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(54) **ARC LIFTER DISTRACTION ADJUSTOR FOR DISTRACTION HISTOGENESIS**

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(73) Assignee: **BioDynamik, Inc.**, Lake Forest, CA (US)

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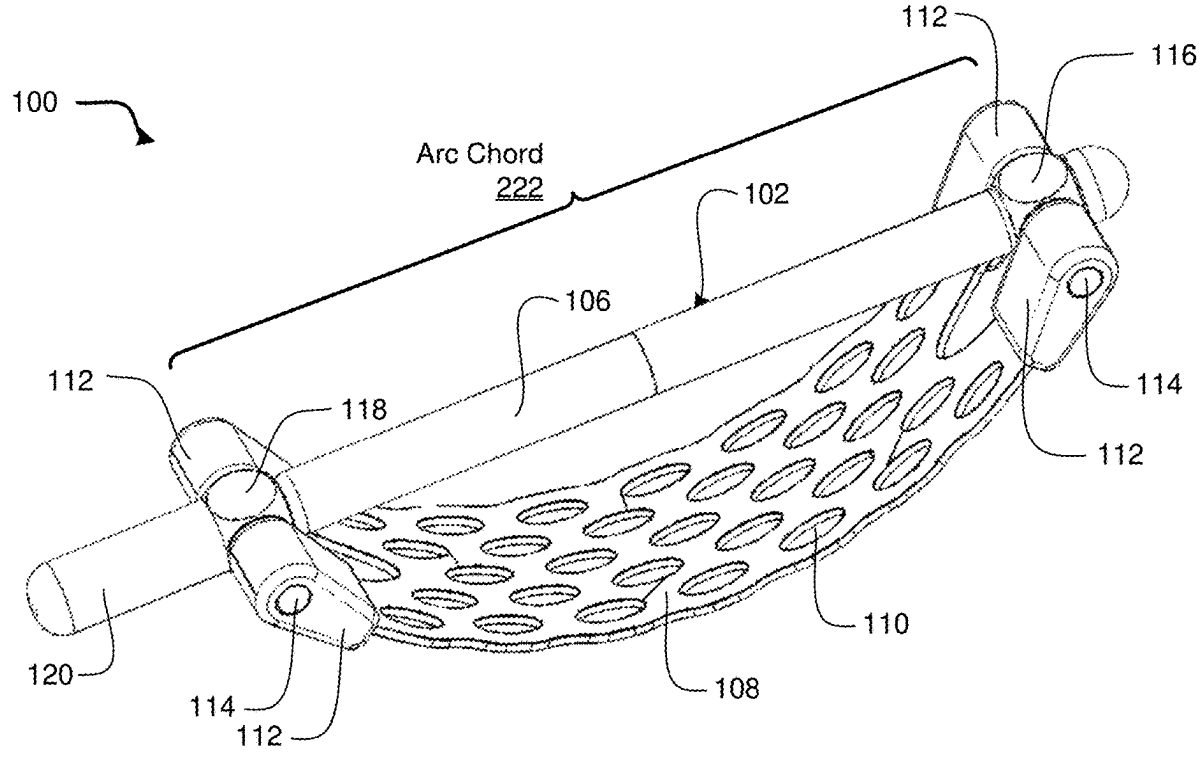
*A61B 17/66* (2006.01)

(52) **U.S. Cl.**
CPC ..... *A61B 17/66* (2013.01)

(57) **ABSTRACT**

Systems, methods, and devices for distraction histogenesis. A device includes a rigid elongated member comprising a magnetic portion and a threaded portion. The device includes an adjustment coupler comprising a hollow interior defined by a sidewall, wherein the adjustment coupler comprises internal threading attached to the sidewall. The device includes a compliant elongated member coupled to each of the adjustment coupler and the rigid elongated member. The device is such that rotation of the rigid elongated member causes the threaded portion to screw into or out of the sidewall of the adjustment coupler.



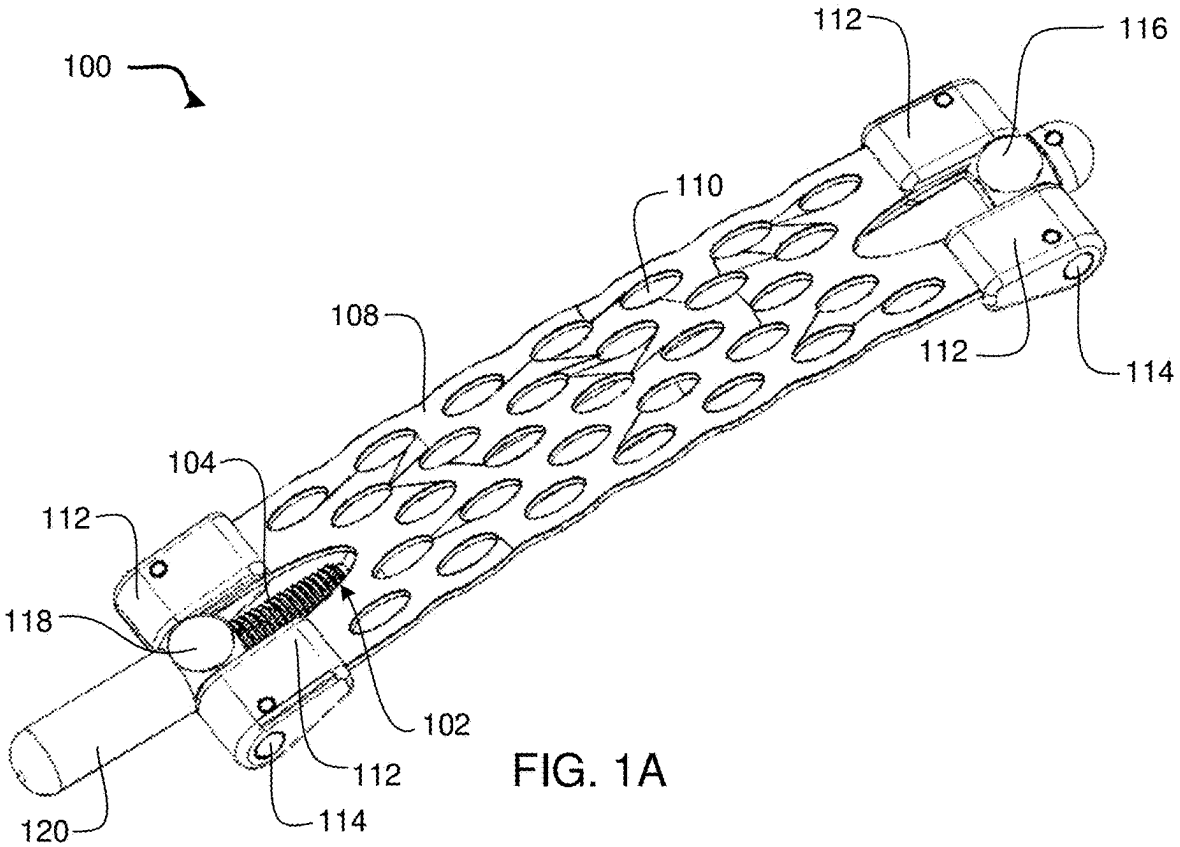

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FIG. 1A

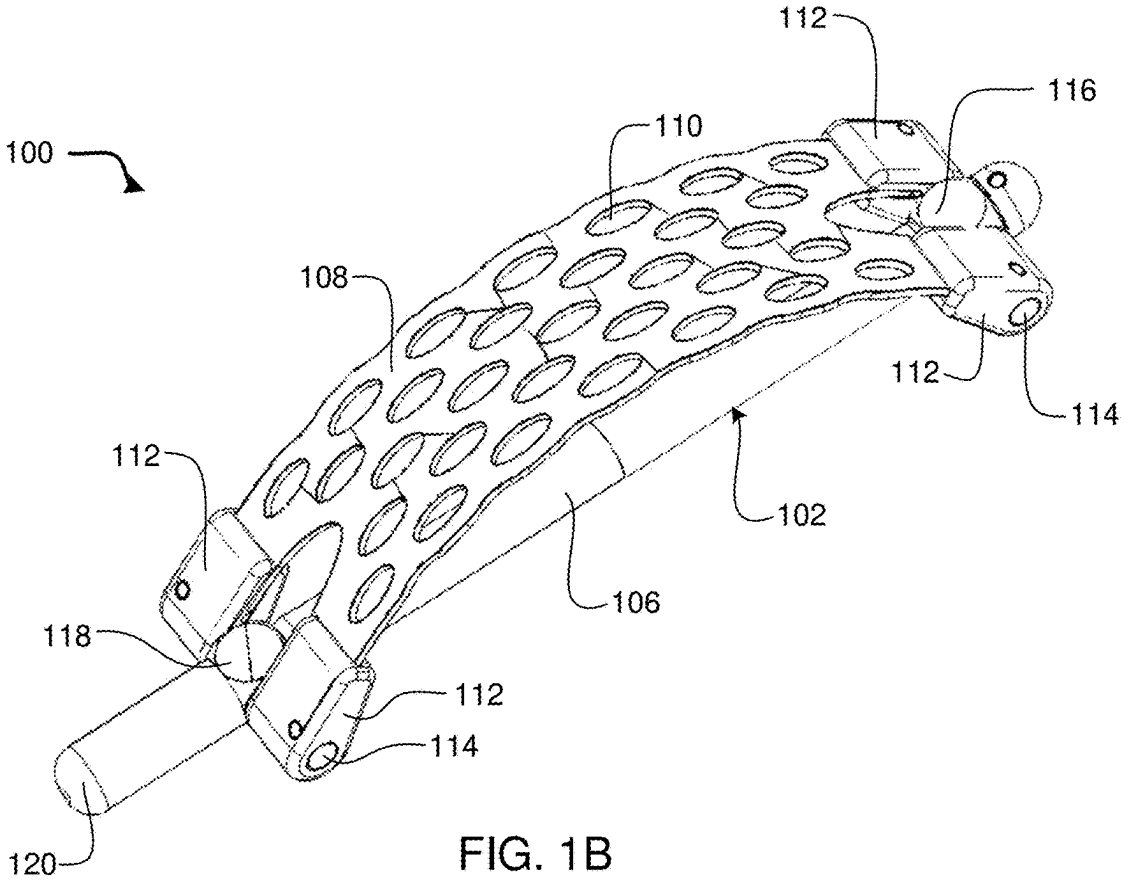
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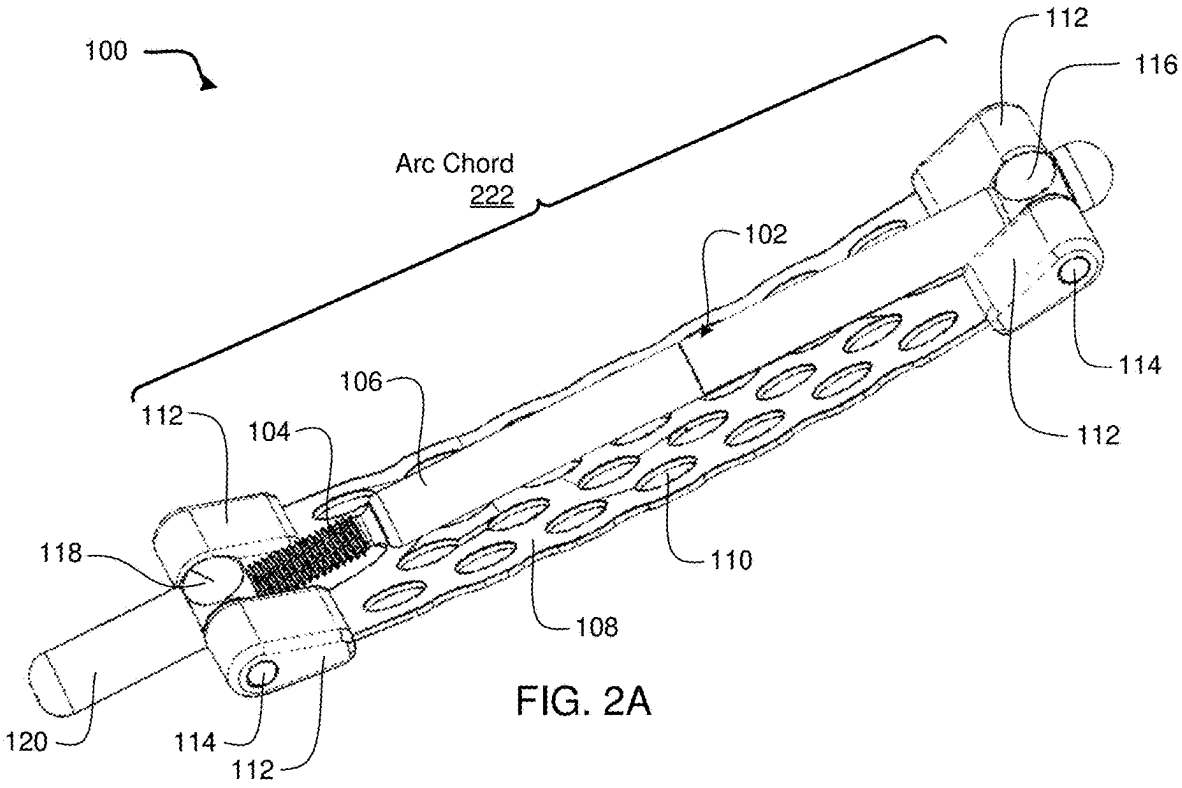
FIG. 1B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Arc Chord
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FIG. 2A

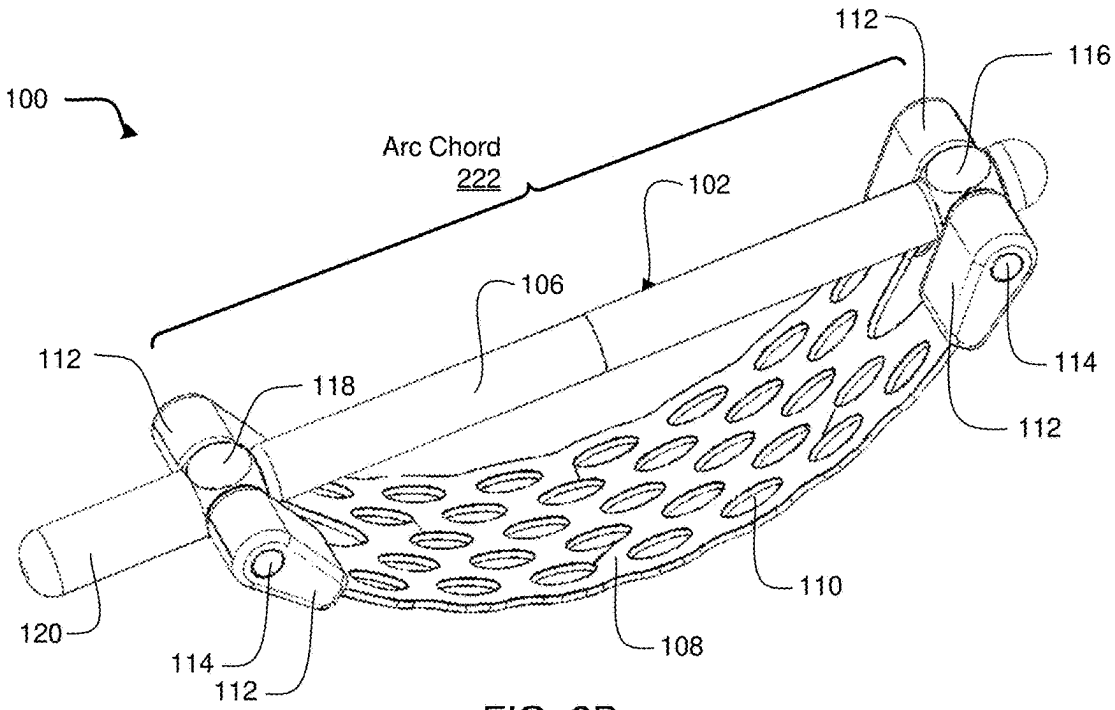
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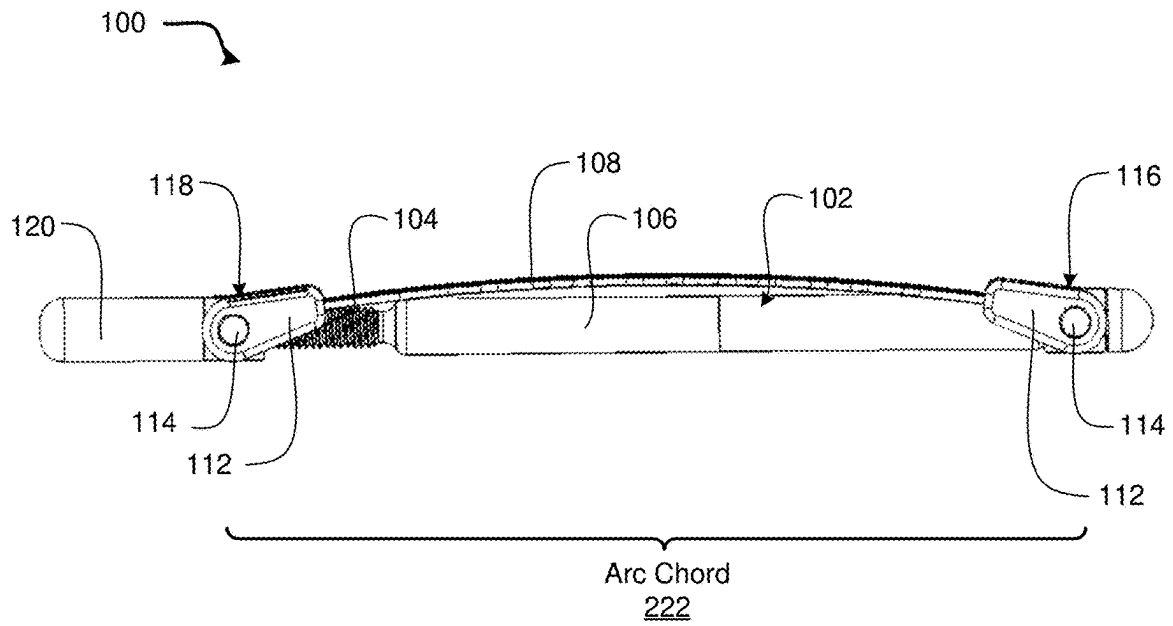
FIG. 2B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Arc Chord
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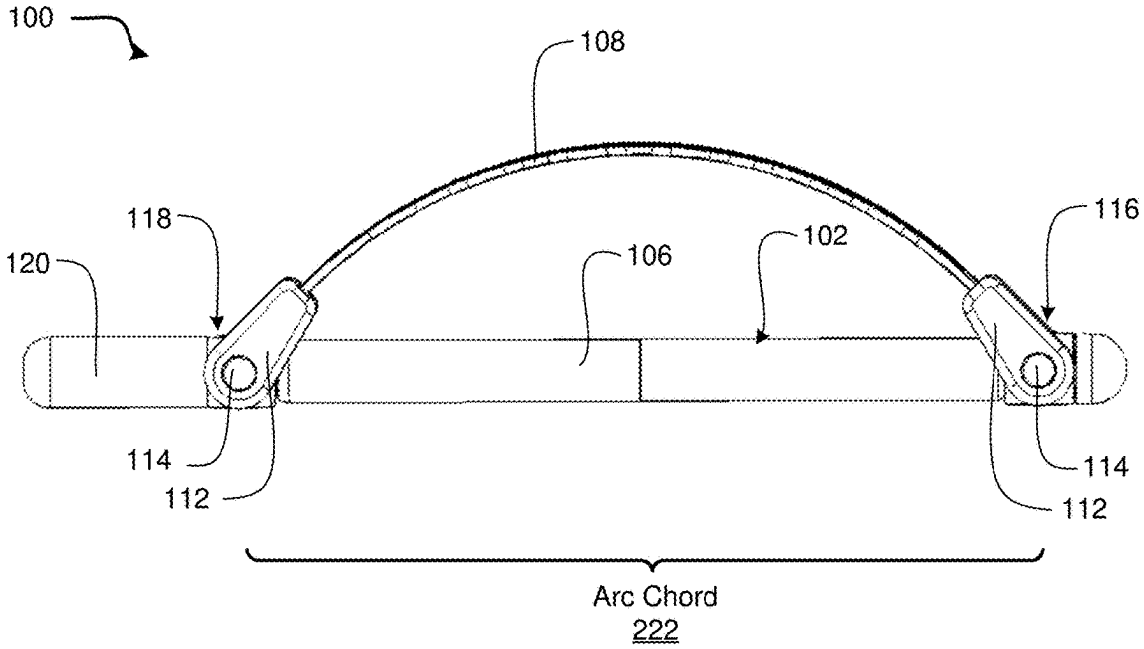
FIG. 3A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Arc Chord
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FIG. 3B

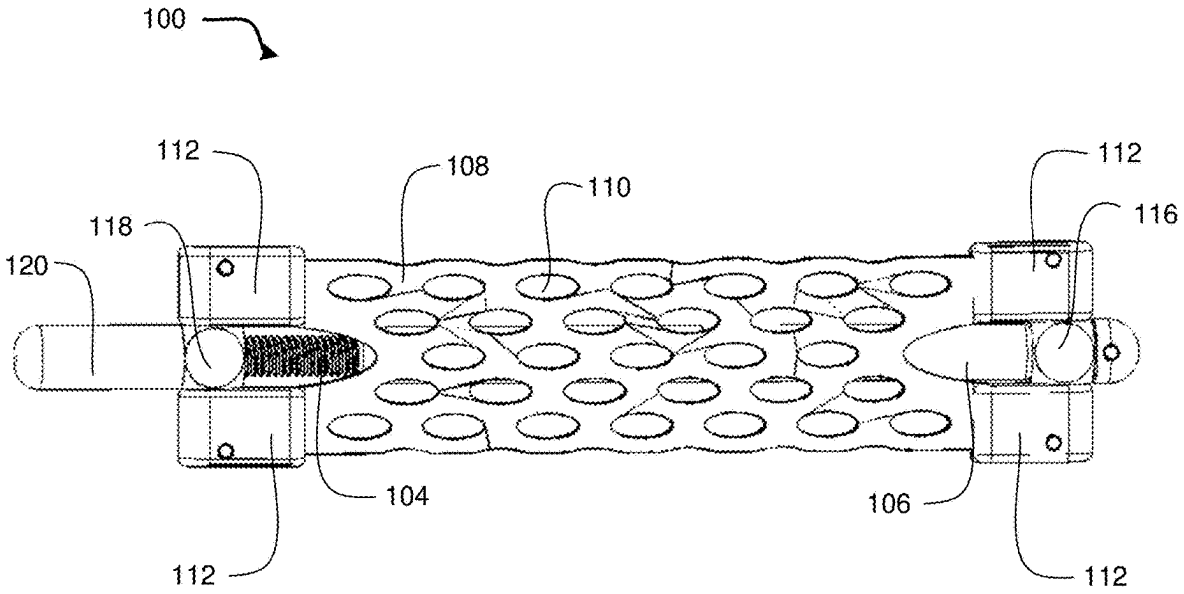
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FIG. 4A

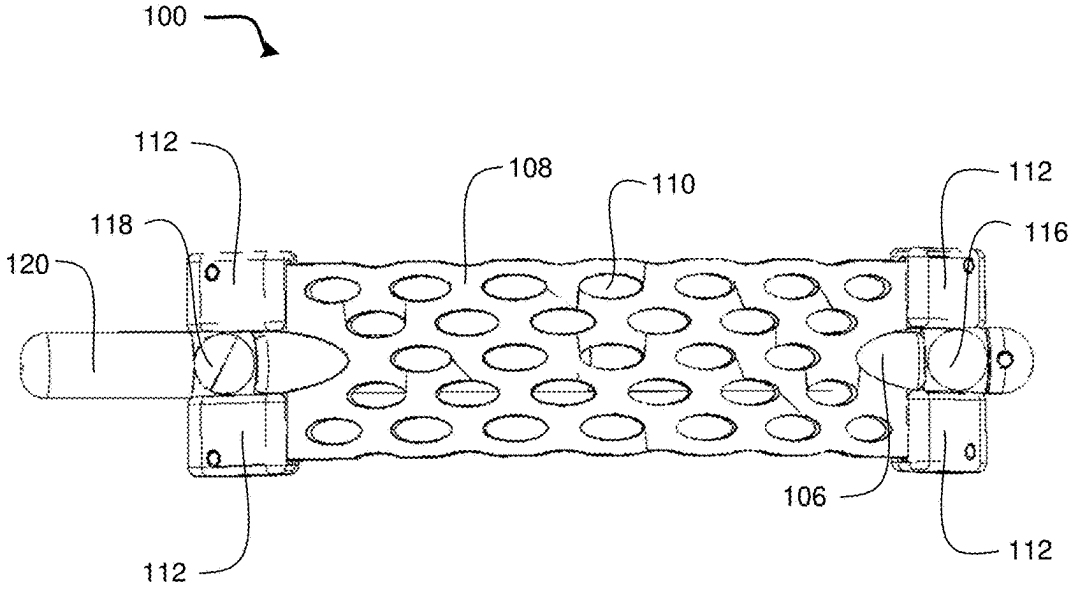
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FIG. 4B

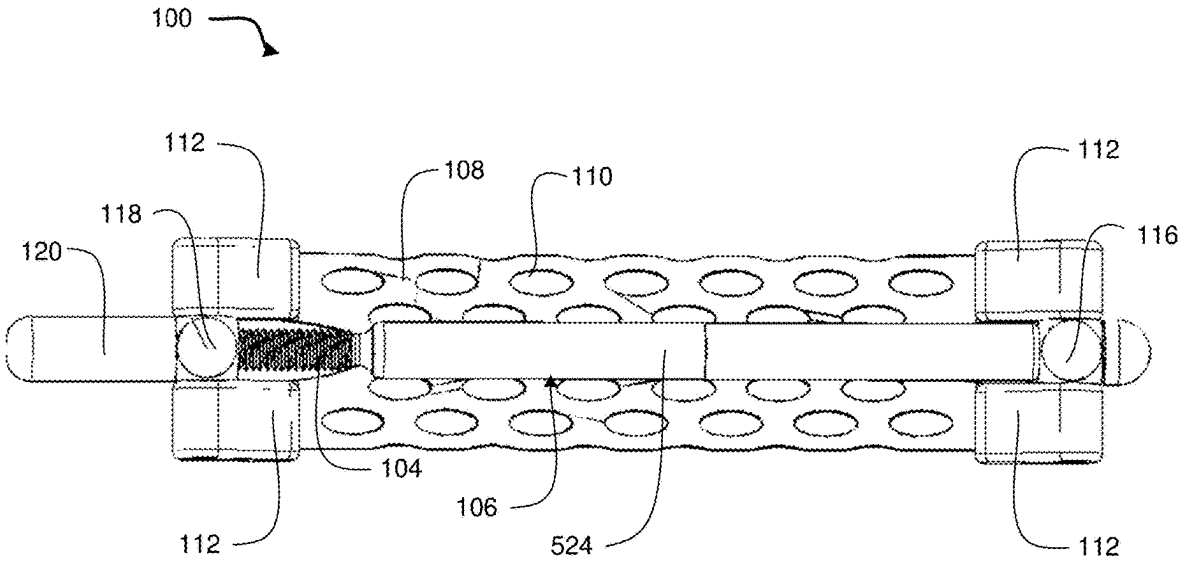
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FIG. 5A

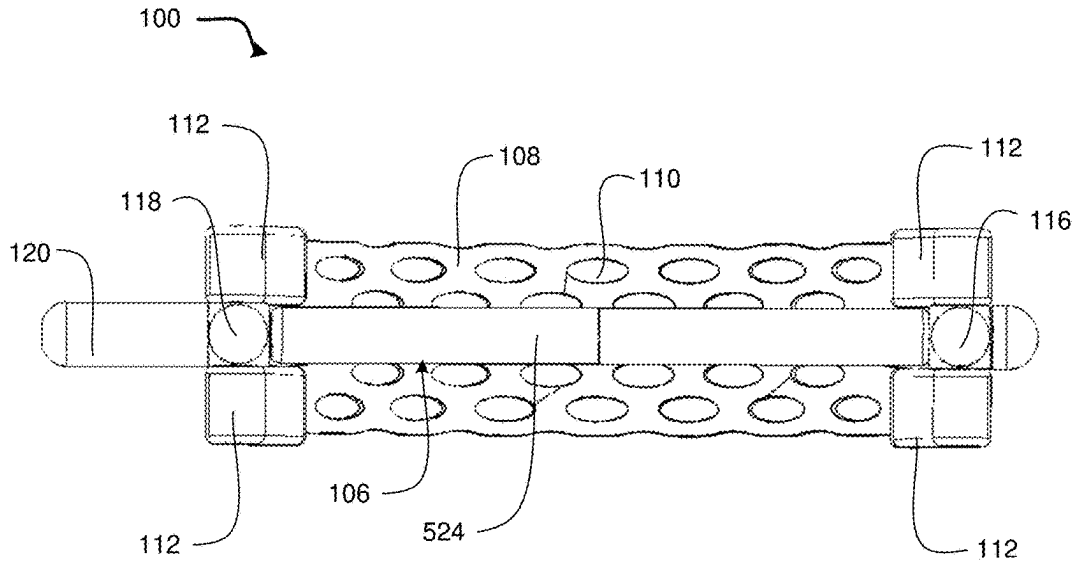
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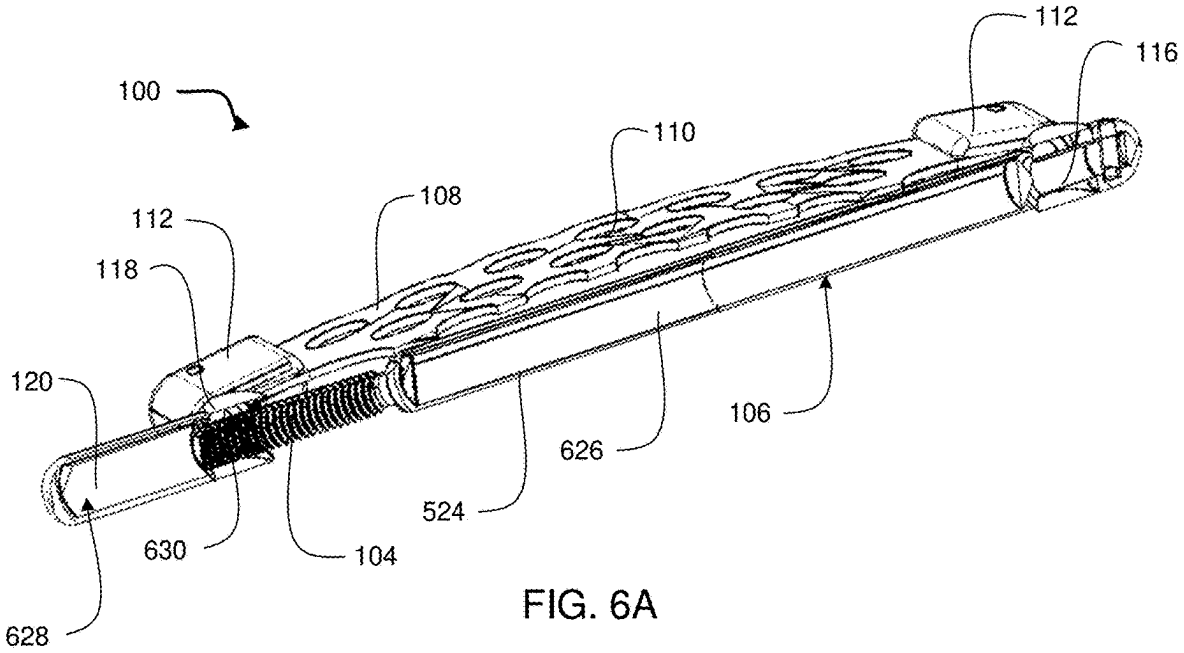
FIG. 5B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104
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FIG. 6A

