

## DESCRIPTION

### Title of Invention

BUSHING, LEAD-ACID BATTERY, AND ASSEMBLED BATTERY

### 5 Technical Field

[0001] The present invention relates to a bushing, a lead-acid battery, and an assembled battery.

### Background Art

10 [0002] A lead-acid battery includes a positive electrode, a negative electrode, a separator, and a case accommodating the positive electrode, the negative electrode, the separator, and an electrolyte. The positive electrode is connected to a positive electrode terminal (electrode terminal), and the negative electrode is connected to a negative electrode terminal (electrode terminal). A plurality of the lead-acid  
15 batteries are combined to constitute an assembled battery (see, for example, Patent Literature 1).

### Citation List

#### Patent Literature

20 [0003] Patent Literature 1: Japanese Unexamined Patent Publication No. 2011-146222

### Summary of Invention

#### Technical Problem

25 [0004] In the assembled battery, the plurality of lead-acid batteries are electrically connected in series (parallel) by a connecting member. Welding, bolt fastening, or the like is adopted as a method for connecting the lead-acid battery and the connecting member. Bolt

fastening is adopted from the viewpoint of workability.

[0005] During liquid-type lead-acid battery maintenance, for example, the specific gravity of the electrolyte or the like may be checked by the electrolyte in the case being taken out in part. At this time, the electrolyte taken out by a worker may spill. In this case, the electrolyte may adhere around the connection part between the electrode terminal of the lead-acid battery and the connecting member and infiltrate into the connection part between the electrode terminal and a connecting terminal.

[0006] In a case where the electrode terminal of the lead-acid battery and the connecting member are welded together, electrical connectivity is not significantly affected even in a case where the electrolyte adheres to the welded part. In contrast, in a configuration in which the electrode terminal of the lead-acid battery and the connecting member are bolt-connected, electrical connectivity may be affected by electrolyte infiltration into the connection part between the electrode terminal and the connecting member. In this case, a decline in the performance of the assembled battery may arise. In addition, depending on the environment of use of the lead-acid battery, a liquid such as water may infiltrate into the case through the electrode terminal. In this case, a decline in the performance of the lead-acid battery may arise to eventually result in a decline in the performance of the assembled battery.

[0007] One aspect of the present invention is to provide a bushing, a lead-acid battery, and an assembled battery capable of suppressing a decline in performance.

### **Solution to Problem**

[0008] A bushing according to one aspect of the present invention is a bushing disposed between an electrode terminal and a case in a lead-acid battery including a positive electrode, a negative electrode, a separator, the case accommodating the positive electrode, the negative electrode, the separator, and an electrolyte, and the electrode terminal exposed from the case at least in part, and the bushing includes: a tubular main body portion extending in one direction, the electrode terminal being inserted into the main body portion; and a protruding portion provided in one end portion of the main body portion in an extension direction, protruding from an end surface of the one end portion, and having a ring shape when viewed from the extension direction of the main body portion.

[0009] The bushing according to one aspect of the present invention includes the protruding portion. The protruding portion is provided in one end portion of the main body portion in the extension direction, protrudes from the end surface of the one end portion, and has a ring shape when viewed from the extension direction of the main body portion. As a result, the protruding portion is disposed so as to surround the electrode terminal when the bushing is attached to the electrode terminal. Accordingly, in the bushing, the protruding portion functions as a seal member by the connecting member and the protruding portion abutting against each other when the electrode terminal of the lead-acid battery and the connecting member are connected. Accordingly, the bushing is capable of suppressing liquid infiltration into the connection part between the electrode terminal and

the connecting member and liquid infiltration into the lead-acid battery. As a result, the bushing is capable of suppressing a decline in the performance of the lead-acid battery and an assembled battery.

[0010] In one embodiment, an inner peripheral surface of the protruding portion may be flush with an inner peripheral surface of the main body portion. In this configuration, the inner peripheral surface of the protruding portion and the electrode terminal come into close contact with each other. Accordingly, it is possible to suppress liquid infiltration from the outside between the main body portion and the electrode terminal. Accordingly, the bushing is capable of suppressing a decline in the performance of the lead-acid battery and the assembled battery.

[0011] In one embodiment, the bushing may include a ring-shaped flange portion provided in the one end portion of the main body portion in an extension direction and projecting outward beyond an outer peripheral surface of the main body portion. In this configuration, it is possible to prevent a liquid from infiltrating between the outer peripheral surface of the main body portion and the case by the flange portion coming into contact with the case. Accordingly, the bushing is capable of preventing liquid infiltration into the case between the outer peripheral surface of the main body portion and the case. As a result, the bushing is capable of suppressing a decline in the performance of the lead-acid battery and the assembled battery.

[0012] In one embodiment, the main body portion may have a ring-shaped overhanging portion formed along a circumferential direction of an outer peripheral surface of the main body portion and

protruding outward from the outer peripheral surface. In this configuration, it is possible to further ensure close contact between the bushing and the case by the overhanging portion coming into contact with the case. Accordingly, the bushing is capable of further preventing liquid infiltration between the case and the bushing.

[0013] In one embodiment, a plurality of the overhanging portions may be provided in the extension direction of the main body portion. In this configuration, the close contact between the bushing and the case can be further ensured, and thus liquid infiltration between the case and the bushing can be further prevented.

