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(54) **MAGNETICALLY ACTUATED SYSTEMS AND DEVICES FOR PERFORMING DISTRACTION HISTOGENESIS SURGICAL PROCEDURES**

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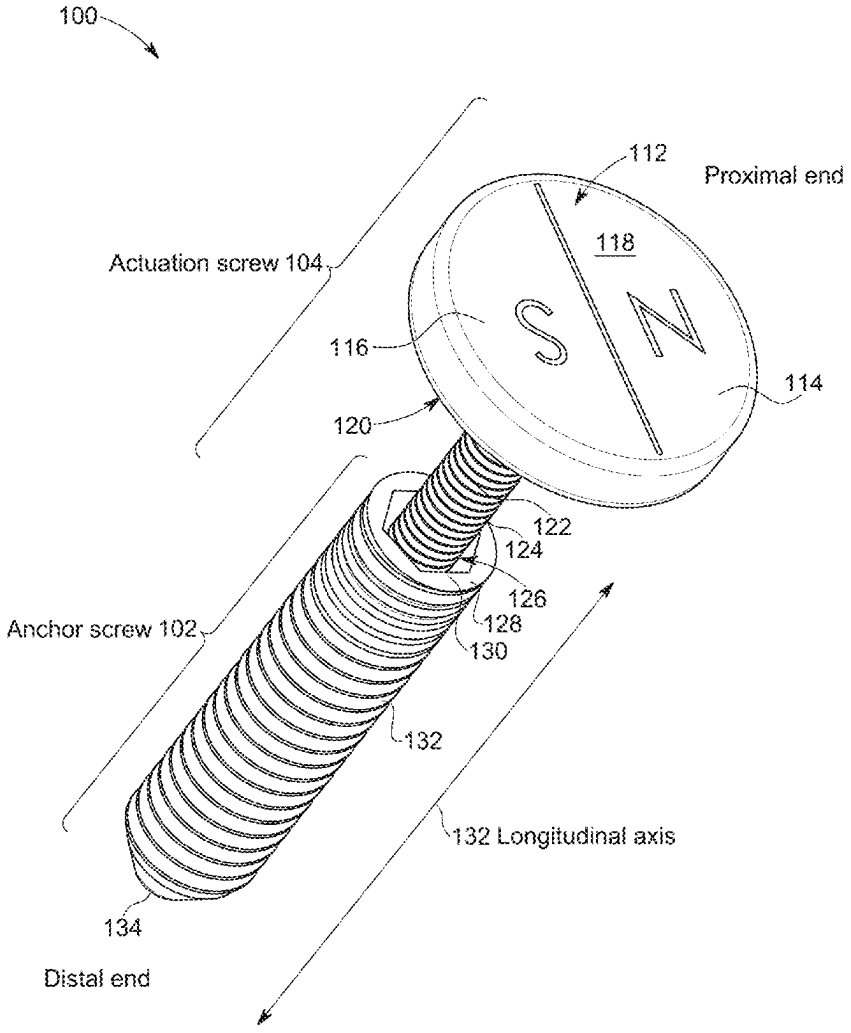
A61B 17/00 (2006.01)

(52) **U.S. Cl.**
CPC ***A61B 17/66*** (2013.01); *A61B 2017/00477* (2013.01); *A61B 2017/00876* (2013.01)

(57) **ABSTRACT**

Systems, methods, and devices for performing a distraction histogenesis surgical procedure. A system includes an anchor screw comprising a hollow interior defined by a sidewall, wherein the anchor screw comprises internal actuation threading attached to an interior surface of the sidewall and further comprises external anchor threading attached to an exterior surface of the sidewall. The system includes an actuation screw comprising a screw shaft that comprises external actuation threading. The system includes a magnet coupled to the actuation screw. The system is such that the external actuation threading of the screw shaft corresponds with the internal actuation threading of the anchor screw. The system is such that rotation of the magnet causes synchronous rotation of the actuation screw.



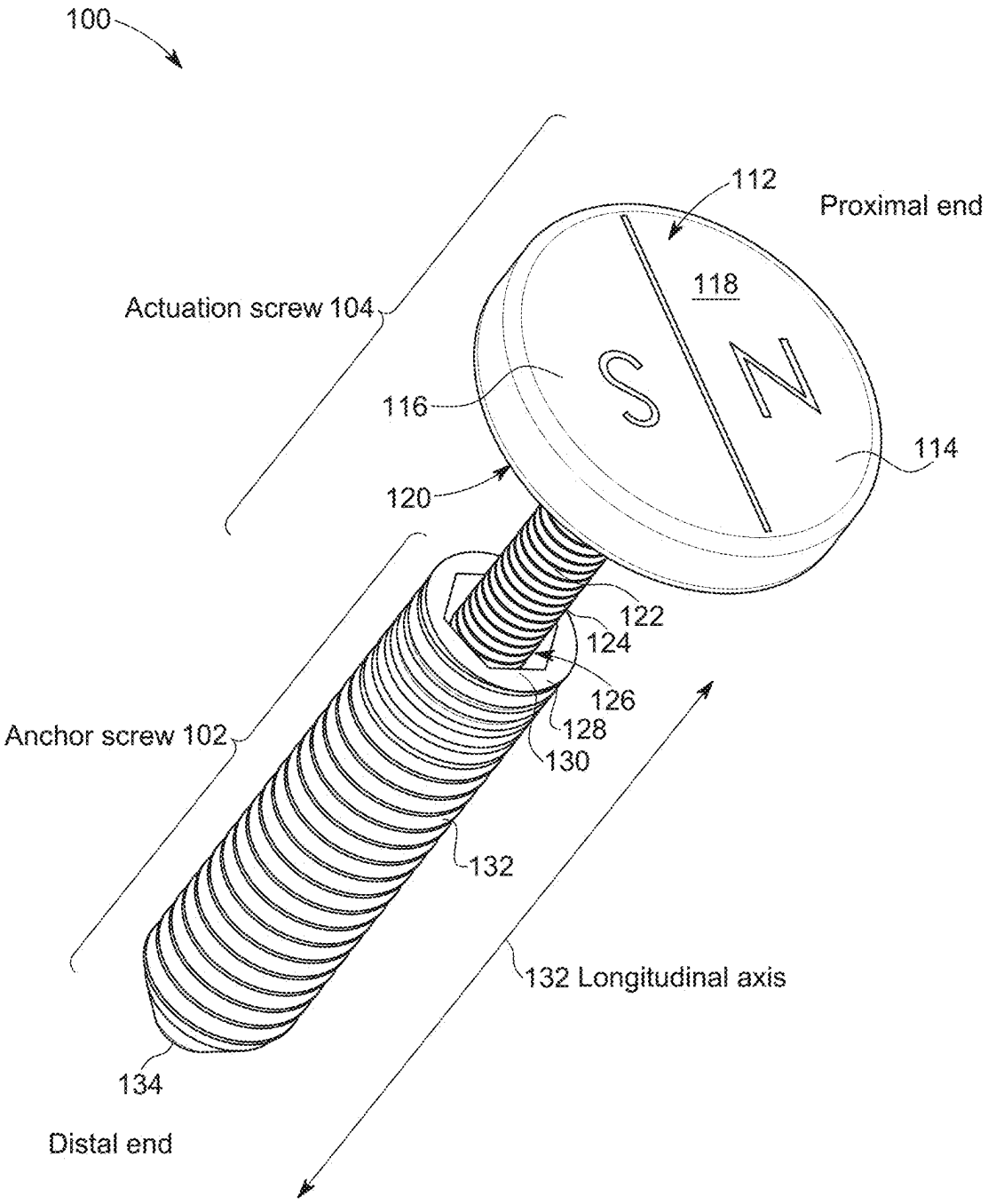

100
112
Proximal end
118
Actuation screw 104
S
N
116
114
120
122
124
126
128
130
Anchor screw 102
132
132 Longitudinal axis
134
Distal end

FIG. 1

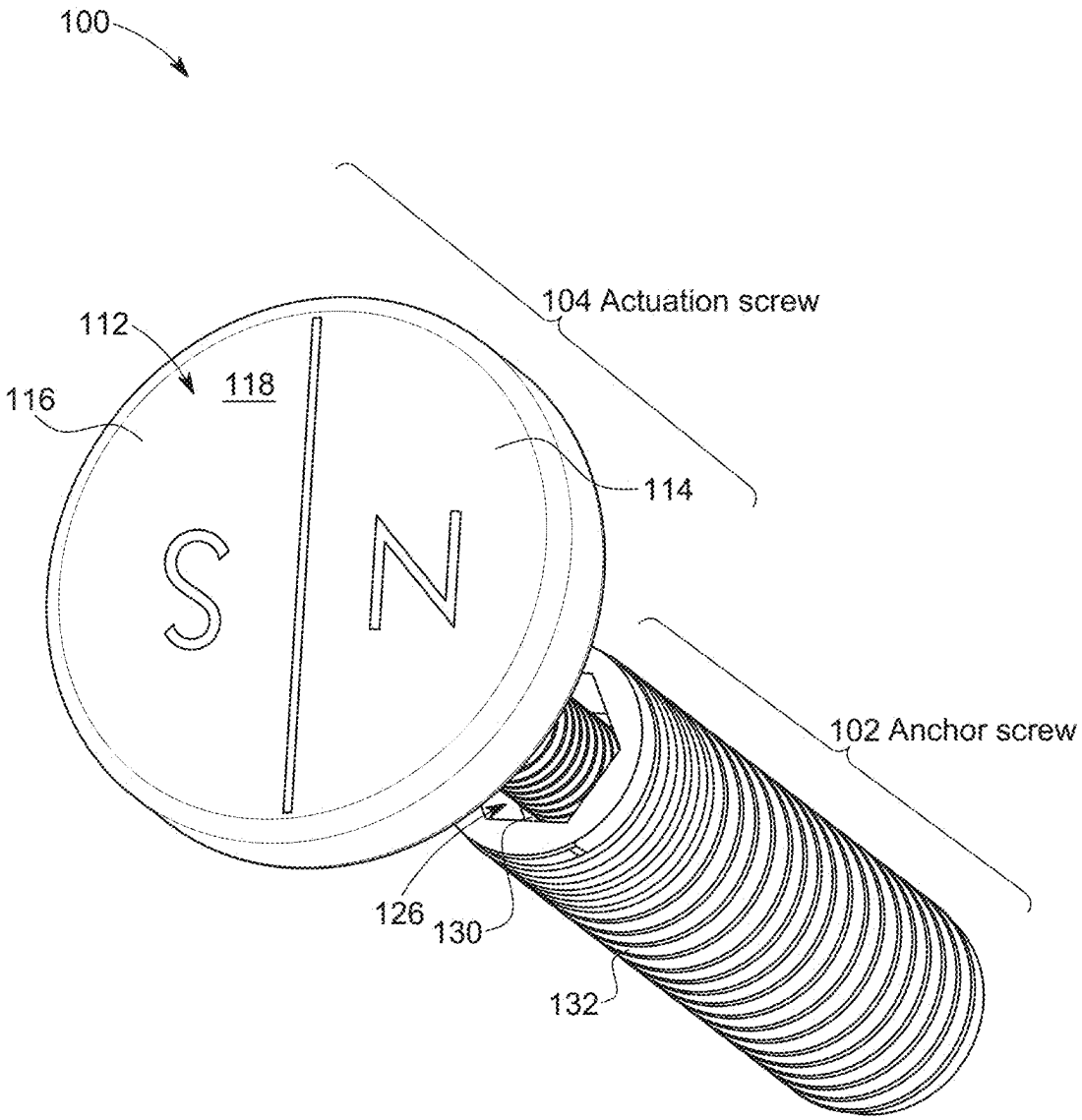

100
104 Actuation screw
112
118
116
114
S
N
102 Anchor screw
126
130
132

FIG. 2

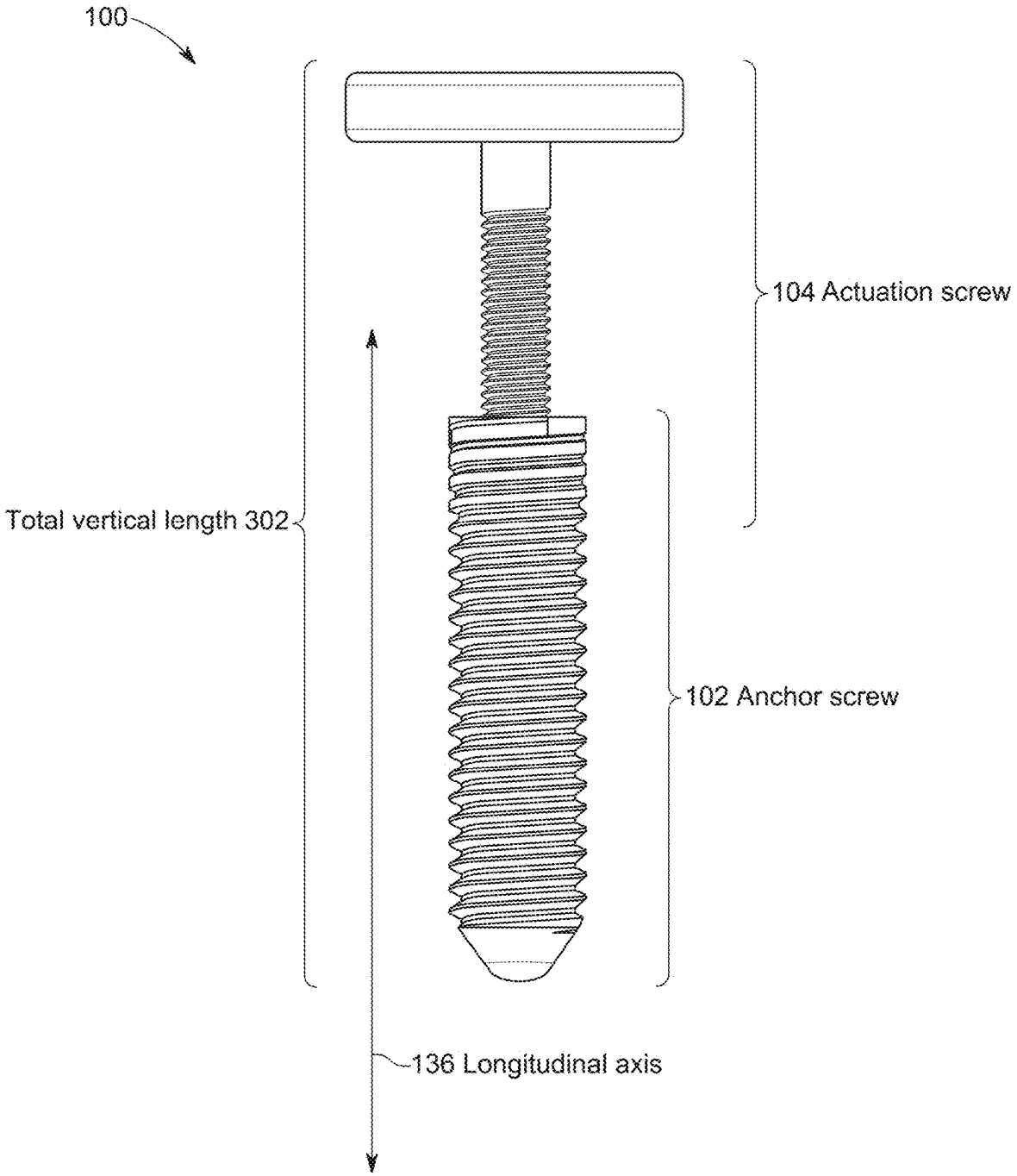

100
104 Actuation screw
Total vertical length 302
102 Anchor screw
136 Longitudinal axis

FIG. 3

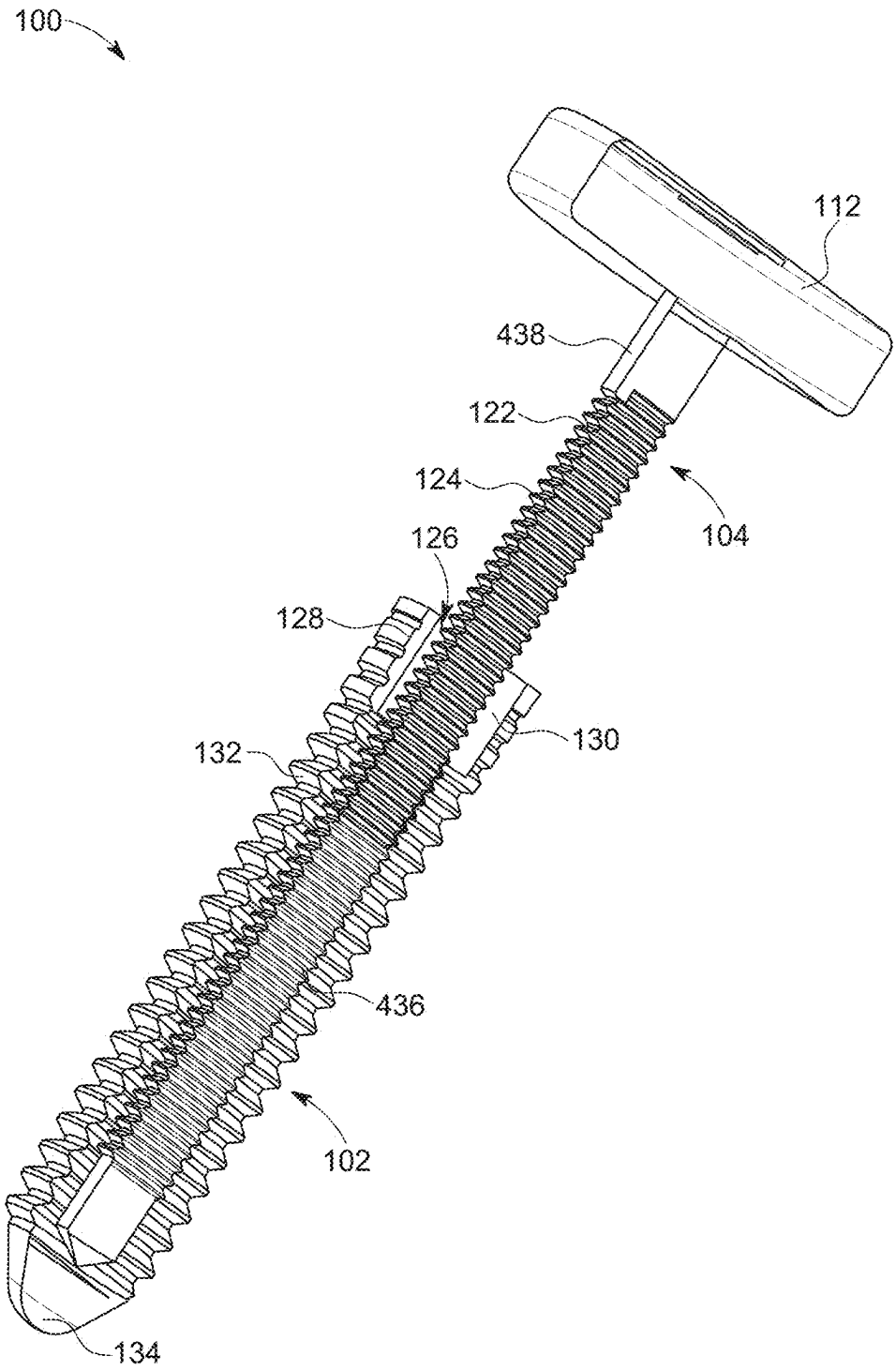


FIG. 4

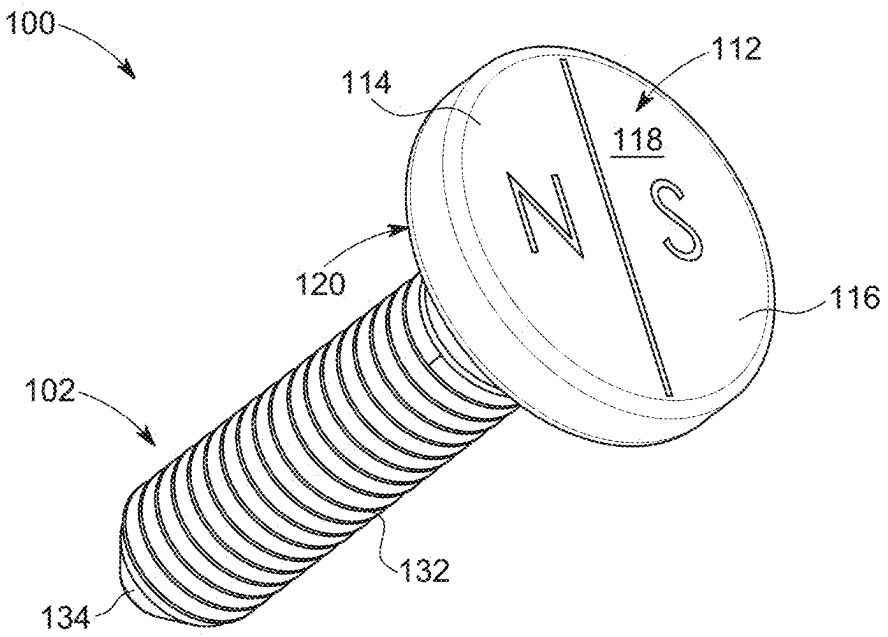


FIG. 5

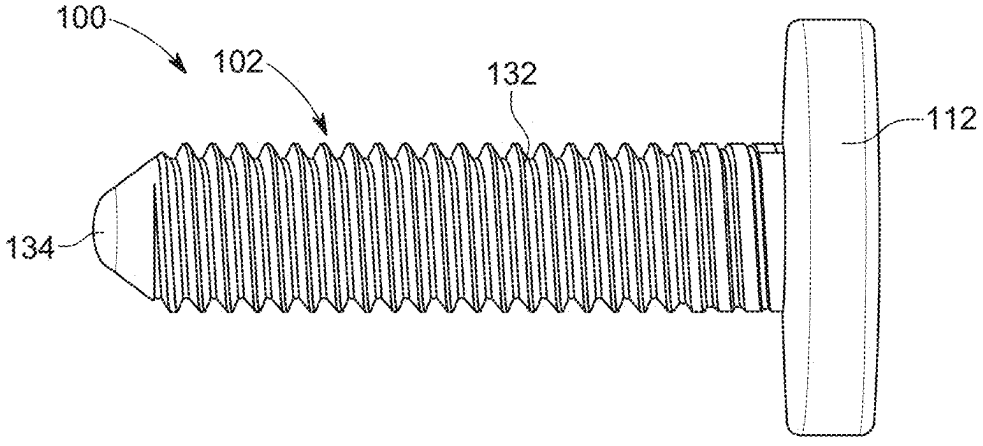


FIG. 6

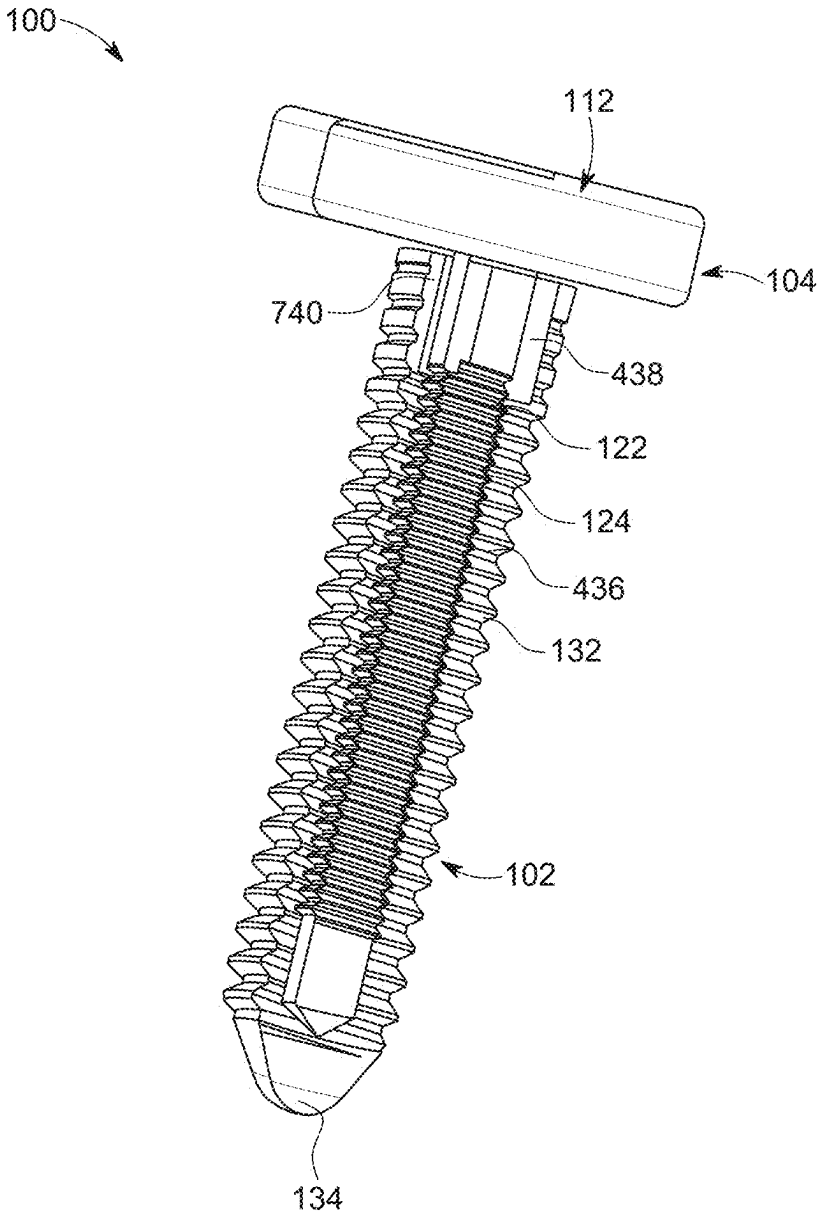


FIG. 7

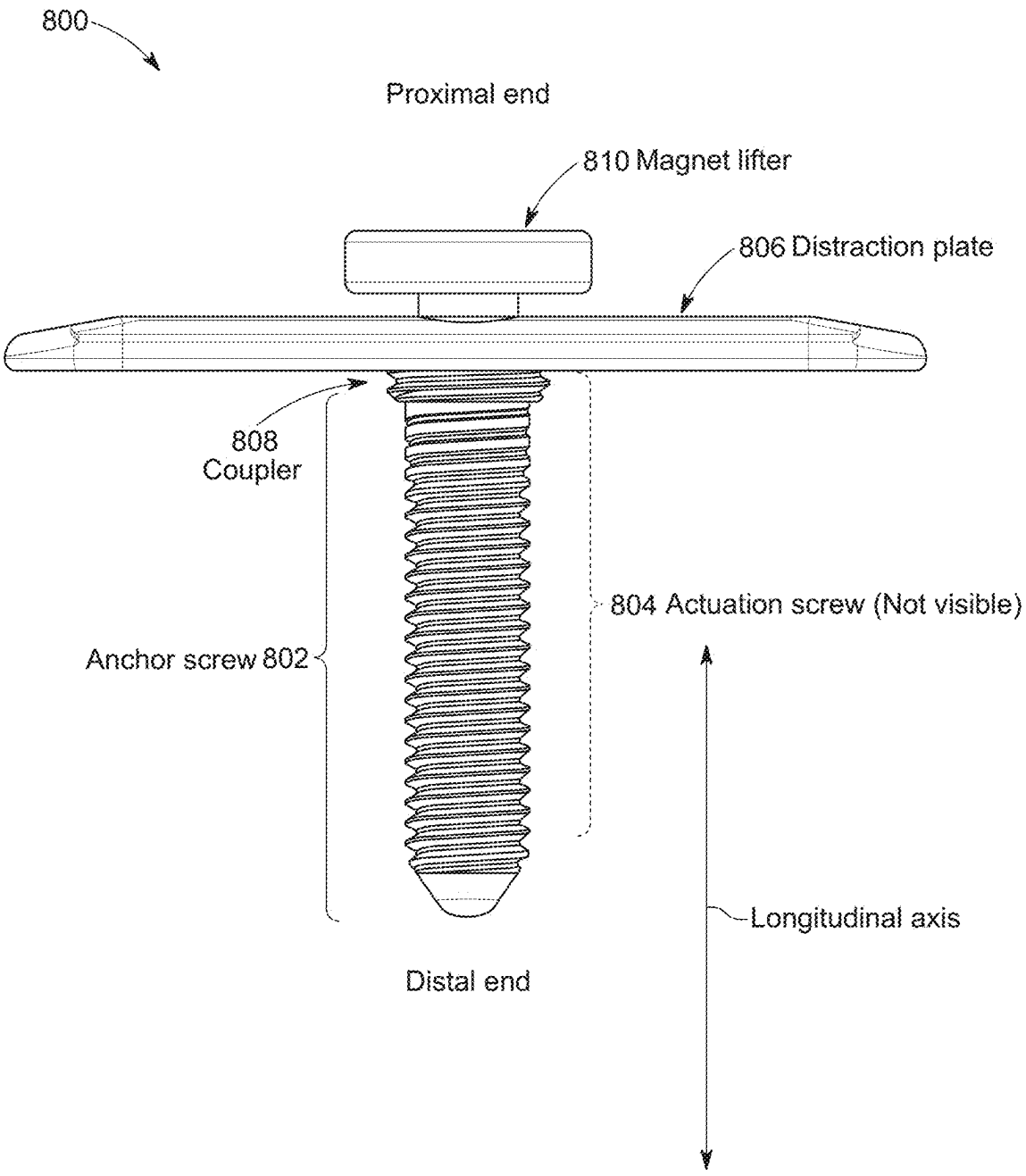

800
Proximal end
810 Magnet lifter
806 Distraction plate
808
Coupler
804 Actuation screw (Not visible)
Anchor screw 802
Longitudinal axis
Distal end

