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Chen et al.

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(54) **BIDIRECTIONAL HUB ASSEMBLY**

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(51) **Int. Cl.**

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F16D 41/26	(2006.01)
F16D 41/30	(2006.01)
F16D 41/16	(2006.01)

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

CPC ***B60B 27/047*** (2013.01); ***F16D 41/16*** (2013.01); ***F16D 41/26*** (2013.01); ***F16D 41/30*** (2013.01)

(58) **Field of Classification Search**

CPC B60B 27/047; F16D 41/12; F16D 41/16; F16D 41/30

See application file for complete search history.

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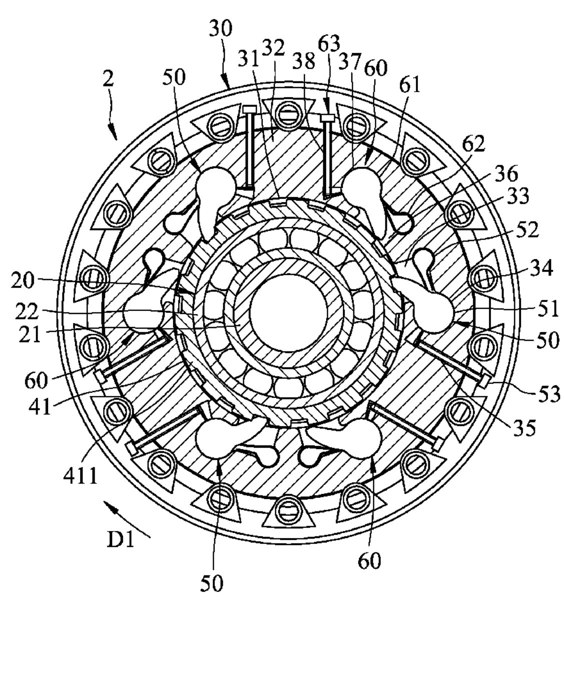
(57) **ABSTRACT**

A bidirectional hub assembly includes an axle unit, a hub shell mounted on the axle unit, a driving unit mounted on the axle unit, and a plurality of right-hand-drive and left-hand-drive units that are mounted to the hub shell. Each of the right-hand-drive and left-hand-drive units has a pawl engageable with the driving unit. The bidirectional hub assembly serves as a right-hand-drive hub when the pawl of at least one of the right-hand-drive units is in an enabled state and the pawl of each of the left-hand-drive units is in a disabled state, and serves as a left-hand-drive hub when the pawl of at least one of the left-hand-drive units is in an enabled state and the pawl of each of the right-hand-drive units is in a disabled state.

