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## ENERGY ABSORPTION STRAP INTEGRATED WITH A TELESCOPE DRIVE BRACKET


### Abstract

A steering column assembly includes a lower jacket. The steering column assembly also includes an upper jacket disposed within the lower jacket and being telescopingly adjustable relative to the lower jacket. The steering column assembly further includes a telescope drive assembly electrically moving a telescope drive nut axially to telescopingly adjust the upper jacket. The steering column assembly yet further includes an energy absorption strap directly coupled to the upper jacket and directly coupled to the telescope drive nut to transfer axial movement of the telescope drive nut to the upper jacket.



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## Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION [0001] This application is a divisional application of, and claims priority to, U.S. application Ser. No. 18/530,601, filed Dec. 6, 2023, the disclosure of which is incorporated by reference herein in its entirety.

TECHNICAL FIELD

[0002] The following description relates to energy absorption devices for steering columns and, more particularly, to an energy absorption strap integrated with telescope drive bracket for a steering column assembly.

BACKGROUND

[0003] 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 assembly for translating steering input to an output that interacts with a steering linkage to ultimately cause the vehicle wheels to turn. Steering columns often include various safety features, such as airbags to lessen impact forces. In addition, many steering column assemblies are collapsible and include one or more energy absorption features, such as energy absorption straps. Some energy absorption straps are configured to roll along their length to absorb energy, and are often referred to as roll straps. Typically, roll straps absorb energy during the deformation of the strap in an impact event wherein kinetic energy can be dissipated through compression of the steering column assembly.

[0004] In power telescoping (i.e., translating) steering columns, a drive bracket is used to connect a telescope actuator to an upper jacket to carry out telescoping motion of the upper jacket relative to a lower jacket. The energy absorption function is achieved with the above-described energy absorption strap, which is a separate component housed within a drive bracket. The drive bracket is frangibly connected to the upper jacket to release at a prescribed load in order to allow the energy absorption strap to engage and become the load path. Typically, a collection of connecting parts is included in the overall assemblies of the telescope drive bracket and the energy absorption strap assembly. The number of parts, combined with the associated assembly steps adds cost and assembly complexity to the overall system.

SUMMARY

[0005] According to one aspect of the disclosure, a steering column assembly includes a lower jacket. The steering column assembly also includes an upper jacket disposed within the lower jacket and being telescopingly adjustable relative to the lower jacket. The steering column assembly further includes a telescope drive assembly electrically moving a telescope drive nut axially to telescopingly adjust the upper jacket. The steering column assembly yet further includes an energy absorption strap directly coupled to the upper jacket and directly coupled to the telescope drive nut to transfer axial movement of the telescope drive nut to the upper jacket.

[0006] According to another aspect of the disclosure, an energy absorption strap for a vehicle steering column includes a radially outer leg including a first radially extending flange and a second radially extending flange. The energy absorption strap also includes a central leg. The energy absorption strap further includes a radially inner leg. The energy absorption strap further includes a first curved segment connecting the radially outer leg and the central leg. The energy absorption strap yet further includes a second curved segment connecting the central leg and the radially inner leg.

[0007] According to another aspect of the disclosure, a method of assembling an energy absorption strap to a steering column is provided. The method includes orienting the energy absorption strap perpendicular to a longitudinal axis of the steering column. The method also includes positioning a

locking tab within an hourglass shaped aperture defined by an upper jacket of the steering column. The method further includes rotating the energy absorption strap 90 degrees to orient the energy absorption strap parallel to the longitudinal axis of the steering column.
[0008] These and other aspects of the present disclosure are disclosed in the following detailed description of the embodiments, the appended claims, and the accompanying figures.

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## Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0009] The disclosure is best understood from the following detailed description when read in conjunction with the accompanying drawings. It is emphasized that, according to common practice, the various features of the drawings are not to-scale. On the contrary, the dimensions of the various features are arbitrarily expanded or reduced for clarity.
[0010] FIG. **1** schematically illustrates a vehicle with a steering system;
[0011] FIG. **2** is a perspective view of a portion of a steering column having a power telescope assembly and an energy absorption strap, with the energy absorption strap having a telescope drive bracket integrally formed therein;
[0012] FIG. **3** illustrates a first partially disassembled condition of an energy absorption strap and the power telescope assembly;
[0013] FIG. **4** illustrates a second partially disassembled condition of an energy absorption strap and the power telescope assembly;
[0014] FIGS. **5-10** illustrate an assembly sequence of the energy absorption strap to the upper jacket and to a telescope drive nut;
[0015] FIG. **11** is a perspective view of a portion of the energy absorption strap disposed within a tunnel defined by the lower jacket with an upper section of the energy absorption strap removed for clarity;
[0016] FIG. **12** is a perspective view of a portion of the energy absorption strap illustrating upper jacket anti-roll physics; and
[0017] FIG. **13** is an elevation view of the energy absorption strap illustrating strap anti-lift physics.
DETAILED DESCRIPTION
[0018] 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, and not intended to intimate that the scope of the disclosure, including the claims, is limited to that embodiment.
[0019] 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 systems, for example, steer-by-wire and driver interface steering. These steering system systems typically include a steering column assembly for translating steering input to an output that interacts with a steering linkage to ultimately cause the vehicle wheels to turn. Steering columns include various safety features, such as airbags to lessen impact forces. In addition, many steering columns are collapsible and include one or more energy absorption features, such as energy absorption straps, which allow a certain amount of compression.
[0020] 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 suitable vehicles. The vehicle **20** may include a propulsion system **30**, such as an ignition system, an electronic system, or combinations thereof.

