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(54) Title: FAST ADJUST EXTERNAL FIXATION CONNECTION ROD

(57) Abstract: The present disclosure provides various embodiments of an external fixation connection rod having articulatable joints that can be attached to external supports, such as rings. In some embodiments, the fixation connection rod includes a telescopic rod and connecting mechanisms for coupling the joints of the connection rod to the external supports, and the connecting mechanisms are operable to substantially lock the orientation of the joints. In some other embodiments, the connection rod includes a housing having parallel axial bores defined therethrough and sleeves slidably disposed in the axial bores. Also included in the present disclosure are methods of maintaining the orientation of first and second fixator rings for immobilizing bone segments.

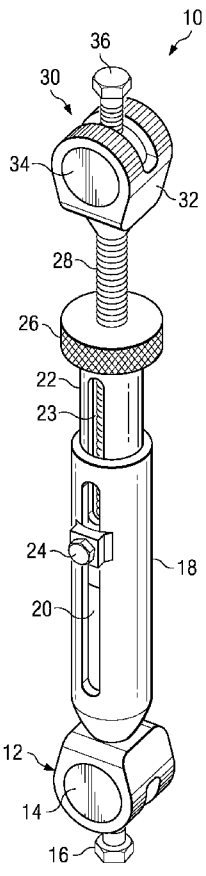


FIG. 1

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FAST ADJUST EXTERNAL FIXATION CONNECTION ROD

TECHNICAL FIELD

[0001] The present disclosure relates in general to the field of external fixation, and more specifically, to connection rods having articulatable joints for attachment to the rings or other external supports of the fixation device.

BACKGROUND

[0002] Without limiting the scope of the disclosure, this background section is described in connection with external fixation devices and specifically connection rods. Generally, external fixation devices are commonly used in a variety of surgical procedures including limb lengthening, deformity correction, fracture reduction and treatment of non-unions, mal-unions and bone defects. The process involves a rigid framework comprising several rings that are placed externally around the limb and attached to bone segments using wires and half pins inserted into the bone segments and connected to the related section of the external rigid framework. The opposite rings of the rigid framework are interconnected by either threaded or telescopic rods directly or in conjunction with uni-planar or multi-planar hinges, which allow the surgeon to connect opposite rings that are not parallel to each other after manipulation with bone segments either rapidly (acutely) or gradually over a period of time.

[0003] For example, in bone fracture reduction or non-union treatment, the wires and half pins are inserted into each bone segment and attached to rings of a rigid framework. The rigid framework is used to acutely reduce a displacement and restore alignment between the bone segments. During the realignment of the bone segments, the orientations of opposite rings often are not parallel. Those opposite rings of the rigid framework are connected together by threaded or telescopic rods with attached uni-planar or multi-planar hinges. This allows the opposite bone segment to be rigidly fixed until complete fracture healing or bone consolidation is completed.

SUMMARY

[0007] The present enclosure includes embodiments of a external fixation connection rod that allows for rapid, coarse adjustments of the rod length and is operable to be easily and rigidly attached to non-parallel external fixator rings.

[0008] Described in one embodiment is a connecting rod for an external fixation device comprising a telescopic housing having a housing body having an axial bore defined therethrough; a first joint coupled to an end portion of the housing body; and a first rotating member received in the first joint, wherein the first rotating member is operable to rotate relative to the first joint about a first axis. The first rotating member comprises a first connection mechanism operable to releasably couple the first rotating member to a first fixator ring. The connecting rod further includes an adjustment sleeve slidably disposed within the axial bore, the adjustment sleeve and the telescopic housing being releasably coupled by a fastener, and an externally threaded elongated member threadably coupled the adjustment sleeve. The elongated member comprises a threaded rod; a second joint coupled to an end portion of the threaded rod; and a second rotating member received in the second joint, wherein the second rotating member is operable rotate relative to the second joint about a second axis. The second rotating member comprises a second connection mechanism operable to releasably couple the second rotating member to a second fixator ring. The first and second connection mechanisms are operable to substantially limit the rotational movement of the first and second rotating members, respectively.

[0009] In some embodiments the first and second connection mechanisms each comprise a fastener aperture defined in the first and second rotating member, respectively, and each fastener aperture is operable to receive a ring fastener disposed through a bore defined in the first or second ring.

[0010] In some embodiments, the first and second joints each comprise a socket, and the first and second rotating members comprise a first and second ball members, respectively, the first and second ball member being disposed in the socket of the first and second joints, respectively. In some exemplary embodiments, the sockets of first and second joints are seated in first and second seating members, respectively, and the seating members each have an inner recessed portion for receiving the socket of first or second joints, and an outer ring contact portion for providing a contact surface with the first or second ring.

[0011] In some particular embodiments, the first connection mechanism comprises a first connecting body extending radially from the first ball member, to the outside of the socket of the first joint, and through an aperture defined in the first seating member, and the first connecting body has a threaded portion operable to be inserted through a bore defined in the first ring. The second connection mechanism also comprises a second connecting body extending radially from the second ball member, to the outside of the socket of the second joint, and through an aperture defined in the second seating member, and the second connecting body has a threaded portion operable to be inserted through a bore defined in the second ring. In these embodiments, the threaded portions of the first and second connecting bodies each are operable to receive a mating nut.

[0012] The present disclosure also includes embodiments direct to a connecting rod for an external fixation device comprising a telescopic housing having a housing body, in which a first portion of the housing body comprises a first axial bore defined therethrough, and a second portion of the housing body comprises a second axial bore defined therethrough. The first and second axial bores have first and second longitudinal axes, respectively, and the first and second longitudinal axes are parallel and coplanar. The connecting rod further includes first and second sleeves slidably disposed within the first and second axial bores, respectively, and the first sleeve has an adjustment mechanism rotatably disposed on an end portion of the first sleeve. The

connect rod further includes an elongated member threadably coupled to the adjustment mechanism such that rotating the adjustment mechanism causes the elongated member to translate along the first axis of the first axial bore. The housing body comprises first and second apertures defined in the walls of the first and second portions of the housing body, respectively, and the first and second apertures are aligned along the first and second axes, respectively. A first fastener is disposed through the first aperture of the housing body and received in a fastener aperture defined in the first sleeve, and a second fastener is disposed through the second aperture of the housing body and received in a fastener aperture defined in the second sleeve, the first and second fasteners being operable to releasably couple the first and second sleeves to the housing body, respectively.

[0012] The present disclosure also includes embodiments for a method of maintaining the orientation of first and second fixator rings for immobilizing bone segments. One exemplary embodiment of the disclosed method includes providing a connecting rod comprising a telescopic housing having an axial bore defined therethrough; an adjustment sleeve slidably disposed within the axial bore, the adjustment sleeve and the telescopic housing; and an externally threaded elongated member threadably coupled to the adjustment sleeve. A first joint is coupled to an end portion of the housing, and a first rotating member is received in the first joint. Furthermore, the first rotating member comprises a first connection mechanism operable to releasably couple the first rotating member to the first fixator ring and substantially limit the rotational movement of the first rotating member. A second joint is coupled to an end portion of the housing, and a second rotating member is received in the second joint. Furthermore, the second rotating member comprises a second connection mechanism operable to releasably couple the second rotating member to the second fixator ring and substantially limit the rotational movement of the second rotating member. The disclosed embodiment further includes adjusting the longitudinal position of adjustment sleeve relative to the telescopic housing, and releasably coupling the adjustment sleeve to the telescopic housing using a sleeve fastener. The disclosed embodiment further includes using the first connection mechanism to releasably couple the first rotating member to the first fixator ring and substantially limit the rotational movement of the first rotating member, and using the second connection mechanism to releasably couple

the second rotating member to the second fixator ring and substantially limit the rotational movement of the second rotating member.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] For a more complete understanding of the features and advantages of the present disclosure, reference is now made to the detailed description of the disclosure along with the accompanying figures in which:

FIGURE 1 is a perspective view of one embodiment of an external fixation connection rod of the present disclosure;

FIGURE 2 is an exploded view of the external fixation connection rod of FIGURE 1;

FIGURE 3 is a cutaway view of the external fixation connection rod of FIGURE 1;

FIGURE 4 is a perspective view of a portion of the external fixation connection rod of the present disclosure;

FIGURE 5 is an exploded view of the portion of the external fixation connection rod of FIGURE 4;

FIGURE 6 is a side view of one embodiment of the external fixation connection rod of the present disclosure;

FIGURE 7 is a side view of one embodiment of the external fixation connection rod of the present disclosure attached to an external fixation device;

FIGURE 8 is a perspective view of one embodiment of the external fixation connection rod of the present disclosure attached to an external fixation device;

FIGURE 9 is a perspective view of another embodiment of an external fixation connection rod of the present disclosure;

FIGURE 10 is an exploded view of a portion of the external fixation connection rod of FIGURE 9;

FIGURE 11 is an assembled view of the portion of the external fixation connection rod of FIGURE 10;

FIGURE 12 is a cutway, side view of another portion of the external fixation connection rod of FIGURE 9;

FIGURE 13 is a perspective view of yet another embodiment of an external fixation connection rod of the present disclosure; and

FIGURE 14 is a cutway, side view of the external fixation connection rod of FIGURE 13.

DETAILED DESCRIPTION

[0013] While the making and using of various embodiments of the present disclosure are discussed in detail below, it should be appreciated that the present disclosure provides many applicable inventive concepts that can be embodied in a wide variety of specific contexts. The specific embodiments discussed herein are merely illustrative of specific ways to make and use the disclosure and do not limit the scope of the disclosure.

[0014] To facilitate the understanding of this disclosure, a number of terms are defined below. Terms defined herein have meanings as commonly understood by a person of ordinary skill in the areas relevant to the present disclosure. Terms such as "a", "an" and "the" are not intended to refer to only a singular entity, but include the general class of which a specific example may be used for illustration. The terminology herein is used to describe specific embodiments of the disclosure, but their usage does not limit the disclosure, except as outlined in the claims.

[0015] The present disclosure includes embodiments directed to an external fixation connection rod with a housing that allows for rapid and gradual adjustment in length and having joint attachments to parallel or non-parallel rings or other external supports. The external fixation connection rod includes a telescopic housing having an axial bore defined therethrough. A first joint is coupled to an end portion of the housing body, and a first rotating member is received in

the first joint. The first rotating member is operable to rotate relative to the first joint about a first axis, and comprises a first connection mechanism. The first connection mechanism releasably couples the first rotating member to a first fixator ring.

[0016] An adjustment sleeve is slidably disposed within the axial bore of the telescopic housing, and a sleeve fastener is used to secure the adjustment sleeve to the telescopic housing. The adjustment sleeve allows for coarse longitudinal length adjustments with respect to the telescopic housing. In some embodiments, the adjustment sleeve comprises an adjustment mechanism having a rotation element. The rotation element has an internally threaded bore defined therethrough, which allows for threaded connection to a threaded elongated member. The elongated member includes a threaded rod, and the external thread of the threaded rod and the internal thread of the threaded bore mate with each other such that rotating the rotation element causes the threaded elongated member to translate along a longitudinal axis of the connecting rod. Coupled to an end portion of the threaded rod is a second joint and a second rotating member received in the second joint. The second rotating member includes a second connection mechanism operable to releasably couple the second rotating member to a second fixator ring. Additionally, the first and second connection mechanism are operable to substantially limit the rotational movement of the first and second rotating members, respectively.

[0017] FIGURE 1 is a perspective view of one embodiment of the external fixation connection rod of the present disclosure. The external fixation connection rod 10 includes a first articulatable joint 12 that houses a first rotating member 14. The first rotating member 14 includes a fastener 16 inserted into a fastener aperture defined (not shown) in the first rotating member 14 to secure the first articulatable joint 12 to an external fixator ring or other fixation device (not shown).

[0018] A telescopic housing 18 extends from the first articulatable joint 12 and has an axial bore (not shown) extending longitudinally from the first articulatable joint 12. The first articulatable joint 12 allows angular and rotational alignment of the telescopic housing 18. The telescopic housing 18 includes a telescopic housing adjustment aperture 20 in a wall of the telescopic housing. An adjustment sleeve 22 is positioned in the axial bore (not shown) of the telescopic housing 18. The adjustment sleeve 22 is slidable within the axial bore (not shown) to allow

adjustment of the end-to-end length of the connecting rod 10 in a rapid manner. The adjustment sleeve 22 includes a sleeve fastener 24 disposed through the telescopic housing adjustment aperture 20 to secure the adjustment sleeve 22 to the telescopic housing 18.