6 Claims, 9 Drawing Sheets



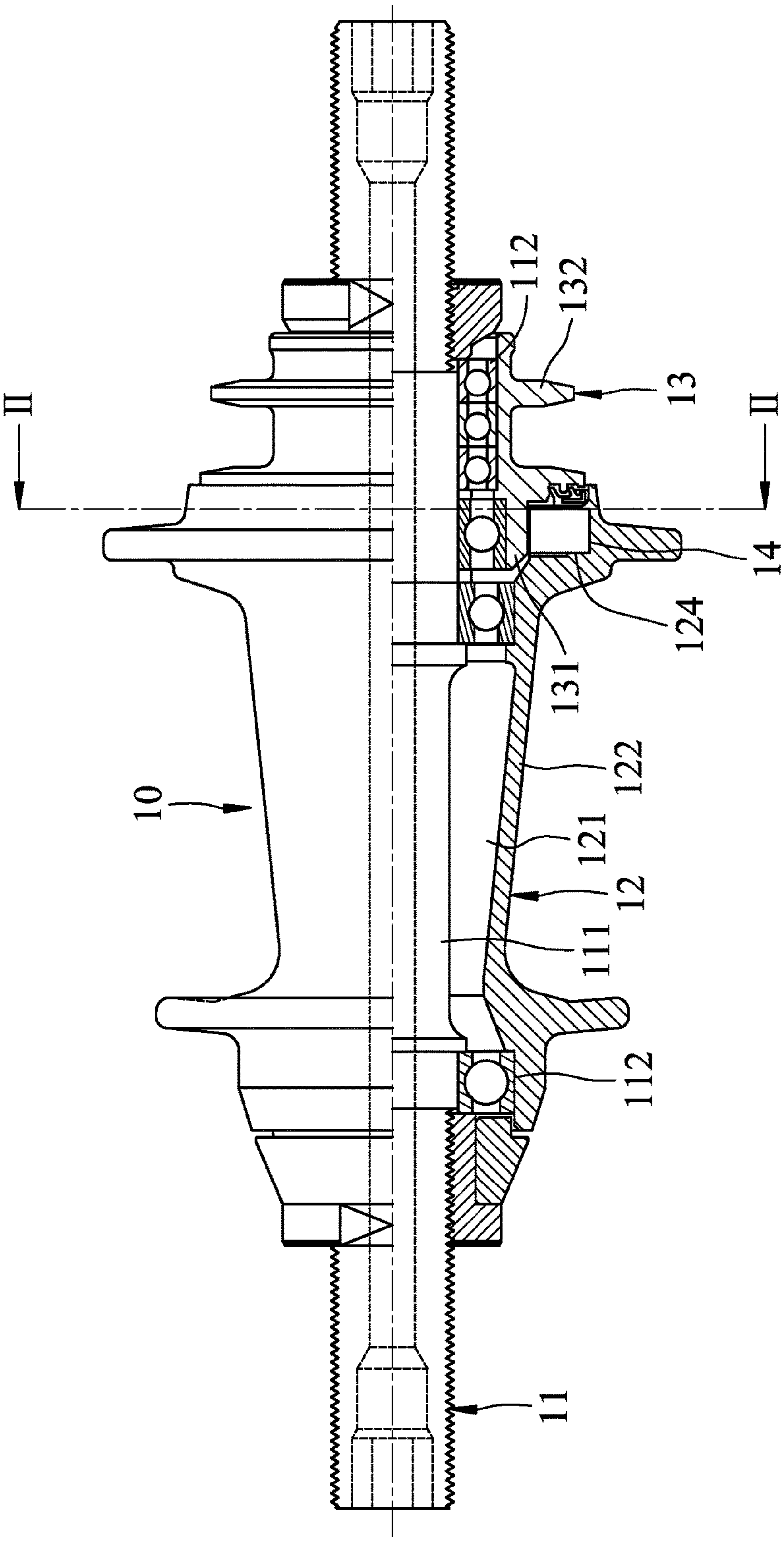


FIG.1
PRIOR ART

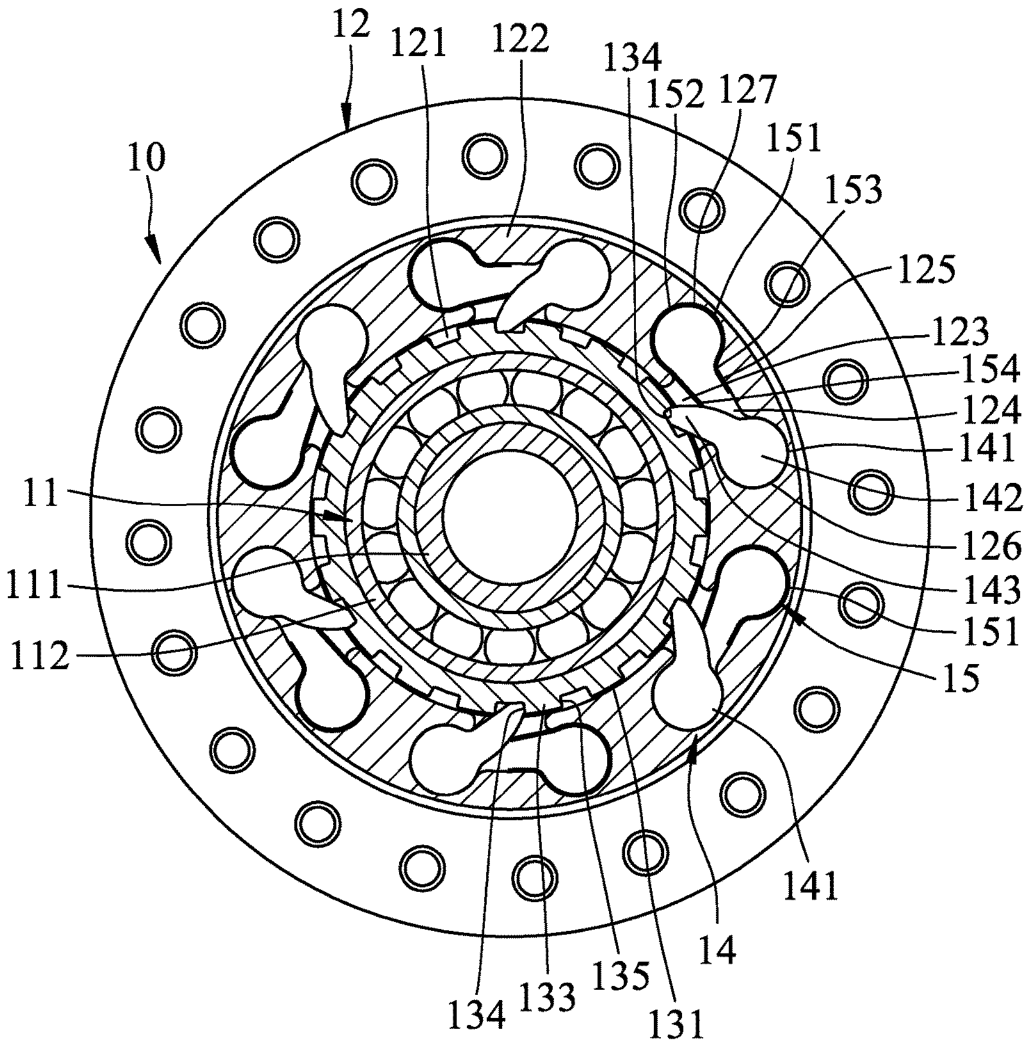


FIG.2
PRIOR ART

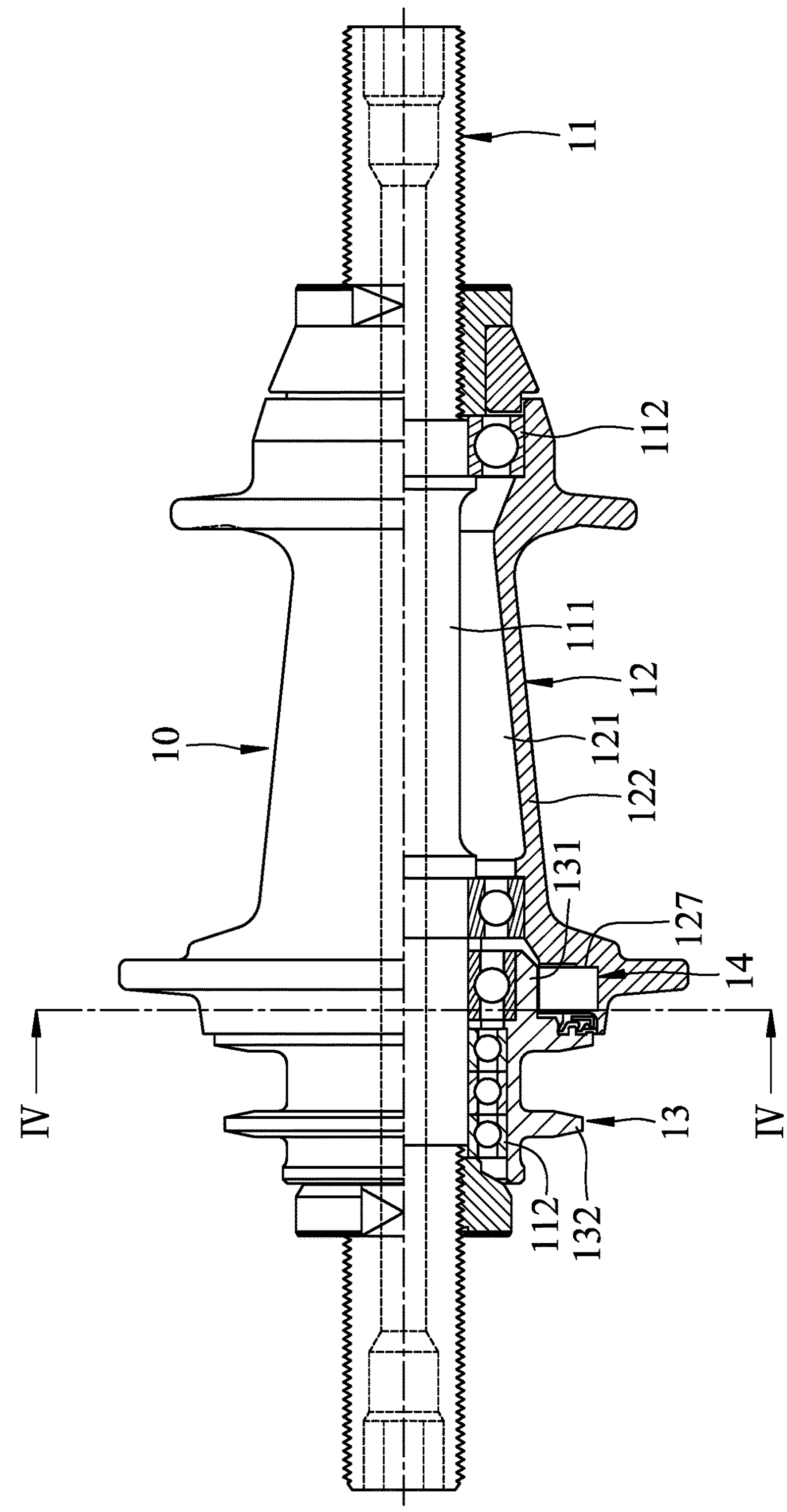


FIG.3
PRIOR ART

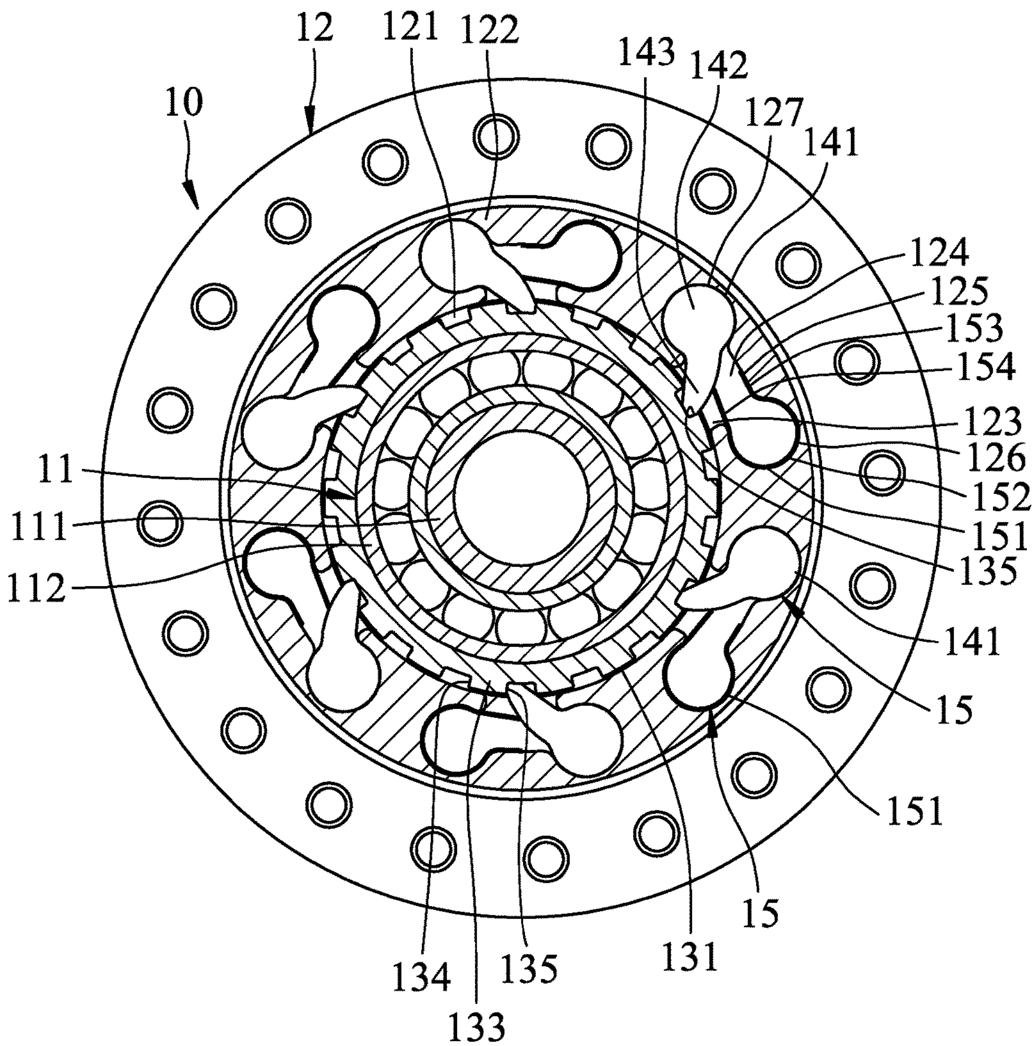


FIG.4