[0021] In some embodiments, the vehicle **20** may further include 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 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** may include a steering column **45** that extends along a longitudinal axis A 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 other features conventionally located opposite the input device **42**.

[0022] 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 upper jacket **48** and the lower jacket **50** are permitted to move axially with respect to one another during an impact or other compressive forces. The relative axial movement is described herein as being telescoping, wherein the upper jacket **48** telescopes within the lower jacket **50** over a range of axial positions from an extended column position to a retracted column position. The steering column assembly **44** may include additional portions provide rake and/or tilt movement.

[0023] An energy absorption apparatus **52** is coupled to the upper jacket **48** to provide variable stroke load absorption settings. During a collapse event, a force may move or collapse the upper jacket **48** along the longitudinal axis A of the steering column **45** and the energy absorption apparatus **52** dissipates at least some of the kinetic energy of collapsing first jacket **48** and the second jacket **50**. The details of the energy absorption apparatus **52** are described herein.

[0024] 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 type 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 or other 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 the wheels **61**.

[0025] FIG. **2** illustrates a portion of the steering column **45**, the energy absorption apparatus **52** and a telescope drive assembly **100**. The telescope drive assembly **100** is a powered actuator which actuates telescoping movement of the upper jacket **48** relative to the lower jacket **50**. The telescope drive assembly **100** includes an electric actuator **102**, such as an electric motor, that drives rotational movement of a threaded rod **104**. A gearbox **106** may facilitate the transfer of power from an output shaft (not shown) of the electric actuator **102** to the threaded rod **104**. Rotation of the threaded rod **104** results in translation of a telescope drive nut **108** which is threaded to an outer surface of the threaded rod **104**. Translation of the telescope drive nut **108** is generally parallel to the longitudinal axis A of the steering column **45**.

[0026] The energy absorption apparatus **52** includes an energy absorption strap **110** (EA strap **110**) which is directly coupled to the upper jacket **48**. As described herein, the telescope drive nut **108** is directly coupled to the EA strap **110**. Unlike prior steering systems, the embodiments disclosed herein do not require a component which is often referred to as a telescope drive bracket. Additionally, several coupling connecting components, such as rivets, brackets and weld plates, are not required in the embodiments disclosed herein, thereby reducing system cost and assembly complexity.

[0027] Referring now to FIGS. **3** and **4**, the EA strap **110** is shown assembled to the upper jacket **48** with an anti-lift fastener **112**, but is still disassembled from the telescope drive nut **108**. As shown, the upper jacket **48** axially telescopes with the lower jacket **50** and a portion of the EA strap **110** remains radially outward of the lower jacket **50** once moved to the assembled position (FIG. **3**), where a fastener **114** may be inserted through a pair of holes **116** defined by a radially outer leg **118** of the EA strap **110** and through a hole **120** defined by the telescope drive nut **108**. As shown in FIG. **3**, the radially outer leg **118** of the EA strap **110** includes a first radially extending flange **122** and a second radially extending flange **124**. The space defined between the first and second radially extending flanges **122**, **124** of the radially outer leg **118** is sufficient to seat a portion of the telescope drive nut **108** therein. The telescope drive nut **108** is positioned to align the hole **120** of the telescope drive nut **108** with the pair of holes **116** of the radially outer leg **118** of the EA strap **110** for insertion of the fastener **114** to directly couple the telescope drive nut **108** to the EA strap **110**. The direct coupling of the telescope drive nut **108** to the EA strap **110**, combined with direct coupling of the EA strap **110** to the upper jacket **48** results in the radially outer leg **118** of the EA strap **110** functioning as a telescope drive bracket, as axial movement of the telescope drive nut **108** along the threaded rod **104** directly actuates telescope movement of the upper jacket **48** relative to the lower jacket **50**.

