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Inventor(s) Beers; Tiffany A. et al.

Compact motorized tensioning device for footwear

Abstract

A tensioning system for articles of footwear and articles of apparel is disclosed. The tensioning system includes a spool system that can be engaged or disengaged from a driveshaft through the use of a cam device. The motorized tensioning device includes a torque transmitting system that allows for incremental tightening, incremental loosening and full loosening of the tensile element.

Inventors: **Beers; Tiffany A. (Portland, OR), Frederick; Ryan (Seattle, WA), Lindsay; Clayton (Beaverton, OR), Orand; Austin J. (Portland, OR), Owings; Andrew A. (Portland, OR)**

Applicant: **NIKE, Inc.** (Beaverton, OR)

Family ID: **62146056**

Assignee: **NIKE, Inc. (Beaverton, OR)**

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References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
7096559	12/2005	Johnson	N/A	N/A
7096659	12/2005	Hatamiya et al.	N/A	N/A
10758011	12/2019	Bock	N/A	A43C 11/165
10827804	12/2019	Schneider	N/A	A43C 11/165
11154119	12/2020	Beers et al.	N/A	N/A
11844402	12/2022	Beers et al.	N/A	N/A
2006/0053659	12/2005	Johnson	N/A	N/A
2007/0261270	12/2006	Nadel et al.	N/A	N/A
2014/0068838	12/2013	Beers et al.	N/A	N/A
2020/0054096	12/2019	Beers et al.	N/A	N/A
2022/0000221	12/2021	Beers et al.	N/A	N/A

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
103153112	12/2012	CN	N/A
103381003	12/2012	CN	N/A
203505737	12/2013	CN	N/A
203801869	12/2013	CN	N/A
203814733	12/2013	CN	N/A
104219977	12/2013	CN	N/A
104582519	12/2014	CN	N/A
104822284	12/2014	CN	N/A
110167382	12/2018	CN	N/A
114831388	12/2021	CN	N/A
3541224	12/2022	EP	N/A
2009071652	12/2008	WO	N/A
2018094156	12/2017	WO	N/A

OTHER PUBLICATIONS

"International Application Serial No. PCT US2017 062190, International Search Report mailed Mar. 12, 2018", 3 pgs. cited by applicant
"International Application Serial No. PCT US2017 062190, Written Opinion mailed Mar. 12, 2018", 10 pgs. cited by applicant
"International Application Serial No. PCT US2017 062190, International Preliminary Report on Patentability mailed May 31, 2019", 12 pgs. cited by applicant
"European Application Serial No. 17871048.9, Extended European Search Report mailed Nov. 7, 2019", 8 pgs. cited by applicant
"European Application Serial No. 17871048.9, Response filed May 31, 2020 to Extended European Search Report mailed Nov. 7, 2019", I left the e-receipt at the end of the doc. response drafted May 26, but filed May 31, 74 pgs. cited by applicant
"Chinese Application Serial No. 201780082883.7, Office Action mailed Dec. 21, 2020", w English translation, 14 pgs. cited by applicant
"Application Serial No. 16 346,646, Non Final Office Action mailed Feb. 25, 2021", 7 pgs. cited by applicant
"Application Serial No. 16 346,646, Response filed May 25, 2021 to Non Final Office Action mailed Feb. 25, 2021", 10 pgs. cited by applicant
"Chinese Application Serial No. 201780082883.7, Response filed Apr. 21, 2021 to Office Action mailed Dec. 21, 2020", w English claims, 15 pgs. cited by applicant
"Application Serial No. 16 346,646, Notice of Allowance mailed Jun. 16, 2021", 5 pgs. cited by applicant
"Application Serial No. 16 346,646, Corrected Notice of Allowability mailed Jun. 28, 2021", 2 pgs. cited by applicant
"Chinese Application Serial No. 201780082883.7, Office Action mailed Jul. 6, 2021", With English translation, 12 pgs. cited by applicant
"Application Serial No. 16 346,646, Corrected Notice of Allowability mailed Oct. 1, 2021", 2 pgs. cited by applicant
"Chinese Application Serial No. 201780082883.7, Response filed Nov. 22, 2021 to Office Action mailed Jul. 6, 2021", w English claims, 19 pgs. cited by applicant
"Chinese Application Serial No. 201780082883.7, Response to Examiner Telephone Interview filed Jan. 24, 2022", w English claims, 11 pgs. cited by applicant
"U.S. Appl. No. 17/480,637, Non Final Office Action mailed Nov. 2, 2022", 8 pgs. cited by applicant
"U.S. Appl. No. 17/480,637, Examiner Interview Summary mailed Jan. 17, 2023", 3 pgs. cited by applicant
"Chinese Application Serial No. 202210442661.4, Voluntary Amendment filed Nov. 23, 2022", w English claims, 11 pgs. cited by applicant
"U.S. Appl. No. 17/480,637, Response filed Feb. 2, 2023 to Non Final Office Action mailed Nov. 2, 2022", 9 pgs. cited by applicant
"U.S. Appl. No. 17/480,637, Non Final Office Action mailed Apr. 18, 2023", 8 pgs. cited by applicant
"U.S. Appl. No. 17/480,637, Examiner Interview Summary mailed Jun. 5, 2023", 2 pgs. cited by applicant
"U.S. Appl. No. 17/480,637, Response filed Jun. 6, 2023 to Non Final Office Action mailed Apr. 18, 2023", 9 pgs. cited by applicant
"European Application Serial No. 23156932.8, Response filed May 2, 2023 to Invitation to Remedy Deficiencies (R. 58 EPC) mailed Feb. 23, 2023", 13 pgs. cited by applicant
"European Application Serial No. 23156932.8, Extended European Search Report mailed Jun. 14, 2023", 9 pgs. cited by applicant

"Application Serial No. 17 480,637, Notice of Allowance mailed Aug. 7, 2023", 5 pgs. cited by applicant
"European Application Serial No. 23156932.8, Response filed Jan. 16, 2024 to Extended European Search Report mailed Jun. 14, 2023", 22 pgs. cited by applicant
"Chinese Application Serial No. 202210442661.4, Office Action mailed Feb. 5, 2024", With English Translation, 9 pgs. cited by applicant

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Primary Examiner: Upchurch; David M

Attorney, Agent or Firm: Schwegman, Lundberg & Woessner, P.A.

Background/Summary

RELATED APPLICATIONS (1) This application is a continuation of U.S. patent application Ser. No. 17/480,637, filed Sep. 21, 2021, issued on Dec. 19, 2023 as U.S. Pat. No. 11,844,402, which application is a continuation of U.S. patent application Ser. No. 16/346,646, filed May 1, 2019, issued on Oct. 26, 2021 as U.S. Pat. No. 11,154,119, which application is a U.S. National Stage Filing under 35 U.S.C. 371 from International Patent Application Serial No. PCT/US2017/062190, filed Nov. 17, 2017, which application claims the benefit of priority to U.S. Provisional Application Ser. No. 62/424,287, filed Nov. 18, 2016, the contents of which are hereby incorporated by reference in their entireties.