PRIOR ART

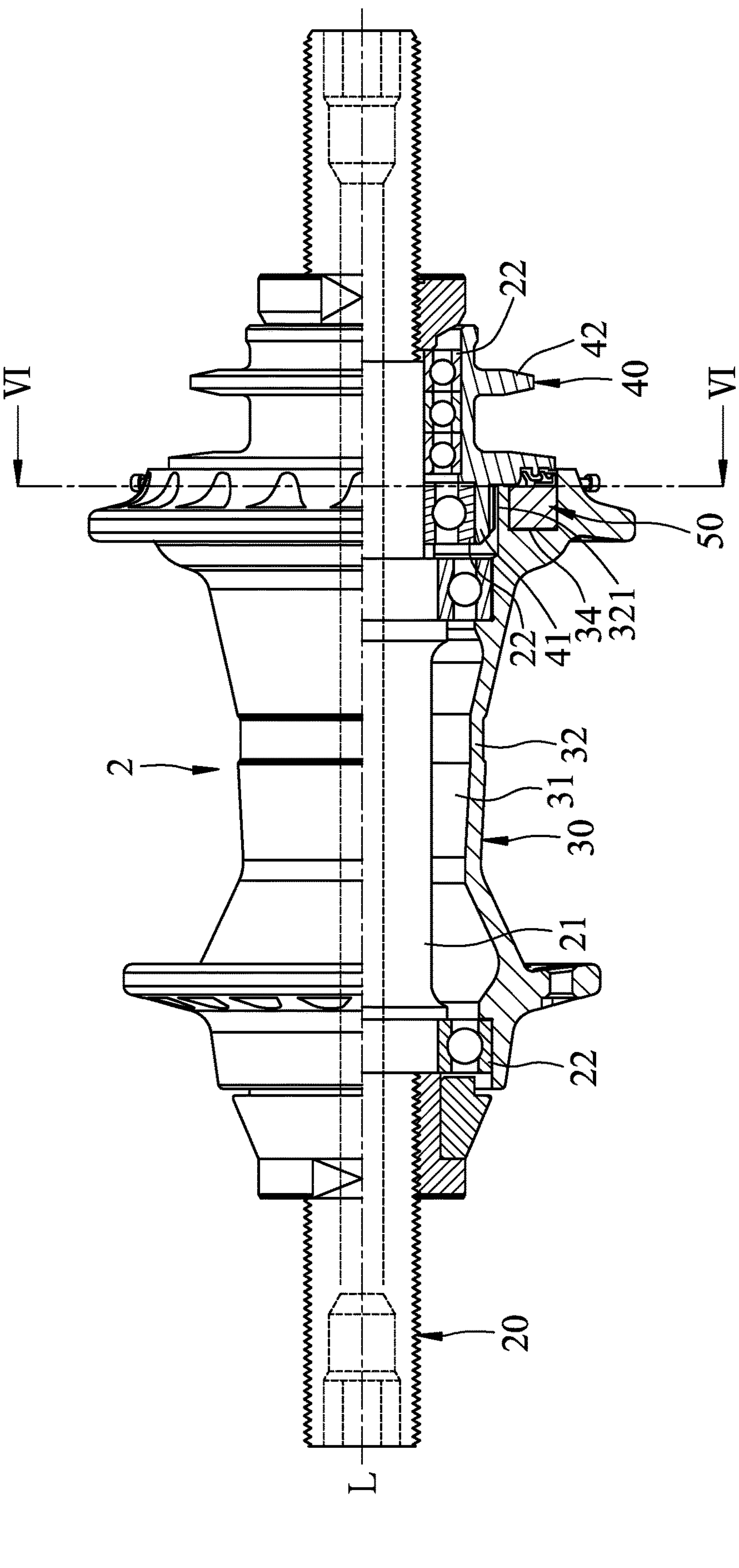


FIG.5

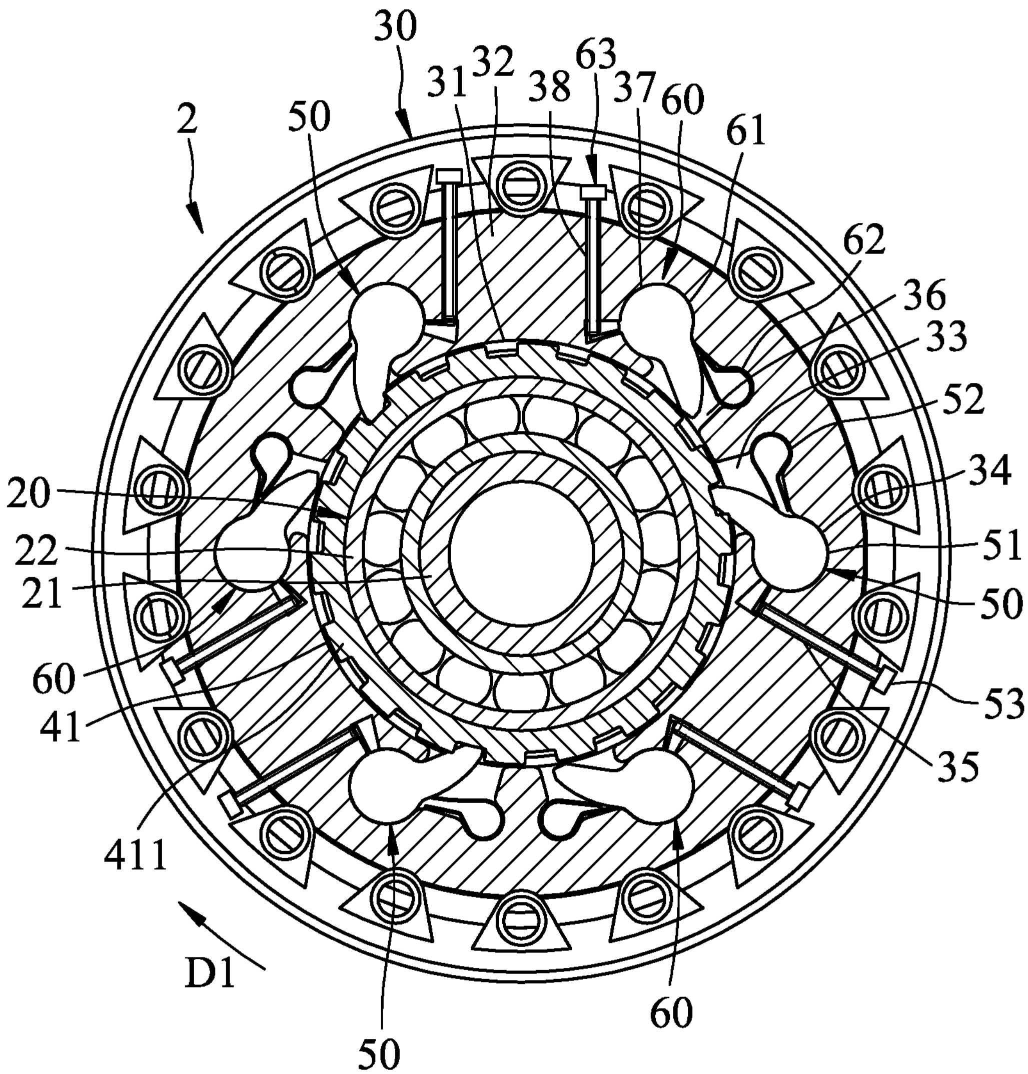

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FIG.6

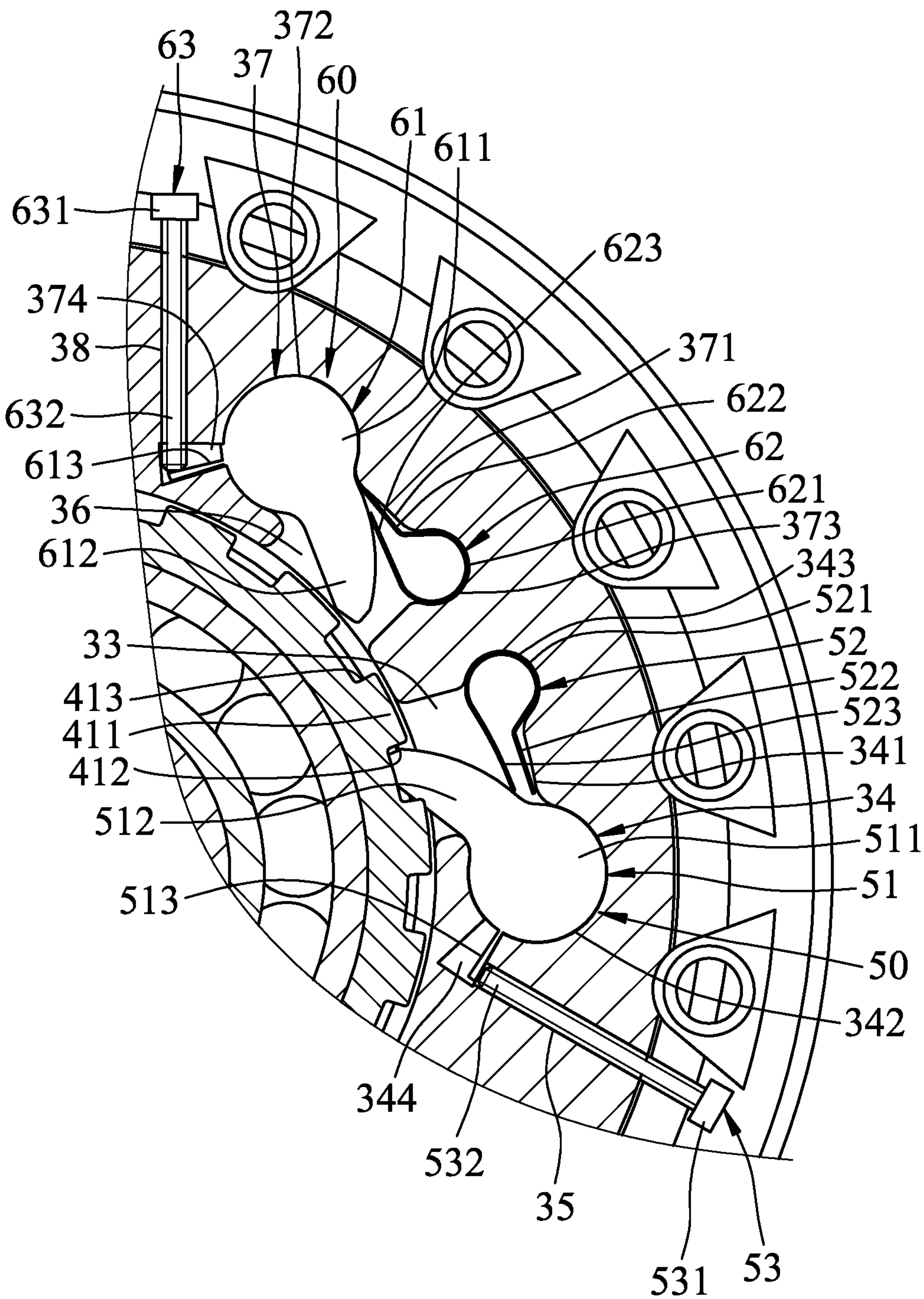
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FIG.7

