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Translating power adjustable steering column with geared rack for an absolute sensor

Abstract

An axially adjustable steering column assembly includes an upper jacket. The assembly also includes a lower jacket, wherein the upper jacket is received within the lower jacket and is telecopingly adjustable therein, the lower jacket having a position sensor operatively coupled thereto. The assembly further includes a column mounting bracket, wherein the lower jacket translates and rotates relative to the column mounting bracket. The assembly yet further includes a geared rack operatively coupled to the column mounting bracket, the geared rack correspondingly rotatable with the lower jacket, wherein the geared rack is in contact with a gear wheel of the position sensor to detect the axial position of the axially adjustable steering column assembly.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION (1) This application claims the benefits of priority to U.S. patent application Ser. No. 18/200,267, filed May 22, 2023, which claims priority to U.S. Provisional Patent Application Ser. No. 63/388,298, filed Jul. 12, 2022, the disclosures of which are incorporated by reference herein in their entireties.

FIELD OF THE INVENTION
(1) The embodiments described herein relate to vehicle steering systems and, more particularly, to a translating power adjustable steering column with a geared rack for an absolute sensor.
BACKGROUND
(2) A vehicle, such as a car, truck, sport utility vehicle, crossover, mini-van, marine craft, aircraft, all-terrain vehicle, recreational vehicle, or other suitable vehicles, include various steering system schemes, for example, steer-by-wire and driver interface steering. These steering system schemes typically include a steering column for translating steering input to an output that interacts with a steering linkage to ultimately cause the vehicle wheels (or other elements) to turn the vehicle.
(3) Some steering columns are axially adjustable between positions. In the past, a function of axially adjustable steering columns was to provide flexibility in the location of the hand wheel and facilitate more comfortable driving positions for different sizes of drivers. However, now there are opportunities for significantly more telescopic travel, which also may be referred to as stow travel (i.e., when the hand wheel is not needed). For example, the hand wheel could be repositioned further away from the driver to allow him or her to do things other than operate the vehicle, such as work on a laptop computer when the vehicle is parked. Other examples include vehicles with autonomous driving capability, such that the hand wheel could be stowed when the vehicle is in an autonomous driving mode.
(4) As the automotive industry increasingly heads toward steer-by-wire technologies, more emphasis is being placed on redundancies in position sensing technologies for guarantee of comfort component locations during functional and stow modes. As such, some OEMs may request the use of direct, absolute sensing of steering column telescope position, in contrast with prior reliance upon encoders and Hall-Pulse analysis. Absolute position sensing requires that the sensor be able to physically read the position of the steering column's telescope position. For an externally translating, internally telescoping column, the column assembly has two distinct interfaces that

may move simultaneously during a stow function. The first movement is upper jacket movement in relation to the lower jacket (i.e., typical of standard power telescope adjustable columns), but this movement is also paired with a second translating interface between the lower jacket and a column mounting bracket. These two motions together create a high stow rate and large stow displacement in the vehicle that shuttles the handwheel toward and into the instrument panel.

(5) Standard telescope sensing systems with an absolute position sensor involves a geared rack that is driven by the motion of the upper jacket. This geared rack runs along the absolute position sensor, which in turn drives cogged wheels on the sensor. The rotational motion of the cogged wheels is then used to account for the position of the upper jacket in its telescope motion. This externally translating, internally telescoping column poses a challenge regarding how to use an absolute position sensor to sense the displacement of the lower jacket relative to the column mounting bracket. This is because the stowing motion only moves in one plane (i.e., fore/aft in vehicle), while the lower jacket can also articulate vertically during a rake function. This causes a unique situation requiring special considerations as to how a geared rack can be implemented to interface with the absolute position sensor. The geared rack must be fixed in position to the column mounting bracket, but must also be able to articulate with the rake motions of the lower jacket.

SUMMARY

(6) According to one aspect of the disclosure, an axially adjustable steering column assembly includes an upper jacket. The assembly also includes a lower jacket, wherein the upper jacket is received within the lower jacket and is telecopingly adjustable therein, the lower jacket having a position sensor operatively coupled thereto. The assembly further includes a column mounting bracket, wherein the lower jacket translates and rotates relative to the column mounting bracket. The assembly yet further includes a geared rack operatively coupled to the column mounting bracket, the geared rack correspondingly rotatable with the lower jacket, wherein the geared rack is in contact with a gear wheel of the position sensor to detect the axial position of the axially adjustable steering column assembly.