FIG. 8

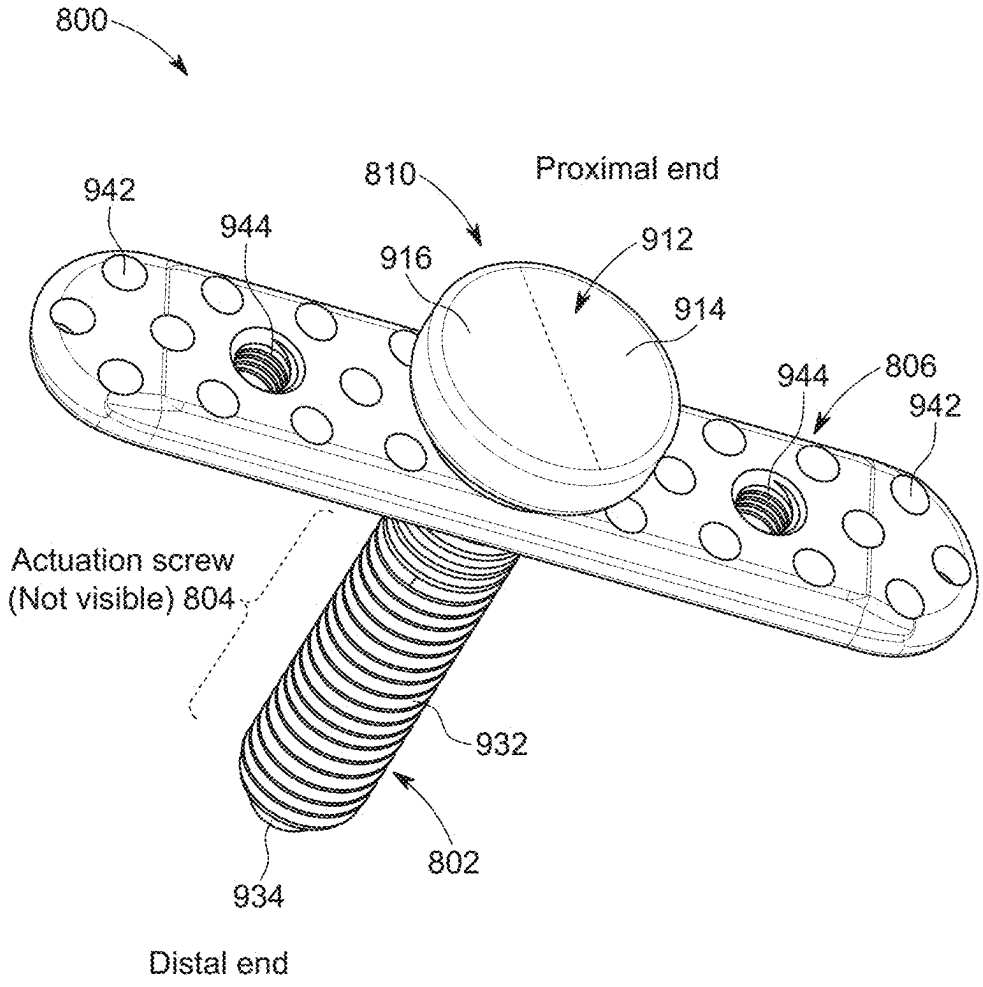

800
942
944
810
Proximal end
916
912
914
944
806
942
Actuation screw
(Not visible) 804
932
802
934
Distal end

FIG. 9

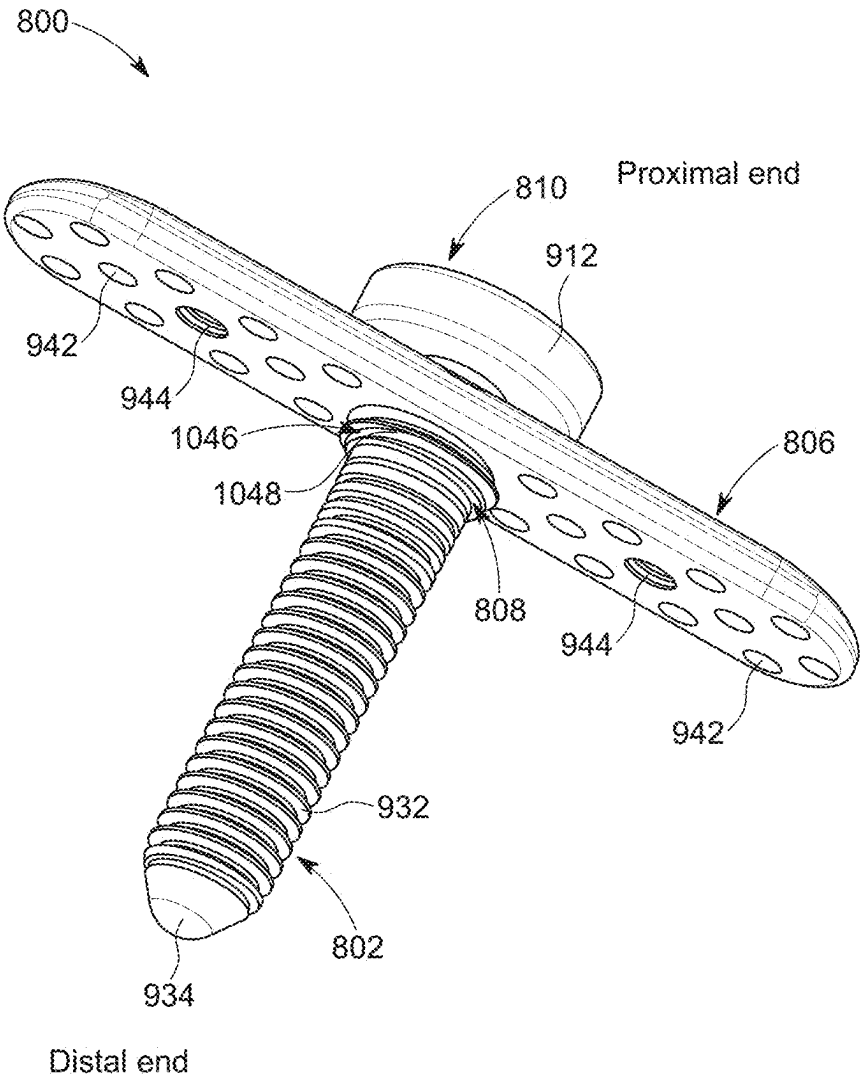

800
810
Proximal end
912
942
944
1046
1048
806
808
944
942
932
802
934
Distal end

FIG. 10

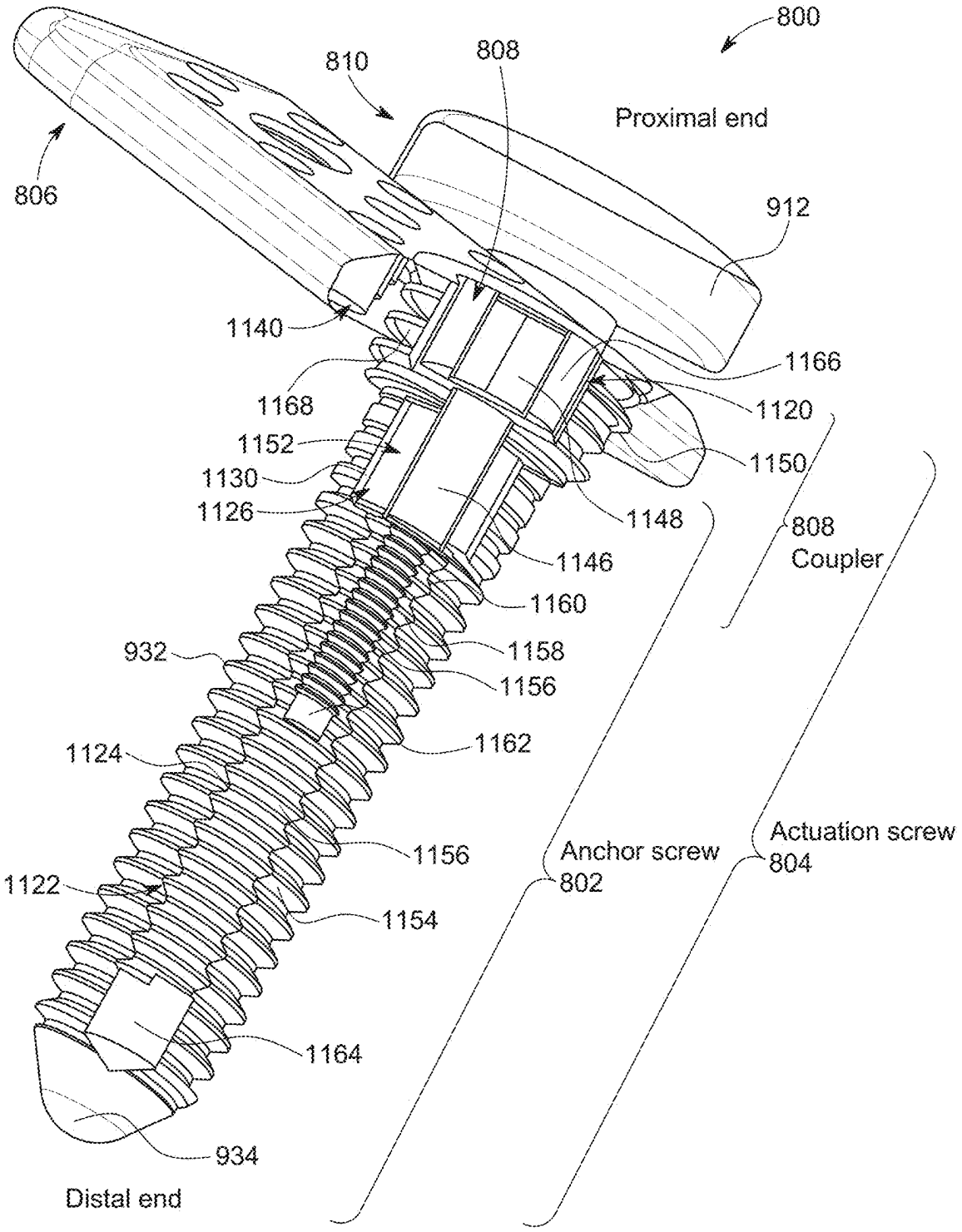

800
810
808
Proximal end
806
912
1140
1166
1168
1120
1152
1150
1130
1126
1148
808
Coupler
1146
1160
932
1158
1156
1124
1162
1156
Anchor screw
802
Actuation screw
804
1122
1154
1164
934
Distal end

FIG. 11

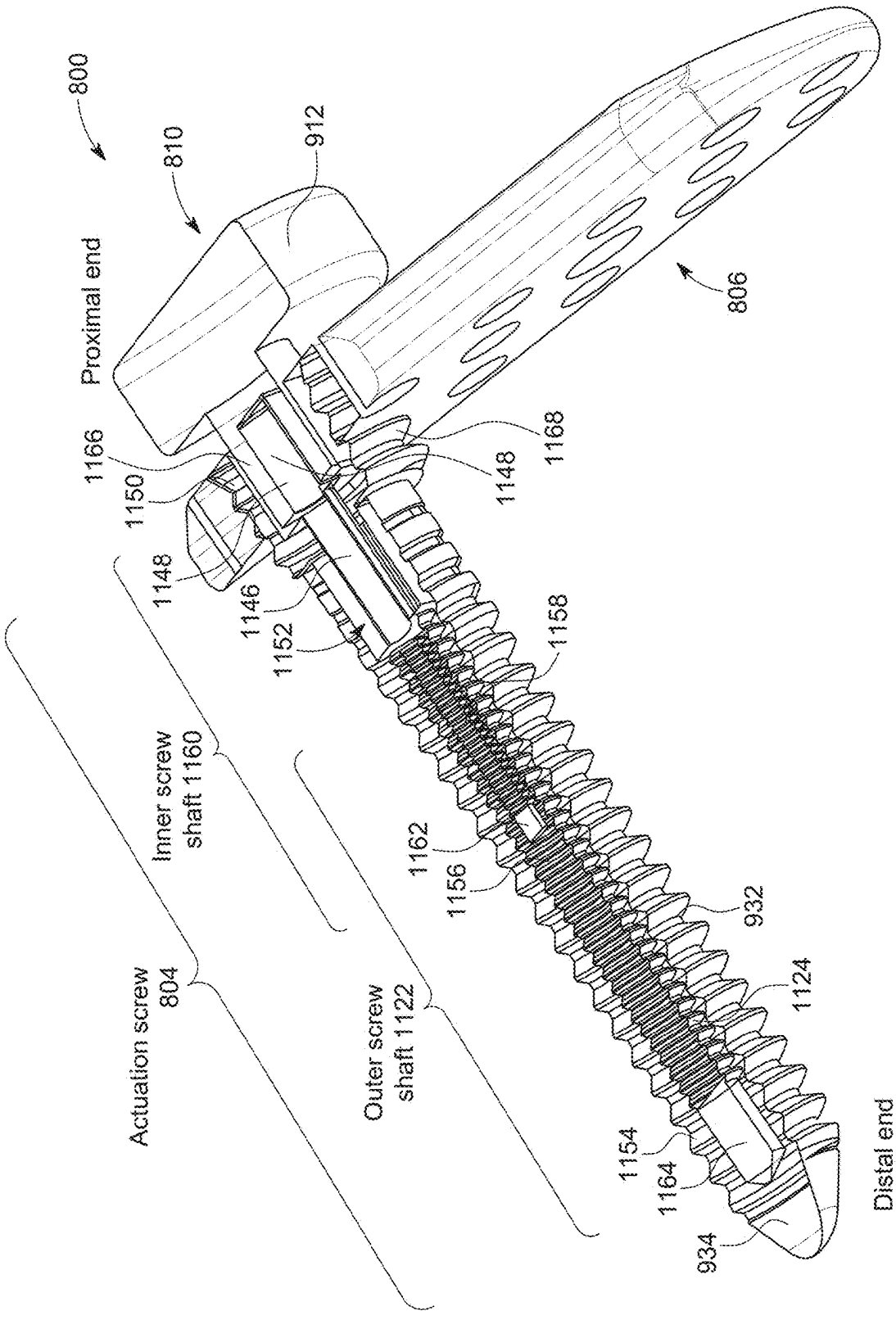

800
810
912
Proximal end
806
1166
1150
1148
1146
1152
1148
1168
1158
Actuation screw 804
Inner screw shaft 1160
Outer screw shaft 1122
1162
1156
932
1124
1154
1164
934
Distal end

FIG. 12

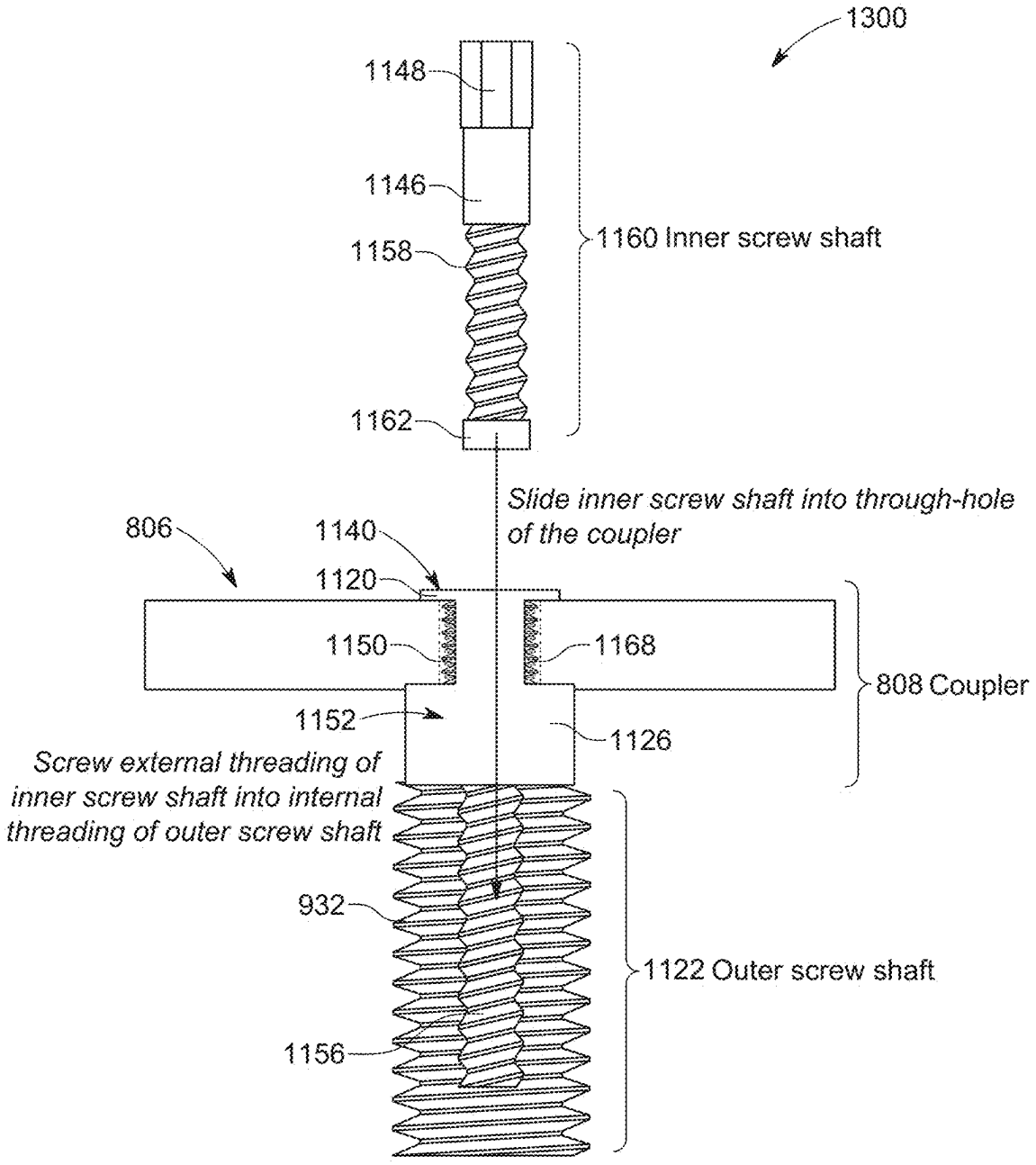

1300
1148
1146
1158
1160 Inner screw shaft
1162
Slide inner screw shaft into through-hole of the coupler
806
1140
1120
1150
1168
808 Coupler
1152
1126
Screw external threading of inner screw shaft into internal threading of outer screw shaft
932
1122 Outer screw shaft
1156

FIG. 13

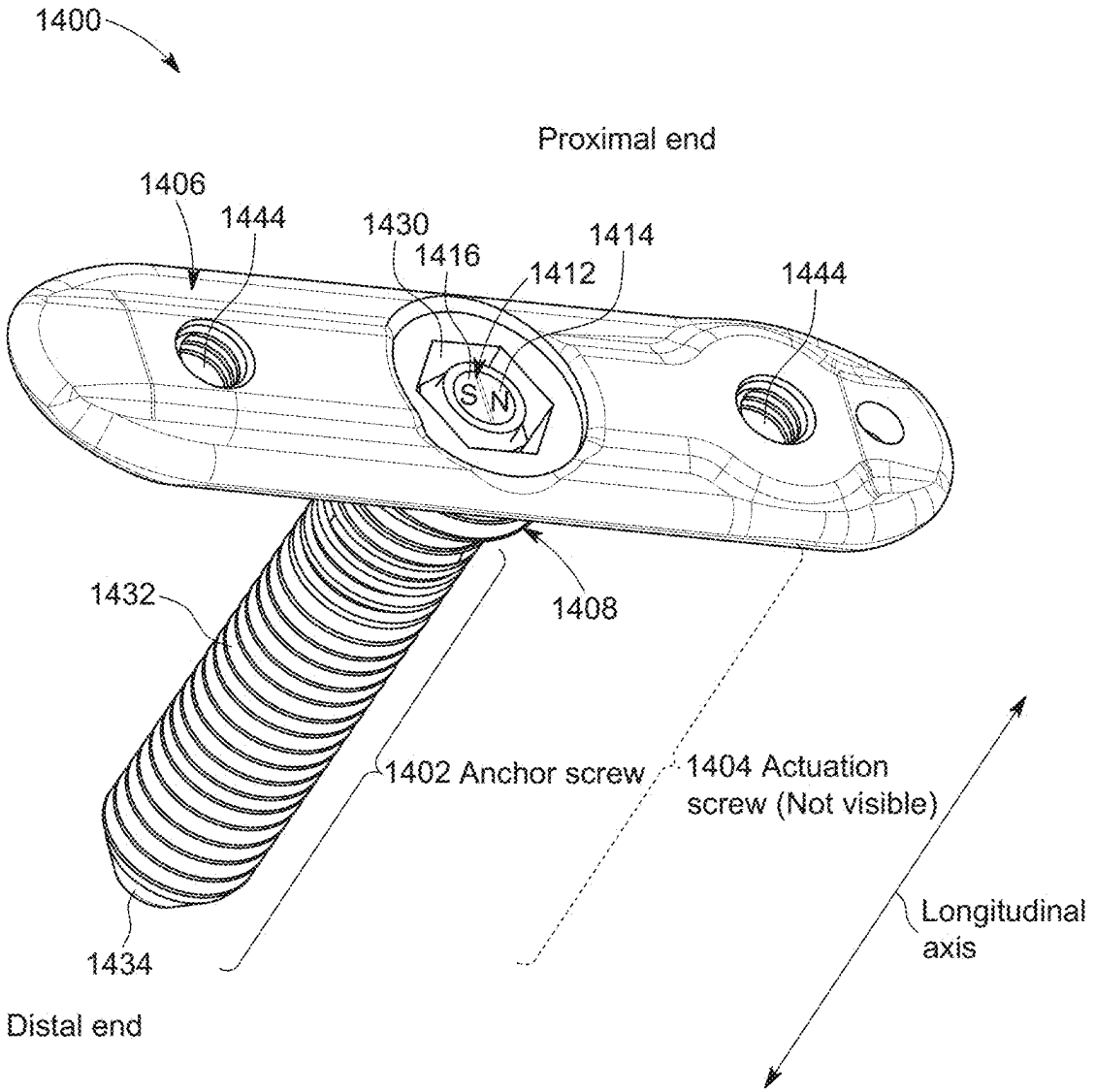

1400
Proximal end
1406
1444
1430
1416
1414
1412
1444
S
N
1432
1408
1402 Anchor screw
1404 Actuation screw (Not visible)
Longitudinal axis
1434
Distal end

FIG. 14

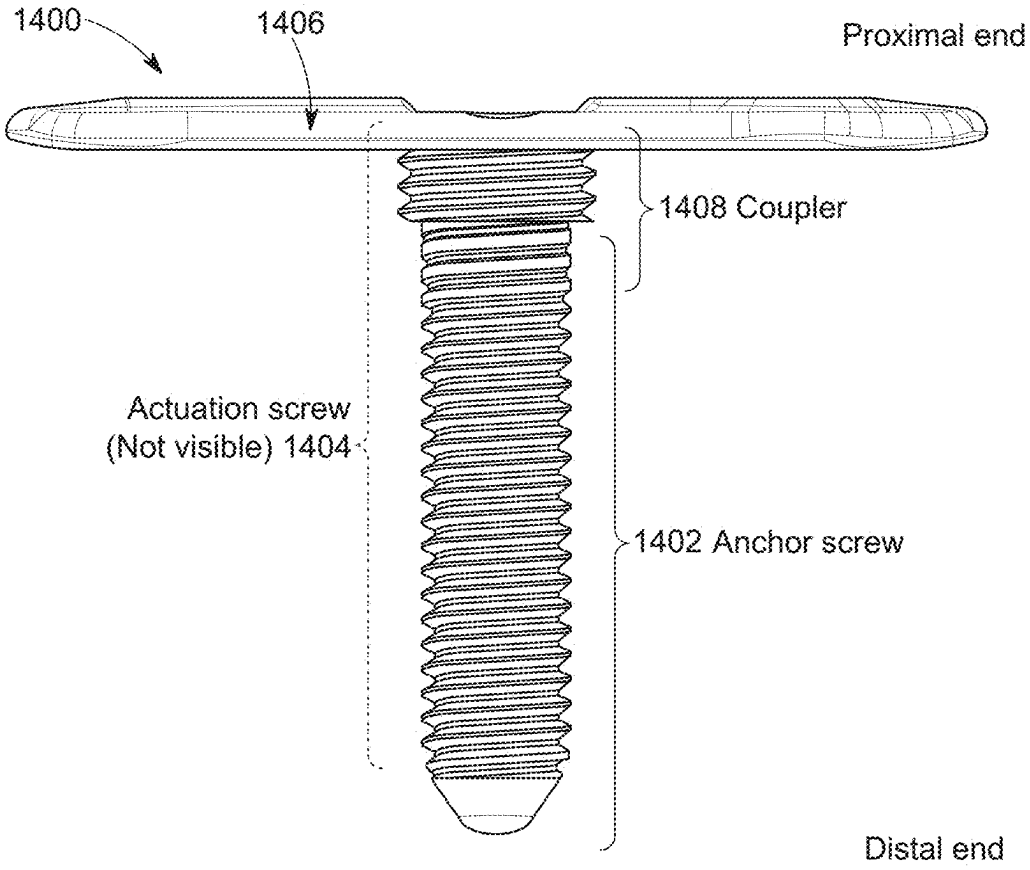

1400
1406
Proximal end
1408 Coupler
Actuation screw
(Not visible) 1404
1402 Anchor screw
Distal end

