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Steering device for vehicle

Abstract

A steering device for a vehicle includes a ball nut coupled with a nut pulley; a motor provided with a motor pulley connected with the nut pulley through a belt; a housing receiving the nut pulley, the belt, and the motor pulley; and a plurality of supports protruding from an inner circumferential surface of the housing to prevent the belt from jumping off the motor pulley.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

(1) This application claims priority from Korean Patent Application No. 10-2021-0048017, filed on Apr. 13, 2021, which is hereby incorporated by reference for all purposes as if fully set forth herein.

BACKGROUND

Field

(2) The present embodiments relate to a steering device for a vehicle and, more particularly, to a steering device for a vehicle that may ensure normal steering and driver safety by preventing jumping without proper engagement between the teeth of the pulley and the belt.

Description of Related Art

(3) The rack-driven power assist steering system or steer-by-wire steering system includes a ball screw having two opposite ends connected with a tie rod and a knuckle arm, a ball nut coupled with the ball screw via balls, and a motor for rotating the ball nut. The steering device assists the driver in steering or steers the vehicle based on the driver's steering wheel manipulation information

(4) The motor and the ball nut are connected by a belt. In other words, the torque of the motor is transferred to the ball nut as the motor pulley of the motor shaft and the nut pulley of the ball nut are connected by the belt.

(5) The gear teeth of the belt may jump off the gear teeth of the motor pulley due to external impact while steering. Such jump occurs, the motor shaft may idle, cutting off power transfer to the ball screw and failing to control the ball screw. Further, although the belt and the motor pulley are engaged back with each other, the axial position of the ball screw may not be precisely determined, so that the driver may be put at risk of an accident.

BRIEF SUMMARY

(6) The present embodiments have been conceived in the foregoing background and relate to a steering device for a vehicle that may ensure normal steering and driver safety by preventing jumping without proper engagement between the teeth of the pulley and the belt.

(7) According to the present embodiments, there may be provided a steering device for a vehicle, comprising a ball nut coupled with a nut pulley, a motor provided with a motor pulley connected with the nut pulley through a belt, a housing receiving the nut pulley, the belt, and the motor pulley, and a support protruding from an inner circumferential surface of the housing to prevent the belt from jumping off the motor pulley.

(8) According to the present embodiments, it is possible to ensure normal steering and the driver's safety by preventing jumping without proper engagement between the teeth of the pulley and the belt.

Description

DESCRIPTION OF DRAWINGS

(1) The above and other objects, features, and advantages of the present disclosure will be more clearly understood from the following detailed description, taken in conjunction with the accompanying drawings, in which:

(2) FIG. **1** is an exploded perspective view illustrating a steering column for a vehicle according to the present embodiments;

(3) FIG. **2** is a cross-sectional view illustrating an assembled state of FIG. **1**;

(4) FIG. **3** is a view illustrating a portion of FIG. **2**;

(5) FIG. **4** is an enlarged view illustrating a portion of FIG. **3**;

(6) FIG. **5** is a view illustrating a state of the belt being prevented from jumping in FIG. **4**; and

(7) FIGS. **6** and **7** are cross-sectional views illustrating a portion of a steering device of a vehicle according to the present embodiments.

DETAILED DESCRIPTION

(8) In the following description of examples or embodiments of the present disclosure, reference will be made to the accompanying drawings in which it is shown by way of illustration specific examples or embodiments that can be implemented, and in which the same reference numerals and signs can be used to designate the same or like components even when they are shown in different accompanying drawings from one another. Further, in the following description of examples or embodiments of the present disclosure, detailed descriptions of well-known functions and components incorporated herein will be omitted when it is determined that the description may make the subject matter in some embodiments of the present disclosure rather unclear. The terms such as “including”, “having”, “containing”, “constituting” “make up of”, and “formed of” used herein are generally intended to allow other components to be added unless the terms are used with the term “only”. As used herein, singular forms are intended to include plural forms unless the context clearly indicates otherwise.