(7) According to another aspect of the disclosure, an axial position sensing system for a steering column assembly includes a column mounting bracket. The axial position sensing system also includes a column structure operatively coupled to the column mounting bracket, the column structure moveable in an axial direction relative to the column mounting bracket and rotatable relative to the column mounting bracket. The axial position sensing system further includes a pair of bushings positioned within the pair of slots. The axial position sensing system yet further includes a geared rack integrally formed with one of the pair of bushings. The axial position sensing system also includes a sensor in operative contact with the geared rack to detect the axial position of the column structure.

(8) These and other advantages and features will become more apparent from the following description taken in conjunction with the drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) The subject matter that is regarded as the invention is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features, and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

(2) FIG. **1** schematically illustrates a vehicle steering system;

(3) FIG. **2** is an elevation view of a steering column assembly for the vehicle steering system in a first rake position;

(4) FIG. **3** is an elevation view of the steering column assembly in a second rake position;

(5) FIG. **4** is an elevation view of the steering column assembly in an axially stowed position;
(6) FIG. **5** is a perspective view of the steering column assembly illustrating a geared rack; and
(7) FIG. **6** is a perspective view of the steering column assembly illustrating the geared rack in contact with an absolute position sensor.

DETAILED DESCRIPTION

(8) The following discussion is directed to various embodiments of the disclosure. Although one or more of these embodiments may be described in more detail than others, the embodiments disclosed should not be interpreted, or otherwise used, as limiting the scope of the disclosure, including the claims. In addition, one skilled in the art will understand that the following description has broad application, and the discussion of any embodiment is meant only to be exemplary of that embodiment.

(9) As described, a vehicle, such as a car, truck, sport utility vehicle, crossover, mini-van, marine craft, aircraft, all-terrain vehicle, recreational vehicle, or other suitable vehicles, include various steering system schemes, for example, steer-by-wire and driver interface steering. These steering system schemes typically include a steering column for translating steering input to an output that interacts with a steering linkage to ultimately cause the vehicle wheels (or other elements) to turn the vehicle. Some steering columns are axially adjustable between positions. In the past, a function of axially adjustable steering columns was to provide flexibility in the location of the hand wheel and facilitate more comfortable driving positions for different sizes of drivers. However, there are now opportunities for significantly more axial travel, which also may be referred to as stow travel (i.e., when the hand wheel is not needed). For example, the hand wheel could be repositioned completely away from the driver to allow him or her to do things other than operate the vehicle, such as work on a laptop computer when the vehicle is parked. Other examples include vehicles with autonomous driving capability, such that the hand wheel could be stowed when the vehicle is in an autonomous driving mode.

(10) Referring now to the drawings, where the various embodiments are shown and described herein, without limiting same, the Figures illustrate embodiments of a steering column assembly that is axially adjustable with improved packaging and other operational benefits. The axial adjustability results from relative movement between two or more steering column portions (e.g. jackets, brackets, rails, and/or the like) that permit axial movement therebetween, in combination with relative movement between multiple steering shaft portions which permit axial movement therebetween. Axial movement refers to movement resulting from relative telescopic, sliding, or translational movement between components.

(11) Referring initially to FIG. **1**, a vehicle **20** is generally illustrated according to the principles of the present disclosure. The vehicle **20** may include any suitable vehicle, such as a car, a truck, a sport utility vehicle, a mini-van, a crossover, any other passenger vehicle, any suitable commercial vehicle, or any other suitable vehicle. While the vehicle **20** may be a passenger vehicle having wheels and for use on roads, the principles of the present disclosure may apply to other vehicles, such as planes, tractors, boats, or other vehicles. The vehicle **20** may include a propulsion system **30**, such as an ignition system, an electronic system, or combinations thereof.

(12) The vehicle **20** further includes a steering system **40**. The steering system **40** may be configured as a driver interface steering system, an autonomous driving system, or a system that allows for both driver interface and autonomous steering. The steering system **40** may include an input device **42**, such as a steering wheel, wherein a driver may mechanically provide a steering input by turning the steering wheel. A steering column assembly **44** includes a steering column **45** that extends along an axis from the input device **42** to an output assembly **46**. The output assembly **46** may include a pinion shaft assembly, an I-shaft, a cardan joint, steer-by-wire components or any feature conventionally located opposite the input device **42**.

(13) The steering column **45** may include at least two axially adjustable portions, for example, an upper jacket **48** and a lower jacket **50** that are axially adjustable with respect to one another. The at

least two axially adjustable portions may further include at least one third portion **49** that is disposed between the upper jacket **48** and the lower jacket **50** in some embodiments. It is to be appreciated that other structural features of the steering column **45** may be part of the upper jacket **48** and the lower jacket **50**, such as brackets, rails, other devices, or combinations thereof.