FIG. 15

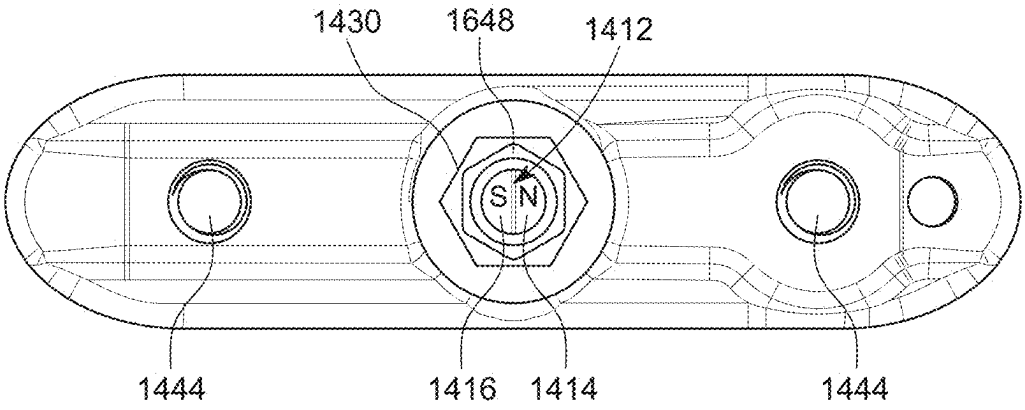

1430
1648
1412
S
N
1444
1416
1414
1444

FIG. 16

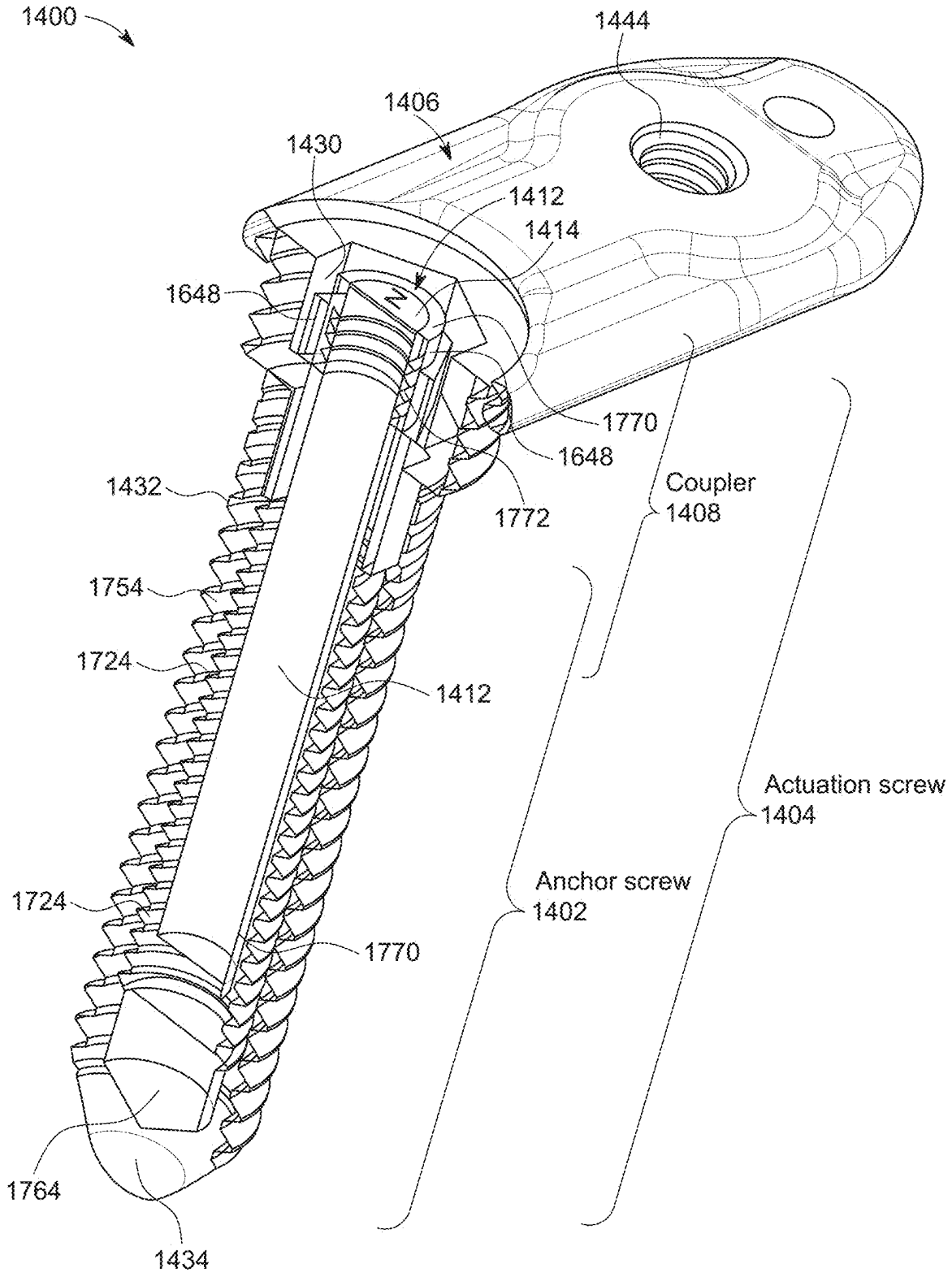

1400
1444
1406
1430
1412
1414
1648
1770
1648
1432
1772
Coupler
1408
1754
1724
1412
Actuation screw
1404
Anchor screw
1402
1724
1770
1764
1434

FIG. 17

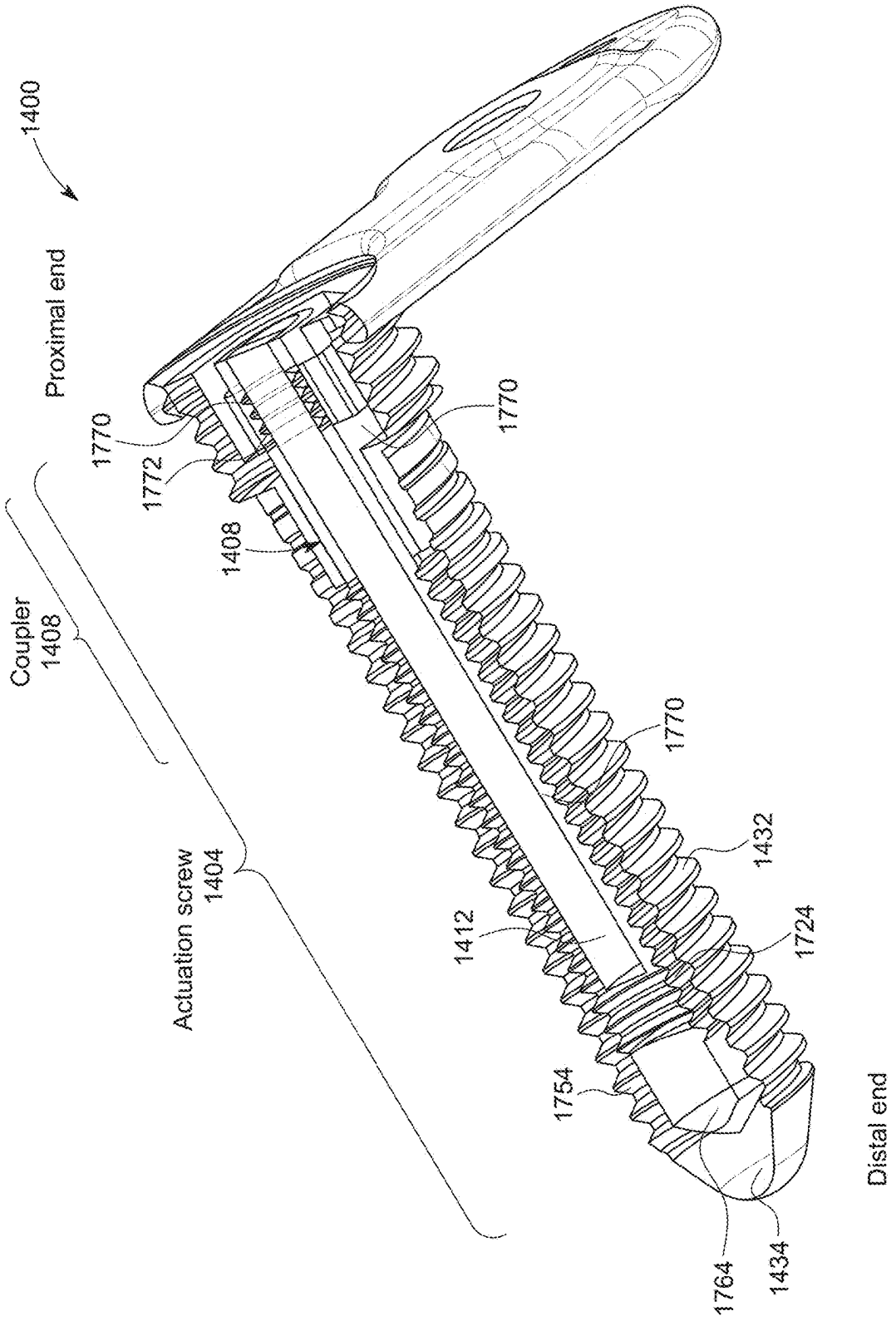

1400
Proximal end
1770
1772
1408
1770
Coupler
1408
Actuation screw
1404
1770
1432
1412
1724
1754
Distal end
1764
1434

FIG. 18

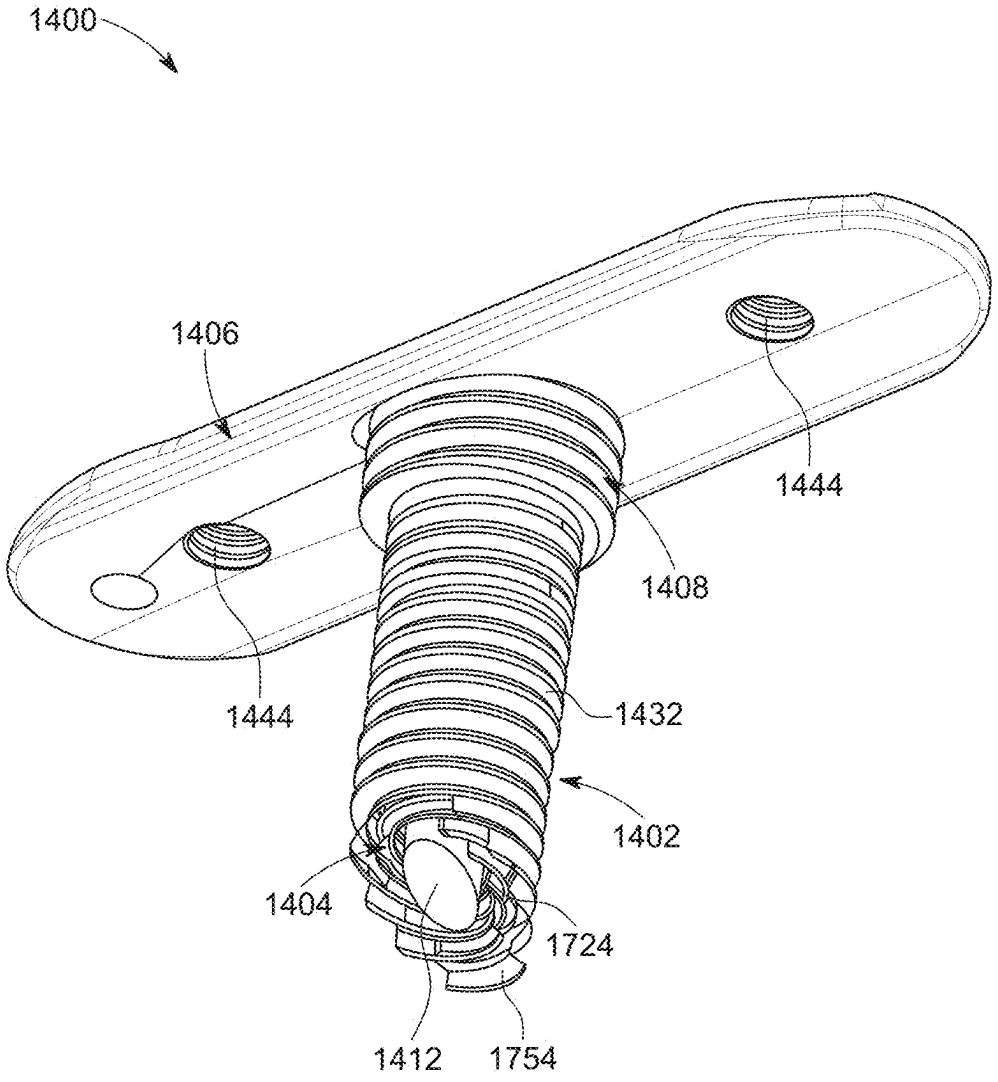


FIG. 19

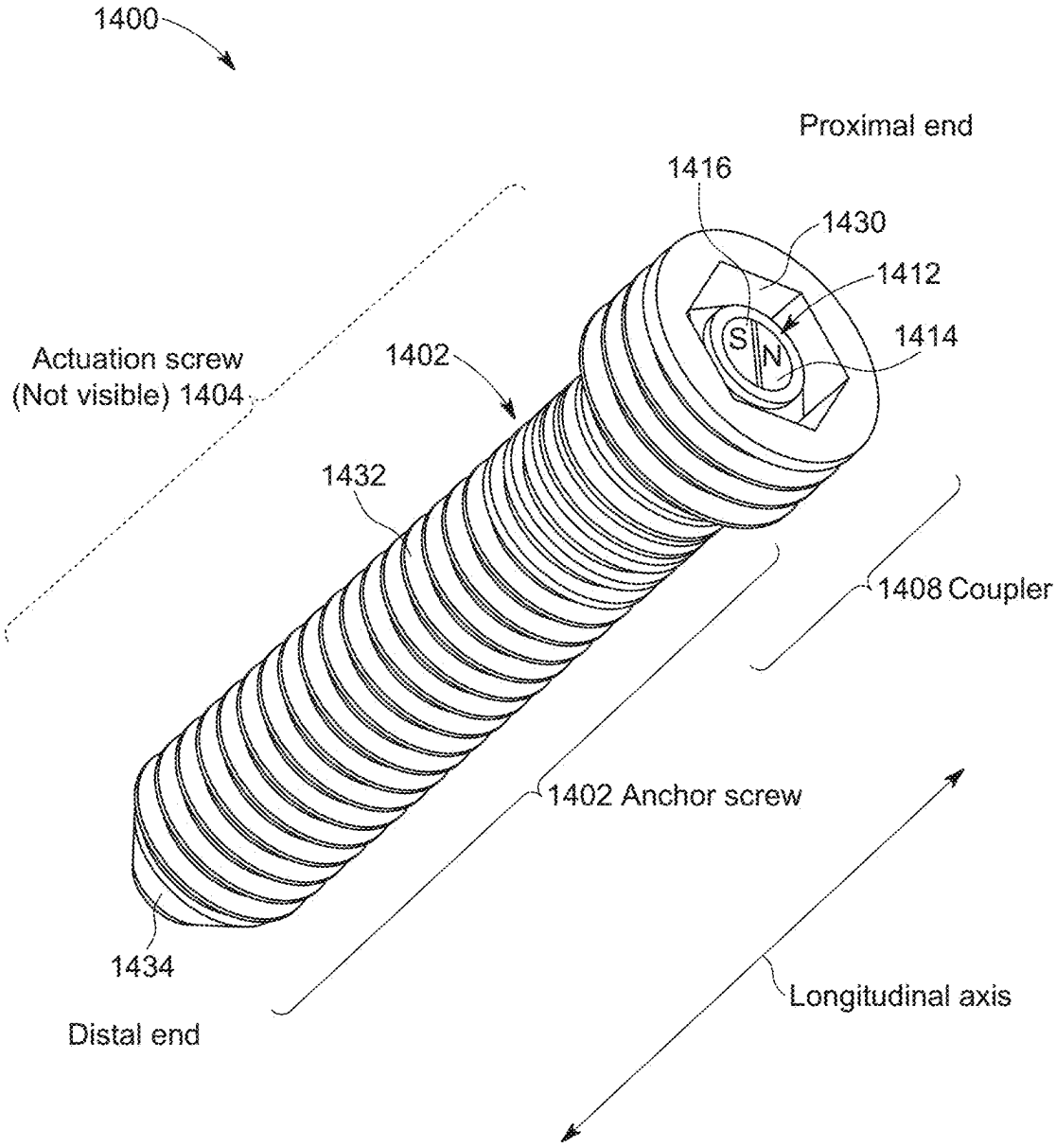

1400
Proximal end
1416
1430
1412
1414
S
N
Actuation screw
(Not visible) 1404
1402
1432
1408 Coupler
1402 Anchor screw
1434
Distal end
Longitudinal axis

FIG. 20

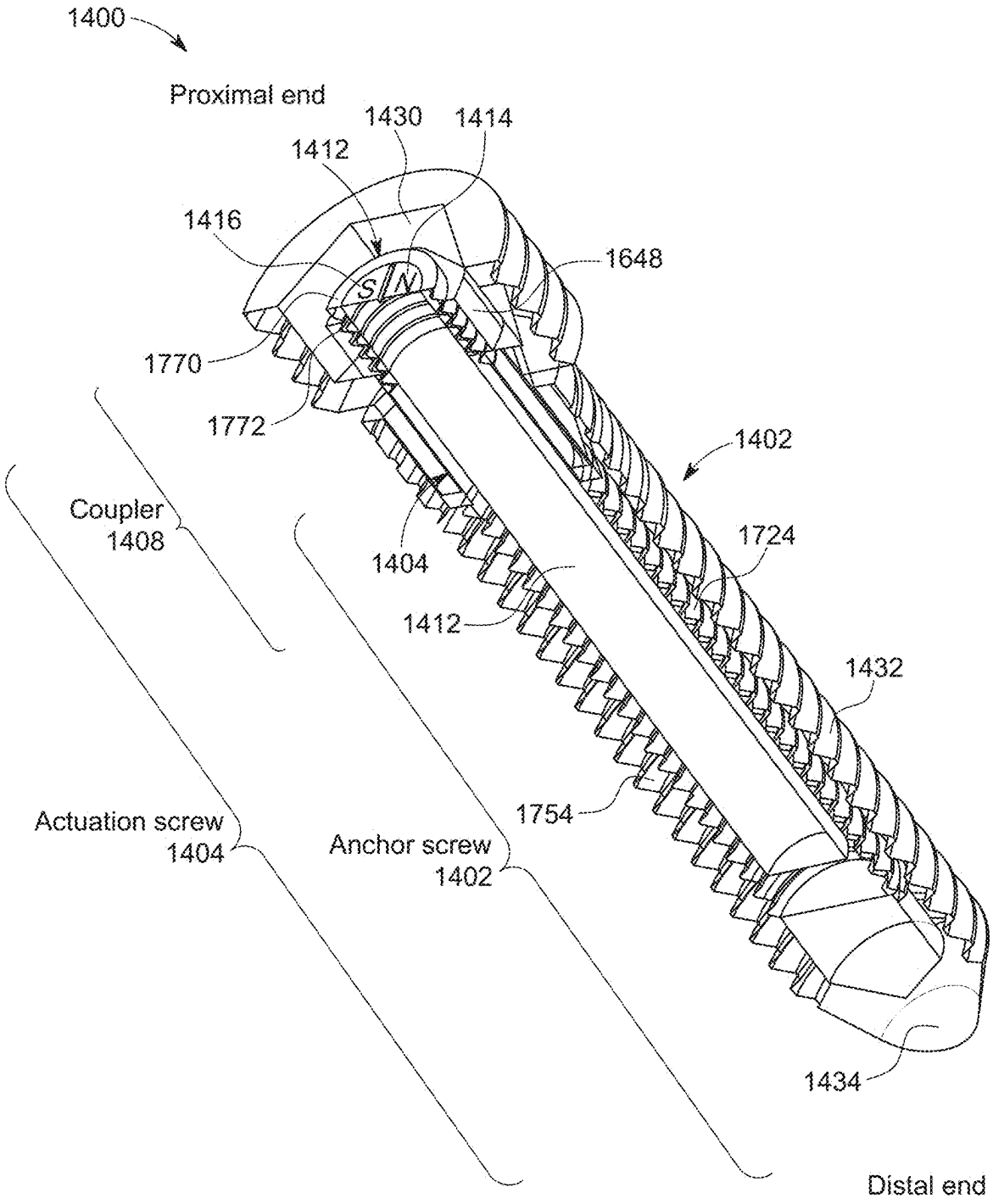

1400
Proximal end
1430
1414
1412
1416
1648
S
N
1770
1772
1402
Coupler
1408
1404
1724
1412
1432
1754
Actuation screw
1404
Anchor screw
1402
1434
Distal end

