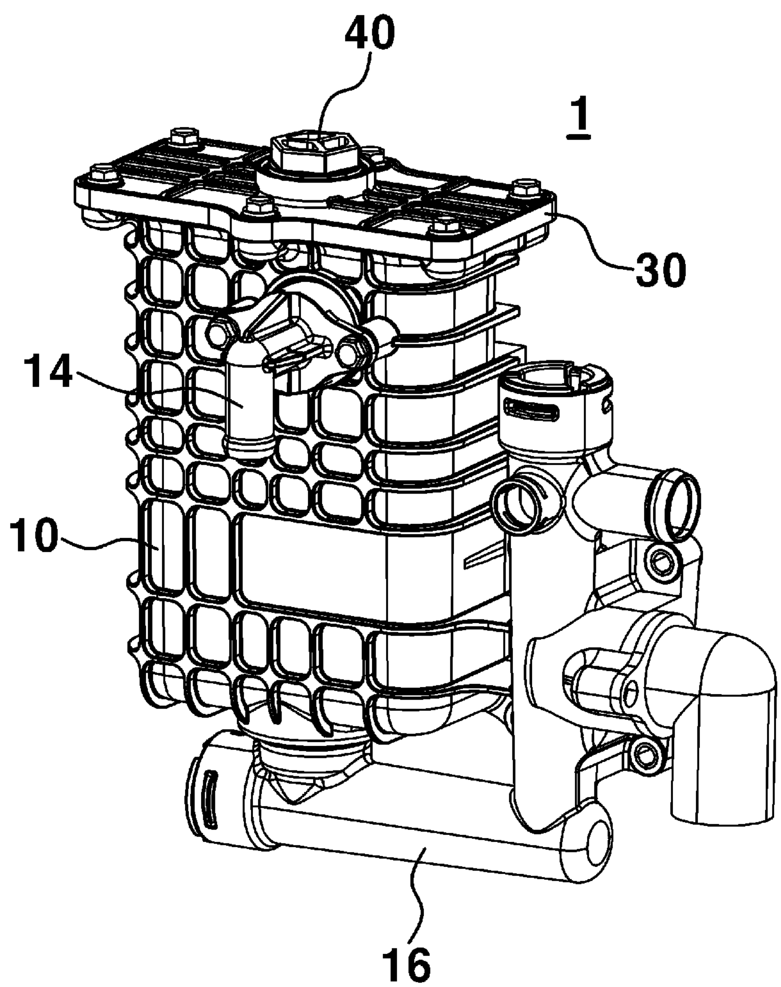


FIG. 2B

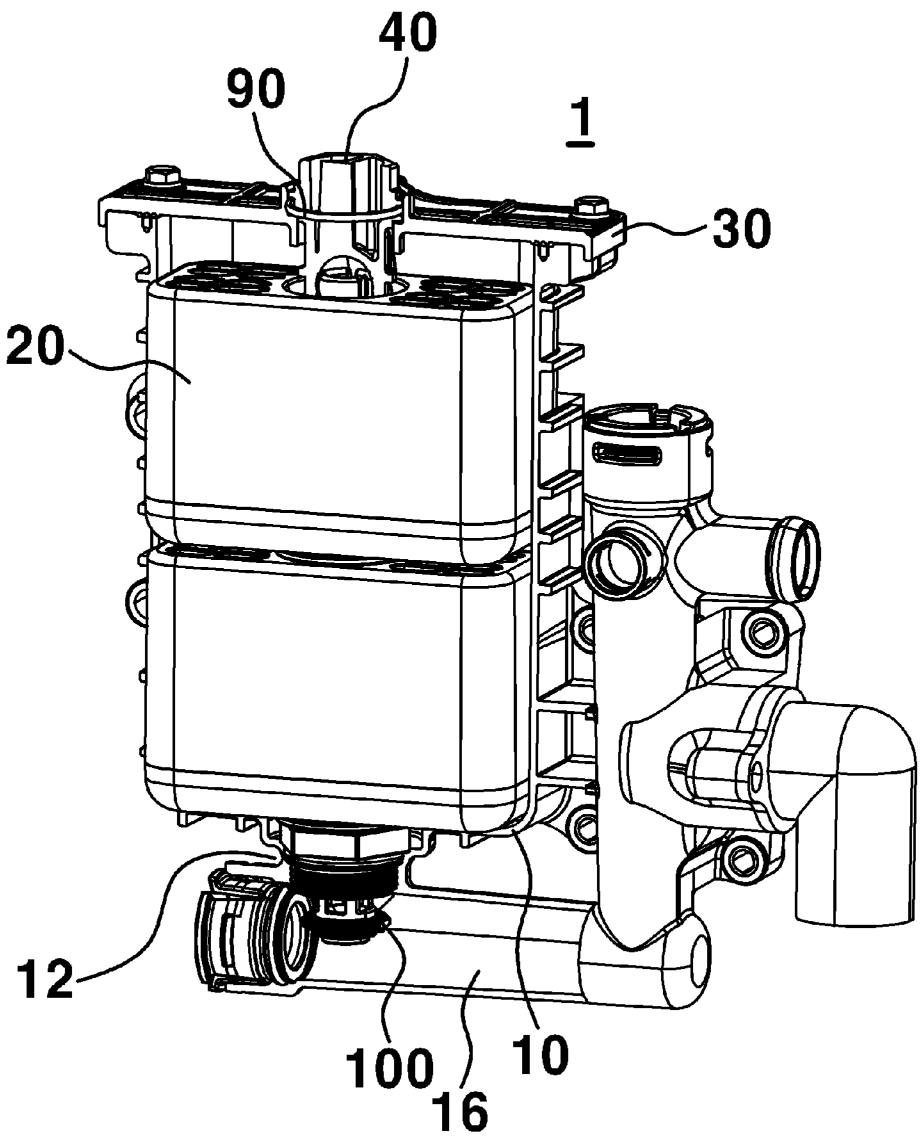


FIG. 3

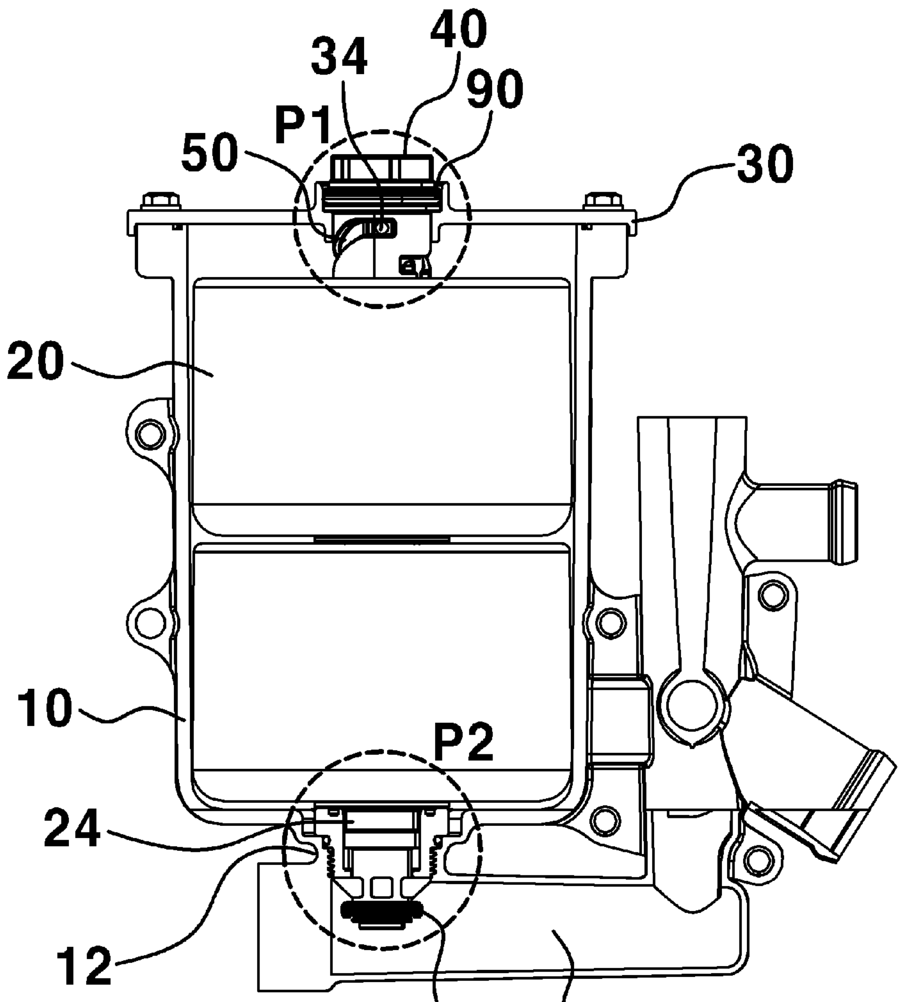


FIG. 4

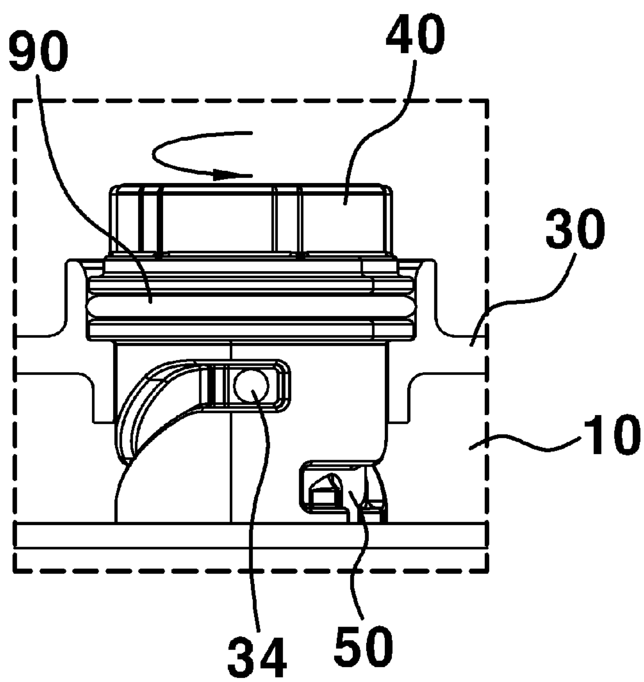


FIG. 5

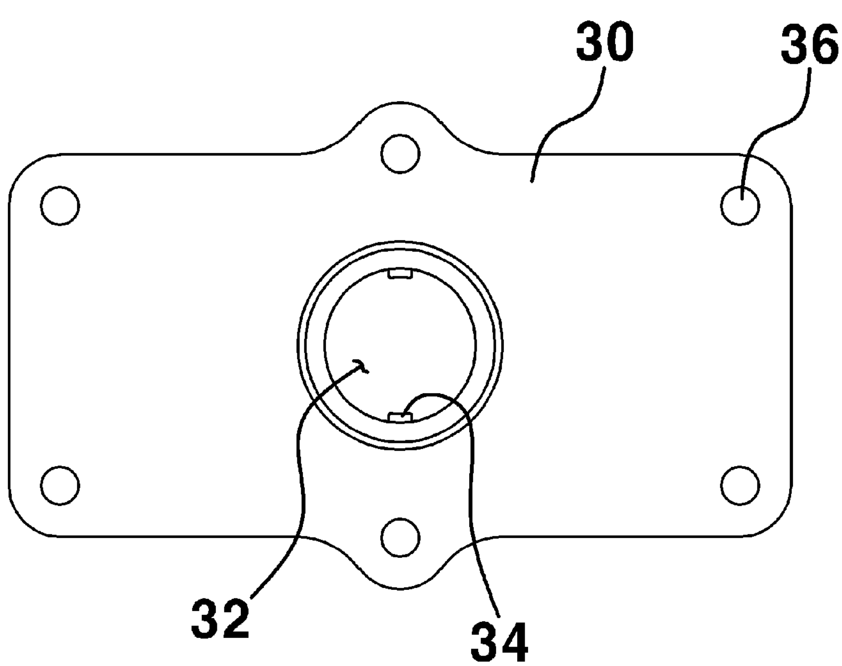


FIG. 6A

