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ELECTRIC STORAGE DEVICE AND SEPARATOR THEREOF

Abstract

Provided is a technique that does not inhibit an intrusion of the electrolytic solution from outside to inside of the electrode assembly, and that can suppress the electrolytic solution from outflowing to the outside from the inside of the electrode assembly. A herein disclosed electric storage device includes the electrode assembly including a positive electrode, a negative electrode, and a separator, includes an electrolytic solution, and includes a case configured to accommodate the electrode assembly and the electrolytic solution. The electric storage device includes a reverse flow inhibiting groove on a surface of the separator. The reverse flow inhibiting groove is a groove in which the electrolytic solution flows from the outside to the inside of the electrode assembly, and is a groove which is in a pattern for inhibiting the electrolytic solution from flowing to the outside from the inside of the electrode assembly.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS
[0001] The present application claims the priority based on Japanese Patent Application No. 2024-019226 filed on Feb. 13, 2024, the entire contents of which are incorporated in the present specification by reference.
BACKGROUND OF THE DISCLOSURE
1. Technical Field
[0002] The present disclosure relates to an electric storage device, and a separator used for the electric storage device.
2. Background
[0003] Japanese Patent Application Publication No. 2022-12289 discloses a nonaqueous electrolytic solution secondary battery that includes an electrode assembly, in which a positive electrode, a negative electrode, and a separator are overlaid, and that includes a nonaqueous electrolytic solution which osmoses inside the electrode assembly. Each of the positive electrode and the negative electrode is formed by making an electrode composite material layer containing an electrode active material be applied to coat a surface of an electrode collecting foil being formed in a strip-like shape. The electrode assembly includes an electrolytic solution flow passage that is a flow channel for the nonaqueous electrolytic solution flowing at an inside and an outside of the electrode assembly. Regarding a negative electrode composite material layer, in a case where an area coming into contact with the electrolytic solution flow passage is treated as a damming part and an area positioning at a central side more than the damming part is treated as a liquid retaining part, the damming part has a higher electric potential with respect to a positive electrode active material in comparison with the negative electrode active material contained in the liquid retaining part and contains the negative electrode active material whose expansion and contraction rate according to increase and decrease of a SOC is large. That publication describes that it is possible, by the configuration described above, to properly inhibit a shortage of the nonaqueous electrolytic solution at the inside of the electrode assembly, so as to maintain a battery performance of the nonaqueous electrolytic solution secondary battery being in a suitable state.
[0004] An electrode disclosed by Japanese Patent Application Publication No. 2023-100057 includes a base material, and an active material layer arranged on a surface of the base material. On a surface of the active material layer, 1 or more grooves are formed. The grooves are configured to extend in a line shape along the surface of the active material layer, and to include an inlet area, a middle area, and an outlet area in a plane view. The inlet area includes an inlet opening part at a peripheral edge of the active material layer. The outlet area includes an outlet opening part at the peripheral edge of the active material layer. The middle area is arranged between the inlet area and the outlet area and connects the inlet area and the outlet area. Each of the inlet area and the outlet area is configured to make a first pressure loss at a time of flowing a fluid in a forward direction be smaller than a second pressure loss at a time of flowing a fluid in a backward direction. The forward direction represents a direction toward the outlet area from the inlet area, and the backward direction represents a direction toward the inlet area from the outlet area. That publication describes that, by the configuration described above, a directivity is caused on a flow of the electrolytic solution in the groove of the electrode, and thus it becomes easy to exhaust a bubble.
SUMMARY
[0005] The present inventor thinks to implement not inhibiting an intrusion of the electrolytic

solution from the outside of the electrode assembly to the inside of the electrode assembly, but suppressing the electrolytic solution from outflowing from the inside to the outside of the electrode assembly.
[0006] According to the herein disclosed technique, an electric storage device is disclosed that includes an electrode assembly including a positive electrode, a negative electrode, and a separator, includes an electrolytic solution, and includes a case configured to accommodate the electrode assembly and the electrolytic solution. The electric storage device includes a reverse flow inhibiting groove on a surface of the separator. The reverse flow inhibiting groove is a groove in which the electrolytic solution flows from the outside to the inside of the electrode assembly, and is a groove which is formed in a pattern for inhibiting a fluid of the electrolytic solution flowing from the inside to the outside of the electrode assembly. In accordance with such a configuration, it is possible to implement not inhibiting an intrusion of the electrolytic solution from the outside of the electrode assembly to the inside of the electrode assembly, but suppressing the electrolytic solution from outflowing to the outside from the inside of the electrode assembly.
[0007] According to the herein disclosed technique, a separator is disclosed that is used for an electric storage device which includes an electrode assembly including a positive electrode, a negative electrode, and a separator, which includes an electrolytic solution, and which includes a case configured to accommodate the electrode assembly and the electrolytic solution. The separator includes a reverse flow inhibiting groove on a surface. The reverse flow inhibiting groove is a groove in which the electrolytic solution flows from the outside to the inside of the electrode assembly, and is a groove which is formed in a pattern for inhibiting the fluid of the electrolytic solution flowing from the inside to the outside of the electrode assembly. In accordance with such a configuration, it is possible to implement not inhibiting an intrusion of the electrolytic solution from the outside of the electrode assembly to the inside of the electrode assembly, but suppressing the electrolytic solution from outflowing to the outside from the inside of the electrode assembly.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0008] FIG. **1** is a perspective view that schematically shows a battery **1**.
[0009] FIG. **2** is a II-II cross section view of FIG. **1**.
[0010] FIG. **3** is a perspective view that shows an electrode assembly **20** attached to a sealing plate **14**.
[0011] FIG. **4** is a perspective view that shows an electrode assembly **20** on which a second electrical collector part **52** is attached.
[0012] FIG. **5** is a schematic view of the electrode assembly **20**.
[0013] FIG. **6** is a plane view of a separator **26**.
[0014] FIG. **7** is an explanation view of a shape of a reverse flow inhibiting groove **27**.
[0015] FIG. **8** is a IIX-IIX cross section view of FIG. **6**.
[0016] FIG. **9** is a plane view of a separator **226**.
[0017] FIG. **10** is a schematic view of an electrode assembly **320**.
[0018] FIG. **11** is a perspective view of an electrode assembly **420**.
DESCRIPTION OF THE EMBODIMENTS
[0019] Below, an embodiment of a herein disclosed technique would be explained. The embodiment explained herein is not intended to particularly restrict the herein disclosed technique. The herein disclosed technique is not restricted to the embodiment explained herein, unless specifically mentioned. Drawings are schematically shown, and thus might not always reflect a real product. The members/parts providing the same effect are suitably provided with the same numerals and signs, and overlapping explanations might be omitted. In the drawings, reference

signs of “F”, “Rr”, “R”, “L”, “U”, and “D” respectively show front, rear, right, left, up, and down. A wording “A to B” representing a numerical value range is to mean, unless specifically mentioned, “equal to or more than A and not more than B” and in addition, is to semantically cover a meaning of “more than A and less than B”.

[0020] In the present specification, a wording “electric storage device” means a device that generates an electric charge and discharge by moving a charge carrier between a pair of electrodes (a positive electrode and a negative electrode) through an electrolyte. The electric storage device described above semantically covers a secondary battery, such as lithium ion secondary battery, nickel hydrogen battery, and nickel cadmium battery, and a capacitor, such as lithium ion capacitor, and electric double layer capacitor. Below, as an example of the above described electric storage device, an embodiment in a case where the lithium ion secondary battery is set to be an object will be described. Thus, the electric storage device explained below might be simply referred to as “battery”.