(9) Terms, such as “first”, “second”, “A”, “B”, “(A)”, or “(B)” may be used herein to describe elements of the disclosure. Each of these terms is not used to define essence, order, sequence, or number of elements etc., but is used merely to distinguish the corresponding element from other elements.

(10) When it is mentioned that a first element “is connected or coupled to”, “contacts or overlaps” etc. a second element, it should be interpreted that, not only can the first element “be directly connected or coupled to” or “directly contact or overlap” the second element, but a third element can also be “interposed” between the first and second elements, or the first and second elements can “be connected or coupled to”, “contact or overlap”, etc. each other via a fourth element. Here, the second element may be included in at least one of two or more elements that “are connected or coupled to”, “contact or overlap”, etc. each other.

(11) When time relative terms, such as “after,” “subsequent to,” “next,” “before,” and the like, are used to describe processes or operations of elements or configurations, or flows or steps in operating, processing, manufacturing methods, these terms may be used to describe non-consecutive or non-sequential processes or operations unless the term “directly” or “immediately” is used together.

(12) In addition, when any dimensions, relative sizes etc. are mentioned, it should be considered that numerical values for an elements or features, or corresponding information (e.g., level, range, etc.) include a tolerance or error range that may be caused by various factors (e.g., process factors, internal or external impact, noise, etc.) even when a relevant description is not specified. Further, the term “may” fully encompasses all the meanings of the term “can”.

(13) FIG. **1** is an exploded perspective view illustrating a steering column for a vehicle according to the present embodiments. FIG. **2** is a cross-sectional view illustrating an assembled state of FIG. **1**. FIG. **3** is a view illustrating a portion of FIG. **2**. FIG. **4** is an enlarged view illustrating a portion

of FIG. **3**. FIG. **5** is a view illustrating a state of the belt being prevented from jumping in FIG. **4**. FIGS. **6** and **7** are cross-sectional views illustrating a portion of a steering device of a vehicle according to the present embodiments.

(14) According to the present embodiments, a steering device **100** of a vehicle includes a ball nut **130** coupled with a nut pulley **140**, a motor **170** provided with a motor pulley **160** connected with the nut pulley **140** through a belt **150**, a housing **110** receiving the nut pulley **140**, the belt **150**, and the motor pulley **160**, and a support **111** protruding from an inner circumferential surface of the housing **110** to prevent the belt **150** from jumping off the motor pulley **160**.

(15) Referring to FIGS. **1** and **2**, the motor pulley **160** of the motor **170** and the nut pulley **140** of the ball nut **130** are connected with each other through the belt **150** so that the ball nut **130** is rotated by the motor **170**. Accordingly, a ball screw **120** coupled with the ball nut **130** via a ball is axially moved.

(16) On the inner circumferential surface of the belt **150** are formed gear teeth engaged with the gear teeth of the motor pulley **160** and the nut pulley **140**. Accordingly, as the belt **150** is rotated, the torque of the motor **170** is transferred to the ball nut **130** and the ball screw **120**.

(17) Two opposite ends of the ball screw **120** are connected with, e.g., tie rods and knuckle arms. Accordingly, the wheels are steered by the axial movement of the ball screw **120**.

(18) In other words, the torque of the motor **170** is converted and the ball screw **120** is axially moved. Accordingly, an electronic control unit provided in the vehicle may assist the driver's manipulation of the steering wheel by controlling the motor **170** or steer the wheel in response to the driver's manipulation of the steering wheel.

(19) A slip may occur between the belt **150** and the motor pulley **160** or nut pulley **140**. The slip may cause jumping between the gear teeth of the belt **150** and the gear teeth of the motor pulley **160** or the gear teeth of the nut pulley **140**. If jumping occurs, power transfer between the motor **170** and the ball screw **120** may be cut off, leading to failure in assisting the driver's steering or in a worst scenario case, rendering it impossible to steer the vehicle and causing an accident.

(20) Further, although the gear teeth are engaged back after jumping occurs, a phase difference occurs between the motor pulley **160** and the nut pulley **140** as compared between before and after jumping. As a result, it may be impossible to precisely determine the position of the ball screw **120**, leaving an error in control of the motor **170** by the electronic control unit and causing an accident.

