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TWO SPEED TRAILER JACK

Abstract

A linear jack includes a shaft, a first sleeve configured to receive the shaft, a second sleeve configured to be received at least partially into the first sleeve, the second sleeve is threadedly coupled to the first sleeve, a third sleeve configured to be received at least partially into the second sleeve, a translating screw disposed at least partially within the third sleeve, wherein the third sleeve is threadedly coupled to the translating screw, and a cover sleeve extending from the translating screw. The cover sleeve can be configured to translate with the translating screw with respect to the third sleeve. A portion of the translating screw extending from an open end of the third sleeve can beat least partially enclosed by the cover sleeve. The shaft can be configured to receive the translating screw.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS [0001] This application claims priority to, the benefit of, and is a continuation of U.S. patent application Ser. No. 17/687,061, filed on Mar. 4, 2022, and entitled “TWO SPEED TRAILER JACK;” which claims priority to, the benefit of, and is a continuation of U.S. patent application Ser. No. 16/950,525, filed on Nov. 17, 2020, and entitled “TWO SPEED TRAILER JACK;” which claims priority to, the benefit of, and is a continuation-in-part of U.S. patent application Ser. No. 16/943,997, filed on Jul. 30, 2020, and entitled “TWO SPEED TRAILER JACK;” which claims priority to, the benefit of, and is a continuation-in-part of U.S. patent application Ser. No. 16/883,811, filed on May 26, 2020, and entitled “TWO SPEED TRAILER JACK;” all of which are incorporated by reference herein in their entirety for all purposes.

FIELD
[0002] The present disclosure relates generally to apparatuses such as jacks for lifting and suspending vehicles, trailers, and other large objects, and, more specifically, to linear jacks that are used to selectively lower and raise, for example, a portion of a trailer.
BACKGROUND
[0003] M any of the different types of trailers that are towed by trucks are connected to the trucks by a releasable coupling such as a gooseneck coupling, a fifth wheel coupling, a bumper pull coupling and the like. After the trailer is released from the truck and is no longer supported by the truck at the forward end of the trailer, a lifting device, such as a jack and/or landing gear assembly, is often used to support the trailer floor or bed, typically in a position generally horizontal to the ground.
[0004] A typical lifting device is attached to the trailer adjacent the truck coupling at the forward end of the trailer. The lifting device includes one or more vertically oriented columns and a vertical leg is mounted on the column. A hand crank is typically connected to the gear mechanism. Selectively rotating the hand crank lowers the leg until the leg contacts the ground and supports the forward end of the trailer when the trailer is being uncoupled from the truck, or raises the leg when the trailer has been connected to a truck and is ready for towing.
SUMMARY
[0005] Disclosed is a linear jack arrangement, including a shaft, a first sleeve configured to receive the shaft, a second sleeve configured to be received at least partially into the first sleeve, the second sleeve is threadedly coupled to the first sleeve, a third sleeve configured to be received at least partially into the second sleeve, a translating screw disposed at least partially within the third sleeve, wherein the third sleeve is threadedly coupled to the translating screw, and a cover sleeve extending from the translating screw. The cover sleeve can be configured to translate with the translating screw with respect to the third sleeve. A portion of the translating screw extending from an open end of the third sleeve can be at least partially enclosed by the cover sleeve. The shaft can be configured to receive the translating screw.
[0006] In various embodiments, the third sleeve is configured to rotate in response to rotation of

the shaft.

[0007] In various embodiments, the third sleeve is mounted in a rotationally fixed manner to the shaft, whereby the third sleeve rotates together with the shaft.

[0008] In various embodiments, the shaft, the first sleeve, the second sleeve, the third sleeve, and the translating screw are coaxially aligned.

[0009] In various embodiments, the second sleeve comprises a first flange and a second flange, wherein the first flange extends radially inward from the second sleeve and the second flange extends radially inward from the second sleeve.

[0010] In various embodiments, the third sleeve comprises a third flange extending radially outward therefrom, wherein the shaft comprises a centerline axis, and the third flange is disposed axially between the first flange and the second flange.

[0011] In various embodiments, the first flange is removably coupled to the second sleeve.

[0012] In various embodiments, the third sleeve comprises a flange extending radially inward therefrom, wherein the third sleeve is threadedly coupled to the translating screw via the flange.

[0013] In various embodiments, the cover sleeve is configured to be received between the second sleeve and the third sleeve.

[0014] In various embodiments, a radially outer surface of the cover sleeve is keyed to a radially inner surface of the second sleeve so as to prevent rotation of the second sleeve with respect to the cover sleeve.

[0015] In various embodiments, the linear jack arrangement further includes an outer tube configured to receive the first sleeve.

[0016] In various embodiments, the first sleeve is disposed entirely within the outer tube.

[0017] In various embodiments, the first sleeve is slidable in the outer tube between a first position, wherein the first sleeve is engaged to the shaft, and a second position wherein the first sleeve is disengaged from the shaft.

[0018] In various embodiments, the shaft comprises a gear whereby the shaft is configured to drive rotation of the first sleeve.

[0019] A method of manufacturing a linear jack is disclosed. The method includes disposing a second sleeve at least partially within a first sleeve, wherein the first sleeve is threadedly coupled to the second sleeve. The method further includes disposing a translating screw at least partially within a third sleeve, wherein the third sleeve is threadedly coupled to the translating screw. The method further includes operatively coupling the third sleeve to a shaft, wherein the third sleeve is configured to rotate in response to rotation of the shaft. The method further includes disposing the third sleeve at least partially within the second sleeve. The method further includes coupling a cover sleeve to the translating screw, wherein the cover sleeve is configured to translate with the translating screw, the cover sleeve is disposed at least partially within the second sleeve, and a portion of the translating screw extending from an open end of the third sleeve is at least partially enclosed by the cover sleeve.

[0020] In various embodiments, the method further includes disposing the cover sleeve to surround the translating screw, disposing the cover sleeve to surround the third sleeve, and disposing the cover sleeve in keyed connection with the second sleeve.

[0021] In various embodiments, the method further includes disposing the cover sleeve between the second sleeve and the third sleeve.

[0022] In various embodiments, the operatively coupling the third sleeve to the shaft includes mounting the third sleeve in a rotationally fixed manner to the shaft, whereby the third sleeve rotates together with the shaft.

[0023] In various embodiments, the operatively coupling the third sleeve to the shaft includes coupling the third sleeve to the shaft via a splined connection.

[0024] In various embodiments, the method further includes disposing the first sleeve within an outer tube, wherein the first sleeve is slidable in the outer tube between a first position, wherein the first sleeve is engaged to the shaft, and a second position wherein the first sleeve is disengaged from the shaft.

[0025] The foregoing features and elements may be combined in various combinations without exclusivity, unless expressly indicated otherwise. These features and elements as well as the operation thereof will become more apparent in light of the following description and the accompanying drawings. It should be understood, however, the following description and drawings are intended to be example in nature and non-limiting.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The subject matter of the present disclosure is particularly pointed out and distinctly claimed in the concluding portion of the specification. A more complete understanding of the present disclosure, however, may best be obtained by referring to the detailed description and claims when considered in connection with the figures, wherein like numerals denote like elements.

[0027] FIG. **1** illustrates a schematic view of a trailer-mounted lifting device supporting a front end of a trailer on a ground surface, in accordance with various embodiments.

[0028] FIG. **2** illustrates an exploded view of a lifting device, in accordance with various embodiments.

[0029] FIG. **3**A and FIG. **3**B illustrate a partially exploded view of a low speed assembly and a shaft of the lifting device of FIG. **2**, the shaft for driving the low speed assembly, in accordance with various embodiments.

[0030] FIG. **4**A and FIG. **4**B illustrate a side view and a section view, respectively, of the lifting device of FIG. **2**, with the lifting device in a retracted state, and a high speed sleeve in a first position, in accordance with various embodiments.

[0031] FIG. **4**C and FIG. **4**D illustrate a side view and a section view, respectively, of the lifting device of FIG. **4**A and FIG. **4**B, with the lifting device in a partially extended state, and the high speed sleeve in the first position, in accordance with various embodiments.

[0032] FIG. **4**E and FIG. **4**F illustrate a side view and a section view, respectively, of the lifting device of FIG. **4**A and FIG. **4**B, with the lifting device in an extended state, and the high speed sleeve in a second position, in accordance with various embodiments.

[0033] FIG. **5**A and FIG. **5**B illustrate aside view and a section view, respectively, of the lifting device of FIG. **4**A and FIG. **4**B, with an outer tube of the lifting device omitted for clarity purposes, in accordance with various embodiments.

[0034] FIG. **6**A and FIG. **6**B illustrate a side view and a section view, respectively, of the lifting device of FIG. **4**A and FIG. **4**B, with the outer tube and the high speed sleeve of the lifting device omitted for clarity purposes, in accordance with various embodiments.

[0035] FIG. **7**A and FIG. **7**B illustrate a side view and a section view, respectively, of the high speed sleeve of FIG. **2**, in accordance with various embodiments.

[0036] FIG. **8**A and FIG. **8**B illustrate a side view and a section view, respectively, of a partially exploded view of the low speed assembly of the lifting device of FIG. **2**, in accordance with various embodiments.

[0037] FIG. **9**A, FIG. **9**B, and FIG. **9**C illustrate a side view, a section view, and a perspective view, respectively, of the low speed sleeve of FIG. **2**, in accordance with various embodiments.

[0038] FIG. **10**A and FIG. **10**B illustrate a perspective view and a sideview, respectively, of a lifting device comprising an attachment feature, in accordance with various embodiments.

[0039] FIG. **11**A and FIG. **11**B illustrate a section view and a perspective view, respectively, of an outer tube of a lifting device comprising an attachment feature for attaching the lifting device to a trailer, in accordance with various embodiments.

[0040] FIG. **12** illustrates a landing gear assembly having two lifting devices, in accordance with various embodiments.

[0041] FIG. **13**A and FIG. **13**B illustrate a lifting device for the landing gear assembly of FIG. **12** with an sleeve of the lifting device in a first position and a second position, respectively, and comprising a shaft driven by a crank with the outer tube removed for clarity purposes, in accordance with various embodiments.

[0042] FIG. **14** illustrates a section view of one of the lifting devices of FIG. **12**, in accordance with various embodiments.

[0043] FIG. **15**A and FIG. **15**B illustrate a section view and a side view, respectively, of a lifting device comprising a low speed assembly comprising a rotating screw and a translating nut, in accordance with various embodiments.

[0044] FIG. **16** illustrates an exploded view of a lifting device comprising a high speed assembly nested within a low speed assembly, in accordance with various embodiments.

[0045] FIG. **17**A and FIG. **17**B illustrate a side view and a section view, respectively, of the lifting device of FIG. **16**, with the lifting device in a retracted state, and a high speed rotating screw in a first position, in accordance with various embodiments.

[0046] FIG. **17**C and FIG. **17**D illustrate a side view and a section view, respectively, of the lifting device of FIG. **17**A and FIG. **17**B, with the lifting device in an extended state, and the high speed rotating screw in a second position, in accordance with various embodiments.

[0047] FIG. **18** illustrates a flow chart of a method of manufacturing a lifting device, in accordance with various embodiments.

[0048] FIG. **19**A and FIG. **19**B illustrate a side view and a section view, respectively, of a lifting device comprising a first jack screw assembly including a thread pitch that is equal to a second jack screw assembly, in accordance with various embodiments.

[0049] FIG. **20** illustrates an exploded view of a lifting device comprising a planetary gear system, in accordance with various embodiments.

[0050] FIG. **21**A and FIG. **21**B illustrate a side view and a section view, respectively, of the lifting device of FIG. **20**, with the lifting device in a retracted state, and an sleeve in a first position and a sun gear in a first position, in accordance with various embodiments.

[0051] FIG. **21**C and FIG. **21**D illustrate a side view and a section view, respectively, of the lifting device of FIG. **21**A and FIG. **21**B, with the lifting device in an extended state, and the sleeve in a second position and a sun gear in a second position, in accordance with various embodiments.

[0052] FIG. **22** illustrates an exploded view of a lifting device, in accordance with various embodiments.

[0053] FIG. **23**A illustrates a section view of the lifting device of FIG. **22**, with the lifting device in a retracted state, and an sleeve in a first position, in accordance with various embodiments.

[0054] FIG. **23**B and FIG. **23**C illustrate a side view and a section view, respectively, of the lifting device of FIG. **23**A, with the lifting device in an extended state, in accordance with various embodiments.

[0055] FIG. **23**D and FIG. **23**E illustrate the lifting device of FIG. **22** with the sleeve in a first position and a second position, respectively, in accordance with various embodiments.

[0056] FIG. **24**A and FIG. **24**B illustrate a swiveling foot of the lifting device of FIG. **22**, respectively, in accordance with various embodiments.

[0057] FIG. **25** illustrates an exploded view of a two-piece telescoping shaft for a lifting device, in accordance with various embodiments.

[0058] FIG. **26**A and FIG. **26**B illustrate a section view and a side view, respectively of a lifting device in a retracted state and having the two-piece telescoping shaft of FIG. **25**, in accordance with various embodiments.

[0059] FIG. **26**C and FIG. **26**D illustrate a section view and a side view, respectively of the lifting device of FIG. **26**A and FIG. **26**B in a fully extended state and having the two-piece telescoping shaft of FIG. **25**, in accordance with various embodiments.

[0060] FIG. **27** illustrates a flow chart of a method of assembling a lifting device, in accordance with various embodiments.

[0061] FIG. **28**A and FIG. **28**B illustrate a side view and a section view, respectively, of a lifting device in a retracted state, and a high speed sleeve in a first position, in accordance with various embodiments.

[0062] FIG. **28**C and FIG. **28**D illustrate a side view and a section view, respectively, of the lifting device of FIG. **28**A and FIG. **28**B, with the lifting device in an extended state, and the high speed sleeve in a second position, in accordance with various embodiments.