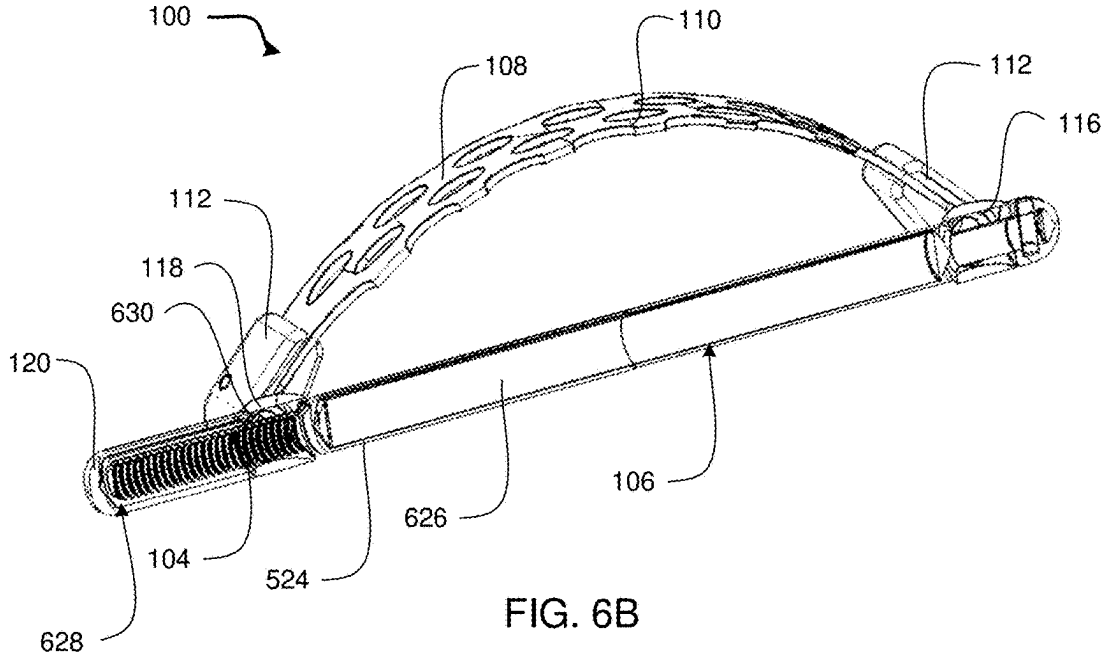
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FIG. 6B

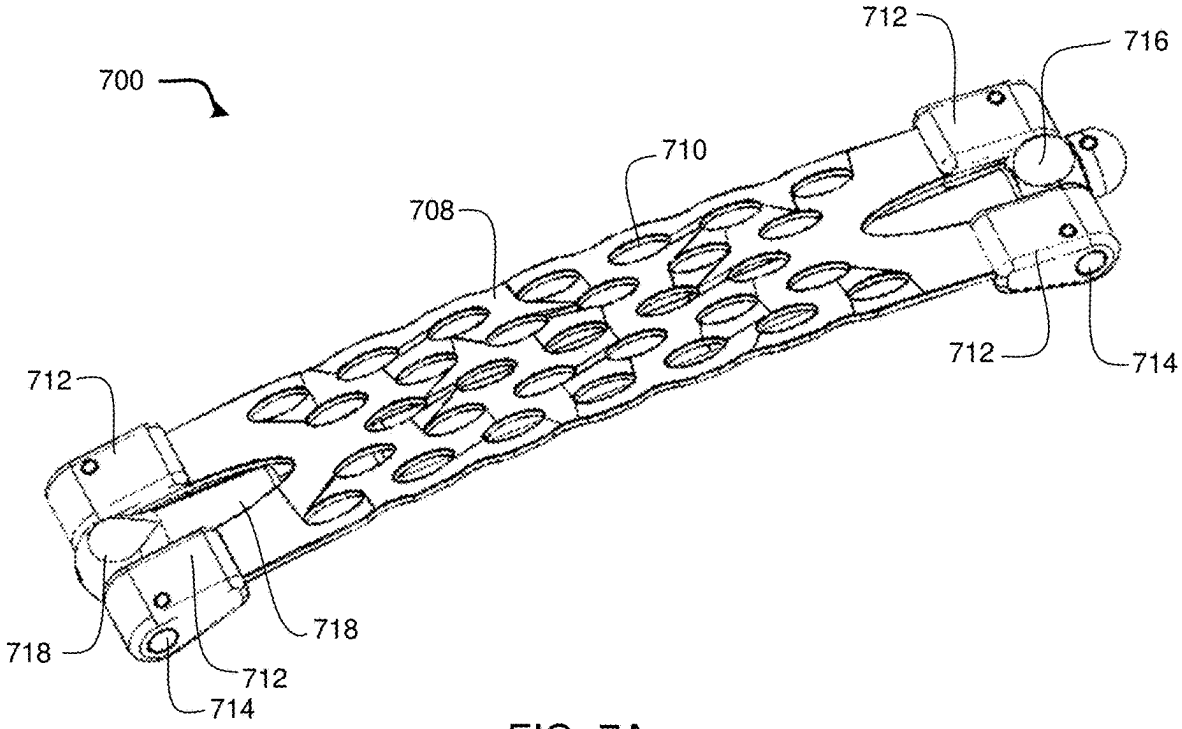
700
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FIG. 7A

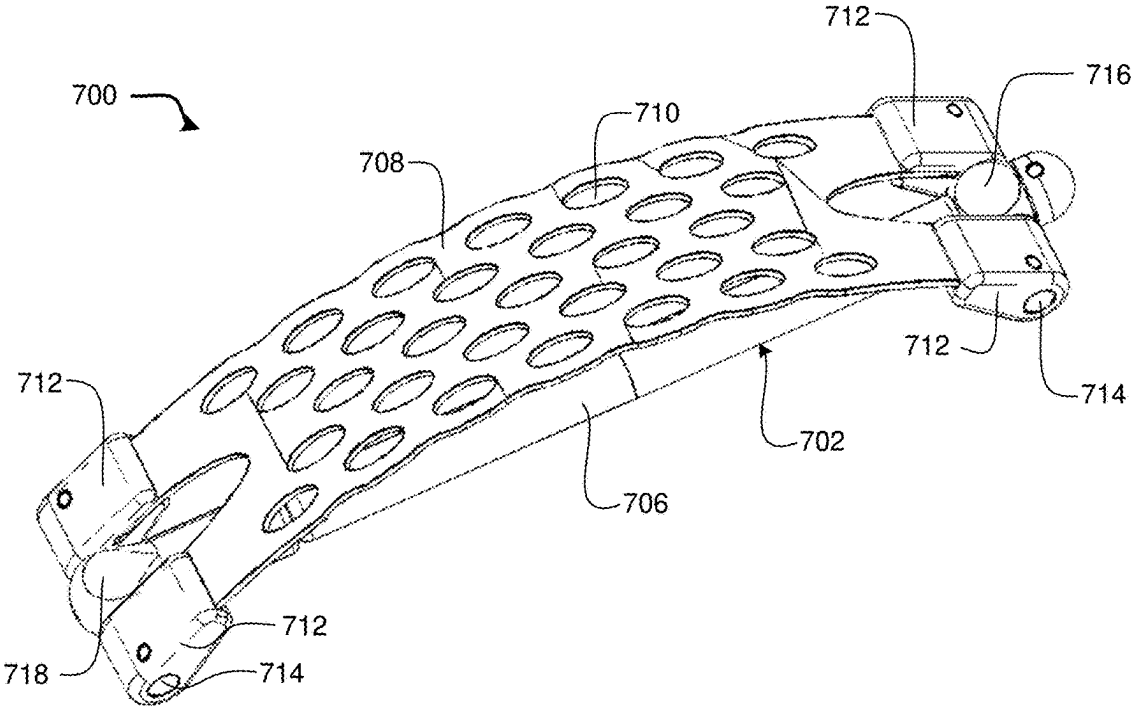
700
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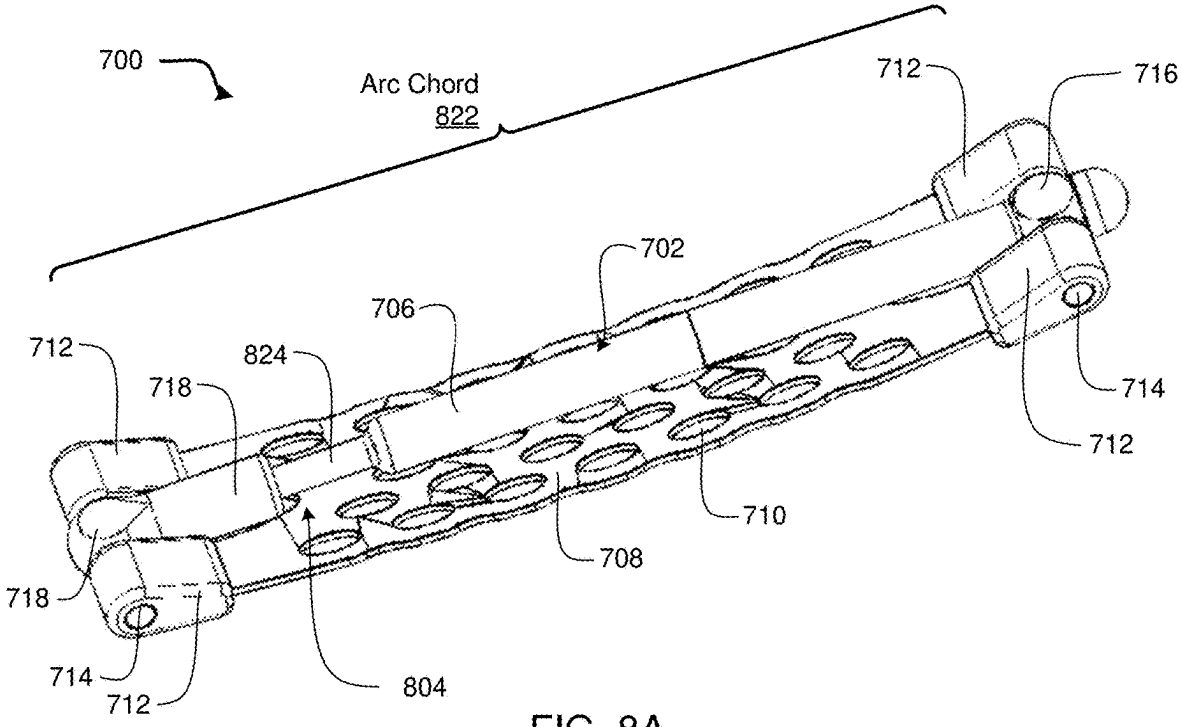
FIG. 7B


700
Arc Chord
822
712
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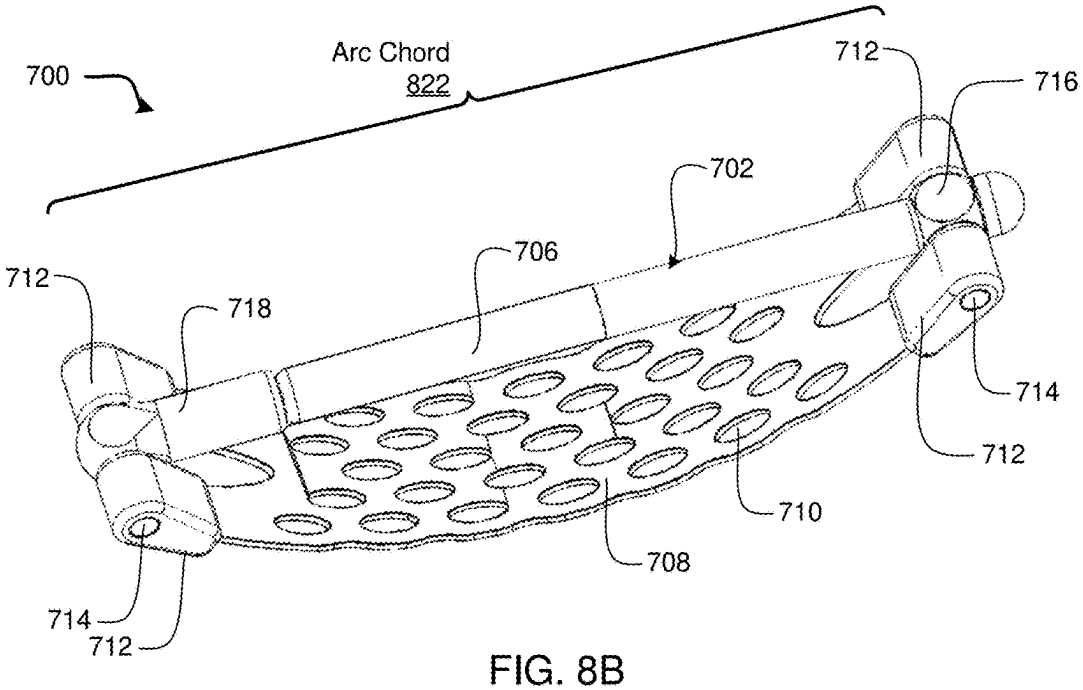
712
804

FIG. 8A


700
Arc Chord
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712
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702
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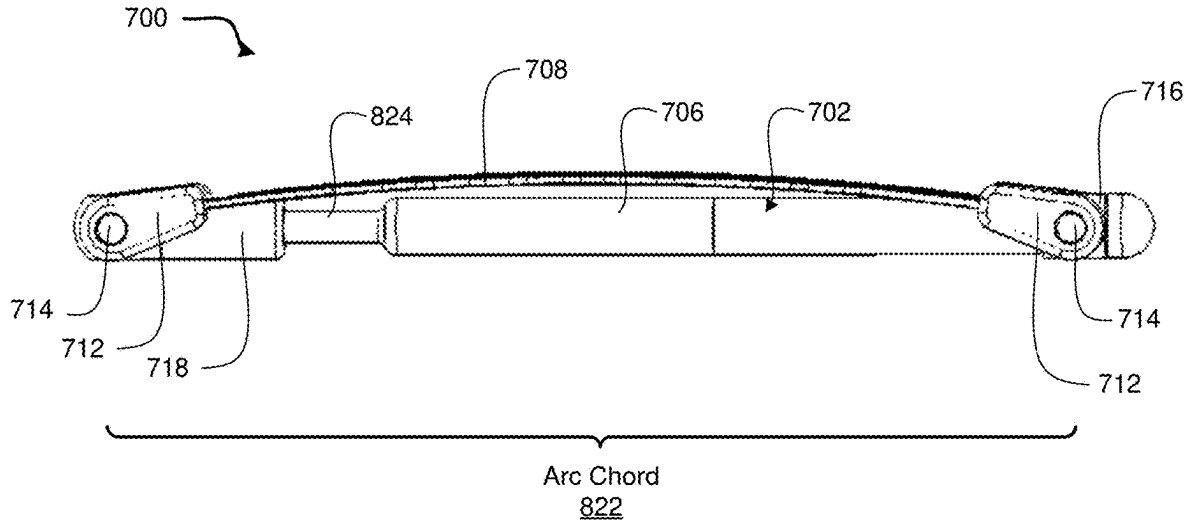
712