[0021] FIG. **1** is a perspective view that schematically shows a battery **1**. FIG. **2** is a II-II cross section view of FIG. **1**. As shown in FIG. **1** and FIG. **2**, the battery **1** includes a case **10**, an electrode assembly **20**, a positive electrode terminal **30**, a negative electrode terminal **40**, outside conductive members **35**, **45**, a positive electrode collecting member **50**, a negative electrode collecting member **60**, an insulator **70**, a gasket **90**, and an outside insulating member **92**. Although omitted in drawings, the battery **1** includes, for example, an electrolytic solution. As the electrolytic solution, it is possible to use an electrolytic solution used as an electrolytic solution of this kind of lithium ion secondary battery, without particular restriction. A composition of the electrolytic solution described above is not to characterize the herein disclosed technique, and thus a detailed explanation herein is omitted.

[0022] The case **10** in this embodiment is a housing configured to accommodate the electrode assembly **20** and the electrolytic solution at the inside. The case **10** herein has an outer appearance that is formed in a flat and bottomed rectangular parallelepiped shape (a square shape). A material of the case **10** might be the same as a material conventionally used, and is not particularly restricted. It is preferable that the case **10** is made of a metal, and it is further preferable that the case is, for example, made from aluminum, aluminum alloy, iron, iron alloy, or the like.

[0023] The case **10** in this embodiment includes an outer case **12** and a sealing plate (a cover) **14**. The outer case **12** includes, as shown in FIG. **1**, a bottom part **12***a* formed in a flat surface rectangular shape, a pair of first side walls **12***b* extending in a vertical direction Z from a pair of opposed sides of the bottom part **12***a* and being opposed mutually, and a pair of second side walls **12***c* extending in the vertical direction Z from a pair of opposed sides of the bottom part **12***a* and being opposed mutually. In this embodiment, the first side walls **12***b* are longer side walls extending from a pair of long opposed sides of the bottom part **12***a*. The second side walls **12***c* are shorter side walls extending from a pair of short opposed sides of the bottom part **12***a*. In this embodiment, an area size of the second side wall **12***c* is smaller than an area size in of the first side wall **12***b*. A portion being opposed to the bottom part **12***a* and being surrounded by the pair of first side walls **12***b* and the pair of second side walls **12***c* is an opening part **12***h*. The sealing plate **14** is a member configured to seal the opening part **12***h* of the outer case **12**. The sealing plate **14** is opposed to the bottom part **12***a* of the outer case **12**. The sealing plate **14** is approximately rectangular in a plane view. The case **10** is integrated by making the sealing plate **14** be joined to a peripheral edge of the opening part of the outer case **12**. A joining means is a welding, such as laser welding, for example. The case **10** is airtightly sealed (hermetically sealed).

[0024] The sealing plate **14** is provided with a liquid injection hole **15** and a gas exhausting valve **17**. The liquid injection hole **15** is for injecting the electrolytic solution after the sealing plate **14** is assembled to the outer case **12**. The liquid injection hole **15** is sealed by a sealing member **16**. The gas exhausting valve **17** is a thin-walled part that is configured to be broken when a pressure inside the case **10** becomes equal to or more than a predetermined value, so as to exhaust the gas inside the case **10** to the outside.

[0025] In this embodiment, the positive electrode terminal **30** and the negative electrode terminal **40** are attached to the sealing plate **14**. In this embodiment, the positive electrode terminal **30** is arranged at one of end parts (a left end part of FIG. **1** and FIG. **2**) in a long side direction Y of the sealing plate **14**. In this embodiment, the negative electrode terminal **40** is arranged at the other end part (a right end part of FIG. **1** and FIG. **2**) in the long side direction Y of the sealing plate **14**.

[0026] The positive electrode terminal **30** is, as shown in FIG. **2**, electrically connected to a positive electrode **22** of the electrode assembly **20** through the positive electrode collecting member **50** at the inside of the outer case **12** (see FIG. **5**). The positive electrode terminal **30** is, for example, inserted into a terminal taking out hole **18** and then pulled out from the inside to the outside of the sealing plate **14**. The positive electrode terminal **30** is insulated from the sealing plate **14** by the insulator **70** and the gasket **90**. It is preferable that the positive electrode terminal **30** is made of metal, and it is more preferable that the positive electrode terminal is made from, for example, aluminum or aluminum alloy. On the positive electrode terminal **30**, the outside conductive member **35** is fixed. The positive electrode terminal **30** is joined to the outside conductive member **35**.

[0027] The negative electrode terminal **40** is, as shown in FIG. **2**, electrically connected to the negative electrode **24** of the electrode assembly **20** through the negative electrode collecting member **60** at the inside of the outer case **12** (see FIG. **5**). The negative electrode terminal **40** is, for example, inserted into a terminal taking out hole **19** and pulled out from the inside to the outside of the sealing plate **14**. The negative electrode terminal **40** is insulated from the sealing plate **14** by the insulator **70** and the gasket **90**. It is preferable that the negative electrode terminal **40** is made of metal, and it is more preferable that the negative electrode terminal is made from, for example, copper or copper alloy. On the negative electrode terminal **40**, the outside conductive member **45** is fixed. The negative electrode terminal **40** is joined to the outside conductive member **45**.

[0028] The positive electrode collecting member **50** is, for example, a member configured to electrically connect the positive electrode **22** and the positive electrode terminal **30** at the inside of the outer case **12**. As shown in FIG. **2**, the positive electrode collecting member **50** includes a first electrical collector part **51** and a second electrical collector part **52**. The first electrical collector part **51** is, for example, formed in a cross section letter “L” shape. The first electrical collector part **51** includes, for example, a base **51***a* and a lead **51***b*. As shown in FIG. **2**, the base **51***a* is arranged along a surface at an inner side of the sealing plate **14**. The lead **51***b* is, for example, configured to extend from one of end parts in a width direction Y of the base **51***a* toward the bottom part **12***a* (see FIG. **1**). To the lead **51***b*, for example, the second electrical collector part **52** is connected.

[0029] FIG. **3** is a perspective view that shows the electrode assembly **20** attached to the sealing plate **14**. FIG. **4** is a perspective view that shows the electrode assembly **20** to which the second electrical collector part **52** is attached. As shown in FIGS. **1** to **4**, the second electrical collector part **52** extends toward the bottom part **12***a* of the outer case **12**. In this embodiment, the second electrical collector part **52** includes a first connection piece **52***a* and a second connection piece **52***b*. The first connection piece **52***a* is, for example, a portion electrically connected to the first electrical collector part **51**. In this embodiment, the first connection piece **52***a* is connected to the first electrical collector part **51** through a connecting portion **521**. The connecting portion **521** is, for example, a thin-walled part. The first connection piece **52***a* is, for example, configured to extend along a vertical direction Z. The first connection piece **52***a* is, in this embodiment, arranged almost vertically to a winding axis WL of each electrode assembly **20**. Although not particularly restricting, a fuse part **52***f* might be formed on the first connection piece **52***a*. The fuse part **52***f* is configured to melt down when a current equal to or more than 1000 A (for example, a short circuit current) flows in the battery **1**.

[0030] The second connection piece **52***b* is, for example, a portion joined to the positive electrode tab group **23**. In this embodiment, the second connection piece **52***b* is configured to extend along the vertical direction Z. The second connection piece **52***b* is arranged almost vertically to the winding axis WL of each electrode assembly **20**. A surface connected to plural positive electrode tabs **22***t* of the second connection piece **52***b* is arranged almost parallel to the second side wall **12***c* of the outer case **12**. From a perspective of sufficiently securing a width of the second connection piece **52***b* and additionally decreasing the battery resistance of the battery **1**, the surface connected to the plural positive electrode tabs **22***t* of the second connection piece **52***b* (see FIG. **5**) is arranged to be opposed to a first end part **201** of the electrode assembly **20**.