[0063] FIG. **29**A illustrates a section view of an upper portion of the lifting device of FIG. **28**B, in accordance with various embodiments.

[0064] FIG. **29**B illustrates a section view of a lower portion of the lifting device of FIG. **28**B, in accordance with various embodiments.

[0065] FIG. **30** illustrates a section view of the lower portion of the lifting device of FIG. **28**B, with the outer tube and the high speed assembly omitted, in accordance with various embodiments.

[0066] FIG. **31** illustrates a flow chart of a method of assembling a lifting device, in accordance with various embodiments.

DETAILED DESCRIPTION

[0067] All ranges and ratio limits disclosed herein may be combined. It is to be understood that unless specifically stated otherwise, references to “a,” “an,” and/or “the” may include one or more than one and that reference to an item in the singular may also include the item in the plural.

[0068] The detailed description of various embodiments herein makes reference to the accompanying drawings, which show various embodiments by way of illustration. While these various embodiments are described in sufficient detail to enable those skilled in the art to practice the disclosure, it should be understood that other embodiments may be realized and that logical, chemical, and mechanical changes may be made without departing from the spirit and scope of the disclosure. Thus, the detailed description herein is presented for purposes of illustration only and not of limitation. For example, the steps recited in any of the method or process descriptions may be executed in any order and are not necessarily limited to the order presented. Furthermore, any reference to singular includes plural embodiments, and any reference to more than one component or step may include a singular embodiment or step. Also, any reference to attached, fixed, connected, or the like may include permanent, removable, temporary, partial, full, and/or any other possible attachment option. Additionally, any reference to without contact (or similar phrases) may also include reduced contact or minimal contact. Cross hatching lines may be used throughout the figures to denote different parts but not necessarily to denote the same or different materials.

[0069] Typical lifting devices, such as linear trailer jacks, operate using a constant thread pitch sized to obtain sufficient mechanical advantage to lift a heavy load, such as a trailer. In that regard, as a smaller thread pitch increases mechanical advantage relative to a larger thread pitch, many available linear trailer jacks use a constant, small thread pitch. However, the gain in mechanical advantage is offset by the increase in the number of rotations of an input device (e.g., a handle) needed to extend (translate) the linear trailer jack. In this manner, conventional linear trailer jack may provide the mechanical advantage desired to lift a trailer but at the expense of time consuming, and bothersome, turning.

[0070] Thread pitch, as used herein, is generally defined as the distance between threads on a threaded coupling, such as that found on a screw, lead screw or jack screw. Thread count, expressed for example as threads per inch, is generally defined as the number of threads per inch of linear distance on a threaded coupling, such as that found on a screw, lead screw or jack screw. In that regard, thread pitch and thread count are related, both expressing the spacing of threads about a screw, lead screw or jack screw.

[0071] Systems and methods for a two speed lifting device—such as a linear trailer jack—are provided herein. A lifting device of the present disclosure generally comprises a high speed assembly and a low speed assembly. The high speed assembly generally comprises a screw mechanism comprising a nut threadedly coupled to a screw. In various embodiments, the nut rotates and the screw translates, and in various embodiments, the nut translates and the screw rotates. The screw and nut are threadedly coupled for translating the rotational force to a linear force. The low speed assembly also comprises a nut threadedly coupled to a screw. A thread pitch of the high speed assembly is greater than a thread pitch of the low speed assembly, in various embodiments. In this manner, when driven by a common shaft and/or at the same revolutions per unit time, the high speed assembly causes the lifting device to extend a greater linear distance per rotation of a shaft than the low speed assembly.

[0072] In this manner, the high speed assembly causes more linear extension per rotation and thus reduces the number of rotations needed to lower or raise the lifting device. This reduces or eliminates the wasted time incurred if no such high speed assembly existed. However, when the lifting device begins to touch the ground, and mechanical advantage now becomes more important, in various embodiments, the high speed assembly is disengaged, for example, automatically disengaged. Thus, in response to the lifting device contacting a ground surface, a force is reacted into the high speed assembly, thereby moving a moveable member of the high speed assembly from a first position to a second position, and disengaging the high speed assembly from being drivably coupled with the shaft and/or other motive rotational force. With the moveable member of the high speed assembly in the second position, only the low speed assembly is driven in response to rotation of the shaft, thereby benefiting from the mechanical advantage of the low speed assembly, which has a smaller thread pitch than the high speed assembly. In this manner, lifting devices of the present disclosure may quickly and efficiently extend in overall length, reducing the number of turns required to reach a ground surface, while still providing the mechanical advantage to lift heavy loads. In various embodiments, this transition occurs without any additional action and thus improves ease of use and reduces overall time needed for operation. In this manner, lifting devices of the present disclosure may automatically switch from a high speed mode to a low speed mode in response to the ground force being reacted through the lifting device (i.e., in response to contacting the ground as the jack is extended).

[0073] With reference to FIG. **1**, a trailer **120** partially supported on a ground surface **190** by a lifting device **100** is illustrated, in accordance with various embodiments. Lifting device **100** may be coupled to a front end of the trailer **120**. Lifting device **100** may be generally vertically oriented when supporting the front end of the trailer **120**. Although illustrated coupled to a utility type trailer, lifting devices of the present disclosure may be utilized on any trailer or vehicle where support is desired, for example, with a camper, recreational vehicle, toy hauler, boat, or any other device capable of being towed as a trailer.

[0074] With reference to FIG. **2**, an exploded view of a lifting device **200** is illustrated, in accordance with various embodiments. Lifting device **200** may be a linear jack. Lifting device **200** may generally comprise an outer tube **210**, a high speed assembly **202**, and a low speed assembly **204**. High speed assembly **202** may generally comprise a screw mechanism comprising a rotating nut threadedly coupled to a translating screw, in the manner of a leadscrew or jack screw. In various embodiments, high speed assembly **202** comprises a rotating first sleeve **220** (also referred to herein as a high speed outer sleeve or a first sleeve), and a translating second sleeve **230** (also referred to herein as a high speed inner sleeve or a second sleeve). Low speed assembly **204** may generally comprise a screw mechanism comprising a rotating nut threadedly coupled to a translating screw. Low speed assembly **204** may comprise a rotating third sleeve **240** (also referred to herein as a low speed outer sleeve or a third sleeve), and a translating screw **250** (also referred to herein as a low speed inner sleeve).

[0075] Although the present disclosure is described in accordance with various embodiments on the basis of a screw mechanism having a rotating nut and a translating screw, it should be understood that the present disclosure can be applied with a rotating screw and a translating nut, as illustrated in FIG. **15**A and/or FIG. **16**, for example.

[0076] Outer tube **210** may comprise a centerline axis **292**. Outer tube **210** may be hollow. First sleeve **220** may be disposed at least partially within outer tube **210**. First sleeve **220** may be hollow. Second sleeve **230** may be disposed at least partially within first sleeve **220**. Second sleeve **230** may be hollow. Third sleeve **240** may be disposed at least partially within second sleeve **230**. Third sleeve **240** may be hollow. Translating screw **250** may be disposed at least partially within third sleeve **240**. Translating screw **250** may be hollow. Lifting device **200** may further comprise a shaft **260**. Shaft **260** may be disposed at least partially within translating screw **250**. In this regard, the inner diameter of outer tube **210** may be greater than the outer diameter of first sleeve **220**. The inner diameter of first sleeve **220** may be greater than the outer diameter of second sleeve **230**. The inner diameter of second sleeve **230** may be greater than the outer diameter of third sleeve **240**. The inner diameter of third sleeve **240** may be greater than the outer diameter of translating screw **250**. The inner diameter of translating screw **250** may be greater than the outer diameter, or width, of shaft **260**. Outer tube **210**, first sleeve **220**, second sleeve **230**, third sleeve **240**, translating screw **250**, and shaft **260** are coaxially aligned and/or substantially coaxially aligned, but in various embodiments coaxial alignment is not present. One end of shaft **260** may bear a handle **270** which may be used for rotating the shaft **260**.

[0077] Lifting device **200** may further comprise a gear **265**. Gear **265** may be coupled to, and rotate with, shaft **260**. Gear **265** may be coaxially aligned with shaft **260**. Shaft **260** may drive first sleeve **220** via gear **265** in response to first sleeve **220** moving to a first position, as described in further detail herein. Gear **265** may be splined to the shaft **260** but gear **265** may also be fixedly coupled such as through welding, brazing, a press fit and/or an interference fit. Gear **265** may comprise any suitable gear, for example, a bevel gear or a crown gear.

[0078] Lifting device **200** may further comprise a spring **206**. Spring **206** may be a coil spring, leaf spring, Belleville spring, or other suitable spring for exerting a bias against first sleeve **220**. Spring **206** may be operatively coupled to first sleeve **220**, to assist movement of first sleeve **220** between the first position and a second position, as described herein with further detail. In this regard, first sleeve **220** may be slidable in the outer tube **210** between the first position and the second position. First sleeve **220** may translate along centerline axis **292** between the first position and the second position. The outer tube **210** may comprise a retaining member **212**. Retaining member **212** may be coupled to outer tube **210**, e.g., via a threaded connection, fasteners, and/or a metal joining process, such as welding, brazing, etc. Retaining member **212** may comprise a cap structure coupled to the upper end of outer tube **210**. Retaining member **212** may comprise a flange extending radially inward from an inner diameter surface of outer tube **210**. Shaft **260** may extend through retaining member **212**. Retaining member **212** may retain spring **206** within outer tube **210**. In this regard, spring **206** may be compressed between retaining member **212** and first sleeve **220**. In various embodiments, retaining member **212** comprises a mating surface **214** configured to engage with a mating surface **224** of first sleeve **220** in response to first sleeve **220** moving to the second position (see FIG. **4**F). In this manner, first sleeve **220** may be restricted from rotating within outer tube **210** in the second position. In various embodiments, and as shown, mating surface **224** and mating surface **214** are crenulated and, as shown, having crenulations that are complementary to one another. The crenulations interact, in response to axial compression, to transfer torque to first sleeve **220**.

[0079] In various embodiments, first sleeve **220** is threadedly coupled to second sleeve **230**. Thus, rotation of the first sleeve **220** causes the second sleeve **230** to translate with respect to outer tube **210**. Stated differently, high speed assembly **202** translates rotational motion of first sleeve **220** to linear motion of second sleeve **230**. In various embodiments, third sleeve **240** is threadedly coupled to translating screw **250**. Thus, rotation of the third sleeve **240** causes the translating screw **250** to translate with respect to outer tube **210**. Stated differently, low speed assembly **204** translates rotational motion of third sleeve **240** to linear motion of translating screw **250**.

[0080] Various components of lifting device **200** may be made from a metal or metal alloy, such as cast iron, steel, stainless steel, austenitic stainless steels, ferritic stainless steels, martensitic stainless steels, titanium, titanium alloys, aluminum, aluminum alloys, galvanized steel, or any other suitable metal or metal alloy. In this regard, outer tube **210**, first sleeve **220**, second sleeve **230**, third sleeve **240**, and translating screw **250** may be made from a metal or metal alloy. It is contemplated that various components of lifting device **200**, such as outer tube **210**, may be made from a fiber-reinforced composite material.

[0081] With combined reference to FIG. **2**, FIG. **3**A, and FIG. **3**B, shaft **260** may be operatively coupled to third sleeve **240** such that third sleeve **240** rotates with shaft **260**. In various embodiments, shaft **260** may comprise one or more splines **262** and third sleeve **240** may comprise a center aperture **242** comprising a geometry that is complementary to shaft **260**. In this regard, center aperture **242** may comprise one or more grooves configured to receive the one or more splines **262** of shaft **260** such that shaft **260** interlocks with third sleeve **240** to impart rotational forces (i.e., torque) therebetween. Stated differently, third sleeve **240** and shaft **260** may be coupled via a splined connection. Third sleeve **240** may be drivably coupled to shaft **260** via center aperture **242**. Furthermore, although illustrated as a star shaped aperture, center aperture **242** may comprise various geometries, such as triangular, square, or any other geometry that interlocks shaft **260** with third sleeve **240**. However, shaft **260** may be operatively coupled to third sleeve **240** using various methods without departing from the scope and spirit of the present disclosure, such as via a fastener, for example.

[0082] In operation, rotation of shaft **260** in a first rotational direction, e.g., via handle **270**, causes third sleeve **240** to rotate with respect outer tube **210** and translating screw **250**, which in turn causes translating screw **250** to extend from third sleeve **240** (see FIG. **4**E and FIG. **4**F). Conversely, rotation of shaft **260** in a second rotational direction (opposite the first rotational direction) causes third sleeve **240** to rotate with respect outer tube **210** and translating screw **250**, which in turn causes translating screw **250** to retract into third sleeve **240** (see FIG. **4**A and FIG. **4**B).

[0083] Furthermore, with first sleeve **220** in a first position (see FIG. **4**A through FIG. **4**D) with respect to outer tube **210**, first sleeve **220** may be drivably coupled to shaft **260**. Stated differently, rotation of shaft **260** may drive rotation of first sleeve **220**. In operation, and with first sleeve **220** in a first position (see FIG. **4**A through FIG. **4**D) with respect to outer tube **210** and/or gear **265**, rotation of shaft **260** in a first rotational direction, e.g., via handle **270**, may cause first sleeve **220** to rotate with respect outer tube **210** and second sleeve **230**, which in turn causes second sleeve **230** to extend from first sleeve **220**. Conversely, rotation of shaft **260** in a second rotational direction (opposite the first rotational direction) may cause first sleeve **220** to rotate with respect outer tube **210** and second sleeve **230**, which in turn causes second sleeve **230** to retract into first sleeve **220**. In the first position, spring **206** may bias first sleeve **220** to engage with gear **265**. Thus, with the first sleeve **220** in the first position, both the second sleeve **230** and the translating screw **250** are driven to translate with respect to outer tube **210** in response to rotation of shaft **260**.