(14) The steering column **45** is moveable over a range of positions from a fully extended position to a fully retracted position. In the fully extended position, the upper jacket **48** and the lower jacket **50** are moved axially so that the input device **42** is located near an operator of the vehicle. In the retracted position, the upper jacket **48** and the lower jacket **50** are moved axially so that the input device **42** is located further away from an operator of the vehicle, when compared to the extended position. In some embodiments, the retracted position may correspond to stowing the input device **42**. For example, it may be beneficial to place the input device **42** in a stowed location during autonomous driving. In operation, the axial movement of the upper jacket **48** and the lower jacket **50** may be effectuated by manual movement by an operator or electromechanically by a telescope actuator. This axial movement adjusts between the extended position, the retracted position, and any intermediary positions.

(15) A steering gear assembly **54** may connect to the output assembly **46** via a steering gear input shaft **56**. The steering gear assembly **54** may be configured as a rack-and-pinion, a recirculating ball-type steering gear, or any other types of steering gears associated with autonomous and driver-interface steering systems. The steering gear assembly **54** may then connect to a driving axle **58** via an output shaft **60**. The output shaft **60** may include a pitman arm and sector gear and/or various traditional components. The output shaft **60** is operably connected to the steering gear assembly **54** such that a rotation of the steering gear input shaft **56** causes a responsive movement of the output shaft **60** and causes the drive axle to turn wheels **62**. It is to be appreciated that the steering components described herein may be part of a steer-by-wire system or one which includes a direct mechanical linkage over the span of the components.

(16) With reference now to FIGS. **2** and **3**, the steering column assembly **44** is illustrated in greater detail. The upper jacket **48** is shown protruding from the lower jacket **50**. The lower jacket **50** is operatively coupled to, and axially translatable relative to, a column mounting bracket **70**. The column mounting bracket **70** is fixed relative to a vehicle structure to mount the steering column assembly **44** to the vehicle **20**. The upper jacket **48** is axially adjustable relative to the lower jacket **50** over a first range of axial positions which may be referred to as a “comfort range”. The comfort range is a range of axial positions that are useful for manual driving during operation of the vehicle for different sized operators. The axial movement of the upper jacket **48** relative to the lower jacket **50** is done in a telescoping manner due to the movement of the upper jacket **48** within the lower jacket **50**. The comfort range encompasses the entire comfort range and possibly a portion of the stowing range. The lower jacket **50** is axially adjustable relative to the column mounting bracket **70** over a second range of axial positions which may be referred to as a “stowing range”. The stowing range is a range of axial positions that moves the overall steering column assembly **44** further away from the operator when compared to the comfort range. In some embodiments, the fully retracted position is a stowed position that may result in the steering input device (e.g., steering wheel) being flush with an instrument panel, firewall or other vehicle structure. The axial movement of the lower jacket **50** relative to the column mounting bracket **70** is done in a translating manner due to the movement of the overall upper and lower jackets together adjacent to the column mounting bracket **70**. FIG. **4** illustrates the axial stowing adjustability of the steering column assembly **44**, with the first portion **48** fully retracted within the second portion **50** and with the second portion **50** fully retractably translated, relative to the column mounting bracket **70**.

(17) The steering column assembly **44** includes a first actuator **72** which may be referred to as a comfort actuator. The first actuator **72** is operatively coupled to the upper jacket **48** to control the telescoping movement of the upper jacket **48** relative to the lower jacket **50** over the first range of axial positions. In the illustrated embodiment, the first actuator **72** is mounted to a specific portion

of the steering column assembly **44**, but other mounting locations are contemplated.

(18) The steering column assembly **44** also includes a second actuator **74** which may be referred to as a stowing actuator. The second actuator **74** is operatively coupled to the lower jacket **50** to control the translating movement of the lower jacket **50** relative to the column mounting bracket **70** over the second range of axial positions. In the illustrated embodiment, the second actuator **74** is mounted to a specific portion of the steering column assembly **44**, but other mounting locations are contemplated.

(19) Both the first and second actuators **72**, **74** are located proximate a forward location of the steering column assembly **44** to accommodate the axial movement during a stowing operation. The two actuators **72**, **74** are responsible for the full stow motion of the column, however only the first actuator **72** operates during comfort adjustment within the first range of axial adjustment positions.