[0031] The negative electrode collecting member **60** is a member configured to electrically connect the negative electrode **24** and the negative electrode terminal **40** at the inside of the outer case **12**. The negative electrode collecting member **60** includes, as shown in FIGS. **2** to **4**, a first electrical collector part **61** and a second electrical collector part **62**. The first electrical collector part **61** includes a base **61***a* and a lead **61***b*. The second electrical collector part **62** includes a first connection piece **62***a* and a second connection piece **62***b*. A configuration of the negative electrode collecting member **60** is similar to the configuration of the above described positive electrode collecting member **50**, and thus a detailed explanation herein is omitted. Incidentally, regarding the negative electrode collecting member **60**, a reference sign "**621**" in FIG. **4** indicates a connecting portion and a reference sign "**62***f*" indicates a fuse part.

[0032] As shown in FIG. **3**, the battery **1** includes three electrode assemblies **20**. As shown in FIG. **3** and FIG. **4**, the second electrical collector part **52** of the positive electrode collecting member **50** is arranged at one side (a left side of FIG. **3** and FIG. **4**) in the long side direction Y, the second electrical collector part **62** of the negative electrode collecting member **60** is arranged at the other side in the long side direction Y (a right side of FIG. **3** and FIG. **4**), and they are connected in parallel. As shown in FIG. **2**, one or plural electrode assemblies **20** are arranged inside the outer package **12**, in a state of being covered by an electrode assembly holder **29** that consists of a sheet made of resin, such as polypropylene (PP). Incidentally, a number of the electrode assemblies **20** accommodated by the battery **1** is not particularly restricted, and it might be, for example, 1, 2, or equal to or more than 4.

[0033] FIG. **5** is a schematic view of the electrode assembly **20**. As shown in FIG. **5**, the electrode assembly **20** includes the positive electrode **22**, the negative electrode **24**, and the separator **26** configured to insulate the positive electrode **22** and the negative electrode **24**. As shown in FIG. **5**, the electrode assembly **20** is an electrode assembly (a wound electrode assembly) in which the positive electrode **22** and the negative electrode **24** are laminated via the separator **26** and then wound therein so as to be manufactured.

[0034] As shown in FIG. **2** to FIG. **4**, the electrode assembly **20** includes a body **20***a*, a positive electrode tab group **23**, and a negative electrode tab group **25**. The body **20***a* is a portion in which the positive electrode **22**, the negative electrode **24**, and the separator **26** are laminated, and is formed in a flat shape, for example. A width of the body **20***a* is, for example, equal to or more than 10 cm. The width of the body **20***a* might be, for example, equal to or more than 15 cm, or might be equal to or more than 20 cm. The width of the body **20***a* might be, for example, equal to or less than 50 cm, or might be equal to or less than 40 cm. In the present specification, a wording "width of the body **20***a*" represents, for example, a length of the body **20***a* in a shorter direction of the positive electrode **22** and negative electrode **24** (the width direction Y along a winding axis direction in FIG. **5**).

[0035] As shown in FIG. **1**, FIG. **2**, and FIG. **5**, the electrode assembly **20** is arranged inside the outer package **12** in a direction which makes the winding axis WL be in parallel to the width direction Y. In this embodiment, the electrode assembly **20** is arranged inside the outer package **12** in a direction which makes the winding axis WL be in parallel to the bottom part **12***a* and be orthogonal to the second side wall **12***c*. Then, both ends of the electrode assembly **20** in a direction along the winding axis WL (below, which is referred to as "winding axis direction", too) are opposed to the second side walls **12***c* of the outer case **12**. In the present specification, an end part of the electrode assembly **20** (for example, the body **20***a*) opposed to the second side wall **12***c* at a side closer to the positive electrode collecting member **50** (a left side in the width direction Y of FIG. **2** and FIG. **4**) is referred to as "first end part **201**". An end part of the electrode assembly **20** (for example, the body **20***a*) opposed to the second side wall **12***c* at a side closer to the negative electrode collecting member **60** (a right side in the width direction Y of FIG. **2** and FIG. **4**) is referred to as "second end part **202**". In this embodiment, the first end part **201** and second end part **202** of the electrode assembly **20** are laminate surfaces (open surfaces) configured with the positive electrode **22**, the negative electrode **24**, and the separator **26**, and are opened to the outside of the electrode assembly **20**. At the first end part **201** and the second end part **202**, for example, the electrolytic solution flows in or flows out.

[0036] The positive electrode **22** includes, for example, a positive electrode collecting foil **22***c* (for example, an aluminum foil) formed in a long strip-like shape, and a positive electrode active material layer **22***a* fixed on at least one surface of the positive electrode collecting foil **22***c*. Although not particularly restricting, one of side edge parts in the width direction Y of the positive electrode **22** is provided with a protective layer **22***p*, as needed. Incidentally, as a material for configuring the positive electrode active material layer **22***a* and a material for configuring the protective layer **22***p*, ones used for this kind of the battery (in this embodiment, the lithium ion secondary battery) can be used without particular restriction.

[0037] At one of end parts (a left end part of FIG. **5**) in the width direction Y of the positive electrode collecting foil **22***c*, plural positive electrode tabs **22***t* are provided. Each of the plural positive electrode tabs **22***t* is configured to protrude toward one side (a left side of FIG. **5**) in the width direction Y. The plural positive electrode tabs **22***t* are provided at intervals (intermittently) along a longitudinal direction of the positive electrode **22**. The positive electrode tab **22***t* is a part of the positive electrode collecting foil **22***c*, and is a portion where neither the positive electrode active material layer **22***a* nor the protective layer **22***p* of the positive electrode collecting foil **22***c* is formed (a collecting foil exposed part). In this embodiment, the plural positive electrode tabs **22***t* are configured to protrude in the width direction Y more than the separator **26**. For example, the plural positive electrode tabs **22***t* are laminated at one of the end parts (the left end part of FIG. **5**) in the width direction Y, so as to configure a positive electrode tab group **23** (see FIG. **2** to FIG. **4**). As shown in FIG. **2**, the positive electrode collecting member **50** is joined to the positive electrode tab group **23**. As shown in FIG. **1** to FIG. **3**, the positive electrode tab group **23** joined to the positive electrode collecting member **50** is folded and bent to make tip ends of the plural positive electrode tabs **22***t* configuring the positive electrode tab group **23** be arranged along the second side wall **12***c*. Incidentally, in FIG. **5**, the positive electrode tabs **22***t* are shown in which respective lengths and shapes are approximately the same, but respective lengths and shapes of the positive electrode tabs **22***t* might be different.

[0038] The negative electrode **24** includes, for example, a negative electrode collecting foil **24***c* (for example, a copper foil) formed in a long strip-like shape, and a negative electrode active material layer **24***a* fixed on at least one surface of the negative electrode collecting foil **24***c*. Incidentally, as a material for configuring the negative electrode active material layer **24***a*, it is possible to use one used for this kind of battery (in this embodiment, the lithium ion secondary battery) without particular restriction.