[0084] However, in operation and with first sleeve **220** in a second position (see FIG. **4**E and FIG. **4**F) with respect to outer tube **210** and/or gear **265**, the first sleeve **220** is disengaged from gear **265** (i.e., rotation of shaft **260** and gear **265** does not drive rotation of first sleeve **220** in the disengaged position). In this regard, with first sleeve **220** in the second position, rotation of shaft **260** in the first rotational direction or the second rotational direction may cause only third sleeve **240** (and not first sleeve **220**) to rotate with respect to outer tube **210** and translating screw **250**, thereby driving only the translating screw **250** to translate. Stated differently, the high speed assembly **202** (i.e., the first sleeve **220** and second sleeve **230**) may be disengaged from operation in response to the first sleeve **220** moving to the second position. In this manner, in response to rotation of shaft **260** in the first direction, both the high speed assembly **202** and the low speed assembly **204** (i.e., the third sleeve **240** and translating screw **250**) are driven to increase the overall length of lifting device **200** but, after reacting force from the ground through, for example, foot **275**, rotation of shaft **260** is only imparted to low speed assembly **204** and not high speed assembly **202**. With momentary reference to FIG. **4**E and FIG. **4**F, as the overall length of lifting device **200** is increased, the foot **275** of the lifting device **200** may contact a ground surface **402**, thereby imparting a force **404** from the ground surface **402** into the first sleeve **220** which causes the first sleeve **220** to move with respect to outer tube **210** against the bias of spring **206** from the first position (i.e., engaged with gear **265**) to the second position (i.e., disengaged from gear **265**) thereby decoupling first sleeve **220** from torsional forces imparted by shaft **260**. In this regard, before the lifting device **200** has contacted a ground surface, the overall length of the lifting device **200** is quickly increased to reduce the overall number of rotations of shaft **260** needed to cause lifting device **200** to reach the ground. In response to contacting the ground, the high speed assembly **202** is decoupled from the shaft **260** to take advantage of the mechanical advantage of the low speed assembly **204**. In this manner, time to operate is reduced relative to conventional designed and increased mechanical advantage is selectively activated.

[0085] In various embodiments, second sleeve **230** comprises helically extending grooves or threads **232**. In various embodiments, translating screw **250** comprises helically extending grooves and/or threads **252**. The thread pitch of threads **232** may be greater than the thread pitch of threads **252**. Stated differently, translating screw **250** may comprise more threads per inch (TPI) than second sleeve **230**. In various embodiments, the thread pitch of threads **232** is between 101% and 1000% as large as the thread pitch of threads **252**, though various embodiments, the thread pitch of threads **232** is between 200% and 500% as large as the thread pitch of threads **252**. In various embodiments, the thread pitch of threads **232** is more than twice as large as the thread pitch of threads **252**. In various embodiments, the thread pitch of threads **232** is more than three times as large as the thread pitch of threads **252**. In various embodiments, the thread pitch of threads **232** is more than four times as large as the thread pitch of threads **252**. It should be understood that the maximum thread pitch may be limited by the moment arm for torque applied to the shaft **260** and may be limited to reduce the torque requirement for rotating shaft **260** below a desired threshold. In this manner, the high speed assembly translates further and faster per rotation of shaft **260** than the low speed assembly, causing the lifting device **200** to reach a ground surface faster than if the high speed assembly were not present. Furthermore, in response to the lifting device **200** contacting a ground surface and the high speed assembly disengaging from the shaft **260**, the reduced thread pitch of the low speed assembly takes advantage of the reduced torque required for extending the lifting device **200**.

[0086] The thread pitch of threads **232** may be between 0.1 millimeters (mm) and 304.8 mm (between 0.0039 inches and 12 inches) in accordance with various embodiments, between 1 mm and 101.6 mm (between 0.039 inches and 4 inches) in accordance with various embodiments, between 2 mm and 76.2 mm (between 0.0787 inches and 3 inches) in accordance with various embodiments, and/or between 4 mm and 50.8 mm (between 0.157 inches and 2 inches) in accordance with various embodiments.

[0087] The thread pitch of threads **252** may be between 0.1 millimeters (mm) and 279.4 mm (between 0.0039 inches and 11 inches) in accordance with various embodiments, between 1 mm and 25.4 mm (between 0.039 inches and 1 inch) in accordance with various embodiments, between 1 mm and 6.35 mm (between 0.039 inches and 0.25 inches) in accordance with various embodiments, and/or between 2 mm and 3.175 mm (between 0.0787 inches and 0.125 inches) in accordance with various embodiments.

[0088] With reference to FIG. **2** and FIG. **4**B, second sleeve **230** may be keyed to outer tube **210** to prevent rotation of second sleeve **230** with respect to outer tube **210**. For example, second sleeve **230** may comprise one or more axially extending grooves **234** (see FIG. **2**) disposed in the outer diameter surface thereof and outer tube **210** may comprise corresponding protrusion(s) **216** extending radially inwards from an inner diameter surface thereof that extends into groove(s) **234**.

[0089] With reference to FIG. **5**A and FIG. **5**B, the lifting device of FIG. **4**A with the outer tube, spring, and retaining member omitted is illustrated, in accordance with various embodiments. In various embodiments, translating screw **250** may be keyed to second sleeve **230** to prevent rotation of translating screw **250** with respect to second sleeve **230** and outer tube **210**. For example, translating screw **250** may comprise one or more axially extending grooves **254** (see FIG. **2**) disposed in the outer diameter surface thereof and second sleeve **230** may comprise corresponding protrusion(s) **236** extending radially inwards from an inner diameter surface thereof that extends into groove(s) **254**.

[0090] With reference to FIG. **6**A and FIG. **6**B, the lifting device of FIG. **5**A with the first sleeve **220** further omitted is illustrated, in accordance with various embodiments. Gear **265** may be slid onto shaft **260** just above second sleeve **230**, in accordance with various embodiments. Second sleeve **230** may comprise flange **238** at an upper end thereof extending radially inward to form an end wall through which shaft **260** extends. Furthermore, an upper end of third sleeve **240** may abut flange **238**.

[0091] With reference to FIG. **7**A and FIG. **7**B, high speed first sleeve **220** is illustrated, in accordance with various embodiments. First sleeve **220** may comprise a radially inward extending flange **222** forming an end wall at the upper end of first sleeve **220**. Shaft **260** (see FIG. **5**B) may extend through flange **222**. First sleeve **220** may comprise a plurality of teeth **226**. Plurality of teeth **226** may be disposed on flange **222**. Plurality of teeth **226** may be in meshing relationship with gear **265** (see FIG. **4**B) in response to first sleeve **220** moving to the first position whereby shaft **260** may be drivably coupled to shaft **260**. Plurality of teeth **226** may further comprise crenulations to complement gear **265**, in various embodiments. First sleeve **220** may comprise helically extending ridges **228** (also referred to herein as threads). Threads **228** may be disposed on an inner diameter surface of first sleeve **220**. Threads **228** may engage with complementary threads **232** (See FIG. **2**) disposed on second sleeve **230**. Threads **228** and threads **232** may assist in translating rotational motion of first sleeve **220** into linear motion of second sleeve **230**.

[0092] With reference to FIG. **8**A and FIG. **8**B, low speed assembly **204** is illustrated, in accordance with various embodiments. Third sleeve **240** may comprise helically extending ridges **244** (also referred to herein as threads). Threads **244** may be disposed on an inner diameter surface of third sleeve **240**. Threads **244** may engage with complementary threads **252** disposed on translating screw **250**. Threads **244** and threads **252** may assist in translating rotational motion of third sleeve **240** into linear motion of translating screw **250**.

[0093] With reference to FIG. **9**A, FIG. **9**B, and FIG. **9**C, low speed outer sleeve **240** is illustrated, in accordance with various embodiments. Third sleeve **240** may comprise radially inward extending flange **246** forming an end wall at the upper end of third sleeve **240**. Center aperture **242** may be disposed in flange **246**. Shaft **260** (see FIG. **5**B) may extend through flange **246**.

[0094] With respect to FIG. **10**A and FIG. **10**B, elements with like element numbering, as depicted in FIG. **2**, are intended to be the same and will not necessarily be repeated for the sake of clarity.

[0095] With reference to FIG. **10**A and FIG. **10**B, a lifting device **300** with an attachment feature **318** coupled to the outer tube **310** is illustrated, in accordance with various embodiments. Lifting device **300** may be similar to lifting device **200** of FIG. **2**. Lifting device **300** may be attached to a trailer (e.g., trailer **120** of FIG. **1**) via attachment feature **318**. In this manner, outer tube **310** may be substantially fixed to the trailer during operation, thereby preventing rotation of outer tube **310** and supporting the trailer. Attachment feature **318** may comprise a tube **319** coupled to the outer diameter surface of outer tube **310** for attaching the lifting device **300** to a trailer in a known manner. Tube **319** may be oriented substantially perpendicular with respect to outer tube **310**. Tube **319** may provide a pivot connection between lifting device **300** and a trailer or vehicle to allow lifting device **300** to be rotated between a stowed position and a deployed position.

[0096] With reference to FIG. **11**A and FIG. **11**B, an outer tube **410** comprising an attachment

feature **418** is illustrated, in accordance with various embodiments. Outer tube **410** may be similar to outer tube **210** of FIG. **2**. Attachment feature **418** may comprise a collar **419** coupled to an surrounding the outer diameter surface of outer tube **410**. Collar **419** may comprise a plurality of apertures for coupling collar **419** to a trailer or vehicle via a plurality of fasteners, such as bolts, in a known manner. Collar **419** may be coupled to outer tube **410** via a metal joining process, such as welding for example. In various embodiments, outer tube **410** may be welded directly to a trailer or vehicle, without the use of a dedicated attachment feature.
[0097] With respect to FIG. **12**, elements with like element numbering, as depicted in FIG. **2**, are intended to be the same and will not necessarily be repeated for the sake of clarity.
[0098] With reference to FIG. **12**, a trailer landing gear assembly **500** is illustrated, in accordance with various embodiments. Some trailers may use landing gear, generally comprising a pair of retractable legs, at the front end of the trailer to support said front end when the trailer is to be detached from a truck or tractor. Landing gear assembly **500** has a driven crank **580** which passes through the upper ends of a pair of telescoping, vertical legs or lifting devices **501**, **502**. With additional reference to FIG. **13**A and FIG. **13**B, each lifting device **501**, **502** may be similar to lifting device **200** of FIG. **2**, except that the upper end of the shaft **560** of the lifting device bears a gear **564** (also referred to herein as a second gear) in meshing relation with a gear **582** (also referred to herein as a third gear) disposed on the crank **580**. In this manner, rotation of crank **580** drives rotation of shaft **560**. Crank **580** is disposed substantially perpendicular with respect to shaft **560**. Gear **564** may be a bevel gear. Gear **582** may be a bevel gear. However, other types of gears known for connecting perpendicularly disposed rods may be used without departing from the spirit and scope of the present disclosure.
[0099] With reference to FIG. **14**, a cross-section view of lifting device **501** is illustrated, in accordance with various embodiments. Outer tube **510** may comprise one or more aligned apertures **518** disposed in the upper end of outer tube **510** through which crank **580** extends.
[0100] With reference to FIG. **15**A and FIG. **15**B, a lifting device **600** is illustrated, in accordance with various embodiments. Lifting device **600** may be similar to lifting device **200** (e.g., see FIG. **2** and FIG. **4**B), except that, instead of the low speed assembly having a rotating sleeve and a translating screw, the low speed assembly of lifting device **600** has a rotating screw **650** and a translating sleeve **640**.
[0101] Lifting device **600** may comprise a shaft **660** operatively coupled to rotating screw **650** such that rotating screw **650** rotates with shaft **660**. In various embodiments, shaft **660** may comprise one or more splines **662** and rotating screw **650** may comprise a center aperture **656** comprising a geometry that is complementary to shaft **660**. In this regard, center aperture **656** may comprise one or more grooves configured to receive the one or more splines **662** of shaft **660** such that shaft **660** interlocks with rotating screw **650** to impart rotational forces (i.e., torque) therebetween. Stated differently, aperture **656** and shaft **660** may be coupled via a splined connection. Rotating screw **650** may be drivably coupled to shaft **660** via center aperture **656**. Center aperture **656** may comprise various geometries, such as triangular, square, or any other geometry that interlocks shaft **660** with rotating screw **650**. Shaft **660** may be operatively coupled to rotating screw **650** using various methods without departing from the scope and spirit of the present disclosure, such as via a fastener, for example.
[0102] In operation, rotation of shaft **660** in a first rotational direction, e.g., via handle **670**, causes rotating screw **650** to rotate with respect to outer tube **610** and translating sleeve **640**, which in turn causes translating sleeve **640** to extend from rotating screw **650**. Conversely, rotation of shaft **660** in a second rotational direction (opposite the first rotational direction) causes rotating screw **650** to rotate with respect to outer tube **610** and translating sleeve **640**, which in turn causes translating sleeve **640** to retract into outer tube **610**.
[0103] With reference to FIG. **16**, an exploded view of a lifting device **700** is illustrated, in accordance with various embodiments. Lifting device **700** may be a linear jack. Lifting device **700**

may operate similar to lifting device **200**, except that instead of comprising a low speed assembly nested within a high speed assembly, lifting device **700** of FIG. **16** comprises a high speed assembly **702** nested within a low speed assembly **704**.

[0104] Lifting device **700** may generally comprise an outer tube **710**, a high speed assembly **702**, and a low speed assembly **704**. High speed assembly **702** may generally comprise a screw mechanism comprising a rotating screw threadedly coupled to a translating nut. In various embodiments, high speed assembly **702** comprises a translating sleeve **720** (also referred to herein as a high speed outer sleeve or a first sleeve), and a rotating screw **730** (also referred to herein as a high speed inner sleeve, or a rotating inner sleeve). Low speed assembly **704** may generally comprise a screw mechanism comprising a rotating screw threadedly coupled to a translating nut. Low speed assembly **704** may comprise a translating sleeve **740** (also referred to herein as a low speed outer sleeve), and a rotating sleeve **750** (also referred to herein as a low speed inner sleeve).