FIG. 8B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712
Arc Chord
822

FIG. 9A

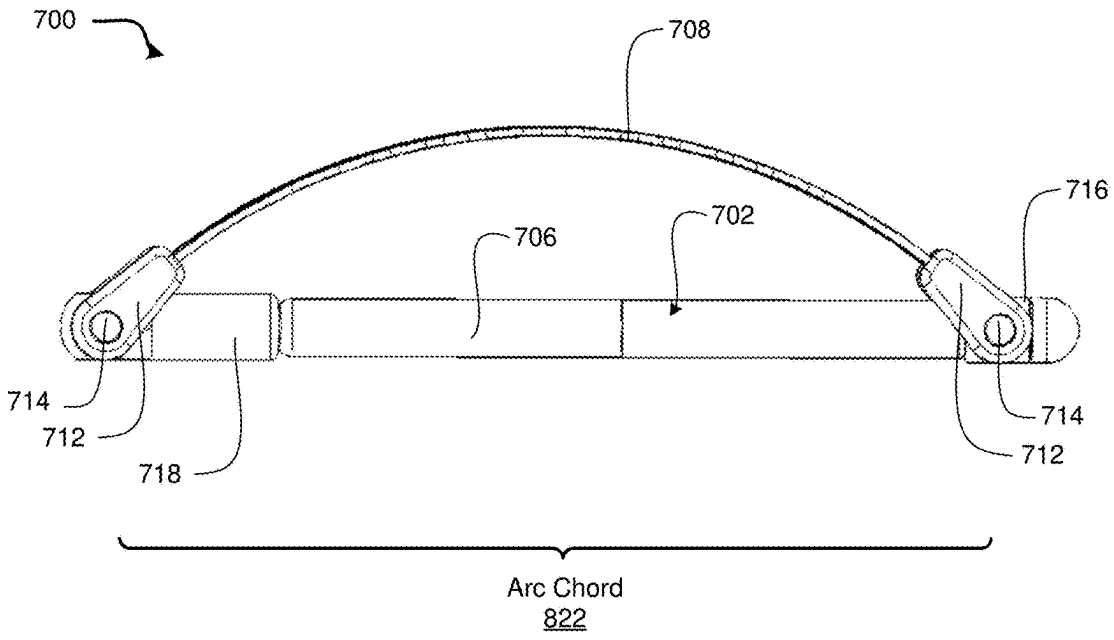

700
708
716
706
702
714
712
718
714
712
Arc Chord
822

FIG. 9B

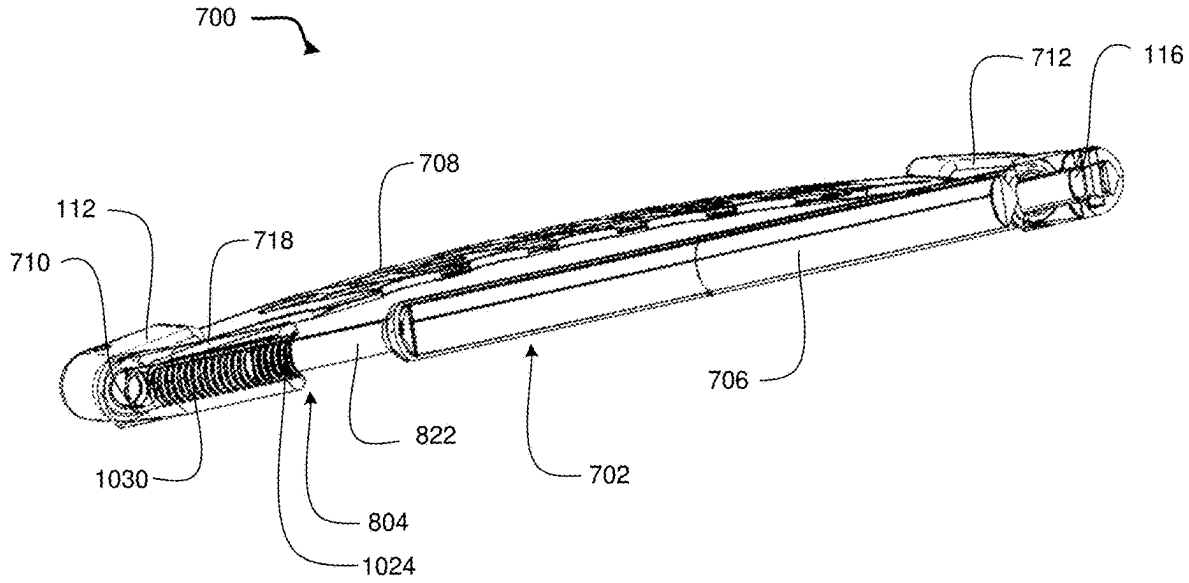



FIG. 10A

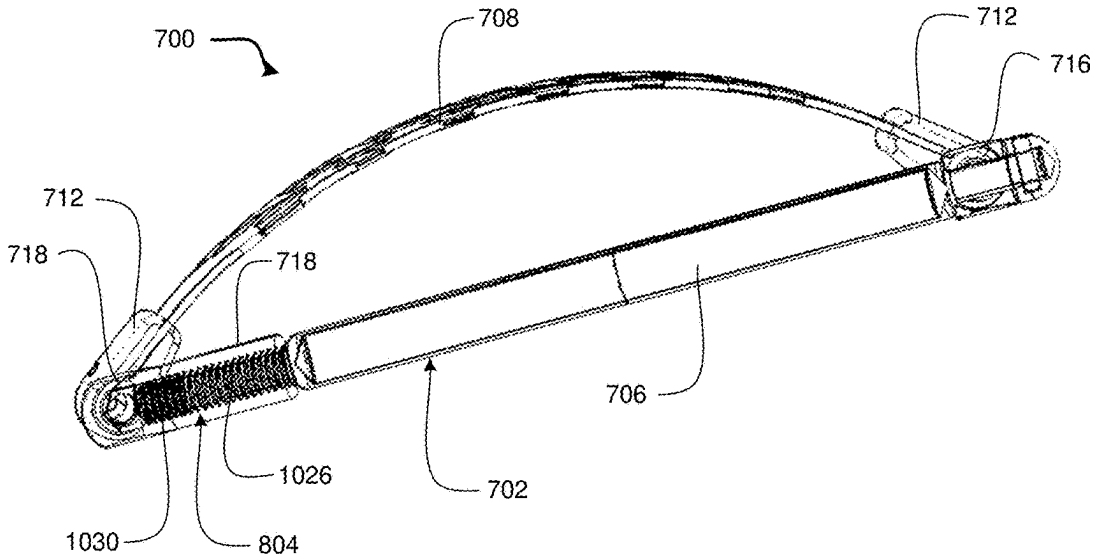



FIG. 10B

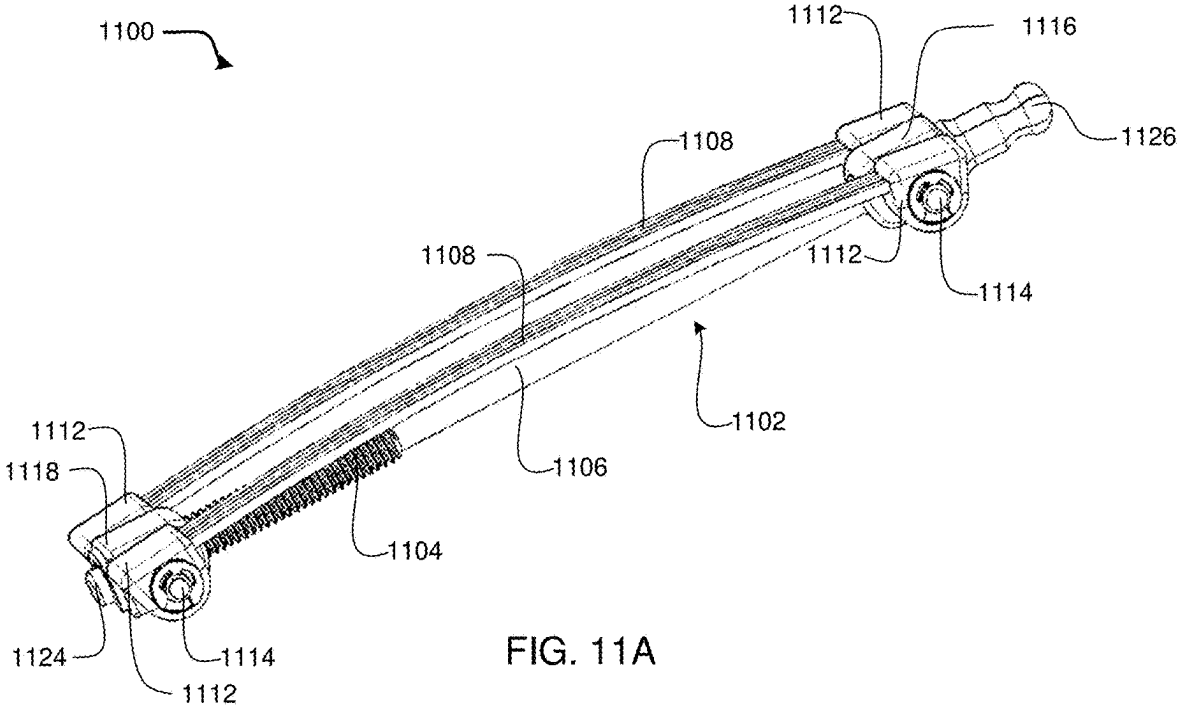



FIG. 11A

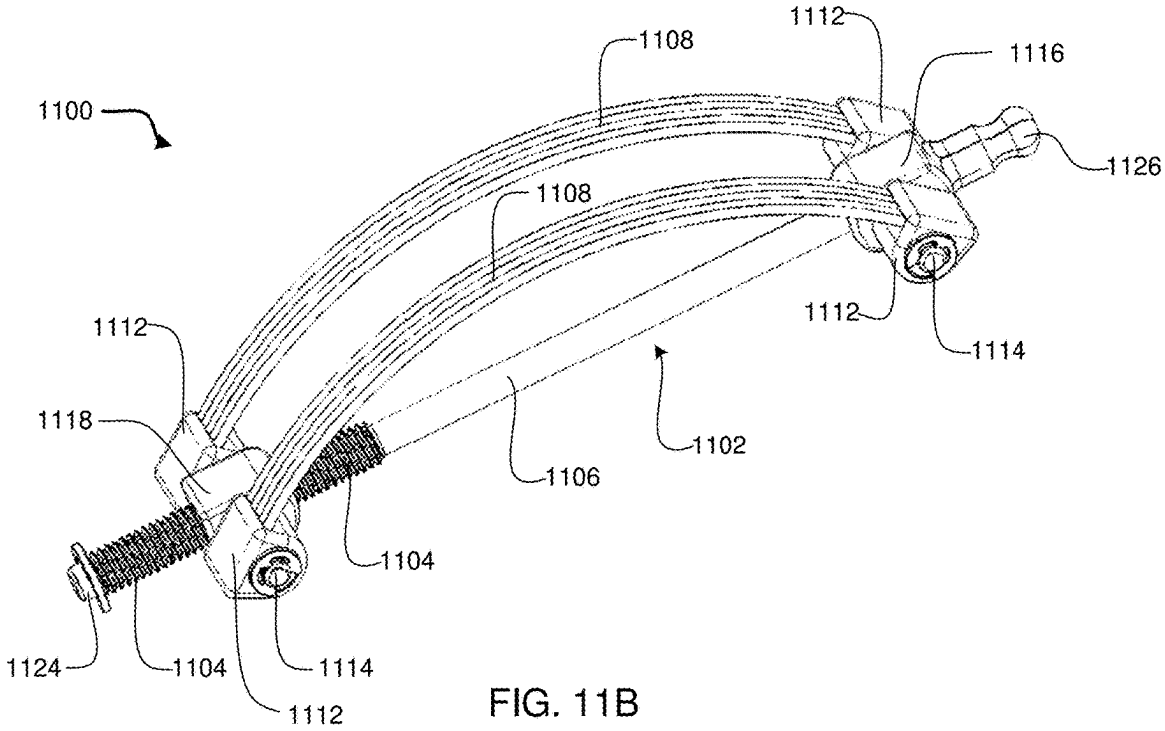



FIG. 11B

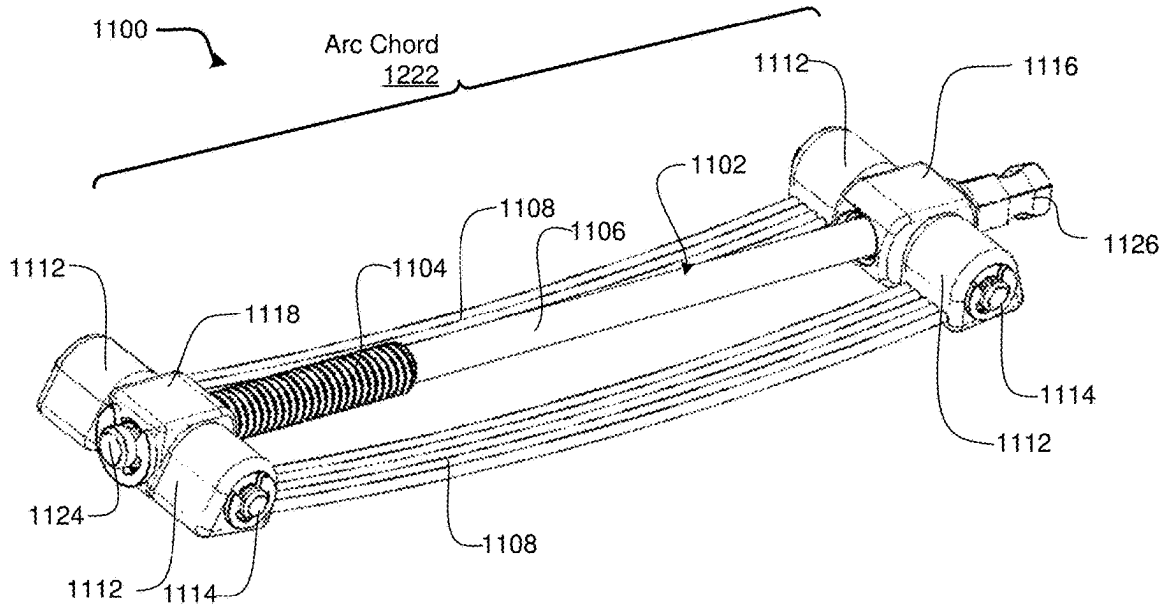



FIG. 12A

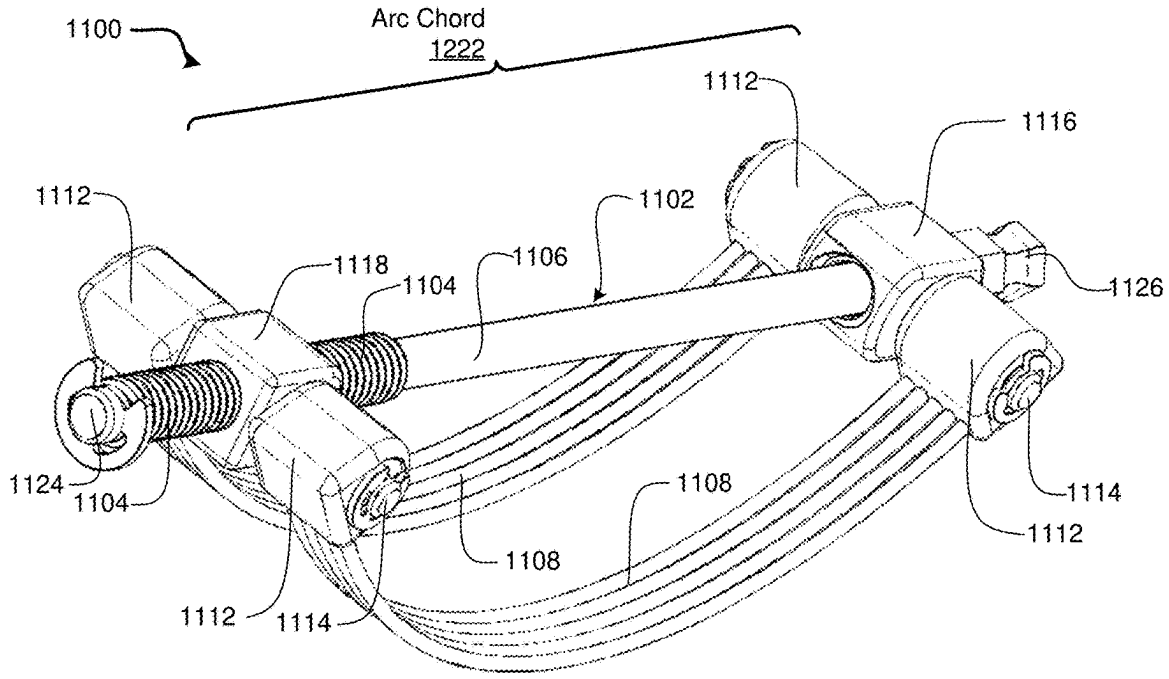



FIG. 12B

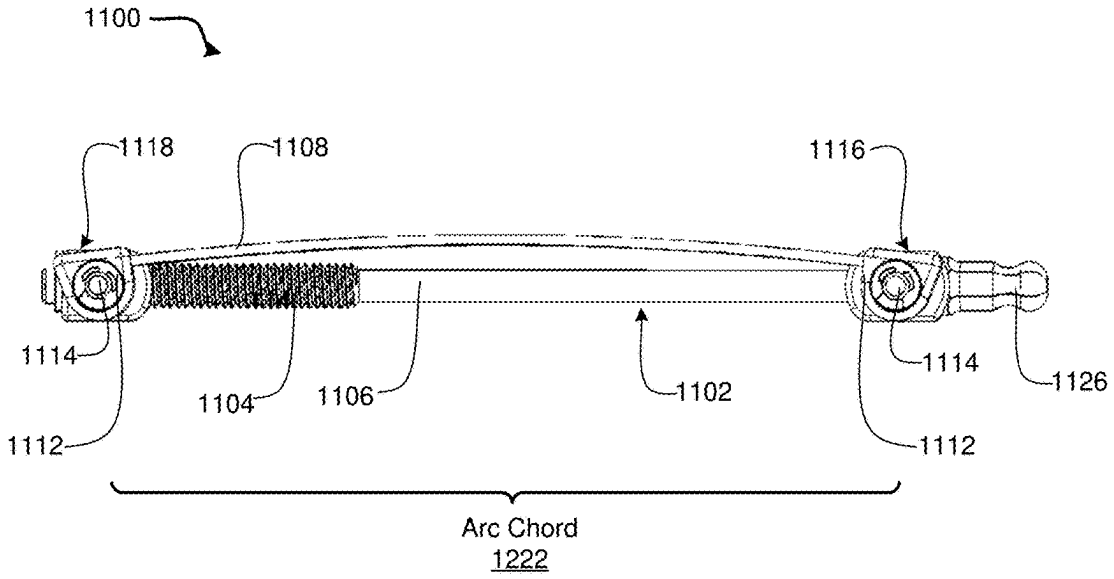



FIG. 13A

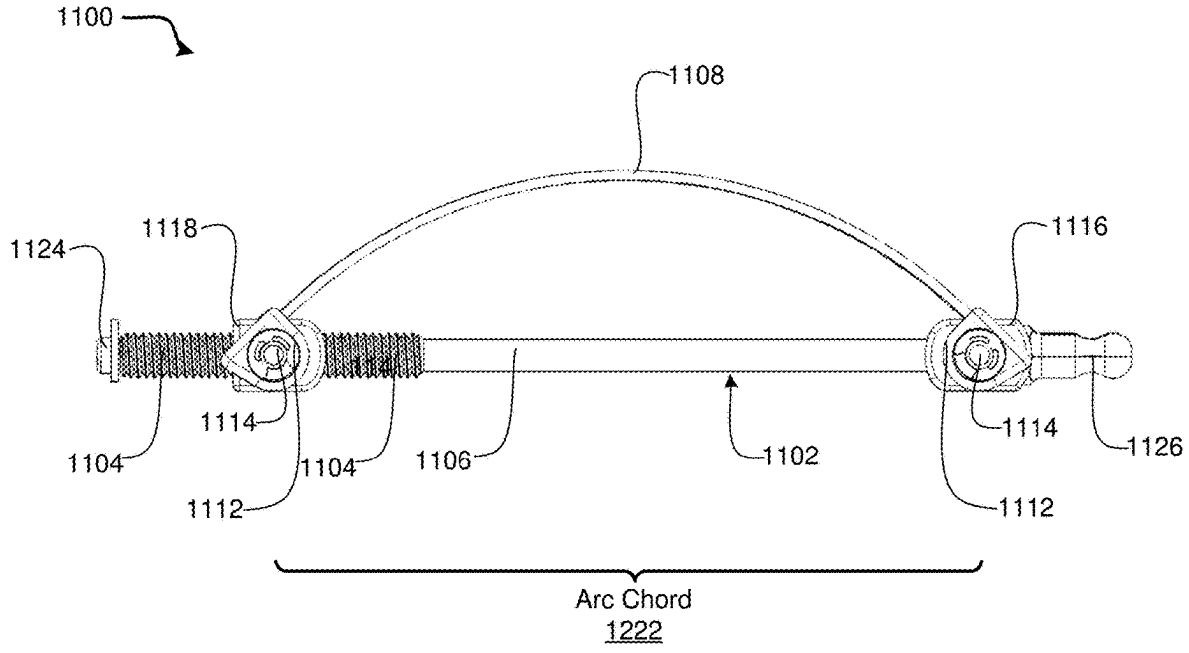



FIG. 13B

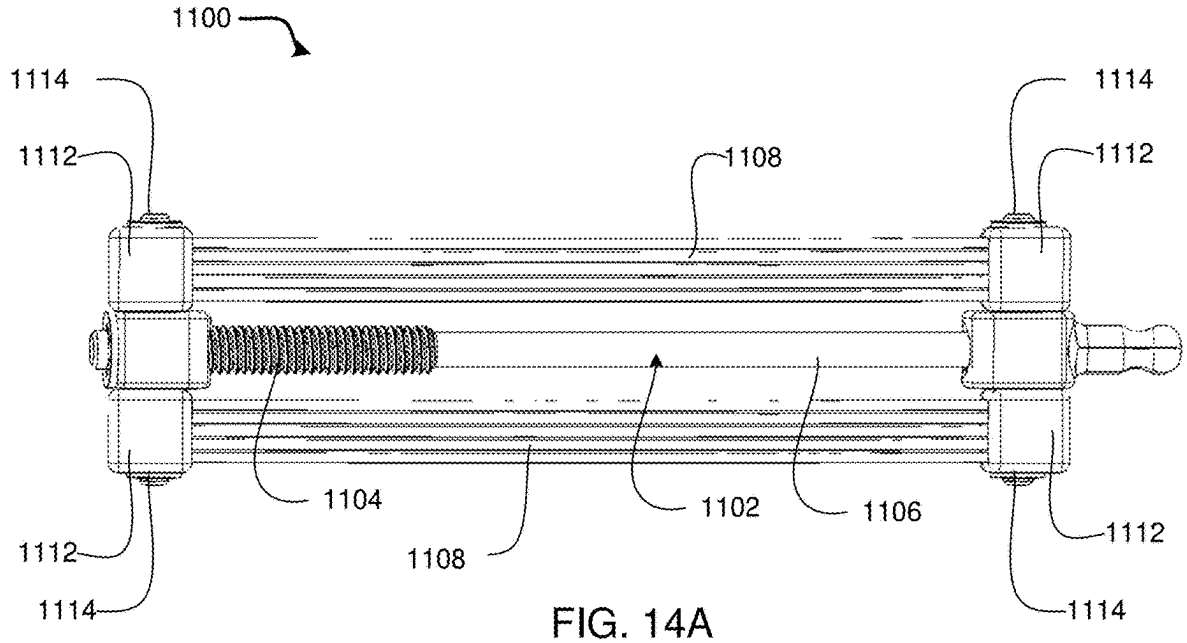



FIG. 14A

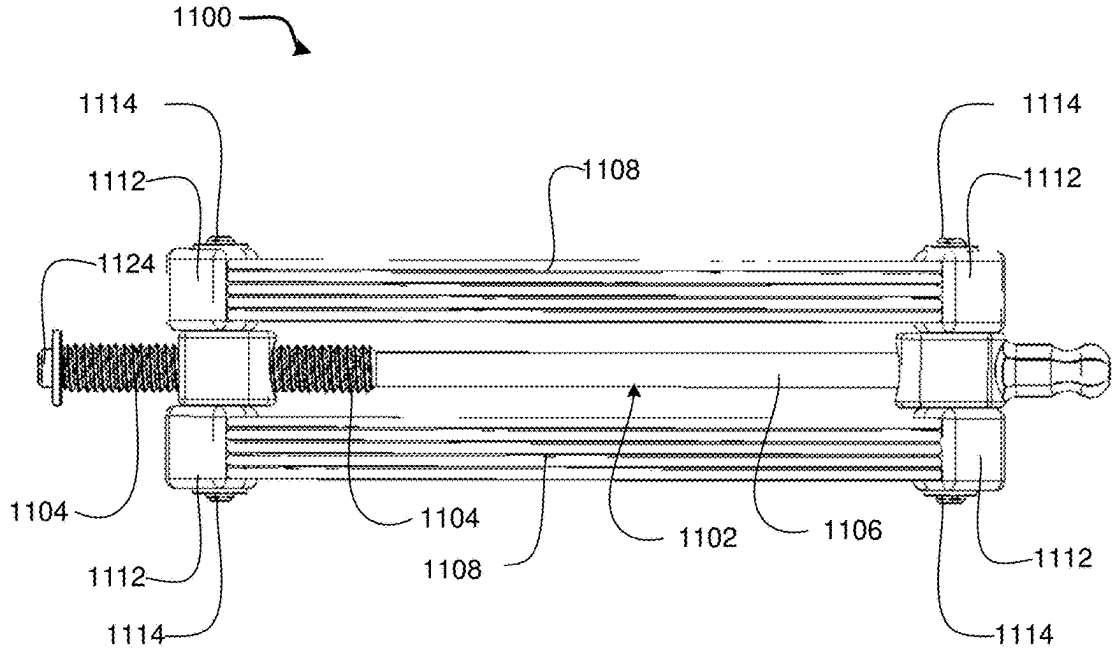
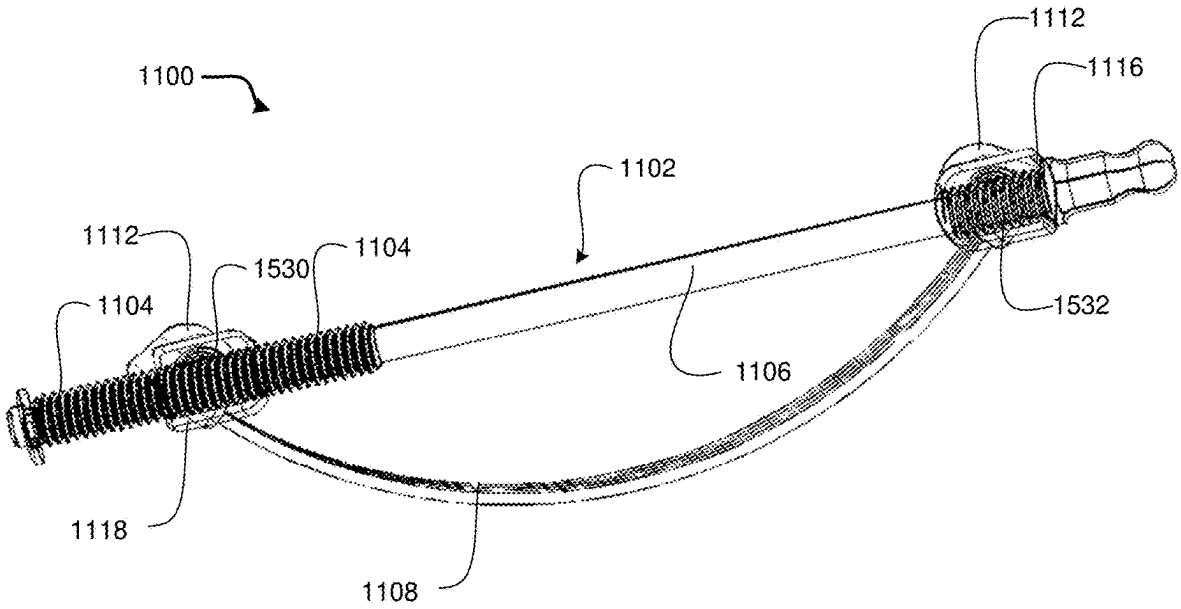



FIG. 14B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1112
1116
1102
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1530
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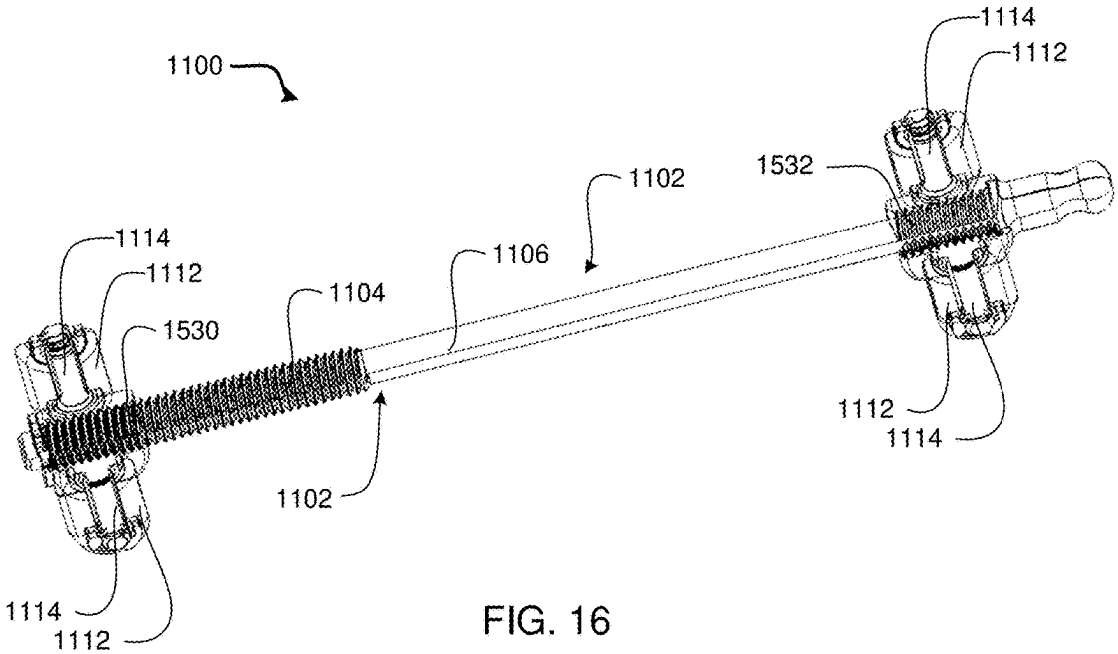
FIG. 15


1100
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1112
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1102
1114
1112

FIG. 16

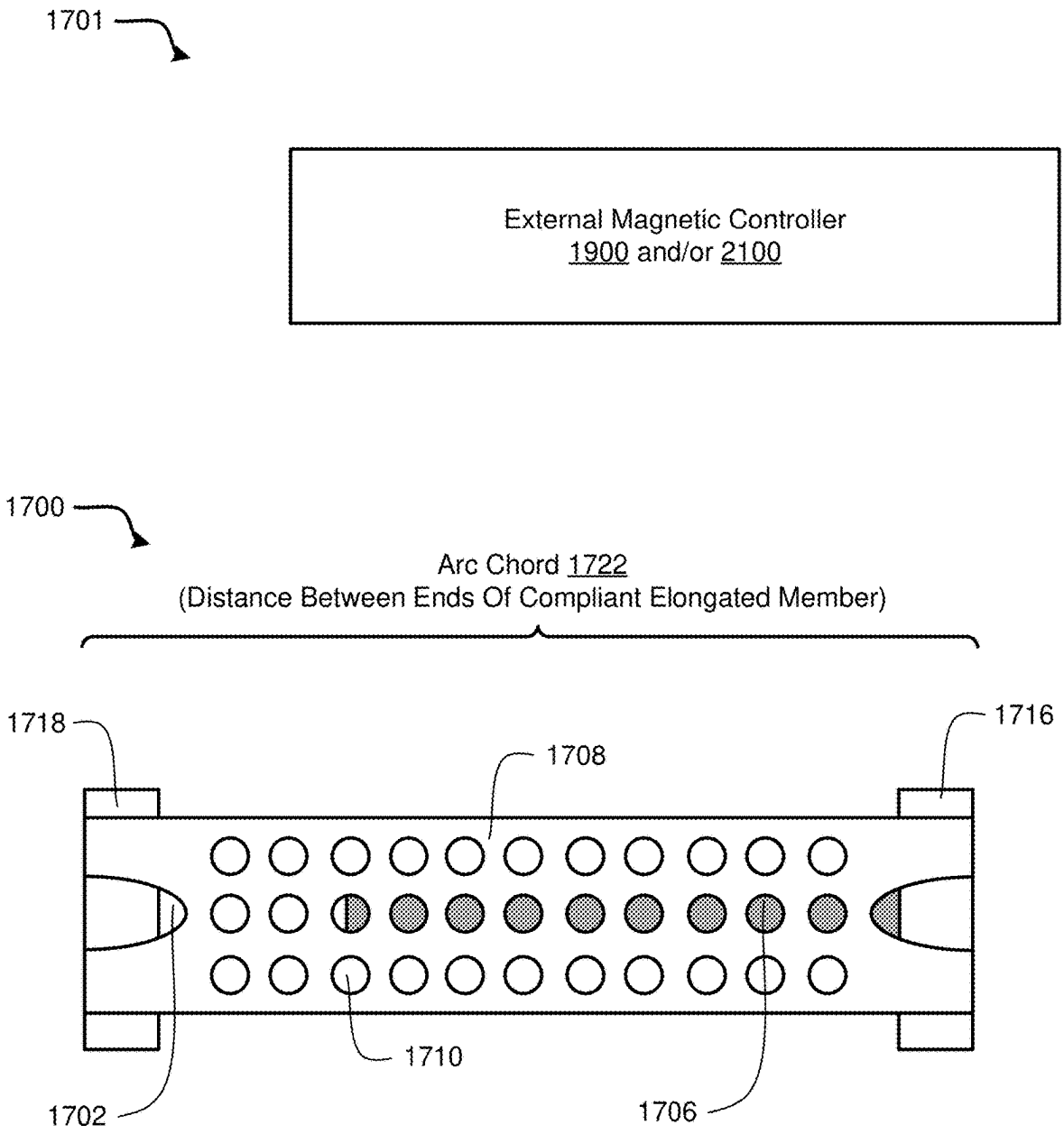

1701
External Magnetic Controller
1900 and/or 2100
1700
Arc Chord 1722
(Distance Between Ends Of Compliant Elongated Member)
1718
1708
1716
1710
1702
1706