[0039] At one of end parts (a right end part of FIG. **5**) in the width direction Y of the negative electrode collecting foil **24***c*, plural negative electrode tabs **24***t* are provided. The plural negative electrode tabs **24***t* are configured to protrude toward one side (a right side of FIG. **5**) in the width direction Y. The plural negative electrode tabs **24***t* are provided at intervals (intermittently) along a longitudinal direction of the negative electrode **24**. The negative electrode tab **24***t* herein is a part of the negative electrode collecting foil **24***c*, and is a portion where the negative electrode active material layer **24***a* of the negative electrode collecting foil **24***c* is not formed (a collecting foil exposed part). In this embodiment, the negative electrode tab **24***t* is configured to protrude in the

width direction Y more than the separator **26**. For example, the plural negative electrode tabs **24***t* are laminated at one end part (the right end part of FIG. **5**) in the width direction Y, so as to configure the negative electrode tab group **25** (see FIG. **2** to FIG. **4**). As shown in FIG. **2**, the negative electrode collecting member **60** is joined to the negative electrode tab group **25**. The negative electrode tab group **25** joined to the negative electrode collecting member **60** is folded and bent to make tip ends of the plural negative electrode tabs **24***t* configuring the negative electrode tab group **25** be arranged along the second side wall **12***c*. Incidentally, in FIG. **5**, the negative electrode tabs **24***t* are shown in which respective lengths and shapes are approximately the same, but the lengths and shapes of respective negative electrode tabs **24***t* might be different.
[0040] FIG. **6** is a plane view of the separator **26**. The separator **26** is a member configured to insulate the positive electrode active material layer **22***a* of the positive electrode **22** from the negative electrode active material layer **24***a* of the negative electrode **24**. The separator **26** configures an outer surface of the electrode assembly **20**. In this embodiment, as shown in FIG. **5** and FIG. **6**, the separator **26** is a separator sheet formed in a long strip-like shape. A width of the separator **26** (a length in the width direction Y along the winding axis direction) is larger than a length of the positive electrode **22** in the same direction from which the positive electrode tab **22***t* is excluded, and is larger than a length of the negative electrode **24** in the same direction from which the negative electrode tab **24***t* is excluded.
[0041] FIG. **7** is an explanation view of a shape of a reverse flow inhibiting groove **27**. In FIG. **7**, a flat surface shape of the reverse flow inhibiting groove **27** is partially shown. The separator **26** herein includes the reverse flow inhibiting groove **27** (see FIG. **6** and FIG. **7**). The reverse flow inhibiting groove **27** herein is a groove formed on a surface of the separator **26** for flowing the electrolytic solution from the outside to the inside of the electrode assembly **20**, and formed in a pattern of inhibiting the electrolytic solution from flowing to the outside from the inside of the electrode assembly **20**. In this embodiment, the reverse flow inhibiting groove **27** is further a flow channel for the electrolytic solution flowing from the outside to the inside of the electrode assembly **20**, and is furthermore a flow channel for the electrolytic solution flowing from the inside to the outside of the electrode assembly **20**. However, the reverse flow inhibiting groove **27** is configured to make the electrolytic solution flow with relative ease in the direction from the outside to the inside of the electrode assembly **20**, and configured to make the electrolytic solution flow with relative difficulty in the direction from the inside to the outside of the electrode assembly **20**. Incidentally, in an explanation described below, the direction from the outside to the inside of the electrode assembly **20** might be referred to as a first direction P, and the direction from the inside to the outside of the electrode assembly **20** might be referred to as a second direction Q (see FIG. **6** and FIG. **7**).
[0042] Regarding a form shown by FIG. **7**, the reverse flow inhibiting groove **27** is provided in a Tesla valve shape. As shown in FIG. **7**, the reverse flow inhibiting groove **27** includes a main pipe **27**A and a sub pipe **27**B formed in a loop shape. The main pipe **27**A configures, for example, a flow channel in which the electrolytic solution flows from the outside to the inside of the electrode assembly **20**, and a flow channel in which the electrolytic solution flows from the inside to the outside of the electrode assembly **20**. The sub pipe **27**B is, for example, a pipe that branches from the main pipe **27**A and then is merged to the main pipe **28**A after the branch from the main pipe **27**A. As shown in FIG. **7**, plural sub pipes **27**B are coupled to the main pipe **27**A. In a form shown by FIG. **7**, each of the sub pipes **27**B is coupled at two positions to the main pipe **27**A. The main pipe **27**A and the sub pipe **27**B are coupled at two positions being a first coupling portion **27**C**1** and a second coupling portion **27**C**2**. The first coupling portion **27**C**1** is arranged at a relatively outer side of the electrode assembly **20**, among two coupling portions of the main pipe **27**A and sub pipe **27**B. The second coupling portion **27**C**2** is arranged at a relatively inner side of the electrode assembly **20**, among the two coupling portions of the main pipe **27**A and sub pipe **27**B.
[0043] In this embodiment, when the electrolytic solution flows in the first direction P (see the

reverse flow inhibiting groove **27** at a left side of FIG. **7**), the electrolytic solution flowing in the main pipe **27**A dividedly flows from the main pipe **27**A to the sub pipe **27**B at the first coupling portion **27**C**1**, but it is difficult to inhibit the flow in the direction P because a dividedly flowing amount of the electrolytic solution to the sub pipe **27**B structurally becomes smaller relatively in comparison to the main pipe **27**A. At the second coupling portion **27**C**2**, the electrolytic solution flowing in the sub pipe **27**B is also merged into the electrolytic solution flowing in the main pipe **27**A along a direction in which the electrolytic solution flowing in the main pipe **27**A flows (here, the first direction P), and thus it does not inhibit the flow in the direction P. In contrary, when the electrolytic solution flows in the second direction Q (see the reverse flow inhibiting groove **27** at the right side of FIG. **7**), at the second coupling portion **27**C**2**, the electrolytic solution flowing in the main pipe **27**A dividedly flows from the main pipe **27**A to the sub pipe **27**B, but it is easy to inhibit the flow in the direction Q because the dividedly flowing amount of the electrolytic solution to the sub pipe **27**B structurally becomes larger relatively in comparison to the main pipe **27**A. At the first coupling portion **27**C**1**, the electrolytic solution flowing in the sub pipe **27**B is merged, from a backward direction with respect to a direction (here, the second direction Q) in which the electrolytic solution flowing in the main pipe **27**A flows, into the electrolytic solution flowing in the main pipe **27**A, and thus it inhibits the flow of the electrolytic solution in the main pipe A to the direction Q.

[0044] As shown in FIG. **4** and FIG. **6**, the separator **26** includes first areas **261** and a second area **262**. The first areas **261** are, for example, areas which are opened to the outside of the electrode assembly **20** at edge parts of the separator **26**. Here, the wording "areas which are opened to the outside of the electrode assembly **20**" represents areas where it is possible to implement an inflow of the electrolytic solution from the outside of the electrode assembly **20** and implement an outflow of the electrolytic solution to the inside of the electrode assembly **20**. In a form shown by FIG. **4**, the first areas **261** are respectively positioned adjacent to the first end part **201** and second end part **202** of the electrode assembly **20** on the separator **26**. In a form shown by FIG. **6**, the first areas **261** are areas provided at both ends in the shorter direction of the separator **26** and formed in strip-like shapes along the longitudinal direction of the separator **26**. The second area **262** is, for example, an area of the separator **26** from which the first areas **261** are excluded. In the form shown by FIG. **4**, the second area **262** is sandwiched between the first areas **261**. In the form shown by FIG. **6**, the second area **262** is an area which is sandwiched by the first areas **261** and further which is formed in a strip-like shape along the longitudinal direction of the separator **26**.

[0045] Although not particularly restricting, a ratio (W1/Wt) regarding a width W1 of the first area **261** (one side) and a width Wt of the separator **26** in FIG. **6** is approximately ⅛ to ½, or preferably ¼ to ⅓. A ratio (W2/Wt) with respect to a width W2 of the second area **262** and the width Wt of the separator **26** is approximately equal to or less than ¾, or preferably ⅓ to ½.

[0046] In this embodiment, the reverse flow inhibiting groove **27** is provided on the first area **261**. It is good that the reverse flow inhibiting groove **27** is, for example, provided on the first area **261** so as to make the main pipe **27**A be arranged along the shorter direction of the separator **26**. In this embodiment, on the second area **262**, a groove **28** having a pattern different from the reverse flow inhibiting groove (see FIG. **8**) is provided. As the pattern of the groove **28** provided on the second area **262**, although not particularly restricted, it is possible to use, for example, a dot shape, a stripe shape along the shorter direction of the separator **26**, a stripe shape along the longitudinal direction of the separator **26**, or the like.

