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Kim et al.

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(54) **POP-UP ACTUATOR FOR VEHICLE DOOR**

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(52) **U.S. Cl.**
CPC ***E05F 15/622*** (2015.01)

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CPC E05Y 2201/696; E05Y 2900/50; E05Y 2201/422–426; E05Y 2400/32; E05Y 2400/328
See application file for complete search history.

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(57) **ABSTRACT**

A pop-up actuator for a vehicle door is applied to a vehicle door and pops up a circumferential portion of the door from a vehicle body when a signal for opening the door is inputted, allowing an occupant to easily open the door. The pop-up actuator for a vehicle door includes a housing provided in a vehicle, a drive motor mounted in the housing, a nut rod configured to rectilinearly moved by operation of the drive motor, and an operating rod coupled to an external portion of the nut rod and configured to extend from the housing by a forward movement of the nut rod to move the door away from a vehicle body.

16 Claims, 13 Drawing Sheets

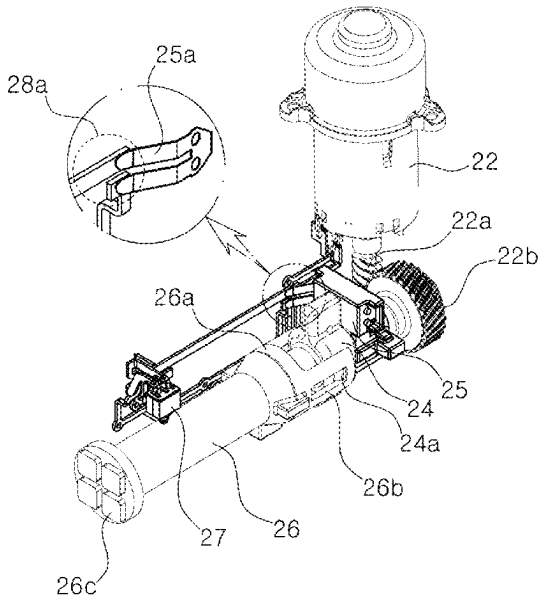

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FIG. 1

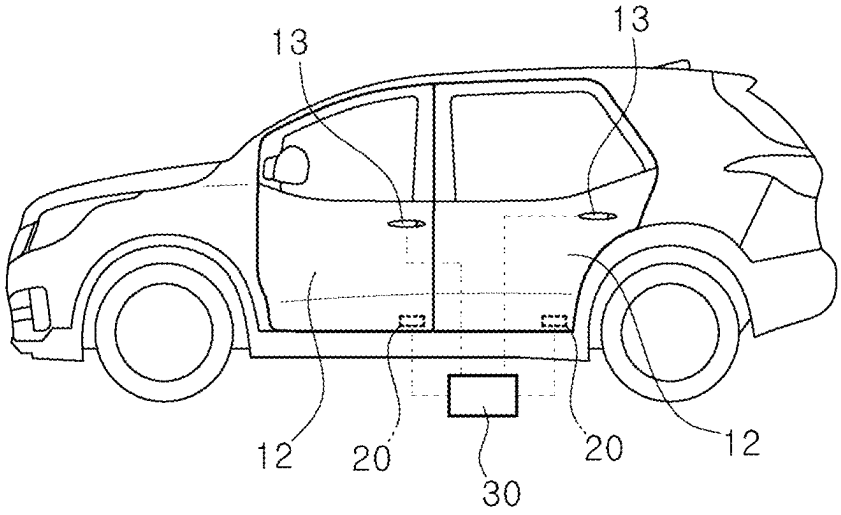


FIG. 2

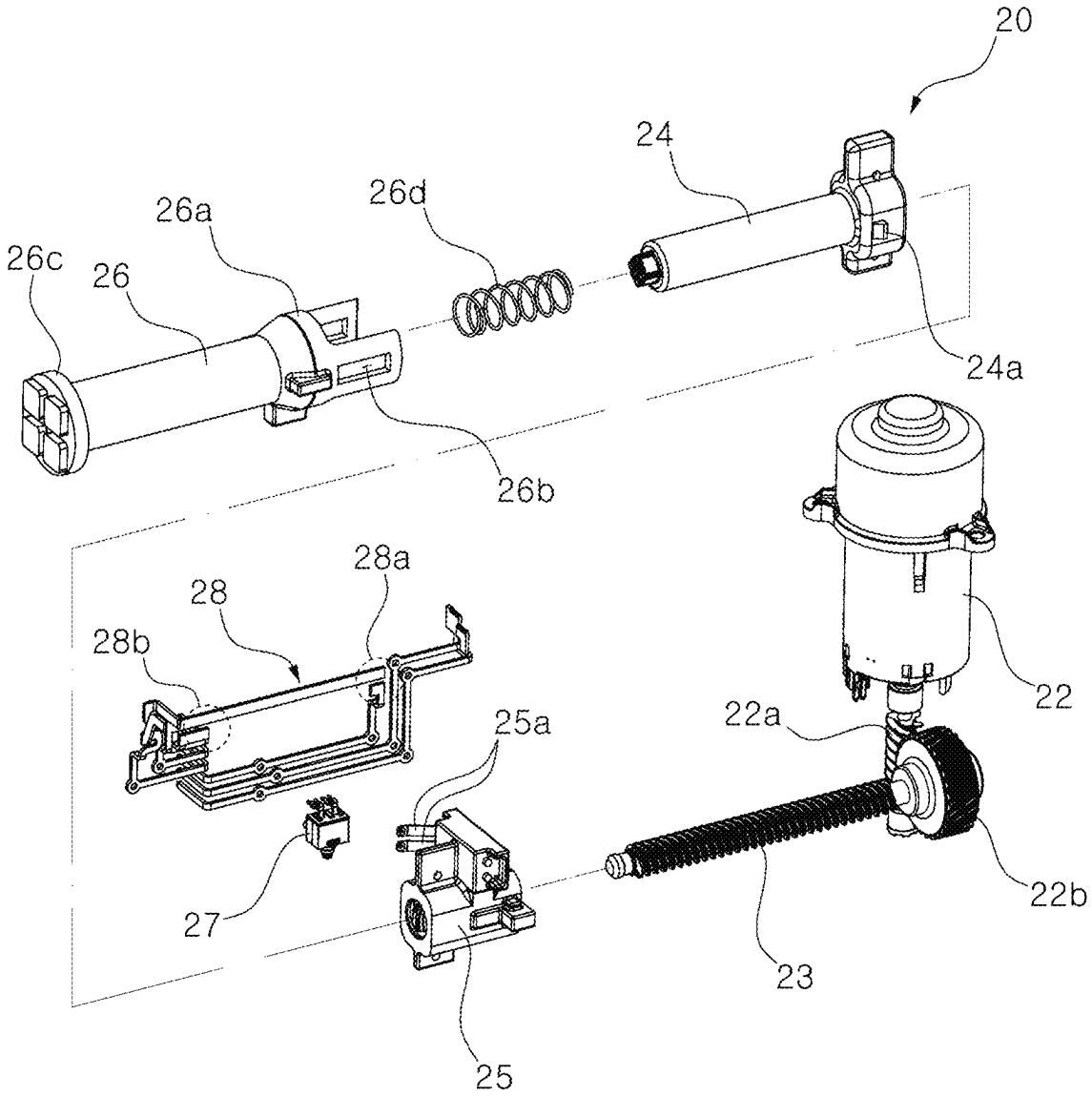


FIG. 3A

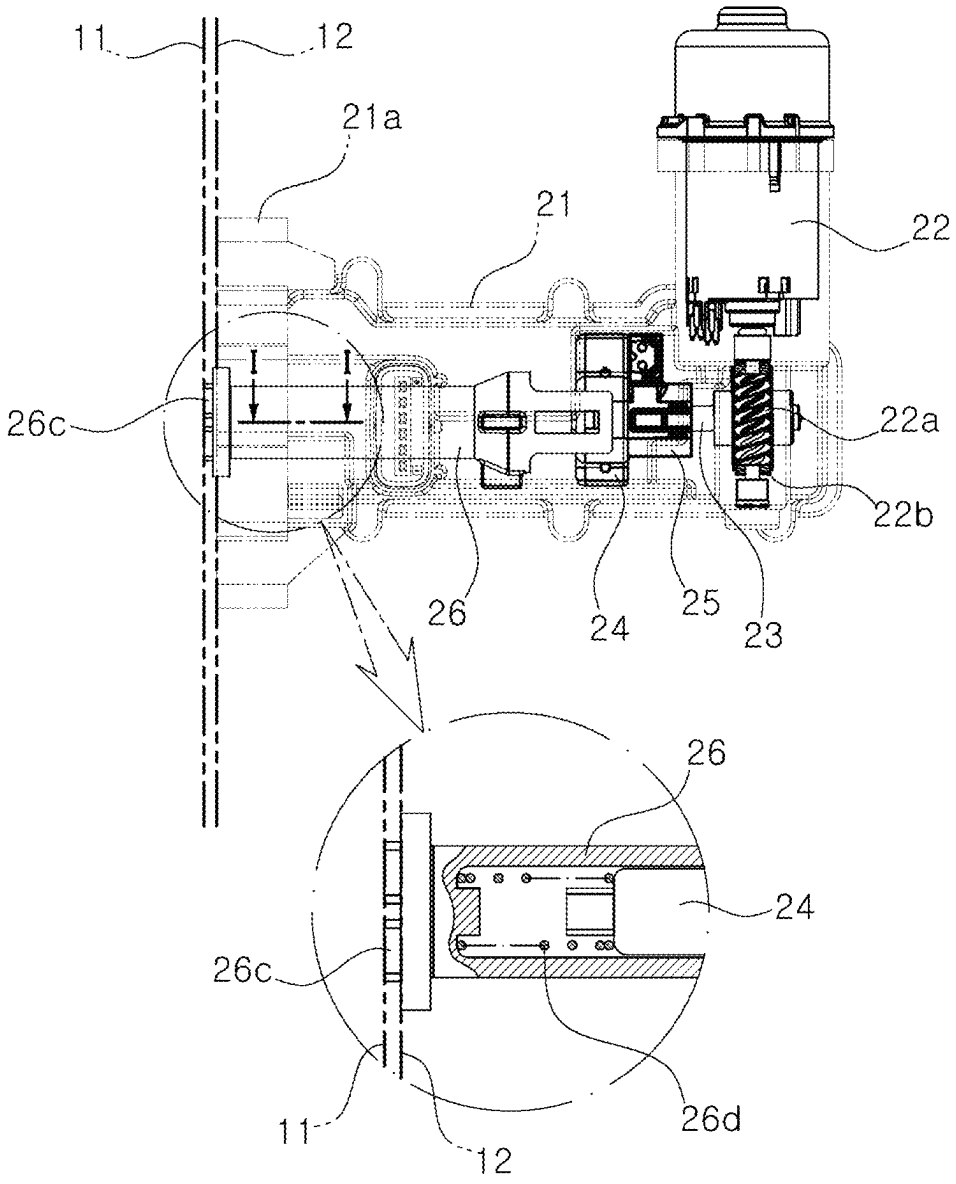


FIG. 3B

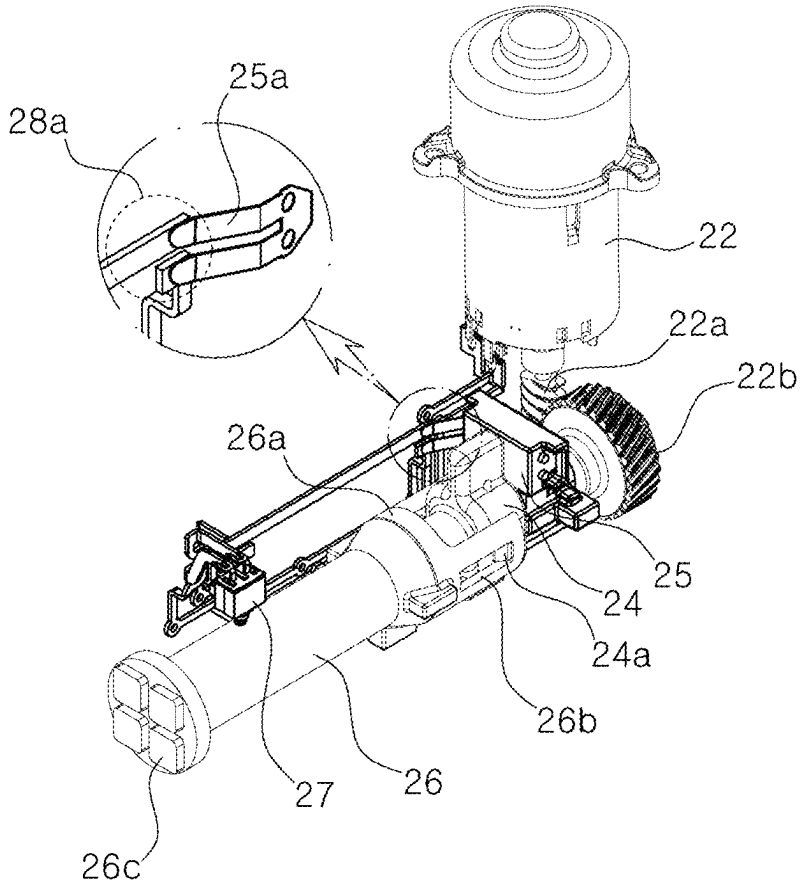


FIG. 4A

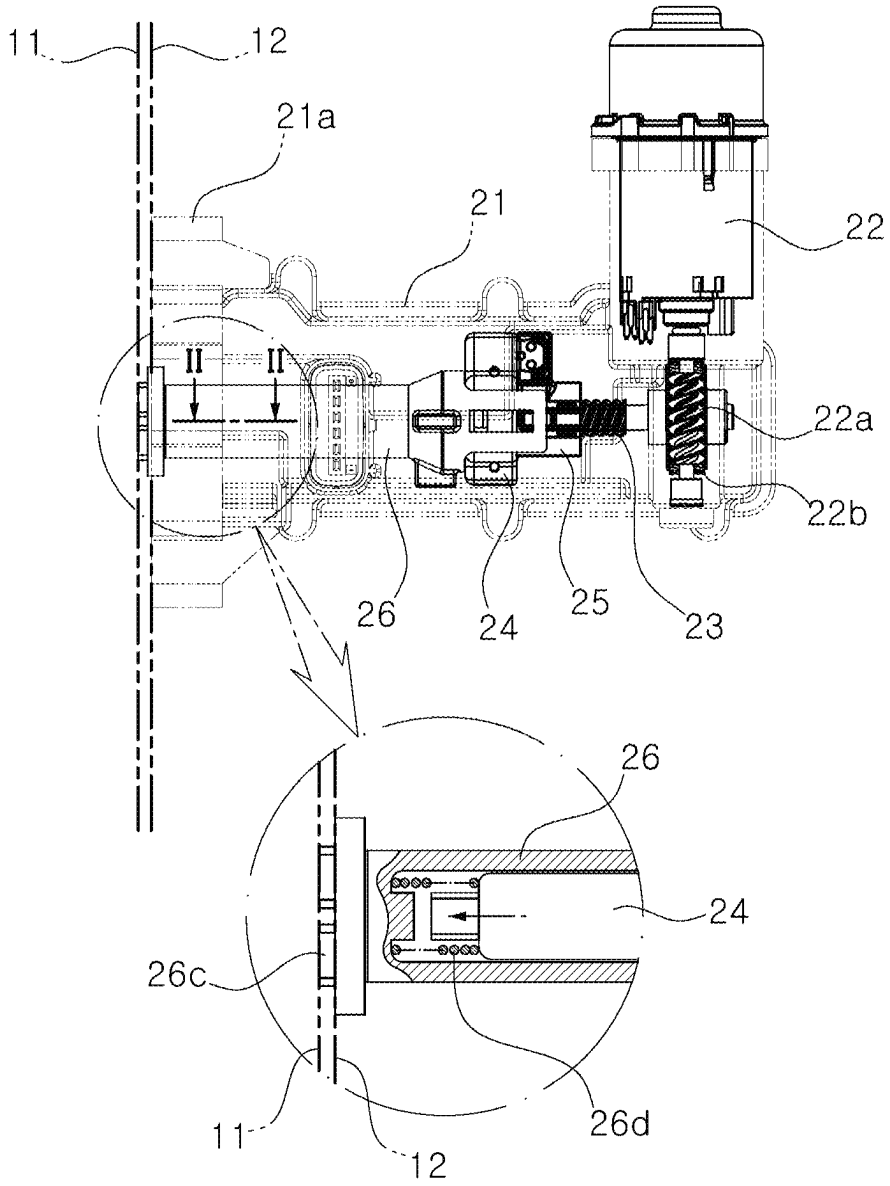


FIG. 4B