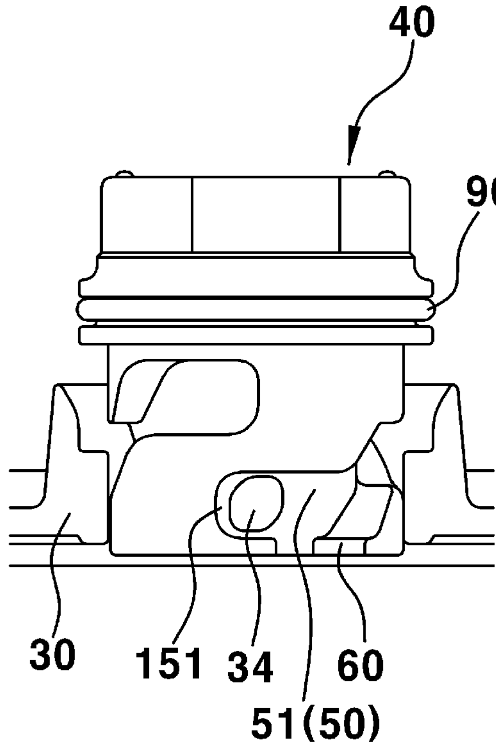


FIG. 6B

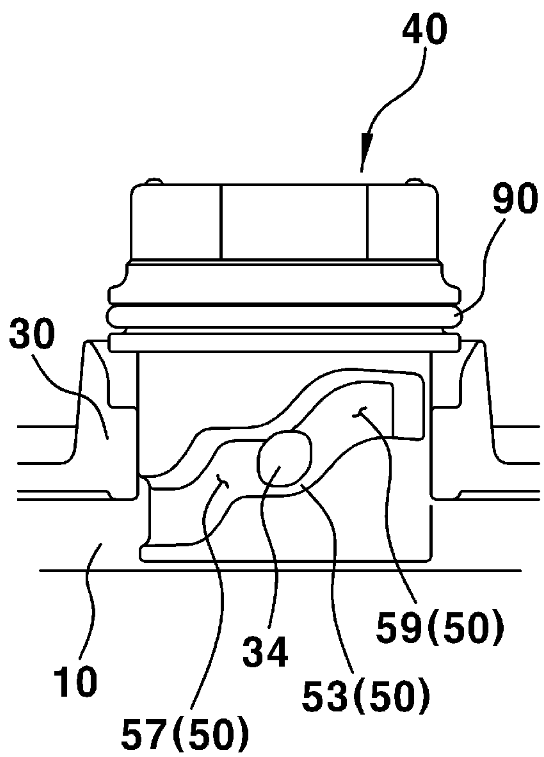


FIG. 6C

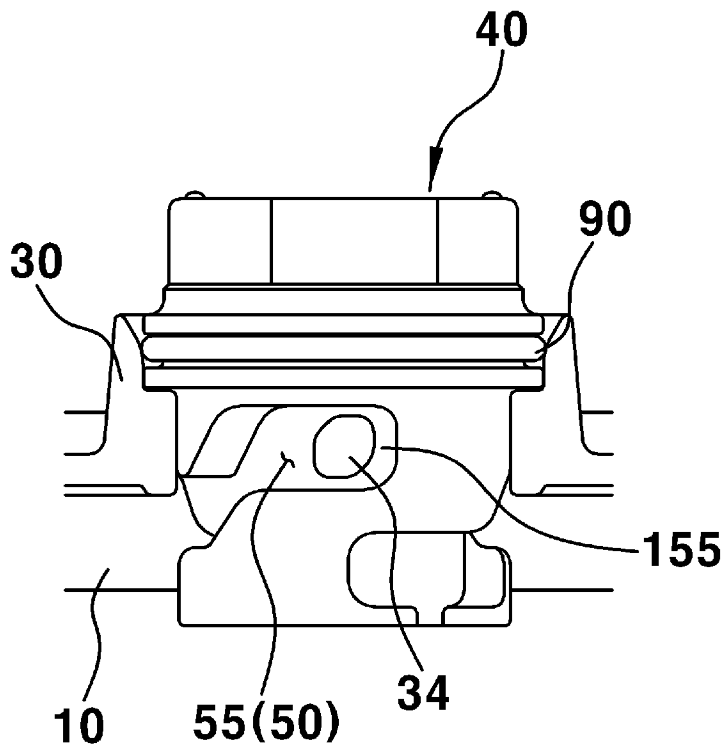


FIG. 7

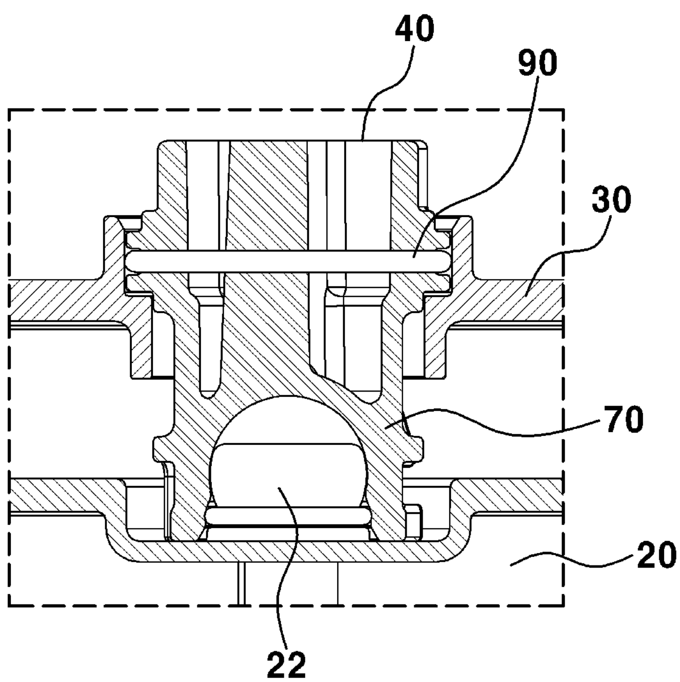


FIG. 8

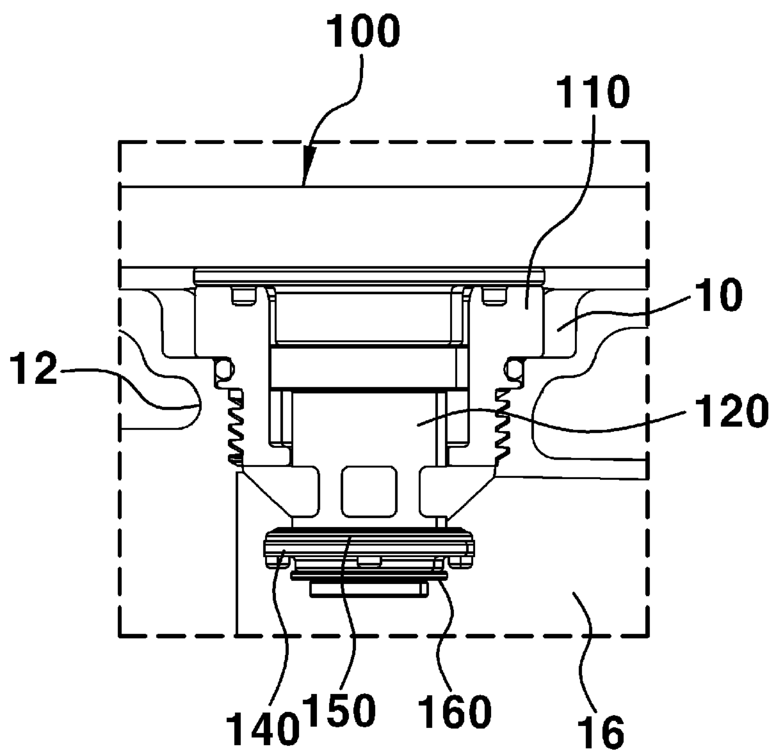

100