[0047] FIG. **8** is an IIX-IIX cross section view of FIG. **6**. In FIG. **8**, a cross section structure of the first area **261** and second area **262** of the separator **26** is partially shown. As shown in FIG. **8**, the separator **26** includes a base material **26**S, a first layer **26**A, and a second layer **26**B. As the base material **26**S, it is possible to use a conventionally known porous sheet used as a separator for this kind of battery, without particular restriction. The base material **26**S might have a single-layer structure, or might have a multi-layer structure including 2 or more layers (for example, 3-layer structure). It is preferable that the base material **26**S is, for example, a porous sheet made from a polyolefin, such as polyethylene (PE) and polypropylene (PP).

[0048] As shown in FIG. **8**, the first layer **26**A is provided on a surface of the base material **26**S. In this embodiment, the first layer **26**A is provided on a first area **261**. In the form shown by FIG. **8**, the reverse flow inhibiting groove **27** is provided on the first layer **26**A. As shown in FIG. **8**, the second layer **26**B is provided on the surface of the base material **26**S. In this embodiment, the second layer **26**B is provided on the second area **262**. In the form shown by FIG. **8**, the groove **28** is provided on the second layer **26**B.

[0049] In this embodiment, the first layer **26**A and the second layer **26**B are adhesion layers. The adhesion layer is, for example, a layer configured with an adhesive agent. As the adhesive agent, it is possible to use, for example, an acrylic resin; a rubber type resin such as styrene butadiene rubber (SBR); a fluorine type resin such as polyvinylidene fluoride (PVdF) and polytetrafluoroethylene (PTFE); or the like; an urethane type resin; a silicone type resin; an epoxy type resin; or the like. Regarding the resin, 1 kind might be used singly, or 2 or more kinds might be combined so as to be used. From a perspective of implementing a superior flexibility and enhancing an adhesive property with respect to an electrode, the fluorine type resin, the acrylic resin, or the like, are preferably used as the adhesive agent. The adhesive agent configuring the first layer **26**A and the adhesive agent configuring the second layer **26**B might be the same or might be different from each other.

[0050] A method for forming the first layer **26**A including the reverse flow inhibiting groove **27** is not particularly restricted, and it is possible to use a conventionally known method. As the method for forming the first layer **26**A, it is possible, for example, to use an ink jet print. In this case, a slurry configured by mixing the above described adhesive agent and a solvent or dispersion medium (for example, a water type solvent, or an organic solvent) for forming the first layer **26**A is applied to coat the base material **26**S in a predetermined pattern. Then, by drying this coating film, it is possible to form the first layer **26**A including the reverse flow inhibiting groove **27**. A method for forming the second layer **26**B including the groove **28** might be the same as the above described one, except for forming the groove **28** instead of the reverse flow inhibiting groove **27**.

[0051] The electrolytic solution includes, for example, an electrolyte salt and a nonaqueous solvent. As the electrolyte salt, it is possible to use, for example, LiPF.sub.6, or the like. A concentration of the electrolyte salt in the electrolytic solution is for example, 0.7 mol/L to 1.3 mol/L. The nonaqueous solvent might be, for example, carbonates. As the carbonates, it is possible to use, for example, ethylene carbonate (EC), diethyl carbonate (DEC), dimethyl carbonate (DMC), ethyl methyl carbonate (EMC), monofluoroethylene carbonate (MFEC), difluoroethylene carbonate (DFEC), monofluoromethyl difluoromethyl carbonate (F-DMC), trifluoro dimethyl carbonate (TFDMC), or the like. Regarding them, it is possible to use single one or a combination of 2 or more kinds.

[0052] The battery **1** can be used for various purposes, but among them, it is preferably used as a power source for a motor (a power supply for driving) mounted on a vehicle, such as passenger car and truck. The type of the vehicle is not particularly restricted, but as a suitable instance, it is possible to be, for example, a plug-in hybrid electric vehicle (PHEV), a hybrid electric vehicle (HEV), a battery electric vehicle (BEV), or the like.

[0053] As described above, the battery **1** includes the electrode assembly **20**, including the positive electrode **22**, the negative electrode **24**, and the separator **26** establishing an insulation between the positive electrode **22** and the negative electrode **24**, includes the electrolytic solution, and includes the case **10** configured to accommodate the electrode assembly **20** and the electrolytic solution. The battery **1** includes the reverse flow inhibiting groove **27** on the surface of the separator **26**. The reverse flow inhibiting groove **27** is a groove in which the electrolytic solution flows from the outside to the inside of the electrode assembly **20**, and is formed in a pattern for inhibiting the electrolytic solution from flowing to the outside from the inside of the electrode assembly **20**.

[0054] As described above, the reverse flow inhibiting groove **27** is the groove in which the electrolytic solution flows from the outside to the inside of the electrode assembly **20**, but is also the groove for inhibiting the electrolytic solution from flowing to the outside from the inside of the electrode assembly **20**. In other words, the reverse flow inhibiting groove **27** promotes the electrolytic solution impregnating into the electrode assembly **20**, and further suppresses the outflow of the electrolytic solution from the electrode assembly **20**. By including the separator **26** provided with the reverse flow inhibiting groove **27**, in the battery **1**, without inhibiting the intrusion of the electrolytic solution from the outside of the electrode assembly **20** to the inside of the electrode assembly **20**, it is possible to suppress the outflow of the electrolytic solution from the inside to the outside of the electrode assembly **20**. By this, it is possible to enhance an uniformity of distribution of the electrolytic solution in the electrode assembly **20**.
[0055] The battery **1** might include, at the edge part of the separator **26**, the reverse flow inhibiting groove **27** on the first area **261** which is opened to the outside of the electrode assembly **20**. In other words, the separator **26** might include the reverse flow inhibiting groove **27** on the first area **261** configuring the edge part. The first area **261** is, for example, an area of the electrode assembly **20** in which the inflow and the outflow of the electrolytic solution into and from the electrode assembly **20** occur. By providing the reverse flow inhibiting groove **27** on the first area **261**, it is possible to further suitably suppress the electrolytic solution inflowing (impregnating) into the electrode assembly **20** from outflowing (reverse-flowing) to the outside of the electrode assembly **20**.
[0056] The separator **26** might include the base material **26**S and the first layer **26**A on the surface of the base material **26**S. The first layer **26**A might be provided on the first area **261**. The reverse flow inhibiting groove **27** might be provided on the first layer **26**A. By including the first layer **26**A where the reverse flow inhibiting groove **27** is provided on the first area **261**, it is possible onto the separator **26** to impart not only an outflow inhibiting effect of the electrolytic solution, but also another effect (for example, an adhesion effect).
[0057] The separator **26** might include the second area **262** from which the first area **261** is excluded. On the surface of the base material **26**S regarding the second area **262**, a second layer **26**B might be provided. On the second layer **26**B, the groove **28** having a pattern different from the reverse flow inhibiting groove **27** might be provided. By providing the groove **28** on the second area **262** which has a pattern different from the reverse flow inhibiting groove **27**, it becomes easy to hold the electrolytic solution on the second area **262**. By this, it is possible to enhance the uniformity of the distribution of the electrolytic solution in the electrode assembly **20**. In addition to this, by providing the groove structures on the first area **261** and the second area **262**, it is possible to enhance the uniformity of the thickness of the electrode assembly **20**.
[0058] The battery **1** might include a wound electrode assembly, as the electrode assembly **20**, in which the positive electrode **22** formed in a long sheet shape and the negative electrode **24** formed in a long sheet shape are laminated via the separator **26** formed in a long sheet shape and then are wound in the sheet longitudinal direction. On the wound electrode assembly, for example, in comparison to the laminate electrode assembly, an ununiformity of the distribution of the electrolytic solution tends to be easily caused. By using the separator **26** having the above described configuration for the electrode assembly **20** being the wound electrode assembly, it is possible to further suitably implement the effect of the herein disclosed technique.
[0059] The reverse flow inhibiting groove **27** might include the main pipe **27**A and the sub pipe **27**B that is formed in a loop shape to couple to the main pipe **27**A at two positions. The main pipe **27**A might configure a flow channel in which the electrolytic solution flows from the outside to the inside of the electrode assembly **20**, and a flow channel in which the electrolytic solution flows from the inside to the outside of the electrode assembly **20**. It is good that the reverse flow inhibiting groove **27** is configured as described below, for a case where the electrolytic solution flows from the outside to the inside of the electrode assembly **20** and for a case where the