[0019] An adjustment mechanism 26 is positioned at one end of the adjustment sleeve 22 and threadably connected to a threaded elongated member 28. The adjustment mechanism 26 adjusts longitudinally the threaded elongated member 28 to adjust the overall end-to-end length of the connecting rod 10 in a gradual manner. The threaded elongated member 28 includes a second articulatable joint 30 that includes a second articulatable joint housing 32 adapted to fit a second rotating member 34. The second rotating member 34 includes a second fastener 36 that is received in a fastener aperture (not shown) defined in the second rotating member 34 to secure the second articulatable joint 30 to an external fixator ring or other external support (not shown).

[0020] FIGURE 2 is an exploded view of the embodiment shown in FIGURE 1. The external fixation connection rod 10 includes a first articulatable joint 12 that houses a first rotating member 14. The first rotating member 14 passes through a joint aperture 38 that is sized and proportioned to fit the first rotating member 14. A fastener 16 passes through a slot (not shown) in the first articulatable joint 12 and into a fastener aperture 40 defined in the first rotating member 34 to secure the first articulatable joint 12 to an external fixator ring or other external support (not shown). The first articulatable joint 12 allows angular and rotational alignment of the external fixation connection rod 10 relative to the first external fixator ring or other external support.

[0021] A telescopic housing 18 extends from the first articulatable joint 12 and has an axial bore (not shown) extending longitudinally from the first articulatable joint 12 to the axial bore aperture 42. The telescopic housing 18 includes a telescopic housing adjustment aperture 20. An adjustment sleeve 22 is slidably disposed within the axial bore (not shown) of the telescopic housing 18. The adjustment sleeve 22 is slidable within the axial bore (not shown) to allow adjustment of the end-to-end length of the external fixation connection rod 10 in a rapid manner. The adjustment sleeve 22 includes a sleeve fastener 24 that is inserted through a central opening 44 defined in a sleeve fastener washer 46 and through the telescopic housing adjustment aperture 20 into a sleeve fastener aperture 48 defined in the adjustment sleeve 22.

[0022] An adjustment mechanism 26 is rotatably coupled to an end portion of the adjustment sleeve 22 and threadably connected to a threaded elongated member 28. The adjustment mechanism is operable to rotate but not translate relative to the end portion of the adjustment sleeve 22. The adjustment mechanism 26 adjusts longitudinally the threaded elongated member 28 to adjust the overall end-to-end length of the external fixation connection rod 10 in a gradual manner.

[0023] The threaded elongated member 28 includes a second articulatable joint 30. The second articulatable joint 30 includes a second articulatable joint housing 32 adapted to fit a second rotating member 34. The second rotating member 34 passes through a second joint aperture 50 that is sized and proportioned to fit the second rotating member 34. A second fastener 36 disposed through a slot (not shown) in the second articulatable joint 30 and into a second fastener aperture 52 defined in the second rotating member 34 to secure the second articulatable joint 30 to an external fixator ring or other fixation device (not shown). The second articulatable joint 30 allows angular and rotational alignment of the external fixation connection rod 10 relative to the second external fixator ring (not shown) or other external support.

[0024] FIGURE 3 is a cutaway view of the embodiment shown in FIGURES 1-2. The external fixation connection rod 10 includes a first articulatable joint 12 that houses a first rotating member 14. The first rotating member 14 passes through a joint aperture 38 that is sized and proportioned to fit the first rotating member 14. A fastener 16 is disposed through a slot 54 in the first articulatable joint 12 and rotating member aperture 40 into a fastener aperture 56 defined in the first rotating member 14 to secure the first articulatable joint 12 to an external fixator ring or other external support (not shown). The first articulatable joint 12 allows angular and rotational alignment of the external fixation connection rod 10 relative to the first external fixator ring (not shown) or other external support.

[0025] A telescopic housing 18 extends from the first articulatable joint 12 and has an axial bore 58 extending longitudinally from the first articulatable joint 12 to the axial bore aperture 42. The telescopic housing 18 includes a telescopic housing adjustment aperture 20. An adjustment sleeve 22 is slidably disposed within the axial bore 58 of the telescopic housing 18. The adjustment sleeve 22 is slidable within the axial bore 58 to allow adjustment of the end-to-end

length of the external fixation connection rod 10 in a rapid manner. The adjustment sleeve 22 includes a sleeve fastener 24 that is inserted through a sleeve fastener washer aperture 44 centrally defined in the sleeve fastener washer 46 and through the telescopic housing adjustment aperture (not shown) into a sleeve fastener aperture 48. Alternatively, the sleeve fastener 24 may include a separate sleeve washer 46 as a single unit.

[0026] An adjustment mechanism 26 is rotatably disposed at an end portion of the adjustment sleeve 22 and threadably connected to a threaded elongated member 28. In some embodiments, the adjustment mechanism 26 may include a rotation element, the rotation element having an internally threaded bore defined therethrough. The threaded elongated member 28 is disposed through the threaded bore 60 of the rotation element of the adjustment mechanism, and the external thread of the elongated member and the internal thread of the threaded bore mate with each other such that rotating the rotation element of the adjustment mechanism 26 causes the threaded elongated member 28to translate along a longitudinal axis of the connecting rod. The adjustment mechanism 26 adjusts longitudinally the threaded elongated member 28 to adjust the overall end-to-end length of the external fixation connection rod 10 in a gradual manner. The threaded elongated member 28 includes a second articulatable joint 30.

[0027] The second articulatable joint 30 includes a second articulatable joint housing 32 adapted to fit a second rotating member 34. The second rotating member 34 passes through a second joint aperture 50 that is sized and proportioned to fit the second rotating member 34. A second fastener 36 is inserted through a slot 62 in the second articulatable joint 30 and a second rotating member aperture 52 into a second threaded fastener bore 64 to secure the second articulatable joint 30 to an external fixator ring or other external support (not shown). The second articulatable joint 30 allows angular and rotational alignment of the external fixation connection rod 10 relative to the second external fixator ring (not shown) or other external support.

[0028] FIGURE 4 is a perspective view of a portion of the external fixation connection rod of the present disclosure. The articulatable joint 30 includes an articulatable joint housing 32 adapted to fit a rotating member 34. The rotating member 34 passes through an articulatable joint aperture 50 that is sized and proportioned to fit the rotating member 34. A fastener (not shown) is inserted through a slot 62 in the articulatable joint 30 and a rotating member aperture 52 into a

threaded fastener bore (not shown) to secure the articulatable joint 30 to an external fixator ring or other external support (not shown). The articulatable joint 30 may be textured 76 to provide increased adhesion or traction to the external fixator ring or other external supports (not shown).

[0029] FIGURE 5 is an exploded view of a portion of the external fixation connection rod of the present disclosure. The articulatable joint 30 includes an articulatable joint housing 32 adapted to fit a rotating member 34. The rotating member 34 passes through a joint aperture 50 that is sized and proportioned to fit the rotating member 34. A fastener 36 is inserted through a slot 62 in the articulatable joint 30 and a rotating member aperture 52 into a threaded fastener bore (not shown) to secure the articulatable joint 30 to an external fixator ring or other external support (not shown). The articulatable joint 30 may be textured 76 to provide increased adhesion or traction to the external fixator ring or other external supports (not shown).

[0030] FIGURE 6 is a side view of one embodiment of the external fixation connection rod of the present disclosure. The external fixation connection rod 10 includes a first articulatable joint 12 that houses a first rotating member 14. The first rotating member 14 includes a fastener 16 that is inserted through a slot (not shown) in the first articulatable joint 12 to secure the first articulatable joint 12 to an external fixator ring or other external support (not shown). The first articulatable joint 12 may be rotated about the X1 axis of the first rotating member 14 and around the Y1 axis of the fastener 16. This movement allows the first articulatable joint 12 to be secured by the fastener 16 at different angles relative to an external fixator ring or other fixation support (not shown).

[0031] A telescopic housing 18 extends from the first articulatable joint 12 and has an axial bore (not shown) extending longitudinally from the first articulatable joint 12. The telescopic housing 18 includes a telescopic housing adjustment aperture 20. An adjustment sleeve 22 is slidably disposed within the axial bore (not shown) of the telescopic housing 18. The adjustment sleeve 22 is slidable within the axial bore (not shown) to allow adjustment of the end-to-end length "A" of the external fixation connection rod 10 in a rapid manner. The movement of the adjustment sleeve 22 in the axial bore (not shown) of the telescopic housing 18 allows the distance "B" to be changed and in turn change the end-to-end length "A" of the external fixation connection rod 10.

[0032] The adjustment sleeve 22 includes a sleeve fastener (not shown) disposed through the telescopic housing adjustment aperture 20 to secure the adjustment sleeve 22 to the telescopic housing 18. The telescopic housing adjustment aperture 20 also serves as a window to allow positioning and referencing of the adjustment sleeve 22 and or the threaded elongated member 28 to aid in the adjustment of the end-to-end length "A" of the external fixation connection rod 10 in a rapid manner.

[0033] An adjustment mechanism 26 is rotatably disposed at an end portion of the adjustment sleeve 22 and threadably connected to a threaded elongated member 28. The adjustment mechanism 26 may be rotated in direction "Z" to engage the threads of the threaded elongated member 28 and thereby adjust longitudinally the distance "C" and directly affect the end-to-end length "A" of the external fixation connection rod 10 in a gradual manner. The threaded elongated member 28 includes a second articulatable joint 30 that includes a second articulatable joint housing 32 adapted to fit a second rotating member 34. The second rotating member 34 includes a second fastener 36 that is inserted through a slot (not shown) in the second articulatable joint housing 32 to secure the second articulatable joint 30 to an external fixator ring or other external support (not shown).

[0034] The second articulatable joint 30 may be rotated about the X2 axis of the second rotating member 34 and around the Y2 axis of the second fastener 36. This movement allows the second articulatable joint 32 to be secured by the fastener 36 at different angles relative to an external fixator ring or other fixation support (not shown). It is not necessary for the first articulatable joint 12 be at the same angle, position or face relative to the second articulatable joint 30. In addition, the first articulatable joint 12, the second articulatable joint 30 or both articulatable joint 30 may be textured 76 to provide increased adhesion or traction to the external fixator ring or other external supports (not shown).

[0035] The graduation marks 74 may be calibrated into discrete increments (e.g., one millimeter increments) and may indicate the distance between the first articulatable joint 12 and the second articulatable joint 30 and relate to the end-to-end length "A" of the external fixation connection rod 10.

[0036] The graduation marks 74 indicate the lengths of the external fixation connection rod 10 as a relative value, rather than the distance from some predetermined specific length. The graduation marks do not necessarily have to be based on a traditional measuring system, or indicate the effective length of the strut at all. For instance, the graduation marks could indicate the percentage of total rod extension, or daily increments for cases where the translation takes place over an extended period of time. Reference to a neutral position can be useful to set the base members at a predetermined "neutral" position.

[0037] FIGURE 7 is a side view of one embodiment of the external fixation connection rod of the present disclosure attached to an external fixation device. An external fixation connection rod 10 is connected between a first external fixator ring 80 and a second external fixator ring 82. FIGURE 7 depicts a single external fixation connection rod 10 disposed between the first external fixator ring 80 and the second external fixator ring 82 for simplicity sake. The skilled artisan will readily understand that numerous connecting rods 10 may be attached at various positions about the external fixator rings, that the angle of the external fixation connection rod 10 relative to the first external fixator ring 80 and the second external fixator ring 82 may be varied and the length of the external fixation connection rod 10 may be varied and adjusted.

[0038] A first articulatable joint 12 is secured to the external fixator ring 80 or other external support. The external fixation connection rod 10 includes a first articulatable joint 12 that houses a first rotating member 14. The first rotating member 14 includes a fastener 16 that passes through an aperture (not shown) defined in the first external fixator ring 80 and through a slot (not shown) in the first articulatable joint 12 to secure the first articulatable joint 12 to the external fixator ring 80 or other external support. The first rotating member 14 may be rotated to position the fastener 16 at different positions and in turn at different locations in the slot (not shown) of the first articulatable joint 12. This movement allows the first articulatable joint 12 to be secured at different angles relative to an external fixator ring 80 or other external support.