FIG. 17

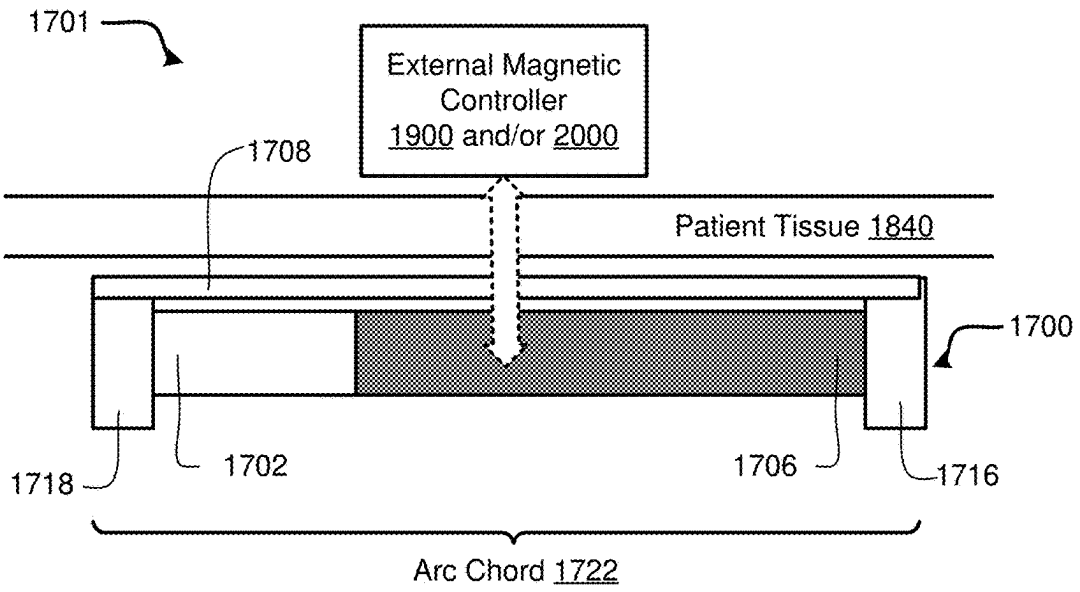



FIG. 18A

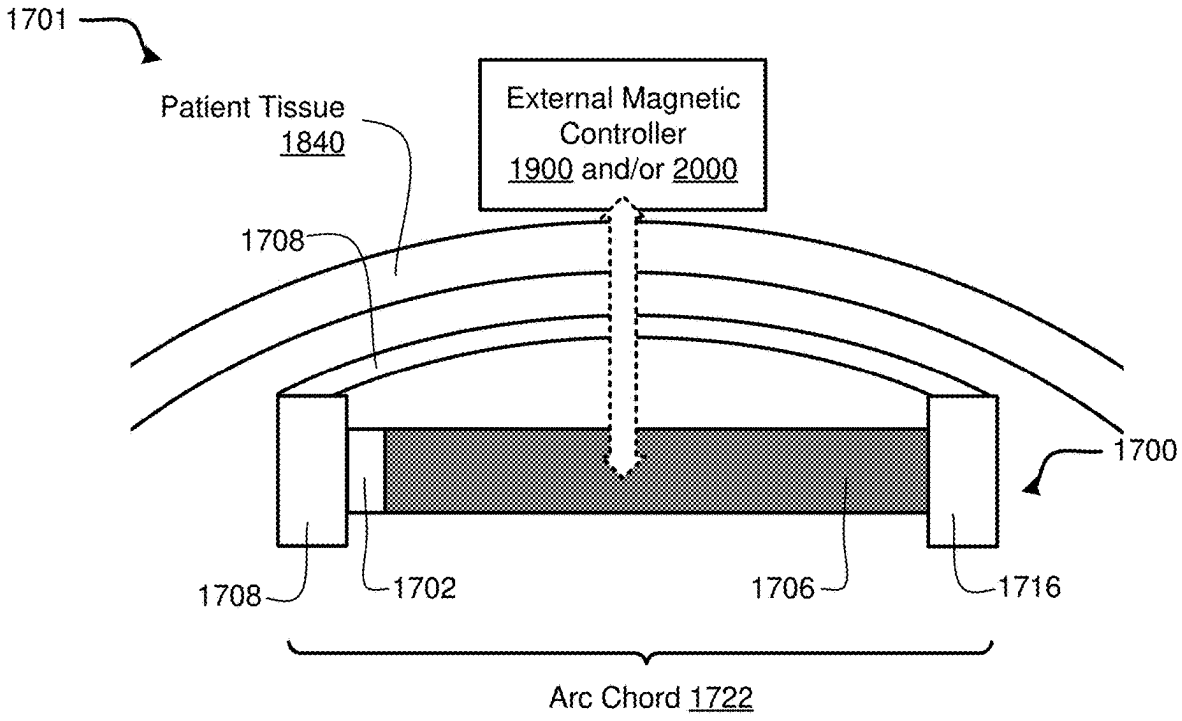



FIG. 18B

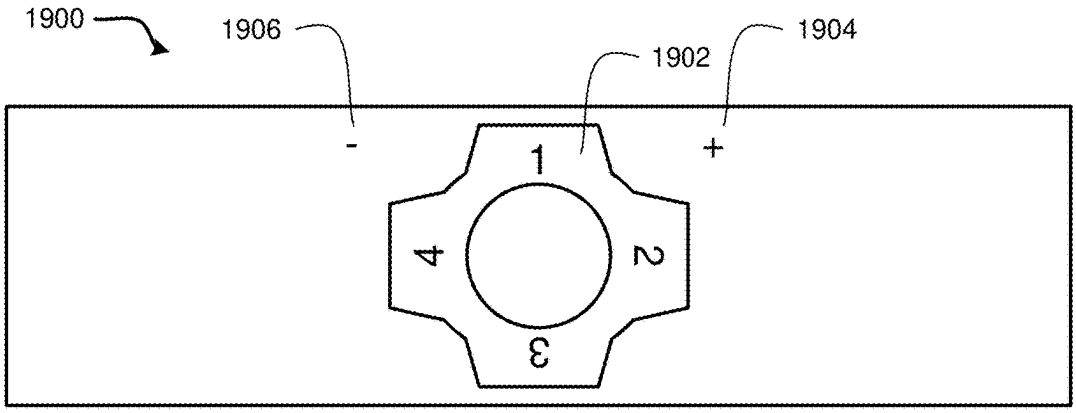



FIG. 19A

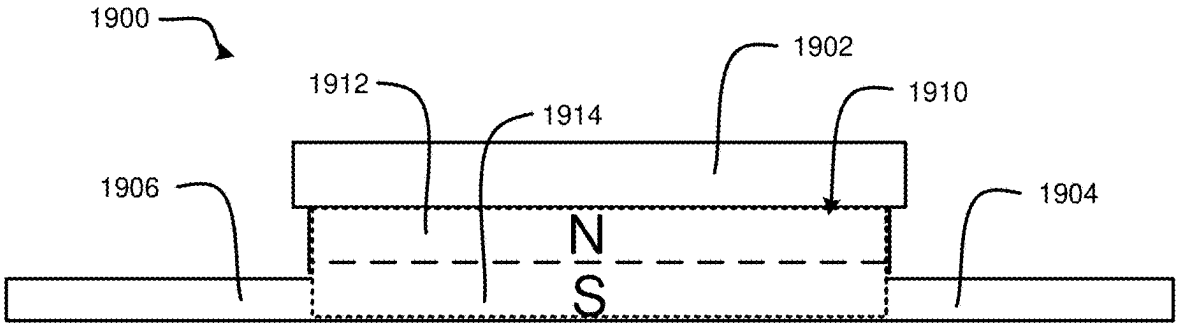



FIG. 19B

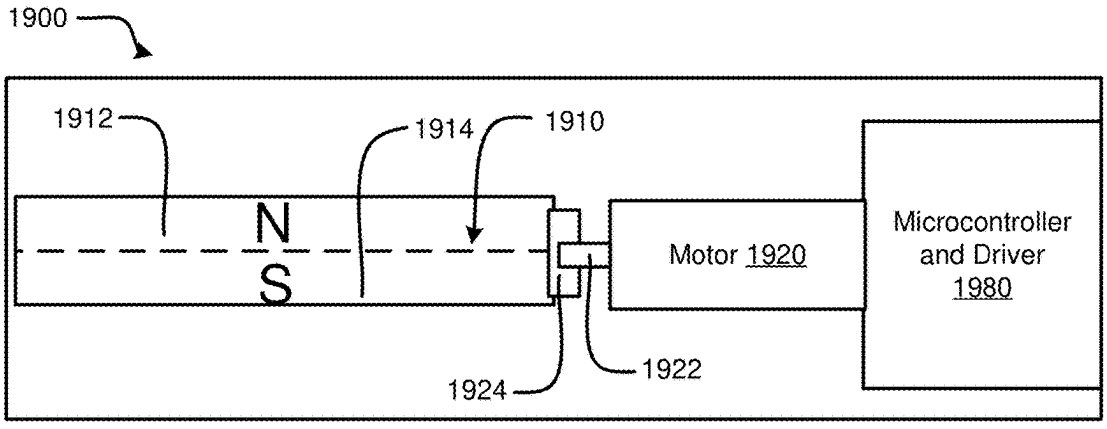



FIG. 19C

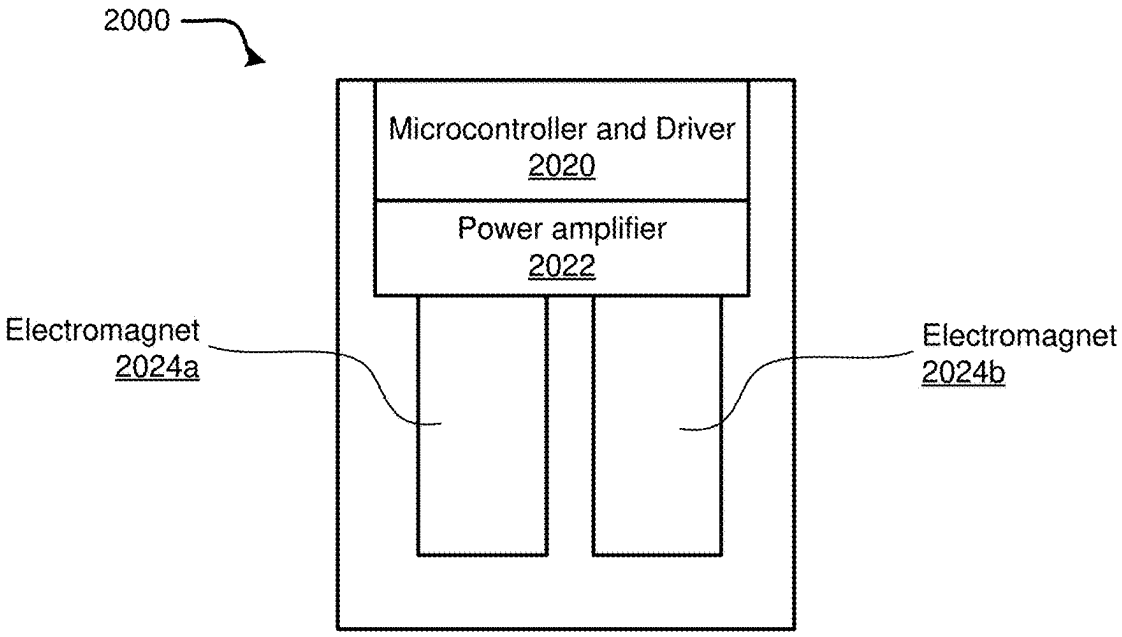



FIG. 20A

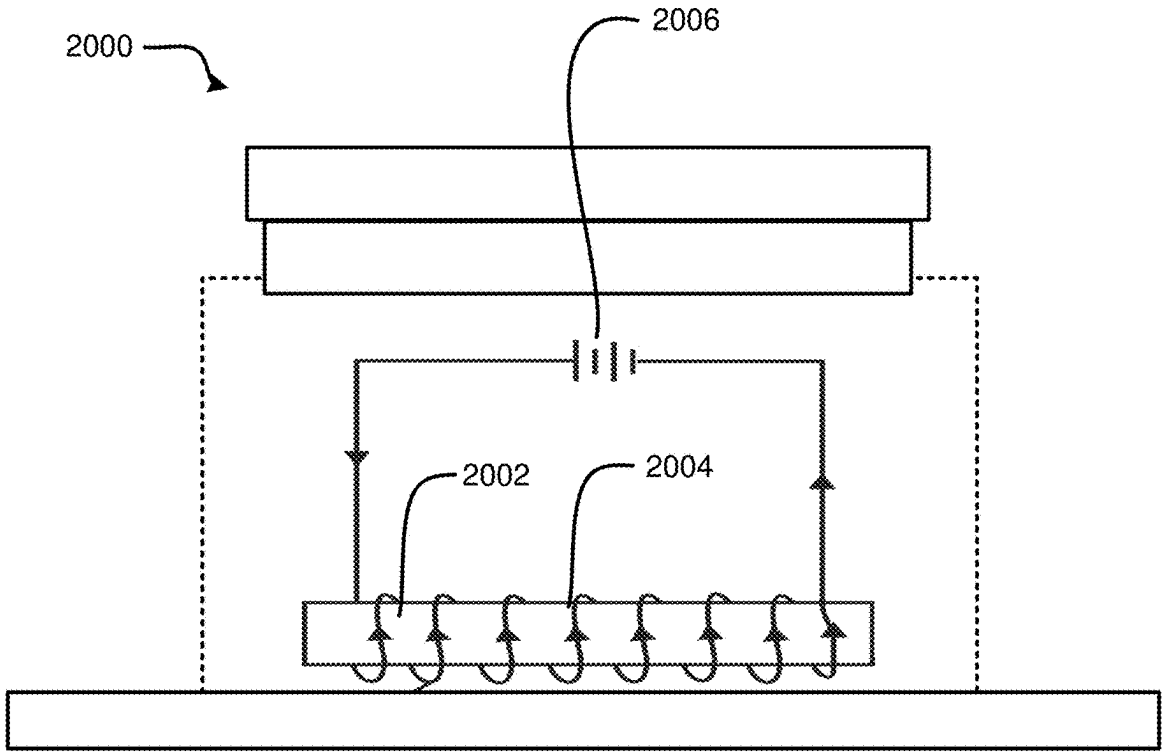



FIG. 20B

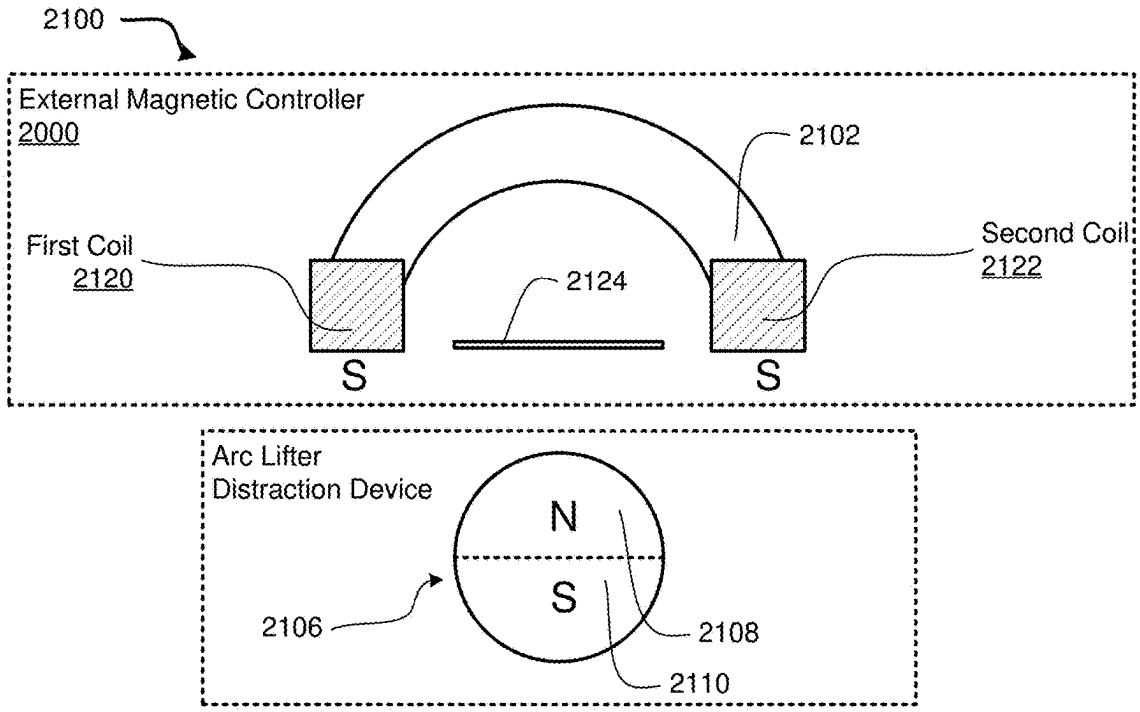



FIG. 21A

Initiation

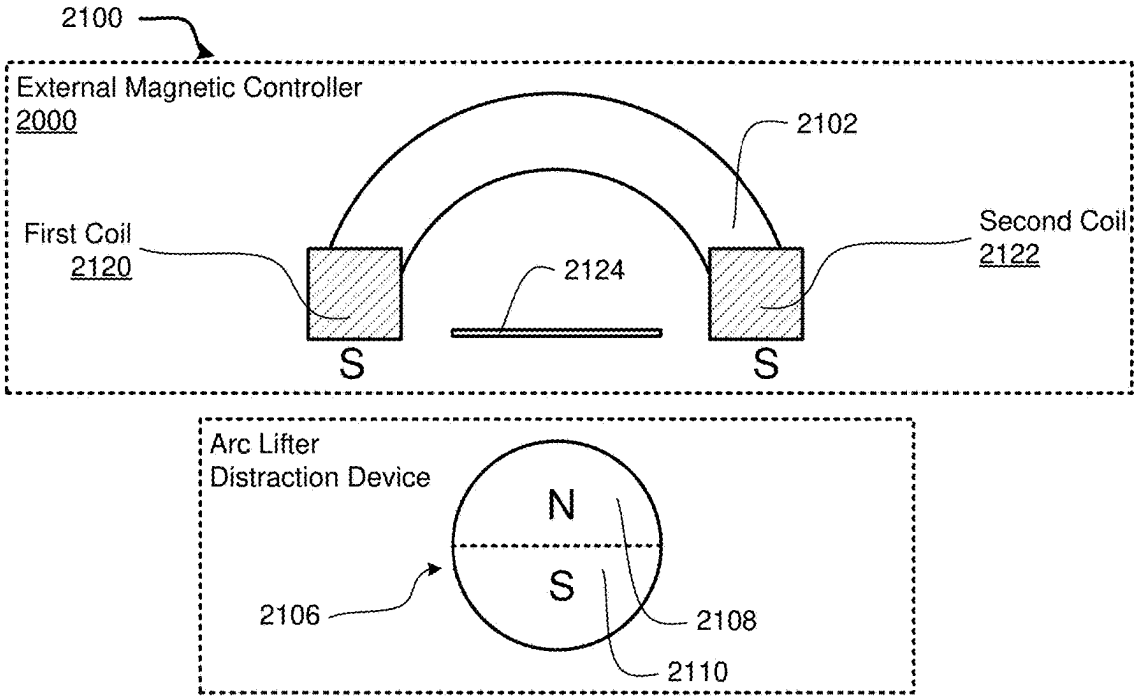



FIG. 21B

0 Degree Rotation Of Implant Magnet

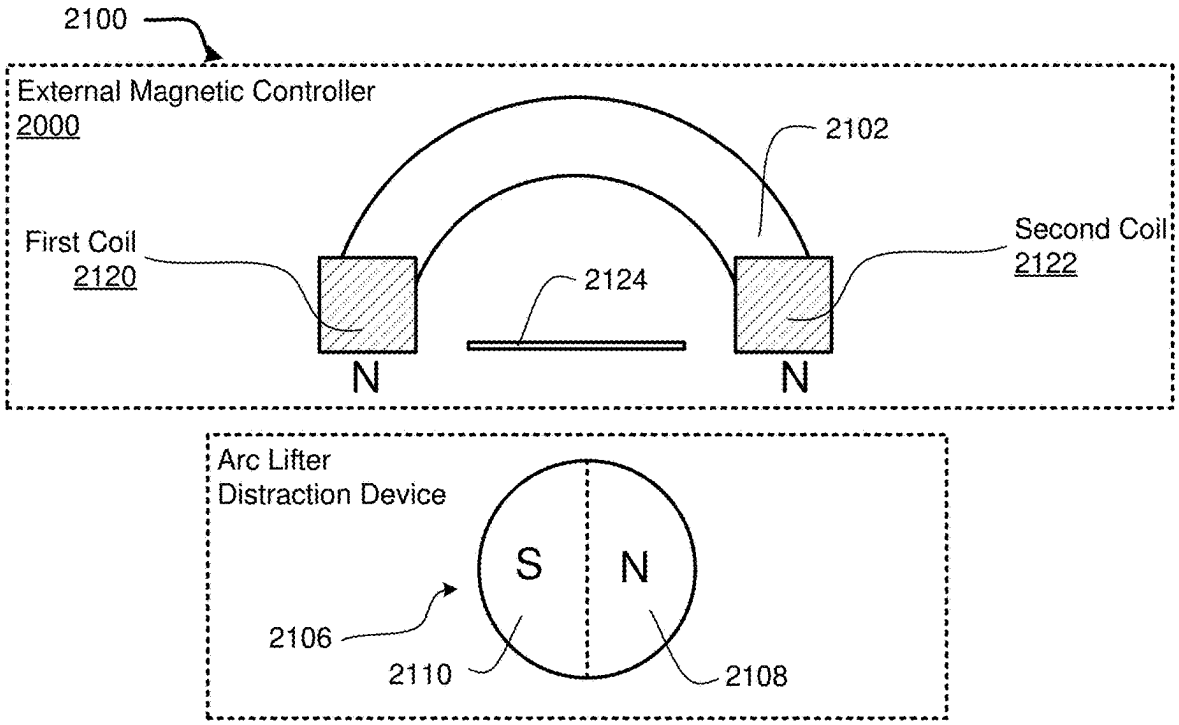



FIG. 21C

90 Degree Rotation Of Implant Magnet

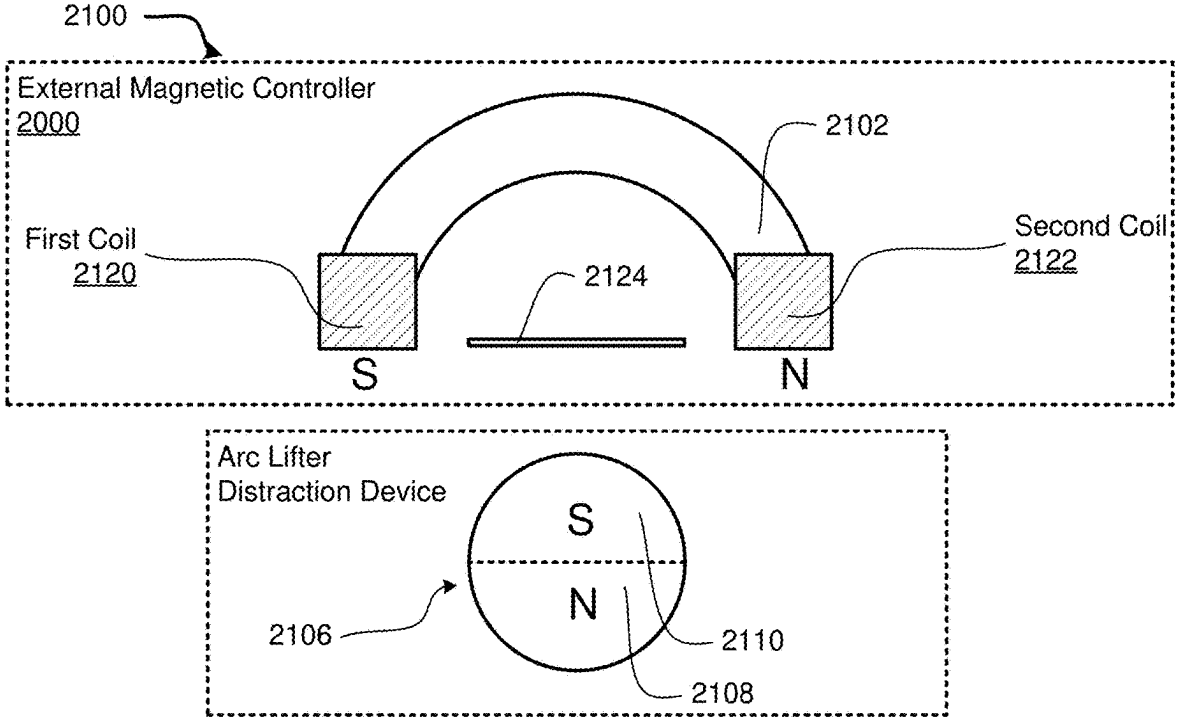



FIG. 21D

180 Degree Rotation Of Implant Magnet

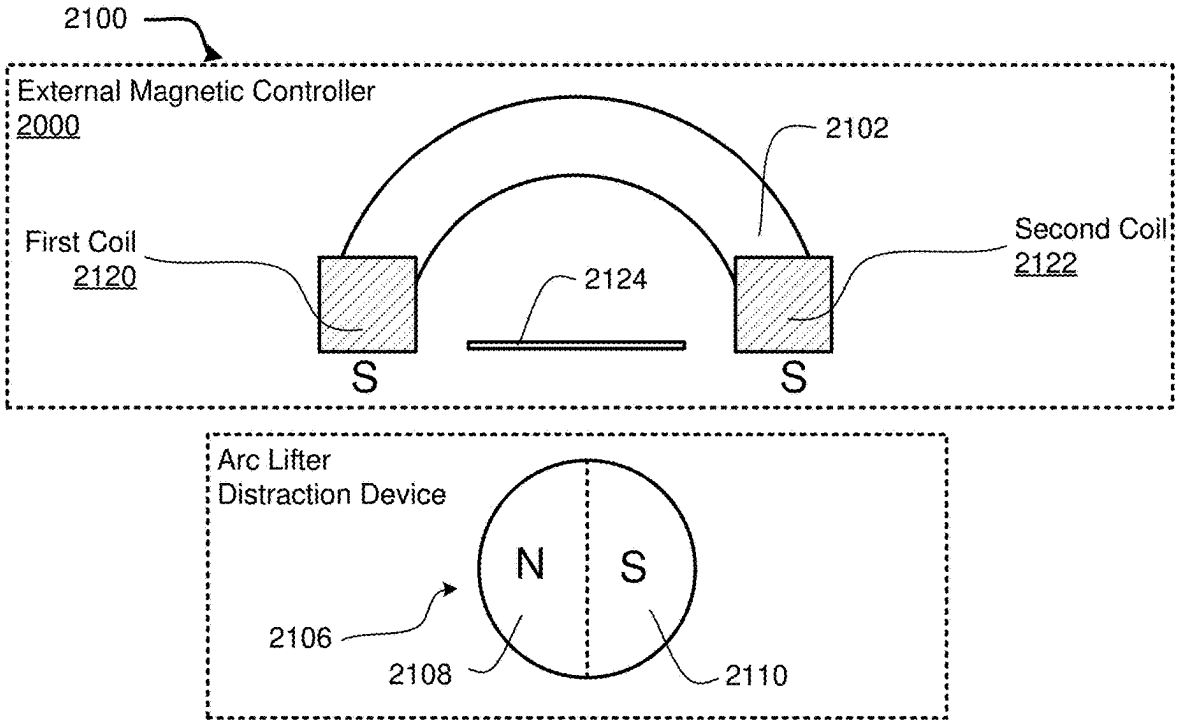



FIG. 21E

270 Degree Rotation Of Implant Magnet

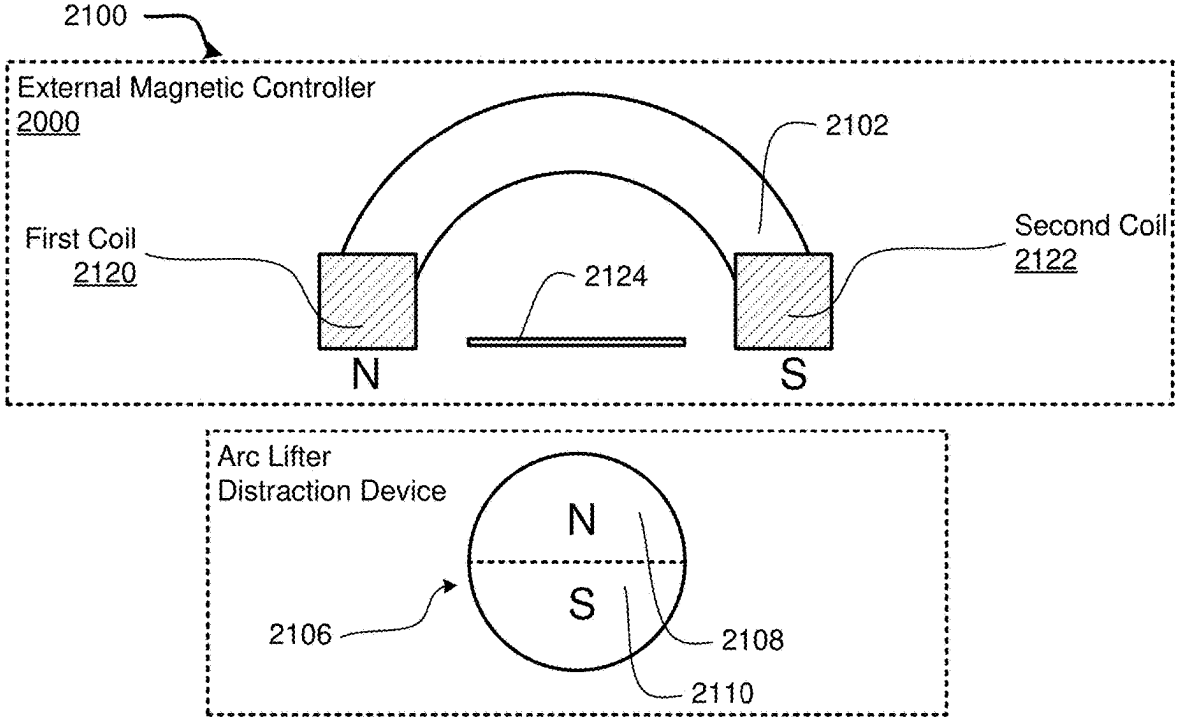



FIG. 21F

360 Degree Rotation Of Implant Magnet

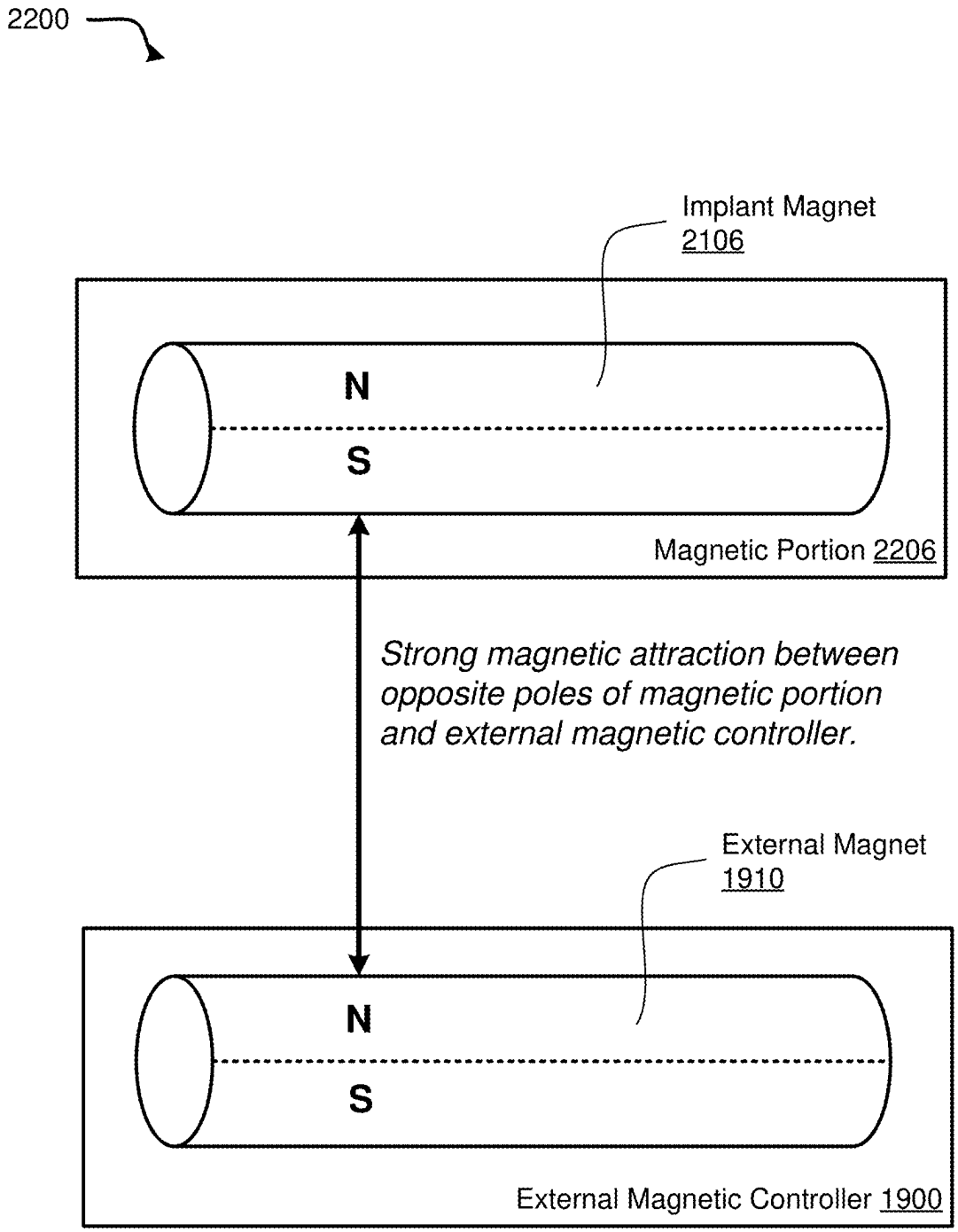

2200
Implant Magnet
2106
N
S
Magnetic Portion 2206
Strong magnetic attraction between opposite poles of magnetic portion and external magnetic controller.
External Magnet
1910
N
S
External Magnetic Controller 1900

FIG. 22A

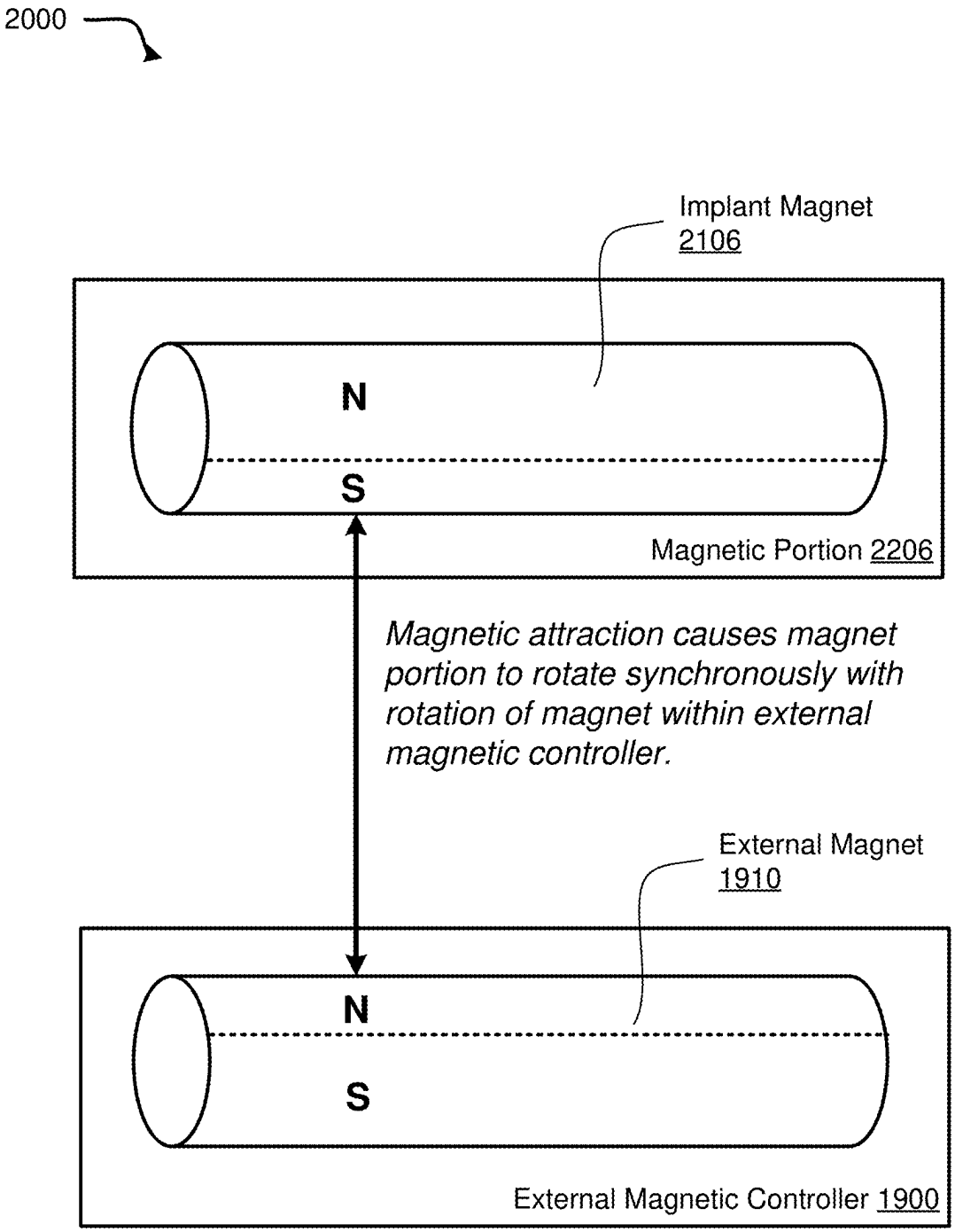

2000
Implant Magnet
2106
N
S
Magnetic Portion 2206
Magnetic attraction causes magnet portion to rotate synchronously with rotation of magnet within external magnetic controller.
External Magnet
1910
N
S
External Magnetic Controller 1900