110
10
12
120
140
150
160
16

FIG. 9

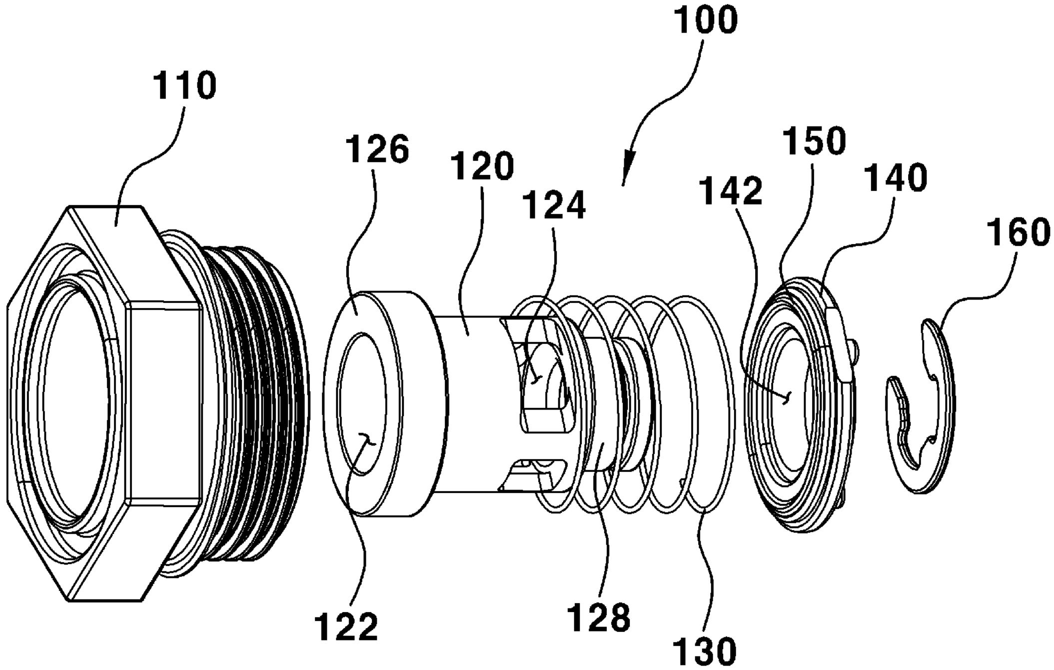

100
110
126
120
124
142
150
140
160
122
128
130

FIG. 10A

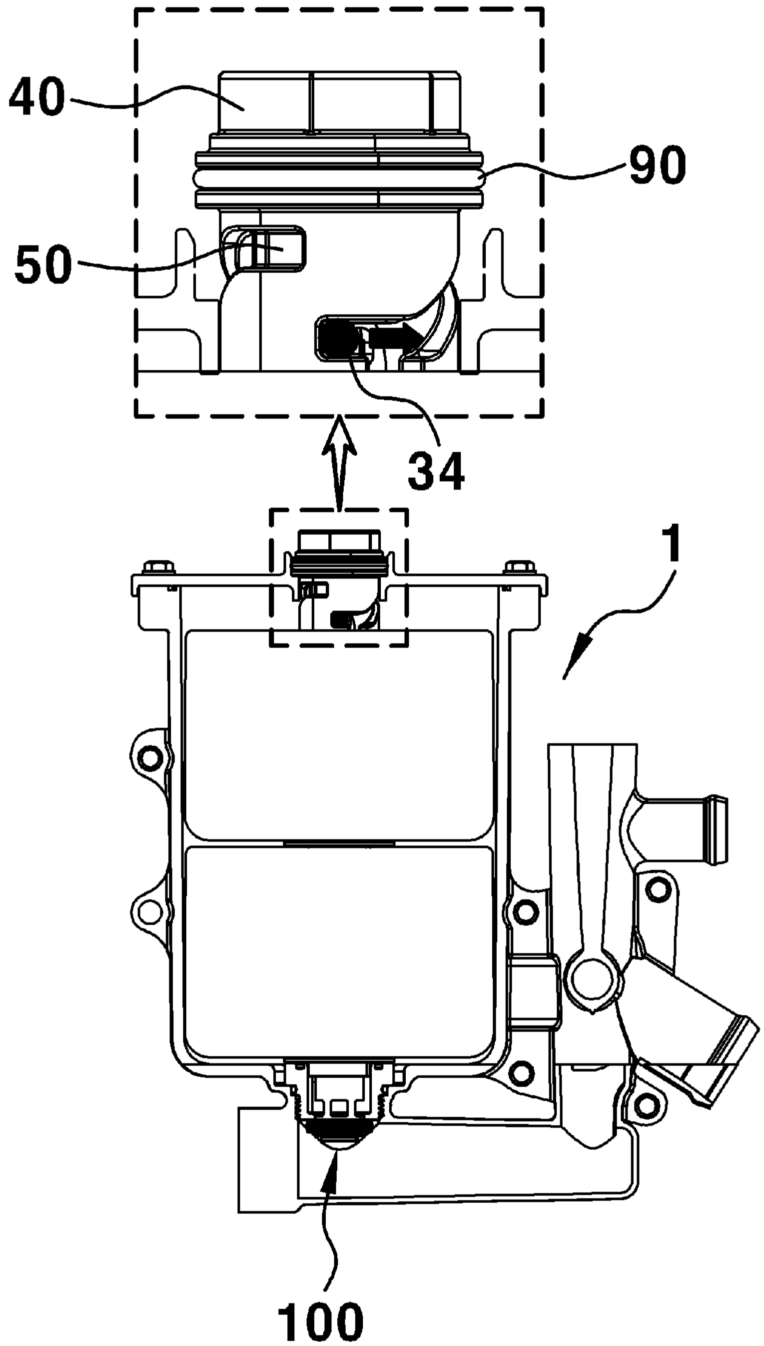


FIG. 10B

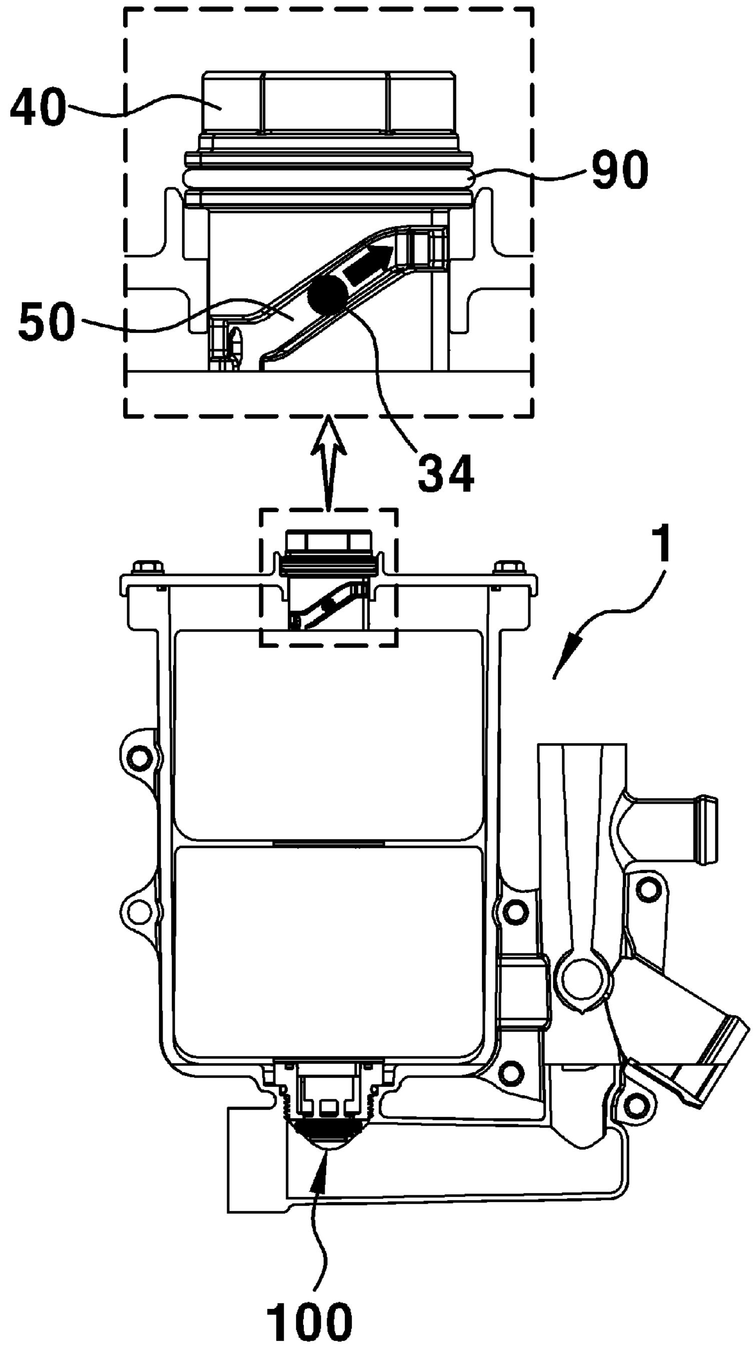


FIG. 10C