SUMMARY
(1) The present embodiments relate generally to articles of footwear and apparel including tensioning systems.
(2) Articles of footwear generally include two primary elements: an upper and a sole structure. The upper is often formed from a plurality of material elements (e.g., textiles, polymer sheet layers, foam layers, leather, synthetic leather) that are stitched or adhesively bonded together to form a void on the interior of the footwear for comfortably and securely receiving a foot. More particularly, the upper forms a structure that extends over instep and toe areas of the foot, along medial and lateral sides of the foot, and around a heel area of the foot. The upper may also incorporate a lacing system to adjust the fit of the footwear, as well as permitting entry and removal of the foot from the void within the upper. Likewise, some articles of apparel may include various kinds of closure systems for adjusting the fit of the apparel.
(3) In one aspect, the present disclosure is directed to a motorized tensioning system comprises a spool system, the spool system including a driveshaft, a spool, a spool extension, an engagement plate, and a cam device. The driveshaft extends through the spool, and the driveshaft is coupled to the cam device. Furthermore, the spool extension is coupled to the spool. In addition, the spool system has an engaged state and a disengaged state, where the engagement plate is coupled to the spool extension in the engaged state, and the engagement plate is spaced apart from the spool extension in the disengaged state.
(4) In another aspect, the present disclosure is directed to an article of footwear with an automated tensioning system, the article of footwear including an upper and a sole structure. The sole structure includes a motorized tensioning device, and the motorized tensioning device includes a spool system. The spool system comprises a driveshaft, a spool, an engagement plate, and a cam device, and the spool system including an engaged state and a disengaged state. In addition, the driveshaft is configured to transmit torque to the cam device, the cam device is configured to transmit torque to the engagement plate, and the engagement plate is configured to transmit torque to the spool in the engaged state. Furthermore, the spool is disengaged from the driveshaft in the

disengaged state.
(5) In another aspect, the present disclosure is directed to a method of controlling a motorized tensioning device with a spool system, the method comprising turning a driveshaft in a first direction, and the driveshaft turning a cam device in the first direction. In addition, the method includes a ramped edge of the cam device pushing against a lower surface of an engagement plate such that a rotation of the cam device increases an axial distance between the cam device and the engagement plate, and increasing the axial distance between a spool that is coupled to the cam device and the engagement plate, thereby transitioning the spool system from an engaged state to a disengaged state.
(6) Other systems, methods, features and advantages of the embodiments will be, or will become, apparent to one of ordinary skill in the art upon examination of the following figures and detailed description. It is intended that all such additional systems, methods, features and advantages be included within this description and this summary, be within the scope of the embodiments, and be protected by the following claims.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) The embodiments can be better understood with reference to the following drawings and description. The components in the figures are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention. Moreover, in the figures, like reference numerals designate corresponding parts throughout the different views.
(2) FIG. **1** is an isometric side view of an embodiment of an article of footwear with a tensioning system;
(3) FIG. **2** is a schematic isometric view of an embodiment of a tensioning device;
(4) FIG. **3** is a schematic cross-sectional view of an embodiment of a spool system;
(5) FIG. **4** is an isometric view of an embodiment of a portion of a spool system in an engaged state;
(6) FIG. **5** is a schematic view of a power flow diagram, according to an embodiment;
(7) FIG. **6** is an isometric view of an embodiment of a portion of a spool system in an engaged state;
(8) FIG. **7** is an isometric view of an embodiment of a portion of a spool system;
(9) FIG. **8** is an isometric view of an embodiment of a portion of a spool system;
(10) FIG. **9** is an isometric view of an embodiment of a portion of a spool system in a disengaged state;
(11) FIG. **10** is a schematic cross-sectional view of an embodiment of a portion of a spool system:
(12) FIG. **11** is a schematic view of a power flow diagram, according to an embodiment;
(13) FIG. **12** is a schematic view of a power flow diagram, according to an embodiment;
(14) FIG. **13** is a schematic view of a lacing embodiment for a spool system;
(15) FIG. **14** is a schematic view of a lacing embodiment for a spool system; and
(16) FIG. **15** is a schematic view of a lacing embodiment for a spool system.
DETAILED DESCRIPTION
(17) FIG. **1** illustrates a bottom perspective view of an embodiment of an article of footwear (“article”) **100** that is configured with a tensioning system **150**. In the current embodiment, article **100** is shown in the form of an athletic shoe. However, in other embodiments, tensioning system **150** may be used with any other kind of footwear including, but not limited to: hiking boots, soccer shoes, football shoes, sneakers, running shoes, cross-training shoes, rugby shoes, basketball shoes, baseball shoes as well as other kinds of shoes. Moreover, in some embodiments article **100** may be configured for use with various kinds of non-sports related footwear, including, but not limited to:

slippers, sandals, high heeled footwear, loafers as well as any other kinds of footwear, in different embodiments, a tensioning system may not be limited to footwear and in other embodiments a tensioning system could be used with various kinds of apparel including clothing, sportswear, sporting equipment and other kinds of apparel. In still other embodiments, a tensioning system may be used with braces, such as medical braces.

(18) For purposes of clarity, some of the embodiments of the following detailed description discuss a tensioning system associated with article **100**. However, it will be understood that other embodiments may incorporate a corresponding article of footwear (e.g., a left article of footwear when article **100** is a right article of footwear) that may share some, and possibly all, of the features of article **100** described herein and shown in the figures.

(19) To assist and clarify the subsequent description of various embodiments, various terms are defined herein. Unless otherwise indicated, the following definitions apply throughout this specification (including the claims). For consistency and convenience, directional adjectives are employed throughout this detailed description corresponding to the illustrated embodiments.

(20) Referring to FIG. **1** for purposes of reference, article **100** may be divided into a forefoot region **120**, a midfoot region **130**, and a heel region **140**. Forefoot region **120** may be generally associated with the toes and joints connecting the metatarsals with the phalanges Midfoot region **130** may be generally associated with the arch of a foot. Likewise, heel region **140** may be generally associated with the heel of a foot, including the calcaneus bone. It will be understood that forefoot region **120**, midfoot region **130** and heel region **140** are only intended for purposes of description and are not intended to demarcate precise regions of article **100**.

(21) For consistency and convenience, directional adjectives are also employed throughout this detailed description corresponding to the illustrated embodiments. The term “lateral” or “lateral direction” as used throughout this detailed description and in the claims refers to a direction extending along a width of a component or element. For example, a lateral axis **170** of article may extend between a medial side **108** and a lateral side **110** of the foot. Additionally, the term “longitudinal” or “longitudinal direction” as used throughout this detailed description and in the claims refers to a direction extending across a length or breadth of an element or component (such as a sole member). In some embodiments, a longitudinal axis **180** may extend from forefoot region **120** to heel region **140** of a foot. It will be understood that each of these directional adjectives may also be applied to individual components or an article of footwear, such as an upper and/or a sole member. In addition, a vertical axis **190** refers to the axis perpendicular to a horizontal surface defined by longitudinal axis **180** and lateral axis **170**. It will be understood that each of these directional adjectives may be applied to various components shown in the embodiments, including article **100**, as well as components of tensioning system **150** and the embodiments of the spool system that will be presented further below.

(22) Article **100** may include upper **102** and sole structure **104**. Generally, upper **102** may be any type of upper. In particular, upper **102** may have any design, shape, size and/or color. For example, in embodiments where article **100** is a basketball shoe, upper **102** could be a high top upper that is shaped to provide high support on an ankle. In embodiments where article **100** is a running shoe, upper **102** could be a low top upper.

(23) In some embodiments, sole structure **104** may be configured to provide traction for article **100**. In addition to providing traction, sole structure **104** may attenuate ground reaction forces when compressed between the foot and the ground during walking, running or other ambulatory activities. The configuration of sole structure **104** may vary significantly in different embodiments to include a variety of conventional or non-conventional structures. In some cases, the configuration of sole structure **104** can be configured according to one or more types of ground surfaces on which sole structure **104** may be used. Examples of ground surfaces include, but are not limited to: natural turf, synthetic turf, dirt, as well as other surfaces.