FIG. 21

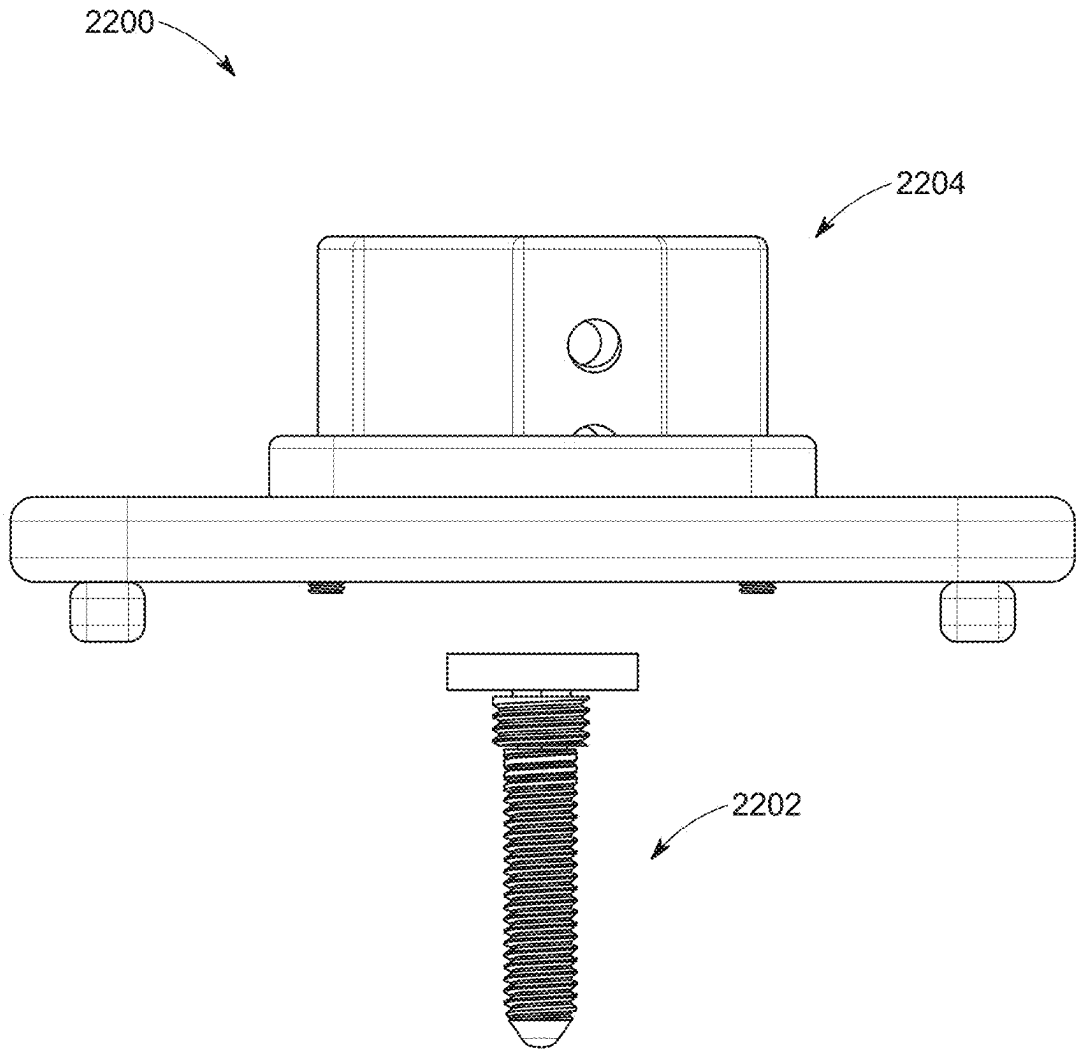


FIG. 22

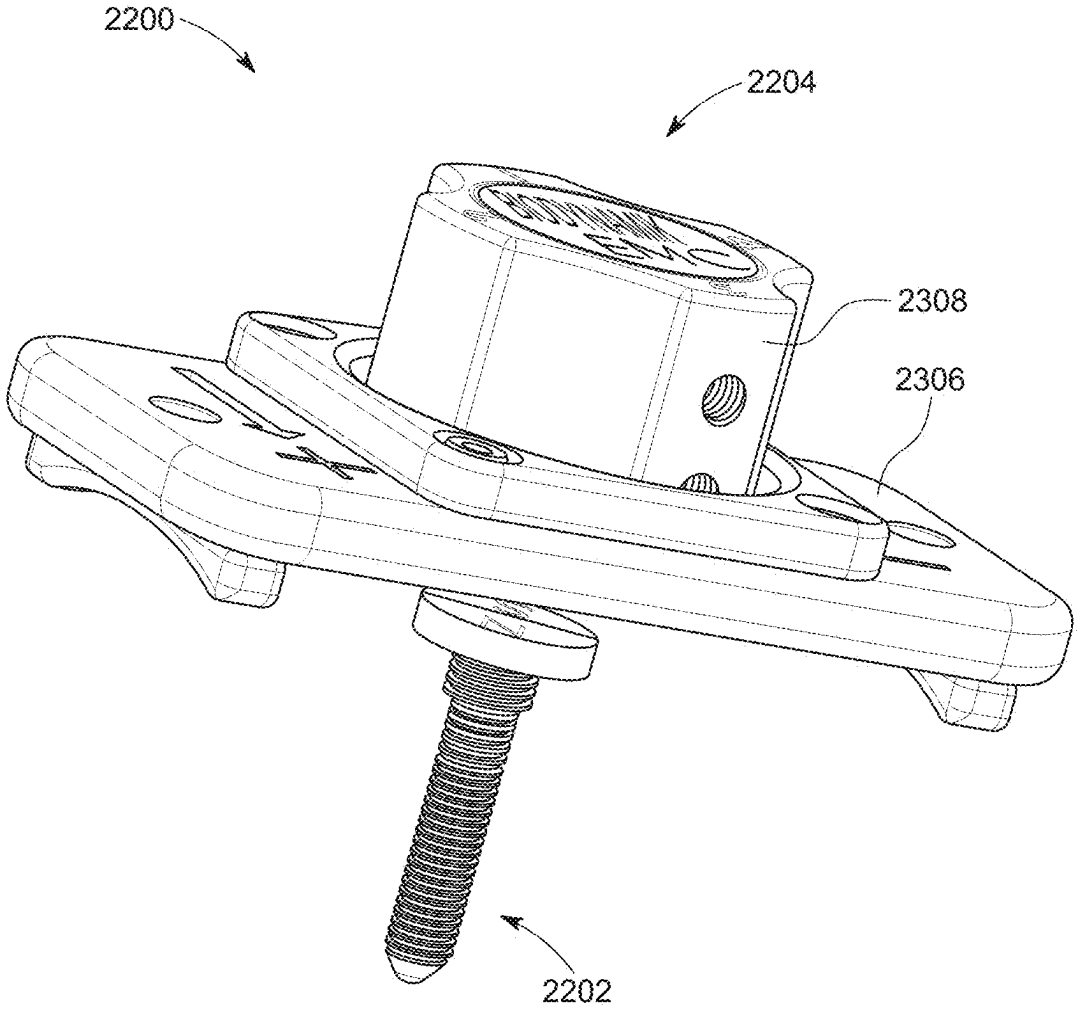


FIG. 23

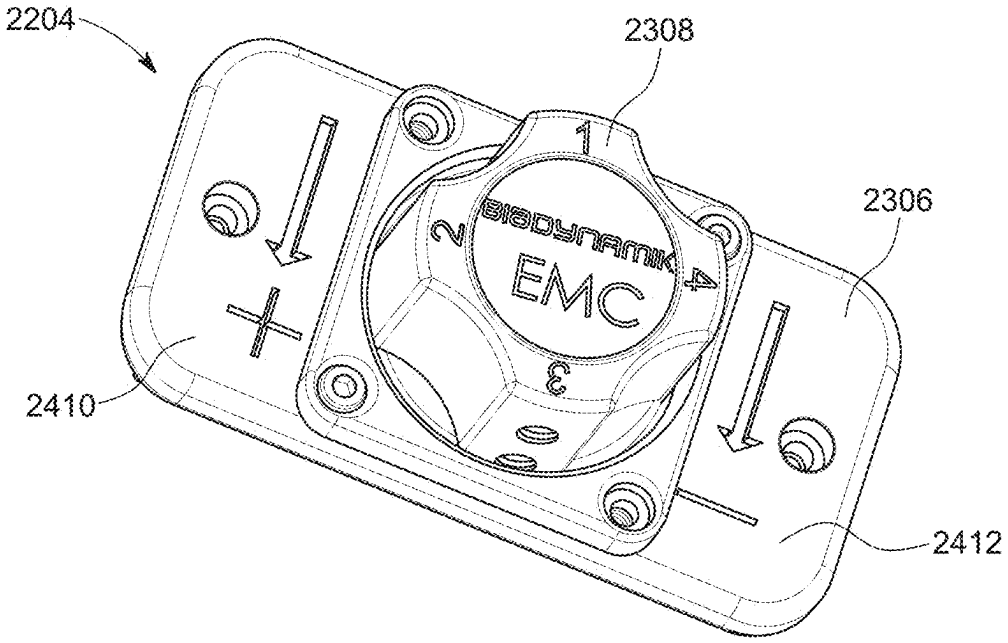

2204
2308
2306
2410
2412
1
2
3
4
BIODYNAMIK
EMC

FIG. 24

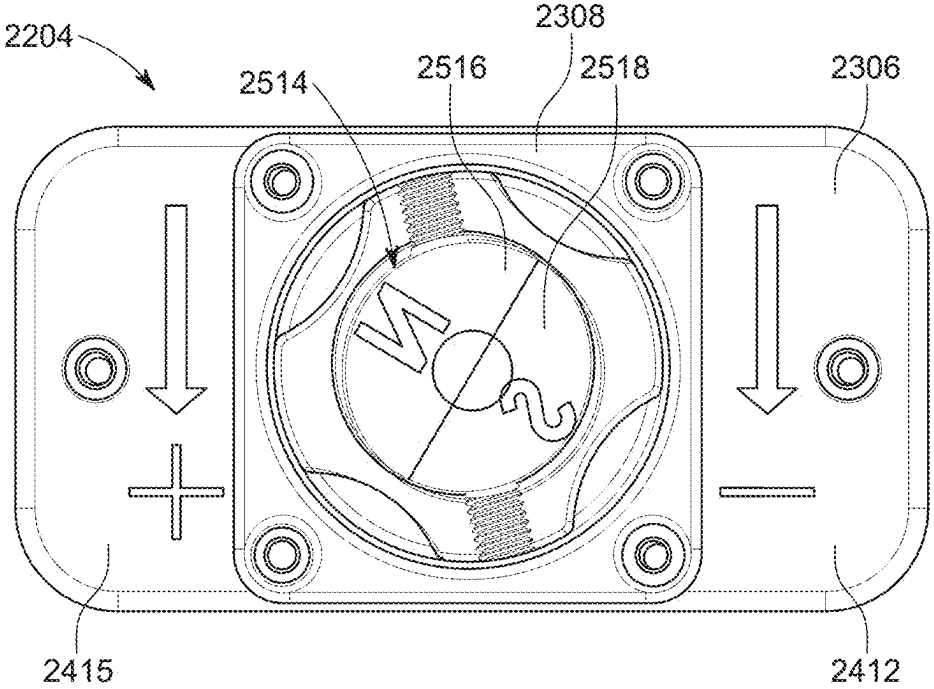

2204
2308
2514
2516
2518
2306
2415
2412

FIG. 25

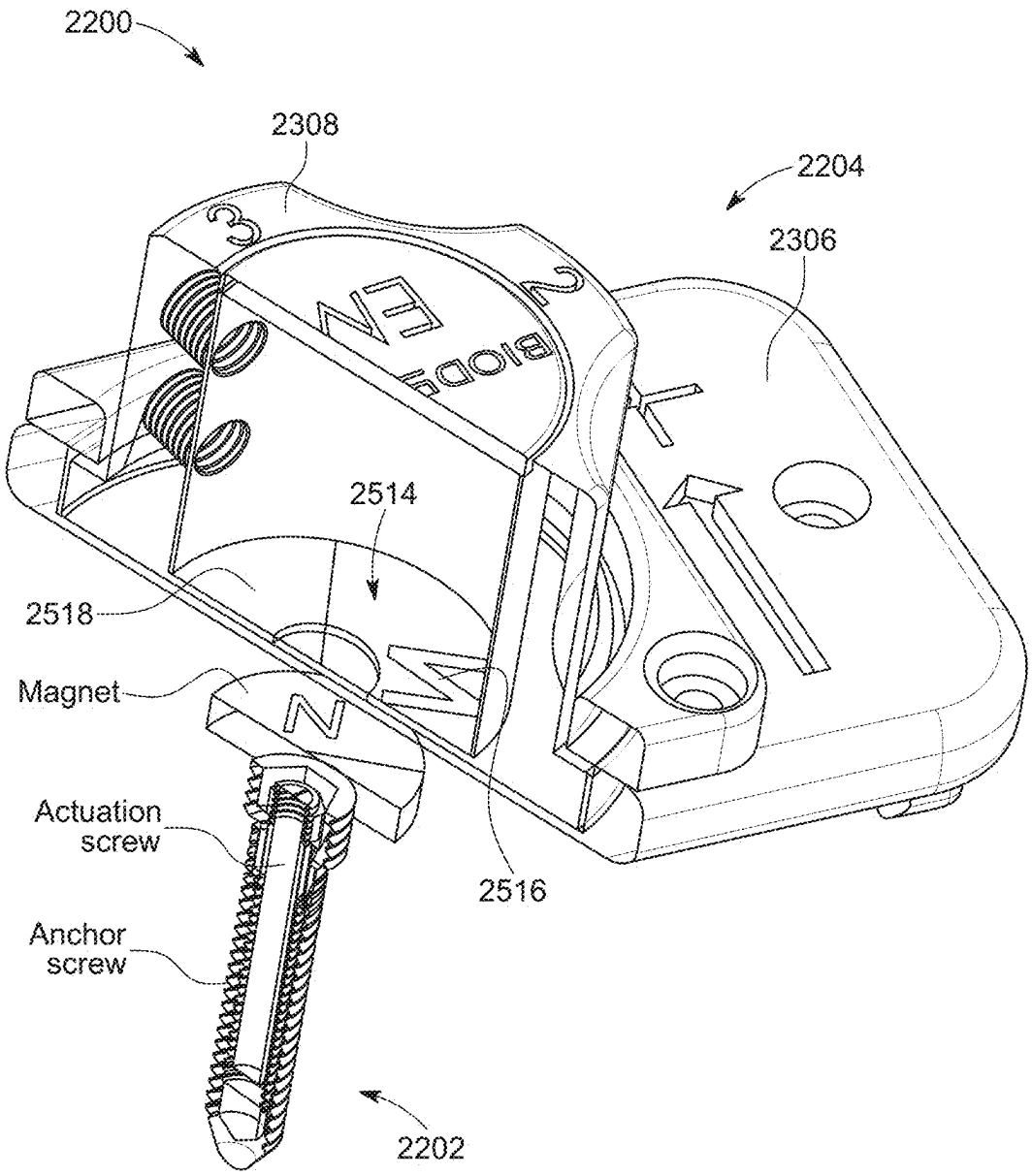

2200
2308
2204
2306
2514
2518
Magnet
Actuation screw
Anchor screw
2516
2202

FIG. 26

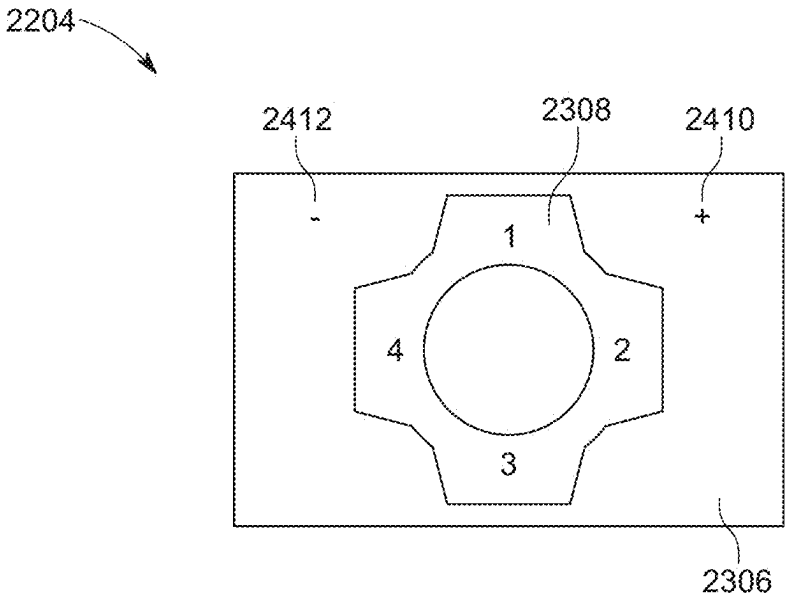


FIG. 27A

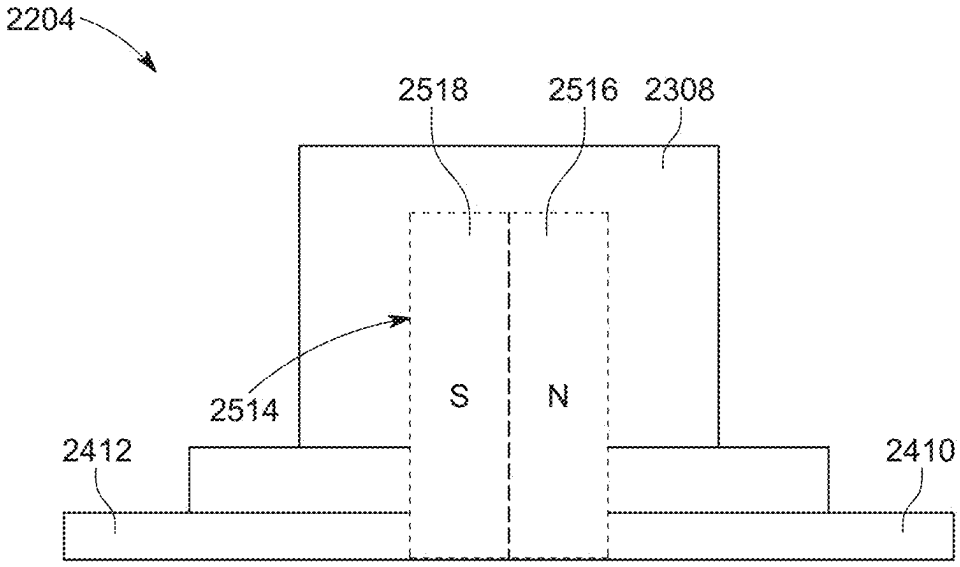


FIG. 27B

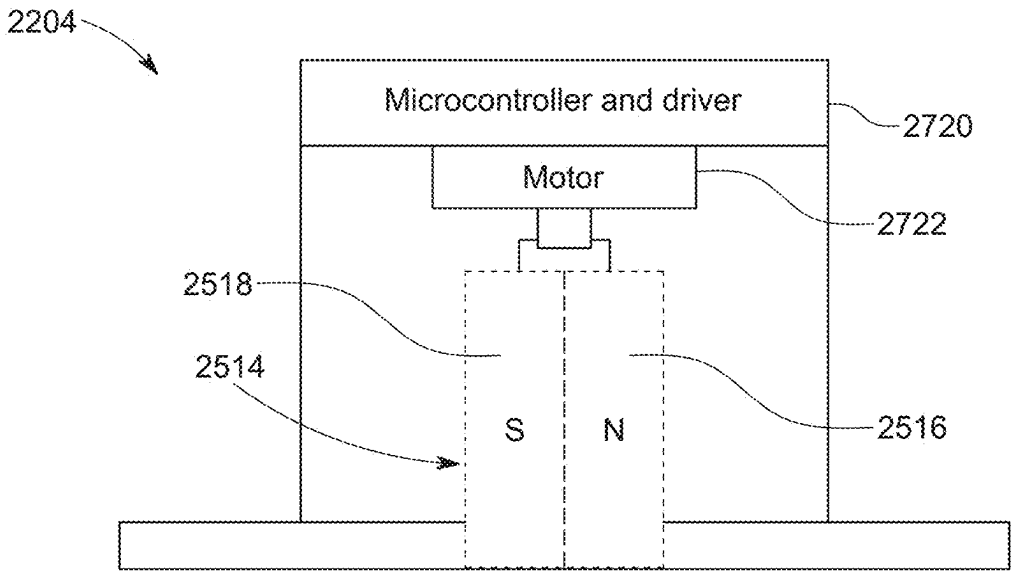


FIG. 27C

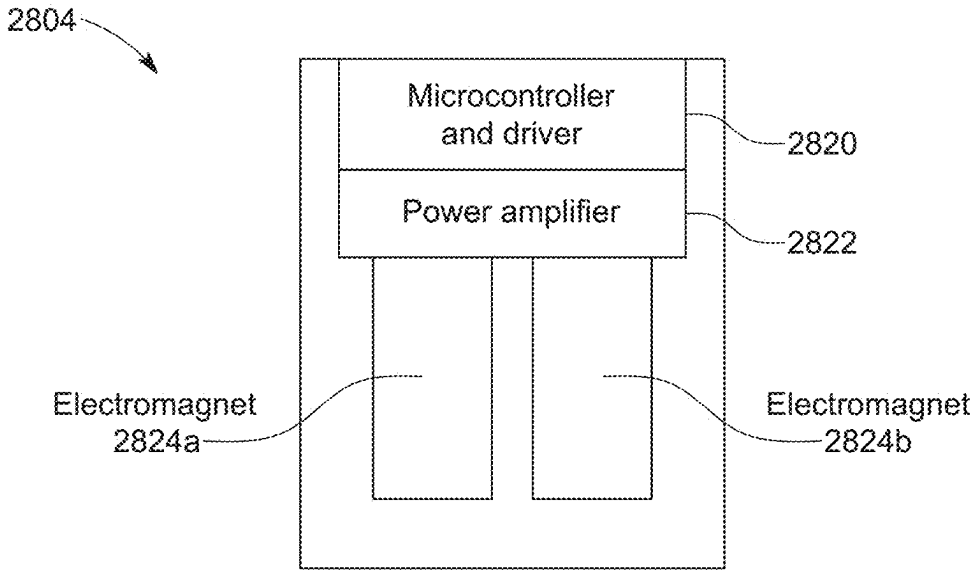


FIG. 28

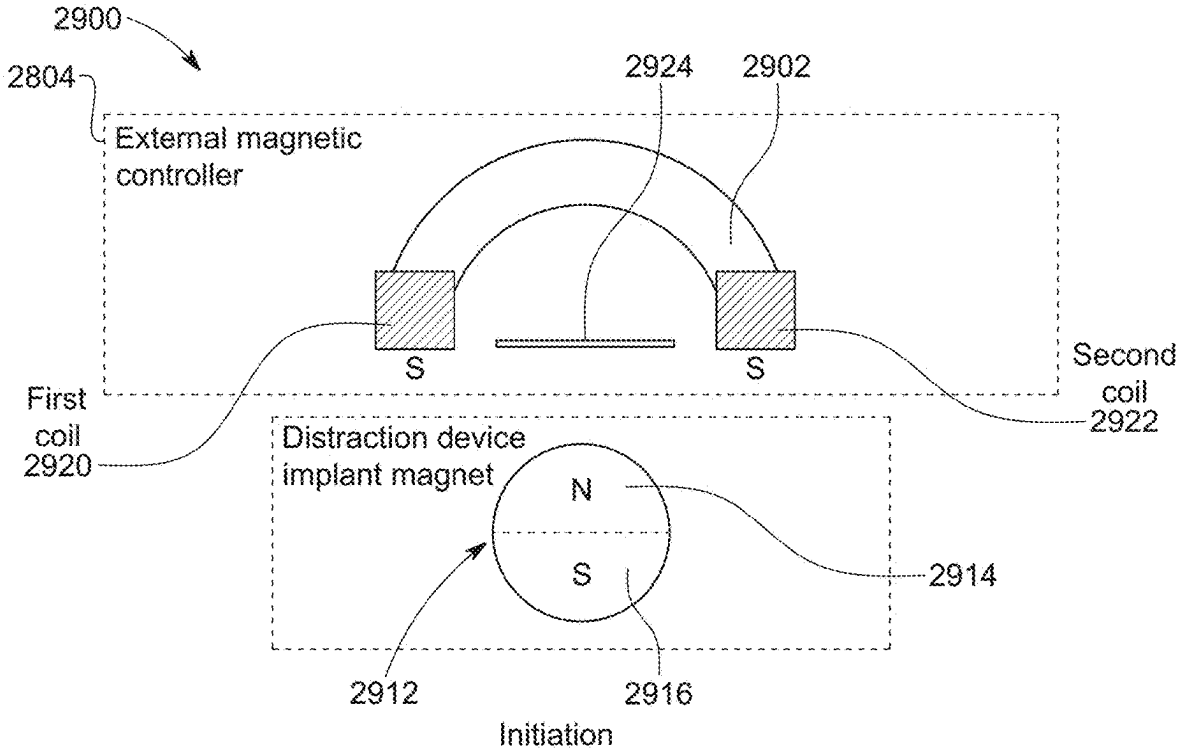


FIG. 29A

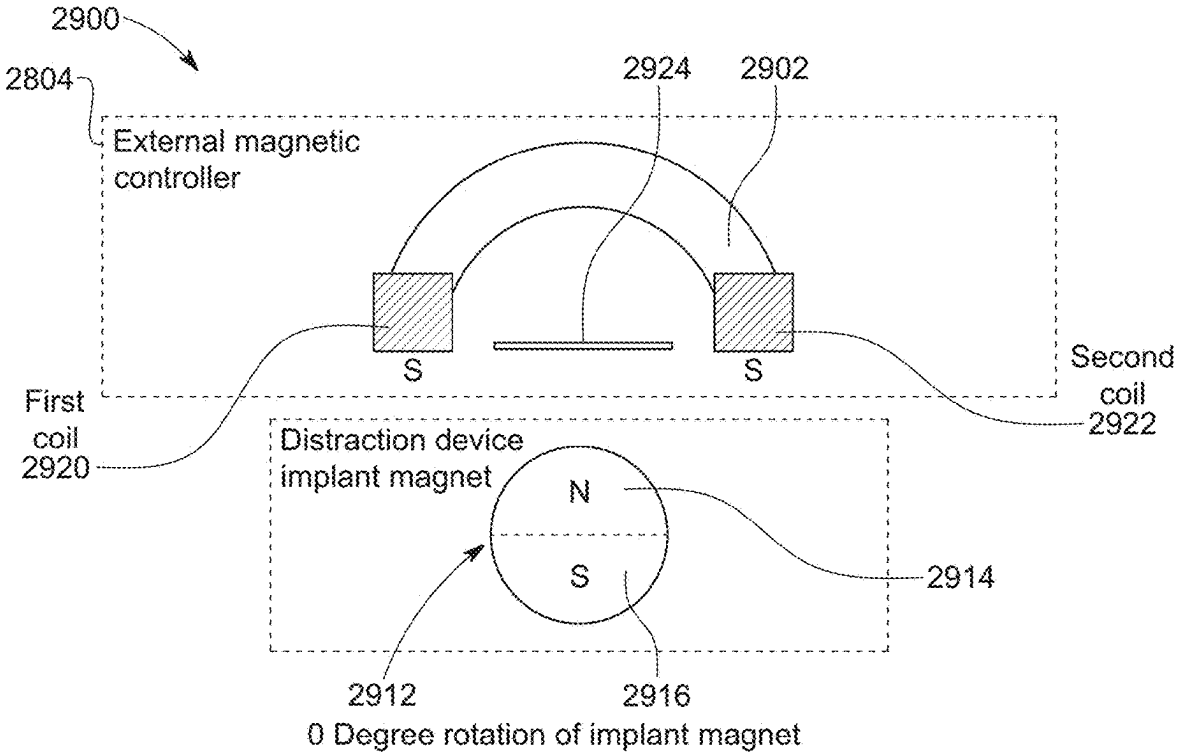


FIG. 29B

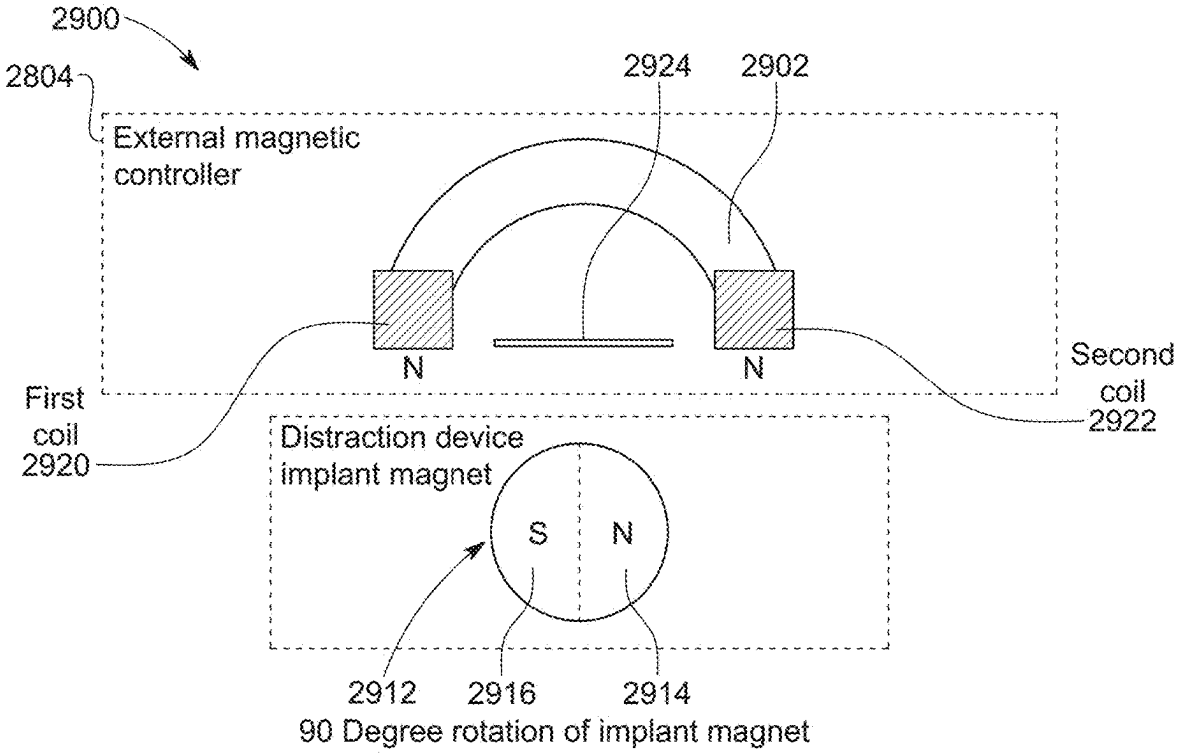


FIG. 29C

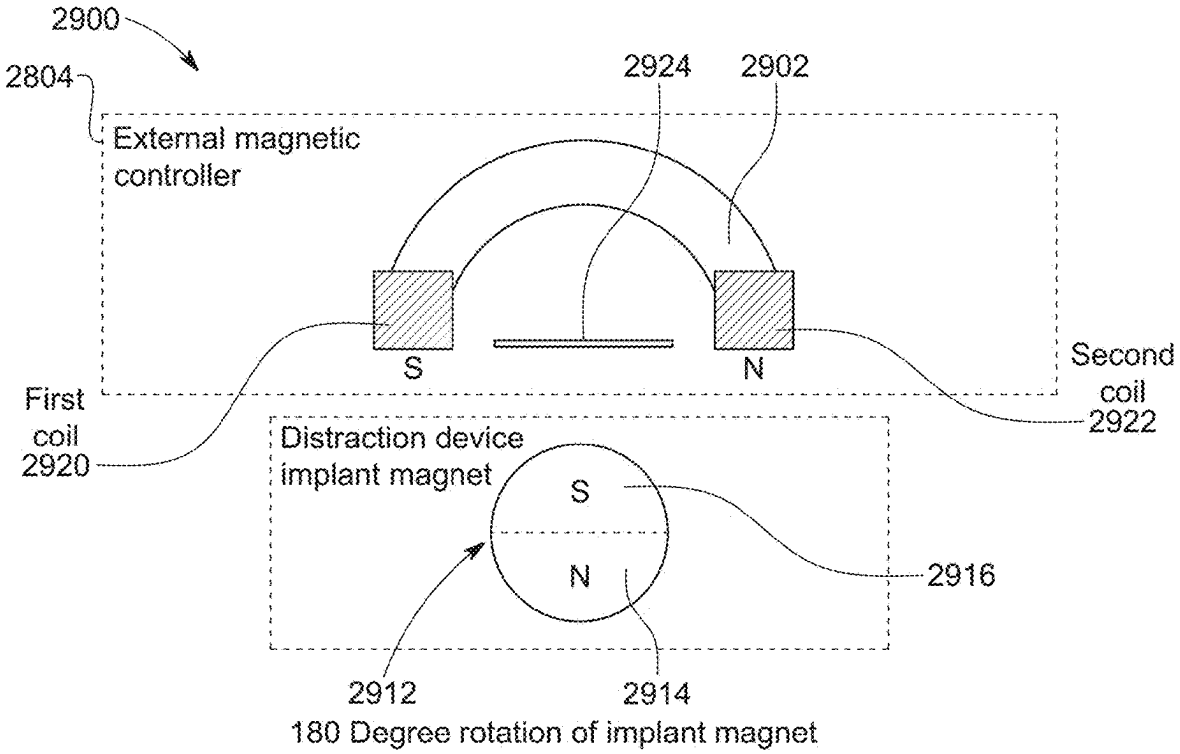


FIG. 29D

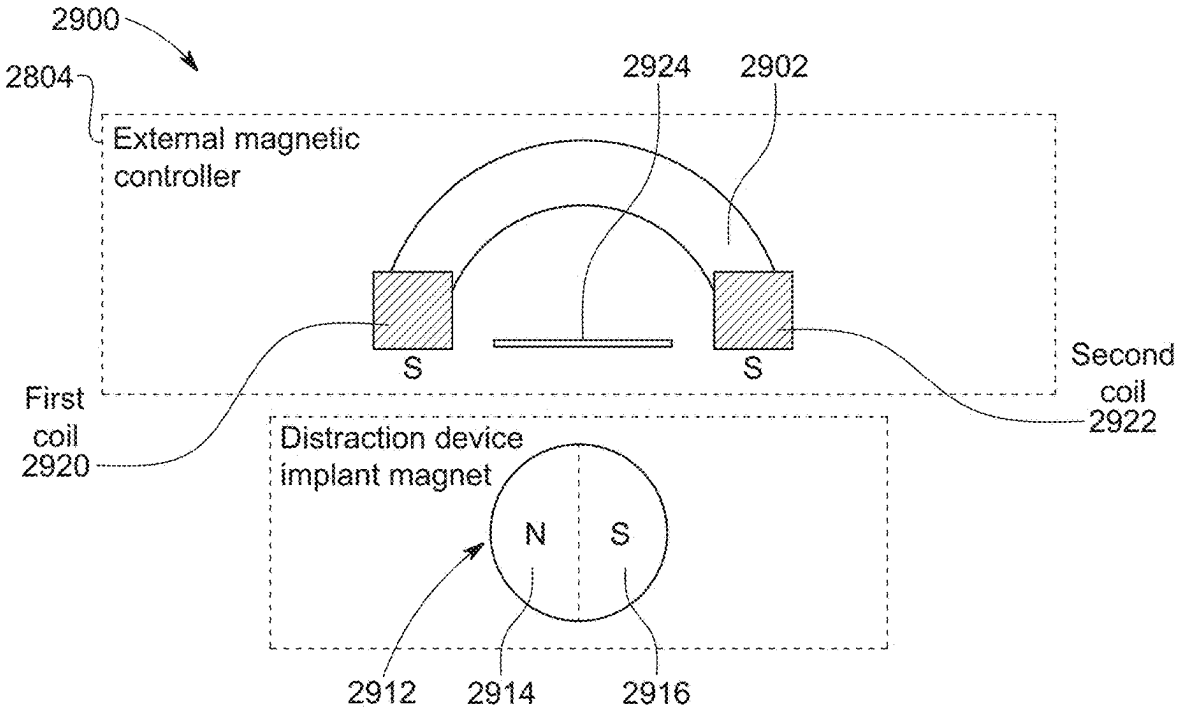


FIG. 29E

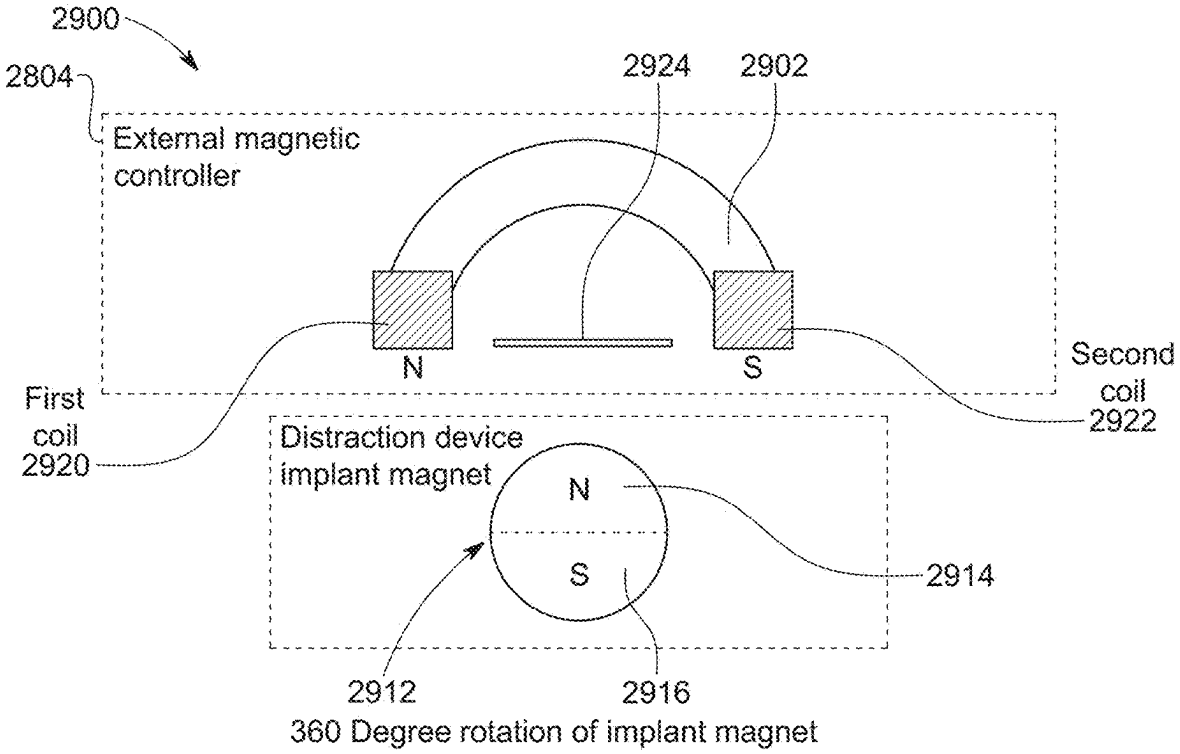


FIG. 29F

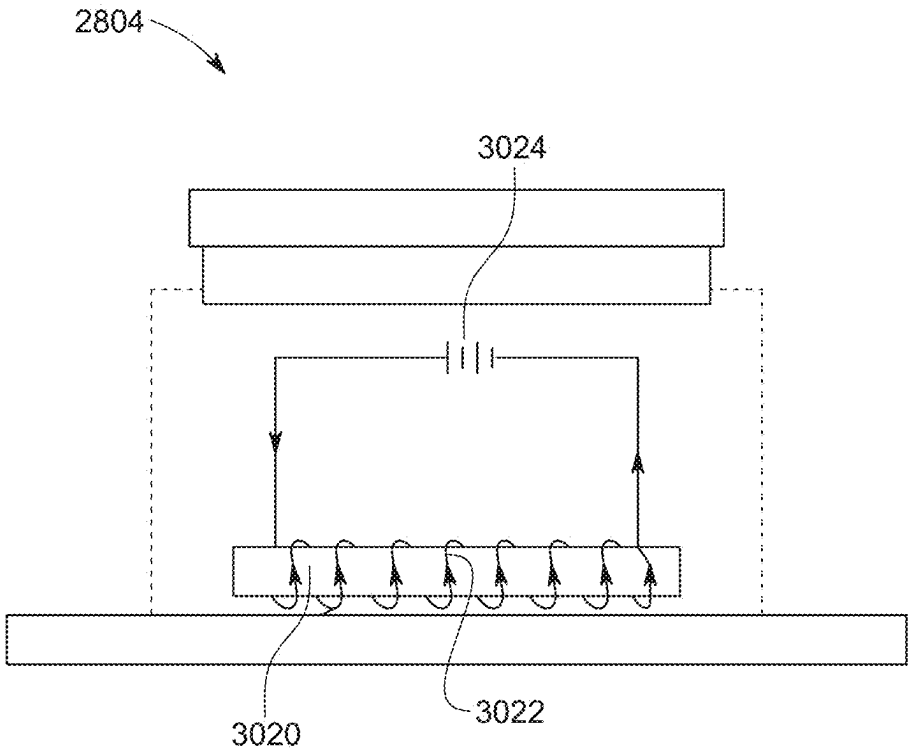


FIG. 30

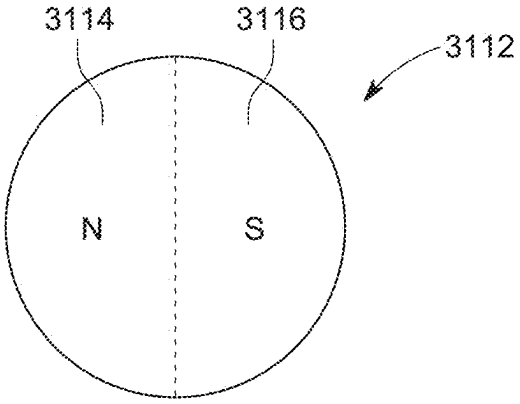


FIG. 31A

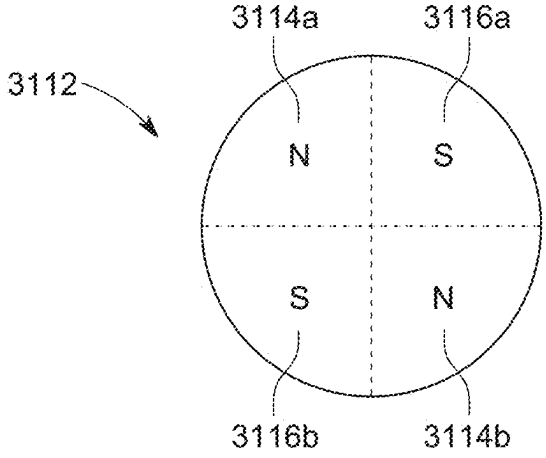


FIG. 31B

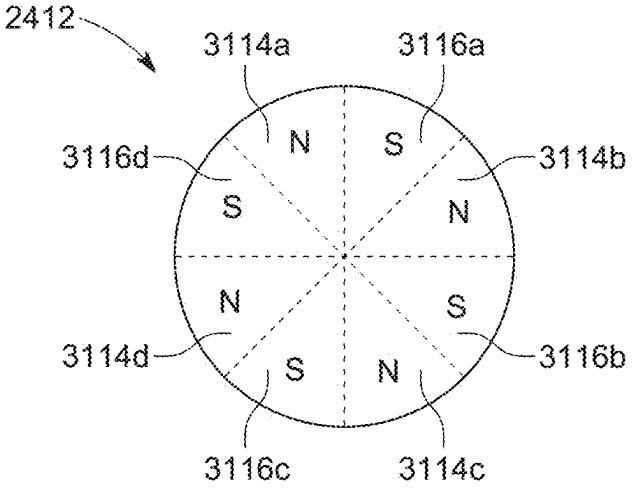


FIG. 31C

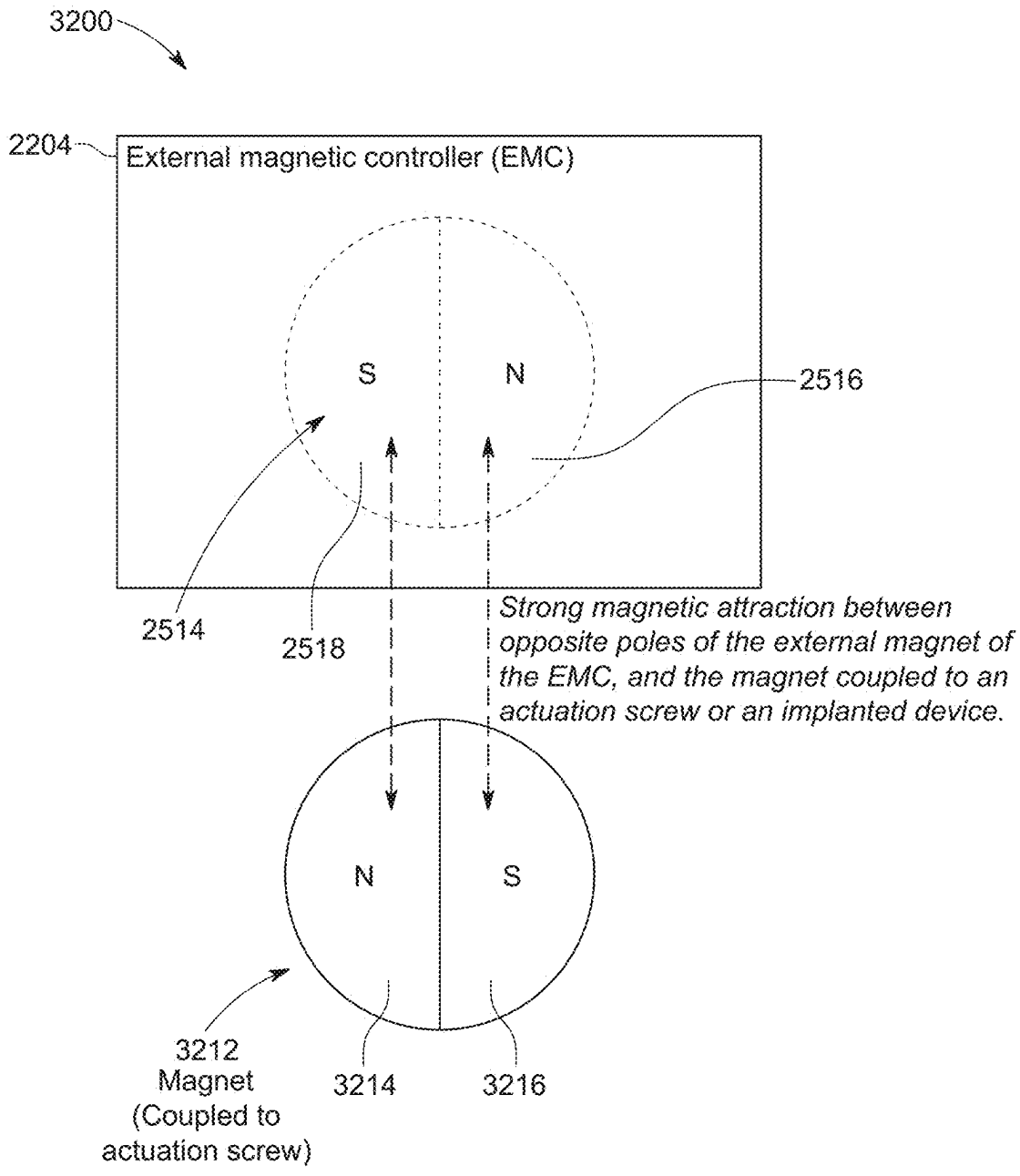