[0014] In one embodiment, the main body portion may be provided with a recess portion formed along the circumferential direction of the outer peripheral surface at a position adjacent to the overhanging portion in the extension direction and recessed inward from the outer peripheral surface. In this configuration, the overhanging portion enters the recess portion in a case where the overhanging portion comes into contact with the case and is deformed. In the bushing, the recess portion allowing the overhanging portion to be deformed is provided as described above, and thus gap formation between the overhanging portion and the case can be suppressed. Accordingly, the bushing is capable of ensuring close contact between the bushing and the case.

[0015] In one embodiment, a pair of the recess portions may be provided at positions sandwiching the overhanging portion in the extension direction. In this configuration, the degree of freedom of the deformation of the overhanging portion increases. Accordingly, the bushing is capable of further ensuring close contact between the bushing

and the case.

[0016] In one embodiment, the main body portion may have a tapered shape tapering from one end portion toward the other end portion in the extension direction. In this configuration, the insertability of the bushing into the case can be improved.

[0017] A lead-acid battery according to one aspect of the present invention includes: a positive electrode, a negative electrode, and a separator; a case accommodating the positive electrode, the negative electrode, the separator, and an electrolyte; an electrode terminal exposed from the case at least in part; and the bushing described above, in which the bushing is disposed with the electrode terminal inserted in the case, and the protruding portion of the bushing protrudes beyond an upper end surface of the electrode terminal.

[0018] The lead-acid battery according to one aspect of the present invention includes the bushing described above. Accordingly, a decline in the performance of the lead-acid battery can be suppressed.

[0019] An assembled battery according to one aspect of the present invention includes: a plurality of the lead-acid batteries described above; and a connecting member electrically connecting one of the lead-acid batteries and another of the lead-acid batteries, in which the connecting member is fixed to the electrode terminal by a bolt.

[0020] In the assembled battery according to one aspect of the present invention, the connecting member is fixed by the bolt to the electrode terminal. In this configuration, electrical connectivity may be affected by electrolyte infiltration into the connection part between the electrode terminal and the connecting member. Accordingly, it is particularly

effective to include the lead-acid battery including the bushing described above in the configuration in which the connecting member is fixed by the bolt to the electrode terminal.

[0021] In one embodiment, the connecting member may have: a connecting portion electrically connecting the electrode terminal of one of the lead-acid batteries and the electrode terminal of another of the lead-acid batteries; and a covering portion covering the connecting portion, and the covering portion may abut against an upper end portion of the protruding portion. In this configuration, the protruding portion is pressed by the covering portion. Accordingly, the protruding portion functions as a seal member in a case where the electrode terminal and the connecting member are connected. Accordingly, in the assembled battery, it is possible to suppress liquid infiltration into the connection part between the electrode terminal and the connecting member and liquid infiltration into the lead-acid battery. As a result, a decline in the performance of the assembled battery can be suppressed.

### **Advantageous Effects of Invention**

[0022] According to one aspect of the present invention, a decline in performance can be suppressed.

### **Brief Description of Drawings**

[0023] FIG. 1 is a diagram illustrating an assembled battery according to an embodiment.

FIG. 2 is an enlarged cross-sectional view illustrating a part of the assembled battery.

FIG. 3 is a diagram illustrating a part of a lead-acid battery broken.

FIG. 4 is a diagram schematically illustrating a cross-sectional configuration of the lead-acid battery.

FIG. 5 is an enlarged cross-sectional view illustrating a part of the lead-acid battery.

5           FIG. 6 is an enlarged cross-sectional view illustrating a part of the lead-acid battery.

FIG. 7(a) is a top view of a bushing, and FIG. 7(b) is a side view of the bushing.

10           FIG. 8(a) is a top view of a bushing according to another embodiment, and FIG. 8(b) is a side view of the bushing according to another embodiment.

### **Description of Embodiments**

[0024] Hereinafter, a preferred embodiment of the present invention will be described in detail with reference to the accompanying drawings.

15           It should be noted that the same or equivalent elements in the description of the drawings will be denoted by the same reference numerals with redundant description omitted.

20           [0025] As illustrated in FIG. 1, an assembled battery 100 includes a plurality of lead-acid batteries 1. The assembled battery 100 is mounted on, for example, a vehicle such as a battery forklift driven by electric energy. The assembled battery 100 is provided with a power cable (not illustrated) connected to the vehicle.

25           [0026] In the assembled battery 100, the plurality of lead-acid batteries 1 are electrically connected in series by connecting wires 102. The connecting wire 102 is a connecting member electrically connecting one lead-acid battery 1 and another lead-acid battery 1. As illustrated in

FIG. 2, the connecting wire 102 has a conductive connecting portion 104 and a covering portion 106 covering the connecting portion 104. The connecting portion 104 is provided with a hole 104a through which a bolt 108 (described later) is inserted. The covering portion 106 is formed of an insulating resin. The covering portion 106 is provided with an opening portion 106a forming a space accommodating the bolt 108.

[0027] The connecting wire 102 is fixed to the lead-acid battery 1. Specifically, the connecting wire 102 is disposed on a positive electrode terminal 10 (negative electrode terminal 12) of the lead-acid battery 1 and is fixed to the positive electrode terminal 10 by the bolt 108. The bolt 108 is screwed in a bolt hole 10h (12h) provided in the upper portion of the positive electrode terminal 10 (negative electrode terminal 12).