(21) Therefore, it is critical to prevent a slip between the belt **150** and the motor pulley **160** or nut pulley **140**. The conventional steering device has a broad contact surface between the belt and the nut pulley and is thus less likely to cause a slip. However, since the contact surface between the belt and the motor pulley is relatively narrow, a slip is highly likely.

(22) According to the disclosure, the belt **150** may be prevented from jumping off the motor pulley **160** by the support **111** protruding from the inner circumferential surface of the housing **110** receiving the nut pulley **140**, the belt **150**, and the motor pulley **160**. Accordingly, it is possible to ensure normal steering and the driver's safety.

(23) Referring to FIG. **3**, the support **111** protrudes from the inner circumferential surface of the housing so that an end thereof faces an outer surface of the belt **150**.

(24) Therefore, as is described below, when the gear teeth of the belt **150** and the gear teeth of the motor pulley **160** fail to be normally engaged and jump off, the outer surface of the belt **150** is supported by the end of the support **111**, preventing jumping.

(25) The support **111** may be formed in a portion, surrounding the motor pulley **160**, of the inner circumferential surface of the housing. In other words, the belt **150** is positioned between the end of the support **111** and the outer circumferential surface of the motor pulley **160**. Accordingly, when the gear teeth of the belt **150** and the gear teeth of the motor pulley **160** are going to jump off while having a gap therebetween, the end of the support **111** supports the outer surface of the belt **150**, restricting the gap growing and preventing jumping.

(26) The number of supports **111** is not limited to a specific number, and one or more supports **111**

may be provided. There may be provided a plurality of supports **111**. If a plurality of supports **111** are provided, the supports **111** may be spaced apart from each other to effectively prevent the belt **150** from jumping.

(27) Further, supports **111** may be provided in first positions A facing two opposite ends of the portion of the belt **150** contacting the motor pulley **160**. In other words, the outer surfaces of the portion of the belt **150**, starting to engage with the motor pulley **160**, and the portion of the belt **150**, starting to disengage from the motor pulley **160**, may face the supports **111** in the first positions A.

(28) Accordingly, specifically, it is possible to prevent jumping at the portion where the belt **150** and the motor pulley **160** engage with or disengage from each other. In particular, it is possible to prevent jumping while the rotation direction of the motor pulley **160** is changed.

(29) A support **111** may also be provided in a second position B facing the center of the portion of the belt **150** contacting the motor pulley **160**. In other words, the outer surface of the portion of the belt **150** engaged with the motor pulley **160** may face the support **111** in the second position B.

(30) Accordingly, it is possible to prevent jumping while the belt **150** is rotated in any one direction by the motor pulley **160**.

(31) As shown in the drawings, supports **111** may be provided in all of the positions A and B. Thus, while the belt **150** is rotated by the motor **170**, the engagement between the belt **150** and the motor pulley **160** may remain stable.

(32) To prevent the belt **150** from jumping by the support **111**, the support **111** may be formed so that an end thereof is positioned adjacent to the outer surface of the belt **150**. Accordingly, the gap between the end of the support **111** and the outer surface of the belt **150** may be formed to be smaller than the height of the gear teeth of the motor pulley **160**.

(33) FIG. **4** illustrates a state in which the belt **150** and the motor pulley **160** are normally engaged with each other. FIG. **5** illustrates a state in which the belt **150** is prevented from jumping by the support **111**.

(34) As illustrated in FIG. **4**, in the state in which the belt **150** and the motor pulley **160** are normally engaged with each other, the end of the support **111** and the outer surface of the belt **150** may be spaced apart from each other, leaving a gap d**1** therebetween. The gap d**1** is formed to be smaller than the height d**2** of the gear teeth of the motor pulley **160** (d**1**<d**2**).

(35) Accordingly, as illustrated in FIG. **5**, if the gear teeth of the belt **150** ride on the gear teeth of the motor pulley **160** and the mountains of the gear teeth are going to overlap as shown in FIG. **5**, the outer surface of the belt **150** is supported by the end of the support **111**, preventing the belt **150** from jumping.