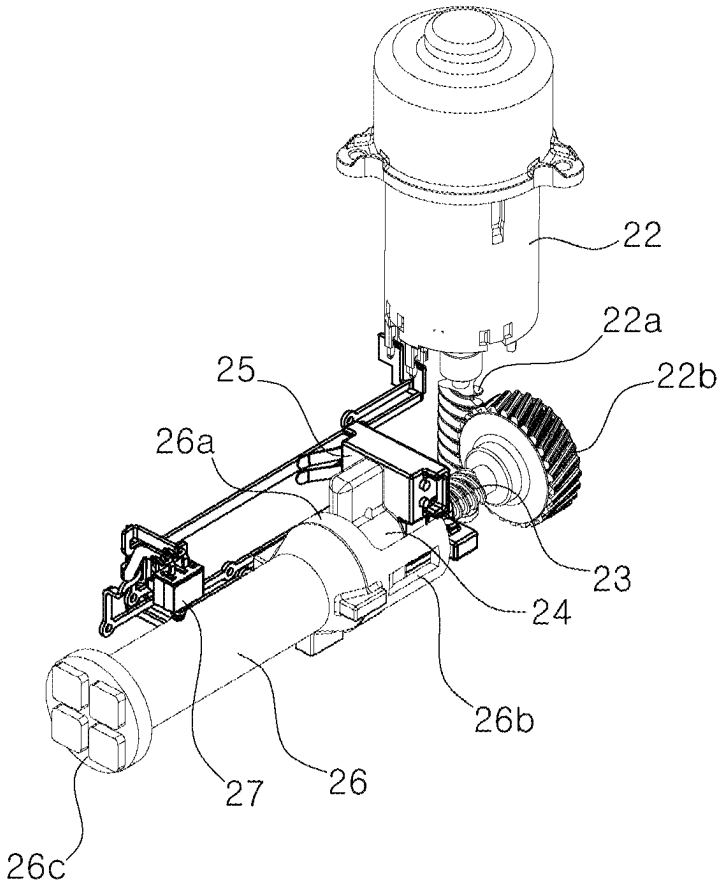


FIG. 5A

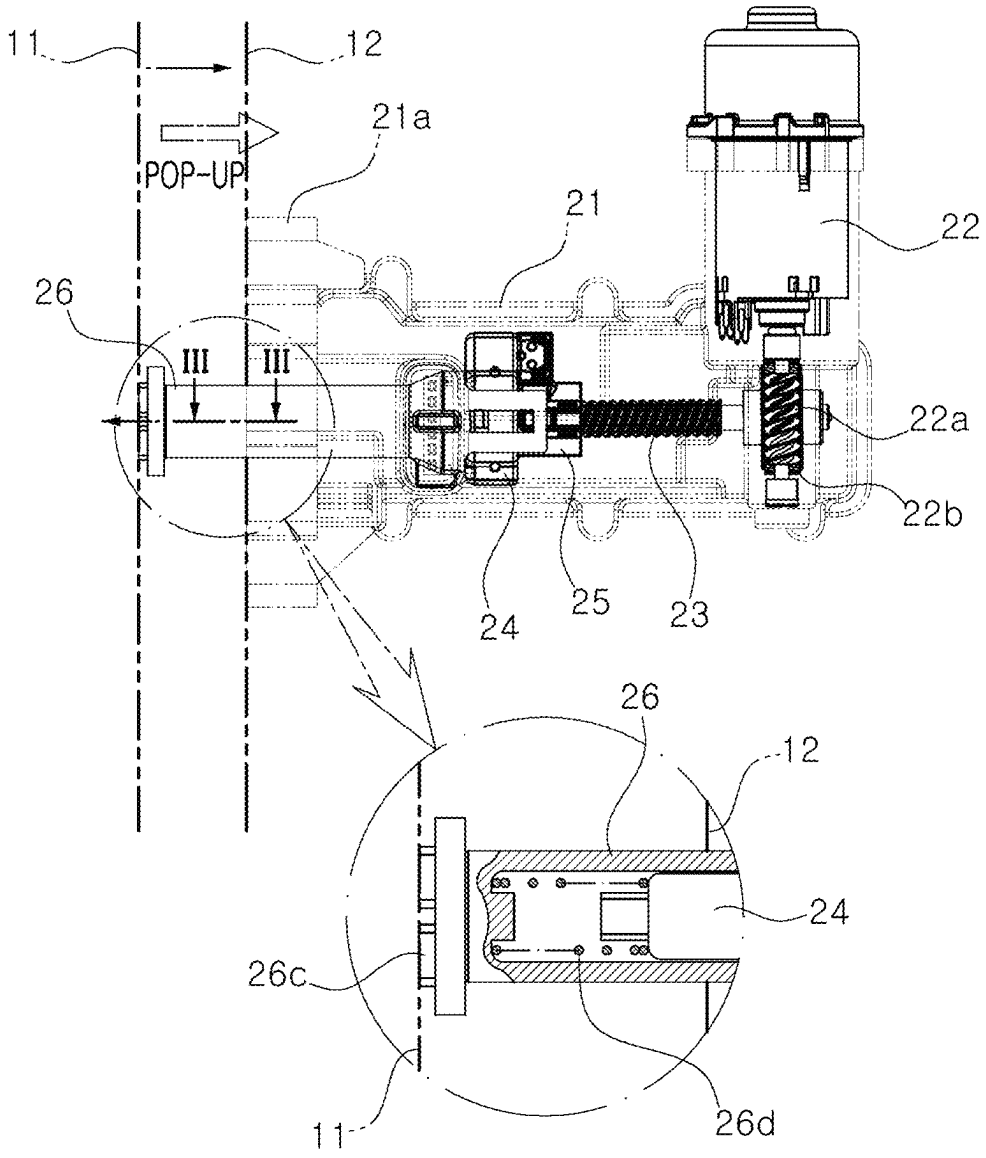

11
12
POP-UP
21a
21
22
26
III
III
22a
22b
24
25
23
26
12
24
26c
11
26d

FIG. 5B

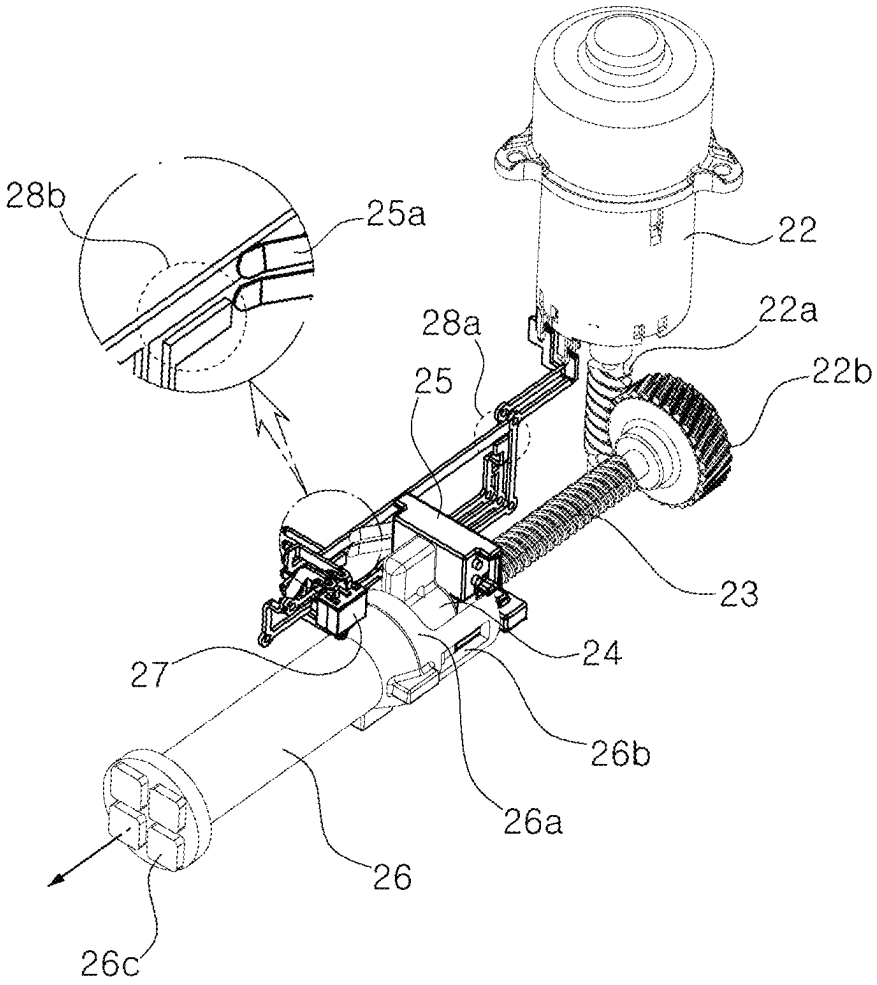


FIG. 6A

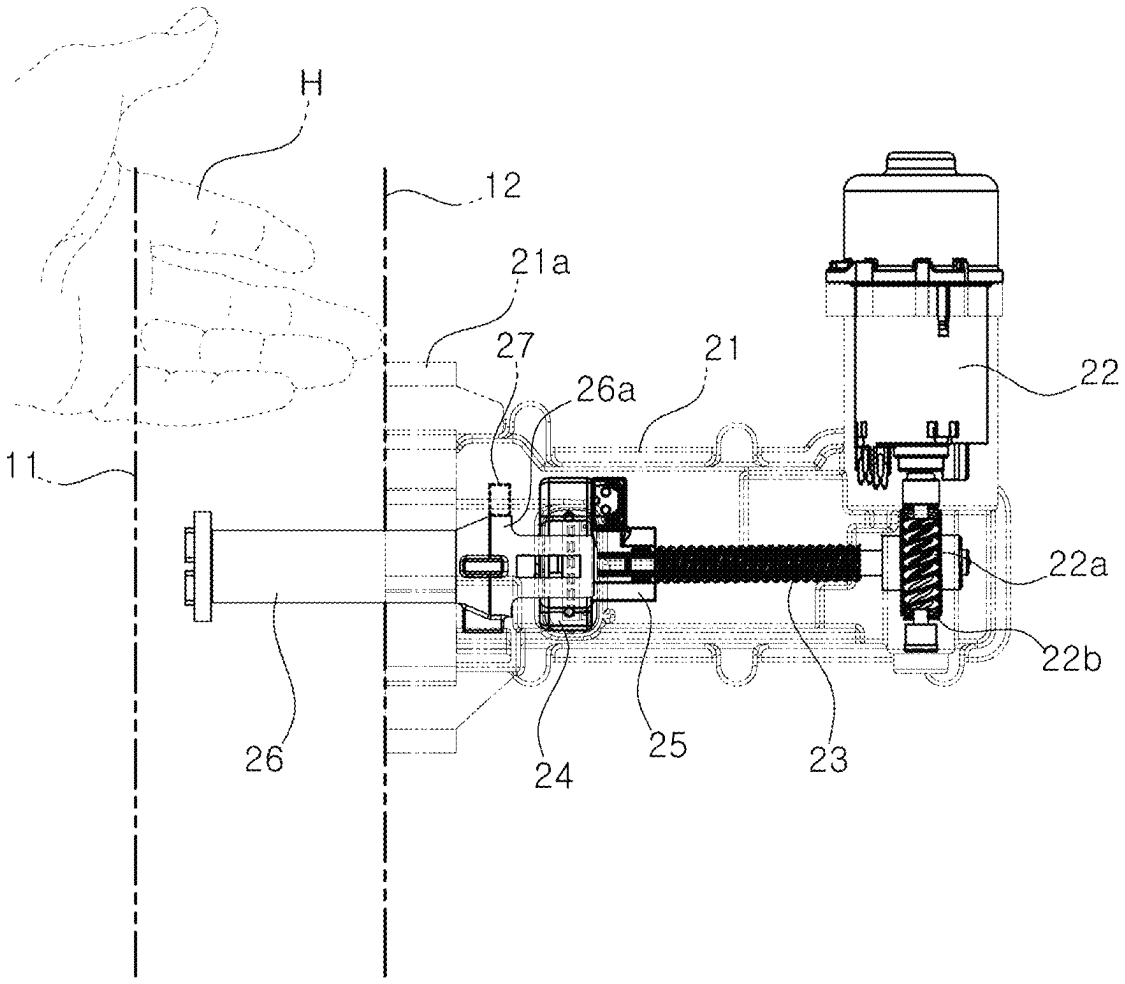


FIG. 6B

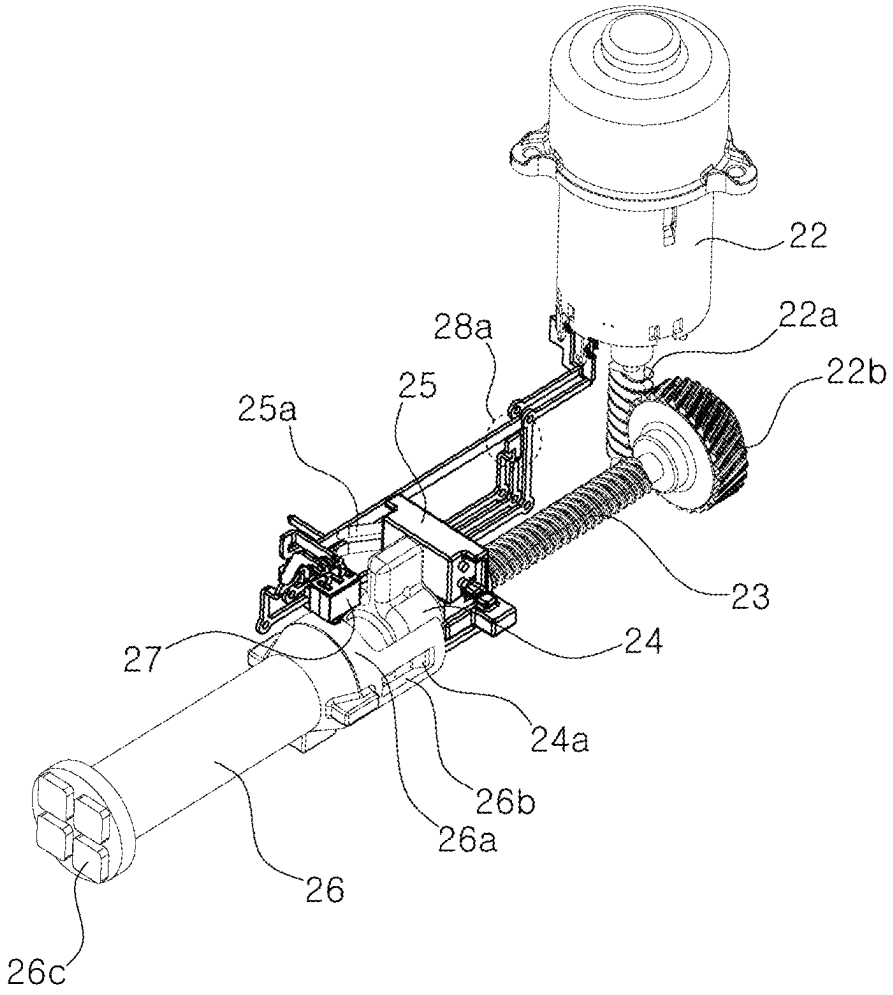


FIG. 7

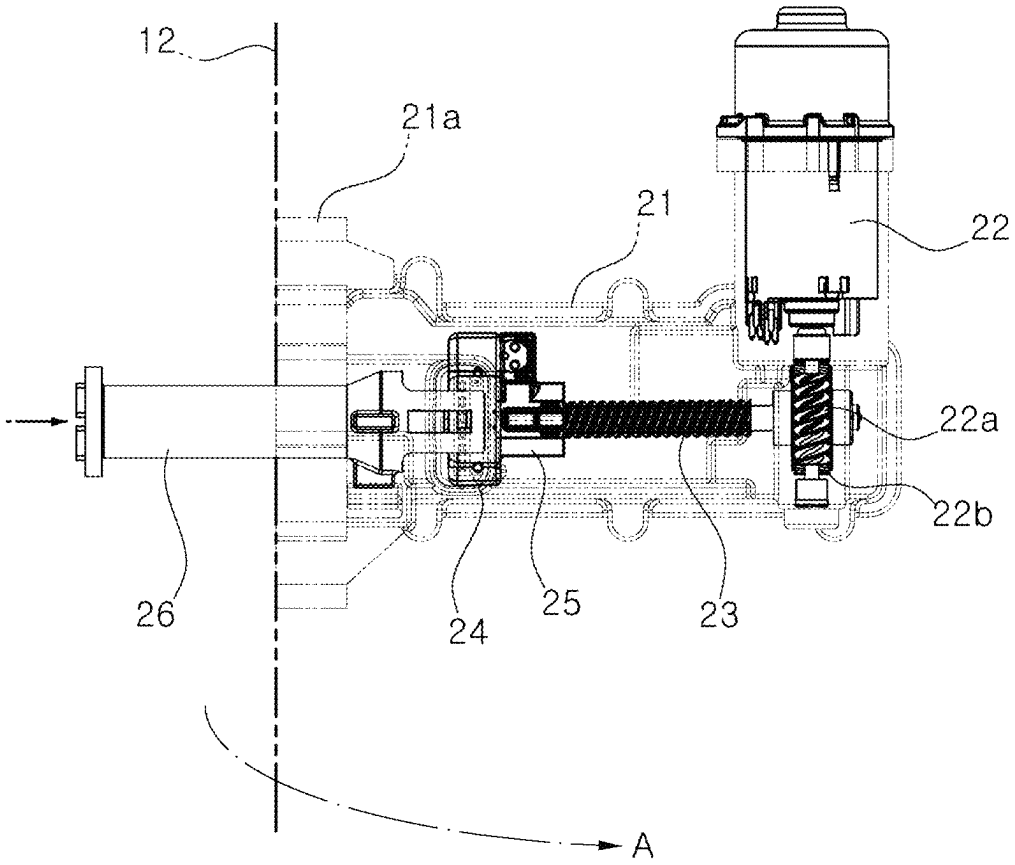


FIG. 8

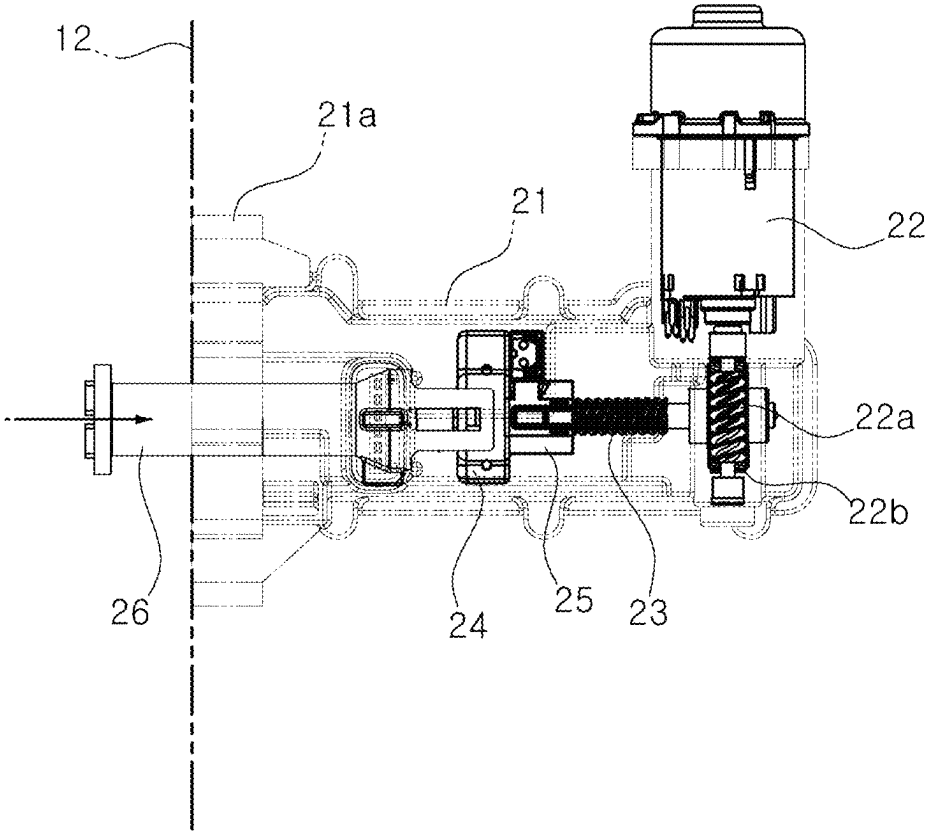
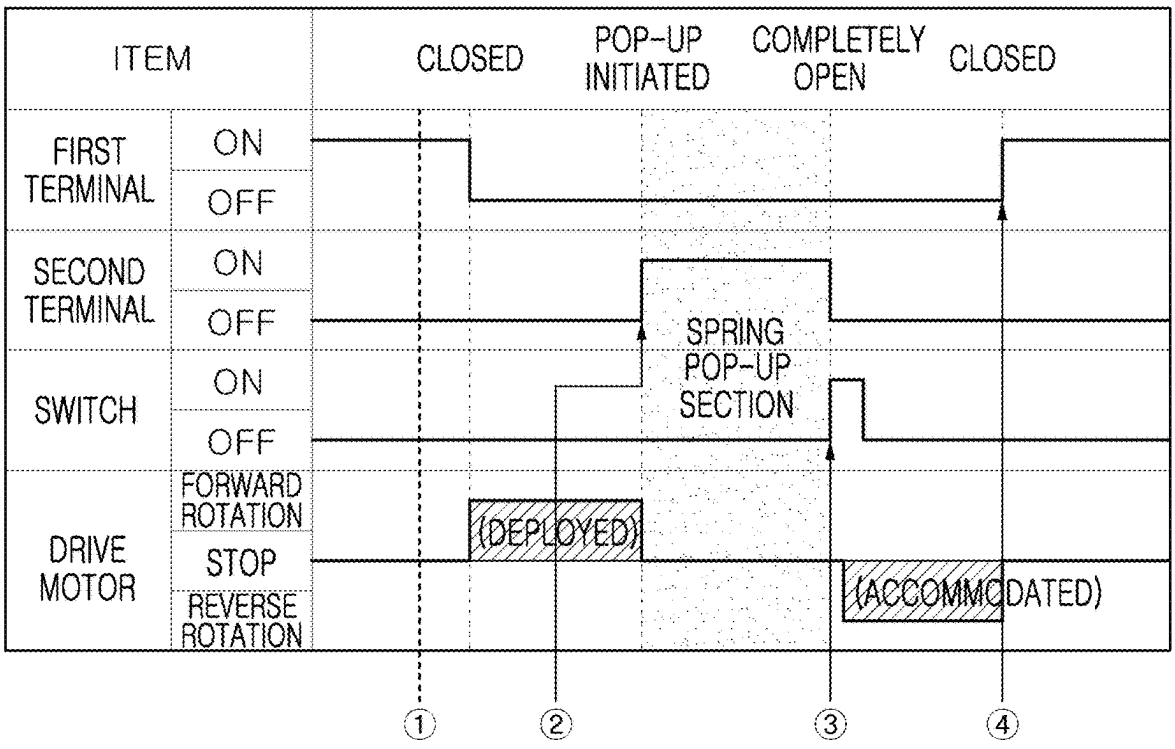


FIG. 9


ITEM
CLOSED
POP-UP INITIATED
COMPLETELY OPEN
CLOSED
FIRST TERMINAL
ON
OFF
SECOND TERMINAL
ON
OFF
SPRING POP-UP SECTION
SWITCH
ON
OFF
DRIVE MOTOR
FORWARD ROTATION
STOP
REVERSE ROTATION
(DEPLOYED)
(ACCOMMODATED)
①
②
③
④

POP-UP ACTUATOR FOR VEHICLE DOOR

CROSS-REFERENCE TO RELATED APPLICATION

The present application claims priority to Korean Patent Application No. 10-2023-0029143, filed on Mar. 6, 2023, the entire contents of which is incorporated herein for all purposes by this reference.

BACKGROUND OF THE PRESENT DISCLOSURE

Field of the Present Disclosure

The present disclosure relates to a pop-up actuator for a vehicle door, which is applied to a vehicle door and pops up a circumferential part of the door from a vehicle body when a signal for opening the door is inputted, allowing an occupant to easily open the door.

Description of Related Art

A door is provided at one side of a vehicle to allow an occupant to get in or out of the vehicle.

Generally, the occupant releases a latch of the door by operating a door handle provided on the door, and the occupant opens the door by rotating the door.