[0028] The lead-acid battery 1 is, for example, a clad-type lead-acid battery including a clad-type electrode. As illustrated in FIG. 4, the lead-acid battery 1 includes a positive electrode 3, a negative electrode 5, and a separator 7. The positive electrode 3, the negative electrode 5, and the separator 7 are accommodated in a case 9. In the lead-acid battery 1, an electrolyte E is accommodated in the case 9.

[0029] As illustrated in FIG. 4, the positive electrode 3 is, for example, a clad-type positive electrode plate including a tubular electrode group 8 including a plurality of tubular electrodes (rod-shaped electrodes) 6 mutually arranged side by side. Each tubular electrode 6 has a clad tube (also referred to as "gauntlet") 6a, a core metal (current collector) 6b inserted in the clad tube 6a, and a positive electrode material 6c filled

between the clad tube 6a and the core metal 6b. The clad tube 6a has a tubular shape, and the cross-sectional shape of the clad tube 6a perpendicular to the longitudinal direction may be a circle, an ellipse, a quadrangle with rounded corners, or the like.

[0030] The negative electrode 5 has a plate shape and is, for example, a paste-type negative electrode plate. The negative electrode 5 has a negative electrode current collector and a negative electrode material held by the negative electrode current collector. A plate-shaped current collector can be used as the negative electrode current collector.

The negative electrode current collector and the core metal of the positive electrode may be identical to or different from each other in composition.

[0031] One surface of the separator 7 is in contact with the positive electrode 3, and the other surface of the separator 7 is in contact with the negative electrode 5. Each of the positive electrode 3 and the negative electrode 5 is sandwiched between the separators 7. Each of the positive electrode 3 and the negative electrode 5 may be sandwiched by two separators or may be sandwiched by one folded separator. The space around the positive electrode 3 that is between the separators 7 and 7 is filled with the electrolyte E.

[0032] The material of the separator 7 is not particularly limited insofar as the material blocks electrical connection between the positive electrode 3 and the negative electrode 5 and allows the electrolyte E to permeate. Examples of the material of the separator 7 include microporous polyethylene and a glass fiber-synthetic resin mixture.

[0033] As illustrated in FIG. 5, each positive electrode 3 is electrically

connected to the positive electrode terminal (electrode terminal) 10. The positive electrode terminal 10 has a columnar shape. A part (upper end portion) of the positive electrode terminal 10 is exposed from the case 9. The positive electrode terminal 10 has a main body portion 10a and a linking portion 10b. The main body portion 10a and the linking portion 10b are integrally formed. The main body portion 10a is formed of lead. The bolt hole 10h is formed in the linking portion 10b. The linking portion 10b is embedded in the extension-direction end portion of the main body portion 10a. The linking portion 10b is formed of brass. Each positive electrode 3 and the positive electrode terminal 10 (main body portion 10a) are electrically connected by a positive electrode strap 14.

[0034] As illustrated in FIG. 6, each negative electrode 5 is electrically connected to the negative electrode terminal (electrode terminal) 12.

The negative electrode terminal 12 has a columnar shape. A part (upper end portion) of the negative electrode terminal 12 is exposed from the case 9. The negative electrode terminal 12 has a main body portion 12a and a linking portion 12b. The main body portion 12a and the linking portion 12b are integrally formed. The main body portion 12a is formed of lead. The bolt hole 12h is formed in the linking portion 12b. The linking portion 12b is embedded in the extension-direction end portion of the main body portion 12a. The linking portion 12b is formed of brass. Each negative electrode 5 and the negative electrode terminal 12 (main body portion 12a) are electrically connected by a negative electrode strap 16.

[0035] As illustrated in FIG. 3, the case 9 has a main body 20 and a lid

22. The case 9 is formed of a material such as polypropylene. The main body 20 is a box-shaped electric tank. The main body 20 accommodates the positive electrode 3, the negative electrode 5, the separator 7, and the electrolyte E.

5 [0036] The lid 22 covers the opening portion of the main body 20. The lid 22 has a first terminal portion (disposition portion) 25 where the positive electrode terminal 10 is disposed, a second terminal portion (disposition portion) 26 where the negative electrode terminal 12 is disposed, and a refill plug 27. The first terminal portion 25 and the  
10 second terminal portion 26 are disposed so as to face each other at positions between which the refill plug 27 is sandwiched.

[0037] As illustrated in FIG. 5, the first terminal portion 25 has a side portion 25a and a bottom portion 25b. The side portion 25a has a circular shape when the lid 22 is viewed from above. The side portion  
15 25a forms a space accommodating the positive electrode terminal 10 and a bushing 30. The side portion 25a extends along the height direction of the case 9. The upper end portion of the side portion 25a protrudes beyond one main surface 22a of the lid 22. The lower end portion of the side portion 25a protrudes beyond the other main surface  
20 22b of the lid 22. The bottom portion 25b is provided in the lower end portion of the side portion 25a and projects inward from the side portion 25a. The bottom portion 25b has a ring shape. The bottom portion 25b forms an opening through which the positive electrode terminal 10 is inserted.