electrolytic solution flows from the inside to the outside of the electrode assembly **20**. In the case where the electrolytic solution flows from the outside to the inside of the electrode assembly **20**, on the first coupling portion **27**C**1** arranged at a relatively outer side of the electrode assembly **20** among the two coupling portions **27**C**1**, **27**C**2** with respect to the main pipe **27**A and the sub pipe **27**B, the electrolytic solution flowing in the main pipe **27**A might dividedly flows from the main pipe **27**A to the sub pipe **27**B. At that time, on the second coupling portion **27**C**2** arranged at a relatively inner side of the electrode assembly **20** among the two coupling portions **27**C**1**, **27**C**2** with respect to the main pipe **27**A and the sub pipe **27**B, the electrolytic solution flowing in the sub pipe **27**B might be merged into the electrolytic solution flowing in the main pipe **27**A along a flowing direction (here, the first direction P) of the electrolytic solution flowing in the main pipe **27**A. In the case where the electrolytic solution flows from the inside to the outside of the electrode assembly **20**, on the second coupling portion **27**C**2**, the electrolytic solution flowing in the main pipe **27**A might dividedly flows from the main pipe **27**A to the sub pipe **27**B. It is good at the first coupling portion **27**C**1** that the electrolytic solution flowing in the sub pipe **27**B is merged into the electrolytic solution flowing in the main pipe **27**A, from a backward direction with respect to the flowing direction of the electrolytic solution flowing in the main pipe **27**A (here, the second direction Q). The above described configuration of the reverse flow inhibiting groove **27** is preferable for implementing the effect of the herein disclosed technique.
[0060] The reverse flow inhibiting groove **27** might be provided in a Tesla valve shape. The above described configuration of the reverse flow inhibiting groove **27** is preferable for implementing the effect of the herein disclosed technique.
[0061] Above, an embodiment of the herein disclosed technique has been explained, but it is merely an illustration, and thus it is not intended to restrict the scope of claims. The technique recited in claims contains ones in which the above described embodiment is variously deformed or changed. Below, another embodiment of the herein disclosed technique will be described. Incidentally, except for the above described matter of the below described embodiment, it is similar to explanation about the above described embodiment. Thus, the overlapping explanation herein is omitted.
[0062] In the above described embodiment, the reverse flow inhibiting groove **27** is provided in the Tesla valve shape. The shape of the reverse flow inhibiting groove is not restricted to the Tesla valve shape, if the effect of the herein disclosed technique is implemented. FIG. **9** is a plane view of a separator **226**. In FIG. **9**, a flat surface structure of the separator **226** is partially enlarged so as to be shown. As shown in FIG. **9**, the separator **226** includes a reverse flow inhibiting groove **227**. In this embodiment, the reverse flow inhibiting groove **227** includes a main pipe **227**A and a valve **227**B. The main pipe **227**A can configure, for example, a flow channel in which the electrolytic solution flows from the outside to the inside of the electrode assembly **20**, and a flow channel in which the electrolytic solution flows from the inside to the outside of the electrode assembly **20**. The valve **227**B is, for example, a portion for inhibiting the electrolytic solution from flowing to the outside from the inside of the electrode assembly **20**. In a form shown by FIG. **9**, the valve **227**B is provided in the main pipe **227**A. In FIG. **9**, plural valves **227**B are provided in one main pipe **227**A, but the number of the valves **227**B in one main pipe **227**A is not particularly restricted, and thus can be suitably changed. Incidentally, as needed, the valves might be provided inside the reverse flow inhibiting groove **27** in the above described embodiment.
[0063] The open surfaces (the first end part **201** and the second end part **202**) of the electrode assembly **20** in the above described embodiment are arranged to be opposed to the second side walls **12***c* of the case **10**. However, the shape of the electrode assembly is not restricted to this. FIG. **10** is a schematic view of an electrode assembly **320**. As shown in FIG. **10**, the electrode assembly **320** is a wound electrode assembly. In a form shown by FIG. **10**, regarding the electrode assembly **320**, a positive electrode **322** formed in a long sheet shape and a negative electrode **324** formed in a long sheet shape are laminated via a separator **326** formed in a long sheet shape, and then wound in

the sheet longitudinal direction. In this embodiment, the electrode assembly **320** is accommodated in the case **10** to make a winding axis WL**3** of the electrode assembly **320** and the vertical direction Z of the case **10** be in approximately parallel (see FIG. **1** and FIG. **2**).

[0064] In this embodiment, the electrode assembly **320** is accommodated in the outer case **12** so as to make a winding axis direction WD**3** be in approximately parallel to the first side wall **12***b* and the second side walls **12***c* and be in approximately vertical to the bottom part **12***a* and the sealing plate **14**. Thus, a first end part **3201** of the electrode assembly **20** is opposed to the bottom part **12***a*, and a second end part **3202** is opposed to the sealing plate **14**. The first end part **3201** and the second end part **3202** herein are laminate surfaces configured with the positive electrode **322**, the negative electrode **324**, and the separator **326**, and are open surfaces. As shown in FIG. **10**, both of a positive electrode tab **322***t* and a negative electrode tab **324***t* are provided on the second end part **3202** of the electrode assembly **320**. Thus, the positive electrode tab **322***t* and the negative electrode tab **324***t* are opposed to the sealing plate **14** (see FIG. **2**).

[0065] In a form shown by FIG. **10**, first areas **3261** on the separator **326** are respectively adjacent to the first end part **3201** and the second end part **3202** of the electrode assembly **320**. In the form shown by FIG. **10**, the first areas **3261** are areas provided at both ends in the shorter direction of the separator **326** and formed in strip-like shapes along the longitudinal direction of the separator **326**. A second area **3262** is, for example, an area of the separator **326** from which the first area **3261** is excluded. In the form shown by FIG. **10**, the second area **3262** is sandwiched by the first areas **3261**. In this embodiment, the second area **3262** is an area which is sandwiched between the first areas **3261** and which is formed in the strip-like shape along the longitudinal direction of the separator **326**. The reverse flow inhibiting groove can be, for example, provided on the first areas **3261**. Incidentally, in FIG. **10**, a reference sign "**322***a*" represents a positive electrode active material layer, a reference sign "**322***c*" represents a positive electrode collecting foil, a reference sign "**322***p*" represents a protective layer, a reference sign "**324***a*" represents a negative electrode active material layer, and a reference sign "**324***c*" represents a negative electrode collecting foil.