FIG. 22B

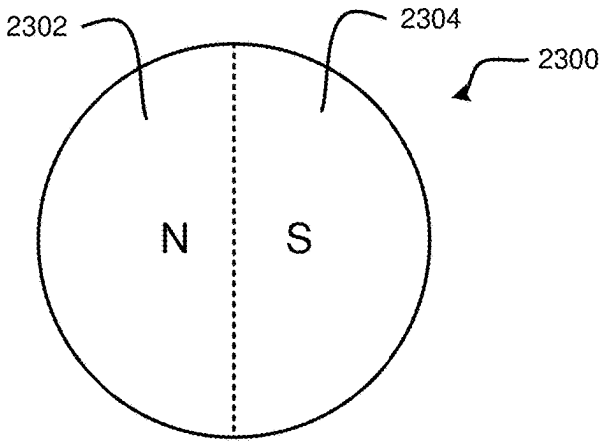



FIG. 23A

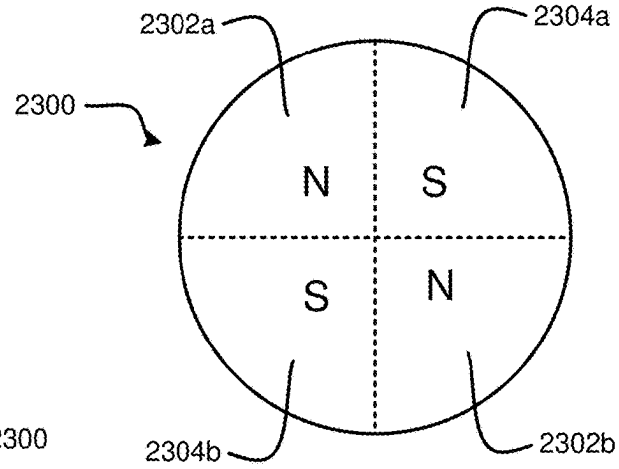



FIG. 23B

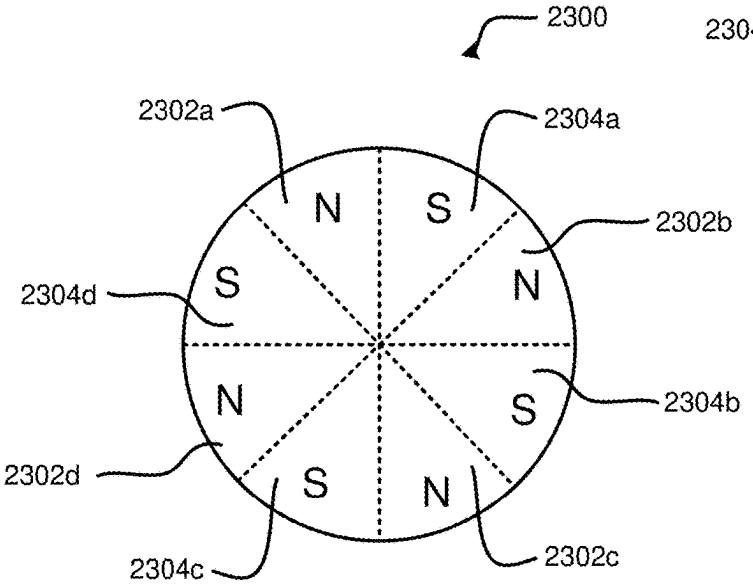



FIG. 23C

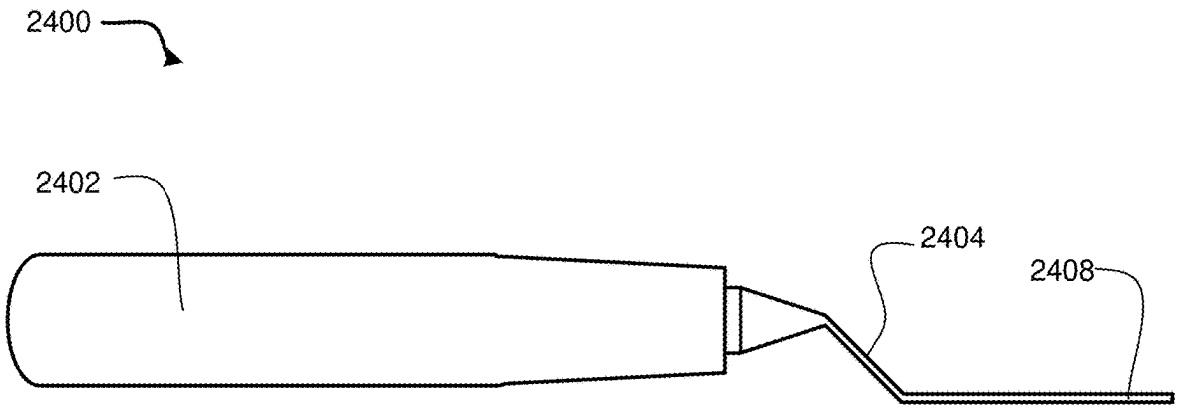



FIG. 24A

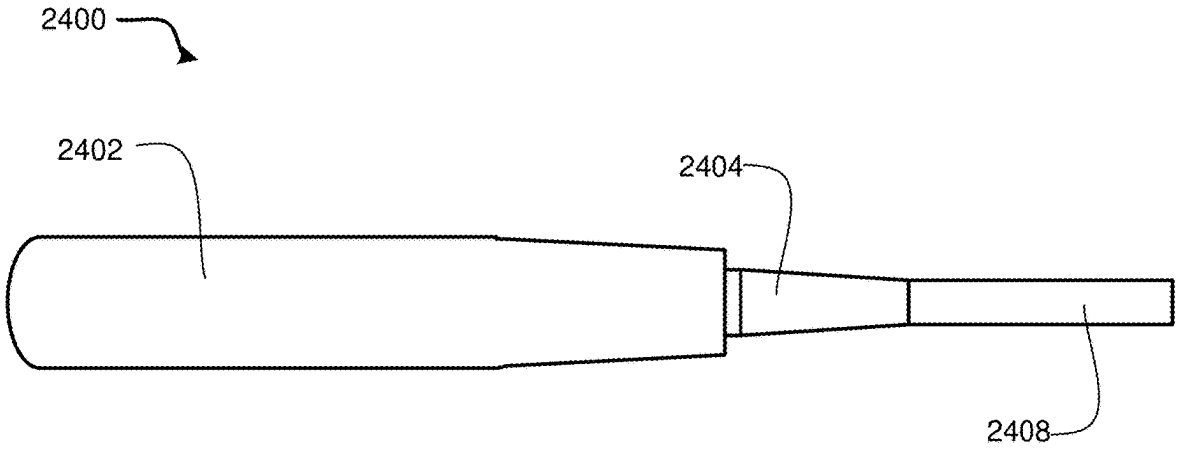



FIG. 24B

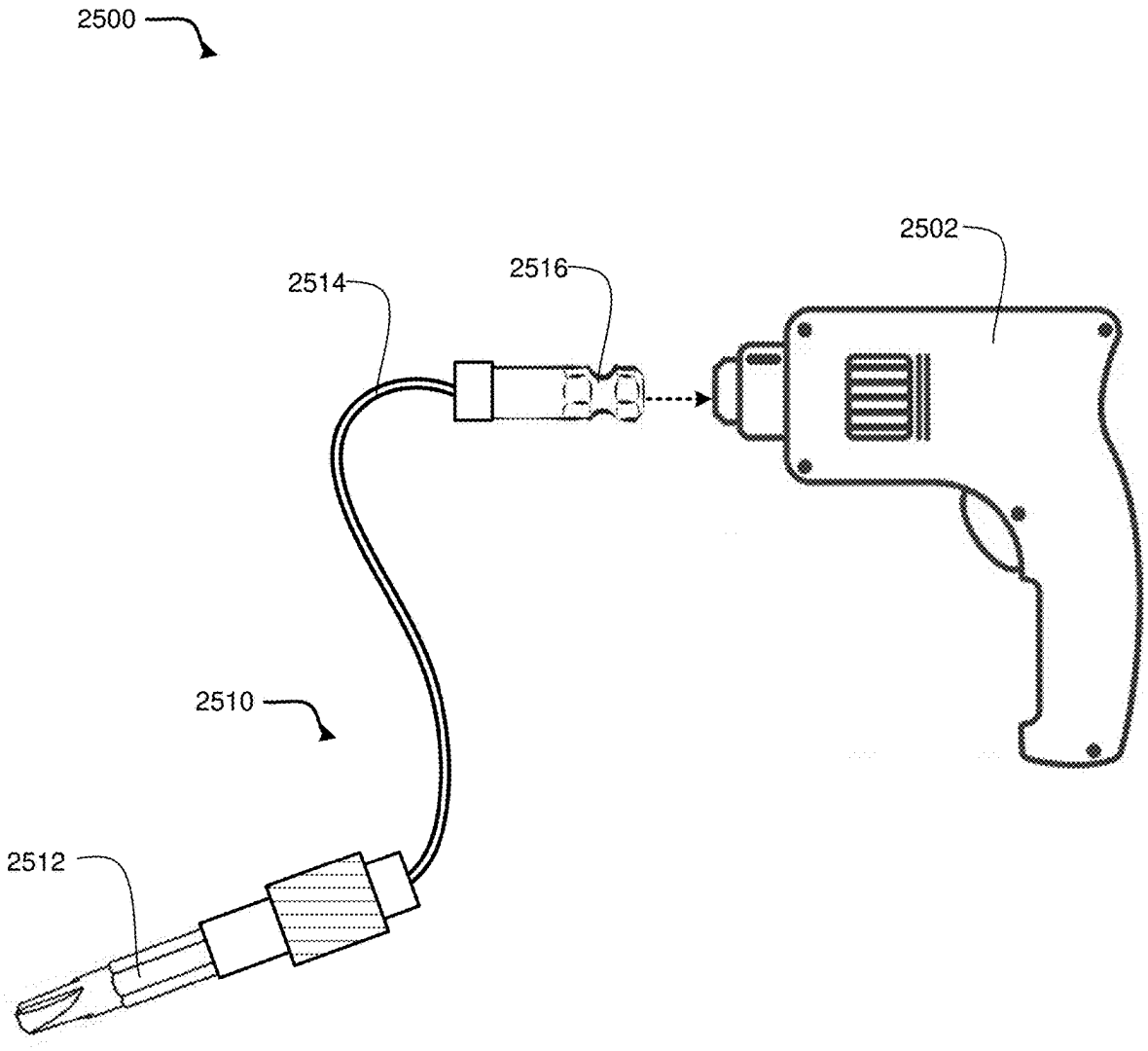



FIG. 25

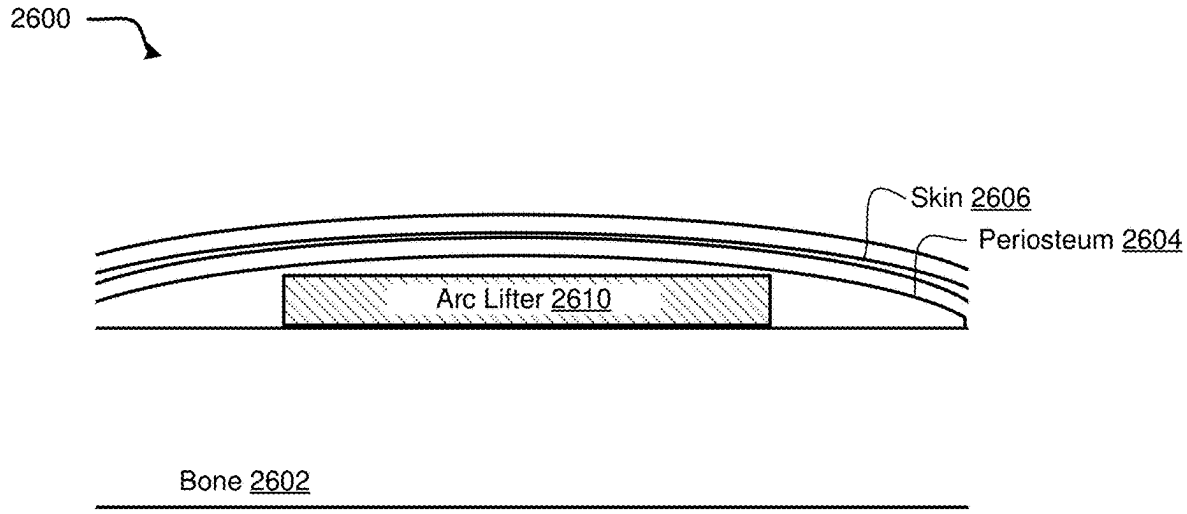



FIG. 26A

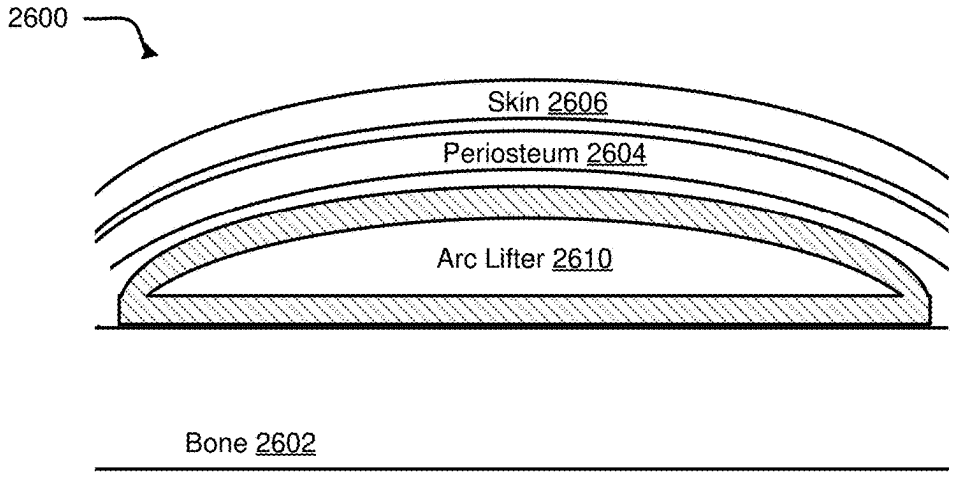
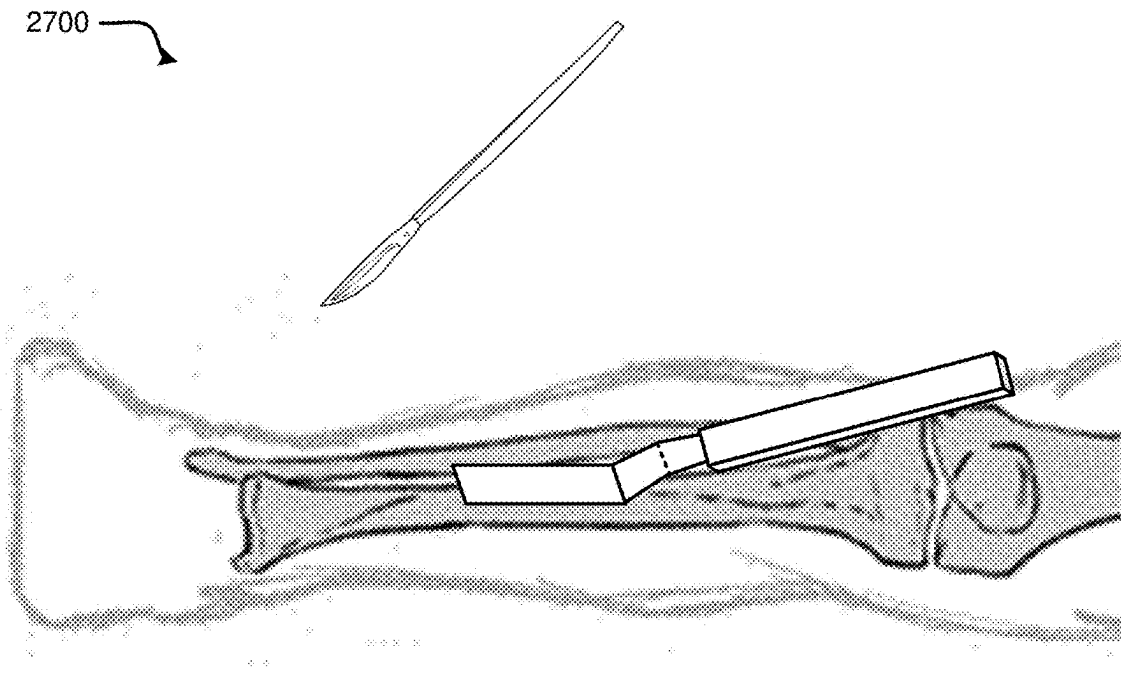



FIG. 26B


2700

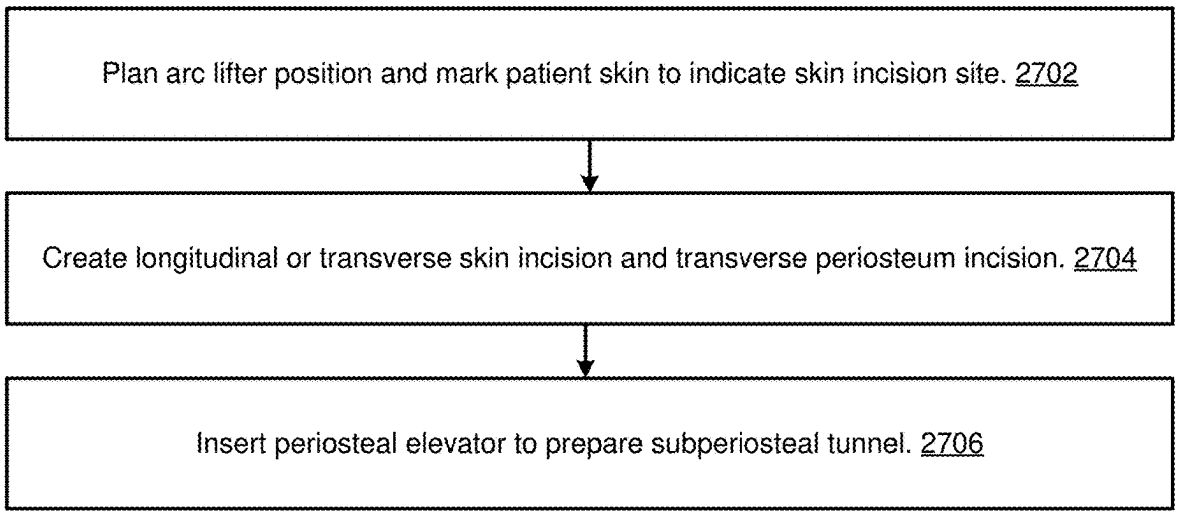
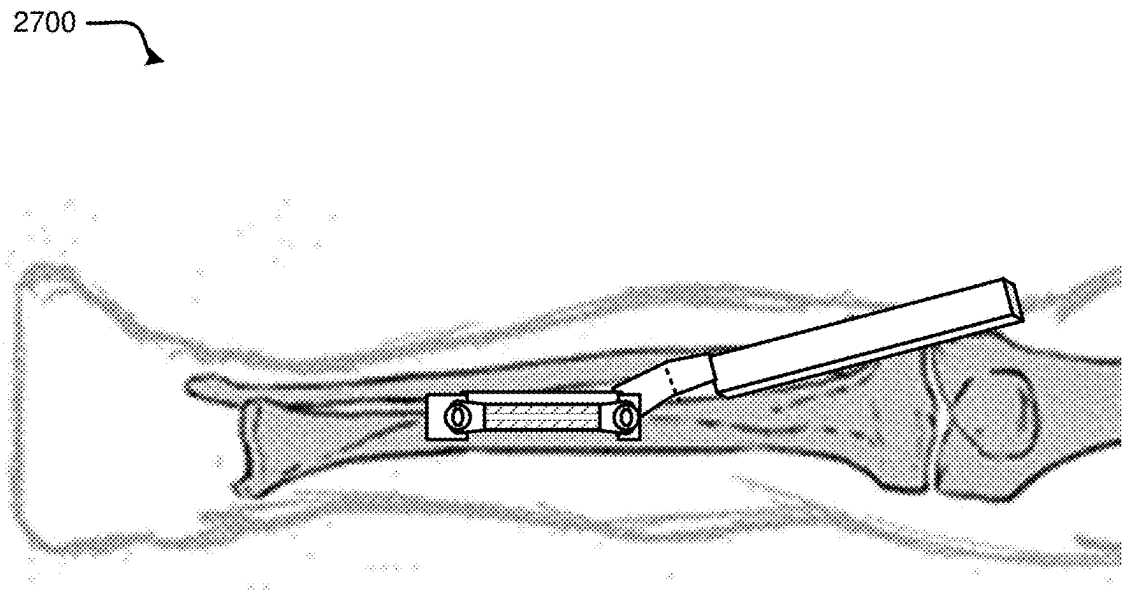
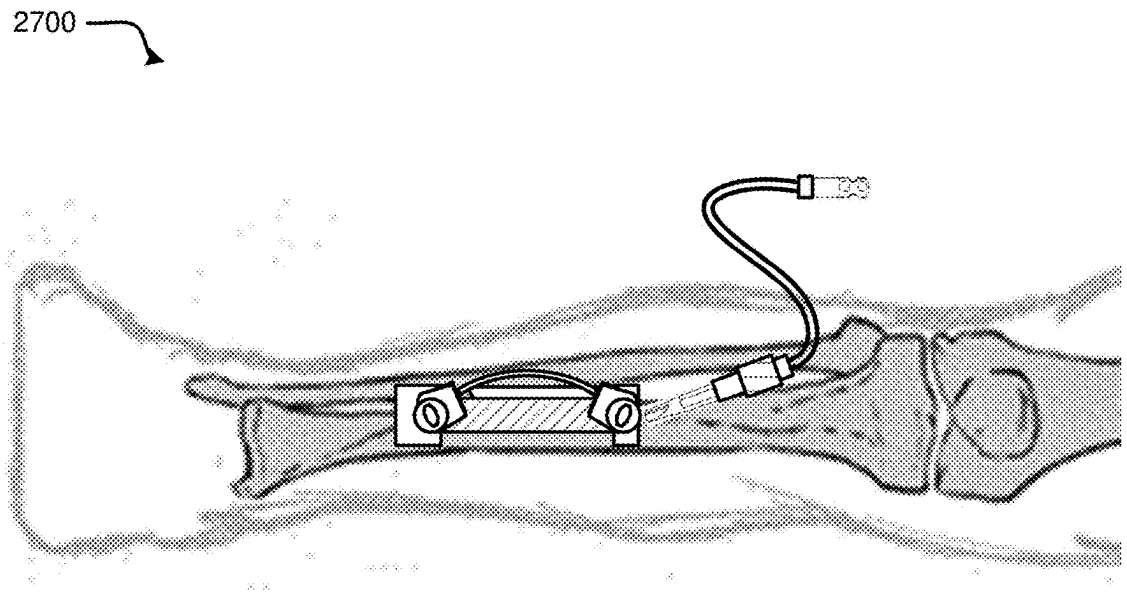

Plan arc lifter position and mark patient skin to indicate skin incision site. 2702
Create longitudinal or transverse skin incision and transverse periosteum incision. 2704
Insert periosteal elevator to prepare subperiosteal tunnel. 2706

FIG. 27A




Insert arc lifter under periosteum, with the guidance of periosteal elevator if needed. Ensure rotation actuation head of arc lifter is exposed. 2708

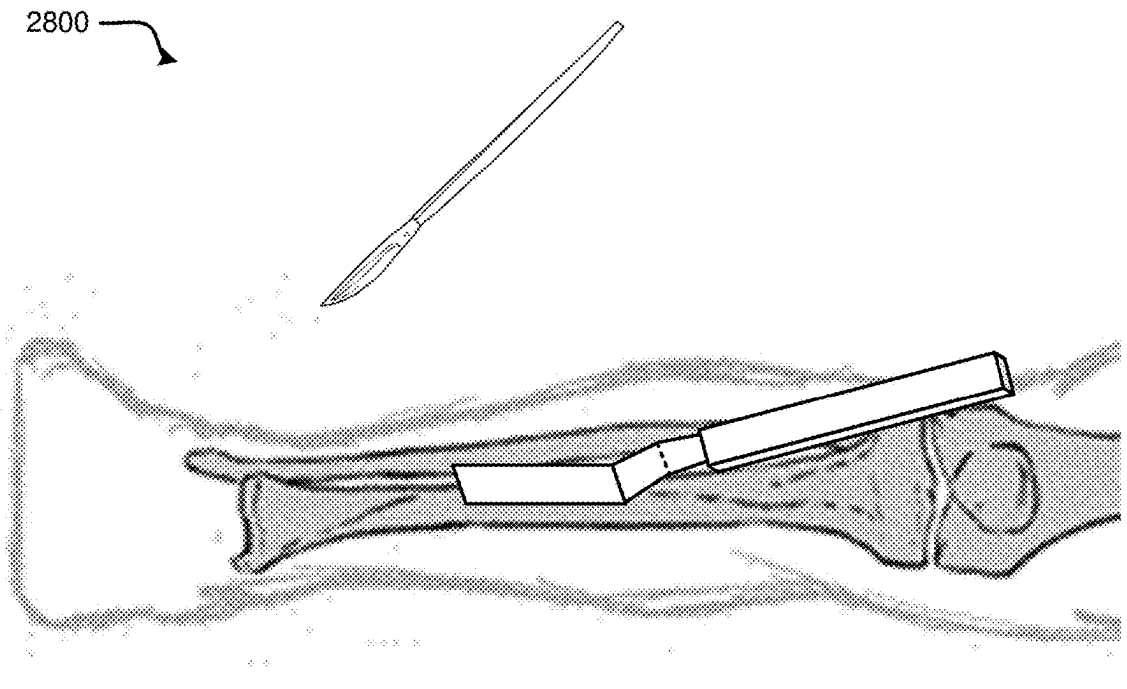
FIG. 27B




Attach flexible driver onto rotation actuation head or arc lifter. 2710

Rotate the rotation actuation head of arc lifter to rotate the rigid elongated member and thereby lift or lower the compliant elongated member to distract or retract periosteum. 2712

FIG. 27C


2800

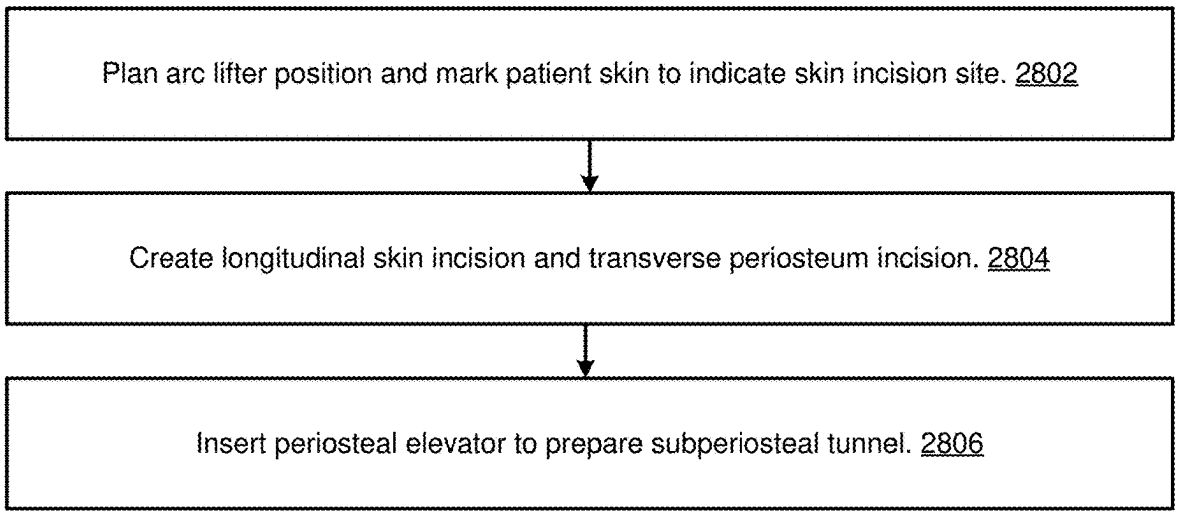
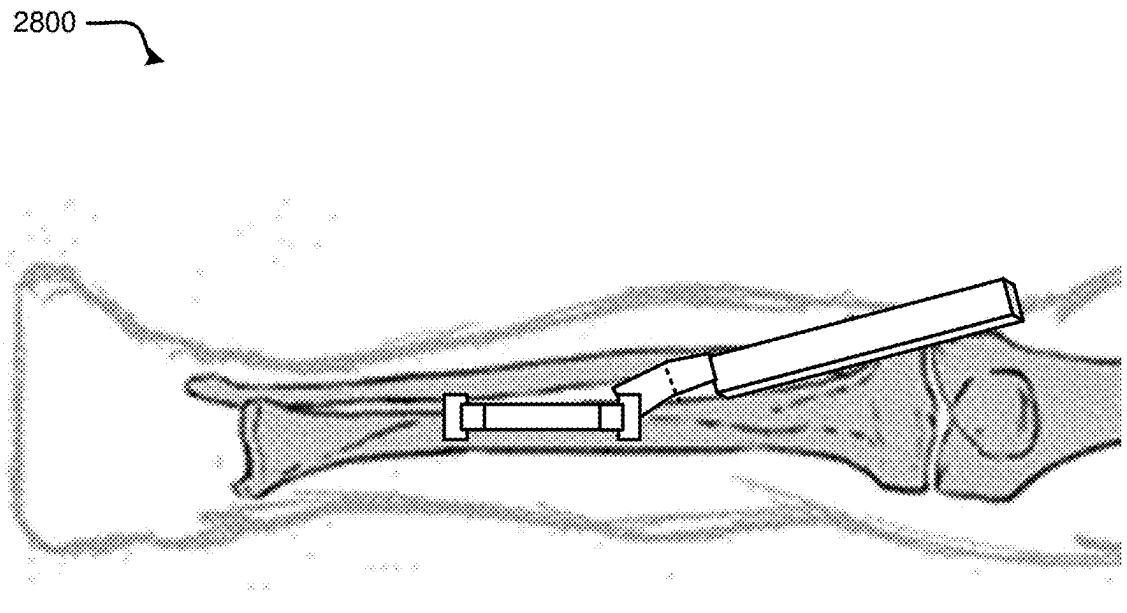

Plan arc lifter position and mark patient skin to indicate skin incision site. 2802
Create longitudinal skin incision and transverse periosteum incision. 2804
Insert periosteal elevator to prepare subperiosteal tunnel. 2806

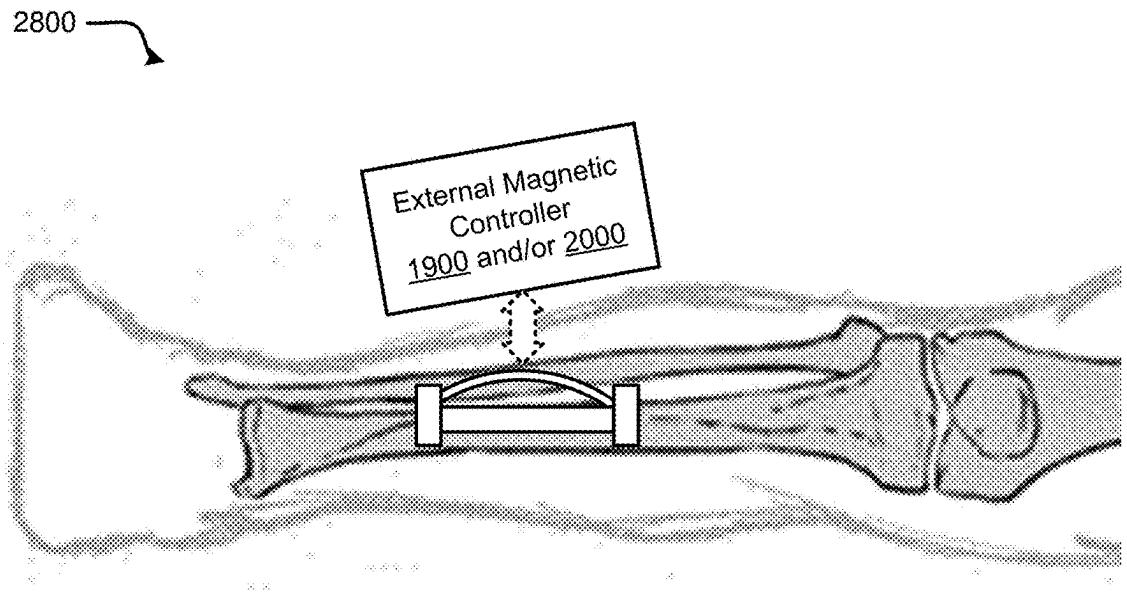
FIG. 28A




Insert arc lifter under periosteum, with the guidance of periosteal elevator if needed. 2808

Close periosteum and skin over the top of arc lifter. 2810

FIG. 28B




Hold external magnetic controller onto the skin in alignment with the arc lifter to form a magnetic coupling between the EMC and a magnet of the arc lifter. 2812

Rotate dial of the external magnetic controller based on its indication (e.g., positive rotation for distraction, negative rotation for retraction) to cause rotation of a rigid elongated member to thereby cause an adjustment in the arc height of a compliant elongated member, and to thereby distract or retract the periosteum. 2814

FIG. 28C

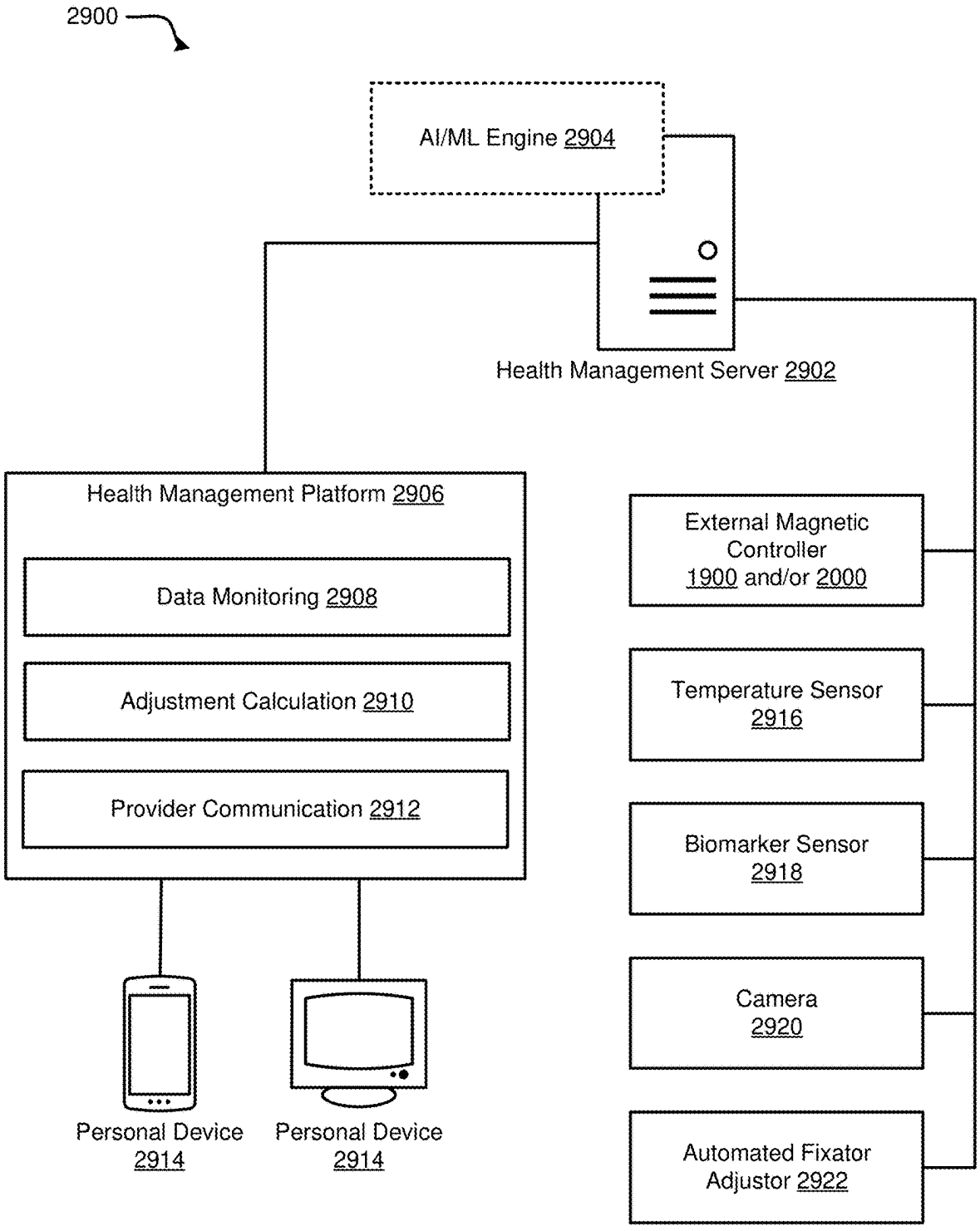

2900
AI/ML Engine 2904
Health Management Server 2902
Health Management Platform 2906
Data Monitoring 2908
Adjustment Calculation 2910
Provider Communication 2912
External Magnetic Controller 1900 and/or 2000
Temperature Sensor 2916
Biomarker Sensor 2918
Camera 2920
Automated Fixator Adjustor 2922
Personal Device 2914
Personal Device 2914

FIG. 29

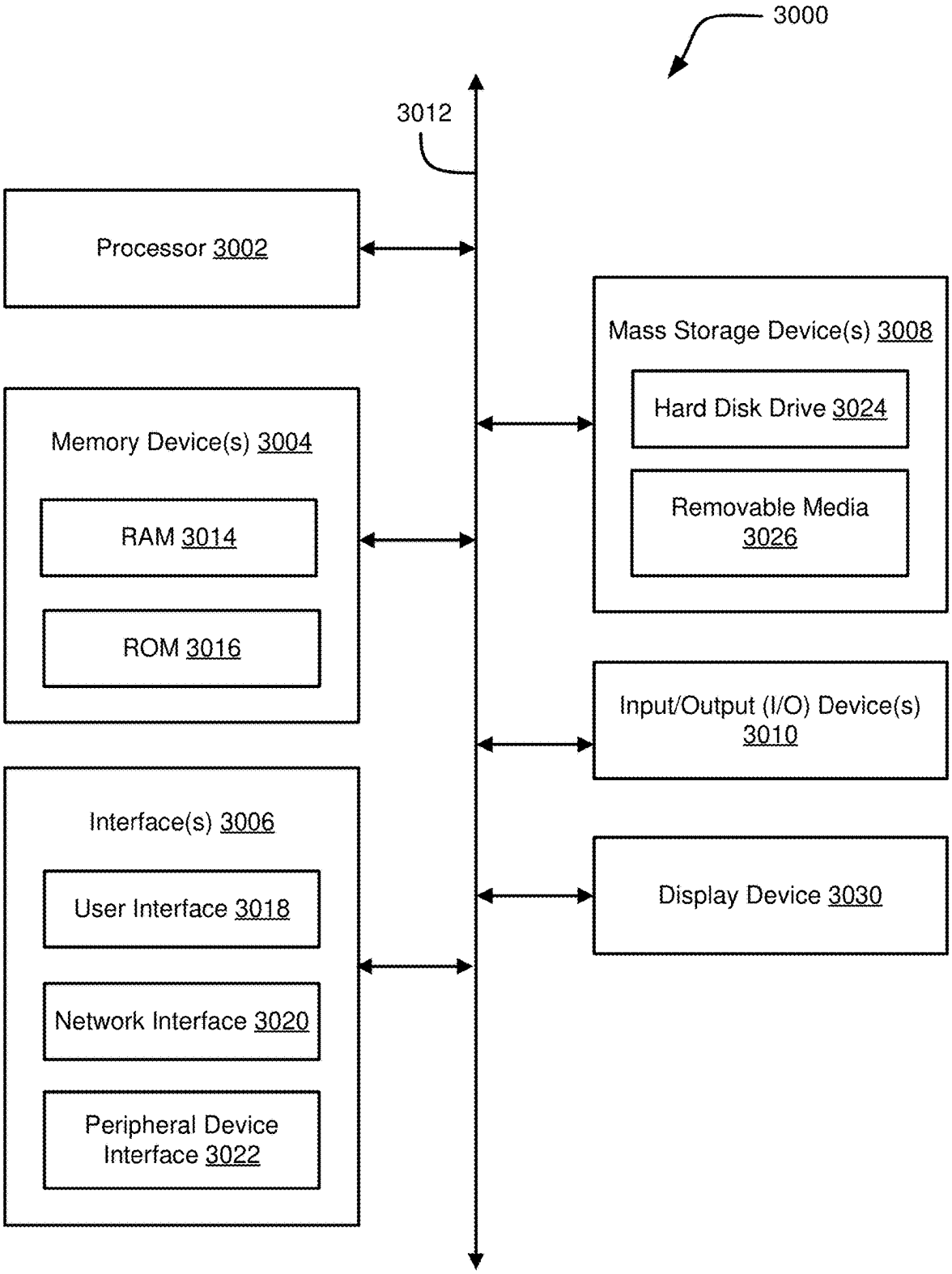

3000
3012
Processor 3002
Mass Storage Device(s) 3008
Hard Disk Drive 3024
Removable Media 3026
Memory Device(s) 3004
RAM 3014
ROM 3016
Input/Output (I/O) Device(s) 3010
Interface(s) 3006
User Interface 3018
Display Device 3030
Network Interface 3020
Peripheral Device Interface 3022

FIG. 30

# ARC LIFTER DISTRACTION ADJUSTOR FOR DISTRACTION HISTOGENESIS

## TECHNICAL FIELD

**[0001]** The disclosure relates generally to systems, methods, and devices for surgical procedures, and relates specifically to systems, methods, and devices for distraction histogenesis procedures such as periosteal distraction osteogenesis.