[0105] Outer tube **710** may comprise a centerline axis **792**. Outer tube **710** may be hollow. Sleeve **740** may be disposed at least partially within outer tube **710**. Sleeve **740** may be hollow. Sleeve **750** may be disposed at least partially within sleeve **740**. Sleeve **750** may be hollow. Sleeve **720** may be disposed at least partially within sleeve **750**. Sleeve **720** may be hollow. Rotating screw **730** may be disposed at least partially within sleeve **720**. Rotating screw **730** may be hollow. Lifting device **700** may further comprise a shaft **760** (also referred to herein as a first shaft). Shaft **760** may be hollow. Lifting device **700** may further comprise a shaft **766** (also referred to herein as a second shaft). Shaft **760** may be disposed at least partially within rotating screw **730**. Shaft **766** may be disposed at least partially within shaft **760**. Shaft **766** may be disposed at least partially within rotating screw **730**. In this regard, the inner diameter of outer tube **710** may be greater than the outer diameter of sleeve **740**. The inner diameter of sleeve **740** may be greater than the outer diameter of sleeve **750**. The inner diameter of sleeve **750** may be greater than the outer diameter of sleeve **720**. The inner diameter of sleeve **720** may be greater than the outer diameter of rotating screw **730**. Outer tube **710**, sleeve **740**, sleeve **750**, sleeve **720**, rotating screw **730**, shaft **760**, and shaft **766** may be coaxially aligned.

[0106] Lifting device **700** may further comprise a gear **765**. Gear **765** may be coupled to, and rotate with, shaft **760**. Gear **765** may be coaxially aligned with shaft **760**. Shaft **760** may drive rotating screw **730** via gear **765** in response to rotating screw **730** moving to a first position with respect to shaft **760**, as described in further detail herein.

[0107] Lifting device **700** may further comprise a spring **706**. Spring **706** may be operatively coupled to rotating screw **730**, to assist movement of rotating screw **730** between the first position and a second position, as described herein in further detail. In this regard, rotating screw **730** may be slidable in the outer tube **210** between the first position and the second position. Rotating screw **730** may comprise a mating surface **734**. Mating surface **734** may be in meshing relationship with gear **765** in response to rotating screw **730** moving to the first position, as illustrated in FIG. **17**B. Mating surface **734** may comprise a plurality of teeth. Rotating screw **730** may comprise a flange **736** extending radially inward from an inner diameter surface of rotating screw **730**. Mating surface **734** may be disposed on flange **736**. Shaft **760** may extend through flange **736** of rotating screw **730**. Rotating screw **730** may comprise a flange **737** extending radially inward from the inner diameter surface of rotating screw **730**. Shaft **766** may extend through flange **737** of rotating screw **730**. Spring **706** may be disposed between flange **736** and flange **737**. Spring **706** may be compressed between flange **737** and gear **765**. Rotating screw **730** may comprise a flange **738** extending radially inward from the inner diameter surface of rotating screw **730**. Flange **737** may be disposed axially between and spaced apart from flange **736** and flange **738**. Shaft **766** may be spaced apart from flange **738** of rotating screw **730** in response to rotating screw **730** moving to the first position, as illustrated in FIG. **17**B. Shaft **766** may engage (i.e., may enter into contact with) flange **738** of rotating screw **730** in response to rotating screw **730** moving to the second position, as illustrated in FIG. **17**D. In response to rotating screw **730** moving to the second position, shaft

766 may be in meshing relation with flange **738** to prevent rotation of rotating screw **730** with respect to shaft **766** and/or shaft **760**. In this manner, rotating screw **730** may be restricted from rotating within outer tube **210** in the second position.

[0108] In various embodiments, rotating screw **730** is threadedly coupled to sleeve **720**. Thus, rotation of the rotating screw **730** causes the sleeve **720** to translate with respect to outer tube **210**. Stated differently, high speed assembly **702** translates rotational motion of rotating screw **730** to linear motion of sleeve **720**. In various embodiments, sleeve **750** is threadedly coupled to sleeve **740**. Thus, rotation of the sleeve **750** causes the sleeve **740** to translate with respect to outer tube **710**. Stated differently, low speed assembly **204** translates rotational motion of sleeve **750** to linear motion of sleeve **740**.

[0109] Sleeve **720** may comprise a flange **722** extending radially outward from an outer diameter surface of sleeve **720** at the upper end thereof. Sleeve **750** may comprise a flange **756** extending radially outward from an outer diameter surface of sleeve **750** at the upper end thereof. Sleeve **720** may rotate with respect to sleeve **750**. A bearing **708** may be disposed between flange **722** and flange **756** to reduce friction between sleeve **720** and sleeve **750**. Bearing **708** may comprise a thrust needle roller bearing or the like, in accordance with various embodiments.

[0110] In various embodiments, the upper end of the shaft **760** may bear a gear **764** in meshing relation with a gear **782** disposed on a crank **780**. In this manner, rotation of crank **780** drives rotation of shaft **760**. Crank **780** may be disposed substantially perpendicular with respect to shaft **760**. Gear **764** may be a bevel gear. Gear **782** may be a bevel gear. However, other types of gears known for connecting perpendicularly disposed rods may be used without departing from the spirit and scope of the present disclosure. One end of crank **780** may bear a handle **770** which may be used for rotating the crank **780**.

[0111] A radially inward extending flange **712** may be disposed at an upper end of outer tube **710**. Shaft **760** may extend through flange **712**. Shaft **760** may be at least partially supported by flange **712**. Shaft **760** may comprise a shoulder which abuts flange **712**. In this manner, flange **712** may prevent shaft **760** from translating within outer tube **710**. A cap **718** may be coupled to the upper end of outer tube **710**. Cap **718** may enclose gear **782** and gear **764**. Cap **718** may comprise an aperture **719** through which crank **780** extends. Crank **780** may be supported by cap **718**.

[0112] With combined reference to FIG. **16** and FIG. **17**B, shaft **760** may be operatively coupled to sleeve **750** such that sleeve **750** rotates with shaft **760**. In various embodiments, shaft **760** may comprise one or more splines **762** and sleeve **750** may comprise a center aperture **759** comprising a geometry that is complementary to shaft **760**. In this regard, center aperture **759** may comprise one or more grooves configured to receive the one or more splines **762** of shaft **760** such that shaft **760** interlocks with sleeve **750** to impart rotational forces (i.e., torque) therebetween. Stated differently, aperture **759** and shaft **760** may be coupled via a splined connection. Sleeve **750** may be drivably coupled to shaft **760** via center aperture **759**. Furthermore, although illustrated as a star shaped aperture, center aperture **759** may comprise various geometries, such as triangular, square, or any other geometry that interlocks shaft **760** with sleeve **750**. However, shaft **760** may be operatively coupled to sleeve **750** using various methods without departing from the scope and spirit of the present disclosure, such as via a fastener, for example.

[0113] Sleeve **750** may comprise a cap **758** coupled to flange **756**. Flange **722** may be installed in a gap formed between cap **758** and flange **756**. Bearing **708** may similarly be installed in the gap formed between cap **758** and flange **756**. Center aperture **759** may be disposed in cap **758**. Cap **758** may be coupled to sleeve **750** via any suitable connection, including welding, fasteners, a threaded connection, etc.

[0114] In operation, rotation of shaft **760** in a first rotational direction, e.g., via handle **770**, causes sleeve **750** to rotate with respect outer tube **710** and translating sleeve **740**, which in turn causes translating sleeve **740** to extend from outer tube **710** (see FIG. **17**C and FIG. **17**D). Conversely, rotation of shaft **760** in a second rotational direction (opposite the first rotational direction) causes sleeve **750** to rotate with respect outer tube **710** and translating sleeve **740**, which in turn causes translating sleeve **740** to retract into outer tube **710** (see FIG. **17**A and FIG. **17**B).

[0115] Furthermore, with rotating screw **730** in a first position (see FIG. **17**A and FIG. **17**B) with respect to outer tube **710**, rotating screw **730** may be drivably coupled to shaft **760**. Stated differently, rotation of shaft **760** may drive rotation of rotating screw **730**. In operation, and with rotating screw **730** in a first position (see FIG. **4**A through FIG. **4**D) with respect to outer tube **710** and/or gear **765**, rotation of shaft **760** in a first rotational direction, e.g., via handle **770**, may cause rotating screw **730** to rotate with respect outer tube **710** and sleeve **720**, which in turn causes sleeve **720** to translate with respect to rotating screw **730** and extend from outer tube **710**. Conversely, rotation of shaft **760** in a second rotational direction (opposite the first rotational direction) may cause rotating screw **730** to rotate with respect outer tube **710** and sleeve **720**, which in turn causes sleeve **720** to retract into outer tube **710**. In the first position, spring **706** may bias rotating screw **730** to engage with gear **765**. Thus, with the rotating screw **730** in the first position, both the sleeve **720** and the sleeve **740** are driven to translate with respect to outer tube **710** in response to rotation of shaft **760**.

[0116] However, in operation and with rotating screw **730** in a second position (see FIG. **17**C and FIG. **17**D) with respect to outer tube **710** and/or gear **765**, the rotating screw **730** is disengaged from gear **765** (i.e., rotation of shaft **760** and gear **765** does not drive rotation of rotating screw **730** in the disengaged position). In this regard, with rotating screw **730** in the second position, rotation of shaft **760** in the first rotational direction or the second rotational direction may cause only sleeve **750** (and not rotating screw **730**) to rotate with respect to outer tube **710** and sleeve **720**, thereby driving only the sleeve **740** to translate. Stated differently, the high speed assembly **702** (i.e., the rotating screw **730** and sleeve **720**) may be disengaged from operation in response to the rotating screw **730** moving to the second position. In this manner, in response to rotation of shaft **760** in the first direction, both the high speed assembly **702** and the low speed assembly **704** are driven to increase the overall length of lifting device **700**. With momentary reference to FIG. **17**C and FIG. **17**D, as the overall length of lifting device **700** is increased, the foot **775** of the lifting device **700** may contact a ground surface **790**, thereby imparting a force **794** from the ground surface **790** into the rotating screw **730** which causes the rotating screw **730** to move with respect to outer tube **710** against the bias of spring **706** from the first position (i.e., engaged with gear **765**) to the second position (i.e., disengaged from gear **765**) thereby decoupling rotating screw **730** from torsional forces imparted by shaft **760**. In this regard, before the lifting device **700** has contacted a ground surface, the overall length of the lifting device **700** is quickly increased to reduce the overall number of rotations of shaft **760** required to cause lifting device **700** to reach the ground. In response to contacting the ground, the high speed assembly **702** is decoupled from the shaft **760** to take advantage of the mechanical advantage of the low speed assembly **704**.

[0117] In various embodiments, rotating screw **730** comprises helically extending grooves or threads **732**. In various embodiments, sleeve **750** comprises helically extending grooves and/or threads **752**. The thread pitch of threads **732** may be greater than the thread pitch of threads **752**. Stated differently, sleeve **750** may comprise more threads per inch (TPI) than rotating screw **730**. In various embodiments, the thread pitch of threads **732** is more than twice as large as the thread pitch of threads **752**. In various embodiments, the thread pitch of threads **732** is more than three times as large as the thread pitch of threads **752**. In various embodiments, the thread pitch of threads **732** is more than four times as large as the thread pitch of threads **752**. It should be understood that the maximum thread pitch may be limited by the moment arm for torque applied to the shaft **760** and may be limited below a desired threshold to reduce the torque requirement for rotating shaft **760**. In this manner, the high speed assembly **702** translates further and faster per rotation of shaft **760** than the low speed assembly **704**, causing the lifting device **700** to reach a ground surface faster than if the high speed assembly were not present. Furthermore, in response to the lifting device **700** contacting a ground surface and the high speed assembly **702** disengaging from the shaft **760**, the reduced thread pitch of the low speed assembly **704** is taken advantage of to reduce the torque required for extending the lifting device **700**.

[0118] With reference to FIG. **16** and FIG. **17**D, sleeve **740** may be keyed to outer tube **710** to prevent rotation of sleeve **740** with respect to outer tube **710**. For example, sleeve **740** may comprise one or more axially extending grooves **748** (see FIG. **16**) disposed in the outer diameter surface thereof and outer tube **710** may comprise corresponding protrusion(s) **716** (see FIG. **17**D) extending radially inwards from an inner diameter surface thereof that extend(s) into groove(s) **748**.

[0119] With reference to FIG. **18**, a flow chart of a method **800** of manufacturing a lifting device, such as a linear jack, is illustrated, in accordance with various embodiments. Method **800** includes disposing a second sleeve at least partially within a first sleeve (step **810**). Method **800** includes disposing a translating screw at least partially within a third sleeve (step **820**). Method **800** includes disposing the third sleeve at least partially within the second sleeve (step **830**).

[0120] With combined reference to FIG. **2** and FIG. **18**, step **810** may include threading second sleeve **230** into first sleeve **220**. Step **820** may include threading screw **250** into third sleeve **240**. Step **830** may include moving third sleeve **240** at least partially into second sleeve **230**. First sleeve **220** may be moved into outer tube **210** via the open upper end of outer tube **210** prior to retaining member **212** being coupled to the upper end of outer tube **210**.

[0121] With respect to FIG. **19**A and FIG. **19**B, elements with like element numbering, as depicted in FIG. **4**A and FIG. **4**B, are intended to be the same and will not necessarily be repeated for the sake of clarity.