[0066] The electrode assembly **20** of the above described embodiment has been the wound electrode assembly. However, a structure of the electrode assembly is not restricted to this. FIG. **11** is a perspective view of an electrode assembly **420**. As shown in FIG. **11**, the electrode assembly **420** is a laminate electrode assembly. As shown in FIG. **11**, the electrode assembly **420** includes a positive electrode **422** formed in a rectangular sheet shape, a negative electrode **424** formed in a rectangular sheet shape, and a separator **426** formed in a rectangular sheet. In this embodiment, the positive electrode **422** and the negative electrode **424** are alternately laminated via the separator **426**. In this embodiment, the positive electrode **422** includes a collecting foil exposed part **422***t* at one of end parts in the long side direction, on which the positive electrode active material layer is not provided. The negative electrode **424** includes a collecting foil exposed part **424***t* at one of end parts in the long side direction, on which the negative electrode active material layer is not provided. In the electrode assembly **420**, the collecting foil exposed parts **422***t* of the positive electrodes **422** are mutually superimposed, and the collecting foil exposed parts **424***t* of the negative electrodes **424** are mutually superimposed. In this embodiment, the electrode assembly **420** is accommodated in the case **10** to make the short side direction of the electrode and the vertical direction Z of the case **10** be in approximately parallel and to make the long side direction of the electrode and the long side direction Y of the case **10** be in approximately parallel (see FIG. **1** and FIG. **2**).

[0067] In this embodiment, regarding the electrode assembly **420**, two laminate surfaces (here, a laminate surface at a first end part **4201** and a laminate surface of a second end part **4202**) configured with the electrode and the separator, a laminate surface of the collecting foil exposed part **422***t* of the positive electrode **422**, and a laminate surface of the collecting foil exposed part **424***t* of the negative electrode **424** are open surfaces. Each of 4 open surfaces described above is opposed to the bottom part **12***a*, the first side wall **12***b*, or the second side wall **12***c* of the case **10**.

Among them, the laminate surface of the collecting foil exposed part **422***t* of the positive electrode **22** is opposed to one of the second side walls **12***c*. The laminate surface of the collecting foil exposed part **424***t* of the negative electrode **24** is opposed to the other one of the second side walls **12***c* (see FIG. **2**).

[0068] In a form shown by FIG. **11**, the first area **4261** on the separator **426** is provided along a pair of opposed long sides and a pair of opposed short sides. The second area **4262** is, for example, an area of the separator **426** from which the first area **4261** is excluded. In the form shown by FIG. **11**, the second area **4262** is surrounded by the first area **4261**. The reverse flow inhibiting groove is, for example, provided on the first area **4261**.

[0069] In the above described embodiment, regarding the separator **26**, the first layer **26**A and the second layer **26**B, which are the adhesion layers, are provided on one surface of the base material **26**S. However, a configuration of the separator is not restricted to this. For example, the first layer **26**A and the second layer **26**B, which are the adhesion layers, might be provided on both surfaces of the base material **26**S. Alternatively, between the base material **26**S and the adhesion layer, a heat resistance layer might be provided. In a case where the heat resistance layer is provided, it is good that only the adhesion layer is provided on one surface of the base material **26**S and only the heat resistance layer is provided on the other surface. It is also good that only the adhesion layer is provided on one surface of the base material **26**S, and the heat resistance layer and the adhesion layer are provided on the other surface. Alternatively, it is also good that only the heat resistance layer is provided on the surface of the base material **26**S, and the heat resistance layer and the adhesion layer are provided on the other surface. In a case where both of the heat resistance layer and the adhesion layer are provided, it is preferable that the heat resistance layer is provided between the base material **26**S and the adhesion layer. Incidentally, as a configuration of the heat resistance layer, a configuration of the heat resistance layer used for this kind of purposes can be applied without particular restriction. The configuration itself of the heat resistance layer is not to characterize the herein disclosed technique, and thus the explanation would be omitted here.

[0070] The herein disclosed technique could contain aspects recited in each of items described below.

[0071] Item 1: An electric storage device, comprising: [0072] an electrode assembly that comprises a positive electrode, a negative electrode, and a separator insulating the positive electrode from the negative electrode; [0073] an electrolytic solution; and [0074] a case that is configured to accommodate the electrode assembly and the electrolytic solution, wherein [0075] a surface of the separator is provided with a reverse flow inhibiting groove that is a groove in which the electrolytic solution flows from an outside to an inside of the electrode assembly and which is in a pattern for inhibiting the electrolytic solution from flowing to the outside from the inside of the electrode assembly.

[0076] Item 2: The electric storage device recited in item 1, wherein [0077] at an edge part of the separator, the reverse flow inhibiting groove is provided on a first area being opened to the outside of the electrode assembly.

[0078] Item 3: The electric storage device recited in item 2, wherein [0079] the separator comprises a base material and a first layer on a surface of the base material, [0080] the first layer is provided on the first area, and [0081] the reverse flow inhibiting groove is provided on the first layer.

[0082] Item 4: The electric storage device recited in item 2 or 3, wherein [0083] the separator comprises a second area from which the first area is excluded, [0084] on a surface of the base material within the second area, a second layer is provided, and [0085] on the second layer, a groove comprising a pattern different from the reverse flow inhibiting groove is provided.

[0086] Item 5: The electric storage device recited in any one of items 1 to 4, wherein [0087] as the electrode assembly, a wound electrode assembly is provided in which the positive electrode in a long sheet shape and the negative electrode in a long sheet shape are laminated with the separator in a long sheet shape interposed therebetween, and then wound in a sheet longitudinal direction.

[0088] Item 6: The electric storage device recited in any one of items 1 to 4, wherein [0089] as the electrode assembly, a laminate electrode assembly is provided in which the positive electrode in a rectangular sheet shape and the negative electrode in a rectangular sheet shape are alternately laminated with the separator in a rectangular sheet shape interposed therebetween.
[0090] Item 7: The electric storage device recited in any one of items 1 to 6, wherein [0091] the reverse flow inhibiting groove comprises a main pipe, and a sub pipe configured to couple to the main pipe at two positions and in a loop shape, [0092] the main pipe configures a flow channel in which the electrolytic solution flows from the outside to the inside of the electrode assembly and a flow channel in which the electrolytic solution flows from the inside to the outside of the electrode assembly, and [0093] the reverse flow inhibiting groove is configured to make the electrolytic solution flowing in the main pipe dividedly flow from the main pipe to the sub pipe on a first coupling portion arranged at a relatively outer side of the electrode assembly among 2 coupling portions configured with the main pipe and the sub pipe and to make the electrolytic solution flowing in the sub pipe be merged, along a flowing direction of the electrolytic solution flowing in the main pipe, into the electrolytic solution flowing in the main pipe on a second coupling portion arranged at a relatively inner side of the electrode assembly among the 2 coupling portions configured with the main pipe and the sub pipe, in a case where the electrolytic solution flows from the outside to the inside of the electrode assembly, and is configured to make the electrolytic solution flowing in the main pipe dividedly flow from the main pipe to the sub pipe on the second coupling portion and to make the electrolytic solution flowing in the sub pipe be merged into the electrolytic solution flowing in the main pipe, from a backward direction with respect to a flowing direction of the electrolytic solution flowing in the main pipe on the first coupling portion, in a case where the electrolytic solution flows from the inside to the outside of the electrode assembly.
[0094] Item 8: The electric storage device recited in any one of items 1 to 6, wherein [0095] the reverse flow inhibiting groove is provided in a Tesla valve shape.
[0096] Item 9: A separator used for an electric storage device, the electric storage device comprising: [0097] an electrode assembly that comprises a positive electrode, a negative electrode, and the separator insulating the positive electrode from the negative electrode; [0098] an electrolytic solution; and [0099] a case configured to accommodate the electrode assembly and the electrolytic solution, the separator comprising: [0100] a reverse flow inhibiting groove on a surface that is a groove in which the electrolytic solution flows from an outside to an inside of the electrode assembly and which is in a pattern for inhibiting the electrolytic solution from flowing to the outside from the inside of the electrode assembly.
[0101] Item 10: The separator recited in item 9, wherein [0102] the reverse flow inhibiting groove is disposed on a first area configuring an edge part.
[0103] Item 11: The separator recited in item 10, comprising a base material, and comprising a first layer on a surface of the base material within the first area, wherein [0104] the reverse flow inhibiting groove is disposed on the first layer.
[0105] Item 12: The separator recited in item 10 or 11, comprising a second layer on a second area from which the first area is excluded, wherein [0106] a groove comprising a pattern different from the reverse flow inhibiting groove is provided on the second layer.
[0107] Item 13: The separator recited in any one of items 9 to 12, wherein [0108] the reverse flow inhibiting groove comprises a main pipe, and a sub pipe configured to couple to the main pipe at two positions and in a loop shape, [0109] the main pipe configures a flow channel in which the electrolytic solution flows from the outside to the inside of the electrode assembly and a flow channel in which the electrolytic solution flows from the inside to the outside of the electrode assembly, and [0110] the reverse flow inhibiting groove is configured to make the electrolytic solution flowing in the main pipe dividedly flow from the main pipe to the sub pipe on a first coupling portion arranged at a relatively outer side of the electrode assembly among 2 coupling portions configured with the main pipe and the sub pipe and to make the electrolytic solution