[0039] A telescopic housing 18 extends from the first articulatable joint 12 and has an axial bore (not shown) extending longitudinally from the first articulatable joint 12. The telescopic housing 18 includes a telescopic housing adjustment aperture 20. An adjustment sleeve 22 is slidably disposed within the axial bore (not shown) of the telescopic housing 18. The adjustment sleeve

22 is slidable within the bore (not shown) to allow adjustment of the end-to-end length "A" of the connecting rod 10 in a rapid manner.

[0040] The adjustment sleeve 22 includes a sleeve fastener 24 positioned through the telescopic housing adjustment aperture 20 to secure the adjustment sleeve 22 to the telescopic housing 18. The telescopic housing adjustment aperture 20 also serves as a window to allow positioning and referencing of the adjustment sleeve 22 and or the threaded elongated member 28 to aid in the adjustment of the end-to-end length of the external fixation connection rod 10. The graduation marks 74 indicate the lengths of the external fixation connection rod 10 as a relative value, rather than the distance from some predetermined specific length. The graduation marks do not necessarily have to be based on a traditional measuring system, or indicate the effective length of the strut at all. For instance, the graduation marks could indicate the percentage of total rod extension, or daily increments for cases where the translation takes place over an extended period of time. Reference to a neutral position can be useful to set the base members at a predetermined "neutral" position.

[0041] An adjustment mechanism 26 is rotatably disposed at an end portion of the adjustment sleeve 22 and threadably connected to a threaded elongated member 28. The adjustment mechanism 26 may be rotated to engage the threads of the threaded elongated member 28 and thereby adjust longitudinally the end-to-end length of the connecting rod 10 in a gradual manner. The threaded elongated member 28 includes a second articulatable joint 30 with a second articulatable joint housing 32 adapted to fit a second rotating member 34. The second rotating member 34 includes a second fastener 36 that is inserted through an aperture (not shown) defined in the second external fixator ring 82 and into a slot (not shown) in the second articulatable joint housing 32 to secure the second articulatable joint 30 to an external fixator ring 82 or other external support.

[0042] The second articulatable joint 30 may be rotated to position the second fastener 36 at different positions and in turn at different locations in the slot of the second articulatable joint 30. This movement allows the second articulatable joint 30 to be secured at different angles relative to an external fixator ring 82 or other external support. It is not necessary for the first articulatable joint 12 be at the same angle, position or face relative to the second articulatable

joint 30. In addition, the first articulatable joint 12, the second articulatable joint 30 or both articulatable joints 30 may be textured 76 to provide increased adhesion or traction to the external fixator ring 80 and 82 or other external supports.

[0043] FIGURE 8 is a perspective view of one embodiment of the external fixation device using the external fixation connection rod of the present disclosure. The external fixation device includes a first external fixator ring 80 and a second external fixator ring 82 connected by one or more external fixation connection rods 10. In this embodiment, there are 3 external fixation connection rods 10a, 10b and 10c. Each of the external fixation connection rods (10a, 10b, and 10c) includes a first articulatable joint that houses a first rotating member. The first rotating member includes a fastener inserted through a slot (not shown) in the first articulatable joint to secure the first articulatable joint to an external fixator ring 80. In other embodiments, the external fixation connection rod 10 may be any connection rods described in this disclosure or constructed in accordance to the principles disclosed herein.

[0044] Referring to FIGURES 9-12, an external fixation connection rod 10 includes a telescopic housing 100 having an axial bore (not shown) defined therethrough. A first joint 102 is coupled to an end portion 104 of the housing body 106, and a first rotating member 103 is received in the first joint 102. The first joint 102 includes a socket 108 that may be integrally connected or releasably coupled to the end portion 104 of the housing body 106. The first rotating member 103 includes a ball member 110, which is operable to rotate relative to the socket 108 about a first axis.

[0045] In the illustrated embodiment, the external fixation connection rod 10 further includes a seating member 120 having an inner recessed portion 122 for receiving the socket 108 of first joint 102. The seating member 120 further has an outer ring contact portion 124 for providing a contact surface with a first fixator ring 200. In some embodiments, the outer ring contact portion 124 may include grooves 128 defined therein to improve traction with the ring. Although the illustrated embodiment includes seating members 120 to improve the traction with the fixator ring 200, it is to be appreciated that some embodiments may not include a seating member 120.

[0046] The first rotating member 103 also includes a first connection mechanism 112 operable to releasably couple the first rotating member 103 to the first fixator ring 200. In the illustrated embodiment, the first connection mechanism 112 includes a first connecting body 130 extending radially from the ball member 110 to the outside of the socket 108 of the first joint 102, and through an aperture defined in the seating member 102. The first connecting body 130 has a threaded portion 132 operable to be inserted through a bore 134 defined in the first ring 200. To lock the ball member 110 and socket 108 to the first ring 200, a nut 136 is disposed over the threaded portion 132, which can be tightened to cause the ball member 110 to exert a pulling force on the socket 108 and seating member 102. In some embodiments, the first connecting body 130 further comprises a flared portion 138, and the aperture 126 defined in the seating member 120 comprises a corresponding interfering portion operable to cooperate with the flared portion 138 of the first connecting body 130 to limit the rotational movement of the ball member 110 relative to the socket 108.

[00] It is to be appreciated that the embodiments discussed herein are merely exemplary, and any of the discussed embodiment can be modified in accordance with the principles disclosed herein. For example, the socket 108 and ball member 110 may be configured to satisfy various design needs. To allow for increased range of motion for the ball member 110, the socket 108 in some embodiments may include a plurality of recessed portions defined in the wall of the socket 108 as illustrated in FIGURES 9-12. Additionally, the recessed portions in the wall of socket 108 allow the ball member 110 and joint 102 to automatically, and without excessive rotation, accommodate the various orientations of the rings 200 as the ball member 110 and socket 108 are being locked to the first ring 200. In the exemplary embodiment illustrated in FIGURES 9-12, the recessed portions are aligned such that they cooperate to form crossed channels.

[0047] Also shown in the FIGURES 9-12 is an adjustment sleeve 140 slidably disposed within the axial bore (not shown) of the telescopic housing 100, and a sleeve fastener 142 is used to secure the adjustment sleeve 140 to the telescopic housing 100. The adjustment sleeve 140 allows for coarse longitudinal length adjustments with respect to the telescopic housing 100. In some embodiments, the adjustment sleeve comprises an adjustment mechanism 144 having a rotation element 146, such as a thumb wheel. The rotation element 146 has an internally

threaded bore (not shown) defined therethrough, which allows for threaded connection to a threaded elongated member 148. The elongated member includes a threaded rod 150 and the external thread of the threaded rod and the internal thread of the threaded bore mate with each other such that rotating the rotation element 146 causes the threaded elongated member 148 to translate along a longitudinal axis of the connecting rod 10.

[0048] Coupled to an end portion 152 of the threaded rod 150 is a second joint 102 and a second rotating member 103 received in the second joint 102. The second rotating member 103 includes a second connection mechanism 112 operable to releasably couple the second rotating member 103 to a second fixator ring 200. In the illustrated embodiment, the configurations of the second joint 102, second rotating member 103, and the second connection mechanism 112 are similar to the configurations of the first joint 102, first rotating member 103, and the first connection mechanism 112 as described above. A seating member 120 can be disposed between the rotating member 103 and the second fixator ring 200 to improve traction as discussed above.

[0049] It is to be appreciated that the embodiments of the present disclosure can be modified in accordance with the principles described herein to satisfy various design constraints. For example, illustrated in FIGURES 13 and 14 is an external fixation connection rod 10 configured to accommodate an external fixation device with a relatively short ring-to-ring length. Specifically, the external fixation connection rod 10 includes a telescopic housing 300 having a housing body, in which a first portion of the housing body 300 comprises a first axial bore defined therethrough, and a second portion of the housing body 300 comprises a second axial bore defined therethrough. The first and second axial bores define first and second longitudinal axes, respectively, and the first and second longitudinal axes are parallel and coplanar. The housing body further comprises first and second apertures 310 defined in the walls of the first and second portions of the housing body 300, respectively. The first and second apertures 300 are aligned along the first and second axes, respectively. Sleeves 302 and 304 are slidably disposed in the first and second axial bores, respectively, and each include a fastener aperture (not shown) defined therein. Fastener 306 are inserted through the housing apertures 310 and received in the fastener apertures of the first and second sleeves 302 and 304 to lock the sleeves

in a desired longitudinal position. As such, the longitudinal movement of the sleeves 302 and 304 in the axial bores allows for coarse length adjustments.

[0050] To provide a means for gradual length adjustment, the sleeve 304 further includes an adjustment mechanism 314 having a rotation element 316. The rotation element 316 is rotatably disposed on an end portion of the sleeve 304, and has an internally threaded bore defined therethrough. A threaded elongated member 318 is disposed through the threaded bore of the rotation element 316 of the adjustment mechanism 314. The external thread of the elongated member and the internal thread of the threaded bore engage each other such that rotating the rotation element 316 causes the threaded elongated member 318 to translate along a longitudinal axis of the connecting rod. A joint 320 is disposed on an end portion of the threaded elongated member 318 for connection with an external ring or support device. The joint 312 may be any suitable joints or connectors described in the present application or known in the art. The sleeve 302 also includes a joint 312 at an end portion for connection with an external ring or support device. The joint 312 may be any suitable joints or connectors described in the present application or known in the art.

[0051] In some embodiments, the sleeve 302 can also include a second adjustment mechanism rotatably disposed on an end portion of the second sleeve. The second adjustment mechanism is threadably coupled to a second elongated member, and rotating the second adjustment mechanism causes the second elongated member to translate along the second axis of the second axial bore.

[0050] The present disclosure also includes embodiments for maintaining the orientation of first and second fixator rings for immobilizing bone segments. One exemplary embodiment includes providing a connecting rod comprising a telescopic housing having an axial bore defined therethrough; an adjustment sleeve slidably disposed within the axial bore, the adjustment sleeve and the telescopic housing; and an externally threaded elongated member threadably coupled the adjustment sleeve. A first joint is coupled to an end portion of the housing, and a first rotating member is received in the first joint. Furthermore, the first rotating member comprises a first connection mechanism operable to releasably couple the first rotating member to the first fixator ring and substantially limit the rotational movement of the first rotating member. A second joint

is coupled to an end portion of the housing, and a second rotating member is received in the second joint. Furthermore, the second rotating member comprises a second connection mechanism operable to releasably couple the second rotating member to the second fixator ring and substantially limit the rotational movement of the second rotating member. The disclosed embodiment further includes adjusting the longitudinal position of adjustment sleeve relative to the telescopic housing, and releasably coupling the adjustment sleeve to the telescopic housing using a sleeve fastener. The disclosed embodiment further includes using the first connection mechanism to releasably couple the first rotating member to the first fixator ring and substantially limit the rotational movement of the first rotating member, and using the second connection mechanism to releasably couple the second rotating member to the second fixator ring and substantially limit the rotational movement of the second rotating member.

[0051] The methods of the present disclosure may be performed with a subject, e.g., a human or another vertebrate animal. One or more bones (of the subject) to be fixed may be selected. Any suitable bone(s) may be selected, such as a long bone(s) and/or at least a pair of bones connected via an anatomical joint. Exemplary bones include leg bones (femur, tibia, and fibula), arm bones (humerus, radius, and ulna), foot bones (calcaneus, talus, metatarsals, and phalanges), wrist/hand bones (carpals, metacarpals, and phalanges), etc. In exemplary embodiments, one or more bones including at least one long bone may be selected.

[0052] An external fixation device may be constructed along and at least partially around the selected bone(s). The external fixation device may include a plurality of rings fixed in position relative to one another by numerous connecting rods secured to the rings.

[0053] The external fixation device may be connected to the selected bone(s). Connection may be performed at any suitable time, such as before, during, and/or after construction of the external fixation device. For example, the external fixation device may be assembled and then connected to bone, or individual external fixation device members or external fixation device sub-assemblies may be connected to the bone before the external fixation device is fully assembled. Connection of the external fixation device to bone may include placing connectors, such as wires, pins, screw, and/or rods, among others, through the skin and into, through, and/or around the selected bone.

[0054] The external fixation device may be reconfigured while it is connected to the one or more selected bones. Reconfiguration may include adjusting the length, angle, position, and/or connection site of one or more external fixation device components, particularly connecting rod. In some embodiments, reconfiguration may involve lengthening and/or shortening one or more (or all) connecting rods of the external fixation device. In some embodiments, reconfiguration may involve replacing one or more connecting rods with a different connecting rod(s). The different connecting rod may be of different size, pivotability, adjustability, shape, and/or the like.