(24) In different embodiments, sole structure **104** may include different components. For example,

sole structure **104** may include an outsole, a midsole, and/or an insole. In addition, in some cases, sole structure **104** can include one or more cleat members or traction elements that are configured to increase traction with a ground surface.
(25) In some embodiments, sole structure **104** may be joined with upper **102**. In some cases, upper **102** is configured to wrap around a foot and secure sole structure **104** to the foot. In some cases, upper **102** may include an opening that provides access to an interior cavity of article **100**.
(26) Some embodiments may include provisions for facilitating the adjustment of an article to a wearer's foot. In some embodiments, these provisions may include a tensioning system. In some embodiments, tensioning system may further include other components to include, but are not limited to, a motorized tensioning device, a housing unit, tensile elements, a motor, gears, spools or reels. Such components may assist in securing and providing a custom fit to a wearer's foot. These components may help secure the article to a wearer's foot in some embodiments, as will be explained further in detail below.
(27) In different embodiments, a tensioning system may include a tensile element. The term “tensile element” as used throughout this detailed description and in the claims refers to any component that has a generally elongated shape and high tensile strength. In some cases, a tensile element could also have a generally low elasticity. Examples of different tensile elements include, but are not limited to: laces, cables, straps and cords. In some cases, tensile elements may be used to fasten and/or tighten an article, including articles of clothing and/or footwear. In other cases, tensile elements may be used to apply tension at a predetermined location for purposes of actuating some components or system.
(28) In addition, as noted above, in different embodiments, article **100** may include a tensioning system **150**. Tensioning system **150** may comprise various components and systems for adjusting the size of throat opening **132** leading to an interior void and tightening (or loosening) upper **102** around a wearer's foot. In one embodiment, tensioning system **150** comprises a fastening mechanism for the article of footwear. Some examples of different tensioning systems that can be used are disclosed in Beers et al., U.S. Patent Publication Number 2014/0070042 published Mar. 13, 2014 and entitled “Motorized Tensioning System with Sensors” and Beers et al., U.S. Pat. No. 8,056,269, issued Nov. 15, 2011 (previously U.S. Patent Publication Number 2009/0272013, published Nov. 5, 2009) and entitled “Article of Footwear with Lighting System,” the entire disclosures of which are incorporated herein by reference.
(29) A tensioning system may include provisions for providing a customizable and comfortable fit of an article to a wearer's foot. In some embodiments, the provisions may comprise of various components and systems for modifying the dimensions of the interior cavity of the article of footwear, thereby tightening (or loosening) upper **102** around a wearers foot. In some embodiments, tensioning system **150** may comprise of a tensile element such as a lace **152** as well as a motorized tensioning device **160**. In FIG. **1**, the motorized tensioning device can be understood to be located within a housing unit **182**. Housing unit **162** comprising motorized tensioning device **160** can be positioned adjacent to sole structure **104** in some embodiments. While motorized tensioning device **160** is disposed in midfoot region **130** in FIG. **1**, it should be understood that motorized tensioning device **160** can be located in forefoot region **120**, midfoot region **130**, and/or heel region **140**. Furthermore, in other embodiments, motorized tensioning device **160** can be disposed adjacent to or along portions of upper **102**.
(30) Provisions for mounting housing unit **162** or motorized tensioning device **160** comprising the motorized tensioning device to sole structure **104** can vary in different embodiments. In some cases, a motorized tensioning device may be removably attached, so that the motorized tensioning device can be easily removed by a user and modified (for example, when a lace must be changed) in other cases, a motorized tensioning device could be fixedly attached to sole structure **104**. In one embodiment, for example, an external harness (not shown) may be used to mount the motorized tensioning device to sole structure **104**. In other embodiments, motorized tensioning device **160** can

be joined in any manner to a surface of article **100**, including mechanical attachments, adhesives, and/or molding.

(31) In some embodiments, lace **152** may be configured to pass through various different lacing guides **154** (as shown in phantom in FIG. **1**). In some cases, lacing guides **154** may provide a similar function to traditional eyelets on uppers. In particular, as lace **152** is pulled or tensioned, a throat opening **132** may generally constrict so that upper **102** is tightened around a foot. In some embodiments, lacing guides **154** may be used to arrange lace in different configurations. Furthermore, in some embodiments, lacing guides **154** may be used to facilitate the tightening or loosening of lace **152** while in various states of tension. For example, in some embodiments, lacing guides **154** may expand as lace **152** is configured in a tensioned or tightened state. With this arrangement, lace **152** is provided more room when tensioning article. Likewise, in some embodiments, lacing guides **154** could compress as lace **152** is configured from a tensioned state to a non-tensioned or loose state. In some embodiments, lace **152**, positioned through lacing guides **154**, may be arranged in various configurations.

(32) The arrangement of lacing guides **154** in this embodiment is only intended to be exemplary and it will be understood that other embodiments are not limited to a particular configuration for lacing guides **154**. Furthermore, the particular types of lacing guides **154** illustrated in the embodiments are also exemplary and other embodiments may incorporate any other kinds of lacing guides or similar lacing provisions. In some other embodiments, for example, lace **152** could be inserted through traditional eyelets. Some examples of lace guiding provisions that may be incorporated into the embodiments are disclosed in Cotterman et al., U.S. Patent Application Publication Number 2012/0000091, published on Jan. 5, 2012, and titled “Lace Guide”, which is hereby incorporated by reference in its entirety. Additional examples are disclosed in Goodman at al., U S. Patent Application Publication Number 2011/0266384, published on Nov. 3, 2011, and titled “Reel Based Lacing System” (the “Reel Based Lacing Application”), which is hereby incorporated by reference in its entirety. Still additional examples of lace guides are disclosed in Kerns et al., U.S. Patent Application Publication Number 2011/0225843, published on Sep. 22, 2011, and titled “Guides For Lacing Systems”, which is hereby incorporated by reference in its entirety. Another example of tensioning systems and lace guides is disclosed in Beers et al., PCT Application Number US2016/032249, filed May 13, 2016 and titled “Motorized Tensioning Device With Split Spool System”. Beers et al., PCT Application Number US2016/032048, filed May 12, 2016 and titled “Motorized Tensioning Device With Compact Spool System.” and Pheil et al., U.S. patent application Ser. No. 14/955,705, filed on Dec. 1, 2015, and titled “An Automated Tensioning System for An Article Of Footwear,” the disclosures of which are hereby incorporated by reference in their entirety.

(33) Lace **152** may comprise any type of type of lacing material known in the art Examples of lace that may be used include cables or fibers having a low modulus of elasticity as well as a high tensile strength. A lace may comprise a single strand of material, or can comprise multiple strands of material. An exemplary material for the lace is SPECTRA™, manufactured by Honeywell of Morris Township NJ, although other kinds of extended chain, high modulus polyethylene liber materials can also be used as a lace. Still further exemplary properties of a lace can be found in the Reel Based Lacing Application mentioned above.

(34) In some embodiments, a motorized tensioning device may generally be configured to automatically apply tension to a lace for purposes of tightening and loosening upper **102**. A motorized tensioning device may thus include provisions for winding a lace onto, and unwinding a lace from, a spool internal to the motorized tensioning device. Moreover, the provisions may include an electric motor that automatically winds and unwinds the spool in response to various inputs or controls, as also disclosed in the An Automated Tensioning System for An Article Of Footwear application, the Motorized Tensioning Device With Split Spool System, and the Motorized Tensioning Device With Compact Spool System application. In one embodiment,

tensioning system **150** is an automatic tensioning system that can provide automated fastening to the article For purposes of this disclosure, an automated feature or activity is one that can occur without a continuous command or repeated interaction by a user throughout the duration of the automated activity. For example, the articles incorporating the tensioning system described herein may be able to auto-lace or auto-loosen without sustained or repeated manual adjustment or manual control by the user. In other embodiments, tensioning system **150** may not be automated and can be adjusted by manual controls such as buttons or dials, and/or direct interaction with lace **152**, as also disclosed in the An Automated Tensioning System for An Article Of Footwear application: the Motorized Tensioning Device With Split Spool System, and the Motorized Tensioning Device With Compact Spool System application.