[0122] With reference to FIG. **19**A and FIG. **19**B, a lifting device **201** is illustrated, in accordance with various embodiments. Lifting device **201** may be similar to lifting device **200** of FIG. **2**, except that the thread pitch of second sleeve **230** and first sleeve **220** is equal to the thread pitch of third sleeve **240** and screw **250**. In this regard, first sleeve **220** may comprise helically extending threads **229**. Threads **229** may be disposed on an inner diameter surface of first sleeve **220**. Second sleeve **230** may comprise helically extending threads **233**. Threads **233** may be disposed on an outer diameter surface of second sleeve **230**. The thread pitch of threads **233** and threads **229** may be equal to the thread pitch of threads **252** of screw **250** and threads **244** of third sleeve **240** (see FIG. **8**A and FIG. **8**B).

[0123] With reference to FIG. **20**, an exploded view of a lifting device **900** is illustrated, in accordance with various embodiments. Lifting device **900** may be a linear jack. Lifting device **900** may generally comprise an outer tube **910**, a high speed assembly **902**, and a low speed assembly **904**. High speed assembly **902** may generally comprise a screw mechanism comprising a rotating nut threadedly coupled to a translating screw, in the manner of a leadscrew or jack screw. In various embodiments, high speed assembly **902** comprises a rotating sleeve **940**, and a translating screw **950**. Low speed assembly **904** may generally comprise a screw mechanism comprising a rotating nut threadedly coupled to a translating screw. Low speed assembly **904** may comprise a rotating sleeve **920**, and a translating sleeve **930**.

[0124] Although the present disclosure is described in accordance with various embodiments on the basis of a screw mechanism having a rotating nut and a translating screw, it should be understood that the present disclosure can be applied with a rotating screw and a translating nut, as illustrated in FIG. **15**A and/or FIG. **16**, for example.

[0125] Outer tube **910** may comprise a centerline axis **992**. Outer tube **910** may be hollow. Sleeve **920** may be disposed at least partially within outer tube **910**. In various embodiments, sleeve **920** is placed into the open upper end of outer tube **910** prior to retaining member **912** being coupled to outer tube **910**. Sleeve **920** may be hollow. Sleeve **930** may be disposed at least partially within sleeve **920**. Sleeve **930** may be hollow. Sleeve **940** may be disposed at least partially within sleeve **930**. Sleeve **940** may be hollow. Translating screw **950** may be disposed at least partially within sleeve **940**. Translating screw **950** may be hollow. Lifting device **900** may further comprise a shaft **960** (also referred to herein as an input shaft). Shaft **960** may be disposed at least partially within outer tube **910**. Lifting device **900** may further comprise a shaft **966** (also referred to herein as an output shaft). Shaft **960** may be disposed at least partially within screw **950**. In this regard, the inner diameter of outer tube **910** may be greater than the outer diameter of sleeve **920**. The inner diameter of sleeve **920** may be greater than the outer diameter of sleeve **930**. The inner diameter of sleeve **930** may be greater than the outer diameter of sleeve **940**. The inner diameter of sleeve **940** may be greater than the outer diameter of translating screw **950**. The inner diameter of translating screw **950** may be greater than the outer diameter, or width, of shaft **966**. Outer tube **910**, sleeve **920**, sleeve **930**, sleeve **940**, translating screw **950**, shaft **960**, and shaft **966** may be coaxially aligned and/or substantially coaxially aligned, but in various embodiments coaxial alignment is not present. One end of shaft **960** may bear a handle **970** which may be used for rotating the shaft **960**.

[0126] Lifting device **900** may further comprise a planetary gear system **980**. The planetary gear system **980** in various embodiments as shown includes a ring gear **981**, one or more planet gears **982**, and a sun gear **983**. The system **980** may include one, two, three, four, five, six, seven, eight, or more planet gears **982**. Each of the gears **981**, **982**, **983** includes a plurality of teeth. For example, the ring gear **981** includes teeth **132**, each planet gear **982** includes teeth **134**, and sun gear **983** includes teeth **136**. The teeth **132**, **134**, and **136** are sized and shaped to mesh together such that the various gears **981**, **982**, **983** engage each other. For example, the ring gear **981** and the sun gear **983** may each engage the planet gears **982***a*, **982***b*, **982***c*.

[0127] The planetary gear system **980** may include a carrier **984** comprising a first plate **985***a* and a second plate **985***b*. Planet gears **982***a*, **982***b*, **982***c* may be rotatably coupled to carrier **984**—e.g., supported between first plate **985***a* and second plate **985***b*. Carrier **984** may further comprise a capped flange **986**. Capped flange may comprise a splined aperture **122** configured to receive shaft **960**. Splined aperture **122** may interlock with splines **962** disposed on shaft **960**. In this manner, torsional forces may be transmitted from shaft **960** into carrier **984** via capped flange **986**.

[0128] In various embodiments, the ring gear **981** may be stationary. For example, ring gear **981** may be fixed to the inner diameter surface of outer tube **910**, such as via a splined connection, a threaded connection, a friction fit, a snap fit, a weld, or the like. In these embodiments, the input shaft may be coupled to the carrier **984**, and input loads (e.g., torque) on the input shaft **960** may be transmitted through the carrier **984** to the planet gears **982***a*, **982***b*, **982***c*. Thus, the carrier **984** may drive the system **980**.

[0129] First plate **985***a* and second plate **985***b* may comprise a first plurality of holes aligned to receive a plurality of bolts, such as bolt **142***a*, bolt **142***b*, and bolt **142***c*, for example. Capped flange **986** may similarly comprise a plurality of holes aligned to receive the plurality of bolts **142***a*, **142***b*, **142***c*. In various embodiments, bolt **142***a*, bolt **142***b*, and bolt **142***c* hold capped flange **986**, first plate **985***a*, and a second plate **985***b* together. First plate **985***a* and second plate **985***b* may comprise a second plurality of holes aligned to receive shafts associated with planet gears **982***a*, **982***b*, **982***c*. In this manner, bolts **142***a*, **142***b*, **142***c* may each extend between adjacent planet gears **982***a*, **982***b*, **982***c*.

[0130] Sleeve **920** may be drivably coupled to shaft **960**. In various embodiments, bolts **142** may extend into holes **144** disposed in flange **924** of sleeve **920**. Input loads (e.g., torque) may be transmitted from shaft **960**, through carrier **984** and bolts **142**, into sleeve **920**. In this manner, sleeve **920** may rotate at a 1:1 ratio with shaft **960**.

[0131] The outer tube **910** may comprise a retaining member **912**. Retaining member **912** may be coupled to outer tube **910**, e.g., via a threaded connection, snap fit, friction fit, fasteners, and/or a metal joining process, such as welding, brazing, etc. Retaining member **912** may comprise a cap structure coupled to the upper end of outer tube **910**. Retaining member **912** may comprise a flange extending radially inward from outer tube **910**. Shaft **960** may extend through retaining member **912**. Lifting device **900** may further comprise a bearing **908** supporting, at least in part, shaft **960**. Bearing **908** may be disposed between retaining member **912** and capped flange **986**. Shaft **960** may extend through bearing **908**.

[0132] Lifting device **900** may further comprise a spring **906**. Spring **906** may be a coil spring, leaf spring, Belleville spring, or other suitable spring for exerting a bias against sun gear **983**. Spring **906** may be operatively coupled to sleeve **920** and sun gear **983**, via shaft **966**, to assist movement of sleeve **920** and sun gear **983** between first and second positions, as described herein with further detail. In this regard, sleeve **920** may be slidable in the outer tube **910** between the first position and the second position. Sleeve **920** may translate along centerline axis **992** between the first position and the second position. Spring **906** may be compressed between capped flange **986** and shaft **960**, in accordance with various embodiments. Spring **906** may be compressed between capped flange **986** and sun gear **983**, in accordance with various embodiments. Spring **906** may bias shaft **960**, shaft **966**, sun gear **983**, and sleeve **920** to translate together with respect to outer tube **910** between the first position (see FIG. **21**B) and the second position (see FIG. **21**D). Sleeve **920** may translate with respect to, and about, bolts **142** between the first position and the second position.
[0133] With combined reference to FIG. **20**, FIG. **21**A, and FIG. **21**B, rotation of shaft **960** may drive rotation of carrier **984** (e.g., via splined aperture **122**), wherein, in response, the carrier **984** drives rotation of bolts **142***a*, **142***b*, **142***c*, wherein, in response, the bolts **142***a*, **142***b*, **142***c* drive rotation of sleeve **920**. In various embodiments, sleeve **920** is threadedly coupled to sleeve **930**. Thus, rotation of the sleeve **920** causes the sleeve **930** to translate with respect to outer tube **910**. Stated differently, low speed assembly **904** translates rotational motion of sleeve **920** to linear motion of sleeve **930**. Low speed assembly **904** may be driven by shaft **960** regardless of the position of sleeve **920** and/or sun gear **983**, in accordance with various embodiments.
[0134] Furthermore, with sleeve **920** in the first position (see FIG. **21**B) with respect to outer tube **910**, spring **906** biases sun gear **983** in meshing relation with planet gears **982**. In this regard, sleeve **940** may be drivably coupled to shaft **960** via planetary gear system **980**. Rotation of shaft **960** may drive rotation of carrier **984** (e.g., via splined aperture **122**), wherein, in response, the carrier **984** drives rotation of planet gears **982***a*, **982***b*, **982***c*, wherein, in response, the planet gears **982***a*, **982***b*, **982***c* drive rotation of shaft **966**, wherein, in response, shaft **966** drives rotation of sleeve **940**. In various embodiments, sleeve **940** is threadedly coupled to translating screw **950**. Thus, rotation of the sleeve **940** causes the translating screw **950** to translate with respect to outer tube **910**. Stated differently, high speed assembly **902** translates rotational motion of sleeve **940** to linear motion of translating screw **950**.
[0135] In various embodiments, rotation of shaft **960** may drive rotation of shaft **966** at a 1:n ratio, wherein n is greater than 1. In various embodiments, n is equal to the number of rotations of shaft **966** per rotation of shaft **960**. Planetary gear system **980** may be geared to any suitable ratio which causes shaft **966** to rotate faster than shaft **960**, thus causing sleeve **940** to rotate faster than sleeve **920**.
[0136] In various embodiments, with sleeve **920** in the first position (see FIG. **21**B) with respect to outer tube **910** and sun gear **983** in meshing relation with planet gears **982**, rotation of shaft **960** in a first rotational direction, e.g., via handle **970**, may cause sleeve **940** to rotate with respect outer tube **910** and translating screw **950**, which in turn causes translating screw **950** to extend from sleeve **940**. Conversely, rotation of shaft **960** in a second rotational direction (opposite the first rotational direction) may cause sleeve **940** to rotate with respect outer tube **910** and translating screw **950**, which in turn causes translating screw **950** to retract into sleeve **940**. In the first position, spring **906** may bias sun gear **983** to engage with planet gears **982**. Thus, with the sun gear **983** in the first position, both the sleeve **930** and the translating screw **950** are driven to translate with respect to outer tube **910** in response to rotation of shaft **960**.
[0137] However, in operation and with sleeve **920** and sun gear **983** in second positions (see FIG. **21**D) with respect to outer tube **910** and/or planet gears **982**, the sun gear **983** (and thus the output shaft **966**) is disengaged from planet gears **982** (i.e., rotation of shaft **960** does not drive rotation of output shaft **966** and sleeve **940** in the disengaged position). In this regard, with sun gear **983** in the

second position, rotation of shaft **960** in the first rotational direction or the second rotational direction may cause only sleeve **920** (and not sleeve **940**) to rotate with respect to outer tube **910**, thereby driving only the sleeve **930** to translate. Stated differently, the high speed assembly **902** (i.e., the sleeve **940** and translating screw **950**) may be disengaged from operation in response to the sleeve **920** and/or sun gear **983** moving to the second position. In this manner, in response to rotation of shaft **960** in the first direction, both the high speed assembly **902** and the low speed assembly **904** (i.e., the sleeve **920** and sleeve **930**) are driven to increase the overall length of lifting device **900** but, after reacting force from the ground through, for example, foot **975**, rotation of shaft **960** is only imparted to low speed assembly **904** and not high speed assembly **902**. With momentary reference to FIG. **21**C and FIG. **21**D, as the overall length of lifting device **900** is increased, the foot **975** of the lifting device **900** may contact a ground surface **402**, thereby imparting a force **404** from the ground surface **402** into the sleeve **920** which causes the sleeve **920** to move with respect to outer tube **910** against the bias of spring **906** from the first position. Said force may be transmitted through sleeve **920** into shaft **966**, thereby pushing shaft **966** upwards against the bias of spring **906** and removing sun gear **983** from meshing relation with planet gears **982**. In this manner, sun gear **983** may move from the first position (i.e., engaged with planet gears **982**) to the second position (i.e., disengaged from planet gears **982**) thereby decoupling sleeve **940** from torsional forces imparted by shaft **960**. In this regard, before the lifting device **900** has contacted a ground surface, the overall length of the lifting device **900** is quickly increased to reduce the overall number of rotations of shaft **960** needed to cause lifting device **900** to reach the ground. In response to contacting the ground, the high speed assembly **902** is decoupled from the shaft **960** to take advantage of the mechanical advantage of the low speed assembly **904**. In this manner, time to operate is reduced relative to conventional designed and increased mechanical advantage is selectively activated.

[0138] In various embodiments, sleeve **930** comprises threads **932**. In various embodiments, translating screw **950** comprises threads **952**. The thread pitch of threads **932** may be equal to, less than, or greater than the thread pitch of threads **952**. In various embodiments, the thread pitch of threads **932** is equal to the thread pitch of threads **952**. In response to shaft **966** rotating faster than shaft **960**, translating screw **950** may translate faster in linear distance than sleeve **930**, even though threads **952** and threads **932** may comprise the same thread pitch.

[0139] With reference to FIG. **20** and FIG. **4**B, sleeve **930** may be keyed to outer tube **910** to prevent rotation of sleeve **930** with respect to outer tube **910**. For example, sleeve **930** may comprise one or more axially extending grooves **934** (see FIG. **20**) disposed in the outer diameter surface thereof and outer tube **910** may comprise corresponding protrusion(s) **916** extending radially inwards from an inner diameter surface thereof that extends into groove(s) **934**.