[0055] The external fixation device may be braced to facilitate reconfiguration. Bracing the external fixation device may stiffen and/or stabilize the external fixation device such that reconfiguration produces fewer undesired changes to the external fixation device structure as the external fixation device is weakened and altered during reconfiguration. Bracing may be performed by a pair of connecting rods of the external fixation device. In some examples, the brace may be configured to be clipped onto the external fixation device members before the brace is fully secured to the external fixation device members. For example, the brace may include one or more external fixation device engagement elements that are biased to opposingly engage one or more respective external fixation device members. In any case, each engagement element may be secured in place on the external fixation device member by operating a user control, manually or with a tool. Furthermore, the relative spacing and angular disposition of the engagement elements may be fixed by operating a user control, either the same user control(s) for securing the engagement element to a frame member or a distinct user control.

[0056] In some examples, the brace may include one or more movable joints, and the brace may be installed in engagement with the external fixation device members with one or more of the joints in a movable configuration. The movable joints then may be adjusted to a locked (fixed) configuration. Alternatively, or in addition, the brace may include a plurality of movable joints and one or more of the movable joints may be locked before or during brace placement onto the frame, and one or more other of the movable joints may be locked after brace placement onto the external fixation device.

[0057] The brace may be removed after frame reconfiguration. Accordingly, the brace may be installed with the frame (and connecting rod) fixing bone and removed with the frame reconfigured and still fixing bone. The brace thus may be present on the external fixation device for only a fraction of the time that the external fixation device is fixing bone.

[0058] It is contemplated that any embodiment discussed in this specification can be implemented with respect to any method, kit, reagent, or composition of the disclosure, and vice versa. Furthermore, compositions of the disclosure can be used to achieve methods of the disclosure.

[0059] It will be understood that particular embodiments described herein are shown by way of illustration and not as limitations of the disclosure. The principal features of this disclosure can be employed in various embodiments without departing from the scope of the disclosure. Those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, numerous equivalents to the specific procedures described herein. Such equivalents are considered to be within the scope of this disclosure and are covered by the claims.

[0060] All publications and patent applications mentioned in the specification are indicative of the level of skill of those skilled in the art to which this disclosure pertains. All publications and patent applications are herein incorporated by reference to the same extent as if each individual publication or patent application was specifically and individually indicated to be incorporated by reference.

[0061] The use of the word "a" or "an" when used in conjunction with the term "comprising" in the claims and/or the specification may mean "one," but it is also consistent with the meaning of "one or more," "at least one," and "one or more than one." The use of the term "or" in the claims is used to mean "and/or" unless explicitly indicated to refer to alternatives only or the alternatives are mutually exclusive, although the disclosure supports a definition that refers to only alternatives and "and/or." Throughout this application, the term "about" is used to indicate that a value includes the inherent variation of error for the device, the method being employed to determine the value, or the variation that exists among the study subjects.

[0062] As used in this specification and claim(s), the words "comprising" (and any form of comprising, such as "comprise" and "comprises"), "having" (and any form of having, such as "have" and "has"), "including" (and any form of including, such as "includes" and "include") or "containing" (and any form of containing, such as "contains" and "contain") are inclusive or open-ended and do not exclude additional, unrecited elements or method steps.

[0063] The term "or combinations thereof' as used herein refers to all permutations and combinations of the listed items preceding the term. For example, "A, B, C, or combinations thereof' is intended to include at least one of: A, B, C, AB, AC, BC, or ABC, and if order is important in a particular context, also BA, CA, CB, CBA, BCA, ACB, BAC, or CAB. Continuing with this example, expressly included are combinations that contain repeats of one or more item or term, such as BB, AAA, MB, BBC, AAABCCCC, CBBAAA, CABABB, and so forth. The skilled artisan will understand that typically there is no limit on the number of items or terms in any combination, unless otherwise apparent from the context.

[0064] All of the compositions and/or methods disclosed and claimed herein can be made and executed without undue experimentation in light of the present disclosure. While the compositions and methods of this disclosure have been described in terms of preferred embodiments, it will be apparent to those of skill in the art that variations may be applied to the compositions and/or methods and in the steps or in the sequence of steps of the method described herein without departing from the concept, spirit and scope of the disclosure. All such similar substitutes and modifications apparent to those skilled in the art are deemed to be within the spirit, scope and concept of the disclosure as defined by the appended claims.

What is claimed is:

1. A connecting rod for an external fixation device comprising:

a telescopic housing comprising:

a housing body having an axial bore defined therethrough,

a first joint coupled to an end portion of the housing body;

a first rotating member received in the first joint, wherein the first rotating member is operable to rotate relative to the first joint about a first axis, and the first rotating member comprises a first connection mechanism operable to releasably couple the first rotating member to a first fixator ring;

an adjustment sleeve slidably disposed within the axial bore, the adjustment sleeve and the telescopic housing being releasably coupled by a fastener; and

an externally threaded elongated member threadably coupled the adjustment sleeve, the elongated member comprising:

a threaded rod,

a second joint coupled to an end portion of the threaded rod;

a second rotating member received in the second joint, wherein the second rotating member is operable to rotate relative to the second joint about a second axis, and the second rotating member comprises a second connection mechanism operable to releasably couple the second rotating member to a second fixator ring; and

wherein, the first and second connection mechanisms are operable to substantially limit the rotational movement of the first and second rotating members, respectively.

2. The connecting rod of claim 1, wherein the first and second connection mechanisms each comprise a fastener aperture defined in the first and second rotating member, respectively, and

further wherein each fastener aperture is operable to receive a ring fastener disposed through a bore defined in the first or second ring.

3. The connecting rod of claim 2, wherein the first joint comprises a textured surface operable to provide frictional contact with a surface of the first ring.

4. The connecting rod of claim 3, wherein the textured surface comprises parallel grooves defined therein.

5. The connecting rod of claim 2, wherein the second joint comprises a textured surface operable to provide frictional contact with a surface of the second ring.

6. The connecting rod of claim 5, wherein the textured surface comprises parallel grooves defined therein.

7. The connecting rod of claim 1, wherein the first and second joints each comprise a socket, and further wherein the first and second rotating members comprise a first and second ball members, respectively, the first and second ball member being disposed in the socket of the first and second joints, respectively.

8. The connecting rod of claim 7, wherein the sockets of first and second joints are seated in first and second seating members, respectively, the seating members each having an inner recessed portion for receiving the socket of first or second joints, and further having an outer ring contact portion for providing a contact surface with the first or second ring.

9. The connecting rod of claim 8,

wherein the first connection mechanism comprises a first connecting body extending radially from the first ball member, to the outside of the socket of the first joint, and through an aperture defined in the first seating member, and further wherein the first connecting body has a threaded portion operable to be inserted through a bore defined in the first ring;

wherein the second connection mechanism comprises a second connecting body extending radially from the second ball member, to the outside of the socket of the second joint,

and through an aperture defined in the second seating member, and further wherein the second connecting body has a threaded portion operable to be inserted through a bore defined in the second ring; and

wherein the threaded portions of the first and second connecting bodies each are operable to receive a mating nut.

10. The connecting rod of claim 9, wherein the first connecting body comprises a flared portion, and the aperture defined in the first seating member comprises a corresponding interfering portion operable to cooperate with the flared portion of the first connecting body to limit the rotational movement of the first ball member relative to the first joint.

11. The connecting rod of claim 9, wherein the second connecting body comprises a flared portion, and the aperture defined in the second seating member comprises a corresponding interfering portion operable to cooperate with the flared portion of the second connecting body to limit the rotational movement of the second ball member relative to the second joint.

12. The connecting rod of claim 7, wherein the sockets of the first and second joints each comprise a plurality of recessed portions defined in the wall of each socket.

13. The connecting rod of claim 12, wherein the recessed portions defined in the socket of the first joint cooperate to form crossed channels.

14. The connecting rod of claim 1, wherein the telescopic housing comprises an aperture defined in a wall of the housing, the aperture extending longitudinally along the housing, and the adjustment sleeve comprises a threaded radial bore, and further wherein the fastener comprises a screw inserted through the aperture of the telescopic housing and received in the threaded radial bore.

15. The connecting rod of claim 14, further comprising a washer having a central opening defined therein, the washer being disposed on an outer surface of the telescopic housing, and further wherein the screw is inserted through the central opening of the washer, through the aperture of the telescopic housing, and received in the threaded bore.

16. The connecting rod of claim 1, wherein the adjustment sleeve comprises an aperture defined in a wall of the adjustment sleeve, the aperture extending longitudinally along the adjustment sleeve.

17. The connecting rod of claim 1, wherein the adjustment sleeve comprises an adjustment mechanism having a rotation element, the rotation element having an internally threaded bore defined therethrough, wherein the threaded elongated member is disposed through the threaded bore of the rotation element of the adjustment mechanism, the external thread of the elongated member and the internal thread of the threaded bore mating with each other such that rotating the rotation element causes the threaded elongated member to translate along a longitudinal axis of the connecting rod.

18. The connecting rod of claim 17, wherein the adjustment mechanism is rotatably coupled to an end portion of the adjustment sleeve, the adjustment mechanism being operable to rotate but not translate relative to the end portion of the adjustment sleeve.

19. A method of maintaining the orientation of first and second fixator rings for immobilizing bone segments, comprising:

providing a connecting rod comprising:

a telescopic housing comprising an axial bore defined therethrough;

an adjustment sleeve slidably disposed within the axial bore, the adjustment sleeve and the telescopic housing; and

an externally threaded elongated member threadably coupled the adjustment sleeve;

wherein a first joint is coupled to an end portion of the housing, and a first rotating member is received in the first joint, and further wherein the first rotating member comprises a first connection mechanism operable to releasably couple the first rotating member to the first fixator ring and substantially limit the rotational movement of the first rotating member;

wherein a second joint is coupled to an end portion of the housing, and a second rotating member is received in the second joint, and further wherein the second rotating member comprises a second connection mechanism operable to releasably couple the second rotating member to the second fixator ring and substantially limit the rotational movement of the second rotating member.

adjusting the longitudinal position of adjustment sleeve relative to the telescopic housing;

releasably coupling the adjustment sleeve to the telescopic housing using a sleeve fastener;

using the first connection mechanism to releasably couple the first rotating member to the first fixator ring and substantially limit the rotational movement of the first rotating member; and

using the second connection mechanism to releasably couple the second rotating member to the second fixator ring and substantially limit the rotational movement of the second rotating member.

20. The method of claim 19, wherein the first and second connection mechanisms each comprise a fastener aperture defined in the first and second rotating member, respectively, and wherein the method further comprises:

disposing ring fasteners through bores defined in the first and second ring and into the fastener apertures of the first and second rotating members, whereby the rotational movements of the first and second rotating members are substantially limited.

21. The method of claim 19, wherein the first and second joints each comprise a socket, and further wherein the first and second rotating members comprise a first and second ball members, respectively, the first and second ball member being disposed in the socket of the first and second joints, respectively, and wherein the method further comprises:

providing first and second seating members each having an inner recessed portion for receiving the socket of first or second joints, and further having an outer ring contact portion for providing a contact surface with the first or second ring;

disposing the first seating member between the first joint and the first ring and further disposing the second seating member between the second joint and the second ring.

22. The method of claim 19,

wherein the first connection mechanism comprises a first connecting body extending radially from the first ball member, to the outside of the socket of the first joint, and through an aperture defined in the first seating member, and further wherein the first connecting body has a threaded portion;

wherein the second connection mechanism comprises a second connecting body extending radially from the second ball member, to the outside of the socket of the second joint, and through an aperture defined in the second seating member, and further wherein the second connecting body has a threaded portion;

wherein the method further comprises:

inserting the threaded portion of the first connecting body through a bore defined in the first ring and inserting the threaded portion of the second connecting body through a bore defined in the second ring; and

securing the threaded portions of the first and second connecting bodies to the first and second rings, respectively, with mating nuts.

23. The method of claim 19, wherein the telescopic housing comprises an aperture defined in a wall of the housing, the aperture extending longitudinally along the housing, and wherein the method further comprises monitoring acute translation of the adjustment sleeve relative to the telescopic housing.

24. The method of claim 19, wherein the adjustment sleeve comprises an aperture defined in a wall of the adjustment sleeve, the aperture extending longitudinally along the adjustment sleeve, and wherein the method further comprises monitoring gradual translation of the threaded elongated member relative to the adjustment sleeve.