25 [0038] As illustrated in FIG. 6, the second terminal portion 26 has a side portion 26a and a bottom portion 26b. The side portion 26a has a

circular shape when the lid 22 is viewed from above. The side portion 26a forms a space accommodating the negative electrode terminal 12 and the bushing 30. The side portion 26a extends along the height direction of the case 9. The upper end portion of the side portion 26a protrudes beyond one main surface 22a of the lid 22. The lower end portion of the side portion 26a protrudes beyond the other main surface 22b of the lid 22. The bottom portion 26b is provided in the lower end portion of the side portion 26a and projects inward from the side portion 26a. The bottom portion 26b has a ring shape. The bottom portion 26b forms an opening through which the negative electrode terminal 12 is inserted.

[0039] As illustrated in FIGS. 5 and 6, the electrolyte E is accommodated in the main body 20. A liquid surface Es of the electrolyte E is positioned at the height of contact with at least the positive electrode terminal 10 and the negative electrode terminal 12. In other words, the electrolyte E is filled so as to come into contact with the positive electrode terminal 10 and the negative electrode terminal 12. The electrolyte E can be supplied from the refill plug 27.

[0040] The lead-acid battery 1 includes the bushing 30. As illustrated in FIG. 5, the bushing 30 is disposed between the first terminal portion 25 of the lid 22 and the positive electrode terminal 10. In addition, as illustrated in FIG. 6, the bushing 30 is disposed between the second terminal portion 26 of the lid 22 and the negative electrode terminal 12.

[0041] As illustrated in FIGS. 7(a) and 7(b), the bushing 30 has a main body portion 32, a flange portion 34, and a protruding portion 35. The main body portion 32, the flange portion 34, and the protruding portion

35 are integrally formed.

[0042] The bushing 30 is preferably formed of a highly heat-resistant, insulating, elastic, and flexible material. For example, it is preferable that the bushing 30 is heat-resistant so as not to melt at 100°C or higher.

5 It is preferable that the bushing 30 has an insulating property having a surface resistance of 1000 MΩ or more. Examples of preferable materials forming the bushing 30 include HNBR (hydrogenated nitrile rubber), FKM (fluororubber), VMQ (silicon rubber), ACM (acrylic rubber), and CO (epichlorohydrin rubber). It is preferable that the  
10 bushing 30 is formed of, for example, Skyprene (registered trademark) B-10 (manufactured by Tosoh Corporation).

[0043] As illustrated in FIG. 7(b), the main body portion 32 extends in one direction and has a cylindrical shape. The main body portion 32 is provided with a hollow portion 32a. The hollow portion 32a is defined  
15 by an inner peripheral surface 32i. The hollow portion 32a has a circular shape when viewed from the extension direction of the main body portion 32. The diameter of the hollow portion 32a (inner diameter of the main body portion 32) is preferably equal to or less than the diameters of the positive electrode terminal 10 and the negative  
20 electrode terminal 12. The width of the main body portion 32 (radial dimension of the main body portion 32) is equal from one end portion to the other end portion in the extension direction. The width (outer diameter) of the main body portion 32 is, for example, 30 mm to 40 mm.

25 [0044] The main body portion 32 has a rib (overhanging portion) 36 and a recess portion 38. The rib 36 is formed along the circumferential

direction of an outer peripheral surface 32o of the main body portion 32 and protrudes outward along the radial direction from the outer peripheral surface 32o. The rib 36 has a ring shape. A plurality of the ribs 36 (two in the present embodiment) are disposed in the extension direction of the main body portion 32. The rib 36 may be one or three or more in number. The width of the rib 36 (extension-direction length of the main body portion 32) is, for example, 0.5 mm to 2.0 mm. The amount of protrusion of the rib 36 is, for example, 0.5 mm to 2.0 mm.

[0045] The recess portion 38 is disposed at a position adjacent to the rib 36 in the extension direction of the main body portion 32. In the present embodiment, a pair of the recess portions 38 are provided at positions sandwiching the rib 36 in the extension direction of the main body portion 32. The recess portion 38 is formed along the circumferential direction of the outer peripheral surface 32o of the main body portion 32 and is recessed inward along the radial direction from the outer peripheral surface 32o. The width of the recess portion 38 is 0.5 mm to 2.0 mm. The depth of the recess portion 38 is, for example, 0.5 mm to 2.0 mm.

[0046] A tapered portion 39 is provided in the other end portion (tip portion) of the main body portion 32 in the extension direction. The tapered portion 39 is tapered from the outer peripheral surface 32o toward the other end portion side in the other end portion of the main body portion 32 in the extension direction.

[0047] The flange portion 34 is provided in one end portion of the main body portion 32 in the extension direction. The flange portion 34

projects outward beyond the outer peripheral surface 32o of the main body portion 32 in the radial direction of the main body portion 32. The flange portion 34 has one main surface 34a and the other main surface 34b. One main surface 34a constitutes the upper surface of the bushing 30. One main surface 34a is flush with an end surface 32b of one end portion of the main body portion 32. The other main surface 34b is a surface forming a predetermined angle (approximately 90°) with the outer peripheral surface 32o of the main body portion 32 and continuous with the outer peripheral surface 32o. As illustrated in FIG. 7(a), the flange portion 34 has a circular outer shape when viewed from the extension direction of the main body portion 32. The width of the flange portion 34 (dimension between the pair of main surfaces 34a and 34b) is, for example, 2.5 mm to 4.5 mm. The outer diameter of the flange portion 34 is, for example, 35 mm to 45 mm.