flowing in the sub pipe be merged, along a flowing direction of the electrolytic solution flowing in the main pipe, into the electrolytic solution flowing in the main pipe on a second coupling portion arranged at a relatively inner side of the electrode assembly among the 2 coupling portions configured with the main pipe and the sub pipe, in a case where the electrolytic solution flows from the outside to the inside of the electrode assembly, and is configured to make the electrolytic solution flowing in the main pipe dividedly flow from the main pipe to the sub pipe on the second coupling portion and to make the electrolytic solution flowing in the sub pipe be merged into the electrolytic solution flowing in the main pipe, from a backward direction with respect to a flowing direction of the electrolytic solution flowing in the main pipe on the first coupling portion, in a case where the electrolytic solution flows from the inside to the outside of the electrode assembly.
[0111] Item 14: The separator recited in any one of items 9 to 13, wherein [0112] the reverse flow inhibiting groove is provided in a Tesla valve shape.

Claims

1. An electric storage device, comprising: an electrode assembly that comprises a positive electrode, a negative electrode, and a separator insulating the positive electrode from the negative electrode; an electrolytic solution; and a case that is configured to accommodate the electrode assembly and the electrolytic solution, wherein a surface of the separator is provided with a reverse flow inhibiting groove that is a groove in which the electrolytic solution flows from an outside to an inside of the electrode assembly and which is in a pattern for inhibiting the electrolytic solution from flowing to the outside from the inside of the electrode assembly.
2. The electric storage device according to claim 1, wherein at an edge part of the separator, the reverse flow inhibiting groove is provided on a first area being opened to the outside of the electrode assembly.
3. The electric storage device according to claim 2, wherein the separator comprises a base material and a first layer on a surface of the base material, the first layer is provided on the first area, and the reverse flow inhibiting groove is provided on the first layer.
4. The electric storage device according to claim 3, wherein the separator comprises a second area from which the first area is excluded, on a surface of the base material within the second area, a second layer is provided, and on the second layer, a groove comprising a pattern different from the reverse flow inhibiting groove is provided.
5. The electric storage device according to claim 1, wherein as the electrode assembly, a wound electrode assembly is provided in which the positive electrode in a long sheet shape and the negative electrode in a long sheet shape are laminated with the separator in a long sheet shape interposed therebetween, and then wound in a sheet longitudinal direction.
6. The electric storage device according to claim 1, wherein as the electrode assembly, a laminate electrode assembly is provided in which the positive electrode in a rectangular sheet shape and the negative electrode in a rectangular sheet shape are alternately laminated with the separator in a rectangular sheet shape interposed therebetween.
7. The electric storage device according to claim 1, wherein the reverse flow inhibiting groove comprises a main pipe, and a sub pipe configured to couple to the main pipe at two positions and in a loop shape, the main pipe configures a flow channel in which the electrolytic solution flows from the outside to the inside of the electrode assembly and a flow channel in which the electrolytic solution flows from the inside to the outside of the electrode assembly, and the reverse flow inhibiting groove is configured to make the electrolytic solution flowing in the main pipe dividedly flow from the main pipe to the sub pipe on a first coupling portion arranged at a relatively outer side of the electrode assembly among 2 coupling portions configured with the main pipe and the sub pipe and to make the electrolytic solution flowing in the sub pipe be merged, along a flowing direction of the electrolytic solution flowing in the main pipe, into the electrolytic solution flowing

in the main pipe on a second coupling portion arranged at a relatively inner side of the electrode assembly among the 2 coupling portions configured with the main pipe and the sub pipe, in a case where the electrolytic solution flows from the outside to the inside of the electrode assembly, and is configured to make the electrolytic solution flowing in the main pipe dividedly flow from the main pipe to the sub pipe on the second coupling portion and to make the electrolytic solution flowing in the sub pipe be merged into the electrolytic solution flowing in the main pipe, from a backward direction with respect to a flowing direction of the electrolytic solution flowing in the main pipe on the first coupling portion, in a case where the electrolytic solution flows from the inside to the outside of the electrode assembly.

8. The electric storage device according to claim 7, wherein the reverse flow inhibiting groove is provided in a Tesla valve shape.

9. A separator used for an electric storage device, the electric storage device comprising: an electrode assembly that comprises a positive electrode, a negative electrode, and the separator insulating the positive electrode from the negative electrode; an electrolytic solution; and a case configured to accommodate the electrode assembly and the electrolytic solution, the separator comprising a reverse flow inhibiting groove on a surface that is a groove in which the electrolytic solution flows from an outside to an inside of the electrode assembly and which is in a pattern for inhibiting the electrolytic solution from flowing to the outside from the inside of the electrode assembly.

10. The separator according to claim 9, wherein the reverse flow inhibiting groove is disposed on a first area configuring an edge part.

11. The separator according to claim 10, comprising a base material, and comprising a first layer on a surface of the base material within the first area, wherein the reverse flow inhibiting groove is disposed on the first layer.

12. The separator according to claim 11, comprising a second layer on a second area from which the first area is excluded, wherein a groove comprising a pattern different from the reverse flow inhibiting groove is provided on the second layer.

13. The separator according to claim 9, wherein the reverse flow inhibiting groove comprises a main pipe, and a sub pipe configured to couple to the main pipe at two positions and in a loop shape, the main pipe configures a flow channel in which the electrolytic solution flows from the outside to the inside of the electrode assembly and a flow channel in which the electrolytic solution flows from the inside to the outside of the electrode assembly, and the reverse flow inhibiting groove is configured to make the electrolytic solution flowing in the main pipe dividedly flow from the main pipe to the sub pipe on a first coupling portion arranged at a relatively outer side of the electrode assembly among 2 coupling portions configured with the main pipe and the sub pipe and to make the electrolytic solution flowing in the sub pipe be merged, along a flowing direction of the electrolytic solution flowing in the main pipe, into the electrolytic solution flowing in the main pipe on a second coupling portion arranged at a relatively inner side of the electrode assembly among the 2 coupling portions configured with the main pipe and the sub pipe, in a case where the electrolytic solution flows from the outside to the inside of the electrode assembly, and is configured to make the electrolytic solution flowing in the main pipe dividedly flow from the main pipe to the sub pipe on the second coupling portion and to make the electrolytic solution flowing in the sub pipe be merged into the electrolytic solution flowing in the main pipe, from a backward direction with respect to a flowing direction of the electrolytic solution flowing in the main pipe on the first coupling portion, in a case where the electrolytic solution flows from the inside to the outside of the electrode assembly.

14. The separator according to claim 13, wherein the reverse flow inhibiting groove is provided in a Tesla valve shape.