(35) Thus, in some embodiments, article **100** may include a plurality of control buttons **182** that are capable of initiating control commands In some embodiments, control buttons **182** may allow a user to tighten one or both shoes simultaneously. Optionally, some embodiments could include a 'fully tighten' command that would tighten the footwear until a predetermined threshold is achieved (for example, a threshold pressure, winding distance, etc.). Article **100** may also include provisions for storing and using preferred tension settings. In some embodiments, control buttons **182** may be disposed along any portion of upper **102**.

(36) In different embodiments, a motorized tensioning device may be configured to automatically apply tension to lace **152** or allow a loosening or unwinding of lace **152**. In some embodiments, motorized tensioning device **160** may include provisions for winding lace **152** onto, and unwinding lace **152** from, reel elements **210** internal to motorized tensioning device **160**. Moreover, the provisions may include a motor assembly **250** that actuates components for facilitating the winding and unwinding of lace **152** onto reel elements **210** in response to various inputs or controls.

(37) Referring now to FIG. **2**, an isolated view of motorized tensioning device **180** is depicted, where housing unit **162** is represented with dotted lines. In FIG. **2**, some generalized components of motorized tightening device **160** are shown within a portion of housing unit **162** in dotted lines. It should be understood that these components are shown for illustrative purposes only, and the spool system can be utilized with any other components of a motorized system. In some embodiments, housing unit **162** may be shaped so as to optimize the arrangement of components of motorized tensioning device **160**.

(38) In different embodiments, a motor can perform by rotating an object or component associated with the motor. Thus, in one embodiment, a motor is a device that cart convert electricity or electrical energy into motion or mechanical torque. In some embodiments, a turning movement of a wheel in the motor occurs during operation of the motor. In one embodiment, there may be a component such as a rotor and/or a shaft which are configured to rotate in the motor In some cases, when a current is applied to the motor, the current can be converted to mechanical energy or a rotational movement of a component in the motor.

(39) For purposes of this disclosure, references made to a motor moving in a particular direction (for example, in a forward direction or in a reverse direction) refer to the direction of turning or rotation of the rotating component associated with the motor. For example, in one embodiment, the forward direction may refer to the clockwise rotational direction of a rotor in the motor. In another embodiment, the forward direction can refer to the counter-clockwise rotational direction of a rotor in the motor. Thus, it should be understood that the directional terms are not intended to define precise operations of the motor Rather, references to a direction are intended to represent general rotational movement of a component of the motor. Furthermore, the forward direction and the reverse direction should be understood to represent opposing rotational directions.

(40) In some embodiments, motor assembly **250** could include an electric motor. However, in other embodiments, motor assembly **250** could comprise any kind of non-electric motor known in the art. Examples of different motors that can be used include, but are not limited to: DC motors (such as permanent-magnet motors, brushed DC motors, brushless DC motors, switched reluctance motors,

etc.). AC motors (such as motors with sliding rotors, synchronous electrical motors, asynchronous electrical motors, induction motors, etc.), universal motors, stepper motors, piezoelectric motors, as well as any other kinds of motors known in the art Motor assembly **250** may further include a motor crankshaft that can be used to drive one or more components of motorized tensioning device **160**. Some examples of provisions for powering motor assembly **250**, including various kinds of batteries, are disclosed in the Motorized Tensioning Device With Split Spool System application and the Motorized Tensioning Device With Compact Spool System application referenced above.

(41) In some embodiments, motorized tensioning device **160** can include provisions for reducing the output speed of, and increasing the torque generated by, motor assembly **250**. In some embodiments, motorized tensioning device **160** can include one or more gear reduction assemblies and/or gear reduction systems Some examples of gear reduction assemblies that may be utilized in the embodiments are disclosed in the Motorized Tensioning Device With Split Spool System application referenced above.

(42) As noted previously. In some embodiments, motorized tensioning device **160** can include provisions for winding and unwinding portions of a lace, in some embodiments, motorized tensioning device **160** can include a spool system **200**. In some cases, spool system **200** may include various components. Referring to FIG. **3**, for purposes of illustration, spool system **200** is depicted in isolation and in cross-section in an ‘engaged’ state, where the use of the phrase engaged state will be clarified further below, in FIG. **3**, it can be seen that spool system **200** comprises a spool comprising a spool winding component **310** and a spool extension component (“spool extension”) **330**, a driveshaft **320**, a cam device (cam) **340**, and an engagement plate **350**. In one embodiment, engagement plate **360** can be further associated with or covered by a friction plate **360**, as will be discussed further below. It should be understood that while spool winding component **310** and spool extension **330** are described as two independent components of the spool in the Figures, in other embodiments, the spool may be a single component—or two portions integrally connected—that provides the same function and/or overall structure as spool winding component **310** and spool extension **330**. Furthermore, in different embodiments, it can be understood that spool winding component **310** may be configured to receive at least a first tensile element, where the first tensile element can be wound around the spool when the article of footwear is being tensioned, and the first tensile element is unwound from the spool when the article of footwear is being loosened.

(43) In some embodiments, driveshaft **320** can ne understood to extend from a first shaft end **302** to a second shaft end **304** in a direction substantially aligned with a longitudinal axis **380**. In one embodiment, driveshaft **320** and/or spool winding component **310** can be substantially elongated. In some embodiments, driveshaft **320** and/or spool winding component **310** may have an approximately cylindrical geometry, or may be comprised of distinct sections or portions each having an approximately cylindrical geometry. In one embodiment, various portions of driveshaft **320** and/or spool winding component **310** can have an approximately square or rectangular cross-sectional shape. In addition, spool winding component **310** can be disposed such that it substantially surrounds or is disposed around a middle portion **306** of driveshaft **320** in some embodiments In other words, in some embodiments, spool winding component **310** can include an opening such as a tunnel or channel **316** through which a portion of driveshaft **320** can extend.

(44) In different embodiments, driveshaft **320** can include provisions to help axially secure spool winding component **310** along middle portion **306**. Middle portion **306** can extend or be disposed between first shaft end **302** and second shaft end **304**. In one embodiment, driveshaft **320** includes a collar portion **308**. In some embodiments, collar portion **308** is disposed adjacent to a first spool end **312** of spool winding component **310** in one embodiment, collar portion **308** can have a diameter or width greater than the diameter of channel **316**. For example, in FIG. **3**, collar portion **308** has a first diameter **322**, and channel **316** has a second diameter **324** that is less than first diameter **322**. However, in other embodiments, driveshaft **320** may not include a collar portion **308**,

but use some other device to axially secure spool winding component **310**, like a snap ring.

(45) For purposes of reference, spool system **200** can be understood to include three portions: a shaft portion **352**, a spool portion **354**, and an adjustable portion **356**. Shaft portion **352** corresponds generally to the portion of spool system **200** extending from first shaft end **302** to collar portion **308**. In certain examples, shaft portion **352** comprises only a portion of driveshaft **320**, unassociated with other spool system components. Spool portion **354** corresponds generally to the portion of spool system **200** that includes spool winding component **310**, extending from a first spool end **312** to a second spool end **314**. Adjustable portion **356** can be understood to include engagement plate **350**, cam **340**, and spool extension **330**, in embodiments that Include friction plate **360**, adjustable portion **356** can also include friction plate **360**.