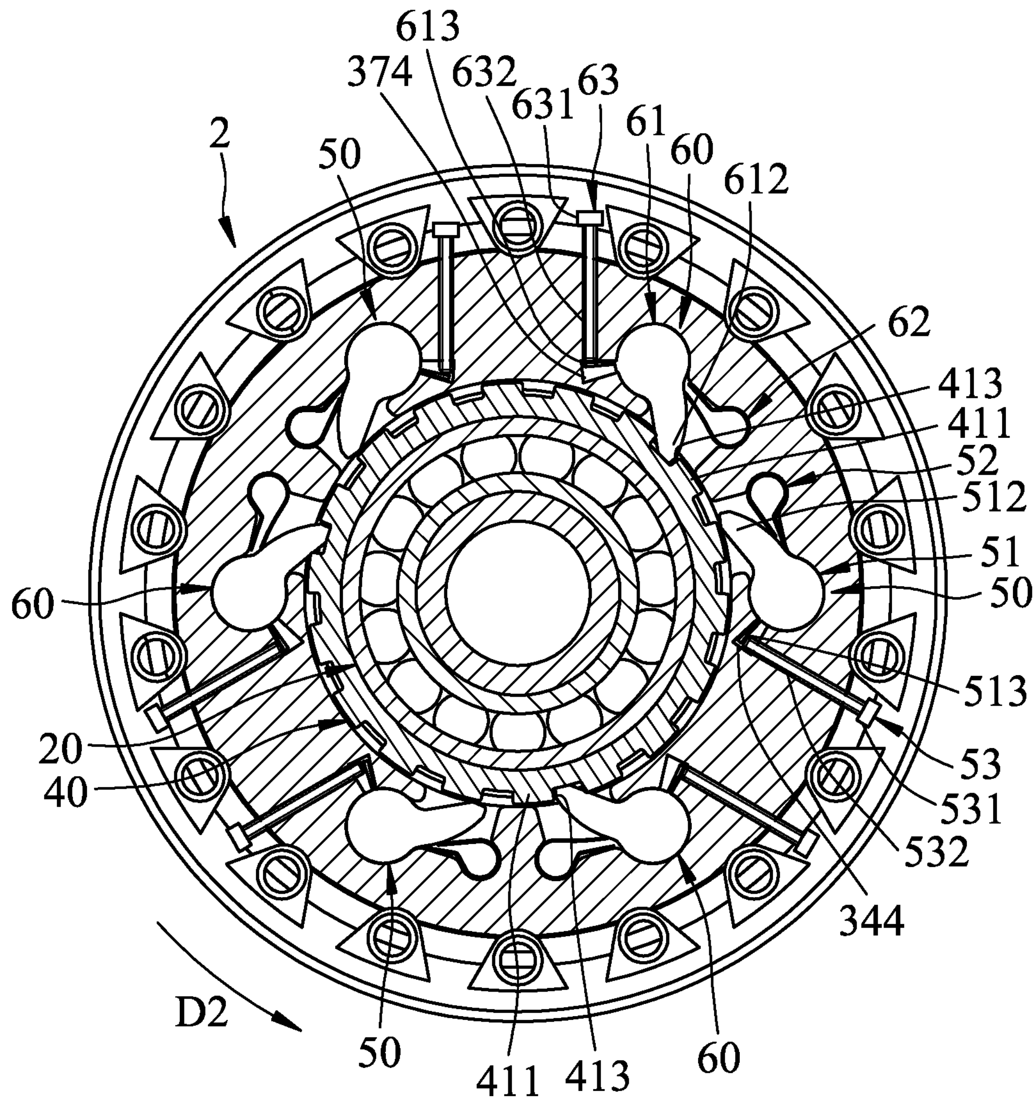
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FIG.8

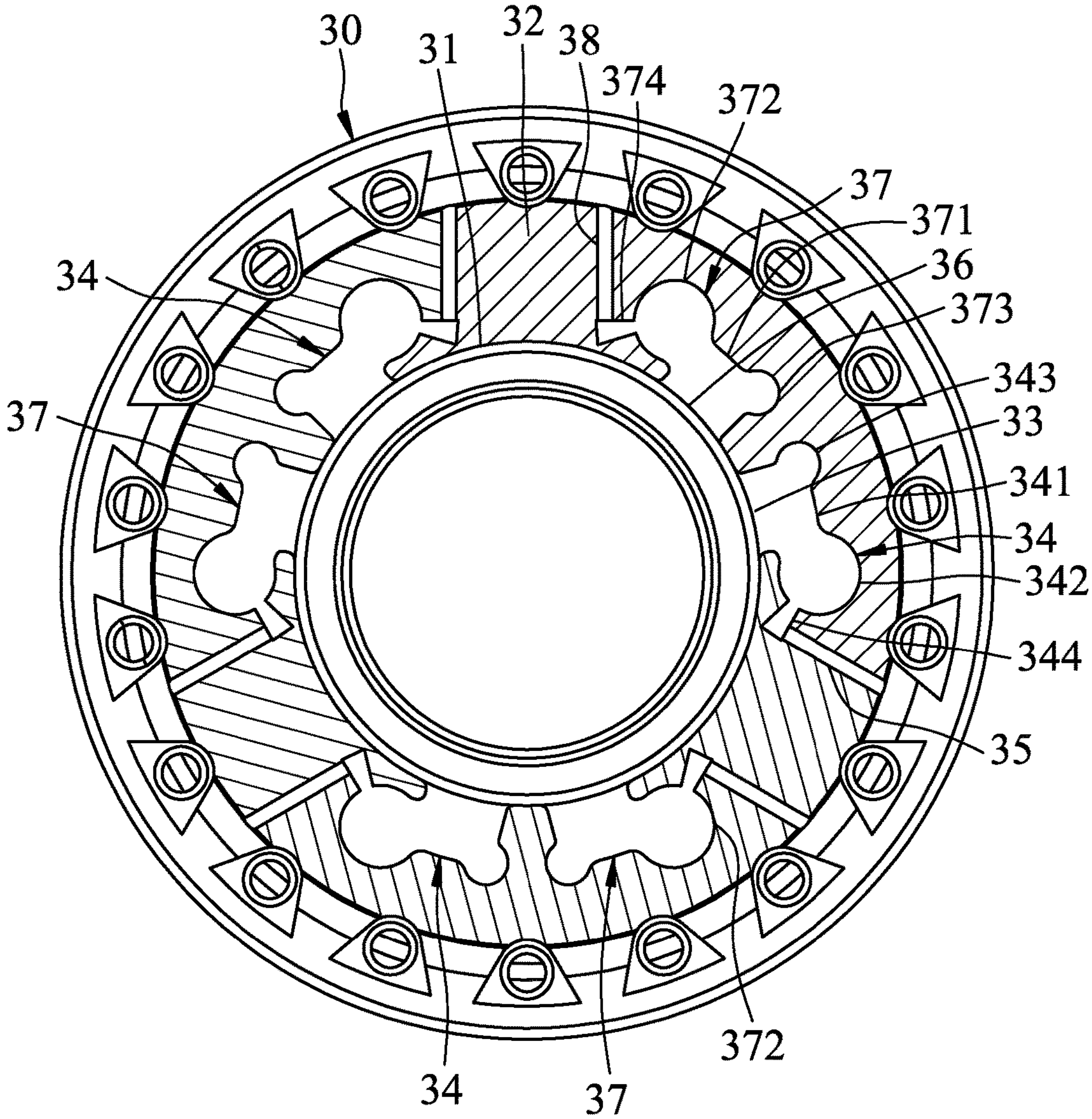
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FIG.9

BIDIRECTIONAL HUB ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority of Taiwanese Application No. 104114594, filed on May 7, 2015.