[0140] In various embodiments, translating screw **950** may be keyed to sleeve **930** to prevent rotation of translating screw **950** with respect to sleeve **930** and outer tube **910**. For example, translating screw **950** may comprise one or more axially extending grooves **954** (see FIG. **20**) disposed in the outer diameter surface thereof and sleeve **930** may comprise corresponding protrusion(s) **936** extending radially inwards from an inner diameter surface thereof that extends into groove(s) **954**.

[0141] With reference to FIG. **22**, an exploded view of a lifting device **10** is illustrated, in accordance with various embodiments. Lifting device **10** may be a linear jack. Lifting device **10** may generally comprise an outer tube **20**, a high speed assembly **12**, and a low speed assembly **14**. High speed assembly **12** may generally comprise a screw mechanism comprising a rotating nut threadedly coupled to a translating screw, in the manner of a leadscrew or jack screw. In various embodiments, high speed assembly **12** comprises a rotating sleeve **30** (also referred to herein as a high speed outer sleeve or a first sleeve), and a translating sleeve **40** (also referred to herein as a high speed inner sleeve or a second sleeve). Low speed assembly **14** may generally comprise a screw mechanism comprising the sleeve **40** of high speed assembly **12** threadedly coupled to an inner screw that both rotates and translates with respect to the sleeve **40**. In this regard, low speed assembly **14** may comprise sleeve **40** (also referred to herein as a low speed outer sleeve), and an inner screw **50** (also referred to herein as a low speed inner sleeve). In this regard, sleeve **40** may belong to both the high speed assembly **12** and the low speed assembly **14**, as described herein in further detail.

[0142] Outer tube **20** may comprise a centerline axis **92**. Outer tube **20** may be hollow. Sleeve **30** may be disposed at least partially within outer tube **20**. Sleeve **30** may be hollow. Sleeve **40** may be disposed at least partially within sleeve **30**. Sleeve **40** may be hollow. Inner screw **50** may be disposed at least partially within sleeve **40**. Inner screw **50** may be hollow. Lifting device **10** may further comprise a shaft **60**. Shaft **60** may be disposed at least partially within inner screw **50**. In this regard, the inner diameter of outer tube **20** may be greater than the outer diameter of sleeve **30**. The inner diameter of sleeve **30** may be greater than the outer diameter of sleeve **40**. The inner diameter of sleeve **40** may be greater than the outer diameter of inner screw **50**. The inner diameter of inner screw **50** may be greater than the outer diameter, or width, of shaft **60**. Outer tube **20**, sleeve **30**, sleeve **40**, inner screw **50**, and shaft **60** are coaxially aligned and/or substantially coaxially aligned, though in various embodiments coaxial alignment is not present. One end of shaft **60** may bear a handle **70** which may be used for rotating the shaft **60**.

[0143] Sleeve **30** may be moveable with respect to outer tube **20** between a first position (see FIG. **23**D) and a second position (see FIG. **23**E). In the first position, sleeve **30** is drivably coupled to shaft **60**. In the second position, sleeve **30** is decoupled from shaft **60**. In this regard, sleeve **30** may further comprise an end plate **32**, a first gear **34**, and a second gear **35**. First gear **34** may be coupled to, and rotate with, sleeve **30**. Second gear **35** may be coupled to, and rotate with, sleeve **30**. In various embodiments, first gear **34** is disposed opposite end plate **32** from second gear **35**. First gear **34** and second gear **35** may be fixed to end plate **32**, such as via a weld, a fastener, a threaded connection, or any other suitable method. In various embodiments, first gear **34** and second gear **35** are manufactured separately from end plate **32**, though in various embodiments, first gear **34**, second gear **35**, and end plate **32** may be manufactured as a single, monolithic component.

[0144] Lifting device **10** may further comprise a gear **65** (also referred to herein as a shaft gear). Shaft gear **65** may be coupled to, and rotate with, shaft **60**. Shaft **60** may drive sleeve **30** via gear **65** in response to sleeve **30** moving to the first position, as described in further detail herein. Gear **65** may be splined to the shaft **60**, but gear **65** may also be fixedly coupled such as through welding, brazing, a press fit and/or an interference fit. Gear **65** may comprise any suitable gear, for example, a bevel gear or a crown gear. Shaft gear **65** may comprise a plurality of teeth configured to meshingly engage with a plurality of teeth of first gear **34**. In this manner, rotation of shaft **60** may drive rotation of sleeve **30**, via shaft gear **65** and first gear **34**.

[0145] Lifting device **10** may further comprise a gear **24** (also referred to herein as an outer tube gear). G ear **24** may be coupled to outer tube **20**. G ear **24** may be splined or threaded to the outer tube **20**, but gear **24** may also be fixedly coupled such as through welding, brazing, a press fit and/or an interference fit. Gear **24** may comprise any suitable gear, for example, a bevel gear or a crown gear. Gear **24** may comprise a plurality of teeth configured to meshingly engage with a plurality of teeth of second gear **35**. In this manner, sleeve **30** may be locked from rotation with respect to outer tube **20** in response to second gear **35** meshingly engaging with gear **24**. Second gear **35** may meshingly engage with gear **24** in response to sleeve **30** moving to the second position (see FIG. **23**E). First gear **34**, second gear **35**, end plate **32**, shaft gear **65**, and gear **24** may be coaxially aligned with shaft **60**.

[0146] Lifting device **10** may further comprise a spring **68**. Spring **68** may be a coil spring, leaf spring, Belleville spring, or other suitable spring for exerting a bias against sleeve **30**. Spring **68** may be operatively coupled to sleeve **30**, to assist movement of sleeve **30** between the first position and a second position, as described herein with further detail. In this regard, sleeve **30** may be slidable in the outer tube **20** between the first position and the second position. sleeve **30** may translate along centerline axis **92** between the first position and the second position. The outer tube **20** may comprise an end cap **22**. End cap **22** may be coupled to outer tube **20**, e.g., via a threaded connection, fasteners, and/or a metal joining process, such as welding, brazing, etc. End cap **22** may comprise a cap structure coupled to the upper end of outer tube **20**. End cap **22** may comprise a flange extending radially inward from an inner diameter surface of outer tube **20**. Shaft **60** may extend through end cap **22**. End cap **22** may retain spring **68** within outer tube **20**. In this regard, spring **68** may be compressed between end cap **22** and sleeve **30**. M ore specifically, spring **68** may be compressed between end cap **22** and second gear **35** in various embodiments. In various embodiments, gear **24** comprises a plurality of teeth configured to engage with second gear **35** in response to sleeve **30** moving to the second position (see FIG. **23**E). In this manner, sleeve **30** may be restricted from rotating within outer tube **20** in the second position.

[0147] In various embodiments, sleeve **30** is threadedly coupled to sleeve **40**. Thus, rotation of the sleeve **30** causes the sleeve **40** to translate with respect to outer tube **20**. Stated differently, high speed assembly **12** translates rotational motion of sleeve **30** to linear motion of sleeve **40**. sleeve **40** is threadedly coupled to inner screw **50**. Thus, rotation of inner screw **50** causes the inner screw **50** to translate with respect to outer tube **20** and sleeve **40**. Stated differently, low speed assembly **14** translates rotational motion of inner screw **50** to linear motion of inner screw **50**.

[0148] Shaft **60** may be operatively coupled to inner screw **50** such that inner screw **50** rotates with shaft **60**. In various embodiments, outer surface **62** of shaft **60** may comprise a geometry that is complementary to a center aperture **52** of inner screw **50**. In this regard, shaft **60** may interlock with inner screw **50** to impart rotational forces (i.e., torque) therebetween. In various embodiments, inner screw **50** and shaft **60** are coupled via a splined connection or the like. However, shaft **60** may be operatively coupled to inner screw **50** using various methods without departing from the scope and spirit of the present disclosure, such as via a fastener, for example.

[0149] In operation, rotation of shaft **60** in a first rotational direction, e.g., via handle **70**, causes inner screw **50** to rotate with respect outer tube **20** and sleeve **40**, which in turn causes inner screw **50** to extend from sleeve **40** (see FIG. **23**B and FIG. **23**C). Conversely, rotation of shaft **60** in a second rotational direction (opposite the first rotational direction) causes inner screw **50** to rotate with respect to sleeve **40**, which in turn causes inner screw **50** to retract into sleeve **40** (see FIG. **23**A).

[0150] Furthermore, with sleeve **30** in a first position (see FIG. **23**A and FIG. **23**D) with respect to outer tube **20**, sleeve **30** may be drivably coupled to shaft **60**. Stated differently, rotation of shaft **60** may drive rotation of sleeve **30**. In operation, and with sleeve **30** in the first position with respect to outer tube **20** and/or gear **65**, rotation of shaft **60** in a first rotational direction, e.g., via handle **70**, may cause sleeve **30** to rotate with respect outer tube **20** and sleeve **40**, which in turn causes sleeve **40** to extend from sleeve **30**. Conversely, rotation of shaft **60** in a second rotational direction (opposite the first rotational direction) may cause sleeve **30** to rotate with respect outer tube **20** and sleeve **40**, which in turn causes sleeve **40** to retract into sleeve **30**. In the first position, spring **68** may bias first gear **34** of sleeve **30** to engage with shaft gear **65**. Thus, with the sleeve **30** in the first position, both the sleeve **40** and the inner screw **50** are driven to translate with respect to outer tube **20** in response to rotation of shaft **60**.

[0151] However, in operation and with sleeve **30** in a second position (see FIG. **23**E) with respect to outer tube **20** and/or gear **65**, the sleeve **30** is disengaged from gear **65** (i.e., rotation of shaft **60** and gear **65** does not drive rotation of sleeve **30** in the disengaged position). In this regard, with sleeve **30** in the second position, rotation of shaft **60** in the first rotational direction or the second rotational direction may cause only inner screw **50** (and not sleeve **30**) to rotate with respect to outer tube **20**, thereby driving only the inner screw **50** to translate. Stated differently, the high speed assembly **12** may be disengaged from operation in response to the sleeve **30** moving to the second position. In this manner, in response to rotation of shaft **60** in the first direction, both the high speed assembly **12** and the low speed assembly **14** (i.e., the sleeve **40** and inner screw **50**) are driven to increase the overall length of lifting device **10** but, after reacting force from the ground through, for example, foot **75**, rotation of shaft **60** is only imparted to low speed assembly **14** and not high speed assembly **12**. With momentary reference to FIG. **23**C, as the overall length of lifting device **10** is increased, the foot **75** of the lifting device **10** may contact a ground surface **402**, thereby imparting a force **404** from the ground surface **402** into the sleeve **30** which causes the sleeve **30** to move with respect to outer tube **20** against the bias of spring **68** from the first position (i.e., engaged with gear **65**) to the second position (i.e., disengaged from gear **65**) thereby decoupling sleeve **30** from torsional forces imparted by shaft **60**. In this regard, before the lifting device **10** has contacted a ground surface, the overall length of the lifting device **10** is quickly increased to reduce the overall number of rotations of shaft **60** needed to cause lifting device **10** to reach the ground. In response to contacting the ground, the high speed assembly **12** is decoupled from the shaft **60** to take advantage of the mechanical advantage of the low speed assembly **14**. In this manner, time to operate is reduced relative to conventional designs and increased mechanical advantage is selectively activated.

[0152] In various embodiments, sleeve **30** comprises helically extending grooves or threads **31** disposed on an inner diameter surface of sleeve **30**. In various embodiments, sleeve **40** comprises helically extending grooves or threads **42** disposed on an outer diameter surface of sleeve **40**. In various embodiments, sleeve **40** comprises helically extending grooves and/or threads **44** disposed on an inner diameter surface of sleeve **40**. In various embodiments, inner screw **50** comprises helically extending grooves and/or threads **54** disposed on an outer diameter surface of inner screw **50**. Threads **31** are complementary to threads **42**, and threads **44** are complementary to threads **54**. The thread pitch of threads **31**, **42** may be greater than the thread pitch of threads **44**, **54**.

[0153] The thread pitch of threads **31**, **42** may be between 0.1 millimeters (mm) and 304.8 mm (between 0.0039 inches and 12 inches) in accordance with various embodiments, between 1 mm and 101.6 mm (between 0.039 inches and 4 inches) in accordance with various embodiments, between 2 mm and 76.2 mm (between 0.0787 inches and 3 inches) in accordance with various embodiments, and/or between 4 mm and 50.8 mm (between 0.157 inches and 2 inches) in accordance with various embodiments.

[0154] The thread pitch of threads **44**, **54** may be between 0.1 millimeters (mm) and 279.4 mm (between 0.0039 inches and 11 inches) in accordance with various embodiments, between 1 mm and 25.4 mm (between 0.039 inches and 1 inch) in accordance with various embodiments, between 1 mm and 6.35 mm (between 0.039 inches and 0.25 inches) in accordance with various embodiments, and/or between 2 mm and 3.175 mm (between 0.0787 inches and 0.125 inches) in accordance with various embodiments.

[0155] In various embodiments, sleeve **40** may be keyed to outer tube **20** to prevent rotation of sleeve **40** with respect to outer tube **20**. For example, sleeve **40** may comprise one or more axially extending grooves **46** (see FIG. **22**) disposed in the outer diameter surface thereof and outer tube **20** may comprise corresponding protrusion(s) extending radially inwards from an inner diameter surface thereof that extends into groove(s) **46**.