(46) In different embodiments, spool winding component **310** can include provisions for securing and/or positioning a lace around spool winding component **310**. For example. In some embodiments, spool winding component **310** can include one or more ‘fins’, handles, or raised portions **332**. Raised portions **332** can help to collect, gather, or otherwise help to position a lace such that it remains associated with a surface of spool winding component **310** and/or prevent a lace from shifting position toward or onto other components of spool system **200**. In addition. In some embodiments, spool winding component **310** can include provisions for securing or engaging with spool extension **330**. In one embodiment, spool winding component **310** includes a lip portion **358** that is associated with second spool end **314**. Lip portion **358** can have a diameter that is larger than adjacent portions of spool winding component **310**. Lip portion **358** can also help to secure or collect a tensile element around spool winding component **310** in some embodiments in a manner similar to raised portions **332**. In different embodiments, lip portion **358** and/or raised portions **332** may extend continuously around the circumference of spool winding component **310**, while in other embodiments, lip portion **358** and/or raised portions **332** can include gaps, openings, or recesses.

(47) In FIG. **3** it can also be seen that in some embodiments, spool system **200** can be assembled or arranged such that the longitudinal length of spool system **200** is substantially greater than a lateral width (relative to a lateral axis **370**). In other words, in some embodiments, spool system **200** can be arranged as a radially compact system, where its radius is short relative to its longitudinal length. This arrangement can allow spool system **200** to be positioned in the motorized tensioning device **160** with minimal space requirements, and relatively minor compartmentalization (see FIG. **2**) in FIG. **3**, it can be seen that in some embodiments, the widest portions of spool system **200** are associated with each of raised portion **332**. In various examples, the maximum diameter or width associated with driveshaft **320** is less than the widths associated with raised portions **332** of spool winding component **310**. In addition, each of the diameters or widths of spool extension **330**, engagement plate **350**, and friction plate **360** are also less than the widths associated with raised portions **332** of spool winding component **310**. As one example, in FIG. **3**, spool extension **330** has a third diameter **326** that is less than a fourth diameter **328** associated with a portion of spool winding component **310** including two generally aligned raised portions **332**.

(48) Furthermore. In some embodiments, while a portion of driveshaft **320** extends through the opening formed in spool winding component **310**, there can be a first portion of driveshaft **320** that extends axially outward from second spool end **314** of spool winding component **310** and is substantially surrounded by cam **340**. In one embodiment, cam **340** is approximately cylindrical and also includes a through-hole channel or opening through which the first portion of driveshaft **320** extends Similarly, there can be a second portion of driveshaft **320** that extends axially outward from the first portion of driveshaft **320**, wherein the second portion is substantially surrounded by engagement plate **350**. In one embodiment, engagement plate **350** is approximately cylindrical and also includes a channel or opening through which the second portion of driveshaft **320** extends. In some embodiments, the channel through engagement plate **350** can be a through-hole opening, and in other embodiments, as shown in FIG. **3**, the channel through engagement plate **350** can be a

blind-hole opening. This arrangement and relative radially compact sizing of each component can allow spool system **200** to be disposed in or fitted into a relatively small housing, which may be particularly useful in applications where the motorized tensioning device is configured for use in an article of footwear.

(49) In the sequence provided by FIGS. **3-8**, spool system **200** is shown from different angles, transitioning between an engaged state and a disengaged state. For purposes of this description, the engaged state of spool system **200** occurs when spool extension **330** is keyed with or coupled to engagement plate **350**, and the disengaged state of spool system **200** occurs when spool extension **330** is no longer keyed with or coupled to engagement plate **350**. In one embodiment, spool winding component **310** can rotate freely ("freewheel") in the disengaged state in at least one direction. In one embodiment, freewheeling occurs when the spool can rotate independently of the driveshaft. Thus, if a tensile element has been wound around spool winding component **310**, the tensile element can be freely unwound from the spool system in the disengaged state.

(50) Referring now to FIG. **4**, an isometric view of a portion of spool system **200** is depicted, providing a larger view of adjustable portion **356**, including a portion of engagement plate **350**, cam **340**, spool extension **330**, and a portion of spool winding component **310**. The depiction in FIG. **4** represents spool system **200** in a fully engaged state. It can be seen that in some embodiments, different components can engage with or connect with one another. In one embodiment, spool extension **330** can be engaged with spool winding component **310** through a kind of lock-tab system. For example, in FIG. **4**, spool winding component **310** includes a first recess **420** associated with second spool end **314**. First recess **420** can be sized and dimensioned to receive a first mating tab portion ("first tab") **410** extending outward from a first extension end **402** of spool extension **330**. Furthermore, in some embodiments, spool extension **330** can include a second recess **440** associated with a second extension end **404**. Second recess **440** can be sized and dimensioned to receive a second mating tab portion ("second tab") **430** extending outward from a first engagement end **406** of engagement plate **350**. Thus, in some embodiments, when first tab **410** is positioned within first recess **420**, it can be understood that spool winding component **310** and spool extension **330** are "keyed" with one another, and a rotation of one component will correspond with rotation of the keyed component. Similarly, in some embodiments, when second tab **430** is positioned within second recess **440**, it can be understood that spool extension **330** and engagement plate **350** are "keyed", coupled, or meshed with one another, and a rotation of one component will correspond with rotation of the keyed component. In one embodiment, if the first keyed component is in a fixed or locked state (e.g., is not able to rotate), the second keyed component will also be in a fixed or locked state. In addition, when the first keyed component is rotating, the second keyed component will also be rotating.

(51) In order to better understand the embodiments, FIG. **5** presents a schematic view of a power flow diagram depicting spool system **200** in a tensioned or engaged state. As indicated by the flow arrow, in one embodiment, when a motor turns or transmits torque to driveshaft **320**, driveshaft **320** engages or transmits torque to cam **340**. In turn, cam **340** engages or transmits torque to engagement plate **350**. Because engagement plate **350** is positioned in mesh with spool extension **330**, the rotation of engagement plate **350** engages or transmits torque to spool extension **330**. Power flow then moves from spool extension **330** to spool winding component **310**, such that torque is transmitted to spool winding component **310**. Any tensile element associated with spool winding component **310** can be wound and tightened as a result.

(52) Referring now to FIG. **6**, the portion of spool system **200** comprising adjustable portion **356** of FIG. **4** is shown with spool extension **330** is depicted in dotted lines, permitting the reader a clearer view of cam **340**. The geometry of cam **340** can vary in different embodiments. In some embodiments, cam **340** can be substantially or partially cylindrical, or may have an approximately cylindrical geometry, or may be comprised of distinct sections or portions each having an approximately cylindrical geometry. For purposes of reference, cam **340** can be understood to

include a first cam end **602** and a second cam end **604**. In some embodiments, first cam end **602** comprises an outer surface that is substantially planar or flat on one side or surface. In some embodiments, cam **340** can have an outer surface with a constant curvature.

(53) FIG. **6** presents adjustable portion **356** of FIG. **6** from a rotated angle to provide the reader with a greater understanding of the embodiments. As shown in FIGS. **6** and **7**, second cam end **304** can include provisions for engaging with engagement plate **350** in some embodiments For example, in FIGS. **6-7**, second cam end **304** is associated with a ramped edge **610** joined to a step portion **620**. Step portion **620** can comprise a substantially sharp change in height relative to the rest of cam **340** in some embodiments, such that it extends upward relative to ramped edge **610**. In one embodiment, step portion **620** comprises a substantially rectangular three-dimensional shape. In other embodiments, step portion **620** can include curvature, or have any other regular or irregular shape. The geometry of step portion **620** can facilitate the interaction between cam **340** and engagement plate **350** in some embodiments, as will be described below.