FIELD

The disclosure relates to a hub assembly, and more particularly to a bidirectional hub assembly.

BACKGROUND

Referring to FIGS. **1** to **4**, a conventional hub assembly **10** includes an axle unit **11**, a hub shell **12**, a driving member **13**, a pawl unit **14** and a resilient unit **15**.

The axle unit **11** includes an axle member **111**, and a plurality of bearings **112** that are mounted on the axle member **111**.

The hub shell **12** is mounted on two of the bearings **112** of the axle unit **11**, is rotatable about the axle member **111**, and has s a surrounding wall **122** and a plurality of installation grooves **124**. The surrounding wall **122** defines an inner space **121** therein. The installation grooves **124** are formed in an inner surrounding surface of an end section of the surrounding wall **122**. Each of the installation grooves **124** is defined by a respective one of groove-defining surfaces of the surrounding wall **122**, and has an opening **123** that communicates spatially with the inner space **121**. Each of the groove-defining surfaces has a bottom surface portion **125** that faces the opening **123** of the corresponding one of the installation grooves **124**, and a first arc surface portion that is connected to one end of the bottom surface portion **125** in the circumferential direction of the surrounding wall **122** and that defines a first mounting groove portion **126** of the corresponding one of the installation grooves **124**, and a second arc surface portion that is connected to an end of the bottom surface portion **125** distal from the first arc surface portion and that defines a second mounting groove portion **127** of the corresponding one of the installation grooves **124**.

The driving member **13** is mounted on the bearings **112** of the axle unit **11**, is rotatable about the axle member **111**, and has a ratchet ring section **131** that extends into the end section of the surrounding wall **122** and that has a plurality of outer teeth **133**, and a sprocket section **132** that is disposed out of the hub shell **12**. Each of the outer teeth **133** has first and second side surfaces **134**, **135** that are opposite to each other in the circumferential direction of the ratchet ring section **131**.

The pawl unit **14** includes a plurality of pawls **141** each of which has s a mounting portion **142** and a claw portion **143**.

The resilient unit **15** includes a plurality of resilient members **151**. Each of the resilient members **151** has a mounting section **152**, a positioning section **153** extending from an end of the mounting section **152** for abutting against the bottom surface portion **125** of a respective one of the groove-defining surfaces of the surrounding wall **122**, and an urging section **154** extending from another end of the mounting section **152** distal from the positioning section **153** for abutting against a respective one of the pawls **141**.

When the mounting portion **142** of each of the pawls **141** is mounted in the first mounting groove portion **126** of a respective one of the installation grooves **124** and when the mounting section **152** of each of the resilient members **151** is mounted in the second mounting groove portion **127** of a respective one of the installation grooves **124** (see FIGS. **1** and **2**), the conventional hub assembly **10** serves as a right-hand-drive hub (i.e., the sprocket section **132** of the driving member **13** is located at the right hand side of a bicycle). When the mounting portion **142** of each of the pawls **141** is mounted in the second mounting groove portion **127** of a respective one of the installation grooves **124** and when the mounting section **152** of each of the resilient members **151** is mounted in the first mounting groove portion **126** of a respective one of the installation grooves **124** (see FIGS. **3** and **4**), the conventional hub assembly **10** serves as a left-hand-drive hub (i.e., the sprocket section **132** of the driving member **13** is located at the left hand side of a bicycle).

However, in the switching operation of the conventional hub assembly **10** between the right-hand-drive use and the left-hand-drive use, all the pawls **141** and the resilient members **151** need to be uninstalled and reinstalled, resulting in a laborious operation.

U.S. Pat. No. 4,766,772 discloses another conventional hub assembly that is capable of serving as a right-hand-drive hub or a left-hand-drive hub without disassembling of components thereof. However, the conventional hub assembly of U.S. Pat. No. 4,766,772 has redundant transmission mechanisms.

SUMMARY

Therefore, an object of the disclosure is to provide a bidirectional hub assembly that can overcome at least one of the aforesaid drawbacks associated with the prior arts.

According to the disclosure, the bidirectional hub assembly includes an axle unit, a hub shell, a driving unit, a plurality of right-hand-drive units and a plurality of left-hand-drive units. The axle unit extends along an axis. The hub shell is mounted on the axle unit, is rotatable about the axis, and has a surrounding wall, a plurality of right-hand-drive installation grooves and a plurality of left-hand-drive installation grooves. The surrounding wall defines an inner space therein. The right-hand-drive and left-hand-drive installation grooves are formed in an inner surrounding surface of an end section of the surrounding wall. Each of the right-hand-drive installation grooves is defined by a respective one of first groove-defining surfaces of the surrounding wall, and has an opening that communicates spatially with the inner space. Each of the first groove-defining surfaces has a bottom surface portion that faces the opening of the corresponding one of the right-hand-drive installation grooves, and a first arc surface portion that is connected to one end of the bottom surface portion in the circumferential direction of the surrounding wall and that defines a first mounting groove portion of the corresponding one of the right-hand-drive installation grooves. Each of the left-hand-drive installation grooves is defined by a respective one of second groove-defining surfaces of the surrounding wall, and has an opening that communicates spatially with the inner space. Each of the second groove-defining surfaces has a bottom surface portion that faces the opening of the corresponding one of the left-hand-drive installation grooves, and a first arc surface portion that is connected to one end of the bottom surface portion in the circumferential direction of the surrounding wall and that defines a first mounting groove portion of the corresponding one of the left-hand-drive installation grooves. The driving unit is mounted on the axle unit, is rotatable about the axis, and has a ratchet ring section that extends into the end section of the surrounding wall and that has a plurality of outer teeth. Each of the outer teeth has s first and second side surfaces that are opposite to each other in the circumferential direction of the ratchet ring section. Each of the right-hand-drive units includes a right-hand-drive pawl that has a mounting portion mounted pivotally in the first mounting groove portion of a respective one of the right-hand-drive installation grooves, a claw portion extending from the mounting portion into the opening of the respective one of the right-hand-drive installation grooves, and a driven portion, a right-hand-drive resilient member that is mounted in the respective one of the right-hand-drive installation grooves for biasing resiliently the claw portion of the right-hand-drive pawl toward the ratchet ring section, and a right-hand-drive switching member that is mounted movably in the hub shell, and that has an operation portion extending out of the surrounding wall, and a driving portion in contact with the driven portion of the right-hand-drive pawl. The right-hand-drive pawl of each of the right-hand-drive units is operable to switch between an enabled state where the right-hand-drive resilient member urges the right-hand-drive pawl to bias resiliently the claw portion to contact the ratchet ring section such that the claw portion is engageable with the first side surface of one of the outer teeth, and a disabled state where the right-hand-drive switching member pushes the driven portion of the right-hand-drive pawl to separate the claw portion from any one of the first side surfaces of the outer teeth of the ratchet ring section against the biasing action of the right-hand-drive resilient member. Each of the left-hand-drive units includes a left-hand-drive pawl that has a mounting portion mounted pivotally in the first mounting groove portion of a respective one of the left-hand-drive installation grooves, a claw portion extending from the mounting portion into the opening of the respective one of the left-hand-drive installation grooves, and a driven portion, a left-hand-drive resilient member that is mounted in the respective one of the left-hand-drive installation grooves for biasing resiliently the claw portion of the left-hand-drive pawl toward the ratchet ring section, and a left-hand-drive switching member that is mounted movably in the hub shell, and that has an operation portion extending out of the surrounding wall, and a driving portion in contact with the driven portion of the left-hand-drive pawl. The left-hand-drive pawl of each of the left-hand-drive units is operable to switch between an enabled state where the left-hand-drive resilient member urges the left-hand-drive pawl to bias resiliently the claw portion to contact the ratchet ring section such that the claw portion is engageable with the second side surface of one of the outer teeth, and a disabled state where the left-hand-drive switching member pushes the driven portion of the left-hand-drive pawl to separate the claw portion from any one of the second side surfaces of the outer teeth of the ratchet ring section against the biasing action of the left-hand-drive resilient member. When the right-hand-drive pawl of at least one of the right-hand-drive units is in the enabled state and the left-hand-drive pawl of each of the left-hand-drive units is in the disabled state, the bidirectional hub assembly serves as a right-hand-drive hub. When the right-hand-drive pawl of each of the right-hand-drive units is in the disabled state and the left-hand-drive pawl of at least one of the left-hand-drive units is in the enabled state, the bidirectional hub assembly serves as a left-hand-drive hub.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages of the disclosure will become apparent in the following detailed description of the embodiment with reference to the accompanying drawings, of which:

FIG. **1** is a partly sectional view of a conventional hub assembly serving as a right-hand-drive hub;

FIG. **2** is a sectional view of the conventional hub assembly taken along line II-II in FIG. **1**;

FIG. **3** is another partly sectional view of the conventional hub assembly serving as a left-hand-drive hub;

FIG. **4** is another sectional view of the conventional hub assembly taken along line IV-IV in FIG. **3**;

FIG. **5** is a partly sectional view of an embodiment of a bidirectional hub assembly according to the disclosure;

FIG. **6** is a sectional view of the embodiment taken along line VI-VI in FIG. **5**, illustrating the embodiment serving as a right-hand-drive hub;

FIG. **7** is an enlarged fragmentary sectional view of a portion of FIG. **6**;

FIG. **8** is another sectional view similar to FIG. **5**, but illustrating the embodiment serving as a left-hand-drive hub; and

FIG. **9** is a sectional view of a hub shell of the embodiment.