[0156] With combined reference to FIG. **22**, FIG. **24**A, and FIG. **24**B, foot **75** may be configured to rotate with respect to inner screw **50**, in accordance with various embodiments. Foot **75** may comprise a sleeve **76** extending axially from foot **75**. In various embodiments, sleeve **76** is manufactured as a separate piece from foot **75** wherein sleeve **76** is coupled to foot **75**, via a fastener **74** for example, though sleeve **76** and foot **75** may be manufactured as a single, monolithic component. Sleeve **76** may comprise a bore **77** configured to receive a bottom end of inner screw **50**. Sleeve **76** may be secured to the end of inner screw **50** such that sleeve **76** can rotate with respect to inner screw **50**. In this manner, inner screw **50** may rotate during extension and/or retraction of lifting device **10**, while foot **75** remains stationary on a ground surface. In various embodiments, a pin **56** may be disposed to extend through inner screw **50** after inner screw **50** is place within sleeve **76**. Pin **56** may extend at least partially into a cylindrical groove disposed in the bore **77** to prevent inner screw **50** from pulling out bore **77**, while simultaneously allowing rotating of inner screw **50** with respect to sleeve **76**. In various embodiments, a bearing **72** may be disposed between inner screw **50** and sleeve **76** for facilitating rotation of inner screw **50** with respect to sleeve **76**. Bearing **72** may comprise a ball bearing, a thrust needle bearing, among other types of bearings. In various embodiments, a grease fitting **79** may be coupled to sleeve **76**. Grease fitting **79** may be removed to install and/or remove pin **56**. Grease fitting **79** may be in fluid communication with bearing **72**. In this manner, grease may be moved into bore **77** and/or cylindrical groove **78** via grease fitting **79**.

[0157] In various embodiments, shaft **60** may be a two-piece telescoping shaft **61** comprising a first shaft **64** and a second shaft **66** configured for telescoping expansion and contraction along the longitudinal axis. FIG. **26**A and FIG. **26**B depict lifting device **10** in a retracted position and comprising the two-piece telescoping shaft **61**. FIG. **26**C and FIG. **26**D depict lifting device **10** in an extended position and comprising the two-piece telescoping shaft **61**. It can be seen that lifting device **10** may comprise a larger range of extension with the two-piece telescoping shaft **61** in comparison to a single piece shaft **60** (see FIG. **23**B and FIG. **23**C). In this manner, by equipping lifting device **10** with a two-piece shaft **61**, the total length of the lifting device **10** is minimized in the retracted position and maximized in the fully extended position.

[0158] With reference to FIG. **26**C, the top end of inner screw **50** may comprise a flange **58** extending radially inward from the radially inner surface of inner screw **50**. Second shaft **66** may interface with inner screw **50** via flange **58**. In various embodiments, the bottom end of second shaft **66** may comprise an aperture **67** extending transversely through second shaft **66** for receiving a pin for retaining the bottom end of second shaft **66** within inner screw **50**. In this manner, the second shaft **66** is prevented from pulling completely out of the inner screw **50**.

[0159] In various embodiments, the top end of second shaft **66** may similarly comprise a flange **59** extending radially inward from the radially inner surface of second shaft **66**. First shaft **64** may interface with second shaft **66** via flange **59**. In various embodiments, the bottom end of first shaft **64** may similarly comprise an aperture **63** extending transversely through first shaft **64** for receiving a pin for retaining the bottom end of first shaft **64** within second shaft **66**. In this manner, the first shaft **64** is prevented from pulling completely out of the second shaft **66**.

[0160] With reference to FIG. **27**, a flow chart of a method **80** of assembling a lifting device, such as a linear jack, is illustrated, in accordance with various embodiments. Method **80** includes coupling an inner sleeve to an outer sleeve, wherein the inner sleeve is disposed at least partially within the outer sleeve (step **81**). Method **80** includes coupling an inner screw to the inner sleeve, wherein the inner screw is disposed at least partially within the inner sleeve (step **82**). Method **80** includes coupling a shaft to the inner screw (step **83**).

[0161] With combined reference to FIG. **22** and FIG. **27**, step **81** may include threading sleeve **40** into sleeve **30**. Step **82** may include threading inner screw **50** into sleeve **40**. Step **83** may include coupling shaft **60** to inner screw **50**. Shaft **60** may be disposed to extend at least partially through sleeve **30**, sleeve **40**, and inner screw **50**.

[0162] With combined reference to FIG. **28**A and FIG. **28**B, a side view and a section view, respectively, of a lifting device **1100** is illustrated, in accordance with various embodiments. Lifting device **1100** may be a linear jack. Lifting device **1100** may operate similar to lifting device **200**, except that translating screw **1150** is received by shaft **1160**. Furthermore, lifting device **1100** comprises a sleeve **1155** (also referred to herein as a cover sleeve) attached to translating screw **1150**. Sleeve **1155** may be affixed to translating screw **1150**. In this regard, sleeve **1155** may be configured to translate together with translating screw **1150** with respect to sleeve **1140**. Sleeve **1155** may be keyed to an adjacent component to prevent rotation of sleeve **1155** and translating screw **1150**. Sleeve **1155** may protect translating screw **1150** from ambient elements such as dust, water, etc., thereby increasing the life and robustness of lifting device **1100**. Sleeve **1155** may also at least partially contain lubricants, thus tending to retain lubricants on or in close proximity to translating screw **1150**.

[0163] Lifting device **1100** may generally comprise an outer tube **1110**. Outer tube **1110** may comprise a centerline axis **1192**. Outer tube **1110** may be hollow. A high speed assembly comprising a first sleeve **1120** (also referred to herein as a high speed outer sleeve or a first outer sleeve) threadedly coupled to a second sleeve **1130** (also referred to herein as a high speed inner sleeve) may be disposed at least partially within outer tube **1110**. Said high speed assembly may generally comprise a screw mechanism comprising a rotating nut threadedly coupled to a translating screw, in the manner of a leadscrew or jack screw. First sleeve **1120** may be hollow. First sleeve **1120** may be threaded on its inner diameter surface. First sleeve **1120** may comprise a hollow cylinder. Second sleeve **1130** may be disposed at least partially within first sleeve **1120**. Second sleeve **1130** may be hollow. Second sleeve **1130** may comprise a hollow cylinder. Second sleeve **1130** may be threaded on its outer diameter surface.

[0164] A low speed assembly comprising sleeve **1140** (also referred to herein as a low speed outer sleeve, a first sleeve, a third sleeve, and/or an outer sleeve) threadedly coupled to a translating screw **1150** may be disposed at least partially within outer tube **1110**. Said low speed assembly may generally comprise a screw mechanism comprising a rotating nut threadedly coupled to a translating screw, in the manner of a leadscrew or jack screw. Said low speed assembly may be disposed at least partially within second sleeve **1130**.

[0165] Although the present disclosure is described in accordance with various embodiments on the basis of a screw mechanism having a rotating nut and a translating screw, it should be understood that the present disclosure can be applied with a rotating screw and a translating nut.

[0166] Third sleeve **1140** may be disposed at least partially within second sleeve **1130**. Third sleeve **1140** may be hollow. Translating screw **1150** may be disposed at least partially within third sleeve **1140**. Translating screw **1150** may be solid. Stated differently, translating screw **1150** may comprise a solid rod with helically extending threads disposed on the outer diameter surface thereof. Lifting device **1100** may further comprise a shaft **1160**. Shaft **1160** may comprise a hollow portion. Translating screw **1150** may be received into the hollow portion of shaft **1160**. Third sleeve **1140** may receive shaft **1160**. In this regard, third sleeve **1140** may surround shaft **1160**.

[0167] In this regard, the inner diameter of outer tube **1110** may be greater than the outer diameter of first sleeve **1120**. The inner diameter of first sleeve **1120** may be greater than the outer diameter of second sleeve **1130**. The inner diameter of second sleeve **1130** may be greater than the outer diameter of third sleeve **1140**. The inner diameter of third sleeve **1140** may be greater than the outer diameter of translating screw **1150**. The inner diameter of third sleeve **1140** may be greater than the outer diameter of shaft **1160**. The inner diameter of shaft **1160** may be greater than the outer diameter of translating screw **1150**. Outer tube **1110**, first sleeve **1120**, second sleeve **1130**, third sleeve **1140**, translating screw **1150**, and shaft **1160** may be coaxially aligned.

[0168] Lifting device **1100** may further comprise a gear **1165**. Gear **1165** may be coupled to, and rotate with, shaft **1160**. Gear **1165** may be coaxially aligned with shaft **1160**. Shaft **1160** may drive first sleeve **1120** via gear **1165** in response to first sleeve **1120** moving to a first position (see FIG. **28**B), as described in further detail herein. Gear **1165** may be splined to the shaft **1160** but gear **1165** may also be fixedly coupled such as through welding, brazing, a press fit and/or an interference fit. Gear **1165** may comprise any suitable gear, for example, a bevel gear or a crown gear.

[0169] Lifting device **1100** may further comprise a spring **1106**. Spring **1106** may be a coil spring, leaf spring, Belleville spring, or other suitable spring for exerting a bias against first sleeve **1120**. Spring **1106** may be operatively coupled to first sleeve **1120**, to assist movement of first sleeve **1120** between the first position (see FIG. **28**B) and a second position (see FIG. **28**D), as described herein with further detail. In this regard, first sleeve **1120** may be slidable in the outer tube **1110** between the first position and the second position. First sleeve **1120** may translate along centerline axis **1192** between the first position and the second position. The outer tube **1110** may comprise a retaining member **1112**. Retaining member **1112** may be coupled to outer tube **1110**, e.g., via a threaded connection, fasteners, and/or a metal joining process, such as welding, brazing, etc. Retaining member **1112** may comprise a cap structure coupled to the upper end of outer tube **1110**. Retaining member **1112** may comprise a flange extending radially inward from outer tube **1110**. Shaft **1160** may extend through retaining member **1112**. Retaining member **1112** may retain spring **1106** within outer tube **1110**. In this regard, spring **1106** may be compressed between retaining member **1112** and first sleeve **1120**. In various embodiments, retaining member **1112** comprises a mating surface **1114** configured to engage with a mating surface **1124** of first sleeve **1120** in response to first sleeve **1120** moving to the second position (see FIG. **28**D). In this manner, first sleeve **1120** may be restricted from rotating within outer tube **1110** in the second position. In various embodiments, and as shown, mating surface **1124** and mating surface **1114** are crenulated and, as shown, having crenulations that are complementary to one another. The crenulations interact, in response to axial compression, to transfer torque to first sleeve **1120**

[0170] In various embodiments, first sleeve **1120** is threadedly coupled to second sleeve **1130**. Thus, rotation of the first sleeve **1120** causes the second sleeve **1130** to translate with respect to outer tube **1110**. Stated differently, the high speed assembly translates rotational motion of first sleeve **1120** to linear motion of second sleeve **1130**. In various embodiments, third sleeve **1140** is threadedly coupled to translating screw **1150**. In various embodiments, third sleeve **1140** is threadedly coupled to translating screw **1150** at a bottom end **1144** of the third sleeve **1140**. In this regard, third sleeve **1140** may comprise a flange **1148** extending radially inward and disposed at the bottom end **1144** thereof whereby translating screw **1150** is threadedly coupled to third sleeve **1140**. Thus, rotation of the third sleeve **1140** causes the translating screw **1150** to translate with respect to outer tube **1110**. Stated differently, the low speed assembly translates rotational motion of third sleeve **1140** to linear motion of translating screw **1150**.

[0171] Shaft **1160** may be operatively coupled to third sleeve **1140** such that third sleeve **1140** rotates with shaft **1160**. Shaft **1160** may be operatively coupled to third sleeve **1140** via a keyed connection, e.g., a splined connection or the like, at an upper end of third sleeve **1140**. In various embodiments, shaft **1160** may comprise one or more splines **1162** and third sleeve **1140** may comprise a center aperture **1142** comprising a geometry that is complementary to shaft **1160**. In this regard, center aperture **1142** may comprise one or more grooves configured to receive the one or more splines **1162** of shaft **1160** such that shaft **1160** interlocks with third sleeve **1140** to impart rotational forces (i.e., torque) therebetween. Stated differently, third sleeve **1140** and shaft **1160** may be coupled via a splined connection. Third sleeve **1140** may be drivably coupled to shaft **1160** via center aperture **1142**. Center aperture **1142** may comprise various geometries, such as triangular, star, circular, square, or any other geometry that interlocks shaft **1160** with third sleeve **1140**. However, shaft **1160** may be operatively coupled to third sleeve **1140** using various methods without departing from the scope and spirit of the present disclosure.

[0172] In operation, rotation of shaft **1160** in a first rotational direction, e.g., via handle **1170**, causes third sleeve **1140** to rotate with respect outer tube **1110** and translating screw **1150**, which in turn causes translating screw **1150** to extend from third sleeve **1140** (see FIG. **28**C and FIG. **28**D). Conversely, rotation of shaft **1160** in a second rotational direction (opposite the first rotational direction) causes third sleeve **1140** to rotate with respect outer tube **1110** and translating screw **1150**, which in turn causes translating screw **1150** to retract into third sleeve **1140** (see FIG. **28**A and FIG. **28**B).

[0173] Furthermore, with first sleeve **1120** in a first position (see FIG. **28**B) with respect to outer tube **1110**, first sleeve **1120** may be drivably coupled to shaft **1160**. Stated differently, rotation of shaft **1160** may drive rotation of first sleeve **1120**. In operation, and with first sleeve **1120** in the first position with respect to outer tube **1110** and/or gear **1165**, rotation of shaft **1160** in a first rotational direction, e.g., via handle **1170**, may cause first sleeve **1120** to rotate with respect outer tube **1110** and second sleeve **1130**, which in turn causes second sleeve **1130** to extend from first sleeve **1120**. Conversely, rotation of shaft **1160** in a second rotational direction (opposite the first rotational direction) may cause first sleeve **1120** to rotate with respect outer tube **1110** and second sleeve **1130**, which in turn causes second sleeve **1130** to retract into first sleeve **1120**. In the first position, spring **1106** may bias first sleeve **1120** to engage with gear **1165**. Thus, with the first sleeve **1120** in the first position, both the second sleeve **1130** and the translating screw **1150** are driven to translate with respect to outer tube **1110** in response to rotation of shaft **1160**.