25. A connecting rod for an external fixation device comprising:

a telescopic housing having a housing body, wherein a first portion of the housing body comprises a first axial bore defined therethrough, and a second portion of the housing body comprises a second axial bore defined therethrough, the first and second axial bores having first and second longitudinal axes, respectively, and further wherein the first and second longitudinal axes are parallel and coplanar;

first and second sleeves slidably disposed within the first and second axial bores, respectively, the first sleeve having an adjustment mechanism rotatably disposed on an end portion of the first sleeve; and

an elongated member threadably coupled to the adjustment mechanism, wherein rotating the adjustment mechanism causes the elongated member to translate along the first axis of the first axial bore;

wherein the housing body comprises first and second apertures defined in the walls of the first and second portions of the housing body, respectively, the first and second apertures being aligned along the first and second axes, respectively; and

wherein a first fastener is disposed through the first aperture of the housing body and received in a fastener aperture defined in the first sleeve, and a second fastener is disposed through the second aperture of the housing body and received in a fastener aperture defined in the second sleeve, the first and second fasteners being operable to releasably couple the first and second sleeves to the housing body, respectively.

26. The connecting rod of claim 25, further comprising a first joint coupled to an end portion of the elongated member.

27. The connecting rod of claim 25, further comprising a second joint coupled to an end portion of the second sleeve.

28. The connecting rod of claim 23, wherein the second sleeve has a second adjustment mechanism rotatably disposed on an end portion of the second sleeve, the second adjustment

mechanism being threadably coupled to a second elongated member, and further wherein rotating the second adjustment mechanism causes the second elongated member to translate along the second axis of the second axial bore.

29. The connecting rod of claim 28, further comprising a second joint coupled to an end portion of the second elongated member.

AMENDED CLAIMS

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What is claimed is:

1. A connecting rod for an external fixation device, the connecting rod defining a longitudinal axis and comprising:

a telescopic housing comprising:

a housing body having an axial bore defined therethrough,

a first joint coupled to an end portion of the housing body;

a first rotating member received in the first joint, wherein the first rotating member is operable to rotate relative to the first joint about a first axis orthogonal to the longitudinal axis of the connecting rod, and the first rotating member comprises a first connection mechanism operable to releasably couple the first rotating member to a first fixator ring;

an adjustment sleeve slidably disposed within the axial bore, the adjustment sleeve and the telescopic housing being releasably coupled by a fastener; and

an externally threaded elongated member threadably coupled the adjustment sleeve, the elongated member comprising:

a threaded rod,

a second joint coupled to an end portion of the threaded rod;

a second rotating member received in the second joint, wherein the second rotating member is operable to rotate relative to the second joint about a second axis orthogonal to the longitudinal axis of the connecting rod, and the second rotating member comprises a second connection mechanism operable to releasably couple the second rotating member to a second fixator ring; and

wherein, the first and second connection mechanisms are operable to substantially limit the rotational movement of the first and second rotating members, respectively.

2. The connecting rod of claim 1, wherein the first and second connection mechanisms each comprise a fastener aperture defined in the first and second rotating member, respectively, and further wherein each fastener aperture is operable to receive a ring fastener disposed through a bore defined in the first or second ring.

3. The connecting rod of claim 2, wherein the first joint comprises a textured surface operable to provide frictional contact with a surface of the first ring.

4. The connecting rod of claim 3, wherein the textured surface comprises parallel grooves defined therein.

5. The connecting rod of claim 2, wherein the second joint comprises a textured surface operable to provide frictional contact with a surface of the second ring.

6. The connecting rod of claim 5, wherein the textured surface comprises parallel grooves defined therein.

7. The connecting rod of claim 1, wherein the first and second joints each comprise a socket, and further wherein the first and second rotating members comprise a first and second ball members, respectively, the first and second ball member being disposed in the socket of the first and second joints, respectively.

8. The connecting rod of claim 7, wherein the sockets of first and second joints are seated in first and second seating members, respectively, the seating members each having an inner recessed portion for receiving the socket of first or second joints, and further having an outer ring contact portion for providing a contact surface with the first or second ring.

9. The connecting rod of claim 8,

wherein the first connection mechanism comprises a first connecting body extending radially from the first ball member, to the outside of the socket of the first joint, and through an aperture defined in the first seating member, and further wherein the first connecting body has a threaded portion operable to be inserted through a bore defined in the first ring;

wherein the second connection mechanism comprises a second connecting body extending radially from the second ball member, to the outside of the socket of the second joint, and through an aperture defined in the second seating member, and further wherein the second connecting body has a threaded portion operable to be inserted through a bore defined in the second ring; and

wherein the threaded portions of the first and second connecting bodies each are operable to receive a mating nut.

10. The connecting rod of claim 9, wherein the first connecting body comprises a flared portion, and the aperture defined in the first seating member comprises a corresponding interfering portion operable to cooperate with the flared portion of the first connecting body to limit the rotational movement of the first ball member relative to the first joint.

11. The connecting rod of claim 9, wherein the second connecting body comprises a flared portion, and the aperture defined in the second seating member comprises a corresponding interfering portion operable to cooperate with the flared portion of the second connecting body to limit the rotational movement of the second ball member relative to the second joint.

12. The connecting rod of claim 7, wherein the sockets of the first and second joints each comprise a plurality of recessed portions defined in the wall of each socket.

13. The connecting rod of claim 12, wherein the recessed portions defined in the socket of the first joint cooperate to form crossed channels.

14. The connecting rod of claim 1, wherein the telescopic housing comprises an aperture defined in a wall of the housing, the aperture extending longitudinally along the housing, and the adjustment sleeve comprises a threaded radial bore, and further wherein the fastener comprises a screw inserted through the aperture of the telescopic housing and received in the threaded radial bore.

15. The connecting rod of claim 14, further comprising a washer having a central opening defined therein, the washer being disposed on an outer surface of the telescopic housing, and further wherein the screw is inserted through the central opening of the washer, through the aperture of the telescopic housing, and received in the threaded bore.

16. The connecting rod of claim 1, wherein the adjustment sleeve comprises an aperture defined in a wall of the adjustment sleeve, the aperture extending longitudinally along the adjustment sleeve.

17. The connecting rod of claim 1, wherein the adjustment sleeve comprises an adjustment mechanism having a rotation element, the rotation element having an internally threaded bore defined therethrough, wherein the threaded elongated member is disposed through the threaded bore of the rotation element of the adjustment mechanism, the external thread of the elongated member and the internal thread of the threaded bore mating with each other such that rotating the rotation element causes the threaded elongated member to translate along the longitudinal axis of the connecting rod.

18. The connecting rod of claim 17, wherein the adjustment mechanism is rotatably coupled to an end portion of the adjustment sleeve, the adjustment mechanism being operable to rotate but not translate relative to the end portion of the adjustment sleeve.

19. A method of maintaining the orientation of first and second fixator rings for immobilizing bone segments, comprising:

providing a connecting rod having a longitudinal axis and comprising:

a telescopic housing comprising an axial bore defined therethrough;

an adjustment sleeve slidably disposed within the axial bore, the adjustment sleeve and the telescopic housing; and

an externally threaded elongated member threadably coupled the adjustment sleeve;

wherein a first joint is coupled to an end portion of the housing, and a first rotating member is received in the first joint, and further wherein the first rotating member comprises a first connection mechanism operable to releasably couple the first rotating member to the first fixator ring and substantially limit the rotational movement of the first rotating member;

wherein a second joint is coupled to an end portion of the housing, and a second rotating member is received in the second joint, and further wherein the second rotating member comprises a second connection mechanism operable to releasably couple the second rotating member to the second fixator ring and substantially limit the rotational movement of the second rotating member.

adjusting the longitudinal position of adjustment sleeve relative to the telescopic housing, thereby rotating the first and second rotating members about first and second axes, respectively, wherein the first and second axes are both orthogonal to the longitudinal axis of the connecting rod;

releasably coupling the adjustment sleeve to the telescopic housing using a sleeve fastener;

using the first connection mechanism to releasably couple the first rotating member to the first fixator ring and substantially limit the rotational movement of the first rotating member; and

using the second connection mechanism to releasably couple the second rotating member to the second fixator ring and substantially limit the rotational movement of the second rotating member.

20. The method of claim 19, wherein the first and second connection mechanisms each comprise a fastener aperture defined in the first and second rotating member, respectively, and wherein the method further comprises:

disposing ring fasteners through bores defined in the first and second ring and into the fastener apertures of the first and second rotating members, whereby the rotational movements of the first and second rotating members are substantially limited.

21. The method of claim 19, wherein the first and second joints each comprise a socket, and further wherein the first and second rotating members comprise a first and second ball members, respectively, the first and second ball member being disposed in the socket of the first and second joints, respectively, and wherein the method further comprises:

providing first and second seating members each having an inner recessed portion for receiving the socket of first or second joints, and further having an outer ring contact portion for providing a contact surface with the first or second ring;

disposing the first seating member between the first joint and the first ring and further disposing the second seating member between the second joint and the second ring.

22. The method of claim 19,

wherein the first connection mechanism comprises a first connecting body extending radially from the first ball member, to the outside of the socket of the first joint, and through an aperture defined in the first seating member, and further wherein the first connecting body has a threaded portion;

wherein the second connection mechanism comprises a second connecting body extending radially from the second ball member, to the outside of the socket of the second joint, and through an aperture defined in the second seating member, and further wherein the second connecting body has a threaded portion;

wherein the method further comprises:

inserting the threaded portion of the first connecting body through a bore defined in the first ring and inserting the threaded portion of the second connecting body through a bore defined in the second ring; and

securing the threaded portions of the first and second connecting bodies to the first and second rings, respectively, with mating nuts.

23. The method of claim 19, wherein the telescopic housing comprises an aperture defined in a wall of the housing, the aperture extending longitudinally along the housing, and wherein the method further comprises monitoring acute translation of the adjustment sleeve relative to the telescopic housing.

24. The method of claim 19, wherein the adjustment sleeve comprises an aperture defined in a wall of the adjustment sleeve, the aperture extending longitudinally along the adjustment sleeve, and wherein the method further comprises monitoring gradual translation of the threaded elongated member relative to the adjustment sleeve.

25. A connecting rod for an external fixation device comprising:

a telescopic housing having a housing body, wherein a first portion of the housing body comprises a first axial bore defined therethrough, and a second portion of the housing body comprises a second axial bore defined therethrough, the first and second axial bores having first and second longitudinal axes, respectively, and further wherein the first and second longitudinal axes are parallel and coplanar;

first and second sleeves slidably disposed within the first and second axial bores, respectively, the first sleeve having an adjustment mechanism rotatably disposed on an end portion of the first sleeve; and

an elongated member threadably coupled to the adjustment mechanism, wherein rotating the adjustment mechanism causes the elongated member to translate along the first axis of the first axial bore;

wherein the housing body comprises first and second apertures defined in the walls of the first and second portions of the housing body, respectively, the first and second apertures being aligned along the first and second axes, respectively; and

wherein a first fastener is disposed through the first aperture of the housing body and received in a fastener aperture defined in the first sleeve, and a second fastener is disposed through the second aperture of the housing body and received in a fastener aperture defined in the second sleeve, the first and second fasteners being operable to releasably couple the first and second sleeves to the housing body, respectively.

26. The connecting rod of claim 25, further comprising a first joint coupled to an end portion of the elongated member.

27. The connecting rod of claim 25, further comprising a second joint coupled to an end portion of the second sleeve.

28. The connecting rod of claim 23, wherein the second sleeve has a second adjustment mechanism rotatably disposed on an end portion of the second sleeve, the second adjustment mechanism being threadably coupled to a second elongated member, and further wherein rotating the second adjustment mechanism causes the second elongated member to translate along the second axis of the second axial bore.

29. The connecting rod of claim 28, further comprising a second joint coupled to an end portion of the second elongated member.

STATEMENT UNDER PCT ARTICLE 19(1)

In response to the International Search Report mailed on 21 April 2009, Applicant amends the present Application as explained herein. Claims 1-29 were originally filed in the present International Application. By the present Amendment under Article 19, claims 1, 17, and 19 have been amended and replaced with claims bearing the same numbers. Thus, Replacement Sheets 23-30 that set forth all pending claims 1-29, as presently amended, are submitted with this Amendment. All other claims remain unchanged. Applicant notes that the two-month deadline for filing Amendents under Article 19(1) fell on a Sunday. Accordingly, the deadline is the following Monday, June 22, 2009. Thus, this Amendment is timely.