DETAILED DESCRIPTION

Referring to FIGS. **5**, **6** and **9**, an embodiment of the bidirectional hub assembly **2** according to the disclosure includes an axle unit **20**, a hub shell **30**, a driving unit **40**, a plurality of right-hand-drive units **50** and a plurality of left-hand-drive units **60**.

The axle unit **20** includes an axle member **21** that extends along an axis (L), and a plurality of bearings **22** that are mounted on the axle member **21**.

The hub shell **30** is mounted on the bearings **22** of the axle unit **20**, is rotatable about the axis (L), and has a surrounding wall **32**, a plurality of right-hand-drive installation grooves **34**, a plurality of right-hand-drive through holes **35**, a plurality of left-hand-drive installation grooves **37** and a plurality of left-hand-drive through holes **38**. The surrounding wall **32** surrounds the axis (L), and defines an inner space **31** therein. The right-hand-drive and left-hand-drive installation grooves **34**, **37** are formed in an inner surrounding surface **321** of an end section of the surrounding wall **32**. In this embodiment, the hub shell **30** has three right-hand-drive installation grooves **34**, three right-hand-drive through holes **35**, three left-hand-drive installation grooves **37** and three left-hand-drive through holes **38**.

The right-hand-drive installation grooves **34** are defined respectively by first groove-defining surfaces of the surrounding wall **32**. Each of the right-hand-drive installation grooves **34** has an opening **33** that communicates spatially with the inner space **31**. Each of the first groove-defining surfaces has a bottom surface portion **341** that faces the opening **33** of the corresponding one of the right-hand-drive installation grooves **34**, a first arc surface portion that is connected to one end of the bottom surface portion **341** in the circumferential direction of the surrounding wall **32** and that defines a first mounting groove portion **342** of the corresponding one of the right-hand-drive installation grooves **34**, and a second arc surface portion that is connected to an end of the bottom surface portion **341** distal from the first arc surface portion and that defines a second mounting groove portion **343** of the corresponding one of the right-hand-drive installation grooves **34**. Each of the right-hand-drive installation grooves **34** further has a limiting groove portion **344** that is formed in the first arc surface portion of the corresponding one of the first groove-defining surfaces and that communicates spatially with the first mounting groove portion **342** of the corresponding right-hand-drive installation groove **34**.

Each of the right-hand-drive through holes **35** is formed in an outer surface of the hub shell **30** and communicates spatially with the limiting groove portion **344** of a respective one of the right-hand-drive installation grooves **34**.

The left-hand-drive installation grooves **37** are defined respectively by second groove-defining surfaces of the surrounding wall **32**. Each of the left-hand-drive installation grooves **37** has an opening **36** that communicates spatially with the inner space **31**. Each of the second groove-defining surfaces has a bottom surface portion **371** that faces the opening **36** of the corresponding one of the left-hand-drive installation grooves **37**, a first arc surface portion that is connected to one end of the bottom surface portion **371** in the circumferential direction of the surrounding wall and that defines a first mounting groove portion **372** of the corresponding one of the left-hand-drive installation grooves **37**, and a second arc surface portion that is connected to an end of the bottom surface portion **371** distal from the first arc surface portion and that defines a second mounting groove portion **373** of the corresponding one of the left-hand-drive installation grooves **37**. Each of the left-hand-drive installation grooves **37** further has a limiting groove portion **374** that is formed in the first arc surface portion of the corresponding one of the second groove-defining surfaces **37** and that communicates spatially with the first mounting groove portion **372** of the corresponding left-hand-drive installation groove **37**.

Each of the left-hand-drive through holes **38** is formed in the outer surface of the hub shell **30** and communicates spatially with the limiting groove portion **374** of a respective one of the left-hand-drive installation grooves **37**.

In this embodiment, the right-hand-drive and left-hand-drive installation grooves **34**, **37** are arranged alternately in the circumferential direction. The first and second mounting groove portions **342**, **343** of each of the right-hand-drive installation grooves **34** are arranged in a first order in the circumferential direction. The first and second mounting groove portions **372**, **373** of each of the left-hand-drive installation grooves **37** are arranged in a second order opposite to the first order in which the first and second mounting groove portions **342**, **343** of each of the right-hand-drive installation grooves **34** are arranged in the circumferential direction. Moreover, for each of the first groove-defining surfaces of the surrounding wall **32**, the first arc surface portion has a radius of curvature greater than that of the second arc surface portion. For each of the second groove-defining surfaces of the surrounding wall **32**, the first arc surface portion has a radius of curvature greater than that of the second arc surface portion. A circumferential distance between each one of the right-hand-drive and left-hand-drive installation grooves **34**, **37** and an adjacent one of the right-hand-drive and left-hand-drive installation grooves **34**, **37** that is proximate to the first mounting groove portion **342**, **372** thereof is greater than that between the one of the right-hand-drive and left-hand-drive installation grooves **34**, **37** and another adjacent one of the right-hand-drive and left-hand-drive installation grooves **34**, **37** that is proximate to the second mounting groove portion **343**, **373** thereof. As such, the wall thickness of the surrounding wall **32** between each one of the right-hand-drive and left-hand-drive installation grooves **34**, **37** and the adjacent one of the right-hand-drive and left-hand-drive installation grooves **34**, **37** that is proximate to the first mounting groove portion **342**, **372** thereof is greater than the wall thickness between the one of the right-hand-drive and left-hand-drive installation grooves **34**, **37** and the adjacent one of the right-hand-drive and left-hand-drive installation grooves **34**, **37** that is proximate to the second mounting groove portion **343**, **373** thereof.

Referring to FIGS. **5** to **7**, The driving unit **40** is mounted on the bearings **22** of the axle unit **20**, is rotatable about the axis (L), and has a ratchet ring section **41** that extends into the end section of the surrounding wall **32** and that has a plurality of outer teeth **411**, and a sprocket section **42** that is disposed out of the hub shell **30** and that is formed integrally with the ratchet ring section **41**. Each of the outer teeth **411** has first and second side surfaces **412**, **413** that are opposite to each other in the circumferential direction of the ratchet ring section **41**.

In this embodiment, the bidirectional hub assembly **2** includes three right-hand-drive units **50** that correspond respectively to the right-hand-drive installation grooves **34**, and three left-hand-drive units **60** that correspond respectively to the left-hand-drive installation grooves **37**. For the sake of brevity, only one right-hand-drive unit **50** and one left-hand-drive unit **60** will be described in the following paragraphs.

The right-hand-drive unit **50** includes a right-hand-drive pawl **51**, a right-hand-drive resilient member **52** and a right-hand-drive switching member **53**.

The right-hand-drive pawl **51** has a right mounting portion **511** mounted pivotally in the first mounting groove portion **342** of a respective one of the right-hand-drive installation grooves **34**, a right claw portion **512** extending from the right mounting portion **511** into the opening **33** of the respective one of the right-hand-drive installation grooves **34**, and a right driven portion **513** extending from the right mounting portion **511** and into the limiting groove portion **344** of the respective one of the right-hand-drive installation grooves **34**.

The right-hand-drive resilient member **52** has a mounting section **521** that is mounted in the second mounting groove portion **343** of the respective one of the right-hand-drive installation grooves **34**, a positioning section **522** that extends from the mounting section **521** and that abuts against the bottom surface portion **341** of the corresponding one of the first groove-defining surfaces, and an urging section **523** that extends from the mounting section **521** and that abuts against the right-hand-drive pawl **51** for biasing resiliently the right claw portion **512** of the right-hand-drive pawl **51** toward the ratchet ring section **41** of the driving unit **40**.