[0048] The protruding portion 35 is provided in one end portion of the main body portion 32 in the extension direction. The protruding portion 35 protrudes from the end surface 32b of one end portion of the main body portion 32. The protruding portion 35 has a ring shape when viewed from the extension direction of the main body portion 32. An inner peripheral surface 35i of the protruding portion 35 is flush with the inner peripheral surface 32i of the main body portion 32. The amount of protrusion of the protruding portion 35 (height of the main body portion 32 from the end surface 32b) is appropriately set depending on the design. As illustrated in FIG. 5, the protruding portion 35 is set so as to protrude upward beyond the upper end surface of the main body portion 10a (12a) of the positive electrode terminal 10

(negative electrode terminal 12). The outer diameter of the protruding portion 35 is smaller than the outer diameter of the main body portion 32 and the outer diameter of the flange portion 34. The protruding portion 35 has a tapered shape that tapers toward the tip side from the base end side connected to the main body portion 32 in a side view.

[0049] A method for attaching the bushing 30 having the above-described configuration to the lead-acid battery 1 will be described. A method for attaching the bushing 30 between the positive electrode terminal 10 and the first terminal portion 25 will be described below as an example with reference to FIG. 5.

[0050] In a case where the bushing 30 is attached, the positive electrode terminal 10 is inserted into the hollow portion 32a of the main body portion 32 of the bushing 30 and the main body portion 32 is inserted between the first terminal portion 25 and the positive electrode terminal 10. Then, the bushing 30 is pushed in until the first terminal portion 25 and the flange portion 34 of the bushing 30 abut against each other. As a result, the protruding portion 35 of the bushing 30 is disposed so as to surround the positive electrode terminal 10.

[0051] When the bushing 30 is pushed in, the lower end portion (tapered portion 39) of the main body portion 32 of the bushing 30 abuts against the bottom portion 25b of the first terminal portion 25. The outer peripheral surface 32o and the rib 36 of the main body portion 32 of the bushing 30 come into contact with the side portion 25a of the first terminal portion 25. The flange portion 34 of the bushing 30 is disposed so as to face the end surface of the upper end portion of the side portion 25a of the first terminal portion 25, and the other main

surface 34b comes into contact with the side portion 25a. As a result, the bushing 30 is attached. The bushing 30 is similarly attached to the second terminal portion 26.

[0052] Subsequently, a method for attaching the connecting wire 102 in a case where the assembled battery 100 is assembled will be described with reference to FIG. 2. In a case where the connecting wire 102 is attached, the connecting wire 102 is disposed on the positive electrode terminal 10. Subsequently, the bolt 108 is inserted through the hole 104a of the connecting portion 104 of the connecting wire 102 and the bolt 108 is screwed into the bolt hole 10h of the positive electrode terminal 10. When the bolt 108 is screwed into the bolt hole 10h, the connecting wire 102 is fixed to the positive electrode terminal 10.

[0053] When the connecting wire 102 is fixed to the positive electrode terminal 10, the connecting portion 104 abuts against the positive electrode terminal 10. As a result, the positive electrode terminal 10 and the connecting portion 104 of the connecting wire 102 are electrically connected. The covering portion 106 abuts against the positive electrode terminal 10 and the bushing 30. Specifically, an abutting surface 107c of a first abutting portion 107a of the covering portion 106 comes into close contact with the main body portion 10a of the positive electrode terminal 10. As a result, the first abutting portion 107a functions as a seal member, and thus it is possible to suppress liquid infiltration from the outside between the connecting portion 104 and the positive electrode terminal 10.

[0054] A second abutting portion 107b of the covering portion 106 abuts against one main surface 34a of the flange portion 34 of the

bushing 30. The width of the covering portion 106 is equal to the width of the main body portion 32 of the bushing 30. In other words, the second abutting portion 107b of the covering portion 106 is not disposed so as to face the side portion 25a of the first terminal portion 25. In this configuration, the covering portion 106 presses down the main body portion 32 of the bushing 30, and thus the close contact between the main body portion 32 of the bushing 30 and the bottom portion 25b of the first terminal portion 25 is improved. In addition, the second abutting portion 107b and the flange portion 34 come into close contact with each other, and thus the second abutting portion 107b functions as a seal member. Accordingly, it is possible to suppress liquid infiltration from the outside between the second abutting portion 107b and the flange portion 34 of the bushing 30.

[0055] The abutting surface 107c of the first abutting portion 107a also abuts against the protruding portion 35 of the bushing 30. The protruding portion 35 of the bushing 30 protrudes upward beyond the upper end surface of the main body portion 10a of the positive electrode terminal 10. Accordingly, when the tip portion of the protruding portion 35 is pressed by the first abutting portion 107a, the protruding portion 35 comes into close contact with the first abutting portion 107a. As a result, the protruding portion 35 functions as a seal member, and thus it is possible to suppress liquid infiltration from the outside between the first abutting portion 107a and the positive electrode terminal 10.

[0056] The protruding portion 35 is disposed in the space that is defined by the positive electrode terminal 10, the abutting surface 107c of the

first abutting portion 107a of the covering portion 106, and the second  
abutting portion 107b. The protruding portion 35 comes into close  
contact with the positive electrode terminal 10, the abutting surface  
107c of the first abutting portion 107a, and the second abutting portion  
107b by being pressed by the abutting surface 107c of the first abutting  
portion 107a. As a result, most of the space defined by the positive  
electrode terminal 10, the abutting surface 107c of the first abutting  
portion 107a of the covering portion 106, and the second abutting  
portion 107b is filled with the protruding portion 35. Accordingly, it is  
possible to suppress gap formation in the path from the outside to the  
positive electrode terminal 10. Accordingly, it is possible to suppress  
liquid infiltration from the outside between the first abutting portion  
107a and the positive electrode terminal 10. The connecting wire 102  
is similarly attached to the negative electrode terminal 12.