## BACKGROUND

**[0002]** In some cases, a patient benefits from perfusion improvement and tissue regeneration to aid in recovery from vascular damage, tissue trauma, bone defects, nerve damage, and other wounds. Perfusion improvement and tissue regeneration can be a major challenge for patient care and can be particularly difficult for patients experiencing chronic wounds, ischemic disease, diabetic foot ulcers, bone defects, and other health challenges.

**[0003]** Tissue regeneration is particularly difficult to trigger when treating diabetic patients, and especially when treating diabetic foot ulcers. Currently, there are few known successful treatments for recalcitrant diabetic foot ulcers. Ongoing research suggests there may be some success in topical therapies and oxygen treatments, but these treatments show limited success.

**[0004]** Additionally, it can be difficult to successfully trigger bone regeneration in response to a bone defect, fracture, or other trauma. Commonly used therapies for bone regeneration include bone graft substitutes, guided bone regeneration (GBR), distraction osteogenesis (DO), and periosteal distraction osteogenesis (PDO). PDO is a combination of tissue expansion and GBR and is implemented to create an artificial space between the bone surface and periosteum layer by expanding the periosteum, muscle, and skin at the same time.

**[0005]** Traditional devices for performing distraction histogenesis, and specifically for performing periosteal distraction osteogenesis, include numerous external components that may be bothersome and painful for the patient, can be difficult and time consuming to install, require numerous component implanted into patient bone tissue, and can be difficult to adjust as time goes on. What is needed are systems, methods, and devices for performing distraction histogenesis that improve patient outcomes, reduce surgery complexity, reduce the number of percutaneous sites, and reduce the quantity of cumbersome and painful external components.

**[0006]** In view of the foregoing, disclosed herein are systems, methods, compositions, and devices for improved surgical procedures, and specifically for improved distraction histogenesis procedures such as periosteal distraction osteogenesis.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0007]** Non-limiting and non-exhaustive implementations of the present disclosure are described with reference to the following figures, wherein like reference numerals refer to like parts throughout the various views unless otherwise specified. Advantages of the present disclosure will become better understood with regard to the following description and accompanying drawings where:

**[0008]** FIG. **1**A is an overhead perspective view of a device for performing a distraction histogenesis procedure, wherein the device is in a planar configuration;

**[0009]** FIG. **1**B is an overhead perspective view of a device for performing a distraction histogenesis procedure, wherein the device is in an expanded configuration;

**[0010]** FIG. **2**A is an underside perspective view of a device for performing a distraction histogenesis procedure, wherein the device is in a planar configuration;

**[0011]** FIG. **2**B is an underside perspective view of a device for performing a distraction histogenesis procedure, wherein the device is in an expanded configuration;

**[0012]** FIG. **3**A is a straight-on side view of a device for performing a distraction histogenesis procedure, wherein the device is in a planar configuration;

**[0013]** FIG. **3**B is a straight-on side view of a device for performing a distraction histogenesis procedure, wherein the device is in an expanded configuration;

**[0014]** FIG. **4**A is an aerial top-down view of a device for performing a distraction histogenesis procedure, wherein the device is in a planar configuration;

**[0015]** FIG. **4**B is an aerial top-down view of a device for performing a distraction histogenesis procedure, wherein the device is in an expanded configuration;

**[0016]** FIG. **5**A is a straight-on underside view of a device for performing a distraction histogenesis procedure, wherein the device is in a planar configuration;

**[0017]** FIG. **5**B is a straight-on underside view of a device for performing a distraction histogenesis procedure, wherein the device is in an expanded configuration;

**[0018]** FIG. **6**A is a cross-sectional perspective view of a device for performing a distraction histogenesis procedure, wherein the device is in a planar configuration;

**[0019]** FIG. **6**B is a cross-sectional perspective view of a device for performing a distraction histogenesis procedure, wherein the device is in a distraction configuration;

**[0020]** FIG. **7**A is an overhead perspective view of a device for performing a distraction histogenesis procedure, wherein the device is in a planar configuration;

**[0021]** FIG. **7**B is an overhead perspective view of a device for performing a distraction histogenesis procedure, wherein the device is in an expanded configuration;

**[0022]** FIG. **8**A is an underside perspective view of a device for performing a distraction histogenesis procedure, wherein the device is in a planar configuration;

**[0023]** FIG. **8**B is an underside perspective view of a device for performing a distraction histogenesis procedure, wherein the device is in an expanded configuration;

**[0024]** FIG. **9**A is a straight-on side view of a device for performing a distraction histogenesis procedure, wherein the device is in a planar configuration;

**[0025]** FIG. **9**B is a straight-on side view of a device for performing a distraction histogenesis procedure, wherein the device is in an expanded configuration;

**[0026]** FIG. **10**A is a cross-sectional perspective view of a device for performing a distraction histogenesis procedure, wherein the device is in a planar configuration;

**[0027]** FIG. **10**B is a cross-sectional perspective view of a device for performing a distraction histogenesis procedure, wherein the device is in a distraction configuration;

**[0028]** FIG. **11**A is an overhead perspective view of a device for performing a distraction histogenesis procedure, wherein the device is in a planar configuration;

**[0029]** FIG. **11**B is an overhead perspective view of a device for performing a distraction histogenesis procedure, wherein the device is in an expanded configuration;

**[0030]** FIG. **12**A is an underside perspective view of a device for performing a distraction histogenesis procedure, wherein the device is in a planar configuration;

**[0031]** FIG. **12**B is an underside perspective view of a device for performing a distraction histogenesis procedure, wherein the device is in an expanded configuration;

**[0032]** FIG. **13**A is a straight-on side view of a device for performing a distraction histogenesis procedure, wherein the device is in a planar configuration;

**[0033]** FIG. **13**B is a straight-on side view of a device for performing a distraction histogenesis procedure, wherein the device is in an expanded configuration;

**[0034]** FIG. **14**A is an aerial top-down view of a device for performing a distraction histogenesis procedure, wherein the device is in a planar configuration;

**[0035]** FIG. **14**B is an aerial top-down view of a device for performing a distraction histogenesis procedure, wherein the device is in an expanded configuration;

**[0036]** FIG. **15** is a cross-sectional perspective view of a device for performing a distraction histogenesis procedure, wherein the device is in a planar configuration;

**[0037]** FIG. **16** is a cross-sectional perspective view of a device for performing a distraction histogenesis procedure, wherein the device is in a distraction configuration;

**[0038]** FIG. **17** is a schematic illustration a system for performing a distraction histogenesis procedure;

**[0039]** FIG. **18**A is a schematic illustration of magnetic coupling between an external magnetic controller and a device for performing a distraction histogenesis procedure, wherein the device is in a planar configuration;

**[0040]** FIG. **18**B is a schematic illustration of magnetic coupling between an external magnetic controller and a device for performing a distraction histogenesis procedure, wherein the device is in an expanded configuration;

**[0041]** FIG. **19**A is a schematic aerial top-down view of an external magnetic controller;

**[0042]** FIG. **19**B is a schematic cross-sectional side view of an external magnetic controller that includes an external magnet;

**[0043]** FIG. **19**C is a schematic cross-sectional side view of an external magnetic controller that includes an external magnet that may be driven by a motor;

**[0044]** FIG. **20**A is a schematic cross-sectional side view of an external magnetic controller that includes an external magnet that may be driven by an electromagnet;

**[0045]** FIG. **20**B is a schematic cross-sectional side view of an external magnetic controller, wherein the external magnetic controller includes an electromagnet;

**[0046]** FIGS. **21**A-**21**F are schematic illustrations of a system for driving an external magnet of an external magnetic controller with a two-pole electromagnet;

**[0047]** FIG. **22**A is a schematic illustration of a magnetic coupling between an external magnetic controller and an implant magnet of an arc lifter distraction device;

**[0048]** FIG. **22**B is a schematic illustration of a magnetic coupling between an external magnetic controller and an implant magnet of an arc lifter distraction device;

**[0049]** FIG. **23**A is a schematic illustration of a cross-sectional aerial top-down view of a magnetic portion of a rigid elongated member of a magnetically-actuated arc lifter distraction device, or an external magnet of an EMC that includes two poles;

**[0050]** FIG. **23**B is a schematic illustration of a cross-sectional aerial top-down view of a magnetic portion of a rigid elongated member of a magnetically-actuated arc lifter distraction device, or an external magnet of an EMC that includes two poles;

**[0051]** FIG. **23**C is a schematic illustration of a cross-sectional aerial top-down view of a magnetic portion of a rigid elongated member of a magnetically-actuated arc lifter distraction device, or an external magnet of an EMC that includes two poles;

**[0052]** FIG. **24**A is a schematic straight-on side view of an elevator for use in connection with a distraction surgical procedure;

**[0053]** FIG. **24**B is a schematic aerial top-down view of an elevator for use in connection with a distraction surgical procedure;

**[0054]** FIG. **25** is a schematic illustration of a system for manually adjusting an arc lifter distraction device;

**[0055]** FIG. **26**A is a schematic cross-sectional illustration of a surgical positioning of an arc lifter distraction device, wherein the device is in a planar configuration;

**[0056]** FIG. **26**B is a schematic cross-sectional illustration of a surgical positioning of an arc lifter distraction device, wherein the device is in an expanded configuration;

**[0057]** FIGS. **27**A-**27**C are schematic block diagrams of a method for performing a distraction surgical procedure with an arc lifter distraction device;

**[0058]** FIGS. **28**A-**28**C are schematic block diagrams of a method for performing a distraction surgical procedure with a magnetically actuated arc lifter distraction device;

**[0059]** FIG. **29** is a schematic block diagram of a system for monitoring health data and remotely actuating adjustment of a distraction device; and

**[0060]** FIG. **30** is a schematic block diagram of an example computing device.

## DETAILED DESCRIPTION

**[0061]** Described herein are systems, methods, and devices for triggering perfusion improvement, growth factors releasement, and tissue regeneration. The disclosures herein may be implemented to trigger regeneration of bone tissue, vascular tissue, microvascular tissue, skin tissue, nerve tissue, and other tissue types. The systems, methods, and devices described herein may be utilized to perform distraction histogenesis surgical procedures on various tissue types and may specifically be utilized to perform periosteal distraction procedures and other distraction histogenesis procedures to trigger regeneration of soft tissues.

**[0062]** A device described herein is designed for performing a distraction histogenesis surgical procedure on a patient. The device may be referred to as a distraction device, arc lifter, or arc lifter distraction device as described herein. The device includes a rigid elongated member and a compliant elongated member that is coupled to the rigid elongated member. The compliant elongated member is designed to bend away from a longitudinal axis of the rigid elongated member in response to adjusting a distance between opposing ends of the compliant elongated member. The distance between the opposing ends of the compliant elongated

member may be adjusted by, for example, moving one end of the compliant elongated member nearer to the opposite end.

**[0063]** The distraction devices described herein may be designed for magnetic actuation or driver-based actuation. The magnetic actuation distraction devices described herein include a magnetic portion designed to form a strong magnetic coupling with a corresponding magnet on an external magnetic controller. The external magnetic controller may cause rotation of the magnetic portion, which may in turn cause distraction or retraction of a compliant elongated member. The driver-based actuation distraction devices described herein may include a means to rotate the rigid elongated member with a screwdriver or other similar device. The rotation of the rigid elongated member may in turn cause distraction or retraction of a compliant elongated member.

**[0064]** The distraction devices described herein are designed to be installed in between patient tissue layers such that bending the compliant elongated member causes distraction of a top tissue layer relative to a bottom tissue layer. Likewise, relaxing a bend in the compliant elongated member causes retraction of the top tissue layer relative to the bottom tissue layer. The distraction devices described herein may be utilized to perform periosteal distraction surgical procedures and may further be utilized to perform distraction histogenesis procedures on other tissue types, including, for example, vascular tissue, microvascular tissue, skin tissue, nerve tissue, and so forth.

**[0065]** Periosteal distraction is a surgical technique that is traditionally used to treat bone defects by stimulating bone growth. Periosteal distraction is designed to gradually stretch the periosteum away from the underlying bone tissue, which may additionally separate the periosteum from the underlying bone tissue. This may create an artificial space between the bone surface and periosteum. In response, the body generates new bone tissue by gradually expanding the periosteum with no need for corticotomy. Periosteal distraction is minimally invasive when compared to traditional bone grafting techniques, and the procedure encourages the body to generate its own bone, which typically integrates more successfully than synthetic materials.

**[0066]** What is needed are improved systems, methods, and devices for periosteal distraction that reduce the risks of infections, reduce the risks of device complications, reduce surgery complexity, reduce the quantity of percutaneous sites prone to infection, reduce the number of external components that may be cumbersome and painful for the patient, and reduce the complexity of tasks performed after surgery. Additionally, what is needed are systems, methods, and devices for triggering regeneration of non-bone tissue types through distraction histogenesis, including, for example, promoting revascularization for increasing perfusion to promote the healing of diabetic foot ulcers and other chronic wounds.

**[0067]** In view of the foregoing, described herein systems, methods, and devices for initiating tissue growth through distraction histogenesis. The distraction histogenesis techniques described herein may be utilized to treat tissue defects by raising systemic growth factor levels. One or more of the devices described herein can be coupled to many different tissues in the body, because the devices are internal and implantable.

**[0068]** In the following description of the disclosure, reference is made to the accompanying drawings, which form a part hereof, and in which is shown by way of illustration specific implementations in which the disclosure may be practiced. It is understood that other implementations may be utilized, and structural changes may be made without departing from the scope of the disclosure.

**[0069]** Before the structures, systems, methods, and compositions described herein are disclosed, it is to be understood that this disclosure is not limited to the particular structures, configurations, process steps, and materials disclosed herein as such structures, configurations, process steps, and materials may vary somewhat. It is also to be understood that the terminology employed herein is used for the purpose of describing particular embodiments only and is not intended to be limiting since the scope of the disclosure will be limited only by the appended claims and equivalents thereof.

**[0070]** In describing and claiming the subject matter of the disclosure, the following terminology will be used in accordance with the definitions set out below.

**[0071]** As used herein, the terms "comprising," "including," "containing," "characterized by," and grammatical equivalents thereof are inclusive or open-ended terms that do not exclude additional, unrecited elements or method steps.

**[0072]** As used herein, the phrase "consisting of" and grammatical equivalents thereof exclude any element, step, or ingredient not specified in the claim.

**[0073]** As used herein, the phrase "consisting essentially of" and grammatical equivalents thereof limit the scope of a claim to the specified ingredients, materials, or steps and those that do not materially affect the basic and novel characteristic or characteristics of the claimed disclosure.

**[0074]** Unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one of ordinary skill in the art to which this disclosure pertains and belongs.

**[0075]** Reference will now be made in detail to the exemplary embodiments, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used throughout the drawings to refer to the same or like parts. It is further noted that elements disclosed with respect to particular embodiments are not restricted to only those embodiments in which they are described. For example, an element described in reference to one embodiment or figure, may be alternatively included in another embodiment or figure regardless of whether or not those elements are shown or described in another embodiment or figure. In other words, elements in the figures may be interchangeable between various embodiments disclosed herein, whether shown or not.

**[0076]** Referring now to the figures, FIGS. **1**A and **1**B are overhead perspective views of a device **100** for performing a distraction histogenesis surgical procedure. FIG. **1**A illustrates wherein the device **100** is in a planar state, and FIG. **1**B illustrates wherein the device **100** is in an expanded state. The device **100** may specifically be utilized to perform a periosteal distraction osteogenesis procedure to lift a periosteum tissue layer away from a bone tissue. The device **100** may be utilized for other distraction histogenesis procedures, including those performed on soft tissues.

**[0077]** The device **100** is configured to be implanted within a patient during a surgical procedure. After implan-

tation, the device **100** may be distracted or retracted according to the patient's needs. In an example use-case, the device **100** is implanted in between bone tissue and a periosteum layer of a patient. The surgical site may be fully closed over the device **100** to prevent infection, and this may include suturing shut one or more of the periosteum or skin layers over the device **100**. The device **100** may then be magnetically actuated without physically touching the device. The magnetic coupling may be performed with an external magnetic controller (EMC) as described herein, or another similar device. A user may thereby utilize an external magnet or electromagnet to distract or retract the device **100** in a controlled manner while the device **100** is installed in the patient.

**[0078]** The device **100** includes a rigid elongated member **102**, which is only partially visible in the views in FIGS. **1**A-**1**B. The rigid elongated member **102** may include a threaded portion **104** attached to a magnetic portion **106**. The device **100** may include a cap **120** configured to receive and encase the threaded portion **104** of the rigid elongated member **102**. The threaded portion **104** is visible in FIG. **1**A because the device **100** is fully planar, and the rigid elongated member **102** comprises its maximum length. The threaded portion **104** is not visible in FIG. **1**B because the device **100** is fully distracted, and the threaded portion **104** is fully disposed within the cap **120**.

**[0079]** The threaded portion **104** of the rigid elongated member **102** comprises threading the corresponds with internal threading (not visible) disposed within an adjustment coupler **118**. The rigid elongated member **102** is rotatable about its longitudinal axis (i.e., a "roll" rotation). When the rigid elongated member **102** rotates about its longitudinal axis, the threaded portion **104** screws into and out of the adjustment coupler **118**.

**[0080]** When the device **100** is installed within a patient, the rigid elongated member **102** is rotated about its longitudinal axis after establishing a magnetic coupling between the magnetic portion **106** of the rigid elongated member **102**, and a corresponding EMC (see e.g., EMC **1900** first illustrated at FIG. **19** and/or EMC **2000** first illustrated at FIG. **21**) or similar device. The magnetic portion **106** includes an elongated magnet comprising two or more poles each running a length of the elongated magnet. The EMC includes a corresponding elongated magnet that forms a magnetic coupling with the magnetic portion **106**. When the corresponding elongated magnet of the EMC is rotated, this causes the magnetic portion **106** to rotate, and thereby causes the rigid elongated member **102** to rotate.

**[0081]** The device **100** includes a compliant elongated member **108** that is coupled to the adjustment coupler **118** at a first end and is additionally coupled to a stationary coupler **116** at an opposite end. The compliant elongated member **108** is capable of bending away from the longitudinal axis of the rigid elongated member **102**. In the view illustrated in FIG. **1**B, the compliant elongated member **108** is bending away from the rigid elongated member **102** to form an arch configuration.

**[0082]** The compliant elongated member **108** is coupled to the stationary coupler **116** and the adjustment coupler **118** by way of one or more pivot heads **112**. As shown in FIGS. **1**A and **1**B, the compliant elongated member **108** may be coupled to the stationary coupler **116** by way of two pivot heads **112** that are located on either side of the stationary coupler **116**. Likewise, the compliant elongated member **108** may be coupled to the adjustment coupler **118** by way of two pivot heads **112** that are located on either side of the adjustment coupler **118**. Each pivot head **112** is attached to its corresponding coupler **116**, **118** by way of a pivot fastener **114**. The pivot fastener **114** enables the pivot head **112** to rotate about the center of the pivot fastener **114**. The pivot fastener **114** may include, for example, a bearing bolt, axle screw, pivot bolt, rotating bolt, spindle bolt, turning screw, and so forth.

**[0083]** The compliant elongated member **108** may include a plurality of holes **110** disposed therethrough. The plurality of holes **110** may serve to reduce the overall mass of the device **100**. The holes **110** may additionally allow for fluids and tissues to pass through the compliant elongated member **108**, and in some cases, this may improve patient outcomes. Additionally, the holes **110** may improve the flexibility of the compliant elongated member **108** to ensure it can form a smooth arch when the device **100** is distracted as shown in FIG. **1**B. FIGS. **2**A and **2**B are underside perspective view of the device **100** for performing a distraction histogenesis procedure, wherein FIG. **2**A illustrates the device **100** in a planar state, and FIG. **2**B illustrates the device **100** in an expanded state.

**[0084]** FIGS. **2**A and **2**B bring attention to what may be referred to herein as the arc chord **222**, which is a distance between opposite end points of the compliant elongated member **108**. The arc chord **222** may be measured from the pivot fastener **114** of the adjustment coupler **118** to the pivot fastener **114** of the stationary coupler **116** as shown in FIGS. **2**A-**2**B. However, the arc chord **222** may be measured from other endpoints as deemed appropriate. The arc chord **222** refers to the straight point-to-point distance of the arc formed by the compliant elongated member **108**. When the device **100** is in a planar state as shown in FIG. **2**A, the arc chord **222** comprises a longer length. When the device **100** is in an expanded state as shown in FIG. **2**B, the arc chord **222** comprises a shorter length.

**[0085]** As shown in FIGS. **2**A and **2**B, the threaded portion **104** of the device **100** is exposed when the device is in a planar state and the arc chord **222** comprises its maximum length. The rigid elongated member **102** may be rotated about its longitudinal axis (i.e., a "roll" rotation) in response to a corresponding elongated magnet of an EMC causing rotation of the magnetic portion **106**. When the EMC causes the magnetic portion **106** to rotate in a tightening direction, the threaded portion **104** will screw further into the internal threading (not visible) disposed within the adjustment coupler **118**. When the EMC causes the magnetic portion **106** to rotate in a loosening direction, the threaded portion **104** unscrews from the internal threading (not visible) disposed within the adjustment coupler **118**. Thus, an EMC may be actuated to adjust the total length of the arc chord **222**, and to thereby cause adjustment in the arc height of the compliant elongated member **108**.

**[0086]** FIG. **2**B illustrates wherein the total length of the arc chord **222** has been shortened by screwing the threaded portion **104** through the corresponding internal threading (not visible) disposed within the adjustment coupler **118**. The threaded portion **104** is then disposed at least partially within the cap **120**, and the compliant elongated member **108** arches further away from the rigid elongated member **102**. The cap **120** may serve to protect a patient from sustaining tissue damage from the threaded portion **104** after

the threaded portion **104** has been screwed through the corresponding internal threading of the adjustment coupler **118**.

**[0087]** FIGS. **3**A and **3**B are straight-on side views of the device **100** for performing a distraction histogenesis procedure, wherein FIG. **3**A illustrates the device **100** in a planar state, and FIG. **3**B illustrates the device **100** in an expanded state.

**[0088]** FIGS. **3**A and **3**B illustrate rotation of the pivot heads **112** about the pivot fasteners **114**. When the total length of the arc chord **222** is shortened by screwing the threaded portion **104** through the adjustment coupler **118** and into the cap **120**, the compliant elongated member **108** will arch away from the rigid elongated member **102** as shown in FIG. **3**B.

**[0089]** The length of the compliant elongated member **108** may be optimized such that the compliant elongated member **108** arches slightly away from the rigid elongated member **102** even when the rigid elongated member **102** is at its maximum length, as shown in FIG. **3**A. Thus, the compliant elongated member **108** may comprise a length that is slightly longer than the distance between the coupling points of the stationary coupler **116** and the adjustment coupler **118**. This may be desirable to ensure the compliant elongated member **108** arches in the desired direction when the device **100** is distracted as shown in FIG. **3**B.

**[0090]** FIGS. **4**A and **4**B are top-down aerial views of the device **100** for performing a distraction histogenesis procedure, wherein FIG. **4**A illustrates the device **100** in a planar state, and FIG. **4**B illustrates the device **100** in an expanded state.

**[0091]** The compliant elongated member **108** may comprise the plurality of holes **110** disposed therethrough, as shown in FIGS. **4**A and **4**B. In alternative implementations, the compliant elongated member **108** may include no holes **110** or may include a different quantity or arrangement of holes **110**. The compliant elongated member **108** is constructed of a material that is sufficiently flexible to allow for the material to bend when the device **100** is distracted, but rigid enough to maintain its shape and prevent collapse when the compliant elongated member **108** presses against patient tissues. The compliant elongated member **108** may specifically be constructed of one or more an elastic alloy, a super elastic polymer, an elastic composite, stainless steel, a titanium polymer, a combination of polymers over metal element to allow for drug elution capabilities, and so forth. The compliant elongated member **108** may specifically be constructed of a super elastic Nitinol sheet or other super elastic alloy.

**[0092]** FIGS. **5**A and **5**B are underside views of the device **100** for performing a distraction histogenesis procedure, wherein FIG. **5**A illustrates the device **100** in a planar state, and FIG. **5**B illustrates the device **100** in an expanded state.

**[0093]** The magnetic portion **106** of the rigid elongated member **102** may include an elongated magnet that is disposed within a housing **524**. The housing **524** may include a hollow cylindrical sheath configured to receive the elongated magnet. The housing **524** may be constructed of a material that will cause minimal disruption to the magnetic coupling between the elongated magnet of the magnetic portion **106**, and the corresponding elongated magnet of an EMC. Such housing material is usually nonferrous metal or plastic.

**[0094]** FIGS. **6**A and **6**B are perspective cross-sectional views of the device **100** for performing a distraction histogenesis procedure, wherein FIG. **6**A illustrates the device **100** in a planar state, and FIG. **6**B illustrates the device **100** in an expanded state.

**[0095]** The cross-sectional views illustrated in FIGS. **6**A and **6**B enable visualization of the internal threading **630** of the adjustment coupler **118**. The adjustment coupler **118** may comprise a hollow cylindrical geometry defined by a sidewall and may include the internal threading **630** attached to an interior side of the sidewall. The internal threading **630** of the adjustment coupler **118** corresponds with the external threading of the threaded portion **104** of the rigid elongated member **102**. The cross-sectional views further enable visualization of the hollow interior **628** defined by the cap **120**. The hollow interior **628** is configured to receive and encase the threaded portion **104** when the device **100** is distracted as shown in FIG. **6**B.

**[0096]** The cross-sectional views further enable visualization of components of the magnetic portion **106**, including an elongated magnet **626** disposed within a housing **524**. The elongated magnet **626** may run an entire length of the housing **524** or may include a length shorter than the housing **524**. The elongated magnet **626** may include two or more diametrically magnetized magnetic poles that run an entire length or shorter of the elongated magnet **626**.

**[0097]** FIGS. **7**A and **7**B are overhead perspective views of a device **700** for performing a distraction histogenesis procedure. FIG. **7**A illustrates wherein the device **700** is in a planar state, and FIG. **7**B illustrates wherein the device **700** is in an expanded state. The device **700** may specifically be utilized to perform a periosteal distraction procedure to lift a periosteum tissue layer away from a bone tissue. The device **700** may be utilized for other distraction histogenesis procedures, including those performed on soft tissues.

**[0098]** The device **700** is similar to the device **100** first described in connection with FIGS. **1**A-**1**B, but with some implementational differences. For example, the device **700** does not include a cap (see **120**) that protrudes outward relative to an adjustment coupler (see **118**). Additionally, the device **700** does not include exposed external threading like the threaded portion (see **104**) of the device **100** first described in connection with FIGS. **1**A-**1**B.

**[0099]** The device **700** includes a rigid elongated member **702**, which is only partially visible in the views of FIGS. **7**A-**7**B. The rigid elongated member **702** includes a magnetic portion **706** and a threaded portion (not visible in FIGS. **7**A-**7**B) that is attached directly to the magnetic portion **706**. The threaded portion of the rigid elongated member **702** comprises external threading that corresponds with internal threading (not visible) disposed within an adjustment coupler **718**.

**[0100]** The device **700** includes a compliant elongated member **708** that may optionally include a plurality of holes **710** disposed therethrough. The compliant elongated member **708** is coupled to each of a stationary coupler **716** and the adjustment coupler **718** by way of a plurality of pivot heads **712** as shown. Each of the pivot heads **712** includes a pivot fastener **714** enabling the pivot head **712** to rotate and enable the compliant elongated member **708** to bend away from the rigid elongated member **702** as shown at least in FIG. **7**B.

**[0101]** FIGS. **8**A and **8**B are underside perspective views of the device **700** for performing a distraction histogenesis

procedure, wherein FIG. **8**A illustrates the device **700** in a planar state, and FIG. **8**B illustrates the device **700** in an expanded state.

**[0102]** FIGS. **8**A and **8**B bring attention to what may be referred to the arc chord **822**, which is a distance between opposite end points of the compliant elongated member **708**. The arc chord **822** may be measured from the pivot fastener **714** of the adjustment coupler **718** to the pivot fastener **714** of the stationary coupler **716** as shown in FIGS. **8**A-**8**B. However, the arc chord **822** may be measured from other endpoints as deemed appropriate. The arc chord **822** refers to the straight point-to-point distance of the arc formed by the compliant elongated member **708**. When the device **700** is in a planar state as shown in FIG. **8**A, the arc chord **822** comprises a longer length. When the device **700** is in an expanded state as shown in FIG. **8**B, the arc chord **822** comprises a shorter length.

**[0103]** The underside views illustrated in FIGS. **8**A-**8**B enable viewing of a shank **824** of the threaded portion **804** of the rigid elongated member **702**. The threaded portion **804** additionally includes external threading (see **1024** at FIGS. **10**A-**10**B) that begins adjacent to the shank **824** and is visible in only the cross-sectional views of FIGS. **10**-**10**B. The rigid elongated member **702** is rotatable about its longitudinal axis (i.e., a "roll" rotation). When the rigid elongated member **702** rotates about its longitudinal axis, the external threading (see **1024**) of the threaded portion **804** screws into and out of the adjustment coupler **718**. The total length of the arc chord **824** is determined based upon where the threaded portion **804** is located relative to the adjustment coupler **718**.

**[0104]** When the device **700** is installed within a patient, the rigid elongated member **702** is rotated about its longitudinal axis after establishing a magnetic coupling between the magnetic portion **706** of the rigid elongated member **702**, and a corresponding EMC or similar device. The magnetic portion **706** includes an elongated magnet comprising two or more poles each running a length of the elongated magnet. The EMC includes a corresponding elongated magnet that forms a magnetic coupling with the magnetic portion **706**. When the corresponding elongated magnet of the EMC is rotated, this causes the magnetic portion **706** to rotate, and thereby causes the rigid elongated member **702** to rotate. This further causes the external threading (see **1024**) of the threaded portion **804** to screw into or out of corresponding internal threading disposed within the adjustment coupler **718**.

**[0105]** When the threaded portion **804** is fully screwed into the adjustment coupler **718**, the arc chord **822** comprises a shortened total length, and the compliant elongated member **708** bends away from the rigid elongated member **702** as shown in FIG. **8**B. Conversely, when the threaded portion **804** is unscrewed from the adjustment coupler **718**, the arc chord **822** comprises a longer total length, and the compliant elongated member **708** may comprise a straight configuration or may slightly bend away from the rigid elongated member **702** as shown in FIG. **8**A.

**[0106]** FIGS. **9**A and **9**B are straight-on side views of the device **700** for performing a distraction histogenesis procedure, wherein FIG. **9**A illustrates the device **700** in a planar state, and FIG. **9**B illustrates the device **700** in an expanded state.

**[0107]** The device **700** may include a stopper to prevent the rigid elongated member **702** from being fully unscrewed from the adjustment coupler **718**. This stopper may ensure the rigid elongated member **702** remains coupled to each of the adjustment coupler **718** and the stationary coupler **716** when the device **700** is installed in a patient. The stopper may ensure that the configuration illustrated in FIG. **9**A represents a fully planar state, wherein the rigid elongated member **702** is unscrewed from the adjustment coupler **718** as much as possible, and the rigid elongated member **702** therefore has its maximum total length.

**[0108]** FIGS. **10**A and **10**B are perspective cross-sectional views of the device **700** for performing a distraction histogenesis procedure, wherein FIG. **10**A illustrates the device **700** in a planar state, and FIG. **10**B illustrates the device **700** in an expanded state.

**[0109]** The cross-sectional views of FIGS. **10**A-**10**B enable viewing of the external threading **1024** of the threaded portion **804** of the rigid elongated member **702**. The cross-sectional views further enable viewing of the corresponding internal threading **1030** disposed within the adjustment coupler **718**. When the rigid elongated member **702** is in a fully planar state as shown in FIG. **10**A, the external threading **1024** is located at a distal end of the internal threading **1030**. When the rigid elongated member **702** is in a fully expanded state as shown in FIG. **10**B, the external threading **1024** is located at a proximal end of the internal threading **1030**. Additionally, in the fully expanded state illustrated in FIG. **10**B, the shank **824** of the threaded portion **804** is disposed within the adjustment coupler **718** and cannot be seen from outside the device **700**.

**[0110]** FIGS. **11**A and **11**B are overhead perspective views of a device **1100** for performing a distraction histogenesis procedure. FIG. **11**A illustrates wherein the device **1100** is in a planar state, and FIG. **11**B illustrates wherein the device **1100** is in an expanded state. The device **1100** may specifically be utilized to perform a periosteal distraction osteogenesis procedure to lift a periosteum tissue layer away from a bone tissue. The device **1100** may be utilized for other distraction histogenesis procedures, including those performed on soft tissues.