[0028] Referring now to FIG. **5**, the EA strap **110** includes the radially outer leg **118**, a central leg **130**, and a radially inner leg **132**. The radially outer leg **118** is connected to the central leg **130** with a first curved segment **134**. The radially inner leg **132** is connected to the central leg **130** with a second curved segment **136**. Therefore, the EA strap **110** is generally S-shaped. The EA strap **110** extends from a first terminal end **138**, which is an end of the radially outer leg **118**, to a second terminal end **140**, which is an end of the radially inner leg **132**. As described above, the pair of holes **116** defined by the first and second radially extending flanges **122**, **124** are located proximate the first terminal end **138** of the EA strap **110**. The EA strap **110** includes a locking tab **150** proximate the second terminal end **140** of the EA strap **110**. The locking tab **150** includes a stem **152** extending radially inwardly (i.e., toward the longitudinal axis A) from the radially inner leg **132**. The locking tab **150** also includes a head segment **154** extending radially inwardly from the stem **152**. The head segment **154** has a larger width than the stem **152** to form a generally T-shaped structure.

[0029] FIGS. **5-10** illustrate an assembly sequence of the EA strap **110** to the upper jacket **48**. To assemble the EA strap **110** to the upper jacket **48**, the longitudinal direction of the EA strap is initially oriented substantially perpendicular to the longitudinal axis A of the steering column **45**, with the locking tab **150** aligned with an aperture **156** defined by the upper jacket **48** (FIG. **5**). The aperture **156** is in a substantially “hourglass” shape. Based on the shape of the aperture **156** and the locking tab **150**, the head segment **154** of the locking tab **150** can be fully inserted through the aperture **156** while the EA strap **110** is still oriented perpendicularly to the longitudinal axis A of the steering column **45** (FIG. **6**). The EA strap **110** is then rotated 90 degrees to orient the EA strap **110** substantially parallel to the longitudinal axis A of the steering column **45** (FIG. **7**). In this orientation, the stem **152** of the locking tab **150** is in tight contact with the inner wall of the hourglass aperture **156** (FIG. **8**). The anti-lift fastener **112** is aligned with an energy absorption slot **158** defined by the central leg **130** of the EA strap **110** proximate the first curved segment **134** (FIG. **9**) and then secured to the central leg **130** (FIG. **10**). The locking tab **150** and the anti-lift fastener **112** directly couple the EA strap **110** to the upper jacket **48**. The energy absorption slot **158** and the central leg **130** are shaped to allow a head of the anti-lift fastener **112** to be seated below a plane of the central leg **130** to allow the head of the anti-lift fastener **112** to pass freely under the central leg **130** during a collapse function of the EA strap **110**.

[0030] Referring now to FIG. **11**, a portion of the lower jacket **50** is shown transparently to illustrate a tunnel **160** defined by the lower jacket **50** and a radially outer surface of the upper jacket **48**. The central leg **130** and the radially inner leg **132** of the EA strap **110** are at least partially positioned within the tunnel **160** in a fully assembled position. The radially inner leg **132** of the EA strap **110** includes a pair of anti-roll tabs **162** extending outward from the radially inner leg **132**, as also shown in FIG. **5**. The anti-roll tabs **162** are dimensioned to contact inner lower jacket walls **164** of the tunnel **160** to prevent rolling of the upper jacket **48** relative to the lower jacket **50**. The anti-roll tabs **162** are resilient to compensate for manufacturing size variation.

[0031] FIG. **12** illustrates the physics associated with the anti-roll measures provided by the embodiments disclosed herein. In particular, an applied roll load F from the upper jacket **48** is shown with a resultant yaw torque T. However, the anti-roll tabs **162** provide a reaction load L. The reaction load L provided by anti-roll tabs **162**, combined with the yaw counter force C provided by the anti-lift fastener **112** balance the issue associated with upper jacket roll.

[0032] FIG. **13** illustrates the physics associated with the anti-lift measures provided by the embodiments disclosed herein. In particular, during telescope adjustment of the upper jacket **48**, a force T substantially parallel to the longitudinal axis A of the steering column **45** is produced, which results in an end of the EA strap **110** being forced upward. However, the anti-lift fastener **112** balances this force.

[0033] The embodiments disclosed herein advantageously reduces cost and assembly complexity of the overall steering system.

[0034] 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, clement, 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

## Claims

**1**. A method of assembling an energy absorption strap to a steering column comprising: orienting the energy absorption strap perpendicular to a longitudinal axis of the steering column; positioning a locking tab within an hourglass shaped aperture defined by an upper jacket of the steering column; and rotating the energy absorption strap 90 degrees to orient the energy absorption strap parallel to the longitudinal axis of the steering column.

**2**. The method of claim 1, further comprising inserting anti-lift fastener within a slot defined by the energy absorption strap and into the upper jacket.

**3**. The method of claim 1, further comprising directly coupling the energy absorption strap to a telescope drive nut of a telescope drive assembly.

**4**. The method of claim 1, wherein the locking tab comprises a stem and a head segment to form a T-shaped geometry, further comprising positioning the head segment within an inner cavity defined by the upper jacket.

**5**. The method of claim 4, wherein the stem is positioned within the hourglass shaped aperture defined by the upper jacket.