3200
2204
External magnetic controller (EMC)
S
N
2516
2514
2518
Strong magnetic attraction between opposite poles of the external magnet of the EMC, and the magnet coupled to an actuation screw or an implanted device.
N
S
3212
Magnet
(Coupled to
actuation screw)
3214
3216

FIG. 32A

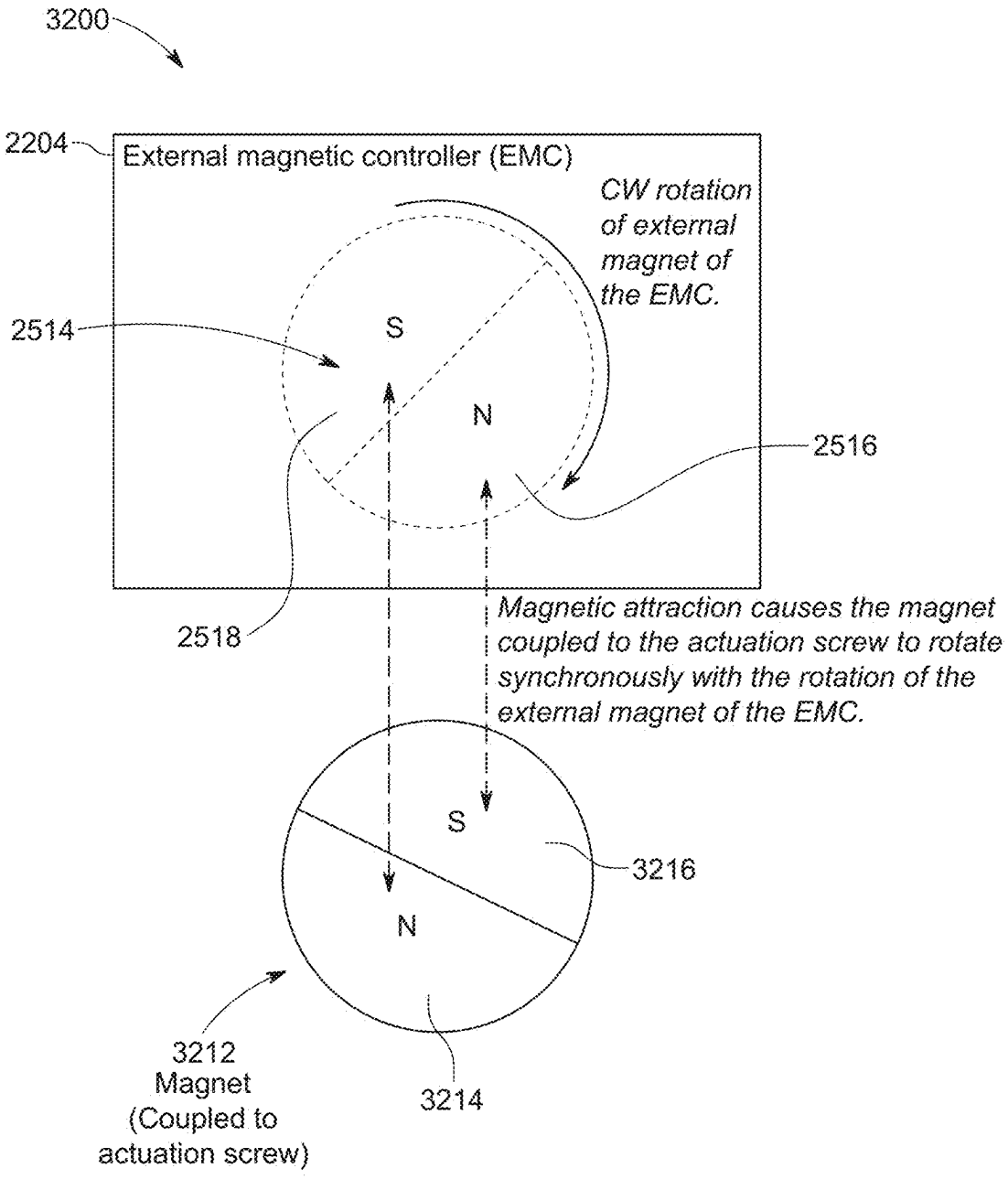

3200
2204
External magnetic controller (EMC)
CW rotation of external magnet of the EMC.
2514
S
N
2516
2518
Magnetic attraction causes the magnet coupled to the actuation screw to rotate synchronously with the rotation of the external magnet of the EMC.
S
3216
N
3212
Magnet
(Coupled to actuation screw)
3214

FIG. 32B

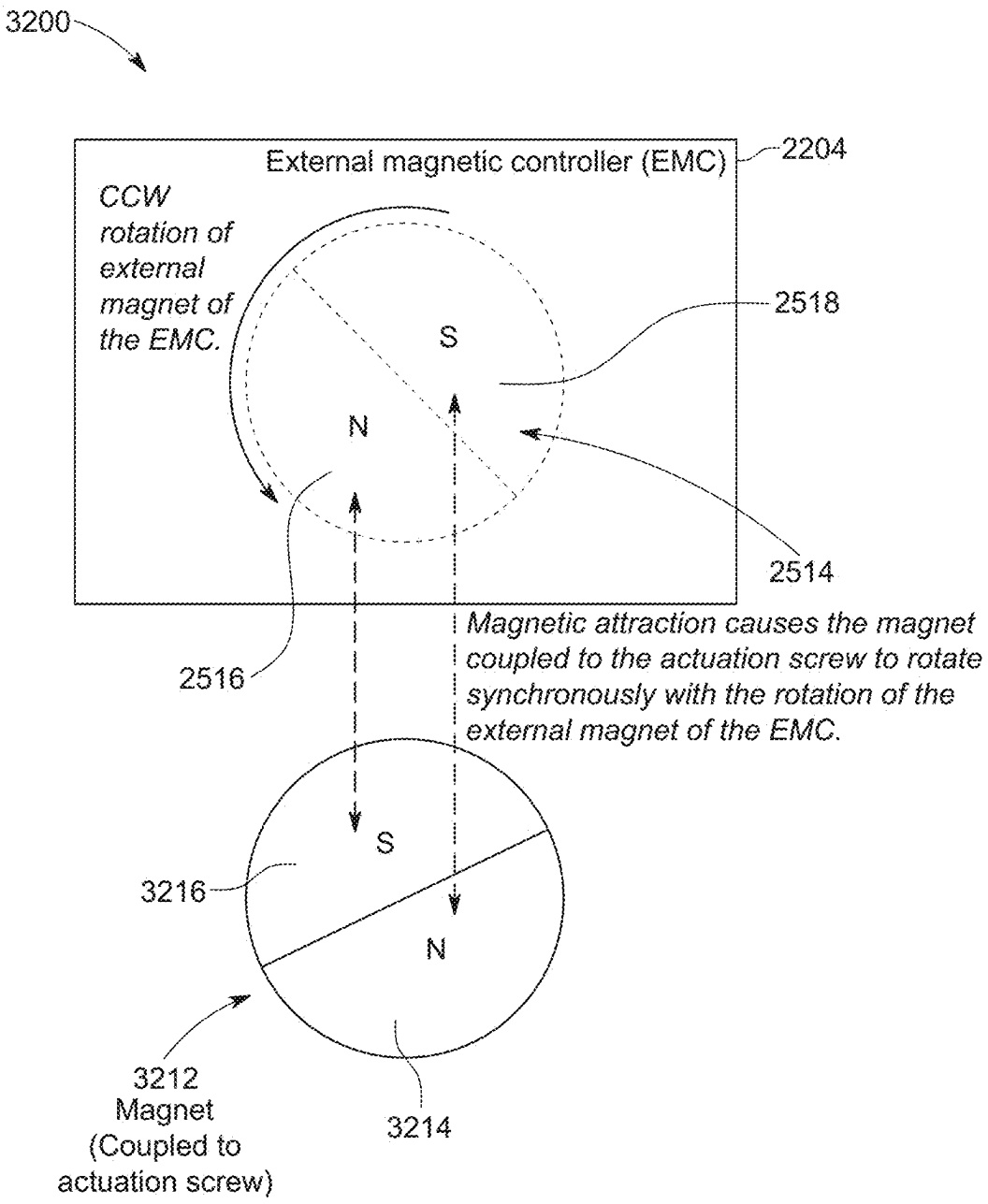

3200
External magnetic controller (EMC)
2204
CCW rotation of external magnet of the EMC.
2518
S
N
2514
2516
Magnetic attraction causes the magnet coupled to the actuation screw to rotate synchronously with the rotation of the external magnet of the EMC.
S
3216
N
3212
Magnet
(Coupled to actuation screw)
3214

FIG. 32C

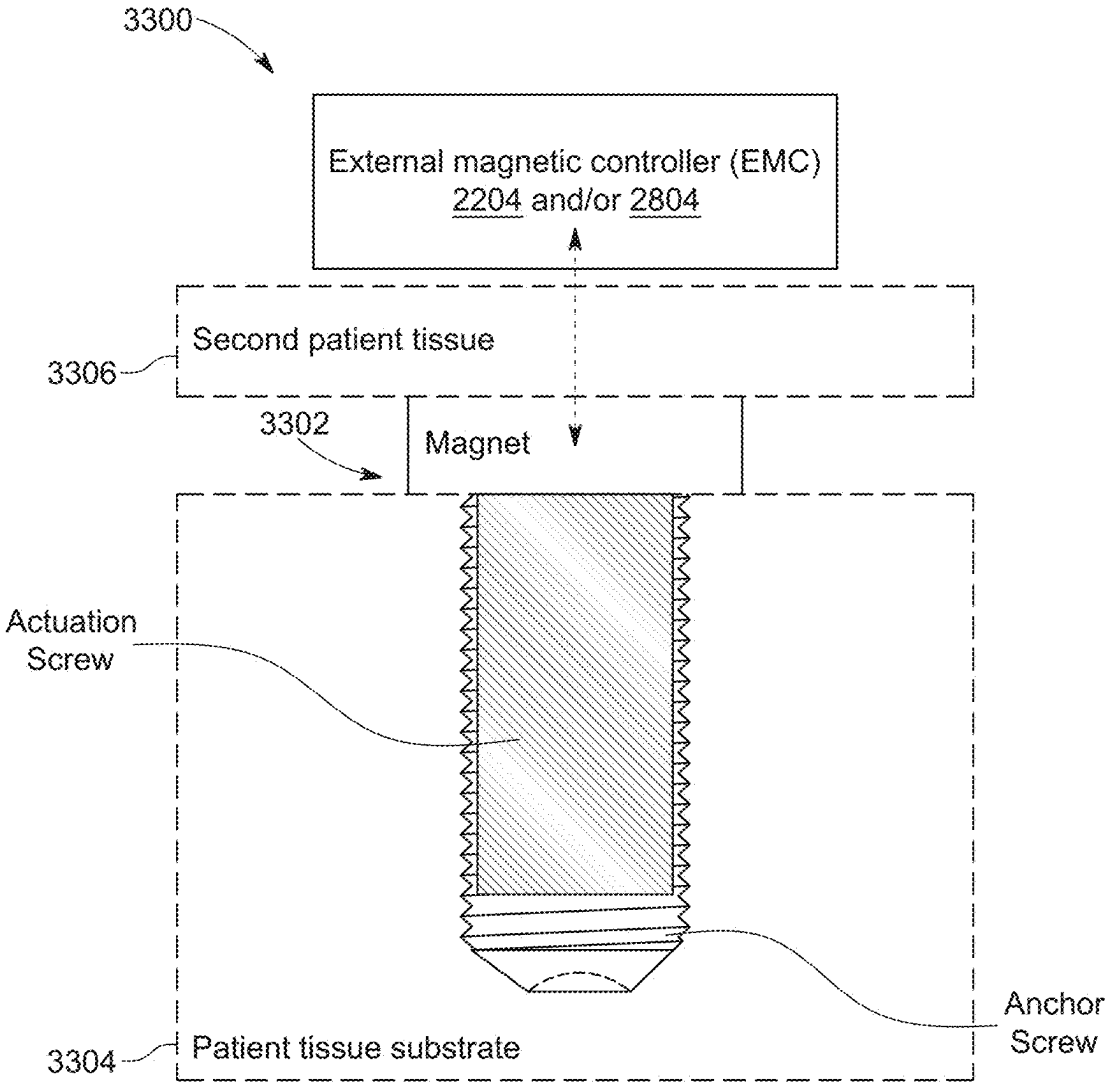

3300
External magnetic controller (EMC)
2204 and/or 2804
Second patient tissue
3306
3302
Magnet
Actuation
Screw
Anchor
Screw
3304
Patient tissue substrate