Recently, as convenience is improved, the occupant manipulates a switch provided at one side of the door or a vehicle body instead of operating the door handle. When the occupant touches the switch, a pop-up actuator operates and pops up a circumferential part of the door from the vehicle body, and the occupant is able to hold and open the popped-up door.

However, there is a problem in that an inertia sensor for detecting an opened or closed state of the door needs to be applied to the door that adopts the pop-up actuator. Because the inertia sensor is an expensive component, there is a problem in that costs of the vehicle increase in case that the pop-up actuator is applied to improve convenience.

Furthermore, because the inertia sensor indirectly detects an operation of the pop-up actuator, there is a problem in that the pop-up actuator erroneously operates due to a detecting error.

The information included in this Background of the present disclosure is only for enhancement of understanding of the general background of the present disclosure and may not be taken as an acknowledgement or any form of suggestion that this information forms the prior art already known to a person skilled in the art.

BRIEF SUMMARY

Various aspects of the present disclosure are directed to providing a pop-up actuator for a vehicle door, which may easily detect an opened state of a door with a simple structure while providing convenience at the time of opening the door.

As an exemplary embodiment of the present disclosure, a pop-up actuator for a vehicle door includes: a housing provided in a vehicle: a drive motor mounted in the housing: a nut rod coupled to the drive motor and configured to be linearly moved by operation of the drive motor; and an operating rod coupled to an external portion of the nut rod and configured to extend from the housing by a forward movement of the nut rod to move the door away from a vehicle body.

The pop-up actuator may further include: an elastic member provided at a front end portion of the nut rod, inserted into the operating rod, and configured to pop up the operating rod by an elastic force of the elastic member, in which the elastic member is compressed by the nut rod when the nut rod is moved forward by a forward rotation of the drive motor, and the operating rod is extended from the housing as the operating rod moves forward relative to the nut rod when the nut rod moves forward with a predetermined distance or more than the predetermined distance so that the operating rod pops up the door.

The pop-up actuator may further include: a controller electrically connected to the drive motor and mounted on the door and configured to rotate the drive motor in a forward direction so that the operating rod is extended from the housing when an outside switch is operated by an occupant.

A terminal may be provided to detect a position of the nut rod.

The terminal may include: a first terminal configured to detect an initial position of the nut rod; and a second terminal configured to detect a forward movement of the nut rod when the nut rod moves forward with a predetermined distance.

The nut rod may include a contactor configured to be selectively connected to one of the first terminal and the second terminal.

An operation switch may be provided to output a signal to the controller so that the operating rod and the nut rod return to initial positions when the operating rod is maximally extended.

The operation switch may be provided to operate after the contactor is connected to the second terminal.

A protruding portion may be formed to protrude from the operating rod in a radial direction of the operating rod, and the protruding portion may come into contact with the operation switch when the operating rod is maximally extended.

The pop-up actuator may further include: a lead nut fastened to a rear end portion of the nut rod, in which the contactor is mounted on the lead nut.

When the outside switch operates, the nut rod may be moved forward by a forward rotation of the drive motor, and the contactor may be separated from the first terminal.

The controller may stop the forward rotation of the drive motor when the nut rod moves forward with a predetermined distance, and the contactor is connected to the second terminal.

When the operating rod is maximally extended and the operation switch operates, the nut rod may move rearward thereof, and the drive motor may rotate in a reverse direction so that the operating rod and the nut rod return to the initial positions thereof.