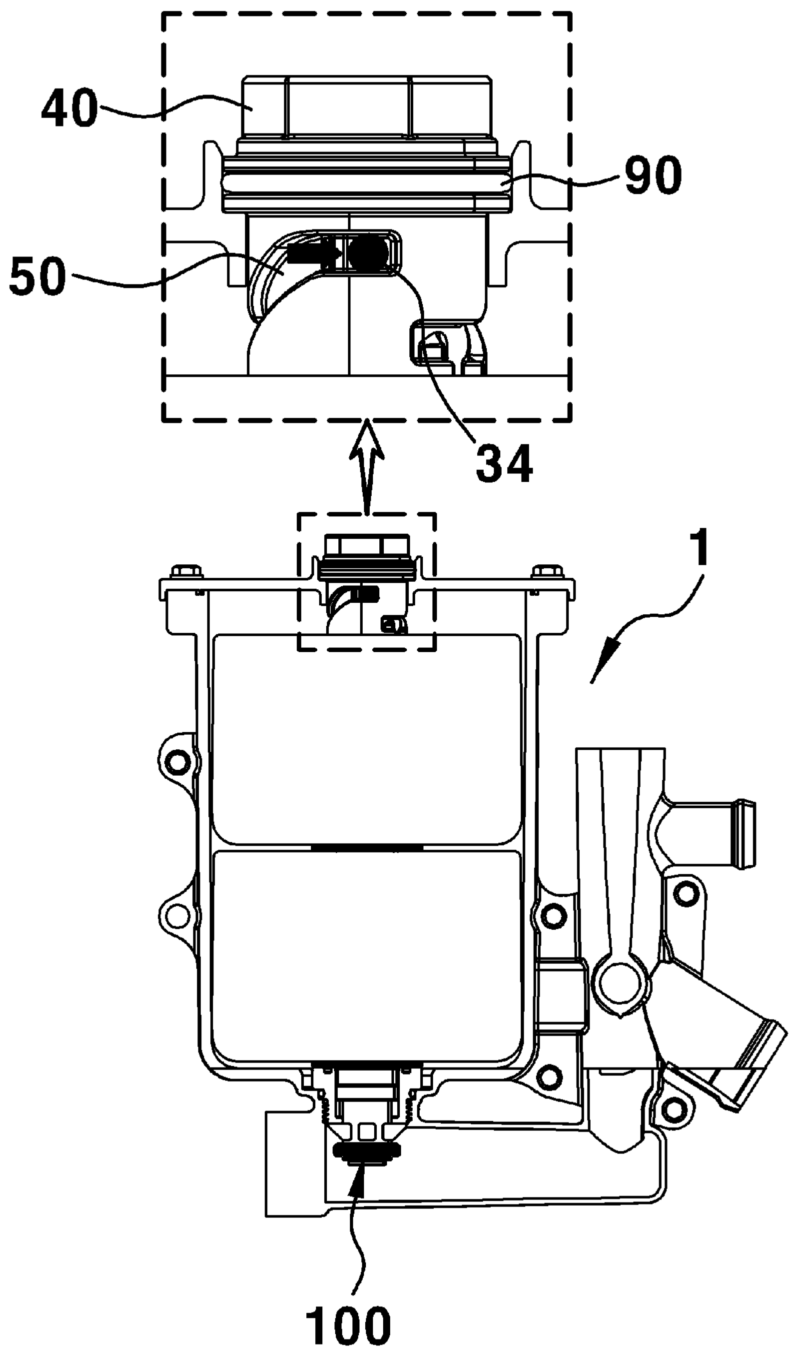


FIG. 11

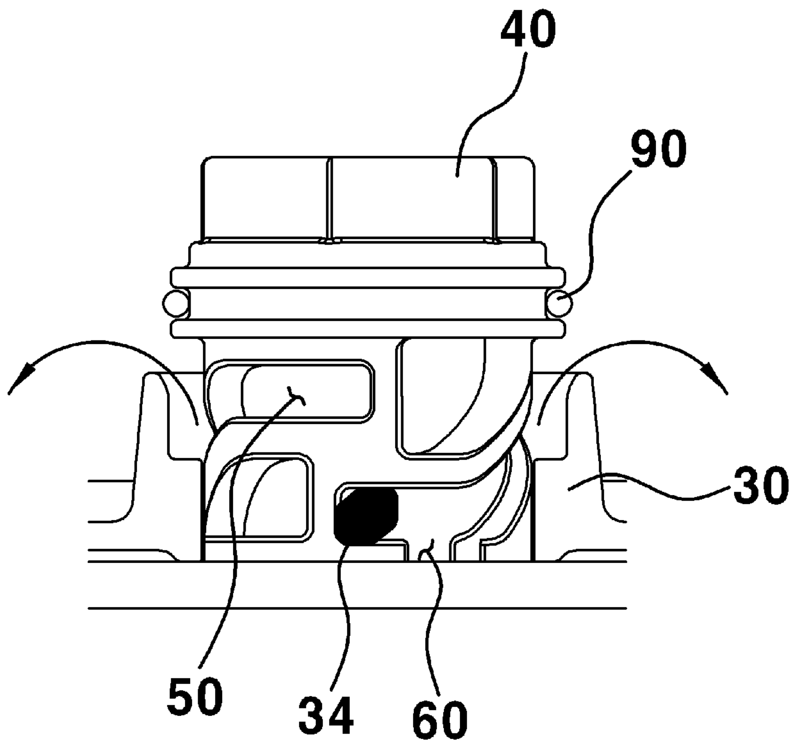
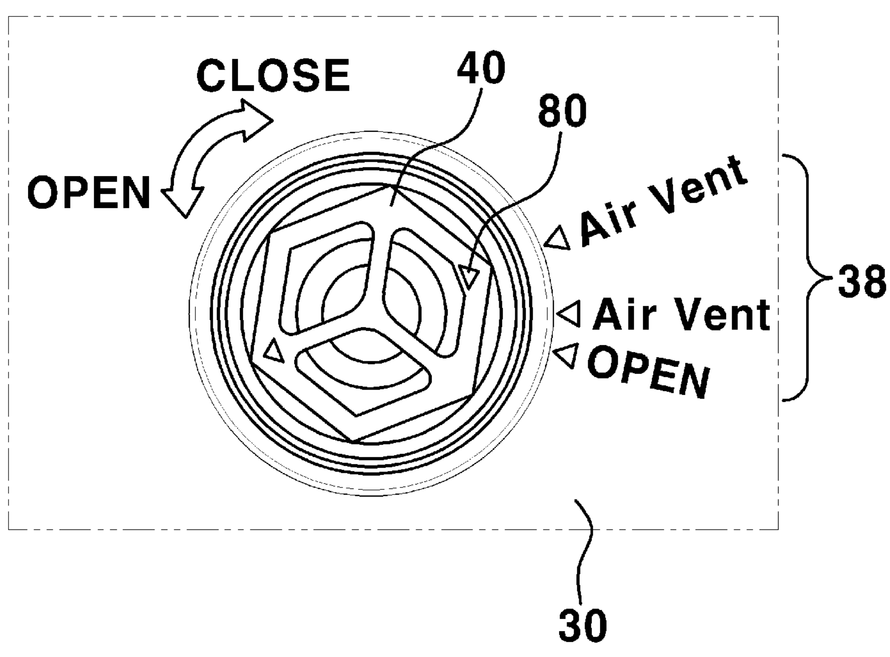


FIG. 12



ION FILTER

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims under 35 U.S.C. § 119(a) the benefit of priority to Korean Patent Application No. 10-2022-0131335 filed on Oct. 13, 2022, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to an ion filter and, particularly, to an ion filter used for circulating a coolant in a fuel cell stack of a fuel cell vehicle.