FIG. 33

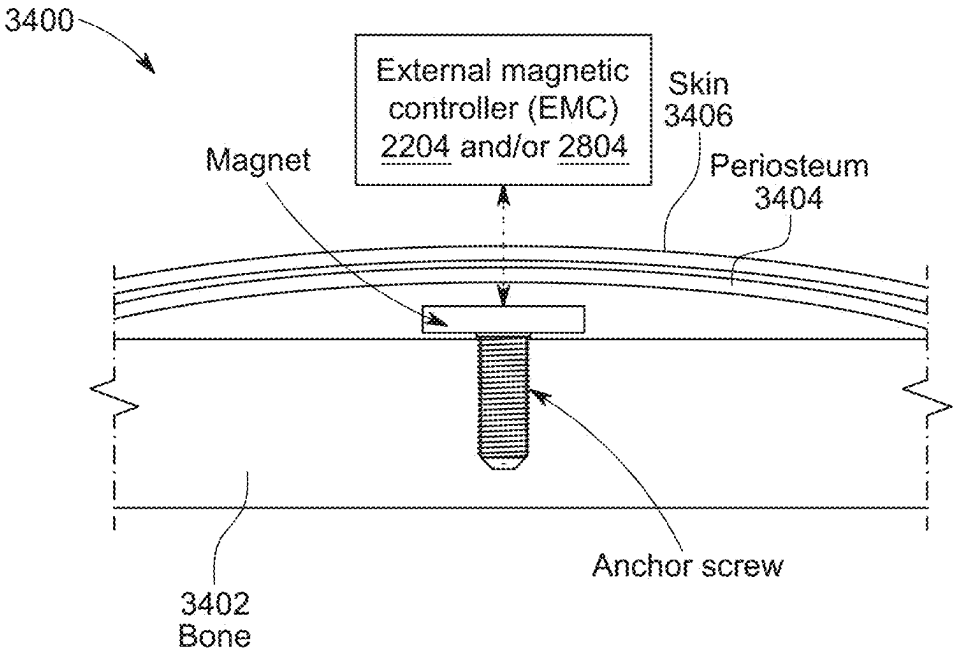


FIG. 34A

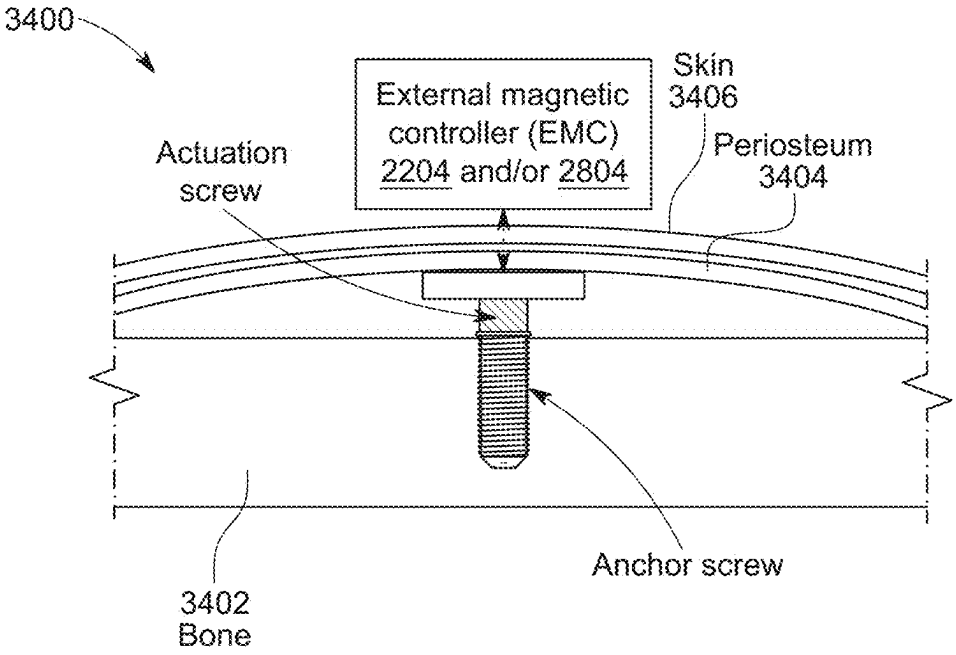


FIG. 34B

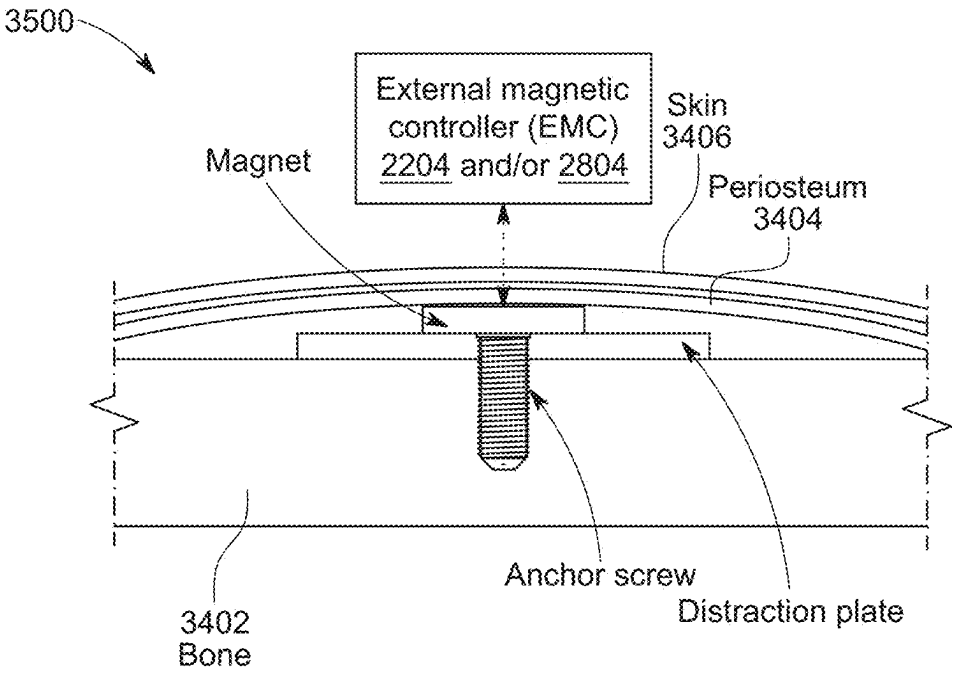


FIG. 35A

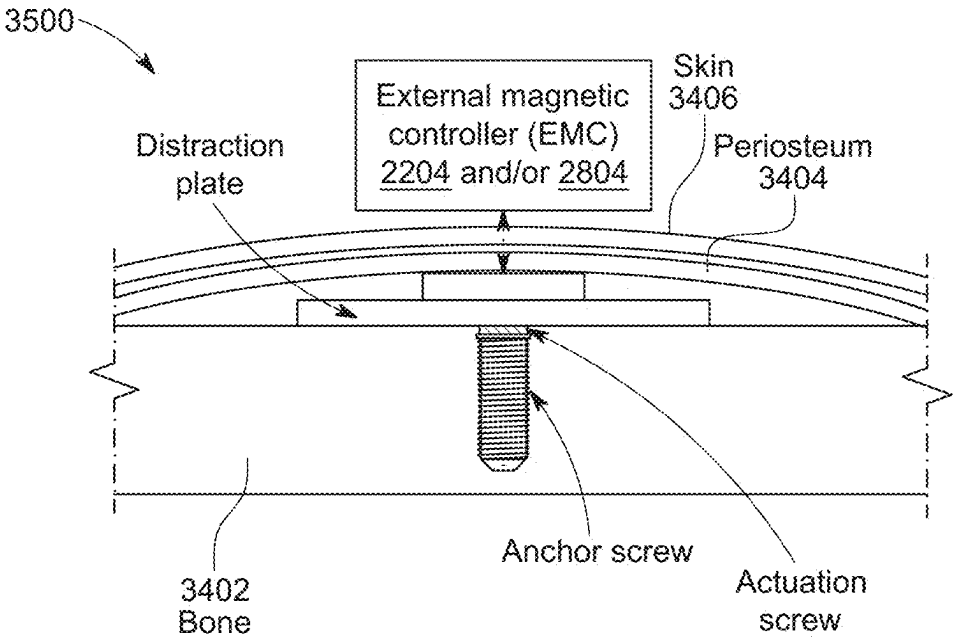


FIG. 35B

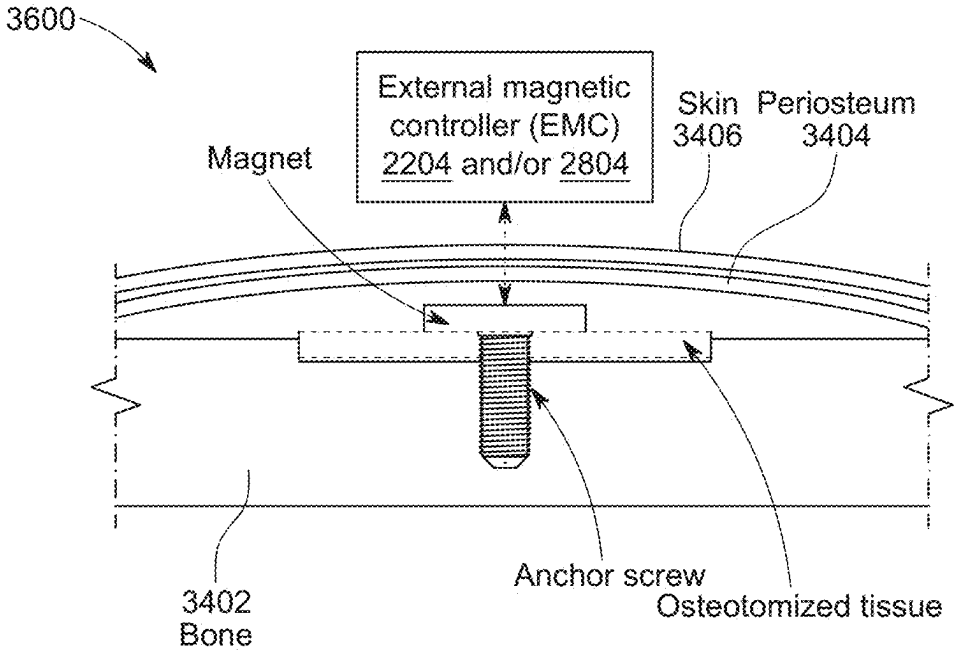


FIG. 36A

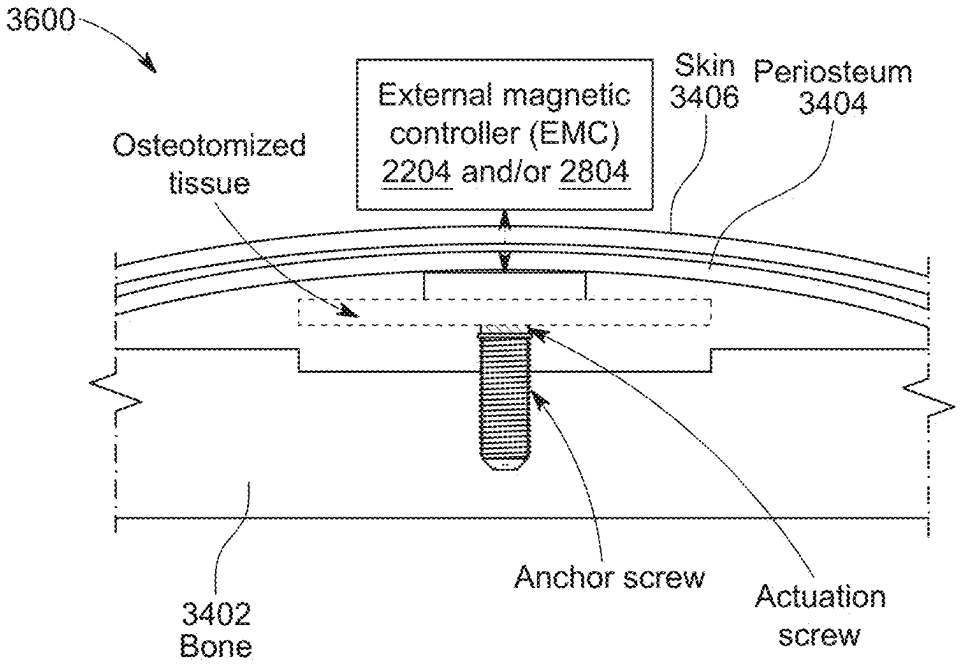
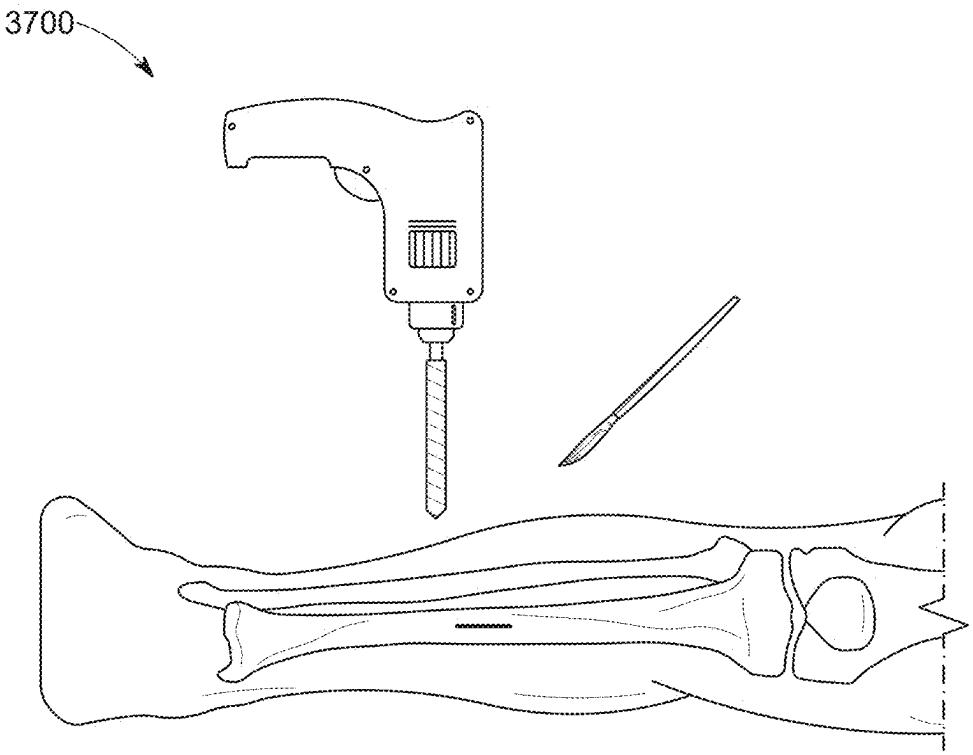


FIG. 36B


3700

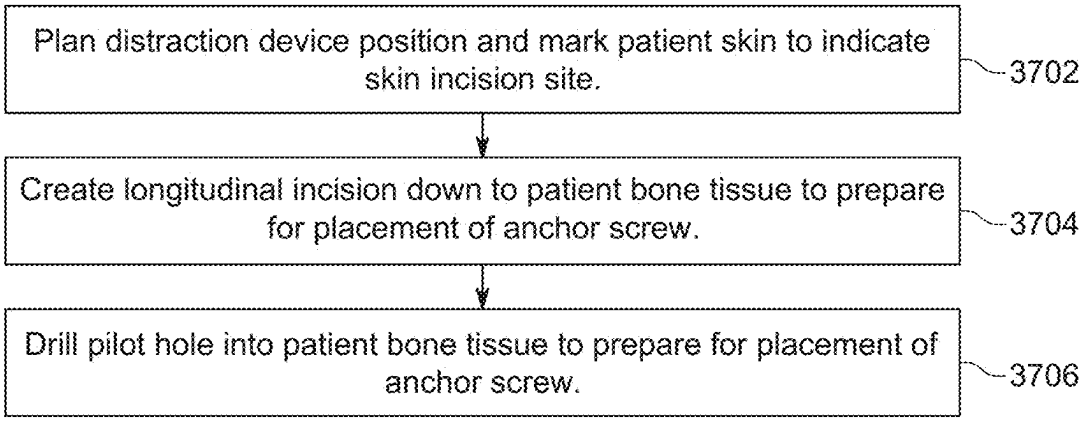

Plan distraction device position and mark patient skin to indicate skin incision site.
3702
Create longitudinal incision down to patient bone tissue to prepare for placement of anchor screw.
3704
Drill pilot hole into patient bone tissue to prepare for placement of anchor screw.
3706

FIG. 37A

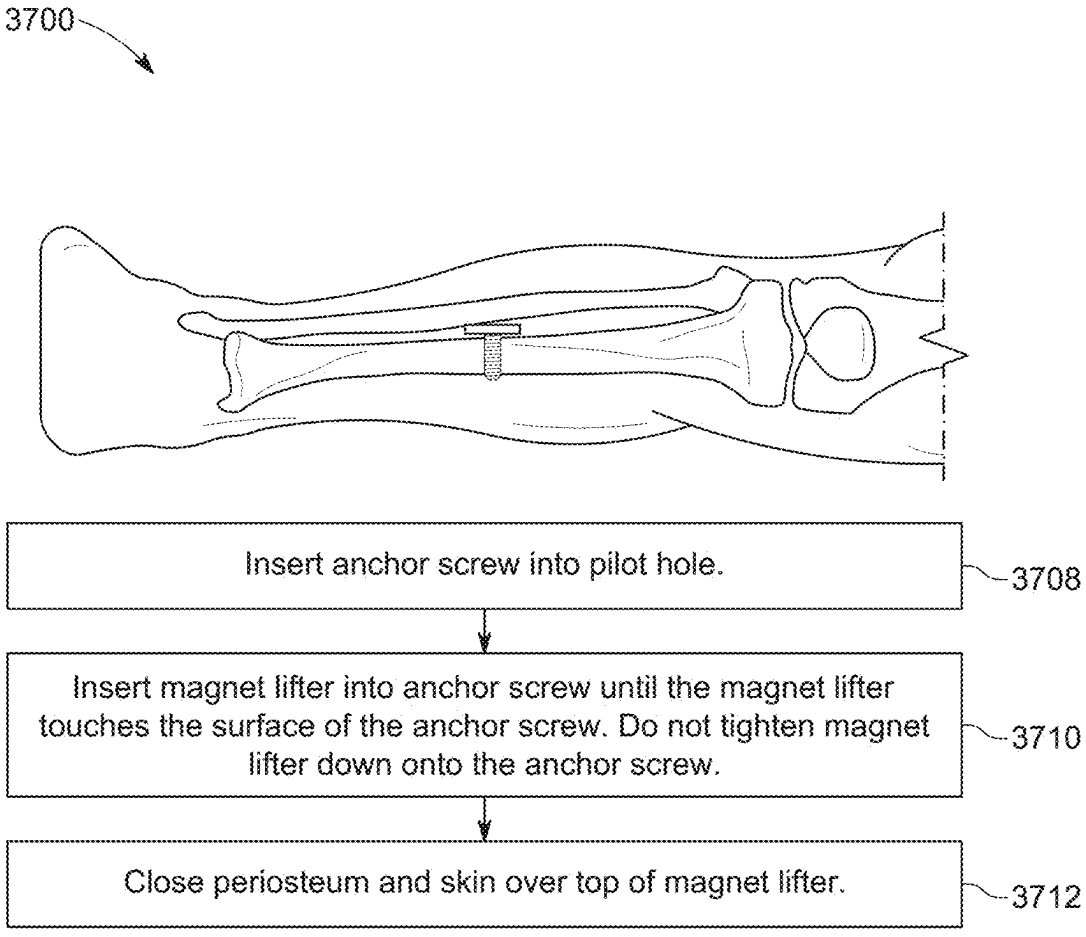

3700
Insert anchor screw into pilot hole.
3708
Insert magnet lifter into anchor screw until the magnet lifter touches the surface of the anchor screw. Do not tighten magnet lifter down onto the anchor screw.
3710
Close periosteum and skin over top of magnet lifter.
3712

FIG. 37B

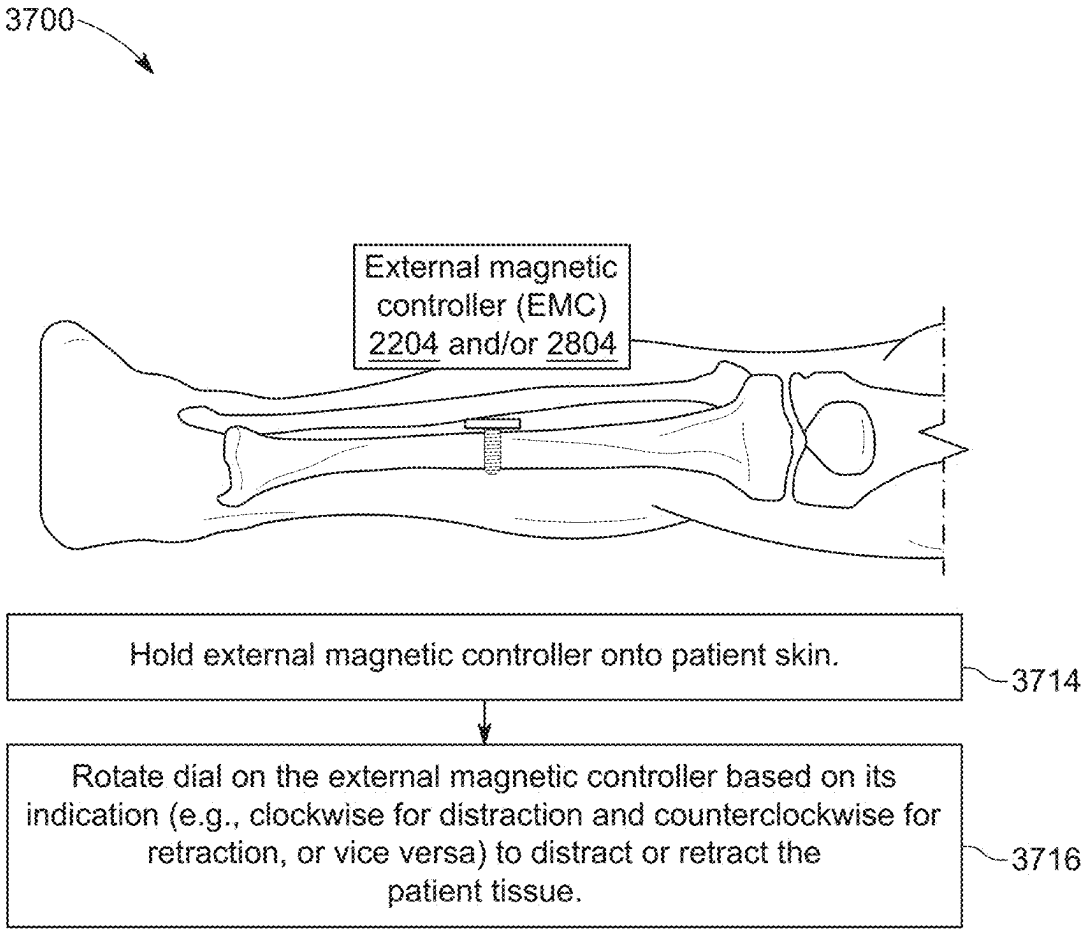
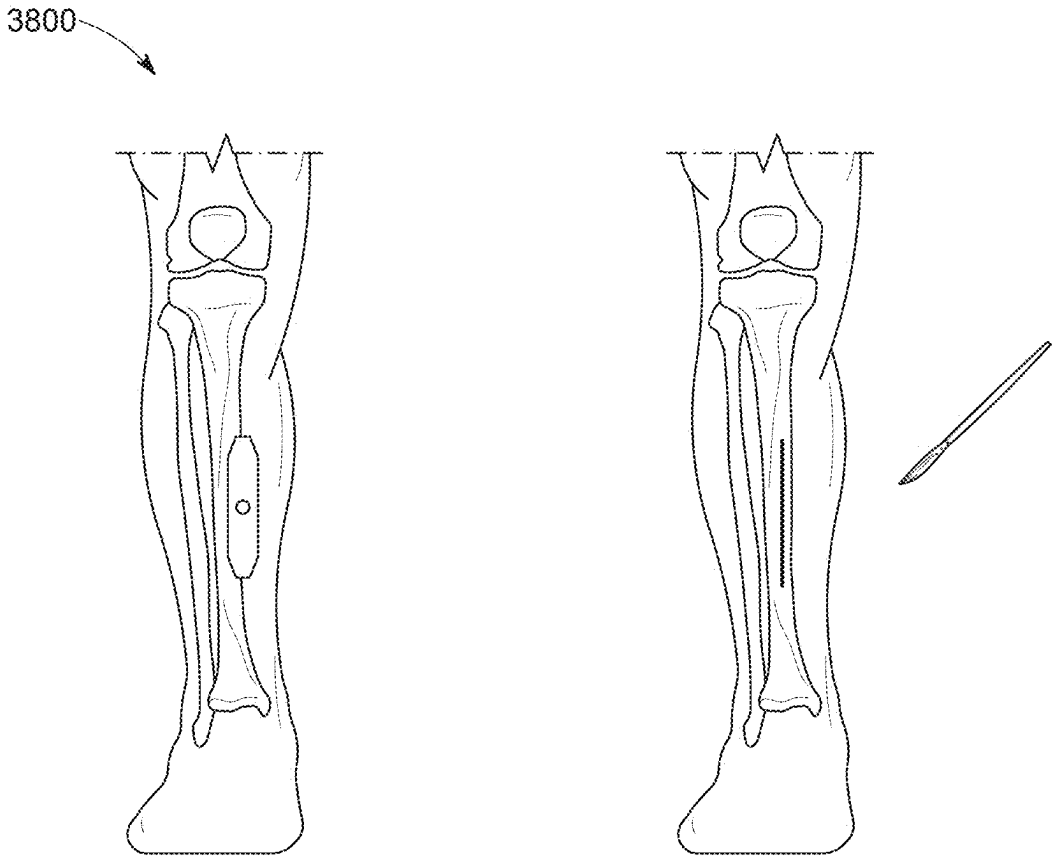

3700
External magnetic controller (EMC) 2204 and/or 2804
Hold external magnetic controller onto patient skin.
3714
Rotate dial on the external magnetic controller based on its indication (e.g., clockwise for distraction and counterclockwise for retraction, or vice versa) to distract or retract the patient tissue.
3716

FIG. 37C


3800

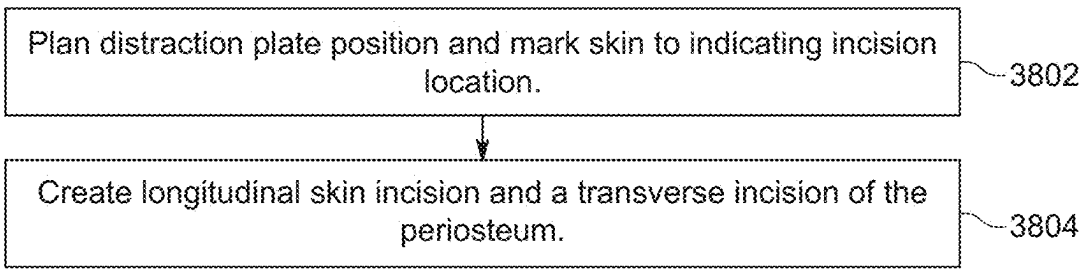
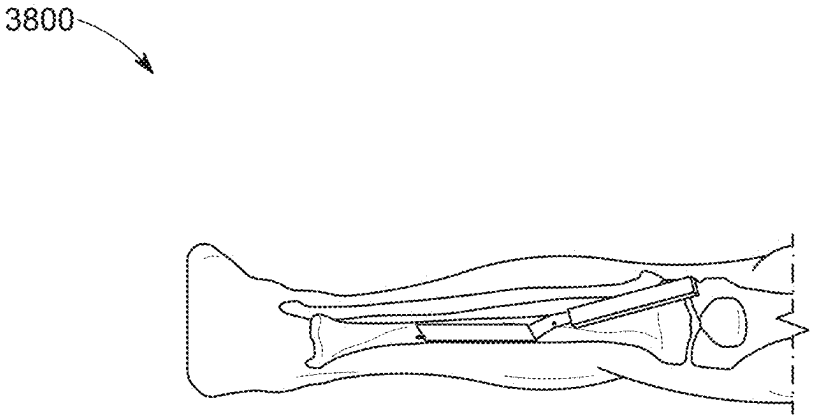

Plan distraction plate position and mark skin to indicating incision location.
3802
Create longitudinal skin incision and a transverse incision of the periosteum.
3804

FIG. 38A


3800

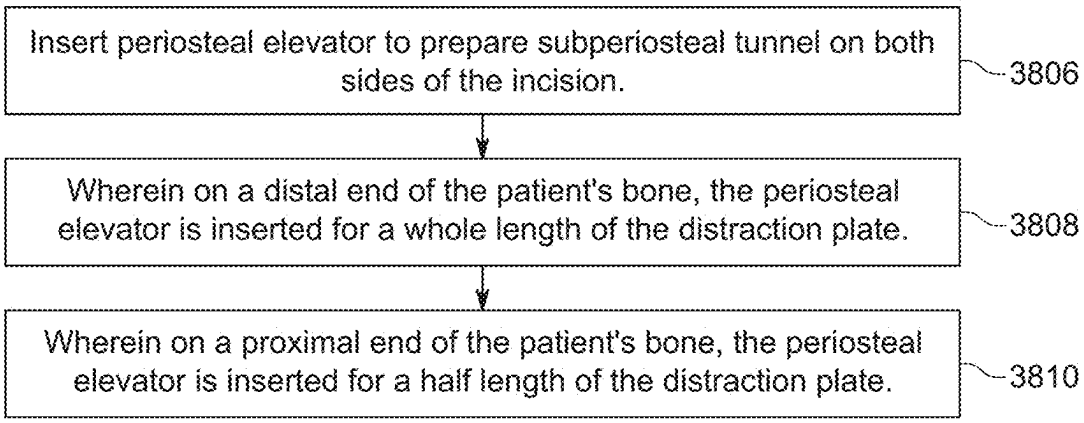

Insert periosteal elevator to prepare subperiosteal tunnel on both sides of the incision.
3806
Wherein on a distal end of the patient's bone, the periosteal elevator is inserted for a whole length of the distraction plate.
3808
Wherein on a proximal end of the patient's bone, the periosteal elevator is inserted for a half length of the distraction plate.
3810

FIG. 38B

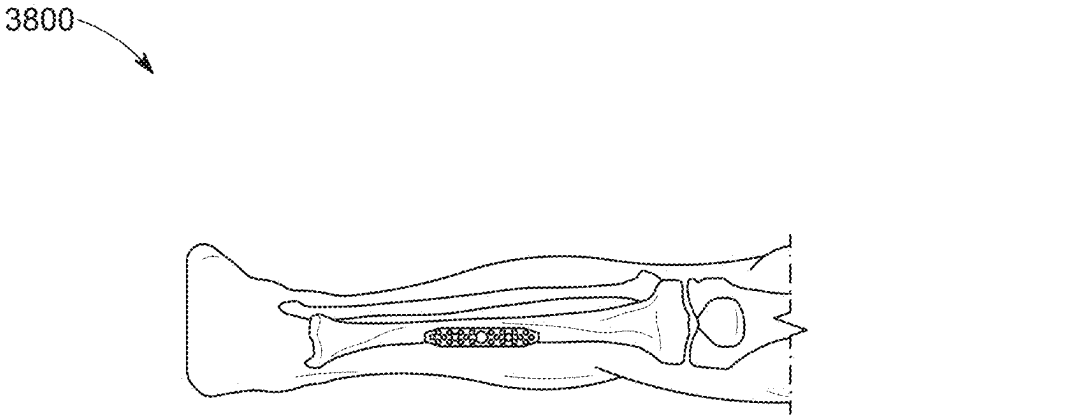
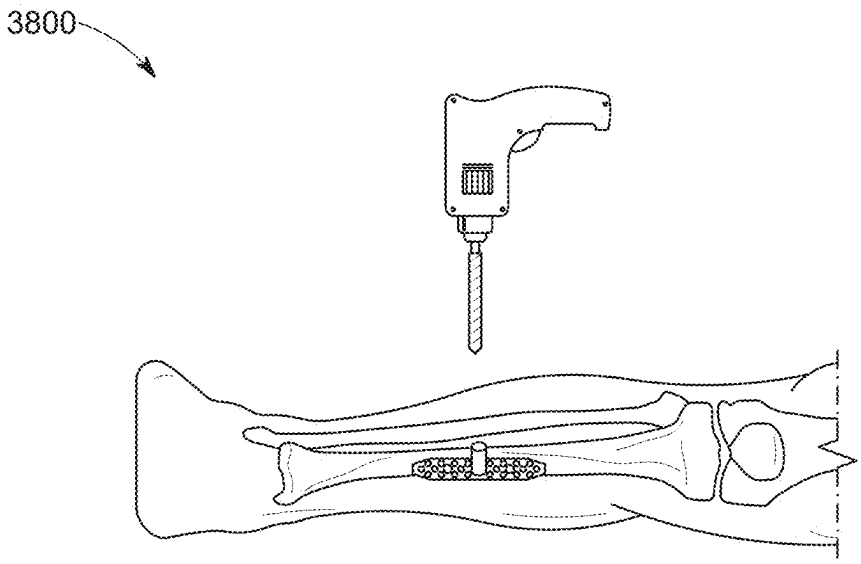

3800
Insert entire distraction plate under periosteum on the distal side.
3812
Pull distraction plate back under periosteum on the proximal side.
3814
Align the central threaded hole of the distraction plate with the incision through the periosteum.
3816

FIG. 38C


3800

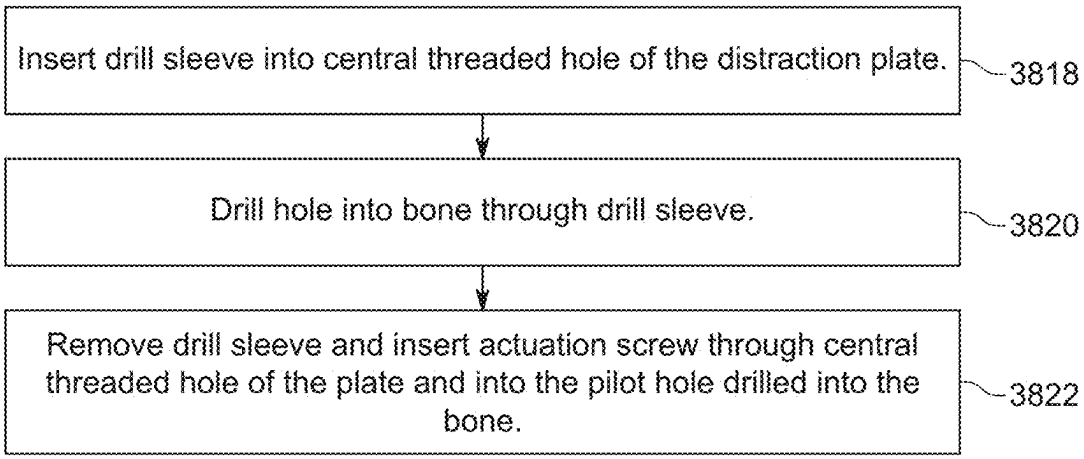

Insert drill sleeve into central threaded hole of the distraction plate.
3818
Drill hole into bone through drill sleeve.
3820
Remove drill sleeve and insert actuation screw through central threaded hole of the plate and into the pilot hole drilled into the bone.
3822