[0057] As described above, the bushing 30 according to the present  
embodiment includes the protruding portion 35. The protruding  
portion 35 is provided in one end portion of the main body portion 32 in  
the extension direction, protrudes from the end surface 32b of one end  
portion, and has a ring shape when viewed from the extension direction  
of the main body portion 32. As a result, the protruding portion 35 is  
disposed so as to surround the positive electrode terminal 10 or the  
negative electrode terminal 12. Accordingly, in a case where the  
positive electrode terminal 10 or the negative electrode terminal 12 is  
connected to the connecting wire 102, the protruding portion 35  
functions as a seal member by the first abutting portion 107a and the  
protruding portion 35 abutting against each other. Accordingly, the

bushing 30 is capable of suppressing liquid infiltration into the connection part between the positive electrode terminal 10 or the negative electrode terminal 12 and the connecting portion 104 of the connecting wire 102 and liquid infiltration into the case 9 between the positive electrode terminal 10 or the negative electrode terminal 12 and the bushing 30. As a result, the bushing 30 is capable of suppressing a decline in the performance of the lead-acid battery 1 and the assembled battery 100.

[0058] In the present embodiment, the linking portion 10b of the positive electrode terminal 10 and the linking portion 12b of the negative electrode terminal 12 are formed of brass. Brass is easily corroded as a result of contact with the electrolyte E. Accordingly, it is necessary to avoid the electrolyte E reaching the linking portion 10b or the linking portion 12b. In a case where the connecting wire 102 is connected to the positive electrode terminal 10 or the negative electrode terminal 12, the bushing 30 according to the present embodiment functions as a seal member by the protruding portion 35 being pressed by the first abutting portion 107a. Accordingly, the bushing 30 is capable of avoiding corrosion of the linking portion 10b of the positive electrode terminal 10 and the linking portion 12b of the negative electrode terminal 12. As a result, the bushing 30 is capable of suppressing a decline in the performance of the assembled battery 100.

[0059] In the bushing 30 according to the present embodiment, the main body portion 32 and the protruding portion 35 are integrally formed. For example, in a case where a seal member such as an O-ring is separately provided instead of the protruding portion 35, a gap

is formed between the main body portion 32 and the O-ring. Accordingly, a liquid is capable of infiltrating from the gap. In the bushing 30, the main body portion 32 and the protruding portion 35 are integrally formed, and thus no gap is formed between the main body portion 32 and the protruding portion 35. Accordingly, the bushing 30 is capable of more reliably suppressing liquid infiltration into the connection part between the positive electrode terminal 10 or the negative electrode terminal 12 and the connecting portion 104 of the connecting wire 102 and liquid infiltration into the case 9 between the positive electrode terminal 10 or the negative electrode terminal 12 and the bushing 30.

[0060] In the bushing 30 according to the present embodiment, the inner peripheral surface 35i of the protruding portion 35 is flush with the inner peripheral surface 32i of the main body portion 32. In this configuration, the inner peripheral surface 35i of the protruding portion 35 and the positive electrode terminal 10 or the negative electrode terminal 12 come into close contact with each other. Accordingly, it is possible to suppress liquid infiltration from the outside between the main body portion 32 and the positive electrode terminal 10 or the negative electrode terminal 12. Accordingly, the bushing 30 is capable of suppressing a decline in the performance of the lead-acid battery 1 and the assembled battery 100.

[0061] The bushing 30 according to the present embodiment includes the ring-shaped flange portion 34 provided in one end portion of the main body portion 32 in the extension direction and projecting outward beyond the outer peripheral surface 32o of the main body portion 32.

In this configuration, it is possible to prevent a liquid from infiltrating between the outer peripheral surface 32o of the main body portion 32 and the case 9 by the flange portion 34 coming into contact with the case 9. Accordingly, the bushing 30 is capable of preventing liquid infiltration into the case 9 between the outer peripheral surface 32o of the main body portion 32 and the case 9. As a result, the bushing 30 is capable of suppressing a decline in the performance of the lead-acid battery 1.

[0062] In the bushing 30 according to the present embodiment, the main body portion 32 has the ring-shaped rib 36 formed along the circumferential direction of the outer peripheral surface 32o of the main body portion 32 and protruding outward from the outer peripheral surface 32o. In this configuration, it is possible to further ensure close contact between the bushing 30 and the case 9 by the rib 36 coming into contact with the case 9. Accordingly, the bushing 30 is capable of further preventing liquid infiltration between the case 9 and the bushing 30.

[0063] In the bushing 30 according to the present embodiment, the plurality of ribs 36 are provided in the extension direction of the main body portion 32. In this configuration, the close contact between the bushing 30 and the case 9 can be further ensured, and thus liquid infiltration between the case 9 and the bushing 30 can be further prevented.