BACKGROUND

[0003] A fuel cell system generates electric energy through an electrochemical reaction of reaction gases in a fuel cell stack. The fuel cell stack is connected to an air supply device configured to supply air containing oxygen required for the electrochemical reaction and a hydrogen supply device configured to supply hydrogen as fuel. The fuel cell system also includes a heat and water management system for discharging heat and water generated as a result of the electrochemical reaction in the fuel cell stack to the outside.

[0004] As described above, the fuel cell stack discharges heat and water as by-products of the reaction between hydrogen and oxygen, which are reaction gases. Therefore, the fuel cell system includes a cooling device for cooling the stack to prevent an increase in a temperature of the stack and uses a water cooling type for cooling the stack by circulating a coolant through a coolant channel in the stack.

[0005] A fuel cell ion filter is provided in a circulation line of the coolant which circulates through the stack and exits the stack. The ion filter improves the electrical insulation stability of the vehicle by maintaining an electrical conductivity increased by positive and negative ions present in the coolant to a certain level or less.

[0006] An ion filter cartridge filled with an ion exchange resin is mounted in an ion filter housing, and the cartridge needs to be replaced at a certain period due to a filtering life of the ion exchange resin. Due to a need for the periodic management, an upper portion of the ion filter housing needs to be positioned at an uppermost end of a thermal management system (TMS) to minimize the leakage of the coolant when the cartridge is replaced.

[0007] As shown in FIG. **1**, an upper portion of an ion filter housing **610** is disposed to match an uppermost line of the TMS approximately indicated by A**1**. To this end, a length of a mounting bracket **630** is greatly increased so that an upper end of the ion filter housing **610** is disposed at the same position as the line A**1**.

[0008] When the upper portion of the ion filter housing **610** is disposed on a line A**2**, that is, when it is disposed at a lower position than the line A**1**, the upper portion of the ion filter housing **610** is lower than an uppermost end of a coolant line. In this case, there is a problem of excessive loss of coolant after the ion filter cartridge is replaced.

[0009] When the upper portion of the ion filter housing **610** is disposed to approximately match a line A**3**, the upper portion of the ion filter housing **610** is higher than the uppermost end of the coolant line. In this case, air bubbles are collected in the ion filter, and the flow of coolant may be lowered.

[0010] As described above, there is a restriction in the arrangement of the ion filter to be disposed to correspond to the uppermost end of the TMS, and the overall weight and cost of the vehicle are increased due to the increase in the length of the mounting bracket **630**.

SUMMARY

[0011] The present disclosure has been made in efforts to solve the problem, and is directed to providing an ion filter which overcomes head restrictions in a fuel cell system and is easily maintained.

[0012] In addition, the present disclosure is directed to providing an ion filter whose shape may be freely configured.

[0013] An ion filter according to the present disclosure includes a housing including an inlet configured so that a fluid is introduced and an outlet configured so that the fluid is discharged, a filter element accommodated in the housing to filter the fluid, a valve assembly provided on the inlet and configured to operate the flow of the fluid introduced into the housing through the inlet to be allowed or blocked, and a gate member provided in the housing and configured to adjust an operation of the valve assembly.

[0014] According to the present disclosure, it is possible to provide the ion filter which overcomes a head restriction in the fuel cell system and is easily maintained.

[0015] In addition, according to the present disclosure, it is possible to provide the ion filter in which the shape of the ion filter housing can be freely configured.

[0016] The effects of the present disclosure are not limited to the above-described effects, and other effects not mentioned will be able to be clearly recognized by those skilled in the art from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. **1** is a diagram illustrating a conventional ion filter in a fuel cell system for a vehicle.

[0018] FIG. **2**A is a diagram illustrating an example of an ion filter.

[0019] FIG. **2**B is a diagram illustrating an example of an ion filter from which a part of a housing in FIG. **2**A is removed.

[0020] FIG. **3** is a diagram illustrating a front view of an example of the ion filter from which the part of the housing has been removed.

[0021] FIG. **4** is a diagram illustrating an enlarged view of an example of a portion indicated by P**1** in FIG. **3**.

[0022] FIG. **5** is a diagram illustrating a top side view of an example of a lid of the ion filter.

[0023] FIGS. **6**A to **6**C are diagrams illustrating an example of a part of the ion filter and describing an example of an associated operation between the lid and a gate member;

[0024] FIG. **7** is a diagram illustrating another example of the coupling relationship between the gate member and a filter element of the ion filter.

[0025] FIG. **8** is a diagram illustrating an enlarged view of an example of a portion indicated by P**2** in FIG. **3**;

[0026] FIG. **9** is a diagram illustrating an example of an exploded perspective view of an example of a valve assembly of FIG. **8**;

[0027] FIGS. **10**A, **10**B and **10**C are diagrams illustrating an example of a linking operation of the gate member and the valve assembly for allowing or blocking the flow of coolant into the ion filter.

[0028] FIG. **11** is a diagram illustrating an example of a ventilation state of the ion filter.

[0029] FIG. **12** is a diagram illustrating an example of a state display part and a selector for allowing a state in which the flow of coolant into the ion filter is allowed or blocked to be observed from the outside as a portion of the lid of the ion.

DETAILED DESCRIPTION

[0030] Referring to FIGS. **2**A, **2**B, and **3**, an ion filter **1** includes a housing **10**. A filter element **20** is accommodated in the housing **10**. The filter element **20** is configured to filter ions present in a coolant passing through the ion filter **1**. In some implementations, the filter element **20** is a cartridge filter. According to the present disclosure, the housing **10** and the filter element **20** may have a cylindrical shape or may have a shape of a polygonal pillar, such as a rectangular pillar. In particular, the filter element **20** may be operated by a gate member **40** to be described below even when the filter element **20** does not have a circular cross section.

[0031] In addition, a lid **30** is detachably coupled to the housing **10**. In some implementations, a coupling hole **36** is provided in the lid **30**. An insertion hole aligned with the coupling hole **36** is also provided in the housing **10**. The coupling hole **36** and the insertion hole are mounted so that a fastening member, such as a bolt, passes through, and thus the housing **10** and the lid **30** may be separably coupled. In addition, the lid **30** is watertightly coupled to the housing **10** so that the coolant in the housing **10** does not leak between the lid **30** and the housing **10**.