FIG. 38D

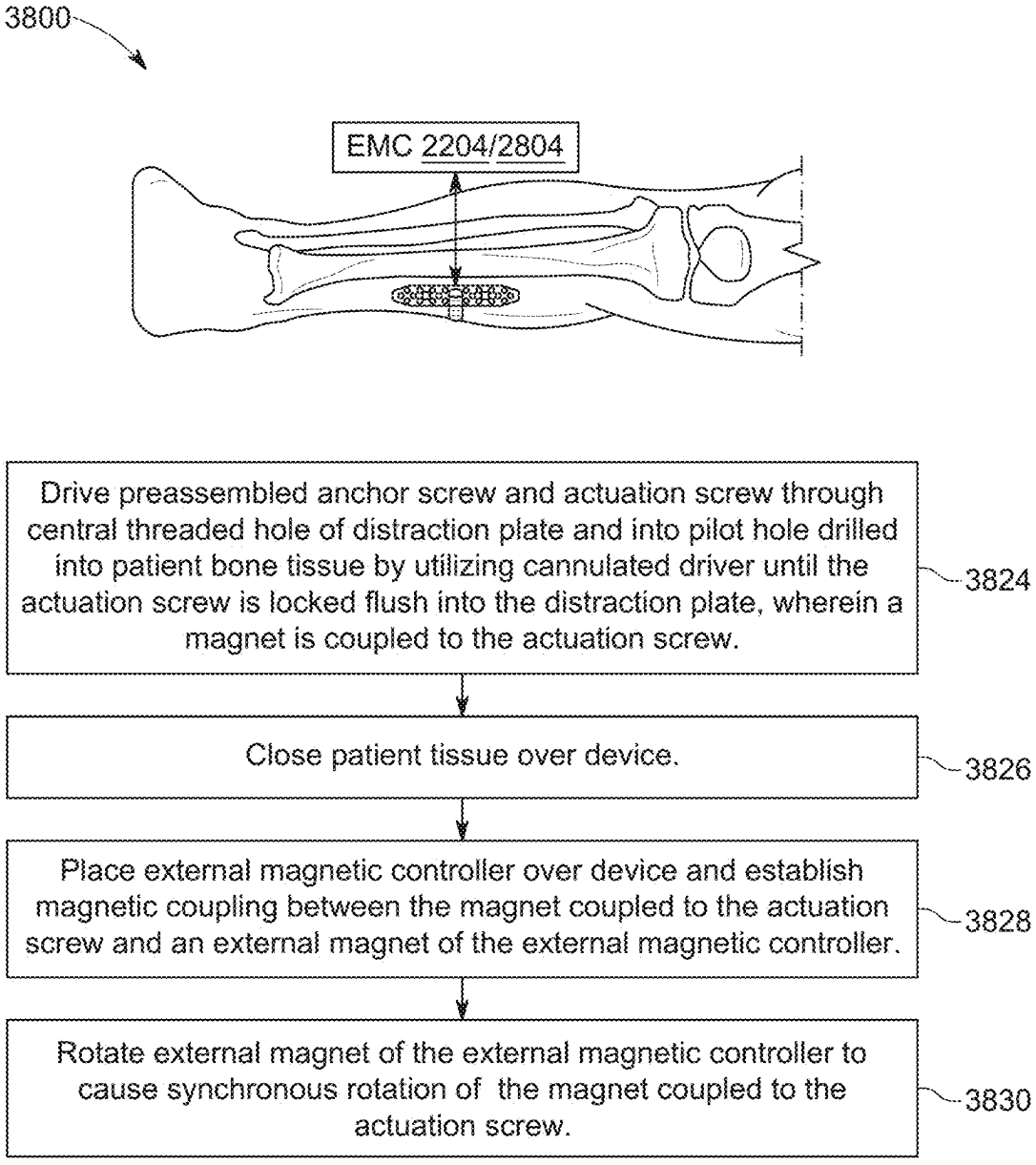

3800
EMC 2204/2804
Drive preassembled anchor screw and actuation screw through central threaded hole of distraction plate and into pilot hole drilled into patient bone tissue by utilizing cannulated driver until the actuation screw is locked flush into the distraction plate, wherein a magnet is coupled to the actuation screw.
3824
Close patient tissue over device.
3826
Place external magnetic controller over device and establish magnetic coupling between the magnet coupled to the actuation screw and an external magnet of the external magnetic controller.
3828
Rotate external magnet of the external magnetic controller to cause synchronous rotation of the magnet coupled to the actuation screw.
3830

FIG. 38E

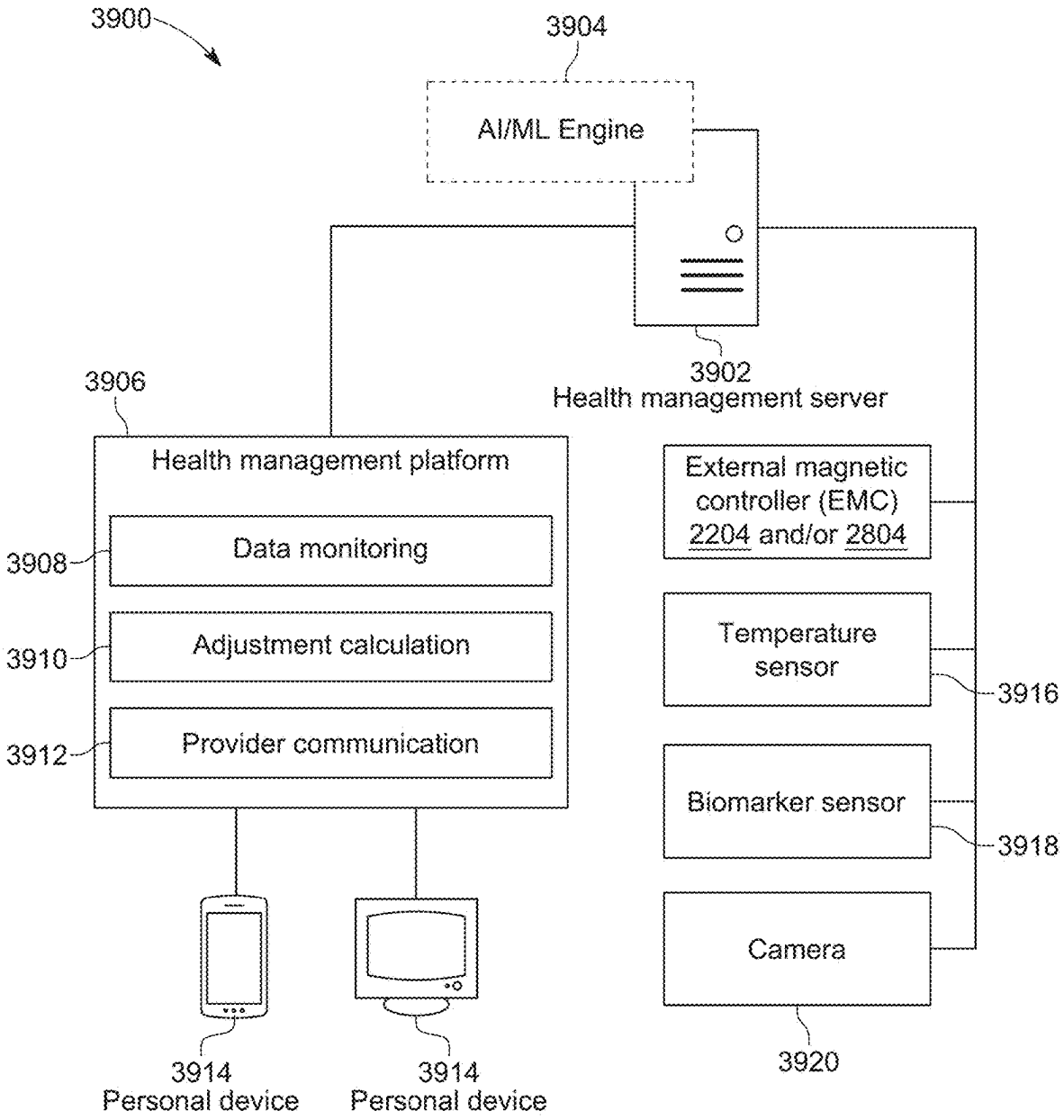

3900
3904
AI/ML Engine
3902
Health management server
3906
Health management platform
Data monitoring
3908
Adjustment calculation
3910
Provider communication
3912
External magnetic controller (EMC) 2204 and/or 2804
Temperature sensor
3916
Biomarker sensor
3918
Camera
3920
3914
Personal device
3914
Personal device

FIG. 39

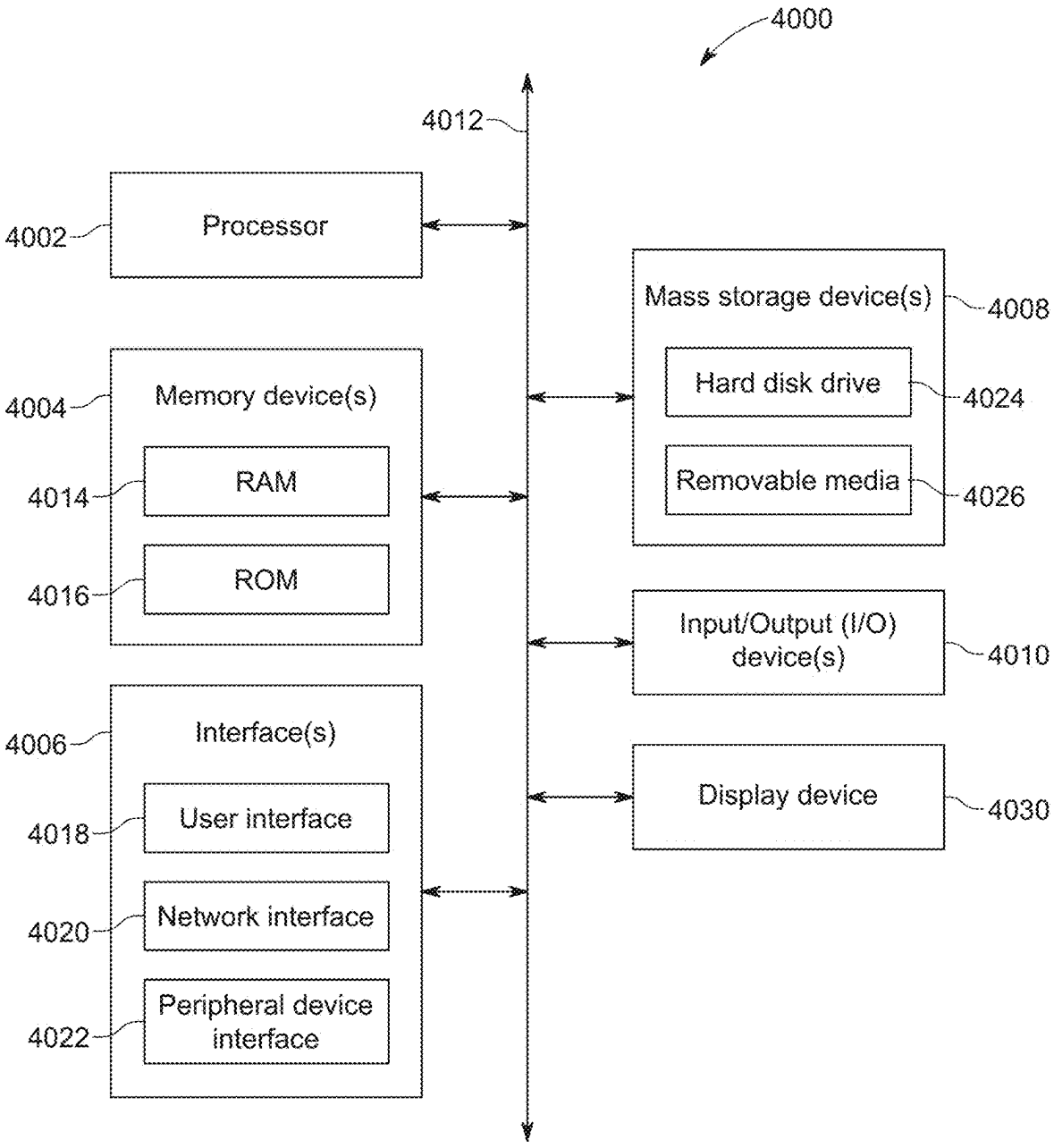

4000
4012
4002
Processor
Mass storage device(s)
4008
Hard disk drive
4024
4004
Memory device(s)
Removable media
4026
4014
RAM
4016
ROM
Input/Output (I/O) device(s)
4010
4006
Interface(s)
Display device
4030
4018
User interface
4020
Network interface
4022
Peripheral device interface

FIG. 40

MAGNETICALLY ACTUATED SYSTEMS AND DEVICES FOR PERFORMING DISTRACTION HISTOGENESIS SURGICAL PROCEDURES

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.

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. Tissue regeneration can be a major challenge for patient care and can be particularly difficult for patients experiencing chronic wounds, ischemic diseases, 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, and devices for improved surgical procedures, and specifically for improved distraction histogenesis procedures such as periosteal distraction.

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** is a perspective view of a system for performing a distraction histogenesis surgical procedure, and specifically illustrates wherein an actuation screw is partially screwed into an anchor screw such that the device is partially distracted;

[0009] FIG. **2** is a perspective view of a system for performing a distraction histogenesis surgical procedure, and specifically illustrates wherein an actuation screw is partially screwed into an anchor screw such that the device is partially distracted;

[0010] FIG. **3** is a straight-on side view of a system for performing a distraction histogenesis surgical procedure, and specifically illustrates wherein an actuation screw is partially screwed into an anchor screw such that the device is partially distracted;

[0011] FIG. **4** is a perspective cross-sectional view of a system for performing a distraction histogenesis surgical procedure, and specifically illustrates wherein an actuation screw is partially screwed into an anchor screw such that the device is partially distracted;

[0012] FIG. **5** is a perspective view of a system for performing a distraction histogenesis surgical procedure, wherein an actuation screw is fully screwed into an anchor screw such that the device is fully retracted and has its minimum total vertical length;

[0013] FIG. **6** is a straight-on side view of a system for performing a distraction histogenesis surgical procedure, wherein an actuation screw is fully screwed into an anchor screw such that the device is fully retracted and has its minimum total vertical length;

[0014] FIG. **7** is a perspective cross-sectional view of a system for performing a distraction histogenesis surgical procedure, wherein an actuation screw is fully screwed into an anchor screw such that the device is fully retracted and has its minimum total vertical length;

[0015] FIG. **8** is a straight-on side view of a system for performing a distraction histogenesis surgical procedure, wherein the device includes a distraction plate, and wherein an actuation screw is fully screwed into an anchor screw such that the device is fully retracted and has its minimum total vertical length;

[0016] FIG. **9** is an overhead perspective view of a system for performing a distraction histogenesis surgical procedure, wherein the device includes a distraction plate, and wherein an actuation screw is fully screwed into an anchor screw such that the device is fully retracted and has its minimum total vertical length;

[0017] FIG. **10** is an underside perspective view of a system for performing a distraction histogenesis surgical procedure, wherein the device includes a distraction plate, and wherein an actuation screw is fully screwed into an anchor screw such that the device is fully retracted and has its minimum total vertical length;

[0018] FIG. **11** is a cross-sectional perspective view of a system for performing a distraction histogenesis surgical procedure, wherein the device includes a distraction plate, and wherein an actuation screw is fully screwed into an anchor screw such that the device is fully retracted and has its minimum total vertical length;

[0019] FIG. **12** is a cross-sectional perspective view of a system for performing a distraction histogenesis surgical procedure, wherein the device includes a distraction plate, and wherein an actuation screw is fully screwed into an

anchor screw such that the device is fully retracted and has its minimum total vertical length;

[0020] FIG. **13** is a schematic illustration of a cross-sectional straight-on side view of an anti-rotational assembly;

[0021] FIG. **14** is a perspective view of a system for performing a distraction histogenesis surgical procedure, wherein the device includes a magnetic core and a distraction plate, and wherein an actuation screw is fully screwed into an anchor screw such that the device is fully retracted and has its minimum total vertical length;

[0022] FIG. **15** is a straight-on side view of a system for performing a distraction histogenesis surgical procedure, wherein the device includes a magnetic core and a distraction plate, and wherein an actuation screw is fully screwed into an anchor screw such that the device is fully retracted and has its minimum total vertical length;

[0023] FIG. **16** is an aerial top-down view of a system for performing a distraction histogenesis surgical procedure, wherein the device includes a magnetic core and a distraction plate, and wherein an actuation screw is fully screwed into an anchor screw such that the device is fully retracted and has its minimum total vertical length;

[0024] FIG. **17** is a cross-sectional perspective view of a system for performing a distraction histogenesis surgical procedure, wherein the device includes a magnetic core and a distraction plate, and wherein an actuation screw is fully screwed into an anchor screw such that the device is fully retracted and has its minimum total vertical length;

[0025] FIG. **18** is a cross-sectional perspective view of a system for performing a distraction histogenesis surgical procedure, wherein the device includes a magnetic core and a distraction plate, and wherein an actuation screw is fully screwed into an anchor screw such that the device is fully retracted and has its minimum total vertical length;

[0026] FIG. **19** is a cross-sectional perspective view of a system for performing a distraction histogenesis surgical procedure, wherein the device includes a magnetic core and a distraction plate, and wherein an actuation screw is fully screwed into an anchor screw such that the device is fully retracted and has its minimum total vertical length;

[0027] FIG. **20** is a perspective view of a system for performing a distraction histogenesis surgical procedure, wherein the device includes a magnetic core, and wherein an actuation screw is fully screwed into an anchor screw such that the device is fully retracted and has its minimum total vertical length;

[0028] FIG. **21** is a perspective cross-sectional view of a system for performing a distraction histogenesis surgical procedure, wherein the device includes a magnetic core, and wherein an actuation screw is fully screwed into an anchor screw such that the device is fully retracted and has its minimum total vertical length;

[0029] FIG. **22** is a straight-on side view of a system for performing a distraction histogenesis surgical procedure, wherein the system includes an external magnetic controller (EMC) that forms a magnetic coupling with a magnet of a distraction device;

[0030] FIG. **23** is a perspective view of a system for performing a distraction histogenesis surgical procedure, wherein the system includes an EMC that forms a magnetic coupling with a magnet of a distraction device;

[0031] FIG. **24** is an overhead perspective view of an EMC configured to form a magnetic coupling with a magnet of a distraction device;

[0032] FIG. **25** is a cross-sectional aerial top-down view of an EMC configured to form a magnetic coupling with a magnet of a distraction device;

[0033] FIG. **26** is a cross-sectional perspective view of a system for performing a distraction histogenesis surgical procedure, wherein the system includes an EMC that forms a magnetic coupling with a magnet of a distraction device;

[0034] FIG. **27**A is a schematic illustration of an aerial top-down view of an EMC;

[0035] FIG. **27**B is a schematic illustration of a cross-sectional straight-on side view of an EMC including an external magnet;

[0036] FIG. **27**C is a schematic illustration of a cross-sectional straight-on side view of an EMC including an external magnet and a motor;

[0037] FIG. **28** is a schematic illustration of a cross-sectional straight-on side view of an EMC including electromagnets;

[0038] FIGS. **29**A-**29**F are schematic illustrations of a system for driving an implant magnet of a distraction device with an EMC comprising electromagnets and a Hall effect sensor or Hall effect array;

[0039] FIG. **30** is a schematic illustration of a straight-on cross-sectional side view of an EMC including an electromagnet;

[0040] FIG. **31**A is a schematic illustration of a cross-sectional aerial top-down view of a magnet of a distraction device or an external magnet of an EMC that includes two poles;

[0041] FIG. **31**B is a schematic illustration of a cross-sectional aerial top-down view of a magnet of a distraction device or an external magnet of an EMC that includes four poles;

[0042] FIG. **31**C is a schematic illustration of a cross-sectional aerial top-down view of a magnet of a distraction device or an external magnet of an EMC that includes eight poles;

[0043] FIG. **32**A is a schematic illustration illustrating magnetic attraction between a magnet of a distraction device and an external magnet of an EMC;

[0044] FIG. **32**B is a schematic illustration illustrating magnetic attraction between a magnet of a distraction device and an external magnet of an EMC, and further illustrates synchronous rotation of the magnet of the distraction device in response to clockwise rotation of the external magnet of an EMC;

[0045] FIG. **32**C is a schematic illustration illustrating magnetic attraction between a magnet of a distraction device and an external magnet of an EMC, and further illustrates synchronous rotation of the magnet of the distraction device in response to counterclockwise rotation of the external magnet of an EMC;

[0046] FIG. **33** is a schematic illustration of a system for performing a distraction histogenesis surgical procedure on patient tissue;

[0047] FIGS. **34**A and **34**B are schematic illustrations of a system and process for performing a distraction histogenesis surgical procedure with an EMC;

[0048] FIGS. **35**A and **35**B are schematic illustrations of a system and process for performing a distraction histogenesis surgical procedure with an EMC;

[0049] FIGS. **36**A and **36**B are schematic illustrations of a system and process for performing a distraction histogenesis and osteotomy surgical procedure with an EMC;

[0050] FIGS. **37**A-**37**C are schematic flow chart diagrams of a method for performing a distraction histogenesis surgical procedure;

[0051] FIGS. **38**A-**38**E are schematic flow chart diagrams of a method for performing a distraction histogenesis surgical procedure;

[0052] FIG. **39** is a schematic block diagram of a system for monitoring health data and remotely actuating adjustment of a distraction device; and

[0053] FIG. **40** is a schematic block diagram of an example computing device.

DETAILED DESCRIPTION

[0054] Described herein are systems, methods, and devices for promoting revisualization, improving perfusion and triggering 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 osteogenesis to trigger regeneration of vascular and soft tissues.

[0055] 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 the healing of diabetic foot ulcers and other ischemic limb diseases.

[0056] 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.

[0057] 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.

[0058] 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.

[0059] In describing and claiming the subject matter of the disclosure, the following terminology will be used in accordance with the definitions set out below.

[0060] 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.

[0061] As used herein, the phrase "consisting of" and grammatical equivalents thereof exclude any element, step, or ingredient not specified in the claim.

[0062] 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.

[0063] 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.

[0064] 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.

[0065] Referring now to the figures, FIG. **1** is a perspective view of a system **100** for performing a distraction histogenesis surgical procedure. The system **100** may be utilized to perform various distraction procedures, including those performed on soft tissues. The system **100** may specifically be utilized to perform a periosteal distraction surgical procedure to lift a periosteum tissue away from adjacent bone tissue and thereby trigger tissue generation.

[0066] The system **100** is configured to be implanted into a patient during a surgical procedure. After implantation, the system **100** may be distracted or retracted according to the patient's needs. In an example use-case, the system **100** is implanted in between bone tissue and a periosteum layer of a patient. The surgical site may be fully closed over the system **100** to prevent infection, and this may include suturing shut one or more of the periosteum or skin layers over the system **100**. The system **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 system **100** in a controlled manner while the system **100** is installed in the patient.

[0067] The system **100** includes two primary components, including an anchor screw **102** and an actuation screw **104**. The system **100** includes a longitudinal axis, and the actua-

tion screw **104** is configured to move up and down along the longitudinal axis and relative to the anchor screw **102**. When the actuation screw **104** is distracted from the anchor screw **102** as shown in FIG. **1**, the system **100** has a longer total length. When the actuation screw **104** is fully retracted into the anchor screw **102**, the system **100** has its minimum total length.

[0068] As shown in FIG. **1**, at least a portion of the actuation screw **104** is configured to be disposed within and encased by the anchor screw **102**. The anchor screw **102** is configured to be screwed into a first tissue of a patient and may specifically be configured to be screwed into bone tissue. The actuation screw **104** is configured to move up and down relative to a longitudinal axis of the anchor screw **102** to adjust an overall length of the system **100**. The vertical position of the actuation screw **104** relative to the anchor screw **102** may be adjusted over time to cause distraction or retraction of a second tissue of the patient.

[0069] The actuation screw **104** includes a screw shaft **122** and a plate magnet **112** attached to the screw shaft **122**. The plate magnet **112** includes at least a first pole **114** and a second pole **116**, and the plate magnet **112** may include additional poles depending on the implementation. The plate magnet **112** may have, for example, four poles, six poles, eight poles, and so forth, without departing from the scope of the disclosure. In some cases, it may be desirable to design the plate magnet **112** with a higher quantity of poles to enable more granularity in unscrewing and screwing the actuation screw **104**.

[0070] The first pole **114** and the second pole **116** comprise opposite magnetic polarity relative to one another. The plate magnet **112** includes a magnet top surface **118** and a magnet bottom surface **120** (not visible in the view illustrated in FIG. **1**) that is opposite to the magnet top surface **118**. As shown in FIG. **1**, the first pole **114** and the second pole **116** are located adjacent to one another such that each of the first pole **114** and the second pole **116** is located at least on the magnet top surface **118** of the plate magnet **112**. The screw shaft **122** is attached to the magnet bottom surface **120** of the plate magnet **112**. The screw shaft **122** comprises external threading **124** that is configured to engage with internal threading disposed within a hollow interior of the anchor screw **102**.

[0071] The anchor screw **102** comprises the longitudinal axis running along a length of the anchor screw **102**. The actuation screw **104** is configured to engage with the anchor screw to adjust a vertical position of the plate magnet **112** along the longitudinal axis of the anchor screw **102**. The anchor screw **102** includes a hollow interior **126** defined by a sidewall **128**. The anchor screw **102** includes internal threading (not visible in FIG. **1**) on an interior surface of the sidewall **128**. The internal threading of the anchor screw **102** corresponds with the external threading **124** of the screw shaft **122** of the actuation screw **104**. The anchor screw **102** includes external threading **132** on an exterior surface of the sidewall **128**. The external threading **132** is configured to engage with a first tissue of a patient to anchor the anchor screw **102** to the first tissue. The anchor screw **102** include a tip **134** disposed at a proximal (i.e., the end proximal to an interior of a patient when the anchor screw **102** is installed into the first tissue of the patient).

[0072] The anchor screw **102** includes a socket interface **130** disposed at a proximal end of the anchor screw **102**, and the socket interface **130** provides a means to directly rotate the anchor screw **102**. The socket interface **130** may include a recess comprising a polygonal cross-sectional geometry such as a quadrilateral, pentagonal, hexagonal, and so forth, cross-sectional geometry. The polygonal cross-sectional geometry of the socket interface **130** enables a machine or human user to get sufficient torque when directly screwing the anchor screw **102**.

[0073] FIG. **2** is a perspective view of the system **100** for performing a distraction histogenesis surgical procedure. The plate magnet **112** of the actuation screw **104** may comprise a strong magnet that extends the entire thickness of the magnet plate. The strength of the plate magnet **112** may be sufficient to ensure the plate magnet **112** maintains stable magnetic coupling with an external magnet that is located external to the patient tissue, even when the magnet is installed within the patient's body. In an implementation, the plate magnet **112** is installed underneath several layers of patient tissue, including, for example, periosteum, fat, tendons, ligaments, and skin. The plate magnet **112** may be sufficiently strong to maintain a magnetic coupling with a separate external magnet that is located entirely external to the patient's body.

[0074] FIG. **3** is a straight-on side view of the system **100** for performing a distraction histogenesis surgical procedure. Like FIGS. **1** and **2**, FIG. **3** also illustrates wherein the actuation screw **104** is partially distracted or screwed out of the anchor screw **102**. The position of the actuation screw **104** along the longitudinal axis of the anchor screw **102** adjusts the total vertical length **302** of the system **100**.

[0075] In practice, the anchor screw **102** may be fully screwed into a first tissue of a patient, such as a bone tissue, such that only the distal end of the anchor screw is visible or located outside the first tissue. The actuation screw **104** may then be fully screwed into the anchor screw **102** to achieve a minimum total vertical length **302** for the system **100**. The actuation screw **104** may be gradually unscrewed from the anchor screw **102** to increase the total vertical length **302** of the device, and thereby cause distraction of a second tissue that is disposed above the actuation screw **104**. The actuation screw **104** may be screwed further into the anchor screw **102** at any time to cause retraction of the second tissue.

[0076] FIG. **4** is a perspective cross-sectional view of the system **100** for performing a distraction histogenesis surgical procedure, wherein the actuation screw **104** is partially distracted from the anchor screw **102**. The cross-sectional view in FIG. **4** enables viewing of internal threading **436** disposed along an interior side of the sidewall **128** of the anchor screw **102**.

[0077] The actuation screw **104** is coupled to the anchor screw **102** by interfacing the external threading **124** of the actuation screw **104** with the internal threading **436** of the anchor screw **102**. Because the actuation screw **104** is screwed into the anchor screw **102**, the actuation screw **104** is prevented from sliding out of the anchor screw **102** when the plate magnet **112** of the actuation screw **104** coupled to another external magnetic component.