[0064] In the bushing 30 according to the present embodiment, the main body portion 32 is provided with the recess portion 38 formed along the circumferential direction of the outer peripheral surface 32o at

a position adjacent to the rib 36 in the extension direction and recessed inward from the outer peripheral surface 32o. In this configuration, the rib 36 enters the recess portion 38 in a case where the rib 36 comes into contact with the case 9 and is deformed. In the bushing 30, the recess portion 38 allowing the rib 36 to be deformed is provided as described above, and thus gap formation between the rib 36 and the case 9 can be suppressed. Accordingly, the bushing 30 is capable of ensuring close contact between the bushing 30 and the case 9.

[0065] In the bushing 30 according to the present embodiment, the pair of recess portions 38 are provided at positions sandwiching the rib 36 in the extension direction. In this configuration, the degree of freedom of the deformation of the rib 36 increases. Accordingly, the bushing 30 is capable of further ensuring close contact between the bushing 30 and the case 9.

[0066] In the bushing 30 according to the present embodiment, the main body portion 32 has a tapered shape that tapers from one end portion toward the other end portion in the extension direction. In this configuration, the insertability of the bushing 30 into the case 9 can be improved.

[0067] In the above-described bushing 30 in the lead-acid battery 1 according to the present embodiment, the positive electrode terminal 10 or the negative electrode terminal 12 is inserted into the main body portion 32 and the protruding portion 35 protrudes beyond the upper end surface of the positive electrode terminal 10 or the negative electrode terminal 12. As a result, in a case where the positive electrode terminal 10 or the negative electrode terminal 12 is connected

to the connecting wire 102 in the lead-acid battery 1, the protruding portion 35 functions as a seal member by the connecting wire 102 and the protruding portion 35 abutting against each other. Accordingly, the lead-acid battery 1 is capable of suppressing liquid infiltration into the connection part between the positive electrode terminal 10 or the negative electrode terminal 12 and the connecting wire 102 and liquid infiltration into the lead-acid battery 1. As a result, a decline in the performance of the lead-acid battery 1 can be suppressed.

[0068] The assembled battery 100 according to the present embodiment includes the plurality of lead-acid batteries 1 and the connecting wire 102 electrically connecting one lead-acid battery 1 and another lead-acid battery 1. The connecting wire 102 is fixed by the bolt 108 to the positive electrode terminal 10 or the negative electrode terminal 12. In the assembled battery 100, the connecting wire 102 is fixed by the bolt 108 to the positive electrode terminal 10 or the negative electrode terminal 12. In this configuration, electrical connectivity may be affected by electrolyte infiltration into the connection part between the positive electrode terminal 10 or the negative electrode terminal 12 and the connecting portion 104 of the connecting wire 102. Accordingly, it is particularly effective to include the lead-acid battery 1 including the bushing 30 in the configuration in which the connecting wire 102 is fixed by the bolt 108 to the positive electrode terminal 10 or the negative electrode terminal 12.

[0069] In the assembled battery 100 according to the present embodiment, the connecting wire 102 has the connecting portion 104 electrically connecting the positive electrode terminal 10 or the negative

electrode terminal 12 of one lead-acid battery 1 and the positive  
electrode terminal 10 or the negative electrode terminal 12 of another  
lead-acid battery 1 and the covering portion 106 covering the  
connecting portion 104. The covering portion 106 abuts against the  
5 upper end portion of the protruding portion 35 of the bushing 30. In  
this configuration, the protruding portion 35 is pressed by the first  
abutting portion 107a of the covering portion 106. Accordingly, the  
protruding portion 35 functions as a seal member in a case where the  
positive electrode terminal 10 or the negative electrode terminal 12 and  
10 the connecting wire 102 are connected. Accordingly, it is possible to  
suppress liquid infiltration into the connection part between the positive  
electrode terminal 10 or the negative electrode terminal 12 and the  
connecting wire 102 and liquid infiltration into the lead-acid battery 1.  
As a result, a decline in the performance of the assembled battery 100  
15 can be suppressed.

[0070] Although the embodiment of the present invention has been  
described above, the present invention is not necessarily limited to the  
embodiment described above and various modifications can be made  
within the gist thereof.

20 [0071] A form in which the positive electrode 3 of the lead-acid battery  
1 is a clad-type electrode has been described as an example in the  
embodiment described above. However, the positive electrode 3 may  
be a paste-type electrode as in the case of the negative electrode 5.

[0072] A form in which the bushing 30 includes the flange portion 34  
25 has been described as an example in the embodiment described above.  
However, the bushing 30 may lack the flange portion 34. As

illustrated in FIGS. 8(a) and 8(b), a bushing 30A may include the main body portion 32 and the protruding portion 35.

[0073] The bushing 30A includes the protruding portion 35. The protruding portion 35 is provided in one end portion of the main body portion 32 in the extension direction, protrudes from the end surface 32b of one end portion, and has a ring shape when viewed from the extension direction of the main body portion 32. As a result, the protruding portion 35 is disposed so as to surround the positive electrode terminal 10 (negative electrode terminal 12). Accordingly, in a case where the positive electrode terminal 10 (negative electrode terminal 12) and the connecting wire 102 are connected, the protruding portion 35 functions as a seal member by the first abutting portion 107a and the protruding portion 35 abutting against each other. Accordingly, the bushing 30A is capable of suppressing liquid infiltration into the connection part between the positive electrode terminal 10 or the negative electrode terminal 12 and the connecting portion 104 of the connecting wire 102 and liquid infiltration into the case 9 between the positive electrode terminal 10 or the negative electrode terminal 12 and the bushing 30A. As a result, the bushing 30A is capable of suppressing a decline in performance.