[0174] However, with combined reference to FIG. **28**C and FIG. **28**D, in operation and with first sleeve **1120** in the second position with respect to outer tube **1110** and/or gear **1165**, the first sleeve **1120** is disengaged from gear **1165** (i.e., rotation of shaft **1160** and gear **1165** does not drive rotation of first sleeve **1120** in the disengaged position). In this regard, with first sleeve **1120** in the second position, rotation of shaft **1160** in the first rotational direction or the second rotational direction may cause only third sleeve **1140** (and not first sleeve **1120**) to rotate with respect to outer tube **1110** and translating screw **1150**, thereby driving only the translating screw **1150** to translate. Stated differently, the high speed assembly (i.e., the first sleeve **1120** and second sleeve **1130**) may be disengaged from operation in response to the first sleeve **1120** moving to the second position. In this manner, in response to rotation of shaft **1160** in the first direction, both the high speed assembly and the low speed assembly (i.e., the third sleeve **1140** and translating screw **1150**) are driven to increase the overall length of lifting device **1100** but, after reacting force from the ground through, for example, foot **1175**, rotation of shaft **1160** is only imparted to the low speed assembly and the not high speed assembly. As the overall length of lifting device **1100** is increased, the foot **1175** of the lifting device **1100** may contact a ground surface—e.g., as described in further detail with respect to FIG. **4**E and FIG. **4**F-thereby imparting a force from the ground surface into the first sleeve **1120** which causes the first sleeve **1120** to move with respect to outer tube **1110** against the bias of spring **1106** from the first position (i.e., engaged with gear **1165**) to the second position (i.e., disengaged from gear **1165**) thereby decoupling first sleeve **1120** from torsional forces imparted by shaft **1160**. In this regard, before the lifting device **1100** has contacted a ground surface, the overall length of the lifting device **1100** is quickly increased to reduce the overall number of rotations of shaft **1160** needed to cause lifting device **1100** to reach the ground. In response to contacting the ground, the high speed assembly is decoupled from the shaft **1160** to take advantage of the mechanical advantage of the low speed assembly. In this manner, time to operate is reduced relative to conventional designed and increased mechanical advantage is selectively activated.

[0175] With reference to FIG. **29**A, a section view of an upper portion of lifting device **1100** is illustrated, in accordance with various embodiments. In various embodiments, second sleeve **1130** comprises helically extending grooves or threads **1132**. In various embodiments, translating screw **1150** comprises helically extending grooves and/or threads **1152**. The thread pitch of threads **1132** may be greater than the thread pitch of threads **1152**. Stated differently, translating screw **1150** may comprise more threads per inch (TPI) than second sleeve **1130**. In this manner, the high speed assembly translates further and faster per rotation of shaft **1160** than the low speed assembly, causing the lifting device **1100** to reach a ground surface faster than if the high speed assembly were not present. Furthermore, in response to the lifting device **1100** contacting a ground surface and the high speed assembly disengaging from the shaft **1160**, the reduced thread pitch of the low speed assembly takes advantage of the reduced torque required for extending the lifting device **1100**.

[0176] In various embodiments, second sleeve **1130** comprises a first flange **1137** extending radially inward therefrom. First flange **1137** may be disposed at an upper end of the second sleeve **1130**. First flange **1137** may be disposed at an upper terminus of the second sleeve **1130**. In various embodiments, first flange **1137** is removably coupled to second sleeve **1130**. Second sleeve **1130** may comprise a second flange **1138** extending radially inward therefrom. Second flange **1138** may be disposed axially from the first flange **1137**. Third sleeve **1140** may comprise a flange **1146** extending radially outward therefrom. Flange **1146** may be disposed at an upper end of the third sleeve **1140**. Flange **1146** may be disposed at an upper terminus of the third sleeve **1140**. Flange **1146** may be captured between the first flange **1136** and the second flange **1138**. Flange **1146** may be configured to transfer axial loads between third sleeve **1140** and second sleeve **1130** via first flange **1136** and second flange **1138**.

[0177] In various embodiments, a bearing **1108** may be disposed between flange **1146** and first flange **1137**. Bearing **1108** may reduce friction between second sleeve **1130** and third sleeve **1140**. Bearing **1108** may assist rotation of third sleeve **1140** with respect to second sleeve **1130**. Bearing **1108** may comprise a thrust needle roller bearing or the like, in accordance with various embodiments.

[0178] With reference to FIG. **29**B, a section view of a lower portion of lifting device **1100** is illustrated, in accordance with various embodiments. Second sleeve **1130** may be keyed to outer tube **1110** to prevent rotation of second sleeve **1130** with respect to outer tube **1110**. For example, second sleeve **1130** may comprise one or more axially extending grooves **1134** disposed in the outer diameter surface thereof and outer tube **1110** may comprise corresponding protrusion(s) **1116** extending radially inwards from an inner diameter surface thereof that extends into groove(s) **1134**.

[0179] In various embodiments, sleeve **1155** may be affixed to the bottom end **1154** of translating screw **1150**. In this regard, sleeve **1155** and translating screw **1150** may move together. Sleeve **1155** may be keyed to second sleeve **1130** to prevent rotation of sleeve **1155** and translating screw **1150** with respect to second sleeve **1130**. For example, sleeve **1155** may comprise one or more axially extending grooves **1157** disposed in the outer diameter surface thereof and second sleeve **1130** may comprise corresponding protrusion(s) **1136** extending radially inwards from an inner diameter surface thereof that extends into groove(s) **1157**.

[0180] Sleeve **1155** may protect translating screw **1150** from ambient elements such as dust, water, etc., thereby increasing the life and robustness of lifting device **1100**. Stated differently, translating screw **1150** may be enclosed within sleeve **1155**. Sleeve **1155** may comprise a hollow cylinder. Third sleeve **1140** may be at least partially disposed within sleeve **1155**.

[0181] With reference to FIG. **30**, a section view of a bottom portion of lifting device **1100** with the outer tube, sleeve, and sleeve omitted for clarity purposes is illustrated, in accordance with various embodiments. Stated differently, the high speed assembly and outer tube are omitted in FIG. **30**. Translating screw **1150** may comprise a flange **1151** extending from the bottom end thereof. Sleeve **1155** may be coupled to flange **1151**. In this manner, sleeve **1155** may be radially spaced apart from translating screw **1150**. In various embodiments, translating screw **1150** and flange **1151** comprise a single, monolithic piece of material. translating screw **1150** and sleeve **1155** may be coupled to foot **1175**. Sleeve **1155** may be made from a metal or metal alloy, such as cast iron, steel, stainless steel, austenitic stainless steels, ferritic stainless steels, martensitic stainless steels, titanium, titanium alloys, aluminum, aluminum alloys, galvanized steel, or any other suitable metal or metal alloy. Sleeve **1155** may be made from a fiber-reinforced composite material.

[0182] With reference to FIG. **31**, a flow chart of a method **1200** of assembling a lifting device, such as a linear jack, is illustrated, in accordance with various embodiments. Method **1200** includes disposing a second sleeve at least partially within a first sleeve (step **1210**). Method **1200** includes disposing a translating screw at least partially within a third sleeve (step **1220**). Method **1200** includes disposing the third sleeve at least partially within the second sleeve (step **1230**). Method **1200** includes coupling a cover sleeve to the translating screw (step **1240**).

[0183] With combined reference to FIG. **28**B and FIG. **31**, step **1210** may include threading second sleeve **1130** into first sleeve **1120**. Step **1220** may include threading translating screw **1150** into third sleeve **1140**. Step **1230** may include moving third sleeve **1140** into second sleeve **1130**. Step **1230** may include coupling third sleeve **1140** in keyed connection with second sleeve **1130**. Step **1240** may include coupling sleeve **1155** to translating screw **1150**, such as via a fastener, a metal joining process, a threaded connection, or any other suitable coupling. Sleeve **1155** is coupled to translating screw **1150** such that sleeve **1155** surrounds translating screw **1150**. Sleeve **1155** may be disposed to surround third sleeve **1140**. Sleeve **1155** may be coupled in keyed connection with second sleeve **1130**.

[0184] Benefits and other advantages have been described herein with regard to specific embodiments. Furthermore, the connecting lines shown in the various figures contained herein are intended to represent example functional relationships and/or physical couplings between the various elements. It should be noted that many alternative or additional functional relationships or physical connections may be present in a practical system. However, the benefits, advantages, and any elements that may cause any benefit or advantage to occur or become more pronounced are not to be construed as critical, required, or essential features or elements of the disclosure. The scope of the disclosure is accordingly to be limited by nothing other than the appended claims, in which reference to an element in the singular is not intended to mean "one and only one" unless explicitly so stated, but rather "one or more." Moreover, where a phrase similar to "at least one of A, B, or C" is used in the claims, it is intended that the phrase be interpreted to mean that A alone may be present in an embodiment, B alone may be present in an embodiment, C alone may be present in an embodiment, or that any combination of the elements A, B and C may be present in a single embodiment; for example, A and B, A and C, B and C, or A and B and C.

[0185] Systems, methods and apparatus are provided herein. In the detailed description herein, references to "various embodiments", "one embodiment", "an embodiment", "an example embodiment", etc., indicate that the embodiment described may include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described. After reading the description, it will be apparent to one skilled in the relevant art(s) how to implement the disclosure in alternative embodiments.

[0186] Furthermore, no element, component, or method step in the present disclosure is intended to be dedicated to the public regardless of whether the element, component, or method step is explicitly recited in the claims. No claim element is intended to invoke 35 U.S.C. 112(f) unless the element is expressly recited using the phrase "means for." As used herein, the terms "comprises", "comprising", or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus.

Claims

1. A linear jack arrangement, comprising: a shaft; a first sleeve configured to receive the shaft; a second sleeve configured to be received at least partially into the first sleeve, the second sleeve is threadedly coupled to the first sleeve; a third sleeve configured to be received at least partially into the second sleeve; a translating screw disposed at least partially within the third sleeve, wherein the third sleeve is threadedly coupled to the translating screw; and a cover sleeve extending from the translating screw, wherein the cover sleeve is configured to translate with the translating screw with respect to the third sleeve, and a portion of the translating screw extending from an open end of the third sleeve is at least partially enclosed by the cover sleeve; wherein the shaft is configured to receive the translating screw.

2. The linear jack arrangement of claim 1, wherein the third sleeve is configured to rotate in response to rotation of the shaft.

3. The linear jack arrangement of claim 2, wherein the third sleeve is mounted in a rotationally fixed manner to the shaft, whereby the third sleeve rotates together with the shaft.
4. The linear jack arrangement of claim 1, wherein the shaft, the first sleeve, the second sleeve, the third sleeve, and the translating screw are coaxially aligned.
5. The linear jack arrangement of claim 4, wherein the second sleeve comprises a first flange and a second flange, wherein the first flange extends radially inward from the second sleeve and the second flange extends radially inward from the second sleeve.
6. The linear jack arrangement of claim 5, wherein the third sleeve comprises a third flange extending radially outward therefrom, wherein the shaft comprises a centerline axis, and the third flange is disposed axially between the first flange and the second flange.
7. The linear jack arrangement of claim 6, wherein the first flange is removably coupled to the second sleeve.
8. The linear jack arrangement of claim 1, wherein the third sleeve comprises a flange extending radially inward therefrom, wherein the third sleeve is threadedly coupled to the translating screw via the flange.
9. The linear jack arrangement of claim 1, wherein the cover sleeve is configured to be received between the second sleeve and the third sleeve.
10. The linear jack arrangement of claim 9, wherein a radially outer surface of the cover sleeve is keyed to a radially inner surface of the second sleeve so as to prevent rotation of the second sleeve with respect to the cover sleeve.
11. The linear jack arrangement of claim 1, further comprising an outer tube configured to receive the first sleeve.
12. The linear jack arrangement of claim 11, wherein the first sleeve is disposed entirely within the outer tube.
13. The linear jack arrangement of claim 12, wherein the first sleeve is slidable in the outer tube between a first position, wherein the first sleeve is engaged to the shaft, and a second position wherein the first sleeve is disengaged from the shaft.
14. The linear jack arrangement of claim 11, wherein the shaft comprises a gear whereby the shaft is configured to drive rotation of the first sleeve.
15. A method of manufacturing a linear jack, comprising: disposing a second sleeve at least partially within a first sleeve, wherein the first sleeve is threadedly coupled to the second sleeve; disposing a translating screw at least partially within a third sleeve, wherein the third sleeve is threadedly coupled to the translating screw; operatively coupling the third sleeve to a shaft, wherein the third sleeve is configured to rotate in response to rotation of the shaft; disposing the third sleeve at least partially within the second sleeve; and coupling a cover sleeve to the translating screw, wherein the cover sleeve is configured to translate with the translating screw, the cover sleeve is disposed at least partially within the second sleeve, and a portion of the translating screw extending from an open end of the third sleeve is at least partially enclosed by the cover sleeve.
16. The method of claim 15, further comprising: disposing the cover sleeve to surround the translating screw; disposing the cover sleeve to surround the third sleeve; and disposing the cover sleeve in keyed connection with the second sleeve.
17. The method of claim 16, further comprising disposing the cover sleeve between the second sleeve and the third sleeve.
18. The method of claim 15, wherein the operatively coupling the third sleeve to the shaft comprises mounting the third sleeve in a rotationally fixed manner to the shaft, whereby the third sleeve rotates together with the shaft.
19. The method of claim 15, wherein the operatively coupling the third sleeve to the shaft comprises coupling the third sleeve to the shaft via a splined connection.
20. The method of claim 15, further comprising disposing the first sleeve within an outer tube,

wherein the first sleeve is slidable in the outer tube between a first position, wherein the first sleeve is engaged to the shaft, and a second position wherein the first sleeve is disengaged from the shaft.