(54) Furthermore, ramped edge **610** can extend from a first step end **622** of step portion **620** and—following a counterclockwise direction relative to the perspective of FIG. **6**—extend downward with a gradually decreasing height, in other words, the length of the cylindrical shape comprising cam **340** can decrease through different portions of cam **340**. As shown in FIGS. **6-7**, in one embodiment, ramped edge **610** can have a first linear portion **612** that is directly adjacent to first step end **622**. Furthermore, first linear portion **612** can then be joined to a sloped portion **614** that extends around a portion of the circumference of cam **340**. In some embodiments, sloped portion **614** decreases in height either continuously or in stages relative to first linear portion **612** until it abuts a second step end **624** (see FIG. **8**) of step portion **620**. In other words, first step end **822** corresponds to the opposite facing side of second step end **624**. As noted below, it can be seen that second step end **624** has a greater height relative to first step end **622**.

(55) Thus, in different embodiments, cam **340** can have varying dimensions. In FIG. **7**, cam has a first height **652** associated with the distance between first cam end **602** and step portion **620**, a second height **654** associated with the distance between first cam end **602** and first linear portion **612**, and a third height **656** associated with the distance between first cam end **802** and an intermediate portion **618** of sloped portion **614**. Furthermore, as spool system **200** begins to disengage, cam **340** can rotate relative to engagement plate, as shown in FIG. **8**. In some embodiments, as shown in FIG. **8**, cam **340** can have a fourth height **658** associated with the distance between first cam end **602** and a second linear portion **616** of ramped edge **610**. In different embodiments, first height **652** is greater than second height **654**. In some embodiments, second height **654** can be greater than third height **656**. In addition, in some embodiments, third height **656** can be greater than fourth height **658**. In addition, it can be understood that in one embodiment, step portion **620** is a substantially dissimilar height relative to the remainder of second cam end **604**. In other words, while ramped edge **610** may decrease in height gradually in some embodiments, the change in height from step portion **620** to first linear portion **612** can occur more abruptly and provide a raised bump or bulged area of second cam end **604**.

(56) Furthermore, in some embodiments, engagement plate **350** can include provisions for engaging with and/or disengaging from cam **340**, as rotational motion of driveshaft **320** occurs. In some embodiments, a lower portion of engagement plate **350** has a substantially or partially cylindrical shape. In one embodiment, there may be one or more spoke portions disposed along the periphery of first engagement end **406**. In FIGS. **6-8**, a first spoke portion **632** extends downward from engagement plate **350** and a second spoke portion **634** extends downward from engagement plate **350**. In one embodiment, second spoke portion **634** can correspond to second tab **430** as described with respect to FIG. **4**. In some embodiments, spoke portions may be space apart from one another. In other embodiments, portions of spoke portions can be joined or abut one another. Furthermore, spoke portions can have varying cross-sectional shapes In different embodiments, including rectangular, square, elliptical, or other regular or irregular shapes. In FIGS. **6-8**, it can be

seen that spoke portions have a substantially rectangular three-dimensional shape. This shape can facilitate the interaction between engagement plate **350** and cam **340**.
(57) Thus, in different embodiments, in the engaged state shown in FIGS. **3-6**, it can be understood that the turning of driveshaft **320**—being keyed to cam **340**—will also cause cam **340** to turn. Furthermore, as best seen in FIG. **7**, because a flat inner surface of step portion **620** of cam **340** is positioned flush against an inner sidewall of engagement plate **350** in the engaged state, when the driveshaft **320** rotates clockwise, second step end **624** of step portion **620** can be disposed flush against and/or push against an inner sidewall of second spoke portion **634**, which can cause a rotation of engagement plate **350**. The rotation of engagement plate **350**—being keyed to spool extension **330**—then causes rotation of spool extension **330**. The rotation of spool extension **330**—being keyed to spool winding component **310**—causes rotation of spool winding component **310**, winding spool winding component **310** and allowing a tensioning or tightening of any tensile elements associated with spool winding component **310**. This was also depicted in the power flow diagram of FIG. **5**. This system may allow for positive engagement of the spool winding component **310** during tightening operations, such that friction is not required to tighten the article of footwear. Furthermore. In one embodiment, this type of system may allow a user to make small adjustments (either tighten or loosen) while the system is still under tension.
(58) Referring to the transition as shown from FIGS. **6-9**, when cam **340** rotates in a direction that is opposite to the direction for winding or tightening—for example, during unwinding or loosening operations of the motorized tensioning device—ramped edge **610** can be configured to raise engagement plate **350**, or otherwise increase the distance between cam **340** and engagement plate **350**. In one embodiment, cam **340** is keyed to driveshaft **320**, and as driveshaft **320** rotates, cam **340** will rotate in the same direction. Ramped edge **610** of cam **340** then pushes against a lower surface of first spoke portion **632** of engagement plate **350**, such that the space between cam **340** and engagement plate **350** increases In some embodiments, cam **340** can raise engagement plate **350** until engagement plate **360** is no longer engaged with or is spaced apart from (e.g., has no contact with) spool extension **330**. In one embodiment, the rotation of cam **340** and translational movement of engagement plate **350** (i.e., in a direction away from cam **340**) can continue until first step end **622** of step portion **620** is positioned substantially flush against an inner sidewall of first spoke portion **632** (see FIG. **9**). In one embodiment, first spoke portion **632** can be understood to provide a kina of ‘brake’ that receives step portion **620**, helping to prevent the components from further translational movement once the spool has been disengaged.
(59) As shown in FIG. **8**, during the disengagement process, the distance between cam **340** and engagement plate **350** can increase. For example, in FIG. **7**, step portion **620** of cam **340** and engagement plate **350** are separated by a first distance **710**, and in FIG. **8**, step portion **620** of cam **340** and engagement plate **350** are separated by a second distance **810**, where second distance **810** is greater than first distance **710**. In FIG. **9**, step portion **620** of cam **340** and engagement plate **350** are separated by a third distance **910**, where third distance **910** is greater than second distance **810**. In addition, first linear portion **612** can be positioned directly beneath and/or flush against a lower surface of first spoke portion **632** when step portion **620** is disposed against the inner sidewall of first spoke portion **632**, providing greater security and support within the system in the disengaged state.
(60) Referring to FIG. **9**, an isometric view of a portion of spool system **200** is depicted, including a portion of engagement plate **350**, cam **340**, spool extension **330**, and a portion of spool winding component **310**. The depiction in FIG. **9** represents spool system **200** in a fully disengaged state. It can be seen that in some embodiments, different components can be disposed in different positions relative to the engaged state that was depicted in FIG. **4**. In one embodiment, spool extension **330** can remain engaged with spool winding component **310** through the lock-tab system described earlier with respect to FIG. **4**. However, in some embodiments, spool extension **330** can now be disconnected or disengaged from engagement plate **350**. In other words, second recess **440** is no

longer associated with second tab **430** of engagement plate **350**. Thus, in some embodiments, it can be understood that spool extension **330** and engagement plate **350** are no longer "Keyed" or meshed with respect to one another.

(61) Referring now to FIG. **10**, for purposes of illustration, spool system **200** is depicted in isolation and in cross-section in the disengaged state, in contrast to FIG. **3**. It can be seen that the spacing between engagement plate **350** and both cam **340** and spool extension **330** is greater in FIG. **10** relative to FIG. **3**. For example, while there is a first gap **382** between engagement plate **350** and spool extension **330** in FIG. **3**, there is a second gap **1082** between engagement plate **350** and spool extension **330** in FIG. **10** that is larger than first gap **382**.