[0074] A form in which the width of the main body portion 32 of the bushing 30, 30A is equal from one end portion to the other end portion in the extension direction has been described as an example in the embodiment described above. However, the main body portion may have a tapered shape that tapers from one end portion toward the other end portion in the extension direction. In this configuration, the

insertability of the bushing into the first terminal portion 25 and the second terminal portion 26 of the case 9 can be improved.

[0075] A form in which the width of the covering portion 106 is equal to the width of the main body portion 32 of the bushing 30 and the second abutting portion 107b of the covering portion 106 is not disposed so as to face the side portion 25a of the first terminal portion 25 has been described as an example in the embodiment described above. However, in an alternative configuration, the second abutting portion 107b of the covering portion 106 may be disposed at a position facing the side portion 25a of the first terminal portion 25. In this configuration, the flange portion 34 is sandwiched by the second abutting portion 107b and the first terminal portion 25, and thus the close contact between the first terminal portion 25 and the flange portion 34 can be improved.

[0076] A form in which the recess portion 38 is provided in the main body portion 32 of the bushing 30, 30A has been described as an example in the embodiment described above. However, the main body portion 32 may lack the recess portion 38.

[0077] A form in which the main body portion 32 of the bushing 30, 30A is provided with the rib 36 and the recess portion 38 has been described as an example in the embodiment described above. However, the rib 36 and the recess portion 38 may not be provided.

[0078] A form in which the plurality of ribs 36 and the plurality of recess portions 38 are disposed in the main body portion 32 of the bushing 30, 30A at predetermined intervals in the extension direction of the main body portion 32 has been described as an example in the

embodiment described above. However, one rib 36 and one recess portion 38 may be provided. In this configuration, the rib 36 and the recess portion 38 are preferably provided on the other end portion (tip portion) side of the main body portion 32 as compared with the extension-direction center of the main body portion 32.

### **Reference Signs List**

[0079] 1: lead-acid battery, 3: positive electrode, 5: negative electrode, 7: separator, 9: case, 10: positive electrode terminal (electrode terminal), 12: negative electrode terminal (electrode terminal), 30, 30A: bushing, 32: main body portion, 32i: inner peripheral surface, 32o: outer peripheral surface, 34: flange portion, 35: protruding portion, 35i: inner peripheral surface, 36: rib (overhanging portion), 38: recess portion, 100: assembled battery, 102: connecting wire (connecting member), 104: connecting portion, 106: covering portion, E: electrolyte.

## CLAIMS

1. A bushing disposed between an electrode terminal and a case in a lead-acid battery including a positive electrode, a negative electrode, a separator, the case accommodating the positive electrode, the negative electrode, the separator, and an electrolyte, and the electrode terminal exposed from the case at least in part, the bushing comprising:

a tubular main body portion extending in one direction, the electrode terminal being inserted into the main body portion; and

a protruding portion provided in one end portion of the main body portion in an extension direction, protruding from an end surface of the one end portion, and having a ring shape when viewed from the extension direction of the main body portion.

2. The bushing according to claim 1, wherein an inner peripheral surface of the protruding portion is flush with an inner peripheral surface of the main body portion.

3. The bushing according to claim 1 or 2, comprising a ring-shaped flange portion provided in the one end portion of the main body portion in an extension direction and projecting outward beyond an outer peripheral surface of the main body portion.

4. The bushing according to any one of claims 1 to 3, wherein the main body portion has a ring-shaped overhanging portion formed along a circumferential direction of an outer peripheral surface of the main body portion and protruding outward from the outer peripheral surface.

5. The bushing according to claim 4, wherein a plurality of the overhanging portions are provided in the extension direction of the main body portion.

6. The bushing according to claim 4 or 5, wherein the main body portion is provided with a recess portion formed along the circumferential direction of the outer peripheral surface at a position adjacent to the overhanging portion in the extension direction and recessed inward from the outer peripheral surface.

7. The bushing according to claim 6, wherein a pair of the recess portions are provided at positions sandwiching the overhanging portion in the extension direction.

8. The bushing according to any one of claims 1 to 7, wherein the main body portion has a tapered shape tapering from one end portion toward the other end portion in the extension direction.

9. A lead-acid battery comprising:  
a positive electrode, a negative electrode, and a separator;  
a case accommodating the positive electrode, the negative electrode, the separator, and an electrolyte;  
an electrode terminal exposed from the case at least in part; and  
the bushing according to any one of claims 1 to 8, wherein  
the bushing is disposed with the electrode terminal inserted in the main body portion in the case, and  
the protruding portion of the bushing protrudes beyond an upper end surface of the electrode terminal.

10. An assembled battery comprising:  
a plurality of the lead-acid batteries according to claim 9; and  
a connecting member electrically connecting one of the lead-acid batteries and another of the lead-acid batteries,  
wherein the connecting member is fixed to the electrode

terminal by a bolt.

11. The assembled battery according to claim 10, wherein  
the connecting member has:

5 a connecting portion electrically connecting the electrode  
terminal of one of the lead-acid batteries and the electrode terminal of  
another of the lead-acid batteries; and

a covering portion covering the connecting portion, and  
the covering portion abuts against a tip portion of the protruding  
portion.

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