(20) With continued reference to FIGS. **2** and **3**, in addition to the axial adjustability of the steering column assembly **44**, the steering column assembly **44** is adjustable in a rake direction which allows angular articulation of the overall steering column assembly **44** about a pivot axis that the lower jacket **50** rotates about. This effectively allows upward or downward movement of the steering input device **42** for a user's preference. A rake actuator assembly **76** is mounted to the lower jacket **50**. As shown, the lower jacket **50**, and therefore the steering column assembly **44**, moves between various rake positions, including a first rake position (FIG. **2**) and a lowered, second rake position (FIG. **3**). It is to be understood that different ranges of rake adjustability will be employed for different steering column applications of use.

(21) As shown in FIG. **5**, the embodiments disclosed herein include tapered rail slots **80** defined within the lower jacket **50**, which form a pair of tracks. In particular, a first track is formed on one side of the lower jacket **50** by one of the slots and a second track is formed on a second side of the lower jacket **50**. At least one sliding wedge bushing **84** is disposed within each of the tapered rail slots **80**. The sliding wedge bushings **84** have a tapered shape that substantially corresponds to the angled orientation of the tapered rail slots **80**. The tapered rail slots **80** in each component serve as a receiving interface for the de-lashing sliding wedge bushings **84** and provide guidance for the lower jacket **50** to translate relative to the column mounting bracket **70** during stow operation.

(22) A geared rack **90** is coupled to one or more wedge bushings **84** and engages the absolute position sensor **92**. The geared rack **90** includes a surface having a plurality of teeth **91** formed on at least a portion of the length of the surface. Each geared rack **90** is coupled to one or more of the wedge bushings **84** or is integrally formed with the wedge bushings **84** to form a single, unitary component. The geared rack **90** and the wedge bushings **84** are operatively coupled to the column mounting bracket **70**. Therefore, the geared rack **90** and the wedge bushings **84** remain stationary relative to the lower jacket **50** during translation of the lower jacket. However, the geared rack **90** and the wedge bushings **84** are coupled to the column mounting bracket **70** in a pivotable manner. As such, during rake articulation of the lower jacket **50**, the wedge bushings **84** remain aligned with their respective tracks of the lower jacket **50** to allow guided translation of the lower jacket **50**.

(23) For the translating function of the stow motion, an absolute position sensor **92** is mounted to the lower jacket **50** (FIG. **6**). As the lower jacket **50** goes through its rake articulations, the wedge bushings **84** follow the articulations, keeping the geared rack **90** in alignment with an absolute position sensor **92** that is fixed to the lower jacket **50**. However, as the steering column assembly **44** moves into stow function, the wedge bushings **84**—fixed positionally to the lower jacket **50**—remain in place with the column mounting bracket **70** as the lower jacket **50** translates relative to the column mounting bracket **70** and the geared rack **90**.

(24) Referring to FIG. **6**, as the lower jacket **50** translates, the plurality of teeth **91** of the geared rack **90** runs along cogged teeth **93** of the absolute position sensor **92**, providing for an accurate account of the axial position of the steering column assembly **44**, without being skewed during different rake positions of the lower jacket **50**.

(25) While the invention has been described in detail in connection with only a limited number of

embodiments, it is to be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Moreover, any feature, element, component or advantage of any one embodiment can be used on any of the other embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description.

Claims

1. An axially adjustable steering column assembly comprising: an upper jacket; a lower jacket, wherein the upper jacket is received within the lower jacket and is telescopingly adjustable therein, the lower jacket having a position sensor operatively coupled thereto; a column mounting bracket, wherein the lower jacket translates and rotates relative to the column mounting bracket; and a geared rack operatively coupled to the column mounting bracket, the geared rack correspondingly rotatable with the lower jacket, wherein the geared rack is in contact with a gear wheel of the position sensor to detect the axial position of the axially adjustable steering column assembly.
2. The axially adjustable steering column assembly of claim 1, wherein the geared rack includes a plurality of rack teeth, the sensor comprising an absolute position sensor having a toothed wheel in contact with the plurality of rack teeth.
3. The axially adjustable steering column assembly of claim 2, wherein the toothed wheel is one of a plurality of toothed wheels of the absolute position sensor.
4. The axially adjustable steering column assembly of claim 1, wherein the geared rack does not translate relative to the column mounting bracket.
5. The axially adjustable steering column assembly of claim 1, further comprising: a first actuator operatively coupled to the upper jacket to control axial adjustment of the upper jacket relative to the lower jacket; a second actuator operatively coupled to the lower jacket to control axial adjustment of the lower jacket relative to the column mounting bracket; and a rake actuator operatively coupled to the lower jacket to control rake adjustment of the lower jacket.
6. The axially adjustable steering column assembly of claim 1, wherein the geared rack is pivotable relative to the column mounting bracket.