(62) As noted above, in some embodiments, spool system **200** can also include friction plate **360**. Friction plate **360** can be disposed adjacent to, around, or substantially surrounding engagement plate **350**. In some embodiments, friction plate **360** can help ensure that engagement plate **350** does not spin or rotate with cam **340** during a loosening operation, but instead moves axially, as described previously.

(63) In order to better understand the embodiments. FIG. **11** presents a schematic view of a power flow diagram depicting spool system **200** in a loosened or disengaged state, while FIG. **12** presents the same power flow diagram of the engaged state of FIG. **5** for comparison purposes. As indicated by the flow arrow in FIG. **11**, in one embodiment, when a motor turns driveshaft **320** in a reverse direction relative to that of FIG. **12**, torque is transmitted to cam **340** in the direction opposite to that of FIG. **12**. In turn, cam **340** engages or transmits torque to engagement plate **350** in the same direction. Because engagement plate **350** is not positioned in mesh with spool extension **330**, no power is applied to spoof extension **330**. In other words, both spool extension **330** and spool winding component **310** are free to move through the manipulation of tensile elements. Any tensile element associated with spool winding component **310** can be unwound and loosened as a result. Thus, in some embodiments, spool system **200** provides a quick release mechanism for a power driven spool that can be initiated by reverse rotation of the driveshaft. As described earlier, this system can comprise a compact internal cam-follower design that axially disengages the drive system from the spool and permits freewheeling to occur.

(64) Referring now to the sequence presented in FIGS. **13-15**, it can be seen that in some embodiments, once spool system **200** is in the disengaged state, a user can easily pull a lace from spool winding component **310** to transition an article of footwear or other object to a fully loosened state. In other words, once spool winding component **310** is disengaged it can "freewheel." This occurs because there is no longer any tension in the system Thus, a user can pull at the tensile element(s) associated with spool winding component **310** and spool winding component **310** can rapidly and freely unwind, without being encumbered by a drive system. In some embodiments, this type of system can be beneficial in helping to prevent "bird-nesting", which occurs when tensile elements become tangled or fouled together. In one embodiment, this feature allows a wearer to quickly open the shoe without having to reverse drive the motor. The disengaged state can also allow a user to quickly loosen an article of footwear and remove a foot from the article of footwear more rapidly.

(65) In FIGS. **13-15**, a first tensile element **1310** and a second tensile element **1320** are each wound around a portion of spool winding component **310**. First tensile element **1310** is wound around a portion of spool winding component **310** bounded by a first raised portion **1330** and a second raised portion **1340**, and second tensile element **1320** is wound around a portion of spool winding component **310** bounded by second raised portion **1340** and lip portion **358**. Referring to FIG. **13**, because spool system **200** is in the disengaged state, when an end of first tensile element **1310** and an end of second tensile element **1320** are pulled away from spool winding component **310**, spool winding component **310** can rotate freely, allowing the two tensile elements to unwind from spool winding component **310**, as shown in FIG. **14**. As the rotation continues, the two tensile elements continue to unwind until the system is fully loosened, as shown in FIG. **15**.

(66) A spool system as described above is not limited to articles of footwear and could be used with apparel, for example. As one particular example, a spool system can be utilized by a tensioning system that is used in adjusting a shoulder pad, worn by a user playing American football, where shoulder pads are common. However, other embodiments could use this adjustable shoulder pad configuration with any other kinds of clothing configured to be worn by players in any other sports, including, for example, hockey, lacrosse, as well as any other sports or activities requiring shoulder pads. Moreover, it should be understood that the principles discussed here can be used for adjusting any kinds of padding including, but not limited to: elbow pads, knee pads, shin pads, padding associated with the hands and arms, padding associated with the feet and legs, padding associated with the torso, padding associated with the head as well as any other kind of padding known in the art.
(67) In still other embodiments, a tensioning system including a motorized tensioning device as described herein can be used with any other kinds of apparel and/or sports equipment including, but not limited to backpacks, hats, gloves, shirts, pants, socks, scarves, jackets, as well as other articles. Other examples of articles include, but are not limited to: shin guards, knee pads, elbow pads, shoulder pads, as well as any other type of protective equipment. Additionally, in some embodiments, the flexible manufacturing system could be used with bags, duffel bags, purses, backpacks, luggage, various kinds of sportswear and/or sporting equipment.
(68) While each of the components in the figures are not necessarily to scale, it should be noted that the illustrations presented in FIGS. **3** and **6-9** are to scale for the one embodiment disclosed in said figures. However, it should be understood that as noted earlier, in other embodiments the relative sizes and dimensions may differ from those illustrated in FIGS. **3** and **6-9** as shown and disclosed herein. In addition, in some other embodiments, the spool and spool extension may be formed integrally as one component, but comprise the same or a substantially similar unitary configuration as the two individually described and depicted components when joined together.
Examples
(69) In Example 1, an article of footwear includes an upper, a sole structure, and a motorized tensioning device seated in the sole structure The motorized tensioning device includes a cam device, a spool, a tensile element wound, at least in part, around the spool, a driveshaft extending through the spool and coupled to the cam device to deliver torque to the cam device to cause the spool to turn to increase or decrease tension on the tensile element, and an engagement plate configured to engage with and receive torque from the cam device, couple to the spool in an engaged state to cause the spool to rotate with the drive shaft, and space apart from the spool in a disengaged state to cause the spool to rotate independently of the drive shaft.
(70) In Example 2, the article of footwear of Example 1 optionally further includes that the cam device includes a step portion and the engagement plate comprises a first spoke portion, the first spoke portion configured to be flush against a first end of the step portion of the cam device when the spool system is in the disengaged state.
(71) In Example 3, the article of footwear of any one or more of Examples 1 and 2 optionally further includes that the engagement plate further comprises a second spoke portion, the second spoke portion configured to be flush against a second end of the step portion of the cam device when the spool system is in the engaged state, the second end of the step portion being disposed on an opposite side of step portion relative to the first end.
(72) In Example 4, the article of footwear of any one or more or Examples 1-3 optionally further includes that the second end of the step portion has a greater height than the first end of the step portion.
(73) In Example 5, the article of footwear of any one or more of Examples 1-4 optionally further includes that the cam device further comprises a ramped edge extending circumferentially about a portion of the cam device from the first edge to the second edge.
(74) In Example 6, the article of footwear of any one or more of Examples 1-5 optionally further