[0032] The housing **10** includes an inlet **12** through which the coolant from the outside is introduced and an outlet **14** through which the coolant having passed through the housing **10** is discharged to the outside. In some implementations, the inlet **12** may be connected to a tubular portion **16**. The tubular portion **16** is connected to a manifold, an external hose, or a pipe portion for supplying a coolant to the ion filter **1**. In addition, in some implementations, the outlet **14** may be provided on the lid **30** or in the housing **10**.

[0033] As shown in FIG. **4**, the gate member **40** is mounted on the lid **30**. Specifically, the gate member **40** is rotatably mounted with respect to the lid **30**. The gate member **40** allows the filter element **20** to be easily replaced while minimizing the loss of coolant when the filter element **20** is replaced.

[0034] To this end, the gate member **40** is operatively coupled to the lid **30**. A guide groove **50** is formed in the gate member **40**. The guide groove **50** is formed to be recessed in an outer surface of the gate member **40** and extends in a substantially longitudinal direction of the gate member **40**.

[0035] In addition, as well shown in FIG. **5**, the lid **30** includes an opening **32**. The gate member **40** is rotatably mounted in the opening **32**. The opening **32** of the lid **30** is provided with a protrusion **34**. In some implementations, a pair of protrusions **34** may be provided to face each other. The protrusion **34** is seated in the guide groove **50** of the gate member **40**, and the gate member **40** may rotate in a state in which the protrusion **34** is seated in the guide groove **50**. Therefore, the protrusion **34** is fixed to the lid **30**, but when the protrusion **34** is viewed from the guide groove **50**, it may be perceived that the protrusion **34** relatively moves along the guide groove **50** when the gate member **40** rotates.

[0036] As shown in FIGS. **6**A to **6**C, the guide groove **50** is configured to extend from a lower side to an upper side of the gate member **40** along a circumference of the gate member **40**. The guide groove **50** includes a lower flat portion **51**, an intermediate flat portion **53**, and an upper flat portion **55**. A lower inclined portion **57** extending obliquely along the circumference of the gate member **40** is provided in the guide groove **50** between the lower flat portion **51** and the intermediate flat portion **53**. Also, the guide groove **50** includes an upper inclined portion **59** obliquely extending along the circumference of the gate member **40** between the intermediate flat portion **53** and the upper flat portion **55**.

[0037] In some implementations, the upper flat portion **55** is provided with an upper stopper **155**. In addition, the lower flat portion **51** is provided with a lower stopper **151**. The lower stopper **151** and the upper stopper **155** are configured to restrict the vertical movement of the filter element **20** by limiting the movement of the protrusion **34**. As described above, the protrusion **34** may include a plurality of positions while continuously moving from the lower flat portion **51** to the upper flat portion **55** of the guide groove **50**.

[0038] The guide groove **50** may include a separation groove **60**. The separation groove **60** may be configured to extend vertically from the guide groove **50**, for example, the lower flat portion **51** to the lower side of the gate member **40**. The separation groove **60** enables the lid **30** coupled to the gate member **40** to be separated from the gate member **40**. However, even when the separation groove **60** is not present, the protrusion **34** of the lid **30** and the guide groove **50** of the gate member **40** may be attached or detached together in a coupled state.

[0039] A packing member **90** is mounted between the gate member **40** and the lid **30**. When a valve assembly **100** is in an open state (i.e., allowing the flow of coolant through the ion filter **1**), the packing member **90** may seal an inner side and outer side of the housing **10**. Therefore, the coolant passing through the ion filter **1** is only discharged through the outlet **14**. However, as described below, the ion filter **1** may be set to a ventilation state. In this case, the packing member **90** is spaced apart from the opening **32**, and the valve assembly **100** may be in a partially open state.

[0040] As shown in FIG. **7**, the gate member **40** is rotatably fixed to the filter element **20**. To this end, the gate member **40** includes a connection part **70**. In some implementations, the connection part **70** may be a socket joint provided at a lower end of the gate member **40**. The filter element **20** includes a coupling part **22**. The coupling part **22** is connected to the connection part **70** to rotatably fix the gate member **40**. In some implementations, the coupling part **22** may be a ball joint inserted into and mounted to the connection part **70**. Therefore, the filter element **20** may move vertically within the housing **10** by the rotation of the gate member **40**. Of course, an extra space is present in the housing **10** in which the filter element **20** may move vertically.

[0041] As shown in FIG. **8**, the ion filter **1** according to the present disclosure includes the valve assembly **100**. The valve assembly **100** is mounted to the inlet **12** of the ion filter **1** and operatively associated with the gate member **40**. This will be described below. The valve assembly **100** includes a closed position at which the flow to the inlet **12** of the ion filter **1** is blocked, an open position at which the flow through the inlet **12** of the ion filter **1** is allowed, and a partially open position between the closed position and the open position.

[0042] As well shown in FIG. **9**, the valve assembly **100** includes a valve housing **110**. The valve housing **110** is fixed to the housing **10**. In some implementations, the valve housing **110** is thread-coupled into the housing **10**. In some implementations, the valve housing **110** may be seated on and fixed to the inlet **12** of the housing **10**.

[0043] The valve assembly **100** includes a core **120**. The core **120** is accommodated inside the valve housing **110**. The core **120** is accommodated inside the valve housing **110** such that the core **120** may linearly move in a longitudinal direction of the housing **10**.

[0044] The core **120** includes a hollow **122**. The hollow **122** is formed in a longitudinal direction of the core **120**, and the coolant flows through the hollow **122**. The core **120** is formed with an opening **124** passing through a circumference thereof. The coolant may flow into an inner side or the hollow **122** of the core **120** through the opening **124**.

[0045] An elastic member **130** is mounted between the valve housing **110** and the core **120**. The elastic member **130** is supported by the valve housing **110**. When the core **120** moves toward the elastic member **130**, the elastic member **130** is compressed between a flange **126** formed at one end of the core **120** and the valve housing **110**. When the core **120** returns to an original position, the elastic member **130** returns to the original position between the flange **126** and the valve housing **110**. As a non-limiting example, the elastic member **130** may be a spring. However, the elastic member **130** may be a member made of various materials and having various structures capable of providing a restoring force as well as the spring.

[0046] A plate member **140** is coupled to the core **120**. In some implementations, the core **120** may be provided with an engagement part **128** which may be inserted into the plate member **140**. The plate member **140** may be formed with a hole **142** into which the engagement part **128** may be inserted. The plate member **140** may block the inlet **12** or a flow path formed in the housing **10**. The plate member **140** is coupled to the core **120** to be positioned outside the valve housing **110**. A sealing member **150** for watertightness may be provided on a surface of the plate member **140** coming into contact with the valve housing **110**. The plate member **140** can prevent backflow by coming into close contact with the valve housing **110** when the flow of coolant is blocked.

[0047] A retainer ring **160** is mounted on the coupling part **22** of the core **120** having passed through the hole **142**. The retainer ring **160** fixes the core **120** and the plate member **140**. As a non-limiting example, the retainer ring **160** may be an E-ring.