With respect to claim 1, amendments have been made to clarify that the recited connecting rod has a longitudinal axis, and the recited first and second rotating members are operable to rotate about first and second axes that are orthogonal to the longitudinal axis of the connecting rod. Similar amendments have been made to claim 19, which now recites the process element of "adjusting the longitudinal position of adjustment sleeve relative to the telescopic housing, thereby rotating the first and second rotating members about first and second axes, respectively, wherein the first and second axes are both orthogonal to the longitudinal axis of the connecting rod." Applicant believes that the amendments discussed above clarify at least some of the distinctions between the claimed devices and methods and the fixation device described in German Patent No. DE 3802743 to Wasserstein, which is directed to joint having a disc that is operable to only rotates about the longitudinal axis defined by a threaded rod.

In addition to the amendments discussed above, amendments have been made to dependent claim 17 to accommodate the amendments made to independent claim 1. Applicant respectfully requests amendment of the pending claims in the manner set forth in the attached replacement sheets. Should the Examiner have any questions or concerns regarding the present Amendment, the Examiner is invited to contact the undersigned Attorney of Record, using the contact information provided below.

Respectfully submitted,

Date: 6/22/09

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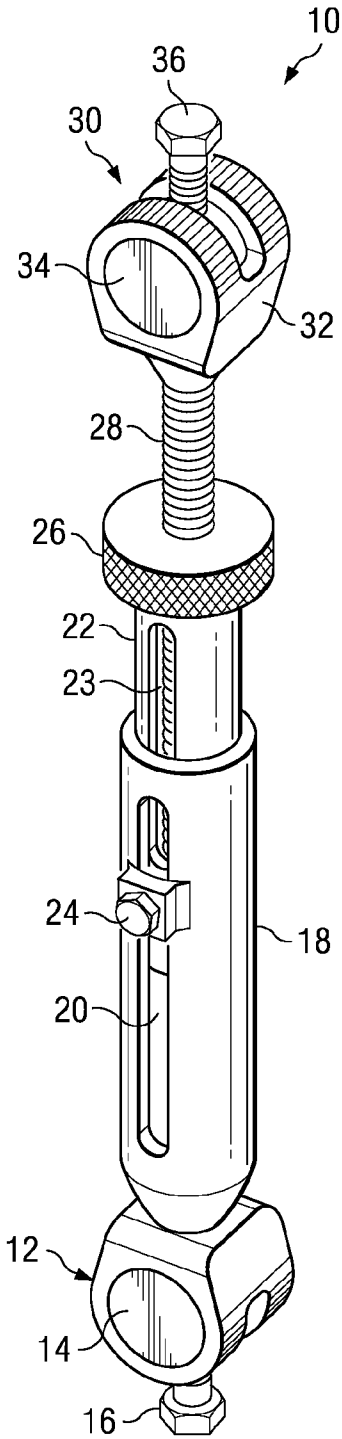