**[0111]** The device **1100** performs similar functions to the devices **100**, **700** first described in connection with FIGS. **1**A-**1**B and FIGS. **7**A-**7**B, respectively. However, the device **1100** is not designed for magnetic coupling with an EMC. Instead, the device **1100** is designed to be distracted and retracted with a driver that directly interfaces with the device **1100**. The device **1100** may be manually distracted and retracted by a user or the device **1100** may be automatically distracted and retracted by an automated adjustor with the same interface.

**[0112]** The device **1100** includes a rigid elongated member **1102**. The rigid elongated member **1102** includes a threaded portion **1104** and may additionally include a smooth portion **1106**. In some cases, the entirety of the rigid elongated member **1102** may include external threading like the threaded portion **1104**.

**[0113]** The device **1100** includes a stationary coupler **1116** attached to the rigid elongated member **1102** at a first end of the rigid elongated member **1102**. The stationary coupler **1116** is coupled to a pivot head **1112** by way of a pivot fastener **1114**. The pivot fastener **1114** enables the pivot head **1112** to rotate about the center of the pivot fastener **1114**. The pivot fastener **1114** may include, for example, a bearing bolt, axle screw, pivot bolt, rotating bolt, spindle bolt, turning screw, and so forth.

**[0114]** The device **1100** further includes an adjustment coupler **1118** attached to the rigid elongated member **1102** at a second end of the rigid elongated member **1102**, which is opposite to the first end of the rigid elongated member **1102**. Like the stationary coupler **1116**, the adjustment coupler **1118** is also coupled to a pivot head **1112** by way of a pivot fastener **1114**.

**[0115]** The device **1100** includes one or more compliant elongated members **1108** capable of bending away from a longitudinal axis of the rigid elongated member **1102**. In the view illustrated in FIG. **11**B, the compliant elongated members **1108** are bending away from the rigid elongated member **1102** to form an arch configuration or "distracted" configuration. The example device **1100** illustrated in FIGS. **11**A and **11**B includes a first compliant elongated member **1108** disposed on a first side of the rigid elongated member **1102**, and a second compliant elongated member **1108** disposed on an opposite side of the rigid elongated member **1102**. The compliant elongated members **1108** are coupled to the stationary coupler **1116** and the adjustment coupler **1118** by way of the pivot heads **1112** as shown in FIGS. **11**A and **11**B.

**[0116]** The adjustment coupler **1118** includes a hole defined by a sidewall, with internal threading attached to the sidewall (not visible in FIGS. **11**A and **11**B). The internal threading of the adjustment coupler **1118** corresponds with the external threading on the threaded portion **1104** of the rigid elongated member **1102**, such that rotation of the rigid elongated member **1102** causes the adjustment coupler **1118** to move back and forth along the longitudinal axis of the rigid elongated member **1102**.

**[0117]** The device **1100** includes a rotation actuation head **1124** attached to an end of the rigid elongated member **1102** that provides a means to rotate the rigid elongated member **1102** about its longitudinal axis (i.e., a "roll" rotation). The rotation actuation head **1124** may include an impression configured to receive a driver head. In these cases, the rotation actuation head **1124** may include, for example, an impression corresponding with a driver head type, such as a slot, coin-slot, hi-torque, cross, pozidriv, supadriv, Phillips, Frearson, French recess, torq-set, mortorq, Robertson, or other driver type. The rotation actuation head **1124** may include a socket head and may specifically include a polygonal cross-sectional geometry configured to interface with a socket. In these cases, the rotation actuation head **1124** may include, for example, a quadrilateral, pentagonal, hexagonal, heptagonal, octagonal, or n-sided cross-sectional geometry configured to interface with a corresponding socket.

**[0118]** The device **1100** is in a planar or retracted state when the distance between the stationary coupler **1116** and the adjustment coupler **1118** is at a maximum. The device **1100** is in a bent or expanded state when the distance between the stationary coupler **1116** and the adjustment coupler **1118** is less than the maximum. When this distance is less than the maximum, the compliant elongated members **1108** will bend away from the longitudinal axis of the rigid elongated member **1102** as shown in FIG. **11**B.

**[0119]** FIGS. **12**A and **12**B are underside perspective views of the device **1100** for performing a distraction histogenesis procedure, wherein FIG. **12**A illustrates the device **1100** in a planar state, and FIG. **12**B illustrates the device **1100** in an expanded state.

**[0120]** FIGS. **12**A and **12**B bring attention to the arc chord **1222**, which is a distance between opposite end points of the compliant elongated member **1108**. The arc chord **1222** may be measured from the pivot fastener **1114** of the adjustment coupler **1118** to the pivot fastener **1114** of the stationary coupler **1116** as shown in FIGS. **12**A-**12**B. However, the arc chord **1222** may be measured from other endpoints as deemed appropriate. The arc chord **1222** refers to the straight point-to-point distance of the arc formed by the compliant elongated member **1108**. When the device **1100** is in a planar state as shown in FIG. **12**A, the arc chord **1222** comprises a longer length. When the device **1100** is in an expanded state as shown in FIG. **12**B, the arc chord **1222** comprises a shorter length.

**[0121]** As shown in FIGS. **12**A and **12**B, the threaded portion **1104** of the rigid elongated member **1102** may screw into and out of the adjustment coupler **1118** to alter the position of the adjustment coupler **1118** along a length of the rigid elongated member **1102**. When the threaded portion **1104** is minimally screwed into the adjustment coupler **1118** as shown in FIG. **12**A, the arc chord **1222** comprises a maximum length. When the threaded portion **1104** is screwed further into the adjustment coupler **1118** as shown in FIG. **12**B, the arc chord **1222** comprises a shorter length.

**[0122]** FIGS. **12**A and **12**B additionally provide a view of the rotation actuation head **1124**, which enables a user to drive rotation of the rigid elongated member **1102**. A user may manually drive rotation of the rigid elongated member **1102** with a driver or other device that is installed in the patient along with the device **100**, or with a driver that is temporarily coupled to the rotation actuation head **1124**. The user may actuate an automated fixator adjuster to autonomously drive rotation of the rigid elongated member **1102**. The automated fixator adjuster may be installed in the patient along with the device **100**, may be installed external to the patient with a coupling to the rotation actuation head **1124**, or may be temporarily coupled to the rotation actuation head **1124** as needed. The automated fixator adjuster may include a driver and a motor to precisely rotate the rigid elongated member **1102** to thereby cause distraction or retraction of the compliant elongated member **1108**.

**[0123]** FIGS. **13**A and **13**B are straight-on side views of the device **1100** for performing a distraction histogenesis procedure, wherein FIG. **13**A illustrates the device **1100** in a planar state, and FIG. **13**B illustrates the device **1100** in an expanded state.

**[0124]** FIGS. **13**A and **13**B illustrate rotation of the pivot heads **1112** about the pivot fasteners **1114**. When the total length of the arc chord **1222** is shortened by screwing the threaded portion **1104** through the adjustment coupler **1118** as shown in FIG. **13**B, the compliant elongated member **1108** will form a taller arch away from the rigid elongated member **1102**.

**[0125]** The length of the compliant elongated member **1108** may be optimized such that the compliant elongated member **1108** arches slightly away from the rigid elongated member **102** even when the arc chord **1222** is at its maximum length, as shown in FIG. **13**A. Thus, the compliant elongated member **1108** may comprise a length that is slightly longer than the distance between the coupling points of the stationary coupler **116** and the adjustment coupler **118**. This may be desirable to ensure the compliant elongated member **1108** arches in the desired direction when the device **1100** is distracted as shown in FIG. **13**B.

**[0126]** FIGS. **14**A and **14**B are top-down aerial views of the device **1100** for performing a distraction histogenesis

procedure, wherein FIG. **14**A illustrates the device **1100** in a planar state, and FIG. **14**B illustrates the device **1100** in an expanded state.

**[0127]** FIG. **15** is a perspective cross-sectional view of the device for performing a distraction histogenesis procedure. The cross-sectional slice is formed along an axis such that only one compliant elongated member **1108** is visible, and further to enable visualization into the couplers **1116**, **1118**.

**[0128]** As shown in the cross-sectional view of FIG. **15**, the adjustment coupler **1118** includes a hollow interior defined by a sidewall and may include internal threading **1530** attached to the interior surface of the sidewall. The internal threading **1530** of the adjustment coupler **1118** corresponds with the external threading of the threaded portion **1104** of the rigid elongated member **1102**. Thus, rotation of the rigid elongated member **1102** may cause the threaded portion **1104** to screw into or out of the sidewall of the adjustment coupler **1118**.

**[0129]** The stationary coupler **1116** may further include a hollow interior defined by a sidewall that comprises internal threading **1532** attached to the interior surface of the sidewall. The rigid elongated member **1102** may include a secondary threaded portion that is configured to interface with the internal threading **1532** of the stationary coupler **1116**. This interfacing may enable installation of the rigid elongated member **1102** within the stationary coupler **1116**.

**[0130]** FIG. **16** is a perspective cross-sectional view of the device for performing a distraction histogenesis procedure. The cross-sectional slice is formed along the y-axis such that no compliant elongated members (see **1108**) are visible, and further to enable visualization into the couplers **1116**, **1118** and the pivot fasteners **1114**.

**[0131]** As shown in the cross-sectional view of FIG. **16**, the pivot fasteners **1114** may include rods extending a width of the pivot heads **1112**. The pivot fasteners **1114** enable the pivot heads **1112** to rotate about the central point defined by the pivot fasteners **1114**. The pivot motion of the pivot heads **1112** may enable corresponding pivoting by the compliant elongated member, which enables the compliant elongated member to distract away from the rigid elongated member **1102** without forming a kink or sharp bend.

**[0132]** FIG. **17** is a schematic illustration of a system **1701** for performing a distraction surgical procedure, and specifically illustrates a straight-on aerial top-down view of a device **1700** for performing the distraction surgical procedure, wherein the device **1700** is a component of the wholistic system **1701**. The device **1700** is configured to be actuated through a magnetic coupling. The device **1700** may include any of the components described in connection with the device **100** first described in connection with FIGS. **1**A and **1**B. The device **1700** may further include any of the components described in connection with the device **700** first described in connection with FIGS. **7**A and **7**B.

**[0133]** The device **1700** includes a rigid elongated member **1702** that includes a magnetic portion **1706** (see, e.g., the magnetic portion **106** first described in connection with FIGS. **1**A-**1**B or the magnetic portion **706** first described in connection with FIGS. **7**A-**7**B). The device **1700** includes a compliant elongated member **1708** that is coupled to the rigid elongated member **1702** by way of two or more couplers **1716**, **1718**. The compliant elongated member **1708** is configured to bend away from a longitudinal axis of the rigid elongated member **1702**. In the view illustrated in FIG. **17**, the compliant elongated member **1708** would bend out of the page away from the rigid elongated member **1702**, which is disposed underneath the compliant elongated member **1708**. The arc chord **1722** corresponds with the distance between opposing ends of the compliant elongated member **1708**.

**[0134]** The system **1701** is designed such that the device **1700** may be installed within a patient body, and the patient's body may be closed to prevent infection (e.g., the patient's skin may be sutured or otherwise resealed after installing the device **1700**). The system **1701** includes an EMC (see, e.g., EMC **1900** illustrated at least at FIGS. **19**A-**19**C, or EMC **2000** illustrated at least at FIGS. **20**A-**20**B) that is configured to be located external to the patient's body such that components within the EMC **1900**, **2000** wirelessly interface with the magnetic portion **1706** of the rigid elongated member **1702** through patient tissue layers, such as skin, fascia, fat, periosteum, and so forth.

**[0135]** FIGS. **18**A and **18**B are schematic illustrations of straight-on side views of the system **1701** and device **1700** for performing a distraction surgical procedure. FIG. **18**A illustrates wherein the compliant elongated member **1708** of the device **1700** is in a relaxed position such that the arc chord **1722** is at the maximum length. FIG. **18**B illustrates wherein the compliant elongated member **1708** of the device **1700** is in a bent state such that the arch length **1722** is less than the maximum.

**[0136]** As shown in FIGS. **18**A-**18**B, the device **1700** may be installed underneath patient tissue **1840**, which may include, for example, periosteum, fascia, fat, muscle, skin, and other tissues. The patient tissue **1840** may be closed after installation of the device **1700** to prevent infection. The EMC **1900**, **2000** may then be located externally to the patient body and placed near the device **1700** to establish a magnetic coupling between the EMC **1900**, **2000** and the device **1700** that is installed underneath the patient tissue **1840**.

**[0137]** The magnetic force of the EMC **1900**, **2000** is sufficiently strong to cause rotation of the magnetic portion **1706** of the rigid elongated member **1702**. The rotation of the rigid elongated member **1702** thereby causes an adjustment in the length of the arc chord **1722** and adjustment to the height of the arc formed by the compliant elongated member **1708**. This is described in connection with the devices **100**, **700** first described in connection with FIGS. **1**A-**1**B and FIGS. **7**A-**7**B, respectively.

**[0138]** The EMC **1900**, **2000** need not necessarily be placed over the device **1700** as shown in FIGS. **18**A-**18**B. The EMC **1900**, **2000** may be placed alongside the device, over top the device, or otherwise near the device to establish a magnetic coupling between the EMC **1900**, **2000** and the device **1700**. If the magnet of the EMC **1900**, **2000** is substantially parallel to an elongated magnet of the device **1700**, the magnetic coupling may be established successfully. In some cases, the EMC **1900**, **2000** may include multiple magnets, and one or more of those multiple magnets may form a substantially parallel magnetic coupling with the elongated magnet of the device **1700**.

**[0139]** FIGS. **19**A-**19**C are schematic illustrations of an EMC **1900** that includes an external magnet. FIG. **19**A is a schematic illustration of an aerial top-down view of an EMC **1900** that may be mechanically adjusted by machine or user. FIG. **19**B is a schematic illustration of a cross-sectional straight-on side view of an EMC **1900** that may be mechanically adjusted by a machine or user. FIG. **19**C is a schematic

illustration of a cross-sectional straight-on side view of an EMC **1900** that may be electronically adjusted with a microcontroller, driver, and motor.

**[0140]** The EMCs described herein may include one or more of a magnet or an electromagnet, and in some cases, an EMC may include each of a magnet and an electromagnet. Any of the EMCs described herein may include any quantity of magnets or electromagnets as deemed appropriate for the particular use-case. Any of the EMCs described herein, including any of those illustrated in FIGS. **19**A-**19**C, **20**A-**20**B, **21**A-**21**F, and **22**A-**22**B, may be utilized in connection with any of magnetically actuated arc lifter distraction devices described herein, including the device **100** first illustrated in connection with FIGS. **1**A-**1**B and the device **700** first illustrated in connection with FIGS. **7**A-**7**B. The arc lifter distraction devices described herein may be coupled to an EMC with an external magnet (see, e.g., EMC **1900**) and/or an EMC with an electromagnet (see, e.g., EMC **2000**).

**[0141]** FIG. **19**A is a schematic illustration of an aerial top-down view of the EMC **1900**. The EMC **1900** includes a magnet or electromagnet that forms a magnetic coupling with the magnetic portion (see, e.g., **106**, **706**, **1706**) of the distraction device (see, e.g., **100**, **700**, **1700**). The EMC **1900** may be utilized to cause rotation of a rigid elongated member (see, e.g., **102**, **702**, **1702**) without physically touching the rigid elongated member. The EMC **1900** may thus be utilized to adjust a length of an arc chord and thereby adjust a height of an arc configuration formed by a compliant elongated member (see, e.g., **108**, **708**, **1708**). Thus, a patient or healthcare provider may wirelessly distract and retract an arc lifter distraction device installed in a patient when the patient's skin barrier is sutured shut.

**[0142]** The EMC **1900** may include a housing that comprises a dial **1902** that may be rotated clockwise and counterclockwise. In the example illustrated in FIG. **19**A, the dial **1902** may be rotated clockwise to rotate in a positive **1904** direction, which would further distract a compliant elongated member. The dial **1902** may be rotated counterclockwise in a negative **1906** direction, which would retract the compliant elongated member.

**[0143]** FIG. **19**B is a schematic illustration of a straight-on cross-sectional view of the EMC **1900**. The EMC **1900** includes an external magnet **1910** that includes at least a first polarity **1912** and a second polarity **1914**. The external magnet **1910** is described as "external" because it may be located external to the patient's body when the EMC **1900** is utilized to distract or retract a magnetically actuation arc lifter distraction device. Like the magnetic portion (see, e.g., **106**, **706**, **1706**) of the magnetically actuated arc lifter distraction devices described herein, the external magnet **1910** is arranged such that each of the first polarity **1912** and the second polarity **1914** are disposed along a length of the elongated magnet. The external magnet **1910** may include a cylindrical geometry as shown in FIG. **19**B, and in this implementation, the first polarity **1912** and the second polarity **1914** run the entire length of the elongated cylindrical geometry as shown in FIG. **19**B.

**[0144]** The EMC **1900** may include more than two poles. In some cases, it may be desirable to include an elongated magnet that comprises more than two poles to provide a finer ability to cause corresponding rotation of the magnetic portion of a rigid elongated member. The systems described herein may be arranged such that elongated magnet of the EMC **1900** includes the same quantity of poles as the magnetic portion of a rigid elongated member.

**[0145]** FIG. **19**C is a schematic illustration of a cross-sectional straight-on side view of an EMC **1900** that includes a microcontroller for driving rotation of an external magnet **1910**. The EMC **1900** includes the external magnet **1910** having the first polarity **1912** and the second polarity **1914**. The EMC **1900** additionally includes a microcontroller and driver **1980** in electronic communication with a motor **1920**. The motor **1920** is in mechanical communication with a driver interface **1922**, and the driver interface **1922** is in mechanical communication with a corresponding socket interface **1924** attached to the external magnet **1910**. The microcontroller and driver **1980** instructs the motor **1920** to cause rotation of the driver interface **1922**, and this may in turn cause rotation of the socket interface **1924** and the external magnet **1910**.

**[0146]** FIGS. **20**A-**20**B are schematic illustrations of an EMC **2000** that includes one or more electromagnets for driving rotation of an implant magnet. FIG. **20**A is a schematic illustration of a straight-on cross-sectional view of an EMC **2000** that includes one or more electromagnets **2024***a*, **2024***b*. The EMC **2000** may include a microcontroller and driver **2020** in electronic communication with the electromagnets **2024***a*, **2024***b*. The EMC **2000** may additionally include a power amplifier **2022** in electronic communication with the electromagnet **2024***a*, **2024***b* and the microcontroller and driver **2020**, wherein the power amplifier **2022** powers a coil of the electromagnets **2024***a*, **2024***b*.

**[0147]** FIG. **20**B is a schematic illustration of a straight-on cross-sectional view of an EMC **2000** that includes an electromagnet in lieu of an external magnet. The EMC **2000** includes an electromagnet comprising a rod **2002**, a coil **2004** wrapped around the rod **2002**, and a battery **2006**. The coil **2004** may be driven by a power amplifier and controller by a microcontroller.

**[0148]** FIGS. **21**A-**21**F are schematic illustrations of a system **2100** for driving an implant magnet **2106** of an arc lifter distraction device with an EMC **2000** that includes electromagnets. FIGS. **21**A-**21**F include a schematic illustration of a cross-sectional straight-on side view of the EMC **2000**, and additionally include an aerial top-down view of the implant magnet **2106** of the arc lifter distraction device to provide context to the current rotational position of the implant magnet **2106**.

**[0149]** The system **2100** includes the implant magnet **2106**, which is a component of an arc lifter distraction device and is implanted in a patient. The implant magnet **2106** may include a magnet of the magnetic portion **106** of the rigid elongated member **102** first described in connection with FIGS. **1**A-**1**B. The implant magnet **2106** may include a magnet of the magnetic portion **706** of the rigid elongated member **702** first described in connection with FIGS. **7**A-**7**B. The implant magnet **2106** includes at least a first pole **2108** and a second pole **2110**. The implant magnet **2106** may include more than two poles, and may specifically include four, six, eight, or more poles.

**[0150]** The system **2100** is arranged such that the EMC **2000** includes a two-pole electromagnet **2102** comprising a first coil **2120** and a second coil **2122**. The EMC **2000** includes a Hall effect sensor or Hall effect array **2124** configured to track a current orientation of the implant magnet **2106** of the distraction device. The system **2100** may be implemented with a two pole electromagnet **2102** that is

connected as shown in FIGS. **21**A-**21**F. The system **2100** may alternatively be implemented with a two pole electromagnet **2102** that comprises two separate (non-connected) electromagnets.

**[0151]** The schematic illustrations of FIGS. **21**A-**21**F describe a principle of traveling waves that enable granular rotation of the implant magnet **2106** by engaging the two-pole electromagnet **2102** of the EMC **2000**. The two-pole electromagnet **2102** may be arranged as an array around the implant magnet **2106** when the EMC **2000** is placed on the patient's skin to form a magnetic coupling with the implant magnet **2106**.

**[0152]** FIG. **21**A illustrates an initiation orientation for the system **2100**. The two-pole electromagnet **2102** includes the first coil **2120** and the second coil **2122**. The EMC **2000** further includes the Hall effect sensor or Hall effect array **2124** to track the current rotational orientation of the implant magnet **2106**. The first coil **2120** and the second coil **2122** are located at approximately the junction between the first pole **2108** and the second pole **2110** of the implant magnet **2106**.

**[0153]** FIG. **21**B illustrates a zero degree rotation orientation for the system **2100**, wherein all components of the system are in the same configuration as described in connection with the initiation orientation of FIG. **21**A.

**[0154]** FIG. **21**C illustrates a 90 degree rotation orientation for the system **2100**. The implant magnet **2106** has rotated 90 degrees relative to the initiation orientation illustrated in FIG. **21**A. The second coil **2122** is engaged.

**[0155]** FIG. **21**D illustrates a 180 degree rotation orientation for the system **2100**. The implant magnet **2106** has rotated 180 degrees relative to the initiation orientation illustrated in FIG. **21**A. The second coil **2122** is engaged.

**[0156]** FIG. **21**E illustrates a 270 degree rotation orientation for the system **2100**. The implant magnet **2106** has rotated 270 degrees relative to the initiation orientation illustrated in FIG. **21**A. The second coil **2122** is engaged.

**[0157]** FIG. **21**F illustrates a 360 degree rotation orientation for the system **2100**. The implant magnet **2106** has the same rotational position as the initiation orientation illustrated in FIG. **21**A. The first coil **2120** and the second coil **2122** are engaged.

**[0158]** FIGS. **22**A and **22**B are schematic illustrations depicting the magnetic coupling between an implant magnet **2106** of a magnetic portion **2206** of an arc lifter distraction device, and an external magnet **1910** of an EMC **1900**. The implant magnet **2106** may be implemented in any of the magnetic-actuation distraction devices described herein, including at least the device **100** first described in connection with FIGS. **1**A-**1**B or the device **700** first described in connection with FIGS. **7**A-**7**B.

**[0159]** As shown in FIG. **22**A, a first polarity of the implant magnet **2106** establishes a magnetic coupling with a corresponding polarity of the external magnet **1910**. In the example illustrated in FIGS. **22**A-**22**B, the first polarity of the implant magnet **2106** is a South polarity, and the corresponding polarity of the external magnet **1910** is a North polarity.

**[0160]** As shown in FIG. **22**B, rotation of magnet **1910** of the EMC **1900** causes synchronous rotation of the implant magnet **2106** of the magnetic portion **2206** due to the magnetic attraction of the corresponding diametrically magnetized magnetic poles. Thus, rotation of the external magnet **1910** of the EMC **1900** may cause rotation of a rigid elongated member of an arc lifter distraction device, which may thereby cause further arching of a compliant elongated member. A patient or healthcare provider may thus place the EMC **1900** externally on the patient over the implanted device, establish the magnetic coupling between the EMC **1900** and the magnetic portion **2206**, and then distract or retract the arch of the compliant elongated member by rotating the external magnet **1910** of the EMC **1900**.

**[0161]** Each of the implant magnet **2106** and the external magnet **1910** may include more than two poles. Typically, the implant magnet **2106** and the external magnet **1910** will include the same quantity of poles. In some cases, it may be desirable to ensure each of the implant magnet **2106** and the external magnet **1910** include more than two poles, such as four, six, eight, ten, or more poles. A greater quantity of poles may allow for more granular rotation of the implant magnet **2106** of the magnetic portion **2206**, which may in turn allow for more granular rotation of a rigid elongated member.

**[0162]** FIGS. **23**A-**23**C are schematic cross-sectional aerial top-down views of exemplary magnets **2300** that may be utilized in connection with the devices described herein. The magnets **2300** may be implemented as the implant magnet of the magnetic portion (see **106**, **706**, **1706**) of a rigid elongated member (see **102**, **702**, **1702**) of a magnetically actuated arc lifter distraction device as described herein. The magnets **2300** may be implemented as the external magnet **1910** of an EMC **1900**. FIGS. **23**A-**23**C each illustrate an aerial top-down view of a top of a magnet **2300** or cross-sectional slice of the magnet **2300**.

**[0163]** FIG. **23**A illustrates an example wherein the magnet **2300** includes two poles, including a first pole **2302** including a first polarity and a second pole **2304** including a second polarity. The first polarity is opposite to the second polarity. The poles **2302**, **2304** are adjacent to one another in the cross-sectional slice such that each of the poles **2302**, **2304** comprises a half-circle cross-sectional geometry.

**[0164]** FIG. **23**B illustrates an example wherein the magnet **2300** includes four poles, including two of a first pole **2302***a*, **2302***b* each having a first polarity. The magnet **2300** further includes two of a second pole **2304***a*, **2304***b* each having a second polarity that is opposite to the first polarity. The poles are arranged in an alternating fashion such that any of the first pole **2302***a*, **2302***b* is adjacent to two of the second pole **2304***a*, **2304***b*. The poles are further arranged such that each of the poles **2302***a*, **2302***b*, **2304***a*, **2304***b* comprises a circular sector (pie slice) cross-sectional geometry.

**[0165]** FIG. **23**C illustrates an example wherein the magnet **2300** includes eight poles, including four of a first pole **2302***a*, **2302***b*, **2302***c*, **2302***d* each having a first polarity. The magnet **2300** further includes four of a second pole **2304***a*, **2304***b*, **2304***c*, **2304***d* each having a second polarity that is opposite to the first polarity. The poles are arranged in an alternating fashion such that any of the first pole **2302***a*, **2302***b*, **2302***c*, **2302***d* is adjacent to two of the second pole. Likewise, any of the second pole **2304***a*, **2304***b*, **2304***c*, **2304***d* is adjacent to two of the first pole. The poles are further arranged such that each of the poles **2302***a*-**2302***d*, **2304***a*-**2304***d* comprises a circular sector (pie slice) cross-sectional geometry.

**[0166]** The magnetically actuated arc lifter distraction devices (see, e.g., **100**, **700**, **1700**) described herein may be implemented with a magnet that comprises a plurality of a

first pole having a first polarity, and a plurality of second pole having a second polarity that is opposite to the first polarity. Additionally, the EMC **1900** described herein may include an external magnet **1910** that comprises a plurality of a first pole having a first polarity, and a plurality of second pole having a second polarity that is opposite to the first polarity. The systems described herein may be implemented such that the magnet of the distraction device includes the same quantity of poles as the external magnet of the EMC. In some cases, it may be desirable to include a greater quantity of poles to enable increased granularity when rotating the external magnet of the EMC, which causes synchronous rotation of the magnet of the distraction device, and which further causes synchronous rotation of the actuation screw of the distraction device.

**[0167]** FIGS. **24**A and **24**B are schematic illustrations of an elevator **2400** for use in connection with performing a distraction surgical procedure. FIG. **24**A illustrates a straight-on wide view of the elevator **2400**, and FIG. **24**B illustrates a straight-on top-down aerial view of the elevator **2400**. The elevator **2400** may specifically be utilized as a periosteal elevator to lift a periosteal tissue away from an outer bone surface. In this case, the elevator **2400** may be utilized to perform a periosteal distraction osteogenesis procedure. The elevator **2400** may be utilized to perform other distraction procedures, including procedures performed on soft tissues.

**[0168]** The elevator **2400** includes a handle **2402**, a neck **2404**, and a blade **2408**. Each of the neck **2404** and the blade **2408** may comprise a smooth and blunt edge to prevent the elevator **2400** from cutting patient tissue or causing additional tissue trauma. During a surgical procedure, a cut may be made through patient tissue that is approximately the length of the width of the blade **2408**. The blade **2408** may then be inserted through the cut and utilized to lift patient tissue away.

**[0169]** FIG. **25** is a schematic illustration of a system **2500** that includes a flexible driver **2510** for performing a distraction surgical procedure. The flexible driver **2510** includes a drill bit **2512**, a flexible shank **2514**, and a rigid shank **2516**. The rigid shank **2516** is configured to be inserted into a corresponding receptacle of a drill **2502**. The flexible shank **2514** enables a user to manipulate the position of the drill bit **2512** to more easily access a rotation actuation head (see, e.g., **1124**) and rotate a rigid elongated member (see, e.g., **1102**).

**[0170]** FIGS. **26**A and **26**B are schematic illustrations of a system **2600** for distraction histogenesis, and specifically illustrates wherein an arc lifter distraction device is installed in a patient. The system **2600** includes an arc lifter **2610** installed in between a patient bone **2602** and patient periosteum **2604**, and further underneath at least skin **2606** of the patient. The arc lifter **2610** may include any of the arc lifter distraction devices described herein, including, for example, the device **100** first described in connection with FIGS. **1**A-**1**B, or the device **700** first described in connection with FIGS. **7**A-**7**B, or the device **1100** first described in connection with FIGS. **11**A-**11**B **1**.

**[0171]** FIG. **26**A illustrates wherein the arc lifter **2610** is in a relaxed state, such that an arc chord is at a maximum. FIG. **26**B illustrates wherein the arc lifter **2610** is in a bent state, such that the arc chord is less than the maximum. As shown in FIG. **26**B, the bending of the arc lifter **2610** causes further distraction of the periosteum **2604** away from the bone **2602**.

**[0172]** FIG. **26**B illustrates wherein the patient skin **2606** is resealed, but a cut remains in the periosteum **2604** of the patient (see left side of FIG. **26**B, wherein periosteum **2604** is not fully continuous). This system **2600** might be implemented when the arc lifter **2610** includes a magnet-actuated arc lifter configured to interface with an external magnetic controller (see, e.g., EMC **1900**, **2000**). In other cases, the skin **2606** may remain opened to allow a user to access the arc lifter **2610** with a flexible driver or other device.

**[0173]** FIGS. **27**A-**27**C are schematic block diagrams of a method **2700** for performing a periosteal distraction osteogenesis procedure. The method **2700** steps may be slightly modified to perform a similar distraction histogenesis procedure on alternative tissue types, including soft tissues. The method **2700** may be performed with an arc lifter distraction device as described herein, including at least the device **1100** first described in connection with FIGS. **11**A-**11**B.

**[0174]** The method **2700** includes planning at **2702** an arc lifter position and marking the patient skin to indicate skin incision site. The method **2700** includes creating at **2704** a longitudinal or transverse skin incision and transverse periosteum incision. The method **2700** include inserting at **2706** a periosteal elevator to prepare subperiosteal tunnel. The method **2700** include inserting at **2708** an arc lifter under the patient periosteum, with the guidance of the periosteal elevator if needed. The method **2700** may be performed to ensure the rotation actuation head of the arc lifter is exposed. The method **2700** includes attaching at **2710** a flexible driver (or flexible socket, or other driver or socket, or other means for actuating rotation actuation head) onto the rotation actuation head of the arc lifter. The method **2700** includes rotating at **2712** the rotation actuation head of the arc lifter to thereby rotate the rigid elongated member of the arc lifter, and to thereby lift or lower the compliant elongated member, and thereby distract or retract the patient periosteum.

**[0175]** FIGS. **28**A-**28**C are schematic block diagrams of a method **2800** for performing a periosteal distraction osteogenesis procedure. The method **2800** steps may be slightly modified to perform a similar distraction histogenesis procedure on alternative tissue types, including soft tissues. The method **2800** may be performed with an arc lifter distraction device as described herein, including at least the distraction device **100** first described in connection with FIGS. **1**A-**1**B or the distraction device **700** first described in connection with FIGS. **7**A-**7**B.