[0048] Referring back to FIG. **3**, the filter element **20** includes a contact part **24**. The contact part **24** operatively associates the valve assembly **100** with the gate member **40**. Specifically, the contact part **24** presses or releases the core **120** of the valve assembly **100** by the vertical movement of the filter element **20**. The valve assembly **100** is positioned at an open position by pressing the core **120** by the contact part **24**, while the valve assembly **100** is positioned at a closed position by being released from the core **120**.

[0049] As shown in FIGS. **10**A to **10**C, an operation of the ion filter **1** according to the present disclosure is as follows.

[0050] In FIG. **10**A, the protrusion **34** is positioned on the lower flat portion **51** of the guide groove **50**, and the valve assembly **100** is positioned at the closed position. Therefore, in this state, the flow from the tubular portion **16** to the inlet **12** of the housing **10** is impossible, and the filter element **20** may be replaced.

[0051] In other words, in FIG. **10**A, the ion filter **1** is in a replaceable state. Since the valve assembly **100** is in the closed state, no coolant is introduced into the housing **10** through the tubular portion **16**. In addition, the gate member **40** is positioned at an uppermost position where the protrusion **34** is positioned on the lower flat portion **51**. Therefore, the filter element **20** coupled to the gate member **40** is also in a state of moving up in the housing **10**, and the filter element **20** may be replaced by detaching the lid **30**.

[0052] When the gate member **40** is rotated in the state of FIG. **10**A, the protrusion **34** is in a state of moving along the lower inclined portion **57** as shown in FIG. **10**B. At this time, the filter element **20** coupled to the gate member **40** gradually moves down in the housing **10**. As the valve assembly **100** is gradually opened by the elastic member **130**, the coolant may be partially introduced into the housing **10** through the tubular portion **16**. At this time, according to the present disclosure, it is possible to implement an air vent function through the intermediate flat portion **53**. This will be described below.

[0053] When the gate member **40** is continuously rotated in the state of FIG. **10**B, the protrusion **34** moves to the upper flat portion **55** through the intermediate flat portion **53** and the upper inclined portion **59** as shown in FIG. **10**C. At this time, the rotation of the gate member **40** may not be further rotated by the upper stopper **155**. In this state, the valve assembly **100** is completely opened, and the coolant is introduced into the housing **10**. In this state, the vehicle is traveling.

[0054] As described above, the ion filter **1** according to the present disclosure can achieve the air vent function through the gate member **40** without a separate configuration for the air vent.

[0055] In the state as in FIG. **10**B, that is, while the protrusion **34** moves from the lower flat portion **51** (the state of FIG. **10**A) to the upper flat portion **55** (the state of FIG. **10**C), the valve assembly **100** may be ventilated as it is in a partially open state (see FIG. **11**). In other words, when the protrusion **34** is positioned on the intermediate flat portion **53**, the packing member **90** is also spaced apart from the opening **32**, and the valve assembly **100** may be ventilated because it is also in the partially open state.

[0056] Moreover, the ion filter **1** may include a state display part **38** and a selector **80** so that a state of the ion filter may be easily recognized from the outside. The state of the ion filter **1** may be displayed in various methods through the state display part **38** and the selector **80**. As a non-limiting example, referring to FIG. **12**, the lid **30** is provided with the state display part **38** indicating open (OPEN), ventilated (AIR VENT), and closed (CLOSE) states. As another non-limiting example, the state display part **38** may also be configured to indicate replacement, operating, and ventilated states of the ion filter **1**. Also, the rotated gate member **40** may have the selector **80** capable of displaying each state. The state of the ion filter **1** can be easily recognized from the outside by the state display part **38**

indicated by the selector **80**. Conventionally, a separate structure for ventilation is included in the ion filter **1**. On the contrary, according to the present disclosure, even the ventilation function may be implemented with one gate member **40**, thereby simplifying the device.

[0057] As described above, the present disclosure provides an ion filter capable of improving maintainability not only in a circular cartridge but also in an atypical cartridge.

What is claimed is:

1. An ion filter comprising:

a housing providing an inlet configured to receive fluid and an outlet configured to discharge the fluid in the housing;

a filter element accommodated in the housing and configured to filter the fluid;

a valve assembly provided at the inlet and configured to selectively allow or block the fluid to be introduced into the housing through the inlet; and

a gate member provided in the housing and configured to control an operation of the valve assembly.

2. The ion filter of claim **1**, wherein the gate member is rotatably mounted with respect to the housing, the filter element is coupled to the gate member, and the filter element is configured to, based on a rotation of the gate member, selectively press or release the valve assembly by linearly moving in the housing.

3. The ion filter of claim **2**, wherein the gate member includes a socket-shaped connection part, and

wherein the filter element includes a ball-shaped coupling part inserted into and coupled to the socket-shaped connection part.

4. The ion filter of claim **2**, wherein the valve assembly includes:

a valve housing coupled to the inlet of the housing, and

a core configured to (i) move in the valve housing by the filter element and (ii) open or close the inlet.

5. The ion filter of claim **4**, wherein the valve assembly further includes an elastic member disposed at a circumferential surface of the core, supported by the valve housing, and configured to provide a restoring force to the core.

6. The ion filter of claim **5**, wherein the valve assembly further includes:

a plate member coupled to the core and covering the inlet from an outside of the valve assembly, and

a sealing member configured to provide sealing between the plate member and the inlet.

7. The ion filter of claim **2**, wherein the housing further includes a lid detachably coupled to the housing and defining an opening in which the gate member is rotatably mounted, and

wherein the lid provides a protrusion at a circumference of the opening to be operatively associated with the gate member.

8. The ion filter of claim **7**, wherein the gate member includes a guide groove recessed from a surface of the gate member and configured to move with respect to the protrusion.

9. The ion filter of claim **8**, wherein the guide groove further includes:

a lower flat portion positioned on a lower side of the gate member, and

an upper flat portion positioned on an upper side of the gate member, and

wherein the guide groove includes an inclined portion extending obliquely along a circumference of the gate member from the lower flat portion to the upper flat portion.

10. The ion filter of claim **9**, wherein the guide groove further includes an intermediate flat portion positioned between the lower flat portion and the upper flat portion.

11. The ion filter of claim **9**, further comprising: a separation groove extending from the lower flat portion to a lower end of the gate member.

12. The ion filter of claim **9**, wherein the lower flat portion and the upper flat portion are provided with a lower stopper and an upper stopper configured to block movement of the protrusion, respectively.

13. The ion filter of claim **10**, further comprising:

a packing member mounted at a circumference of the lid.

14. The ion filter of claim **13**, wherein the filter element is configured to, based on the protrusion being positioned on the upper flat portion, (i) press the valve assembly to be in an open position and (ii) move the packing member to contact the opening.

15. The ion filter of claim **13**, wherein the filter element is configured to, based on the protrusion being positioned on the lower flat portion, (i) release the valve assembly to be in a closed position and (ii) to move the packing member to be spaced apart from the opening.

16. The ion filter of claim **13**, wherein, based on the protrusion being positioned at the intermediate flat portion, the valve assembly is at a partially open position, and the packing member is spaced apart from the opening.

17. The ion filter of claim **10**, wherein a position of the valve assembly is determined according to a position of the protrusion with respect to the guide groove.

18. The ion filter of claim **17**, wherein an upper surface of the gate member is provided with a selector, and

wherein the lid includes a state display part configured to display a state of the ion filter using a point indicated by the selector.

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