includes that the ramped edge comprises a first linear portion joined to the first edge, a second linear portion joined to the second edge, and a slope portion between the first linear portion and the second linear portion.
(75) In Example 7, the article of footwear of any one or more of Examples 1-6 optionally further includes that the first linear portion is disposed beneath the first spoke portion of the engagement plate in the disengaged state and describes a first height and the second linear portion is disposed beneath the second spoke portion in the engaged state and describes a second height greater than the first height.
(76) In Example 8: the article of footwear of any one or more of Examples 1-7 optionally further includes that the tensile element is substantially wound around the spool when the article of footwear is under tension and substantially unwound from the spool when the article of footwear is loosened.
(77) In Example 9, the article of footwear of any one or more of Examples 1-8 optionally further includes that the first tensile element can be freely unwound from the spool system in the disengaged state.
(78) In Example 10, the article of footwear of any one or more of Examples 148 optionally further includes that the spool is substantially elongated and includes a substantially cylindrical shape, wherein the spool comprises an opening extending between a first spool end and a second spool end, and wherein the driveshaft extends through the opening.
(79) In Example 11, the article of footwear of any one or more of Examples 1-10 optionally further includes that a first portion of the driveshaft extends axially outward from the second end of the spool, wherein the cam device a surrounds the first portion.
(80) In Example 12, the article of footwear of any one or more of Examples 1-11 optionally further includes that a second portion of the driveshaft extends axially outward from the first portion of the driveshaft, wherein the engagement plate surrounds the second portion.
(81) In Example 13, the article of footwear of any one or more of Examples 1-12 optionally further includes that the motorized tensioning system and a motor assembly that is configured to transmit torque to the driveshaft are disposed in a housing, the housing seated in the sole structure.
(82) In Example 14, a method of controlling, in an article of footwear, a motorized tensioning device having a spool, includes turning a driveshaft in a first direction, causing the driveshaft to turn a cam device in the first direction, causing a ramped edge of the cam device to push against a lower surface of an engagement plate such that a rotation of the cam device increases an axial distance between the cam device and the engagement plate, increasing the axial distance between the spool is coupled to the cam device and the engagement plate, thereby transitioning the spool system from an engaged state to a disengaged state, and in the disengaged state, imparting a force on one of an upper of the article of footwear and a tensile element of the article of footwear to freely unwind the tensile element around the spool.
(83) In Example 15, the method of Example 14 optionally further includes turning a driveshaft in a second direction, the second direction being a direction opposite to that of the first direction, driveshaft turning a cam device in the second direction, and decreasing an axial distance between the cam device and the engagement plate, thereby transitioning the spool system from the disengaged state to the engaged state.
(84) In Example 16, the method of any one or more of Examples 14 and 15 optionally further includes, in the engaged state, turning the spool in the second direction to wind the tensile element about the spool.
(85) In Example 17, the method of any one or more of Examples 14-16 optionally further includes that the cam device includes a step portion and increasing the axial distance includes placing a first spoke portion of the engagement plate flush against a first end of the step portion of the cam device.
(86) In Example 18, the method of any one or more of Examples 14-17 optionally further includes

that the engagement plate further comprises a second spoke portion, wherein decreasing the axial distance includes placing the second spoke portion configured flush against a second end of the step portion of the cam device, the second end of the step portion being disposed on an opposite side of step portion relative to the first end.
(87) In Example 19, the method of any one or more of Examples 14-18 optionally further includes that the second end of the step portion has a greater height than the first end of the step portion increasing the axial distance includes traversing, with the first spoke portion, a ramped edge of the cam device extending circumferentially about a portion of the cam device from the first edge to the second edge.
(88) While various embodiments have been described, the description is intended to be exemplary, rather than limiting and it will be apparent to those of ordinary skill in the ad that many more embodiments and implementations are possible that are within the scope of the embodiments Although many possible combinations of features are shown in the accompanying figures and discussed in this detailed description, many other combinations of the disclosed features are possible. Any feature of any embodiment may be used in combination with or substituted for any other feature or element in any other embodiment unless specifically restricted Therefore, it will be understood that any of the features shown and/or discussed in the present disclosure may be implemented together in any suitable combination. Accordingly, the embodiments are not to be restricted except in light of the attached claims and their equivalents. Also, various modifications and changes may be made within the scope of the attached claims.

Claims

1. An article of footwear, comprising: an upper; a sole structure; and a motorized tensioning device seated in the sole structure and comprising: an electric motor; a cam device comprising one ramped edge extending circumferentially about a substantial majority of a circumference of the cam device from a first edge of the cam device to a second edge of the cam device; a spool; a tensile element wound, at least in part, around the spool; a driveshaft, coupled to the electric motor, extending through the spool and coupled to the cam device to deliver torque to the cam device to cause the spool to turn to increase or decrease tension on the tensile element; and an engagement plate configured to: engage with and receive torque from the cam device; couple to the spool in an engaged state to cause the spool to rotate with the drive shaft; and space apart from the spool in a disengaged state to cause the spool to rotate independently of the drive shaft.
2. The article of footwear of claim 1, wherein: the cam device includes a step portion; and the engagement plate comprises a first spoke portion, the first spoke portion configured to be flush against a first end of the step portion of the cam device when the spool system is in the disengaged state.
3. The article of footwear of claim 2, wherein the engagement plate further comprises a second spoke portion, the second spoke portion configured to be flush against a second end of the step portion of the cam device when the spool system is in the engaged state, the second end of the step portion being disposed on an opposite side of step portion relative to the first end.
4. The article of footwear of claim 3, wherein the second end of the step portion has a greater height than the first end of the step portion.
5. The article of footwear of claim 1, wherein the ramped edge comprises a first linear portion joined to the first edge, a second linear portion joined to the second edge, and a slope portion between the first linear portion and the second linear portion.
6. The article of footwear of claim 5, wherein the first linear portion is disposed beneath the first spoke portion of the engagement plate in the disengaged state and describes a first height and the second linear portion is disposed beneath the second spoke portion in the engaged state and describes a second height greater than the first height.

7. The article of footwear of claim 1, wherein the tensile element is substantially wound around the spool when the article of footwear is under tension and substantially unwound from the spool when the article of footwear is loosened.
8. The article of footwear of claim 1, wherein the first tensile element can be freely unwound from the spool system in the disengaged state.
9. The article of footwear of claim 1, wherein the spool is substantially elongated and includes a substantially cylindrical shape, wherein the spool comprises an opening extending between a first spool end and a second spool end, and wherein the driveshaft extends through the opening.
10. The article of footwear of claim 9, wherein a first portion of the driveshaft extends axially outward from the second end of the spool, wherein the cam device surrounds the first portion.
11. The article of footwear of claim 1, wherein a second portion of the driveshaft extends axially outward from the first portion of the driveshaft, wherein the engagement plate surrounds the second portion.
12. The article of footwear of claim 1, wherein the motorized tensioning system and a motor assembly that is configured to transmit torque to the driveshaft are disposed in a housing, the housing seated in the sole structure.
13. A method of controlling, in an article of footwear, a motorized tensioning device having a spool, the method comprising: turning a driveshaft in a first direction using an electric motor, causing the driveshaft to turn a cam device in the first direction, causing a ramped edge of the cam device to push against a lower surface of an engagement plate such that a rotation of the cam device increases an axial distance between the cam device and the engagement plate; increasing the axial distance between the spool is coupled to the cam device and the engagement plate, thereby transitioning the spool system from an engaged state to a disengaged state; and in the disengaged state, imparting a force on one of an upper of the article of footwear and a tensile element of the article of footwear to freely unwind the tensile element around the spool.
14. The method of claim 13, further comprising: turning a driveshaft in a second direction, the second direction being a direction opposite to that of the first direction, the driveshaft turning a cam device in the second direction; and decreasing an axial distance between the cam device and the engagement plate, thereby transitioning the spool system from the disengaged state to the engaged state.
15. The method of claim 14, further comprising, in the engaged state, turning the spool in the second direction to wind the tensile element about the spool.
16. The method of claim 14, wherein: the cam device includes a step portion; and increasing the axial distance includes placing a first spoke portion of the engagement plate flush against a first end of the step portion of the cam device.
17. The method of claim 16, wherein the engagement plate further comprises a second spoke portion, wherein decreasing the axial distance includes placing the second spoke portion configured flush against a second end of the step portion of the cam device, the second end of the step portion being disposed on an opposite side of step portion relative to the first end.
18. The article of footwear of claim 17, wherein the second end of the step portion has a greater height than the first end of the step portion increasing the axial distance includes traversing, with the first spoke portion.
19. The method of claim 18, wherein the ramped edge comprises a first linear portion joined to the first edge, a second linear portion joined to the second edge, and a slope portion between the first linear portion and the second linear portion.
20. The method of claim 19, wherein the first linear portion is disposed beneath the first spoke portion of the engagement plate in the disengaged state and describes a first height and the second linear portion is disposed beneath the second spoke portion in the engaged state and describes a second height greater than the first height.