The controller may be configured to stop the reverse rotation of the drive motor when the nut rod moves rearward thereof, and the contactor is connected to the first terminal.

A damper may be provided at a front end portion of the operating rod.

A coupling groove may be provided in a form of an elongated hole and formed in an external portion of the operating rod, and a coupling protrusion may be formed on an external portion of the nut rod and engage with the coupling groove.

The pop-up actuator may further include: a lead screw threaded-coupled to the nut rod and configured to be rotated by the drive motor and linearly move the nut rod.

A worm gear may be mounted on an output shaft of the drive motor, and a worm wheel may be mounted on the lead screw and be in mesh with the worm gear.

The housing may be provided on the door, and the operating rod may pop up the door while being extended from the door toward the vehicle body.

According to the pop-up actuator for a vehicle door of the present disclosure configured as described above, an expensive inertia sensor is not used to detect a state of the pop-up actuator, and the pop-up actuator is directly connected to the operation switch or terminal, which may improve durability and reduce costs.

Furthermore, whether the door is opened by operation of the pop-up actuator is directly detected by switching instead of detecting using an inertia sensor, which may reduce malfunction.

Furthermore, even in a state in which moisture is frozen between the door and the vehicle body in the winter season, the pop-up actuator may pop up the door, which improves convenience for the occupant and prevents the door from being defectively opened or closed.

The methods and apparatuses of the present disclosure have other features and advantages which will be apparent from or are set forth in more detail in the accompanying drawings, which are incorporated herein, and the following Detailed Description, which together serve to explain certain principles of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side view of a vehicle to which a pop-up actuator for a vehicle door according to an exemplary embodiment of the present disclosure is applied.

FIG. **2** is an exploded perspective view exemplarily illustrating the pop-up actuator for a vehicle door according to an exemplary embodiment of the present disclosure.

FIG. **3**A is a perspective view including an enlarged and encircled view indicated by a dotted arrow in a cross-sectional view according to line I-I and shown in the lower part, and FIG. **3**B is an isometric view in the upper part of FIG. **3**A, illustrating a state before the pop-up actuator for a vehicle door according to an exemplary embodiment of the present disclosure operates.

FIG. **4**A is a perspective view including an enlarged and encircled view indicated by a dotted arrow in a cross-sectional view according to line II-II and shown in the lower part, and FIG. **4**B is an isometric view in the upper part of FIG. **4**A, illustrating an initial operation state of the pop-up actuator for a vehicle door according to an exemplary embodiment of the present disclosure.

FIG. **5**A is a perspective view including an enlarged and encircled view indicated by a dotted arrow in a cross-sectional view according to line III-III and shown in the lower part, and FIG. **5**B is an isometric view in the upper part of FIG. **5**A, illustrating a state in which an operating rod of the pop-up actuator for a vehicle door according to an exemplary embodiment of the present disclosure protrudes from a door and the door begins to pop upwards.

FIG. **6**A and FIG. **6**B are a cross-sectional view and a perspective view, respectively illustrating a state in which the door is completely popped up by the pop-up actuator for a vehicle door according to an exemplary embodiment of the present disclosure.

FIG. **7** is a cross-sectional view exemplarily illustrating a state in which the door is opened in a state in which the pop-up actuator for a vehicle door according to an exemplary embodiment of the present disclosure is deployed.

FIG. **8** is a cross-sectional view exemplarily illustrating a state in which the pop-up actuator for a vehicle door according to an exemplary embodiment of the present disclosure is initiated to be accommodated.

FIG. **9** is a chart illustrating control signals for the pop-up actuator for respective operations of the door to which the pop-up actuator for a vehicle door according to an exemplary embodiment of the present disclosure is applied.

It may be understood that the appended drawings are not necessarily to scale, presenting a somewhat simplified representation of various features illustrative of the basic principles of the present disclosure. The predetermined design features of the present disclosure as included herein, including, for example, specific dimensions, orientations, locations, and shapes will be determined in part by the particularly intended application and use environment.

In the figures, reference numbers refer to the same or equivalent portions of the present disclosure throughout the several figures of the drawing.

DETAILED DESCRIPTION

Reference will now be made in detail to various embodiments of the present disclosure(s), examples of which are illustrated in the accompanying drawings and described below. While the present disclosure(s) will be described in conjunction with exemplary embodiments of the present disclosure, it will be understood that the present description is not intended to limit the present disclosure(s) to those exemplary embodiments of the present disclosure. On the other hand, the present disclosure(s) is/are intended to cover not only the exemplary embodiments of the present disclosure, but also various alternatives, modifications, equivalents and other embodiments, which may be included within the spirit and scope of the present disclosure as defined by the appended claims.

Hereinafter, various embodiments of the present disclosure will be described in detail with reference to the exemplary accompanying drawings, and because these embodiments, as examples, may be implemented in various different forms by those skilled in the art to which the present disclosure pertains, they are not limited to the exemplary embodiments described herein.

Hereinafter, a pop-up actuator for a vehicle door according to an exemplary embodiment of the present disclosure will be described in detail with reference to the accompanying drawings.

The pop-up actuator for a vehicle door according to an exemplary embodiment of the present disclosure may include: a housing **21** provided in a vehicle: a drive motor **22** provided in the housing **21**; a nut rod **24** configured to linearly move by operation of the drive motor **22**; and an operating rod **26** coupled to an external portion of the nut rod **24** and configured to extend from the housing **21** by a forward movement of the nut rod **24** to move the door **12** away from a vehicle body **11**.

The housing **21** may have therein a space in which constituent elements to be described below are accommodated. The housing **21** may be mounted at one side of the door **12** so that the pop-up actuator **20** is provided on the door **12**. The housing **21** may be closed by a cover after the constituent elements are mounted in the housing **21**. The cover and the housing **21** may be airtight by sealing. The

housing **21** may be provided on the door **12** so that the pop-up actuator **20** is deployed from the door **12** toward the vehicle body **11**. Meanwhile, as a modification, the housing **21** may be provided on the vehicle body **11** so that the pop-up actuator **20** may be deployed from the vehicle body **11** toward the door **12**.

An opening portion may be formed at one side of the housing **21** which the operating rod **26** is extended from or moved back into. A housing cap **21***a* may be provided in the opening portion to close the opening portion. The housing cap **21***a* may include a through-hole so that the operating rod **26** is extended from or retracted into the through-hole.

The drive motor **22** may be provided in the housing **21**. The drive motor **22** rotates forward or reversely in response to an operating state of the pop-up actuator **20**. In the instant case, the forward rotation refers to a rotation of the drive motor **22** in one direction, which extends the operating rod **26** so that the pop-up actuator **20** is deployed. The reverse rotation refers to a rotation in a direction opposite to the direction of the forward rotation.

A lead screw **23** may be rotated by the drive motor **22**.

A power transmission member may be provided between the drive motor **22** and the lead screw **23** and transmits power from the drive motor **22** to the lead screw **23**. For example, a worm gear **22***a* may be provided on an output shaft of the drive motor **22**, and a worm wheel **22***b*, which engages with the worm gear **22***a*, may be provided on the lead screw **23** so that the lead screw **23** rotates together with the drive motor **22** as the drive motor **22** rotates.

The nut rod **24** may be thread-coupled to the lead screw **23** in the housing **21**. The nut rod **24** may be provided in the housing **21** to be movable in an axial direction of the nut rod **24** without rotating. Because the nut rod **24** is thread-coupled to the lead screw **23**, the nut rod **24** may linearly move when the lead screw **23** rotates. Therefore, the nut rod **24** may move forward or rearward depending on a rotation direction of the lead screw **23**.

A lead nut **25** may be coupled to a rear end portion of the nut rod **24** and may close the rear end portion of the nut rod **24**. The lead nut **25** may move forward or rearward together with the nut rod **24**. A contactor **25***a* may be provided on an external portion of the lead nut **25**. When the lead nut **25** moves forward or rearward together with the nut rod **24**, the contactor **25***a* may be connected to a first terminal **28***a* or a second terminal **28***b*. When the contactor **25***a* made of a metallic material is connected to the first terminal **28***a* or the second terminal **28***b*, a position of the lead nut **25** and a position of the nut rod **24** may be detected.

The operating rod **26** may be coupled to an external portion of the nut rod **24**. The operating rod **26** may be formed in a hollow shape, and the nut rod **24** may be slidably provided in the operating rod **26**. The operating rod **26** may be formed so that one end portion thereof is closed, and the other end portion thereof is open. The nut rod **24** may be inserted through the other end portion of the operating rod **26**.

The operating rod **26** and the nut rod **24** may be coupled by a coupling groove **26***b* and a coupling protrusion **24***a*. The coupling groove **26***b* may be formed at the other end portion of the operating rod **26**, and the coupling protrusion **24***a* may be formed on the nut rod **24**. When the nut rod **24** is inserted into the operating rod **26**, the coupling protrusion **24***a* may be caught by the coupling groove **26***b* so that the operating rod **26** and the nut rod **24** are coupled. In the instant case, the coupling groove **26***b* may be provided in a form of an elongated hole and formed in a longitudinal direction of the operating rod **26** so that the nut rod **24** may slide by a predetermined length in the operating rod **26**.