**[0176]** The method **2800** includes planning at **2802** an arc lifter position and marking the patient skin to indicate skin incision site. The method **2800** includes creating at **2804** a longitudinal skin incision and transverse periosteum incision. The method **2800** include inserting at **2806** a periosteal elevator to prepare subperiosteal tunnel. The method **2800** include inserting at **2808** an arc lifter under the patient periosteum, with the guidance of the periosteal elevator if needed. The method **2800** includes closing at **2810** the patient periosteum and skin over the top of the arc lifter. The method **2800** includes holding at **2812** the EMC **1900**, **2000** onto the skin. The method **2800** includes rotating at **1910** a dial of the EMC based on its indication (e.g., positive rotation for distraction and negative rotation for retraction, or vice versa) to cause rotation of a rigid elongated member

to thereby cause an adjustment in the arc height of a compliant elongated member, and to thereby distract or retract the periosteum.

**[0177]** FIG. **29** is a schematic block diagram of a system **2900** for remotely monitoring and controlling a distraction device such as the arc lifter distraction devices described herein. The system **2900** may be utilized in connection with any of the systems, methods, or devices described herein. The system **2900** may specifically be utilized in connection with any of the distraction devices **100**, **700**, **1100**, **1700** described herein. The system **2900** may further be utilized in connection with an EMC **1900**, **2000** as described herein, and/or an automated fixator adjustor **2922**.

**[0178]** The system **2900** includes a health management server **2902** that processes operations for a health management platform **2906**. The health management server **2902** renders a graphical user interface (GUI) that is made accessible by way of the health management platform **2906**. The health management platform **2906** is made accessible to one or more personal devices **2914** by way of a computer-executed application, web browser, smart application, or other means. The health management platform **2906** may be accessed with a personal device **2914** that is in communication with a network, such as wide area network, local area network, the Internet, and so forth.

**[0179]** The health management server **2902** may optionally include an artificial intelligence and/or machine learning (AI/ML) engine **2904**. The AI/ML engine **2904** is trained upon a set of training data. The AI/ML engine **2904** may be trained to assess data output by any of the EMC **1900**, **2000**, a temperature sensor **2916**, a biomarker sensor **2918**, a camera **2920**, or an automated fixator adjustor **2922** to monitor the status of a distraction device and determine whether there is a likely issue with the patient. The AI/ML engine **2904** may further be trained on data from numerous orthopedic procedures, including osteotomy and distraction histogenesis procedures, to generate a proposed treatment protocol for adjusting a fixator with the automated fixator adjustor **2922**.

**[0180]** The health management platform **2906** may include modules for providing information regarding data monitoring **2908**, adjustment calculation **2910**, provider communication **2912**, and so forth. The health management platform **2906** may be rendered on an application that is run on a personal device **2914**, such as a mobile phone, a tablet, or other personal computer. The health management platform **2906** may be rendered on a web browser that is accessible by way of a personal device **2914** connected to the Internet or LoRaWAN.

**[0181]** Patients, healthcare providers, administrators, and other users may access the health management platform **2906** with a personal device **2914** to view up-to-date data provided by any of the automated fixator adjustor **2922**, temperature sensor **2916**, biomarker sensor **2918**, or camera **2920**. Additionally, the health management platform **2906** provides current and past information regarding adjustment calculations **2910** for a fixator that is currently or was previously fixated to a patient. The adjustment calculations **2910** may be utilized to change or maintain protocols to be implemented by the automated fixator adjustor **100**. The health management platform **2912** provides a means for secure bidirectional communication with patients and healthcare providers by way of the provider communication **2912** module. The health management platform **2912** additionally provides a means for secure bidirectional communication with devices such as the EMC **1900**, **2000**, temperature sensor **2916**, biomarker sensor **2918**, camera **2920**, and automated fixator adjustor **2922**.

**[0182]** The EMC **1900**, **2000** may be automated to engage rotation of a magnet, which may in turn cause rotation of a magnetic portion of a rigid elongated member as described herein. The EMC **1900**, **2000** may be automated to enable distraction or retraction of a compliant elongated member without manual user intervention. The EMC **1900**, **2000** may include one or more processors configured to execute instructions stored in non-transitory computer readable storage medium. The processors of the EMC **1900**, **2000** may receive instructions from any of the health management server **2902**, a locally stored memory device with the EMC **1900**, **2000**, or from another source such as the personal device **2914**. The EMC **1900**, **2000** may automatically lift or lower the compliant elongated member of a distraction device to make real-time adjustments in accordance with a healthcare provider's protocol. A healthcare provider may amend the adjustment protocol by communicating with the health management server **2902** by way of the health management platform **2906**, or through the personal device **2914**.

**[0183]** The EMC **1900**, **2000** may include one or more Bluetooth® low energy chips and/or near-field communication chips that enable the EMC **1900**, **2000** to wirelessly communicate with personal devices **2914** by way of Bluetooth® or near-field communication. The EMC **1900**, **2000** may further be equipped with Wi-Fi® or LoRaWAN capability that enables the EMC **1900**, **2000** to wirelessly communicate with the health management server **2902** directly.

**[0184]** The temperature sensor **2916** may be temporarily installed within a patient to monitor the real-time internal temperature of the patient. Data output by the temperature sensor **2916** may be assessed to determine if patient tissue is inflamed or if the patient may have an infection at the surgical site or if there is enough blood flow on extremities of patient's body.

**[0185]** The biomarker sensor **2918** may be temporarily installed within a patient to monitor the real-time presence of certain biomarkers. The biomarker sensor **2918** may specifically be tuned to monitor the presence of biomarkers that may signal the patient currently has an infection at the surgical site. The data output by the biomarker sensor **2918** may be utilized to determine if the patient likely has an infection at the surgical site and requires additional care. The biomarker sensor **2918** may additionally measure whether the patient possesses growth factors or positive biomarkers that are known to be associated with healing.

**[0186]** The camera **2920** may include a standalone camera or one or more image sensors, light sources, photocells, other sensors, and other features associated with another computing device such as a mobile phone. The camera **2920** may additionally include other spectroscopy systems, including, for example, NIRS (Near InfraRed Spectroscopy) which may be utilized for measuring tissue oxygenation and to monitor the progression of perfusion to tissues. In some cases, a personal device **2914** comprising a camera communicates with the health management server **2902** by way of a computer-executed application. The health management server **2902** executes the application and may communicate directly with the camera **2920** to receive images and other data captured by the camera **2920**. In some cases, the camera

**2920** may be integrated with any of the systems described herein to capture up-to-date pictures of a fixator installed on a patient, which may include an external monitoring device and/or any suitable orthopedic device.

**[0187]** The automated fixator adjustor **2922** comprises one or more processors configured to execute instructions stored in non-transitory computer readable storage medium. The processors of the automated fixator adjustor **2922** may receive instructions from any of the health management server **2902**, a locally stored memory device with the automated fixator adjustor **2922**, or from another source such as the personal device **2914**. The automated fixator adjustor **2922** may automatically lift or lower a compliant elongated member of a distraction device to make real-time adjustments in accordance with a healthcare provider's protocol. A healthcare provider may amend the adjustment protocol by communicating with the health management server **2902** by way of the health management platform **2906**.

**[0188]** The automated fixator adjustor **2922** may include one or more Bluetooth® low energy chips and/or near-field communication chips that enable the automated fixator adjustor **2922** to wirelessly communicate with personal devices **2914** by way of Bluetooth® or near-field communication. The automated fixator adjustor **2922** may further be equipped with Wi-Fi® or LoRaWAN capability that enables the automated fixator adjustor **2922** to wirelessly communicate with the health management server **2902** directly.

**[0189]** The temperature sensor **2916**, biomarker sensor **2916**, and camera **2920** may include separate components that individually communicate with the health management server **2902** over a network connection. In other implementations, one or more of the temperature sensor **2916**, the biomarker sensor **2918**, or the camera **2920** may be integrated into the EMC **1900**, **2000** and/or the automated fixator adjustor **2922**.

**[0190]** The personal device **2914** is any personal computing device that can communicate with the health management server **2902**. The personal device **2914** may include a smart phone, a tablet, a laptop, a personal computer, virtual or augmented reality device, and so forth. The personal devices **2914** may communicate with the health management server **2902** by way of a local area network (LAN) connection, a wide area network (WAN) connection, or another network connection, 4G/5G data network, or satellite signals.

**[0191]** The personal device **2914** may include an application installed thereon for enabling streamlined communication with the health management server **2902**. The application is configured for multiple platforms, including, for example, smart phone platforms, tablet platforms, Android® operating systems, Linux® operating systems, Windows® operating systems, iOS® operating systems, Macintosh® operating systems, and so forth. The application is configured to provide secure bidirectional communication with one or more of the health management server **2902**, the EMC **1900**, **2000**, the temperature sensor **2916**, the biomarker sensor **2918**, the camera **2920**, or the automated fixator adjustor **2922**. The application may wirelessly receive sensor information, system status information, and may further send commanding signals to sensors and system components. The application is configured to display system information through one or more means, including, for example, graphic displays, audible sounds, videos, and so forth. The application is configured to receive user input and is capable of communicating with multiple systems.

**[0192]** Referring now to FIG. **30**, a block diagram of an example computing device **3000** is illustrated. Computing device **3000** may be used to perform various procedures, such as those discussed herein. Computing device **3000** can perform various monitoring functions as discussed herein, and can execute one or more application programs, such as the application programs or functionality described herein. Computing device **3000** can be any of a wide variety of computing devices, such as a desktop computer, in-dash computer, vehicle control system, a notebook computer, a server computer, a handheld computer, tablet computer and the like.

**[0193]** Computing device **3000** includes one or more processor(s) **3012**, or microcontrollers, one or more memory device(s) **3004**, one or more interface(s) **3006**, one or more mass storage device(s) **3008**, one or more Input/output (I/O) device(s) **3010**, and a display device **3030** all of which are coupled to a bus **3012**. Processor(s) **3012** include one or more processors or controllers that execute instructions stored in memory device(s) **3004** and/or mass storage device (s) **3008**. Processor(s) **3012** may also include diverse types of computer-readable media, such as cache memory.

**[0194]** Memory device(s) **3004** include various computer-readable media, such as volatile memory (e.g., random access memory (RAM) **3014**) and/or nonvolatile memory (e.g., read-only memory (ROM) **3016**). Memory device(s) **3004** may also include rewritable ROM, such as Flash memory.

**[0195]** Mass storage device(s) **3008** include various computer readable media, such as magnetic tapes, magnetic disks, optical disks, solid-state memory (e.g., Flash memory), and so forth. As shown in FIG. **30**, a particular mass storage device **3008** is a hard disk drive **3024**. Various drives may also be included in mass storage device(s) **3008** to enable reading from and/or writing to the various computer readable media. Mass storage device(s) **3008** include removable media **3026** and/or non-removable media.

**[0196]** I/O device(s) **3010** include various devices that allow data and/or other information to be input to or retrieved from computing device **3000**. Example I/O device (s) **3010** include cursor control devices, keyboards, keypads, microphones, monitors, touchscreen devices, or other display devices, speakers, printers, network interface cards, modems, and the like.

**[0197]** Display device **3030** includes any type of device capable of displaying information to one or more users of computing device **3000**. Examples of display device **3030** include a monitor, display terminal, video projection device, and the like.

**[0198]** Interface(s) **3006** include various interfaces that allow computing device **3000** to interact with other systems, devices, or computing environments. Example interface(s) **3006** may include any number of different network interfaces **3020**, such as interfaces to local area networks (LANs), wide area networks (WANs), 4G/5G data network, satellite signals, wireless networks, and the Internet. Other interface(s) include user interface **3018** and peripheral device interface **3022**. The interface(s) **3006** may also include one or more user interface elements **3018**. The interface(s) **3006** may also include one or more peripheral interfaces such as interfaces for printers, pointing devices

(mice, track pad, or any suitable user interface now known to those of ordinary skill in the field, or later discovered), keyboards, and the like.

**[0199]** Bus **3012** allows processor(s) **3012**, memory device(s) **3004**, interface(s) **3006**, mass storage device(s) **3008**, and I/O device(s) **3010** to communicate with one another, as well as other devices or components coupled to bus **3012**. Bus **3012** represents one or more of several types of bus structures, such as a system bus, PCI bus, IEEE bus, USB bus, and so forth.

**[0200]** For purposes of illustration, programs and other executable program components are shown herein as discrete blocks, although it is understood that such programs and components may reside at various times in different storage components of computing device **1800** and are executed by processor(s) **3012**. Alternatively, the systems and procedures described herein can be implemented in hardware, or a combination of hardware, software, and/or firmware. For example, one or more application specific integrated circuits (ASICs) can be programmed to conduct one or more of the systems and procedures described herein. As used herein, the terms "module" or "component" are intended to convey the implementation apparatus for accomplishing a process, such as by hardware, or a combination of hardware, software, and/or firmware, for the purposes of performing all or parts of operations disclosed herein. The terms "module" or "component" are intended to convey independent in how the modules, components, or their functionality or hardware may be implemented in different embodiments.

## EXAMPLES

**[0201]** The following examples pertain to further embodiments.

**[0202]** Example 1 is a device for performing a distraction histogenesis procedure. The device includes a rigid elongated member comprising external threading. The device includes a compliant elongated member, wherein a first end of the compliant elongated member is coupled to the rigid elongated member. The device includes a fastener comprising a hole defined by a sidewall, wherein the fastener comprises internal threading on the sidewall, and wherein the fastener couples a second end of the compliant elongated member to the rigid elongated member. The device is such that rotation of the rigid elongated member causes movement of the fastener.

**[0203]** Example 2 is a device as in Example 1, further comprising a swivel joint, wherein the swivel joint couples the first end of the compliant elongated member to the rigid elongated member.

**[0204]** Example 3 is a device as in any of Examples 1-2, wherein the external threading of the rigid elongated member corresponds with the internal threading of the fastener.

**[0205]** Example 4 is a device as in any of Examples 1-3, wherein the fastener is screwed onto the rigid elongated member such that the fastener move along a longitudinal axis of the rigid elongated member in response to the rotation of the rigid elongated member.

**[0206]** Example 5 is a device as in any of Examples 1-4, wherein the second end of the compliant elongated member is attached to the fastener such that the second end of the compliant elongated member along the longitudinal axis of the rigid elongated member in response to the fastener moving along the longitudinal axis of the rigid elongated member.

**[0207]** Example 6 is a device as in any of Examples 1-5, wherein the second end of the compliant elongated member is located opposite to the first end of the compliant elongated member; and wherein the first end of the compliant elongated member and the swivel joint are located substantially adjacent to a first end of the rigid elongated member.

**[0208]** Example 7 is a device as in any of Examples 1-6, wherein a second end of the rigid elongated member is located opposite to the first end of the rigid elongated member; and wherein the fastener and the second end of the compliant elongated member are located substantially adjacent to the second end of the rigid elongated member when the compliant elongated member is in a maximum relaxed state.

**[0209]** Example 8 is a device as in any of Examples 1-7, wherein the fastener and the second end of the compliant elongated member move toward the first end of the rigid elongated member in response to the rotation of the rigid elongated member; wherein the compliant elongated member is in a maximum bent state when the fastener is located substantially adjacent to the swivel joint.

**[0210]** Example 9 is a device as in any of Examples 1-8, wherein rotation of the rigid elongated member in a first rotational direction causes the fastener to move toward the swivel joint; and wherein rotation of the rigid elongated member in a second rotational direction causes the fastener to move away from the swivel joint.

**[0211]** Example 10 is a device as in any of Examples 1-9, wherein the rotation of the rigid elongated member in a first rotational direction causes the fastener to move toward the swivel joint; wherein the swivel joint swivels in response to the fastener moving toward the swivel joint; and wherein the compliant elongated member bends in response to the fastener moving toward the swivel join.

**[0212]** Example 11 is a device as in any of Examples 1-10, further comprising a drive head attached to the rigid elongated member at a first end of the rigid elongated member.

**[0213]** Example 12 is a device as in any of Examples 1-11, wherein the drive head comprises an impression configured to receive a drill head; wherein rotation of the drill head causes rotation of the rigid elongated member when the drill head is disposed within the impression of the drive head; and wherein rotation of the rigid elongated member in a first rotational direction causes the fastener to move toward the swivel join and further causes the compliant elongated member to bend away from the rigid elongated member.

**[0214]** Example 13 is a device as in any of Examples 1-12, wherein the device is configured to be disposed in between a periosteum layer and an outer surface of a bone.

**[0215]** Example 14 is a device as in any of Examples 1-13, wherein the device is configured to be disposed in between a periosteum layer and an outer surface of a bone to perform a periosteal distraction osteogenesis procedure to initiate regeneration of the bone.

**[0216]** Example 15 is a device as in any of Examples 1-14, wherein the device is disposed in between a periosteum layer and an outer surface of a bone during the distraction osteogenesis procedure; wherein the rotation of the rigid elongated member in a first rotational direction causes the fastener to move toward the swivel joint, and further causes the compliant elongated member to bend away from the

rigid elongated member; and wherein the compliant elongated member bending away from the rigid elongated member causes the periosteum to pull away from the outer surface of the bone.

**[0217]** Example 16 is a device as in any of Examples 1-15, wherein the rotation of the rigid elongated member in a second rotational direction causes the fastener to move away from the swivel joint, and further causes the compliant elongated member to straighten toward the rigid elongated member; and wherein the compliant elongated member straightening toward the rigid elongated member causes the periosteum to relax down toward the outer surface of the bone.

**[0218]** Example 17 is a device as in any of Examples 1-16, wherein the distraction osteogenesis procedure is a periosteal distraction osteogenesis procedure; and wherein, during the periosteal distraction osteogenesis procedure, the rotation of the rigid elongated member causes distraction or retraction of a periosteum of a patient.

**[0219]** Example 18 is a device as in any of Examples 1-17, wherein the compliant elongated member comprises a first compliant elongated member and a second compliant elongated member; wherein a longitudinal axis of the first compliant elongated member is substantially parallel to a longitudinal axis of the rigid elongated member; and wherein a longitudinal axis of the second compliant elongated member is substantially parallel to the longitudinal axis of the rigid elongated member.

**[0220]** Example 19 is a device as in any of Examples 1-18, wherein the rigid elongated member is disposed in between the first compliant elongated member and the second compliant elongated member such that the first compliant elongated member is disposed adjacent to a first side of the rigid elongated member, and the second compliant elongated member is disposed adjacent to a second side of the rigid elongated member.

**[0221]** Example 20 is a device as in any of Examples 1-19, further comprising a nut attached to the rigid elongated member, wherein rotation of the nut causes rotation of the rigid elongated member.

**[0222]** Example 21 is a device for performing a distraction histogenesis procedure. The device includes a rigid elongated member comprising a magnetic portion and a threaded portion. The device includes an adjustment coupler comprising a hollow interior defined by a sidewall, wherein the adjustment coupler comprises internal threading attached to the sidewall. The device includes a compliant elongated member coupled to each of the adjustment coupler and the rigid elongated member. The device is such that the internal threading of the adjustment coupler corresponds with the threaded portion of the rigid elongated member. The device is such that rotation of the rigid elongated member causes the threaded portion to screw into or out of the sidewall of the adjustment coupler.

**[0223]** Example 22 is a device as in Example 21, wherein the adjustment coupler couples the compliant elongated member to the rigid elongated member at a first end of the compliant elongated member; and wherein the device further comprises a stationary coupler that couples the compliant elongated member to the rigid elongated member at a second end of the compliant elongated member.

**[0224]** Example 23 is a device as in any of Examples 21-22, wherein the rotation of the rigid elongated member causes the threaded portion to screw into the sidewall of the adjustment coupler when the rigid elongated member is rotated in a tightening direction; and wherein the compliant elongated member distracts away from a longitudinal axis of the rigid elongated member in response to the threaded portion screwing into the sidewall of the adjustment coupler.

**[0225]** Example 24 is a device as in any of Examples 21-23, wherein the rotation of the rigid elongated member causes the threaded portion to screw out of the sidewall of the adjustment coupler when the rigid elongated member is rotated in a loosening direction; and wherein the compliant elongated member retracts toward a longitudinal axis of the rigid elongated member in response to the threaded portion screwing out of the sidewall of the adjustment coupler.

**[0226]** Example 25 is a device as in any of Examples 21-24, wherein the magnetic portion of the rigid elongated member comprises an elongated magnet, and wherein the elongated magnet comprises at least two poles extending a length of the elongated magnet.

**[0227]** Example 26 is a device as in any of Examples 21-25, wherein the elongated magnet forms a magnetic coupling with a corresponding magnet or electromagnet of an external magnetic controller; and wherein rotation of the corresponding magnet causes corresponding rotation of the elongated magnet.

**[0228]** Example 27 is a device as in any of Examples 21-26, wherein corresponding rotation of the elongated magnet in a tightening direction causes corresponding rotation of the rigid elongated member in the tightening direction; wherein the corresponding rotation of the rigid elongated member in the tightening direction causes the threaded portion to screw into the sidewall of the adjustment coupler; and wherein the threaded portion screwing into the sidewall of the adjustment coupler causes the compliant elongated member to distract away from a longitudinal axis of the rigid elongated member.

**[0229]** Example 28 is a device as in any of Examples 21-27, wherein corresponding rotation of the elongated magnet in a loosening direction causes corresponding rotation of the rigid elongated member in the loosening direction; wherein the corresponding rotation of the rigid elongated member in the loosening direction causes the threaded portion to screw out of the sidewall of the adjustment coupler; and wherein the threaded portion screwing out of the sidewall of the adjustment coupler causes the compliant elongated member to retract toward a longitudinal axis of the rigid elongated member.

**[0230]** Example 29 is a device as in any of Examples 21-28, further comprising a pivot head coupled to the adjustment coupler by way of a pivot fastener; wherein the compliant elongated member is coupled to the adjustment coupler by way of the pivot head.

**[0231]** Example 30 is a device as in any of Examples 21-29, wherein the adjustment coupler couples the compliant elongated member to the rigid elongated member at a first end of the compliant elongated member; wherein the device further comprises a stationary coupler that couples the compliant elongated member to the rigid elongated member at a second end of the compliant elongated member; wherein the device further comprises a first pivot head coupled to the adjustment coupler by way of a first pivot fastener; wherein the device further comprises a second pivot head coupled to the stationary coupler by way of a second pivot fastener; wherein the compliant elongated member is coupled to the adjustment coupler by way of the

first pivot head; and wherein the compliant elongated member is coupled to the stationary coupler by way of the second pivot head.

**[0232]** Example 31 is a device as in any of Examples 21-30, wherein the first pivot head and the second pivot head enable the compliant elongated member to distract away from a longitudinal axis of the rigid elongated member in an arc configuration.

**[0233]** Example 32 is a device as in any of Examples 21-31, wherein the compliant elongated member comprises a first end and a second end that is opposite to the first end; wherein a distance between the first end and the second end of the compliant elongated member is an arc chord of the compliant elongated member; and wherein the arc chord is adjustable by screwing the threaded portion into or out of the sidewall of the adjustment coupler.

**[0234]** Example 33 is a device as in any of Examples 21-32, wherein the device is configured to be disposed in between a periosteum layer and an outer surface of a bone.

**[0235]** Example 34 is a device as in any of Examples 21-33, wherein the device is configured to be disposed in between a periosteum layer and an outer surface of a bone to perform a periosteal distraction osteogenesis procedure to initiate regeneration of the bone by distracting the periosteum layer away from the outer surface of the bone.

**[0236]** Example 35 is a device as in any of Examples 21-34, wherein the device is disposed in between the periosteum layer and the outer surface of the bone during the periosteal distraction osteogenesis procedure; wherein rotation of the rigid elongated member in a tightening direction causes the threaded portion to screw into the sidewall of the adjustment coupler and further causes the compliant elongated member to distract away from the rigid elongated member; and wherein the compliant elongated member distracting away from the rigid elongated member causes the periosteum to stretch and distract away from the outer surface of the bone.

**[0237]** Example 36 is a device as in any of Examples 21-35, wherein the device is disposed in between the periosteum layer and the outer surface of the bone during the periosteal distraction osteogenesis procedure; wherein rotation of the rigid elongated member in a loosening direction causes the threaded portion to screw out of the sidewall of the adjustment coupler and further causes the compliant elongated member to retract toward the rigid elongated member; and wherein the compliant elongated member retracting toward the rigid elongated member allows the periosteum to relax toward the outer surface of the bone.

**[0238]** Example 37 is a device as in any of Examples 21-36, wherein the distraction histogenesis procedure is a periosteal distraction osteogenesis procedure; and wherein, during the periosteal distraction osteogenesis procedure, the rotation of the rigid elongated member causes distraction or retraction of a periosteum of a patient.

**[0239]** Example 38 is a device as in any of Examples 21-37, wherein the magnetic portion of the rigid elongated member comprises an elongated magnet; wherein the rigid elongated member further comprises a housing disposed around the elongated magnet; and wherein the housing is attached to the threaded portion of the rigid elongated member.

**[0240]** Example 39 is a device as in any of Examples 21-38, wherein the device is installed within a patient during the distraction histogenesis procedure such that a skin barrier of the patient is closed over the device; wherein the magnetic portion of the rigid elongated member forms a magnetic coupling with a corresponding magnet of an external magnetic controller when the device is installed within the patient.

**[0241]** Example 40 is a device as in any of Examples 21-39, wherein, in response to establishing the magnetic coupling between the external magnetic controller and the magnetic portion of the rigid elongated member, the corresponding magnet is rotated in a first direction to cause corresponding rotation of the rigid elongated member; and wherein the corresponding rotation of the rigid elongated member causes adjustment to a length of an arc chord formed between a first end of the compliant elongated member and a second end of the compliant elongated member.

**[0242]** The foregoing description has been presented for purposes of illustration. It is not exhaustive and does not limit the invention to the precise forms or embodiments disclosed. Modifications and adaptations will be apparent to those skilled in the art from consideration of the specification and practice of the disclosed embodiments. For example, components described herein may be removed and other components added without departing from the scope or spirit of the embodiments disclosed herein or the appended claims.

**[0243]** Other embodiments will be apparent to those skilled in the art from consideration of the specification and practice of the disclosure disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims.

What is claimed is:

**1**. A device for performing a distraction histogenesis procedure, the device comprising:

a rigid elongated member comprising a magnetic portion and a threaded portion;

an adjustment coupler comprising a hollow interior defined by a sidewall, wherein the adjustment coupler comprises internal threading attached to the sidewall; and

a compliant elongated member coupled to each of the adjustment coupler and the rigid elongated member;

wherein the internal threading of the adjustment coupler corresponds with the threaded portion of the rigid elongated member; and

wherein rotation of the rigid elongated member causes the threaded portion to screw into or out of the sidewall of the adjustment coupler.

**2**. The device of claim **1**, wherein the adjustment coupler couples the compliant elongated member to the rigid elongated member at a first end of the compliant elongated member; and

wherein the device further comprises a stationary coupler that couples the compliant elongated member to the rigid elongated member at a second end of the compliant elongated member.

**3**. The device of claim **1**, wherein the rotation of the rigid elongated member causes the threaded portion to screw into the sidewall of the adjustment coupler when the rigid elongated member is rotated in a tightening direction; and

wherein the compliant elongated member bends away from a longitudinal axis of the rigid elongated member

in response to the threaded portion screwing into the sidewall of the adjustment coupler.

**4**. The device of claim **1**, wherein the rotation of the rigid elongated member causes the threaded portion to screw out of the sidewall of the adjustment coupler when the rigid elongated member is rotated in a loosening direction; and

wherein the compliant elongated member retracts toward a longitudinal axis of the rigid elongated member in response to the threaded portion screwing out of the sidewall of the adjustment coupler.

**5**. The device of claim **1**, wherein the magnetic portion of the rigid elongated member comprises an elongated magnet, and wherein the elongated magnet comprises at least two poles extending a length of the elongated magnet.

**6**. The device of claim **5**, wherein the elongated magnet forms a magnetic coupling with a corresponding magnet of an external magnetic controller, wherein the corresponding magnet of the external magnetic controller comprises one or more of a magnet or an electromagnet; and

wherein rotation of the corresponding magnet causes corresponding rotation of the elongated magnet.

**7**. The device of claim **6**, wherein corresponding rotation of the elongated magnet in a tightening direction causes corresponding rotation of the rigid elongated member in the tightening direction;

wherein the corresponding rotation of the rigid elongated member in the tightening direction causes the threaded portion to screw into the sidewall of the adjustment coupler; and

wherein the threaded portion screwing into the sidewall of the adjustment coupler causes the compliant elongated member to distract away from a longitudinal axis of the rigid elongated member.

**8**. The device of claim **6**, wherein corresponding rotation of the elongated magnet in a loosening direction causes corresponding rotation of the rigid elongated member in the loosening direction;

wherein the corresponding rotation of the rigid elongated member in the loosening direction causes the threaded portion to screw out of the sidewall of the adjustment coupler; and

wherein the threaded portion screwing out of the sidewall of the adjustment coupler causes the compliant elongated member to retract toward a longitudinal axis of the rigid elongated member.

**9**. The device of claim **1**, further comprising a pivot head coupled to the adjustment coupler by way of a pivot fastener;

wherein the compliant elongated member is coupled to the adjustment coupler by way of the pivot head.

**10**. The device of claim **1**, wherein the adjustment coupler couples the compliant elongated member to the rigid elongated member at a first end of the compliant elongated member;

wherein the device further comprises a stationary coupler that couples the compliant elongated member to the rigid elongated member at a second end of the compliant elongated member;

wherein the device further comprises a first pivot head coupled to the adjustment coupler by way of a first pivot fastener;

wherein the device further comprises a second pivot head coupled to the stationary coupler by way of a second pivot fastener;

wherein the compliant elongated member is coupled to the adjustment coupler by way of the first pivot head; and

wherein the compliant elongated member is coupled to the stationary coupler by way of the second pivot head.

**11**. The device of claim **10**, wherein the first pivot head and the second pivot head enable the compliant elongated member to distract away from a longitudinal axis of the rigid elongated member in an arc configuration.

**12**. The device of claim **1**, wherein the compliant elongated member comprises a first end and a second end that is opposite to the first end;

wherein a distance between the first end and the second end of the compliant elongated member is an arc chord of the compliant elongated member; and

wherein the arc chord is adjustable by screwing the threaded portion into or out of the sidewall of the adjustment coupler.

**13**. The device of claim **1**, wherein the device is configured to be disposed in between a periosteum layer and an outer surface of a bone.

**14**. The device of claim **1**, wherein the device is configured to be disposed in between a periosteum layer and an outer surface of a bone to perform a periosteal distraction procedure to improve perfusion and initiate regeneration of the bone or soft tissue by stretching and distracting the periosteum layer away from the outer surface of the bone.

**15**. The device of claim **14**, wherein the device is disposed in between the periosteum layer and the outer surface of the bone during the periosteal distraction procedure;

wherein rotation of the rigid elongated member in a tightening direction causes the threaded portion to screw into the sidewall of the adjustment coupler and further causes the compliant elongated member to distract away from the rigid elongated member; and

wherein the compliant elongated member distracting away from the rigid elongated member causes the periosteum to stretch and distract away from the outer surface of the bone.

**16**. The device of claim **14**, wherein the device is disposed in between the periosteum layer and the outer surface of the bone during the periosteal distraction procedure;

wherein rotation of the rigid elongated member in a loosening direction causes the threaded portion to screw out of the sidewall of the adjustment coupler and further causes the compliant elongated member to retract toward the rigid elongated member; and

wherein the compliant elongated member retracting toward the rigid elongated member allows the periosteum to relax toward the outer surface of the bone.

**17**. The device of claim **1**, wherein the distraction histogenesis procedure is a periosteal distraction procedure; and

wherein, during the periosteal distraction procedure, the rotation of the rigid elongated member causes distraction or retraction of a periosteum of a patient.

**18**. The device of claim **1**, wherein the magnetic portion of the rigid elongated member comprises an elongated magnet;

wherein the rigid elongated member further comprises a housing disposed around the elongated magnet; and

wherein the housing is attached to the threaded portion of the rigid elongated member.

**19**. The device of claim **1**, wherein the device is installed within a patient during the distraction histogenesis procedure such that a skin barrier of the patient is closed over the device;

wherein the magnetic portion of the rigid elongated member forms a magnetic coupling with a corresponding magnet of an external magnetic controller when the device is installed within the patient.

**20**. The device of claim **19**, wherein, in response to establishing the magnetic coupling between the external magnetic controller and the magnetic portion of the rigid elongated member, the corresponding magnet is rotated in a first direction to cause corresponding rotation of the rigid elongated member; and

wherein the corresponding rotation of the rigid elongated member causes adjustment to a length of an arc chord formed between a first end of the compliant elongated member and a second end of the compliant elongated member.

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