The right-hand-drive switching member **53** is mounted movably in the hub shell **30**, and has an operation portion **531** extending out of the surrounding wall **32**, and a driving portion **532** in contact with the right driven portion **513** of the right-hand-drive pawl **51** for switching the right-hand-drive pawl **51** between an enabled state (see FIGS. **6** and **7**) where the right-hand-drive resilient member **52** urges the right-hand-drive pawl **51** to bias resiliently the right claw portion **512** to contact the ratchet ring section **41** such that the right claw portion **512** is engageable with the first side surface **412** of one of the outer teeth **411**, and a disabled state (see FIG. **8**) where the right-hand-drive switching member **53** pushes the right driven portion **513** of the right-hand-drive pawl **51** to separate the right claw portion **512** from any one of the first side surfaces **412** of the outer teeth **411** of the ratchet ring section **41** against the biasing action of the right-hand-drive resilient member **52**.

In this embodiment, each of the right-hand-drive through holes **35** is configured as a threaded hole. The right driven portion **513** of the right-hand-drive pawl **51** is configured as a protruding block. The right-hand-drive switching member

53 has a threaded rod portion that engages threadably a respective one of the right-hand-drive through holes **35**. The length of a portion of the threaded rod portion of the right-hand-drive switching member **53** disposed in the limiting groove portion **344** of the respective one of the right-hand-drive installation grooves **34** is adjustable by rotating the operation portion **531** of the right-hand-drive switching member **53**, so that the driving portion **532** in contact with the right driven portion **513** of the right-hand-drive pawl **51** rotates the right claw portion **512** of the right-hand-drive pawl **51**. In a variation of the embodiment, each of the right-hand-drive through holes **35** may be configured as an unthreaded through hole, and the right-hand-drive switching member **53** may be configured as a pin that is inserted movably into the respective one of the right-hand-drive through holes **35** for switching the state of the right-hand-drive pawl **51**.

The left-hand-drive unit **60** includes a left-hand-drive pawl **61**, a left-hand-drive resilient member **62** and a left-hand-drive switching member **63**.

The left-hand-drive pawl **61** has a left mounting portion **611** mounted pivotally in the first mounting groove portion **372** of a respective one of the left-hand-drive installation grooves **37**, a left claw portion **612** extending from the left mounting portion **611** into the opening **36** of the respective one of the left-hand-drive installation grooves **37**, and a left driven portion **613** extending from the left mounting portion **611** and into the limiting groove portion **374** of the respective one of the left-hand-drive installation grooves **37**.

The left-hand-drive resilient member **62** has a mounting section **621** that is mounted in the second mounting groove portion **373** of the respective one of the left-hand-drive installation grooves **37**, a positioning section **622** that extends from the mounting section **621** and that abuts against the bottom surface portion **371** of the corresponding one of the second groove-defining surfaces, and an urging section **623** that extends from the mounting section **621** and that abuts against the left-hand-drive pawl **61** for biasing resiliently the left claw portion **612** of the right-hand-drive pawl **61** toward the ratchet ring section **41** of the driving unit **40**.

The left-hand-drive switching member **63** is mounted movably in the hub shell **30**, and has an operation portion **631** extending out of the surrounding wall **32**, and a driving portion **632** in contact with the left driven portion **613** of the left-hand-drive pawl **61** for switching the left-hand-drive pawl **61** between an enabled state (see FIG. **8**) where the left-hand-drive resilient member **62** urges the left-hand-drive pawl **51** to bias resiliently the left claw portion **612** to contact the ratchet ring section **41** such that the left claw portion **612** is engageable with the second side surface **413** of one of the outer teeth **411**, and a disabled state (see FIGS. **6** and **7**) where the left-hand-drive switching member **63** pushes the left driven portion **613** of the left-hand-drive pawl **61** to separate the left claw portion **612** from any one of the second side surfaces **413** of the outer teeth **411** of the ratchet ring section **41** against the biasing action of the left-hand-drive resilient member **62**.

In this embodiment, each of the left-hand-drive through holes **38** is configured as a threaded hole. The left driven portion **613** of the left-hand-drive pawl **61** is configured as a protruding block. The left-hand-drive switching member **63** has a threaded rod portion that engages threadably a respective one of the left-hand-drive through holes **38**. The length of a portion of the threaded rod portion of the left-hand-drive switching member **63** disposed in the limiting groove portion **374** of the respective one of the left-hand-drive installation grooves **37** is adjustable by rotating the operation portion **631** of the left-hand-drive switching member **63**, so that the driving portion **632** in contact with the left driven portion **613** of the left-hand-drive pawl **61** rotates the left claw portion **612** of the left-hand-drive pawl **61**. In a variation of the embodiment, each of the left-hand-drive through holes **38** may be configured as an unthreaded through hole, and the left-hand-drive switching member **63** may be configured as a pin that is inserted movably into the respective one of the left-hand-drive through holes **38**.

When the bidirectional hub assembly **2** of this disclosure serves as a right-hand-drive hub (i.e., the sprocket section **42** of the driving unit **40** is located at the right hand side of a bicycle), the operation portion **531** of the right-hand-drive switching member **53** of each of the right-hand-drive units **50** is rotated to decrease the length of the portion of the right-hand-drive switching member **53** in the limiting groove portion **344** of the respective one of the right-hand-drive installation grooves **34**, so as to switch the right-hand-drive pawl **51** of the corresponding right-hand-drive unit **50** to the enabled state, and the operation portion **631** of the left-hand-drive switching member **63** of each of the left-hand-drive units **60** is rotated to increase the length of the portion of the left-hand-drive switching member **63** in the limiting groove portion **374** of the respective one of the left-hand-drive installation grooves **37**, so as to switch the left-hand-drive pawl **61** of the corresponding left-hand-drive unit **60** to the disabled state. As such, when the driving unit **40** rotates in a first rotational direction (D**1**) (see FIG. **6**), the hub shell **30** is driven to co-rotate with the driving unit **40** through the engagement between the ratchet ring section **41** and the right-hand-drive units **50**. When the driving unit **40** rotates in a rotational direction opposite to the first rotational direction (D**1**), the outer teeth **411** of the ratchet ring section **41** push the right-hand-drive pawl **51** of each of the right-hand-drive units **50** to be disengaged from the corresponding first side surface **412** (see FIG. **7**), resulting in idle rotation of the driving unit **40**.

When the bidirectional hub assembly **2** of this disclosure serves as a left-hand-drive hub (i.e., the sprocket section **42** of the driving unit **40** is located at the left hand side of a bicycle), the operation portion **531** of the right-hand-drive switching member **53** of each of the right-hand-drive units **50** is rotated to increase the length of the portion of the right-hand-drive switching member **53** in the limiting groove portion **344** of the respective one of the right-hand-drive installation grooves **34**, so as to switch the right-hand-drive pawl **51** of the corresponding right-hand-drive unit **50** to the disabled state, and the operation portion **631** of the left-hand-drive switching member **63** of each of the left-hand-drive units **60** is rotated to decrease the length of the portion of the left-hand-drive switching member **63** in the limiting groove portion **374** of the respective one of the left-hand-drive installation grooves **37**, so as to switch the left-hand-drive pawl **61** of the corresponding left-hand-drive unit **60** to the enabled state. As such, when the driving unit **40** rotates in a second rotational direction (D**2**) (see FIG. **8**), the hub shell **30** is driven to co-rotate with the driving unit **40** through the engagement between the ratchet ring section **41** and the left-hand-drive units **60**. When the driving unit **40** rotates in a rotational direction opposite to the second rotational direction (D**2**), the outer teeth **411** of the ratchet ring section **41** push the left-hand-drive pawl of each of the left-hand-drive units **60** to be disengaged from the corresponding second side surface **413**, resulting in idle rotation of the driving unit **40**.

To sum up, the bidirectional hub assembly **2** of this disclosure has the following advantages:

1. The bidirectional hub assembly **2** is converted between a right-hand-drive hub and a left-hand-drive hub through simple operation of the right-hand-drive switching members **53** and the left-hand-drive switching members **63** without uninstalling any component thereof.

2. Since the first arc surface portion of each of the first groove-defining surfaces has a radius of curvature greater than that of the second arc surface portion of the corresponding first groove-defining surface, and the first arc surface portion of each of the second groove-defining surfaces has a radius of curvature greater than that of the second arc surface portion of the corresponding second groove-defining surface, the hub shell **30** of the bidirectional hub assembly **2** of this disclosure has less voids compared with the hub shell **12** of the conventional hub assembly **10** in the prior art (see FIG. **2**).

3. Since the wall thickness of the surrounding wall between each one of the right-hand-drive and left-hand-drive installation grooves **34**, **37** and the adjacent one of the right-hand-drive and left-hand-drive installation grooves **34**, **37** that is proximate to the first mounting groove portion **342**, **372** thereof is greater than the wall thickness between the one of the right-hand-drive and left-hand-drive installation grooves **34**, **37** and the adjacent one of the right-hand-drive and left-hand-drive installation grooves **34**, **37** that is proximate to the second mounting groove portion **343**, **373** thereof, the portions of the surrounding wall **32** of the hub shell **30** for supporting the right-hand-drive pawls **51** and the left-hand-drive pawls **61** have better structural strengths.