A protruding portion **26***a* may be formed at the other end portion of the operating rod **26** and may protrude in a radial direction of the operating rod **26**. When the operating rod **26** is maximally extended from the housing **21**, the protruding portion **26***a* may come into contact with an operation switch **27** so that the operation switch **27** operates.

An elastic member **26***d* may be inserted into the operating rod **26** and compressed or extended in the longitudinal direction of the operating rod **26**. The elastic member **26***d* may be provided in the operating rod **26** to contact with a front end portion of the nut rod **24**. For example, the elastic member **26***d* may be provided in a form of a spring including a coil shape. At the initial time of the operation of the drive motor **22**, the elastic member **26***d* may be compressed by the forward movement of the nut rod **24**. After the elastic member **26***d* is maximally compressed, the elastic member **26***d* applies a force that pushes the operating rod **26** toward the vehicle body **11**. Therefore, the operating rod **26** may be extended toward the vehicle body **11** to pop up the door **12** from the vehicle body **11**.

A damper **26***c* may be provided at a front end portion of the operating rod **26** and may prevent impact and noise that occur when the operating rod **26** collides with the vehicle body **11**. The damper **26***c* may be made of a material such as rubber and may reduce impact or noise that occurs when one end portion of the operating rod **26** strikes the vehicle body **11** when the operating rod **26** is extended.

The operation switch **27** may be mounted in the housing **21**. When the operating rod **26** moves, the operation switch **27** may be operated by the protruding portion **26***a* formed on the external portion of the operating rod **26**. That is, when the operating rod **26** is maximally extended from the housing **21**, the protruding portion **26***a* may operate the operation switch **27**, and the pop-up actuator **20** may begin to be retracted.

A pattern unit **28** may include a plurality of patterns to apply power to the drive motor **22**, detect a position of the nut rod **24**, or input an operational signal for the operation switch **27**. The pattern unit **28** may be inserted and embedded in the housing **21**, and one side of the pattern unit **28** may be connected to a separate connector.

The pattern unit **28** may include the first terminal **28***a* and the second terminal **28***b*. The first terminal **28***a* and the second terminal **28***b* may be electrically connected to the contactor **25***a* provided on the lead nut **25**. The first terminal **28***a* may have two patterns separated apart from each other. When the contactor **25***a*, which is a conductor, connects the two patterns, a circuit may be configured, and the position of the lead nut **25** may be detected. Likewise, the second terminal **28***b* may have two patterns kept separated from each other. When the contactor **25***a* connects the two patterns, the position of the lead nut **25** may be detected. When the nut rod **24** and the lead nut **25** are positioned at initial positions, the first terminal **28***a* may be connected to the contactor **25***a*. When the nut rod **24** and the lead nut **25** move forward with a predetermined distance, the second terminal **28***b* may be connected to the contactor **25***a* to detect the forward movements of the nut rod **24** and the lead nut **25**.

Meanwhile, as a modification, the first terminal **28***a* and the second terminal **28***b* may be substituted with switches. That is, the first terminal **28***a* and the second terminal **28***b* may be provided as switches that are operated by the contactor **25***a* when the lead nut **25** is positioned at the initial position and the lead nut **25** is maximally extended, respectively.

When a signal is inputted from an outside switch **13** provided on the door **12**, a controller **30** may be configured to control rotation of the drive motor **22**. Furthermore, when signals are inputted from the operation switch **27**, the first terminal **28***a*, and the second terminal **28***b*, the controller **30** electrically connected to the drive motor **22** may be configured for controlling the drive motor **22** to control the operation of the pop-up actuator **20** so that the pop-up actuator **20** is fully deployed or returns to an initial state.

An operation of the pop-up actuator for a vehicle door according to an exemplary embodiment of the present disclosure, which is configured as described above, will be described below.

In a state in which the door **12** is closed (see FIG. **3**A and FIG. **3**B), the pop-up actuator **20** may not be extended from the housing **21**. Furthermore, a circumferential portion of the door **12** may be in contact with the vehicle body **11** of the vehicle. When the door **12** is closed, the contactor **25***a* may be connected to the first terminal **28***a*, and the controller **30** may recognize that the operating rod **26**, the nut rod **24**, the lead nut **25**, and the like are accommodated in the pop-up actuator **20**.

When the occupant operates the outside switch **13** provided on an outside handle to get in the vehicle, the drive motor **22** may begin to operate by the controller **30**, and the nut rod **24** may move forward and compress the elastic member **26***d* (see FIG. **4**A and FIG. **4**B). When the outside switch **13** is operated, a signal of the outside switch **13** may be inputted to the controller **30**, and the controller **30** may apply an operational signal to the drive motor **22** (see ① in FIG. **9**). When the operational signal is applied from the controller **30**, the drive motor **22** may begin to rotate. During a process of popping up the door **12**, the drive motor **22** may rotate in a direction in which the nut rod **24** is extended to the outside of the housing **21**. When the drive motor **22** rotates, the worm gear **22***a* and the worm wheel **22***b* may rotate, so that the lead screw **23** may rotate. Because the lead screw **23** and the nut rod **24** are thread-coupled to each other and the rotation of the nut rod **24** is restricted, the nut rod **24** and the lead nut **25** may linearly move when the lead screw **23** rotates. In the instant case, the nut rod **24** and the operating rod **26** may not be extended outward, and the elastic member **26***d* may be compressed as the nut rod **24** moves. In the instant case, the contactor **25***a* may be separated from the first terminal **28***a* as the nut rod **24** moves forward thereof.

Thereafter, as illustrated in FIG. **5**A and FIG. **5**B, the door **12** may be popped up. When the drive motor **22** continuously rotates, the nut rod **24** and the lead nut **25** may continuously move linearly forward thereof. When the elastic member **26***d* is maximally compressed by the forward movement of the nut rod **24**, the nut rod **24** and the operating rod **26** may be extended to the outside thereof. When the elastic member **26***d* is maximally compressed by the forward movement of the nut rod **24**, the elastic member **26***d* may push the operating rod **26** without being compressed any further. When the operating rod **26** is pushed and extended from the housing **21**, the door **12** may pop up from the vehicle body **11**. When the operating rod **26** is extended between the vehicle body **11** and the door **12**, the door **12** may be popped up by the extended operating rod **26**, and a gap may be formed between the door **12** and the vehicle body **11**. Furthermore, as the nut rod **24** moves forward, the contactor **25***a* may be connected to the second terminal **28***b*. When the nut rod **24** moves forward with a predetermined distance and the contactor **25***a* is connected to the second terminal **28***b*, the controller **30** may be configured to stop the drive motor **22** (see ② in FIG. **9**).

When the door **12** completely pops up, the occupant may put his or her hand H into the gap between the door **12** and the vehicle body **11** and open the door **12** (see FIG. **6**A and FIG. **6**B). Even though the nut rod **24** does not move forward as the drive motor **22** is stopped, the compressed elastic member **26***d* additionally may push the operating rod **26** while being retracted so that a clearance between the door **12** and the vehicle body may increase to the extent that the occupant may put his or her hand H into the clearance between the door **12** and the vehicle body. Therefore, the occupant may open the door **12**. In the instant case, when the operating rod **26** is maximally extended, the protruding portion **26***a* may operate the operation switch **27** (see ③ in FIG. **9**). When the pop-up actuator **20** is fully deployed, the operation switch **27** may be operated after the contactor **25***a* is connected to the second terminal **28***b*.

FIG. **7** illustrates a state in which the door **12** is being opened in a direction of arrow A by the occupant. The occupant may continuously open the door **12** so that the door **12** is sufficiently opened to enable the occupant to get in or out. Meanwhile, because the operation switch **27** has already operated, the controller **30** may be configured to rotate the drive motor **22** in a reverse direction opposite to the direction in which the drive motor **22** rotates to pop up the door **12**. When the drive motor **22** rotates reversely, the operating rod **26**, the nut rod **24**, and the lead nut **25** may move rearward and begin to be encased in the housing **21**.

Thereafter, when the drive motor **22** continuously rotates reversely, the operating rod **26**, the nut rod **24**, and the lead nut **25** may be accommodated in the housing **21**, as illustrated in FIG. **8**.

When the operating rod **26**, the nut rod **24**, and the lead nut **25** are completely accommodated, the operating rod **26**, the nut rod **24**, and the lead nut **25** may be restored to the initial positions, the contactor **25***a* may be connected to the first terminal **28***a*, and the controller **30** may stop the drive motor **22** (see ④ in FIG. **9**).

The pop-up actuator **20** according to an exemplary embodiment of the present disclosure has been referred to as being provided on the door **12**. However, as a modification, the pop-up actuator **20** may be provided on the vehicle body **11** and pop up the door **12** while being extended from the vehicle body **11**.