(36) As shown in FIG. **6**, the end of the support **111** may be brought in contact with the belt **150**. As the support **111** contacts the belt **150**, it is possible to more reliably prevent the belt **150** from jumping. Given the assemblability of the belt **150** and the motor **170**, a proper gap may be designed between the support **111** and the belt **150**.

(37) It is preferable to form the end of the support **111** to have a curved surface. Specifically, it is preferable to form the support **111** so that two opposite surfaces of the support **111** facing in the rotation direction of the belt **150** are curved surfaces. Referring to the drawings, it is preferable that two opposite surfaces of the support **111**, not in the axial direction of the motor pulley **160** but in the direction perpendicular thereto, are curved surfaces. Accordingly, although the end of the support **111** is positioned adjacent to or in contact with the belt **150**, it is possible to prevent collision to the support **111** in the rotation direction of the belt **150** while minimizing friction.

(38) As shown in FIGS. **1** to **6**, the end of the support **111** may be formed to be convex. For example, as shown in the drawings, the support **111** may be formed to have a substantially semi-circular cross section.

(39) Alternatively, as shown in FIG. **7**, the end of the support **111** may be formed to be concave. If the end of the support **111** is formed to be concave, the support **111** is allowed to face the outer

surface of the belt **150** in a larger area as compared with when the end of the support **111** is formed to be convex, allowing for more reliable prevention from jumping.
(40) In particular, the end of the support **111** may be formed in a shape complementary to its opposite portion of the belt **150**. As shown in the drawings, the supports **111** in the first positions A may be formed to be partially flat and partially curved, and the support **111** in the second position B may be formed to have a curved surface which is deepest in the center.
(41) By the so-shaped steering device for a vehicle, it is possible to ensure normal steering and the driver's safety by preventing jumping without proper engagement between the teeth of the pulley and the belt.
(42) The above description has been presented to enable any person skilled in the art to make and use the technical idea of the present disclosure, and has been provided in the context of a particular application and its requirements. Various modifications, additions and substitutions to the described embodiments will be readily apparent to those skilled in the art, and the general principles defined herein may be applied to other embodiments and applications without departing from the spirit and scope of the present disclosure. The above description and the accompanying drawings provide an example of the technical idea of the present disclosure for illustrative purposes only. That is, the disclosed embodiments are intended to illustrate the scope of the technical idea of the present disclosure. Thus, the scope of the present disclosure is not limited to the embodiments shown, but is to be accorded the widest scope consistent with the claims. The scope of protection of the present disclosure should be construed based on the following claims, and all technical ideas within the scope of equivalents thereof should be construed as being included within the scope of the present disclosure.

Claims

1. A steering device for a vehicle, comprising: a ball nut coupled with a nut pulley; a motor provided with a motor pulley connected with the nut pulley through a belt; a housing receiving the nut pulley, the belt, and the motor pulley; and a plurality of supports protruding from an inner circumferential surface of the housing to prevent the belt from jumping off the motor pulley, wherein the plurality of supports are formed in a portion, surrounding the motor pulley, of the inner circumferential surface of the housing, and wherein the plurality of supports are provided in a first position facing each of two opposite ends of the belt contacting the motor pulley and a second position facing a center of a portion of the belt contacting the motor pulley.
2. The steering device of claim 1, wherein each end of the plurality of supports faces an outer surface of the belt.
3. The steering device of claim 2, wherein a gap between the end of the support and the outer surface of the belt is smaller than a height of gear teeth of the motor pulley.
4. The steering device of claim 3, wherein the end of the support contacts the belt.
5. The steering device of claim 2, wherein the end of the support is formed to have a curved surface.
6. The steering device of claim 5, wherein the end of the support is formed to be convex.
7. The steering device of claim 5, wherein the end of the support is formed to be concave.
8. The steering device of claim 7, wherein the end of the support is formed in a shape complementary to an opposite portion of the belt.