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FIG. 1

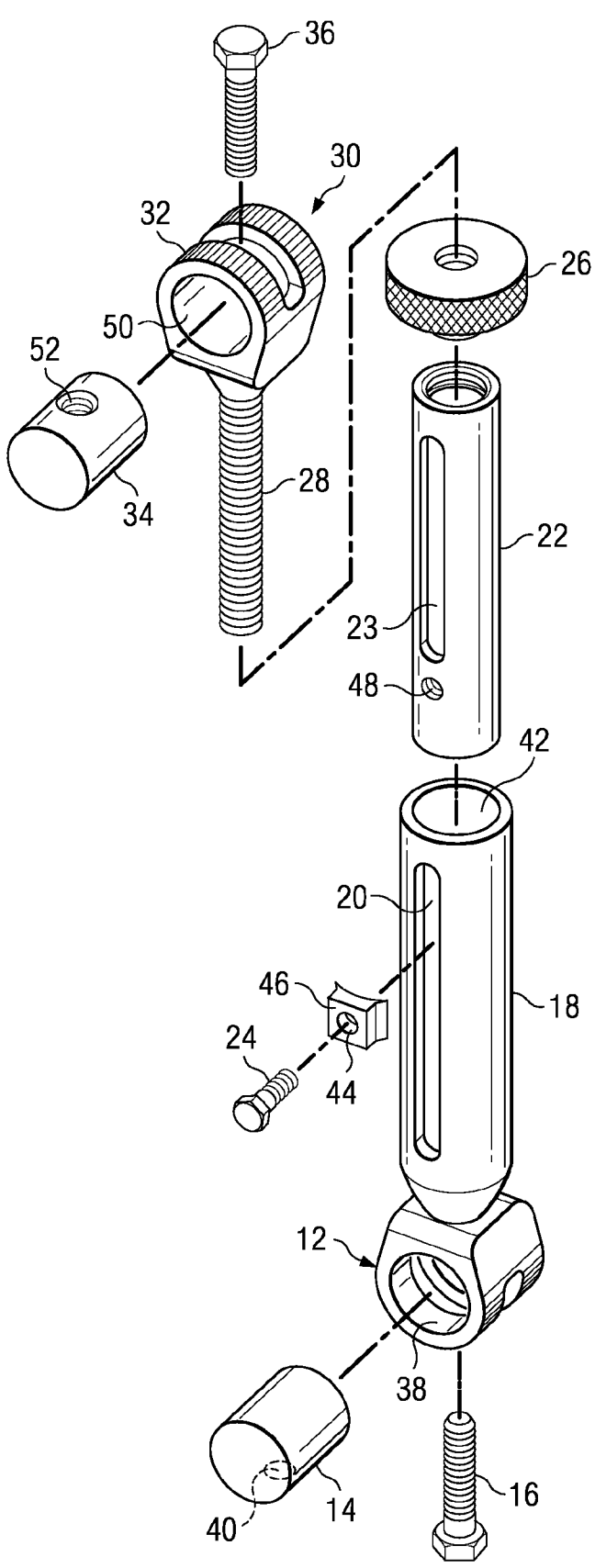

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FIG. 2

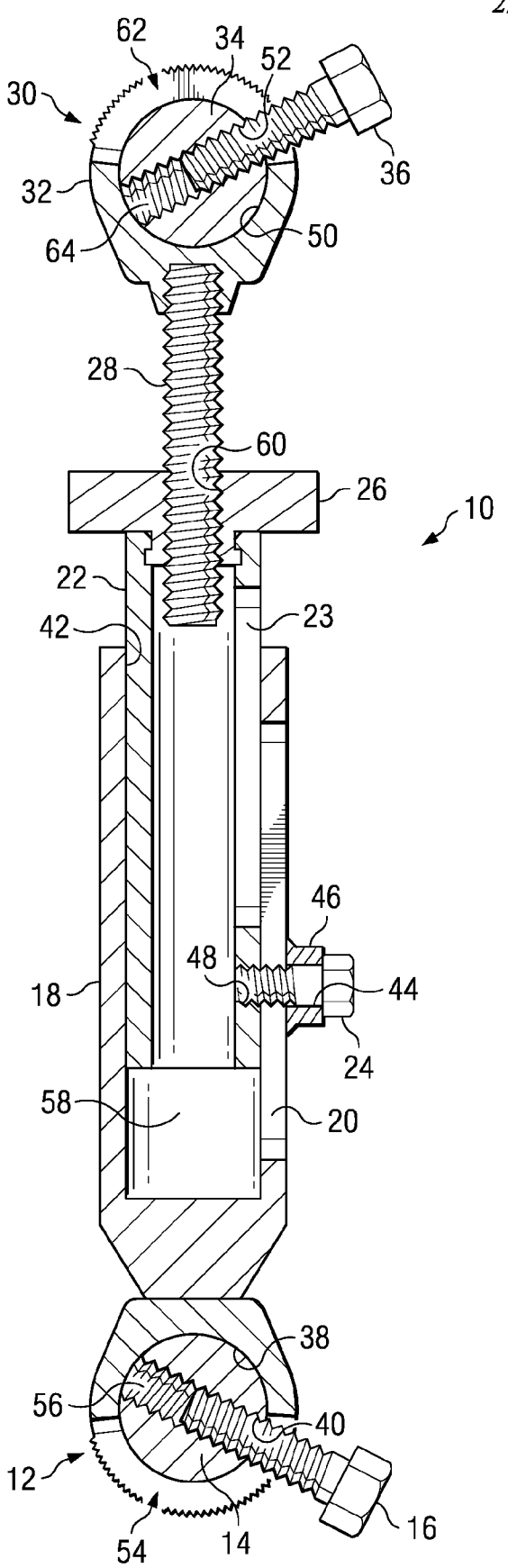

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FIG. 3

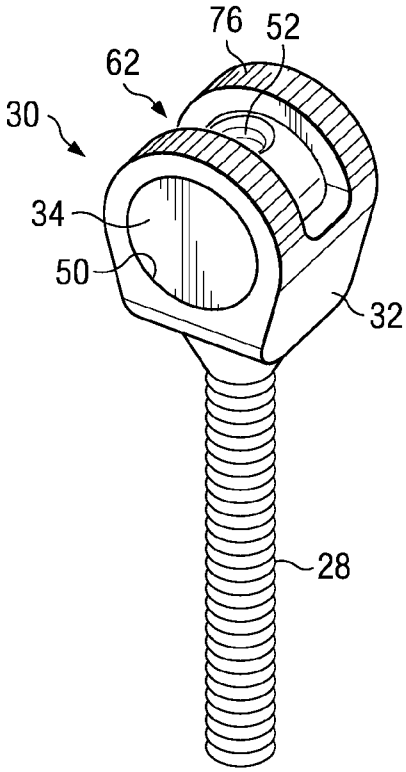

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FIG. 4

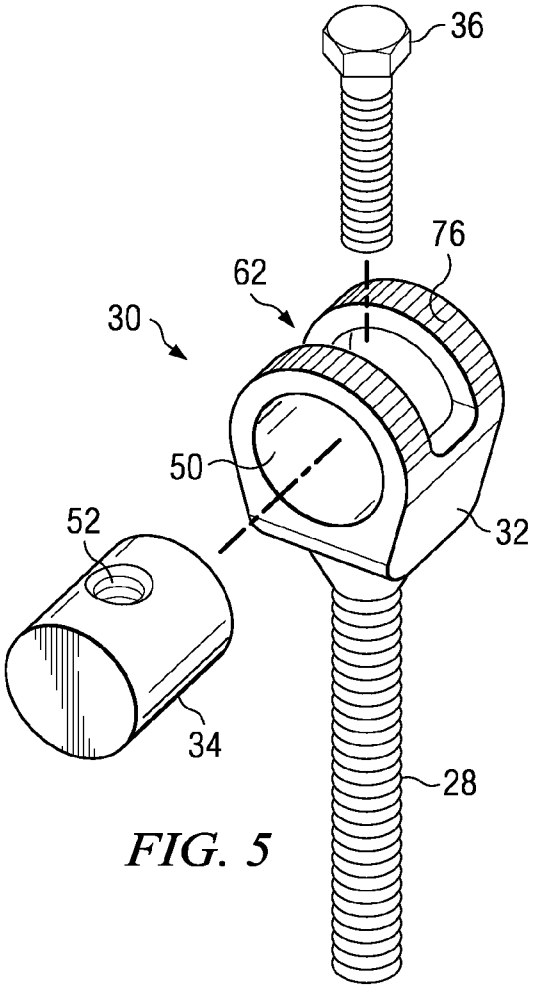

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FIG. 5

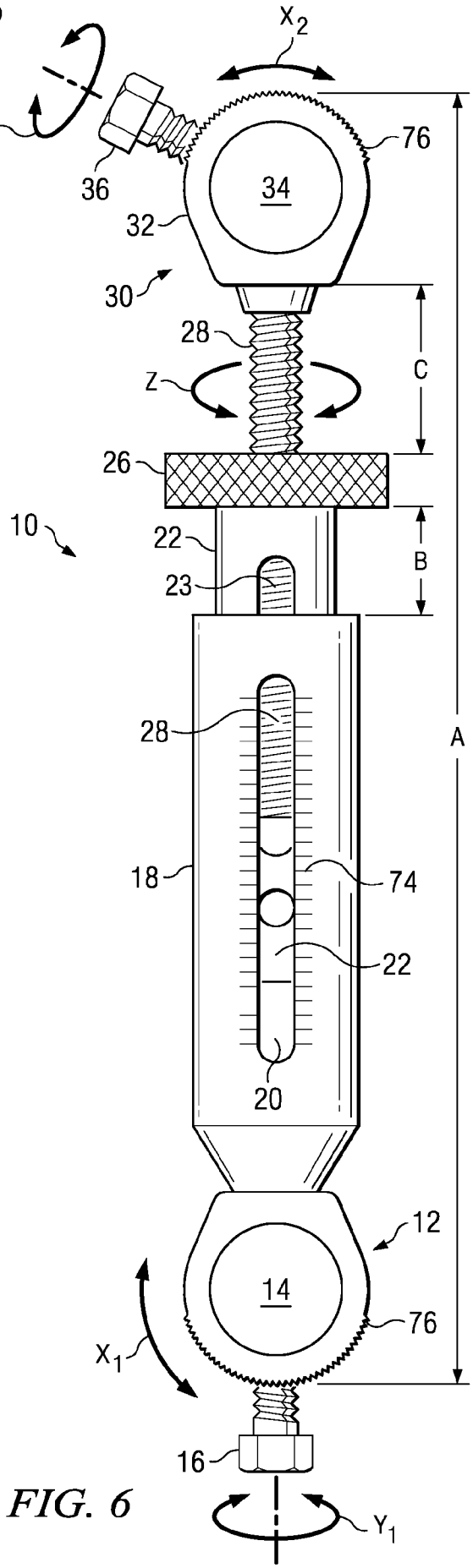

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FIG. 6

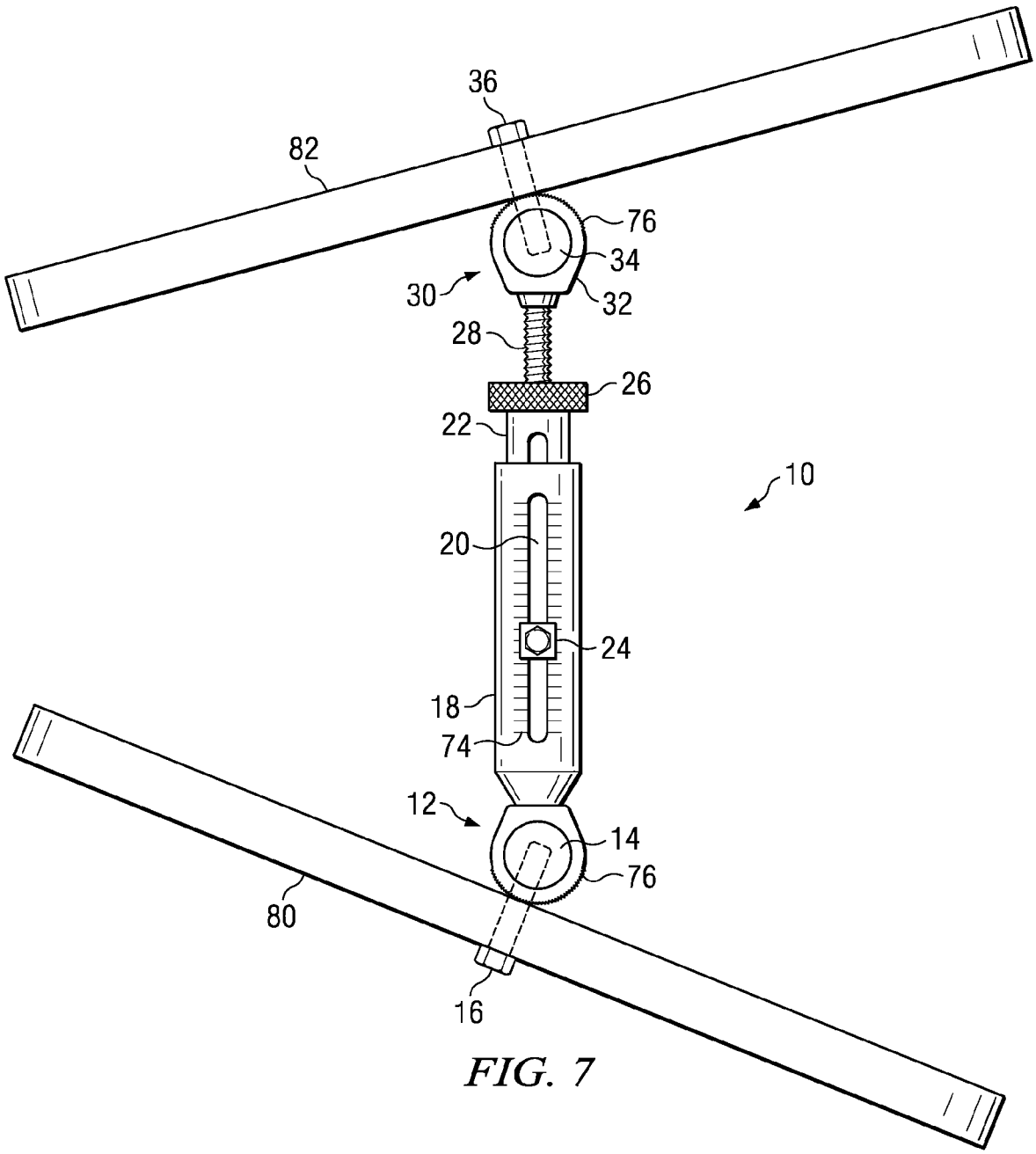


FIG. 7

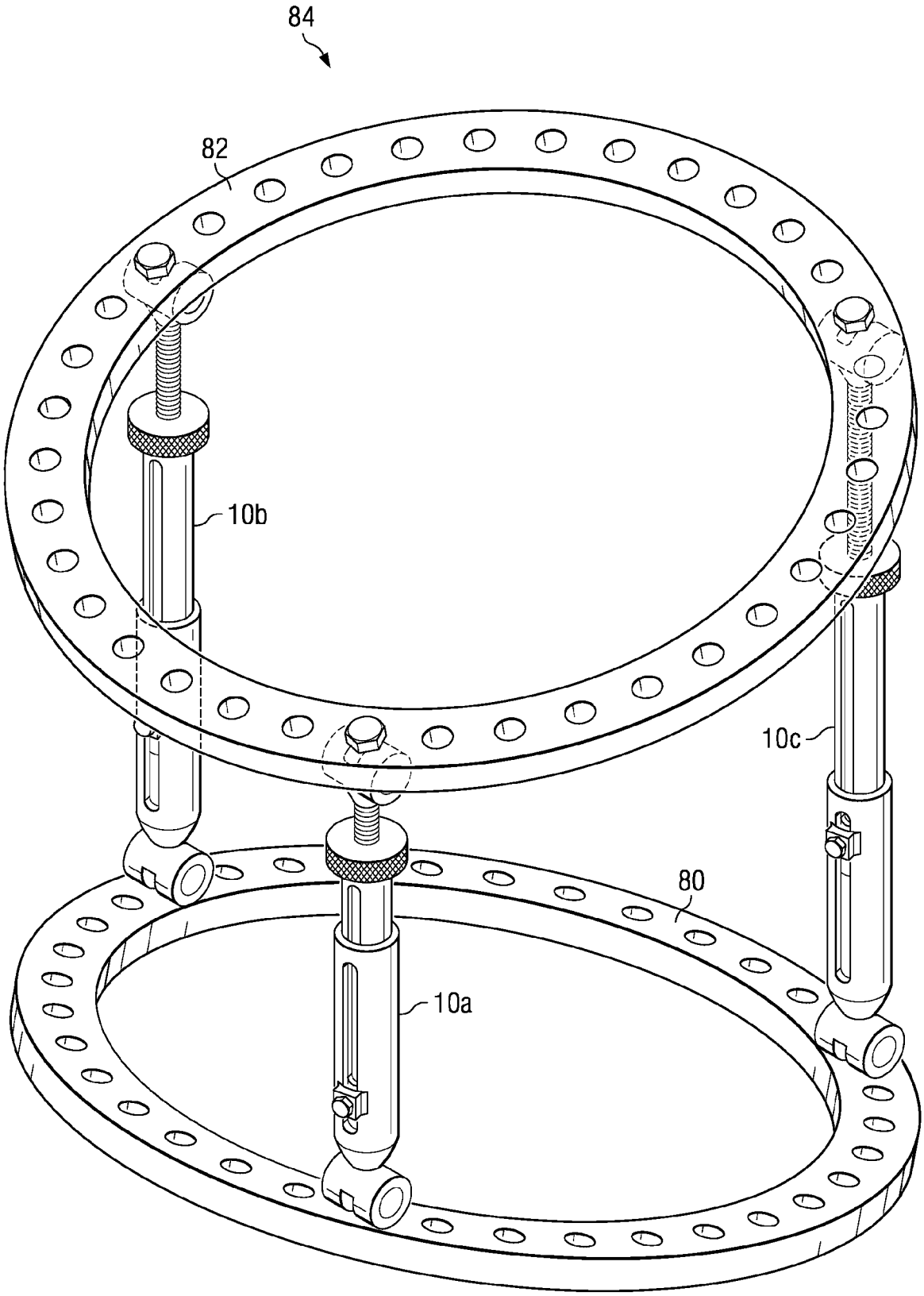


FIG. 8

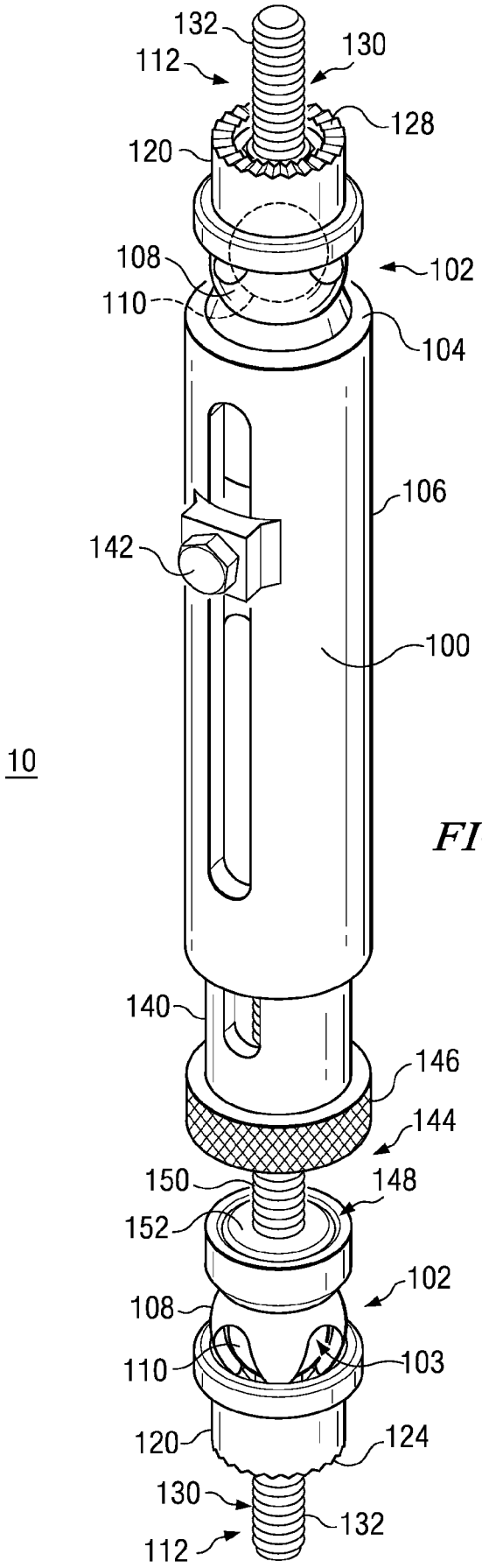

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FIG. 9

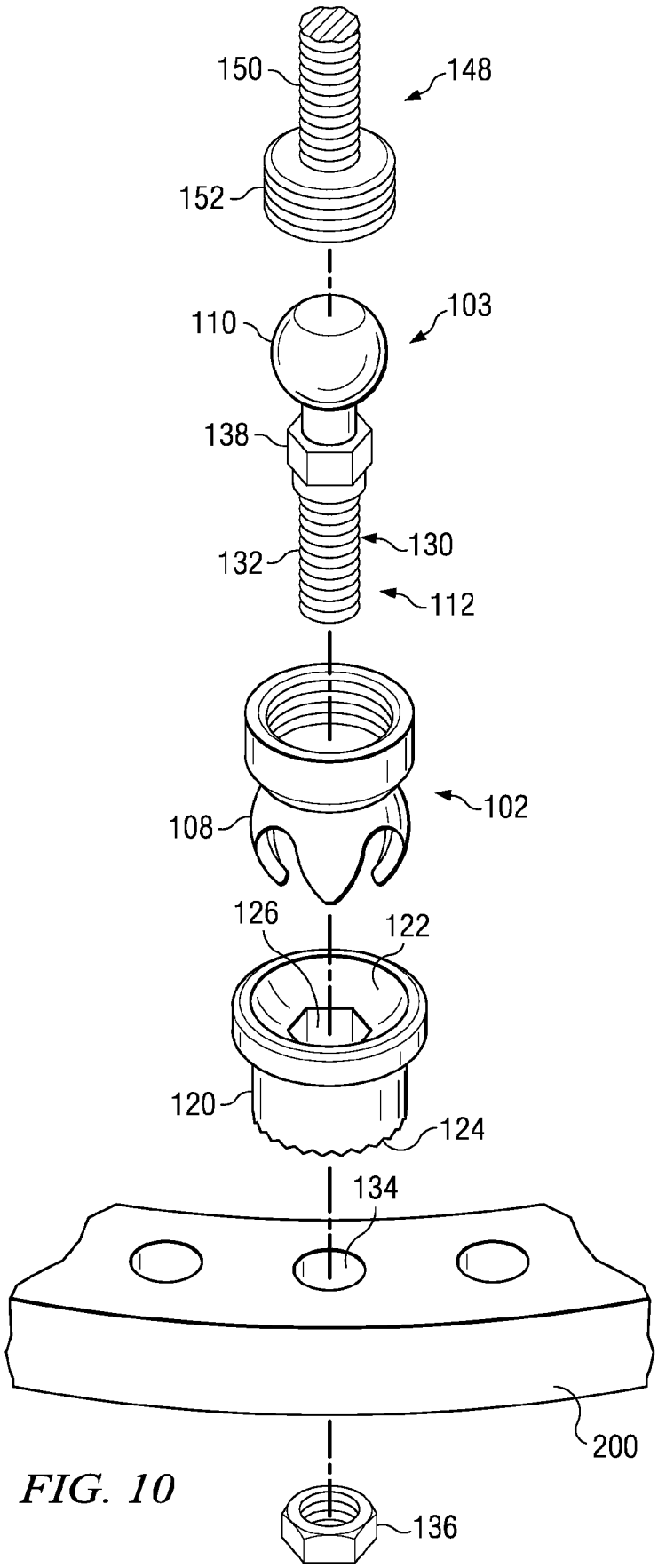

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FIG. 10

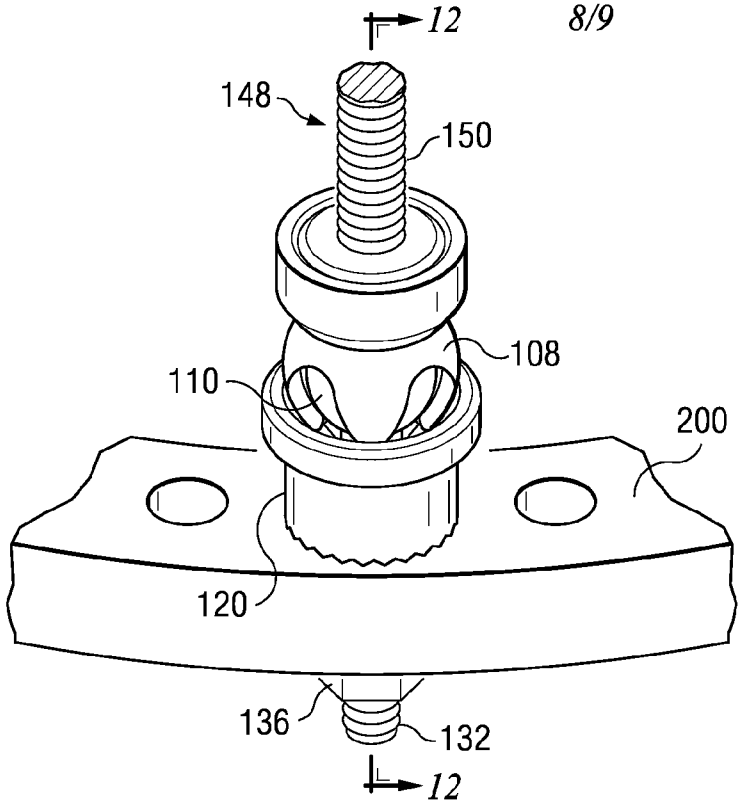

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FIG. 11

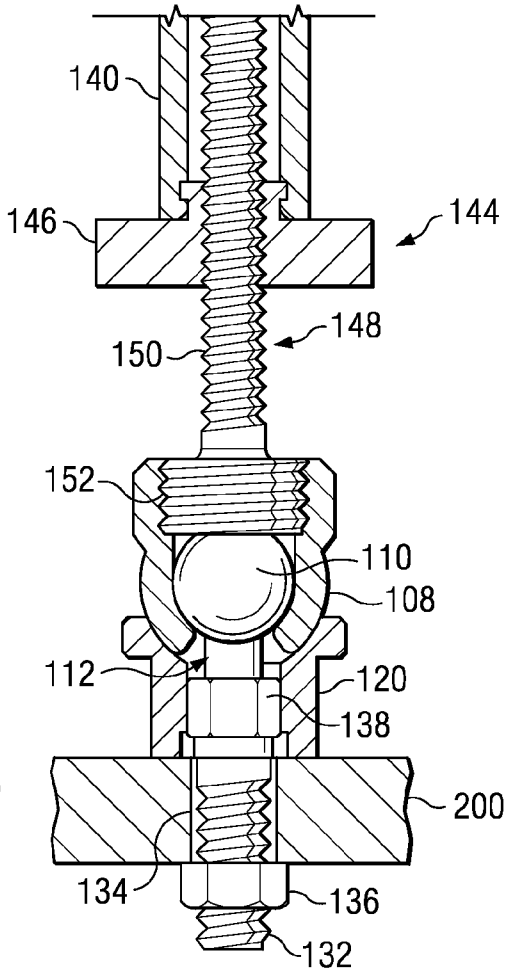

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FIG. 12

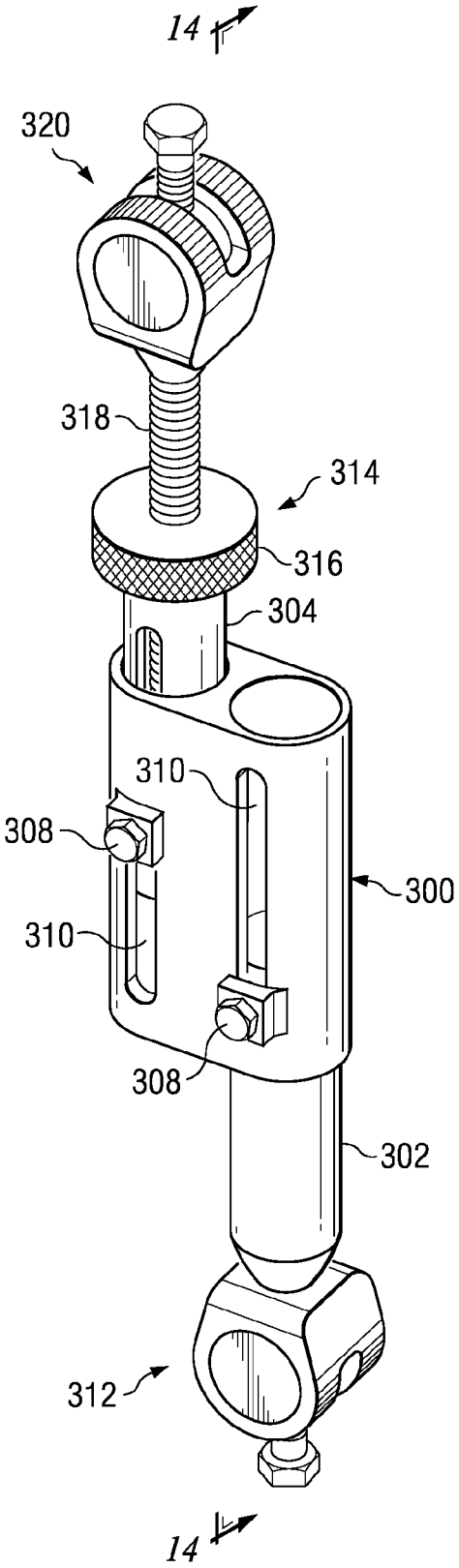

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FIG. 13