Furthermore, the pop-up actuator **20** may be applied to not only the door **12** of the vehicle but also an opening/closing portion provided in the vehicle and configured to be opened or closed. For example, the pop-up actuator may be applied to pop up a hood configured to cover an engine compartment, a fuel door configured to open or close a refueling port, or a charge port door configured to open or close a charge port for a battery.

Furthermore, the term related to a control device such as "controller", "control apparatus", "control unit", "control device", "control module", or "server", etc refers to a hardware device including a memory and a processor configured to execute one or more steps interpreted as an algorithm structure. The memory stores algorithm steps, and the processor executes the algorithm steps to perform one or more processes of a method in accordance with various exemplary embodiments of the present disclosure. The control device according to exemplary embodiments of the present disclosure may be implemented through a nonvolatile memory configured to store algorithms for controlling operation of various components of a vehicle or data about software commands for executing the algorithms, and a

processor configured to perform operation to be described above using the data stored in the memory. The memory and the processor may be individual chips. Alternatively, the memory and the processor may be integrated in a single chip. The processor may be implemented as one or more processors. The processor may include various logic circuits and operation circuits, may be configured to process data according to a program provided from the memory, and may be configured to generate a control signal according to the processing result.

The control device may be at least one microprocessor operated by a predetermined program which may include a series of commands for carrying out the method included in the aforementioned various exemplary embodiments of the present disclosure.

The aforementioned invention can also be embodied as computer readable codes on a computer readable recording medium. The computer readable recording medium is any data storage device that can store data which may be thereafter read by a computer system and store and execute program instructions which may be thereafter read by a computer system. Examples of the computer readable recording medium include Hard Disk Drive (HDD), solid state disk (SSD), silicon disk drive (SDD), read-only memory (ROM), random-access memory (RAM), CD-ROMs, magnetic tapes, floppy discs, optical data storage devices, etc and implementation as carrier waves (e.g., transmission over the Internet). Examples of the program instruction include machine language code such as those generated by a compiler, as well as high-level language code which may be executed by a computer using an interpreter or the like.

In various exemplary embodiments of the present disclosure, each operation described above may be performed by a control device, and the control device may be configured by a plurality of control devices, or an integrated single control device.

In various exemplary embodiments of the present disclosure, the memory and the processor may be provided as one chip, or provided as separate chips.

In various exemplary embodiments of the present disclosure, the scope of the present disclosure includes software or machine-executable commands (e.g., an operating system, an application, firmware, a program, etc.) for enabling operations according to the methods of various embodiments to be executed on an apparatus or a computer, a non-transitory computer-readable medium including such software or commands stored thereon and executable on the apparatus or the computer.

In various exemplary embodiments of the present disclosure, the control device may be implemented in a form of hardware or software, or may be implemented in a combination of hardware and software.

Furthermore, the terms such as "unit", "module", etc. included in the specification mean units for processing at least one function or operation, which may be implemented by hardware, software, or a combination thereof.

For convenience in explanation and accurate definition in the appended claims, the terms "upper", "lower", "inner", "outer", "up", "down", "upwards", "downwards", "front", "rear", "back", "inside", "outside", "inwardly", "outwardly", "interior", "exterior", "internal", "external", "forwards", and "backwards" are used to describe features of the exemplary embodiments with reference to the positions of such features as displayed in the figures. It will be further understood that the term "connect" or its derivatives refer both to direct and indirect connection.

The term "and/or" may include a combination of a plurality of related listed items or any of a plurality of related listed items. For example, "A and/or B" includes all three cases such as "A", "B", and "A and B".

In the present specification, unless stated otherwise, a singular expression includes a plural expression unless the context clearly indicates otherwise.

In exemplary embodiments of the present disclosure, "at least one of A and B" may refer to "at least one of A or B" or "at least one of combinations of at least one of A and B". Furthermore, "one or more of A and B" may refer to "one or more of A or B" or "one or more of combinations of one or more of A and B".

In the exemplary embodiment of the present disclosure, it should be understood that a term such as "include" or "have" is directed to designate that the features, numbers, steps, operations, elements, parts, or combinations thereof described in the specification are present, and does not preclude the possibility of addition or presence of one or more other features, numbers, steps, operations, elements, parts, or combinations thereof.

The foregoing descriptions of specific exemplary embodiments of the present disclosure have been presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the present disclosure to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teachings. The exemplary embodiments were chosen and described in order to explain certain principles of the invention and their practical application, to enable others skilled in the art to make and utilize various exemplary embodiments of the present disclosure, as well as various alternatives and modifications thereof. It is intended that the scope of the present disclosure be defined by the Claims appended hereto and their equivalents.

What is claimed is:

1. A pop-up actuator apparatus for a door, the pop-up actuator apparatus comprising:

a housing provided in a vehicle;

a drive motor mounted in the housing;

a nut rod coupled to the drive motor and configured to be linearly moved by operation of the drive motor;

a lead nut coupled to the nut rod and provided with a contactor;

a pattern unit inserted in the housing and configured to apply power to the drive motor and detect a position of the nut rod;

an operating rod coupled to an external portion of the nut rod and configured to extend from the housing by a forward movement of the nut rod to move the door away from a body of the vehicle; and

an elastic member inserted in the operating rod and configured to be compressed by the nut rod being moved by the drive motor to pop up the operating rod by an elastic force of the elastic member,

wherein the pattern unit includes:

a first terminal configured to detect an initial position of the nut rod; and

a second terminal configured to detect the forward movement of the nut rod in response that the nut rod moves forward a predetermined distance, and

wherein when the lead nut moves forward or rearward together with the nut rod, the contactor is configured to be electrically connected to the first terminal to detect the initial position of the nut rod and to the second terminal to detect the forward movement of the nut rod,

wherein a coupling hole is provided in an external portion of the operating rod, and a coupling protrusion is formed on an external portion of the nut rod and engaged with the coupling hole, so that the nut rod slides by the predetermined distance in the operating rod, and

wherein when the elastic member is maximally compressed by the forward movement of the nut rod, the elastic member is configured to push the operating rod outside of the housing without being compressed any further to pop up the door from the body of the vehicle.

2. The pop-up actuator apparatus of claim **1**,

wherein the elastic member is provided at a front end portion of the nut rod and compressed by the nut rod in response to the nut rod being moved forward by a forward rotation of the drive motor, and the operating rod is extended from the housing as the operating rod moves forward relative to the nut rod in response that the nut rod is moving forward the predetermined distance or more than the predetermined distance so that the operating rod pops up the door.

3. The pop-up actuator apparatus of claim **1**, further including:

a controller electrically connected to the drive motor and mounted on the door, wherein the controller is configured to rotate the drive motor in a forward direction so that the operating rod is extended from the housing in response that an outside switch is operated by an occupant.

4. The pop-up actuator apparatus of claim **3**, wherein an operation switch electrically connected to the controller is provided to output a signal to the controller so that the operating rod returns to an initial position of the operating rod and the nut rod returns to the initial position of the nut rod in response that the operating rod is completely extended.

5. The pop-up actuator apparatus of claim **4**, wherein the operation switch is provided to operate after the contactor is connected to the second terminal.

6. The pop-up actuator apparatus of claim **4**, wherein a protruding portion is formed to protrude from the operating rod in a radial direction of the operating rod, and the protruding portion comes into contact with the operation switch in response that the operating rod is completely extended.

7. The pop-up actuator apparatus of claim **4**, wherein in response that an outside switch is operated by the occupant, the nut rod is moved forward by a forward rotation of the drive motor, and the contactor is separated from the first terminal.

8. The pop-up actuator apparatus of claim **7**, wherein a controller is configured to stop the forward rotation of the drive motor in response that the nut rod moves forward the predetermined distance and the contactor is connected to the second terminal.

9. The pop-up actuator apparatus of claim **8**, wherein in response that the operating rod is completely extended and the operation switch operates, the nut rod moves rearward thereof, and the drive motor rotates in a reverse direction so that the operating rod and the nut rod return to the initial positions thereof.

10. The pop-up actuator apparatus of claim **9**, wherein the controller is configured to stop a reverse rotation of the drive motor in response that the nut rod moves rearward and the contactor is connected to the first terminal.

11. The pop-up actuator apparatus of claim **1**,

wherein the lead nut is fastened to a rear end portion of the nut rod.

12. The pop-up actuator apparatus of claim **1**, wherein a damper is provided at a front end portion of the operating rod.

13. The pop-up actuator apparatus of claim **1**,

wherein the coupling hole is provided in a form of an elongated hole in the external portion of the operating rod.

14. The pop-up actuator apparatus of claim **1**, further including:

a lead screw threadly-coupled to the nut rod and configured to be rotated by the drive motor and linearly move the nut rod.

15. The pop-up actuator apparatus of claim **14**,

wherein a worm gear is mounted on an output shaft of the drive motor, and

wherein a worm wheel is fixed on the lead screw and in mesh with the worm gear.

16. The pop-up actuator apparatus of claim **1**,

wherein the housing is provided on the door, and

wherein the operating rod pops up the door while being extended from the door toward the body of the vehicle.

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