4. The bidirectional hub assembly **2** of this disclosure has a relatively simple structure compared with the conventional hub assembly of U.S. Pat. No. 4,766,772.

While the disclosure has been described in connection with what is considered the exemplary embodiment, it is understood that this disclosure is not limited to the disclosed embodiment but is intended to cover various arrangements included within the spirit and scope of the broadest interpretation so as to encompass all such modifications and equivalent arrangements.

What is claimed is:

1. A bidirectional hub assembly comprising:

an axle unit extending along an axis;

a hub shell mounted on said axle unit, rotatable about the axis, and having a surrounding wall, a plurality of right-hand-drive installation grooves and a plurality of left-hand-drive installation grooves, said surrounding wall defining an inner space therein, said right-hand-drive and left-hand-drive installation grooves being formed in an inner surrounding surface of an end section of said surrounding wall, each of said right-hand-drive installation grooves being defined by a respective one of first groove-defining surfaces of said surrounding wall, and having an opening that communicates spatially with said inner space, each of said first groove-defining surfaces having a bottom surface portion that faces said opening of the corresponding one of said right-hand-drive installation grooves, and a first arc surface portion that is connected to one end of said bottom surface portion in the circumferential direction of said surrounding wall and that defines a first mounting groove portion of the corresponding one of said right-hand-drive installation grooves, each of said left-hand-drive installation grooves being defined by a respective one of second groove-defining surfaces of said surrounding wall, and having an opening that communicates spatially with said inner space, each of said second groove-defining surfaces having a bottom surface portion that faces said opening of the corresponding one of said left-hand-drive installation grooves, and a first arc surface portion that is connected to one end of said bottom surface portion in the circumferential direction of said surrounding wall and that defines a first mounting groove portion of the corresponding one of said left-hand-drive installation grooves;

a driving unit mounted on said axle unit, rotatable about the axis, and having a ratchet ring section that extends into said end section of said surrounding wall and that has a plurality of outer teeth, each of said outer teeth having first and second side surfaces that are opposite to each other in the circumferential direction of said ratchet ring section;

a plurality of right-hand-drive units each including a right-hand-drive pawl that has a mounting portion mounted pivotally in said first mounting groove portion of a respective one of said right-hand-drive installation grooves, a claw portion extending from said mounting portion into said opening of the respective one of said right-hand-drive installation grooves, and a driven portion, a right-hand-drive resilient member that is mounted in the respective one of said right-hand-drive installation grooves for biasing resiliently said claw portion of said right-hand-drive pawl toward said ratchet ring section, and a right-hand-drive switching member that is mounted movably in said hub shell, and that has an operation portion extending out of said surrounding wall, and a driving portion in contact with said driven portion of said right-hand-drive pawl, said right-hand-drive pawl of each of said right-hand-drive units being operable to switch between an enabled state where said right-hand-drive resilient member urges said right-hand-drive pawl to bias resiliently said claw portion to contact said ratchet ring section such that said claw portion is engageable with said first side surface of one of said outer teeth, and a disabled state where said right-hand-drive switching member pushes said driven portion of said right-hand-drive pawl to separate said claw portion from any one of said first side surfaces of said outer teeth of said ratchet ring section against the biasing action of said right-hand-drive resilient member; and

a plurality of left-hand-drive units each including a left-hand-drive pawl that has a mounting portion mounted pivotally in said first mounting groove portion of a respective one of said left-hand-drive installation grooves, a claw portion extending from said mounting portion into said opening of the respective one of said left-hand-drive installation grooves, and a driven portion, a left-hand-drive resilient member that is mounted in the respective one of said left-hand-drive installation grooves for biasing resiliently said claw portion of said left-hand-drive pawl toward said ratchet ring section, and a left-hand-drive switching member that is mounted movably in said hub shell, and that has an operation portion extending out of said surrounding wall, and a driving portion in contact with said driven portion of said left-hand-drive pawl, said left-hand-drive pawl of each of said left-hand-drive units being operable to switch between an enabled state where said left-hand-drive resilient member urges said left-hand-drive pawl to bias resiliently said claw portion to contact said ratchet ring section such that said claw portion is engageable with said second side surface of one of said outer teeth, and a disabled state where said left-hand-drive switching member pushes said driven portion of said left-hand-drive pawl to separate said claw portion from any one of said second side surfaces of said outer teeth of said ratchet ring section against the biasing action of said left-hand-drive resilient member;

wherein, when said right-hand-drive pawl of at least one of said right-hand-drive units is in the enabled state and said left-hand-drive pawl of each of said left-hand-drive units is in the disabled state, said bidirectional hub assembly serves as a right-hand-drive hub; and

wherein, when said right-hand-drive pawl of each of said right-hand-drive units is in the disabled state and said left-hand-drive pawl of at least one of said left-hand-drive units is in the enabled state, said bidirectional hub assembly serves as a left-hand-drive hub.

2. The bidirectional hub assembly as claimed in claim **1**, wherein each of said right-hand-drive installation grooves further has a limiting groove portion that is formed in said first arc surface portion of the corresponding one of said first groove-defining surfaces, said hub shell further having a plurality of right-hand-drive through holes each of which is formed in an outer surface of said hub shell and communicates spatially with said limiting groove portion of a respective one of said right-hand-drive installation grooves, said driven portion of said right-hand-drive pawl of each of said right-hand drive units extending into said limiting groove portion of the respective one of said right-hand-drive installation grooves, said right-hand-drive switching member of each of said right-hand-drive units engaging threadably a respective one of said right-hand-drive through holes and being in contact with said driven portion of said right-hand-drive pawl of said right-hand-drive unit, each of said left-hand-drive installation grooves further having a limiting groove portion that is formed in said first arc surface portion of the corresponding one of said second groove-defining surfaces, said hub shell further having a plurality of left-hand-drive through holes each of which is formed in said outer surface of said hub shell and communicates spatially with said limiting groove portion of a respective one of said left-hand-drive installation grooves, said driven portion of said left-hand-drive pawl of each of said left-hand-drive units extending into said limiting groove portion of the respective one of said left-hand-drive installation grooves, said left-hand-drive switching member of each of said left-hand-drive units engaging threadably a respective one of said left-hand-drive through holes and being in contact with said driven portion of said left-hand-drive pawl of said left-hand-drive unit.

3. The bidirectional hub assembly as claimed in claim **1**, wherein each of said first groove-defining surfaces further has a second arc surface portion that is connected to an end of said bottom surface portion distal from said first arc surface portion and that defines a second mounting groove portion of the corresponding one of said right-hand-drive installation grooves, said right-hand-drive resilient member of each of said right-hand-drive units having a mounting section that is mounted in said second mounting groove portion of the respective one of said right-hand-drive installation grooves, a positioning section that extends from said mounting section and that abuts against said bottom surface portion of the corresponding one of said first groove-defining surfaces, and an urging section that extends from said mounting section and that abuts against said right-hand-drive pawl of said right-hand-drive unit, each of said second groove-defining surfaces further having a second arc surface portion that is connected to an end of said bottom surface portion distal from said first arc surface portion and that defines a second mounting groove portion of the corresponding one of said left-hand-drive installation grooves, said left-hand-drive resilient member of each of said left-hand-drive units having a mounting section that is mounted in said second mounting groove portion of the respective one of said left-hand-drive installation grooves, a positioning section that extends from said mounting section and that abuts against said bottom surface portion of the corresponding one of said second groove-defining surfaces, and an urging section that extends from said mounting section and that abuts against said left-hand-drive pawl of said left-hand-drive unit.

4. The bidirectional hub assembly as claimed in claim **3**, wherein:

for each of said first groove-defining surfaces, said first arc surface portion has a radius of curvature greater than that of said second arc surface portion; and

for each of said second groove-defining surfaces, said first arc surface portion has a radius of curvature greater than that of said second arc surface portion.

5. The bidirectional hub assembly as claimed in claim **4**, wherein said right-hand-drive and left-hand-drive installation grooves are arranged alternately in the circumferential direction, said first and second mounting groove portions of each of said right-hand-drive installation grooves being arranged in a first order in the circumferential direction, said first and second mounting groove portions of each of said left-hand-drive installation grooves being arranged in a second order opposite to the first order in which said first and second mounting groove portions of each of said right-hand-drive installation grooves are arranged in the circumferential direction, a circumferential distance between each one of said right-hand-drive and left-hand-drive installation grooves and an adjacent one of said right-hand-drive and left-hand-drive installation grooves that is proximate to said first mounting groove portion thereof being greater than that between the one of said right-hand-drive and left-hand-drive installation grooves and another adjacent one of said right-hand-drive and left-hand-drive installation grooves that is proximate to said second mounting groove portion thereof.

6. The bidirectional hub assembly as claimed in claim **5**, wherein said hub shell has three of said right-hand-drive installation grooves and three of said left-hand-drive installation grooves, said bidirectional hub assembly comprising three of said right-hand-drive units and three of said left-hand-drive units.

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