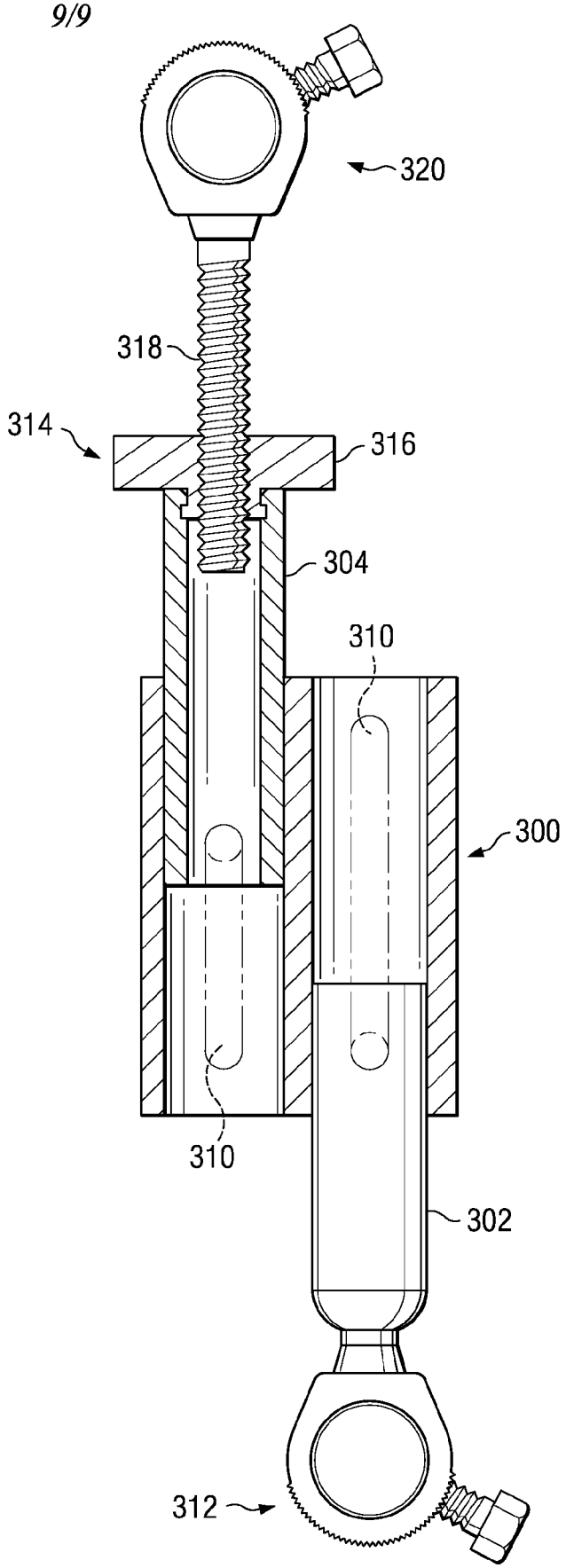

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FIG. 14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2009/033975

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A61B 17/62 (2009.01)
USPC - 606/56
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - A61B 17/60, 62 (2009.01)
USPC - 606/54, 56

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 38 02 743 A1 (WASSERSTEIN) 03 August 1989 (03.08.1989) entire document	1-29
Y	US 2007/0055234 A1 (MCGRATH et al) 08 March 2007 (08.03.2007) entire document	1-24
Y	US 2,346,346 A (ANDERSON) 11 April 1944 (11.04.1944) entire document	3-6
Y	US 2008/0021451 A1 (COULL et al) 24 January 2008 (24.01.2008) entire document	14, 15, 23-29
Y	US 4,889,111 A (BEN-DOV) 26 December 1989 (26.12.1989) entire document	15, 24
Y	US 4,621,627 A (DEBASTIANI et al) 11 November 1986 (11.10.1986) entire document	16

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* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 April 2009	21 APR 2009
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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