[0078] As shown in FIG. **4**, the screw shaft **122** of the actuation screw **104** may include a smooth portion **438** disposed in between the plate magnet **112** and the portion comprising external threading **124**. The actuation screw **104** may include a singular indivisible piece including each of the portion comprising external threading **124**, the smooth portion **438**, and the plate magnet **112**.

[0079] FIG. **5** is a perspective view of the system **100** for performing a distraction histogenesis surgical procedure, wherein the actuation screw **104** is fully screwed into the anchor screw **102** such that the system **100** is fully retracted and has its minimum total vertical length.

[0080] FIG. **6** is a straight-on side view of the system **100** for performing a distraction histogenesis surgical procedure, wherein the actuation screw **104** is fully screwed into the anchor screw **102** such that the system **100** is fully retracted and has its minimum total vertical length.

[0081] As shown in FIGS. **5** and **6**, the screw shaft (see **122**) of the actuation screw **104** is not visible when the actuation screw **104** is fully retracted into the anchor screw **102**. The system **100** may include the configuration illustrated in FIGS. **5** and **6** when the system **100** is first installed into patient tissue. Depending upon the implementation and the specific health considerations of the patient, a surgeon may fully close one or more layers of patient tissue over the plate magnet **112** of the actuation screw **104**. This may reduce the likelihood of infection and improve patient outcomes.

[0082] FIG. **7** is a perspective cross-sectional view of the system **100** for performing a distraction histogenesis surgical procedure, wherein the actuation screw **104** is fully screwed into the anchor screw **102** such that the system **100** is fully retracted and has its minimum total vertical length.

[0083] As shown in FIG. **7**, the length of the screw shaft **122** of the actuation screw **104** may be screwed into the anchor screw **102** for most of a length of the anchor screw **102**. The actuation screw **104** may be securely distracted out of the anchor screw **102** as long as the actuation screw **104** is still coupled to the anchor screw **102** through the corresponding threading. The actuation screw **104** may further be fully removed from the anchor screw **102** by unscrewing the screw shaft **122** from the anchor screw **102**.

[0084] The cross-sectional view of FIG. **7** enables partial viewing of a socket head **740** of the anchor screw **102**. The socket head **740** includes a polygonal cross-sectional geometry to enable a machine or human user to achieve sufficient torque to screw the anchor screw **102** into an anchoring substrate, such as bone tissue. The socket head **740** may include a quadrilateral, pentagonal, hexagonal, and so forth, polygonal cross-sectional geometry. The socket head **740** may be utilized with a corresponding driver that comprises the same polygonal cross-sectional geometry. The socket head **740** may be utilized to screw the anchor screw **102** into a substrate, or two unscrew the anchor screw **102** from the substrate, when the actuation screw **104** is not disposed within the anchor screw **102**.

[0085] In an exemplary use-case, the system **100** is installed in a bone tissue of a patient to perform a periosteal distraction surgical procedure. A surgeon may first drill a pilot hole into the bone tissue, wherein the pilot is sized based on the outer diameter of the anchor screw **102**. The surgeon may then screw the anchor screw **102** into the pilot hole by utilizing a driver that corresponds with the socket head **740** of the anchor screw **102**. After the anchor screw **102** is installed in the bone tissue, the surgeon may then screw the actuation screw **102** into the anchor screw **104**.

[0086] FIG. **8** is a straight-on side view of a system **800** for performing a distraction histogenesis surgical procedure. The system **800** is like the system **100** first described in connection with FIG. **1**, but for the system **800** additionally including a distraction plate **806**. The distraction plate **806** may aid in a distraction histogenesis procedure to lift a second tissue away from a first tissue and/or to stretch the second tissue.

[0087] Like the system **100** first described in connection with FIG. **1**, the system **800** is also configured to magnetically coupled to an external magnet or electromagnet. The system **800** may be installed within a patient, and then distracted (i.e., expanded) or retracted (i.e., contracted) by establishing a magnetic coupling between the system **800** and an external magnetic controller. Thus, the system **800** may be installed within the patient and the patient's skin barrier may be fully closed over the system **800**. The system **800** may still be distracted and retracted by establishing a magnetic coupling between the system **800** and the external magnetic controller that is located external to the patient's skin barrier.

[0088] The system **800** includes the anchor screw **802** that is configured to be anchored into a first tissue of a patient. The system **800** includes the actuation screw **804** that is disposed within a hollow interior formed by a sidewall of the anchor screw **802**. The anchor screw **802** is similar to the anchor screw **102** first described in connection with FIG. **1** and may include all of the components associated with the anchor screw **102**. The actuation screw **804** is similar to the actuation screw **104** first described in connection with FIG. **1** and may include all of the component associated with the actuation screw **104**.

[0089] The system **800** may include a combined actuation screw **804** and magnet lifter **810** such that the magnet lifter **810** cannot be readily separated from the actuation screw **804**. In this case, the actuation screw **804** is similar to the actuation screw **104** first described in connection with FIG. **1**, wherein the actuation screw **804** is a single component including each of a screw shaft and a plate magnet.

[0090] The system **800** may include a separate actuation screw **804** and magnet lifter **810** such that the actuation screw **804** and the magnet lifter **810** constitute separate components that may interface with one another. In this case, the actuation screw **804** may include a screw shaft and a first rotational driver interface, and the magnet lifter **810** may include a plate magnet and a corresponding second rotational driver interface. In an example implementation, the actuation screw **804** may include a driver head, and the magnet lifter **810** may include a corresponding socket interface, such that the socket interface of the magnet lifter **810** may be utilized to drive rotation of the actuation screw **804**.

[0091] The system **800** further includes a distraction plate **806** coupled to the actuation screw **804**. The system **800** includes a coupler **808** that couples the distraction plate **806** to the actuation screw **804** in a manner that prevents the distraction plate **806** from synchronously rotating with the actuation screw **804**, while ensuring the distraction plate **806** is still axially coupled to the actuation screw **804** (i.e., the distraction plate **806** and the actuation screw **804** each distract away from the anchor screw **802** and retract toward the anchor screw **802** when the actuation crew **804** is rotated).

[0092] FIG. **9** is an overhead perspective view of the system **800** for performing a distraction histogenesis surgical procedure. The overhead perspective view shown in FIG. **9** enables further viewing of the distraction plate **806**.

[0093] The distraction plate **806** may include a central threaded hole, which is not visible in FIG. **9** because the coupler **808** and anchor screw **802** are disposed within the

central threaded hole. The central threaded hole may include internal threading that interfaces with one or more of the coupler **808** or the anchor screw **802**. The distraction plate **806** may additionally include one or more peripheral threaded holes **944** comprising internal threading. The peripheral threaded holes **944** may be utilized to anchor the distraction plate **806** to a patient tissue. In an exemplary use-case, the peripheral threaded holes **944** are utilized to anchor the distraction plate **806** to osteotomized bone tissue, such that distraction of the anchor plate **806** causes likewise distraction of the osteotomized bone tissue.

[0094] The distraction plate **806** may additionally include one or more non-threaded holes **942**. The non-threaded holes **942** may reduce the overall mass of the distraction plate **806** and may additionally permit patient fluids and tissues to permeate through the distraction plate **806**.

[0095] The magnet lifter **810** includes a plate magnet **912** that includes at least a first pole **914** and a second pole **916**. The first pole **914** and the second pole **916** comprise opposite polarity relative to one another. The plate magnet **912** may include additional poles, including, for example, four poles, six poles, eight poles, and so forth, without departing from the scope of the disclosure. In some cases, it may be desirable to design the plate magnet **912** with numerous poles to enable finer granularity when unscrewing and screwing the actuation screw.

[0096] As discussed herein, the magnet lifter **810** may comprise a separate component from the actuation screw **804**, or the magnet lifter **810** and actuation screw **804** may comprise a single indivisible component. If the magnet lifter **810** and the actuation screw **804** comprise a single indivisible component, then the plate magnet **912** may be attached directly to a screw shaft of the actuation screw.

[0097] Like the anchor screw **102** first described in connection with FIG. **1**, the anchor screw **802** includes external threading **932** that is configured to interface with a substrate, which may include a substrate tissue of a patient. In an exemplary use-case, the external threading **932** is utilized to install the anchor screw **802** into bone tissue of the patient. The anchor screw **804** additionally includes an anchor tip **934** disposed at a distal end of the anchor screw **804**. The size and geometry of the anchor tip **934** may be optimized for the intended use-case and may specifically depend upon the identity of the substrate tissue.

[0098] FIG. **10** is an underside perspective view of the system **800** for performing a distraction histogenesis surgical procedure. The underside view in FIG. **10** enables viewing of portions of the coupler **808**.

[0099] FIG. **11** is a cross-sectional perspective view of the system **800** for performing a distraction histogenesis surgical procedure. The cross-sectional view of FIG. **11** enables viewing of the actuation screw **804** for the first time, and further enables viewing of various components of the coupler **808**, the magnet lifter **810**, and the anchor screw **802**.

[0100] The cross-sectional view of FIG. **11** enables viewing of the full length of each of the anchor screw **802**, the actuation screw **804**, and the coupler **808**. As shown in FIG. **11**, the anchor tip **934** of the anchor screw **802** serves as the distal-most point of the system **800**. The actuation screw **804** is disposed within the anchor screw **802** and is further disposed through the coupler **808**. The coupler **808** extends through the distraction plate **806** and partially down into the anchor screw **802** when the device is in a fully retracted position as shown in FIG. **11**.

[0101] The cross-sectional view of FIG. **11** further enables viewing of various components of the actuation screw **804**. The actuation screw **804** may include each of an outer screw shaft **1122** and an inner screw shaft **1160**, wherein the inner screw shaft **1160** is configured to be disposed at least partially within the outer screw shaft **1122**.

[0102] The system **800** includes the coupler **808** that is configured to axially couple the distraction plate **806** to the actuation screw **804** while ensuring the distraction plate **806** is not also rotationally coupled to the actuation screw **804**. The coupler **808** includes an anchoring interface **1120** and a rotational interface **1126**. The rotational interface **1126** is attached to the anchoring interface **1120**, and the rotational interface **1126** is located distal relative to the anchoring interface **1120**. The anchoring interface **1120** of the coupler **808** includes external threading **1168** that corresponds with internal threading **1150** of a central threaded hole **1140** of the distraction plate **806**. The external threading **1168** of the anchoring interface **1120** thus enables the coupler **808** to be screwed into and secured to the central threaded hole **1140** of the distraction plate **806**.

[0103] When the actuation screw **804** is installed within the coupler **808** and the anchor screw **802**, a driver head **1148** of the actuation screw **804** may be approximately disposed within a hollow interior space defined by the anchoring interface **1120** of the coupler **808**.

[0104] The rotational interface **1126** may include a polygonal cross-sectional geometry that matches the polygonal cross-sectional geometry of the socket interface **1130** of the anchor screw **802**. In the example illustrated in FIG. **11**, the rotational interface **1126** includes a hexagonal cross-sectional geometry, and may thus be referred to as a hex driver. The exemplary socket interface **1130** illustrated in FIG. **11** corresponds with the rotational interface **1126** and thus includes a hex socket. It should be appreciated that the rotational interface **1126** and the socket interface **1130** may include various numbers of sides as deemed appropriate, including, for example, a quadrilateral, pentagonal, hexagonal, octagonal, and so forth, polygonal cross-sectional geometry.

[0105] The coupler **808** comprises a hollow interior and a through hole, such that the coupler **808** is configured to receive the actuation screw **804**. In the orientation illustrated in FIG. **11**, the actuation screw **804** extends up through the coupler **808** and then interfaces with the magnet lifter **810**. The coupler **808** comprises a smooth hollow interior that enables the actuation screw **804** to freely rotate within the coupler **808**. The magnet lifter **810** may drive rotation of the actuation screw **804** by interfacing the driver head **1148** of the actuation screw **804**. When this occurs, the actuation screw **804** may rotate freely within the coupler **808** while screwing into or out of the anchor screw **802**. Thus, the coupler **808** enables the actuation screw **804** to rotate out of and into the anchor screw **802** without causing synchronous rotation of the distraction plate **806**.

[0106] The coupler **808** enables the distraction plate **806** to be axially coupled to the actuation screw **804** such that distraction plate **806** moves vertically along the longitudinal axis of the system **800** while remaining rotationally stationary when the actuation screw **804** is screwed into and out of the anchor screw **802**.

[0107] The outer screw shaft **1122** of the actuation screw **804** interfaces directly with the anchor screw **802**. The outer screw shaft **1122** includes a sidewall that defines a hollow

interior, wherein external threading **1124** is attached to an exterior surface of the outer screw shaft **1122** sidewall, and wherein internal threading **1156** is attached to an interior surface of the outer screw shaft **1122** sidewall. The proximal end of the outer screw shaft **1122** is located at a distal end of the coupler **808**. The distal end of the outer screw shaft **1122** is formed by an outer actuation point **1164**, which is disposed within the hollow interior of the anchor screw **802** and may nearly reach the distal-most end of the anchor screw **802**. The entirety of the outer screw shaft **1122** is located distal relative to the coupler **808** and the distraction plate **806**.

[0108] The external threading **1124** of the outer screw shaft **1122** is configured to interface with internal threading **1154** attached to an interior surface of a sidewall of the anchor screw **802**. Thus, the outer screw shaft **1122** is configured to mate the actuation screw **804** to the anchor screw **802**. The inner screw shaft **1160** does not mate directly with the anchor screw **802** and contributes to axially coupling the actuation screw **804** to the distraction plate **806** without also rotationally coupling the actuation screw **804** to the distraction plate **806**.

[0109] The inner screw shaft **1160** is configured to be disposed within at least a portion of the outer screw shaft **1122**. The proximal end of the inner screw shaft **1160** comprises a screw head **1148** that may be located within a portion of the coupler **808** and/or the distraction plate **806**. The distal end of the inner screw shaft **1160** comprises an inner actuation point **1162** that is disposed within the hollow interior formed by the outer screw shaft **1122**. The inner screw shaft **1160** is configured to be disposed through the hollow interior **1152** through-hole of the coupler **808**, and thus, in combination with the coupler **808**, the inner screw shaft **1160** enables the actuation screw **804** to be axially coupled to the distraction plate **806** without also being rotationally coupled to the distraction plate **806**.

[0110] The inner screw shaft **1160** includes a threaded portion that includes the external threading **1158**. The inner screw shaft **1160** may additionally include a smooth portion **1146**. The smooth portion **1146** is configured to be disposed within the hollow interior **1152** defined by the rotational interface **1126** of the coupler **808**. The smooth portion **1146** of the inner screw shaft **1160** may rotate freely within the rotational interface **1126** of the coupler **808**.

[0111] The screw head **1148** of the inner screw shaft **1160** of the actuation screw **804** is configured to interface with an actuation screw coupling head **1166** of the magnet lifter **810**. The actuation screw coupling head **1166** may be disposed within the hollow interior space located in between an inner surface of the anchoring interface **1120** of the coupler **808**, and the outer surface of the screw head **1148** of the actuation screw **804**. When the screw coupling head **1166** is located within that hollow interior space, the screw coupling head **1166** may form an interference fit with the screw head **1148** and then drive rotation of the inner screw shaft **1160** of the actuation screw **804**. This may likewise drive rotation of the actuation screw **804** without driving synchronous rotation of the coupler **808** or the distraction plate **806**.

[0112] The rotational interface **1126** of the coupler **808** includes a polygonal cross-sectional exterior geometry that enables the rotational interface **1126** to form a torque coupling with the corresponding polygonal cross-sectional interior geometry of a socket interface **1130** of the anchor screw **802**. This enables a user to simultaneously implant the actuation screw **804** and the anchor screw **802** into a patient as a single unit.

[0113] Further as shown in the cross-sectional view, the central threaded hole **1140** of the distraction plate **806** includes internal threading **1150** that corresponds with external threading **1168** of the anchoring interface **1120** of the coupler **808**. This enables the coupler **808** to be securely screwed into the distraction plate **806**. Further as shown in the cross-sectional view, the anchor screw **802** includes internal threading **1154** that corresponds with the external threading **1124** of the outer screw shaft **1122** of the actuation screw **804**.

[0114] FIG. **12** is a perspective cross-sectional view of the system **800** for performing a distraction histogenesis procedure, wherein the actuation screw **804** is fully retracted into the anchor screw **802**. The cross-sectional view illustrated in FIG. **12** shows that the screw head **1148** of the actuation screw **804** may have an external cross-sectional polygonal geometry that corresponds with an internal cross-sectional polygonal geometry of the screw coupling head **1166** of the magnet lifter **810**. This ensures the magnet lifter **810** may have sufficient torque to rotate the actuator screw **804**.

[0115] The brackets in FIG. **12** further illustrate how the combination of the outer screw shaft **1122** and the inner screw shaft **1160** make up the actuation screw **804**. As shown, the inner screw shaft **1160** is partially disposed within the outer screw shaft **122**, and additionally passes through the coupler **808** and terminates within the central threaded hole **1140** of the distraction plate **806**.

[0116] FIG. **13** is a schematic illustration of an exploded straight-on side view of an anti-rotation assembly **1300**, which is a component of the system **800** described herein. The anti-rotation assembly **1300** includes components of the actuation screw **804** (including the inner screw shaft **1160** and the outer screw shaft **1122**), the coupler **808**, and the distraction plate **806**. The anti-rotation assembly **1300** enables the distraction plate **806** to be axially coupled to the actuation screw **804** without also being rotationally coupled to the actuation screw **804**.

[0117] The anti-rotation assembly **1300** includes the actuation screw **804**, which includes the inner screw shaft **1160** and the outer screw shaft **1122**. The outer screw shaft **1122** comprise a diameter that is greater than a diameter of an entrance through-hole to the rotational interface **1126** of the coupler **808**, and this prevents the outer screw shaft **1122** from sliding up into the coupler **808** or the distraction plate **806**. The inner screw shaft **1160** comprises a diameter that is smaller than the diameter of the central threaded hole **1140** of the distraction plate **806**. The diameter of the inner screw shaft **1160** is also smaller than the diameter of a hollow interior **1152** defining a through-hole extending through the entirety of the coupler **808**, including the anchoring interface **1120** and the rotational interface **1126**.

[0118] During assembly or installation, the inner screw shaft **1160** is slid through the through-hole defined by the sidewall of the coupler **808**. The inner screw shaft **1160** is then securely coupled to the outer screw shaft **1122** by screwing the external threading **1158** of the inner screw shaft **1160** into the internal threading **1156** disposed within the hollow interior of the outer screw shaft **1122**. The inner screw shaft **1160** will be fully installed within the outer screw shaft **1122** when the screw head **1148** is located approximately within the central threaded hole **1140** of the

distraction plate **806** and/or when the smooth portion **1146** of the inner screw shaft **1160** is aligned with the rotational interface **1126** of the coupler **808**. The outer screw shaft **1122** may include stopper that prevents the inner screw shaft **1160** from being screwed in any deeper than desired. The smooth portion **1146** of the inner screw shaft **1160** may include a diameter that is smaller than a diameter of the rotational interface **1126** of the coupler **808**.

[0119] The external threading **1158** of the inner screw shaft **1160** may be tightly engaged with the internal threading **1156** of the outer screw shaft **1122** to prevent these two components of the actuation screw (see **804**) from becoming separated. In some cases, the inner screw shaft **1160** may be glued into the outer screw shaft **1122** to ensure a tight and semi-permanent installation. This may help ensure that a loosening rotation of the actuation screw (see **804**) to remove the actuation screw from the anchor screw (see **802**) does not also loosen the inner screw shaft **1160** from the outer screw shaft **1122**.

[0120] The anchoring interface **1120** of the coupler **808** includes the external threading **1168** that is configured to interface with corresponding internal threading **1150** of the central threaded hole **1140** of the distraction plate **806**. This ensures the coupler **808** is releasably locked into the distraction plate **806**. When the coupler **808** is further coupled to the actuation screw **804**, this further ensures that the distraction plate **806** moves up and down along the longitudinal axis of the system **800** synchronously with the actuation screw **804**.

[0121] The coupler **808** enables the distraction plate **806** to move vertically along the longitudinal axis of the system **800** while remaining rotationally stationary when the actuation screw **804** is screwed into and out of the anchor screw **802**. In practice, if the system **800** is installed in between bone tissue and periosteum tissue to perform periosteal distraction, this ensures the distraction plate **806** remains in place underneath the periosteum tissue, and only moves outward and inward to lift and lower the patient periosteum, without rotating underneath patient periosteum.

[0122] FIGS. **14-21** illustrate various views of a system **1400** for performing a distraction histogenesis surgical procedure. FIGS. **14-19** illustrate wherein the system **1400** includes a distraction plate, and FIGS. **20-21** illustrate wherein the system **1400** does not include the distraction plate. The system **1400** may be utilized with or without the distraction plate based on patient needs. In some cases, the system **1400** may be installed without the distraction plate, and then the distraction plate may be added later based on patient needs, and vice versa.

[0123] The system **1400** is configured to be magnetically coupled to an external magnet or electromagnet. Like the devices **100**, **800** first described in connection with FIGS. **1** and **8**, respectively, the system **1400** may be installed within a patient, and then distracted (i.e., expanded) or retracted (i.e., contracted) by establishing a magnetic coupling between the system **1400** and an external magnetic controller (EMC). Thus, the system **1400** may be installed within the patient and the patient's skin barrier may be fully closed over the system **1400**. The system **1400** may still be distracted and retracted by establishing a magnetic coupling between the system **1400** and the external magnetic controller that is located external to the patient's skin barrier.

[0124] The system **1400** may be utilized in connection with a distraction plate (see, e.g., the distraction plate **806** first described in connection with FIG. **8**) or may be utilized without the distraction plate. The decision on whether to include a distraction plate will be made by a healthcare provider depending upon the patient needs.

[0125] FIG. **14** is a perspective view of the system **1400** with the distraction plate **1406**. The system **1400** includes an actuation screw **1404** fully retracted into an anchor screw **1402**. Like the system **800** first described in connection with FIG. **8**, the distraction plate **1406** is axially coupled to the actuation screw **1404** without also being rotationally coupled to the actuation screw **1404**.

[0126] The system **1400** includes the anchor screw **1402** and the actuation screw **1404** configured to be disposed within the anchor screw **1402**. The actuation screw **1404** comprises a magnetic core **1412** that comprising at least two poles, including at least a first pole **1414** and a second pole **1416**. The magnetic core **1412** may comprise an elongated geometry such that each of the first pole **1414** and the second pole **1416** runs along a length of the magnetic core **1412**. The magnetic core **1412** may comprise a length that is substantially equivalent to a length of the actuation screw **1404**. The magnetic core **1412** may include more than two poles, and in some cases, this may be desirable to enable a machine or user to rotate the actuation screw **1404** (and thereby distract or retract the actuation screw **1404** from the anchor screw **1402**) with increased granularity. The magnetic core **1412** may include two, four, six, eight, ten, or more poles in various implementations. Each of the various poles of the magnetic core **1412** may run the length of the magnetic core.

[0127] The actuation screw **1404** may include the magnetic core **1412** fully integrated into the actuation screw **1404** to form a singular indivisible element. In alternative implementations, the actuation screw **1404** may include a sidewall that defines a hollow interior, and the magnetic core **1412** may be disposed within the hollow interior. In such an implementation, the magnetic core **1412** may form an interference fit with the sidewall of the actuation screw **1404** and/or the magnetic core **1412** may include external threading that is configured to interface with internal threading of the anchor screw **1402**.

[0128] The anchor screw **1402** comprises a sidewall that defines a hollow interior. The anchor screw **1402** includes external threading **1432** attached to an exterior surface of the sidewall, and the external threading **1432** is configured to interface with a patient tissue substrate. The anchor screw **1402** may additionally include internal threading (see **1754** at FIG. **17**) attached to an interior surface of the sidewall. The internal threading **1754** of the anchor screw **1402** is configured to interface with corresponding external threading (see **1724** at FIG. **17**) of the actuation screw **1404**.

[0129] The system **1400** includes the distraction plate **1406** that may be utilized to provide a larger surface for distracting a patient tissue. The distraction plate **1406** includes a central threaded hole configured to receive a coupler **1408**. Like the coupler **808** described in connection with the system **800** first illustrated in FIG. **8**, the coupler **1408** is configured to axially couple the distraction plate **1406** to the actuation screw **1404**.

[0130] The coupler **1408** may include a socket interface **1430** comprising a polygonal cross-sectional geometry. The socket interface **1430** provides a means to remove the coupler **1408**, actuation screw **1404**, and anchor screw **1402** from a patient tissue substrate.

[0131] FIG. **15** is a straight-on side view of the system **1400** for performing a distraction histogenesis surgical procedure. FIG. **15** includes brackets illustrating the approximate lengths of the anchor screw **1402**, actuation screw **1404**, and coupler **1408**. The actuation screw **1404** is disposed within the anchor screw **1402** and is thus not visible in a straight-on side view. The actuation screw **1404** may descend approximately to an end of the anchor screw **1402**. The actuation screw **1404** may also be disposed through the coupler **1408** and the distraction plate **1406** and then terminate at approximately an upper surface of the distraction plate **1406**.

[0132] FIG. **16** is a straight-on aerial top-down view of the system **1400** for performing a distraction histogenesis surgical procedure.

[0133] The socket interface **1430** of the coupler **1408** may include a polygonal cross-sectional geometry like the hexagonal geometry shown in FIG. **16**. The socket interface **1430** is configured to interface with a corresponding driver having a polygonal cross-sectional geometry. The socket interface **1430** enables a user to unscrew the anchor screw **1402** from a patient tissue substrate.

[0134] The actuation screw **1404** may include a screw head **1648** that includes a polygonal cross-sectional geometry, such as a quadrilateral, pentagonal, hexagonal, and so forth, polygonal cross-sectional geometry. In the example illustrated herein, the screw head **1648** of the actuation screw **1404** includes a hexagonal driver head geometry. The socket interface **1430** may be sized such that the screw head **1648** may rotate within the socket interface **1430**.

[0135] FIG. **17** is a cross-sectional perspective view of the system **1400** for performing a distraction histogenesis surgical procedure, wherein the actuation screw **1404** is fully retracted into the anchor screw **1402**. The cross-sectional view of FIG. **17** enables viewing of the actuation screw **1404** that is fully screwed into the anchor screw **1402**.

[0136] The actuation screw **1404** may include the screw head **1648** comprising a polygonal cross-sectional geometry. The screw head **1648** includes the polygonal cross-sectional geometry to enable a user or automated fixator adjustor to achieve sufficient torque when manually adjusting a position of the actuation screw **1404**. Additionally, the polygonal cross-sectional geometry of the screw head **1648** enables a user to screw the entire system **1400** into a patient tissue substrate during an implantation surgery. Likewise, the polygonal cross-sectional geometry of the screw head **1648** aids in unscrewing the actuation screw **1404** during a removal surgery.

[0137] Like the actuation screw **104** first described in connection with FIG. **1**, the actuation screw **1404** also includes external threading **1724** along a longitudinal shaft of an exterior of the actuation screw **1404**. In some cases, the external threading **1724** may be attached directly to the magnetic core **1412**. In other implementations, the external threading **1724** may be attached to a sidewall of the actuation screw **1404**, and the magnetic core **1412** may be disposed within a hollow interior space defined by the sidewall of the actuation screw **1404**. The external threading **1724** is configured to interface with corresponding internal threading **1754** of the anchor screw **1402**. The actuation screw **1404** may include an actuation point **1764** disposed at a distal end of the actuation screw **1404**. The actuation screw **1404** may be sized such that the actuation point **1764** is located near the anchor tip **1434** of the anchor screw **1402**.

[0138] The actuation screw **1404** may be screwed into and out of the anchor screw **1402** by manually rotating the actuation screw **1404** with the screw head **1648**. The actuation screw **1404** may additionally be screwed into and out of the anchor screw **1402** by rotating the magnetic core **1412**. The magnetic core **1412** may be magnetically coupled to a corresponding magnet or electromagnet of an EMC. When the corresponding magnet of the EMC is rotated, the magnetic core **1412** of the actuation screw **1404** will also rotate. Thus, the EMC may be utilized to distract and retract the actuation screw **1404** without physically touching the actuation screw **1404**. This enables a healthcare provider to implant the system **1400** and then close the patient's skin to reduce the likelihood of infection.

[0139] The magnetic core **1412** may include an elongated cylindrical geometry as shown in FIG. **17**. The actuation screw **1404** may include an inner sheath **1770** configured to receive the magnetic core **1412**. The inner sheath **1770** may be disposed within an outer sheath of the actuation screw **1404**, wherein the outer sheath includes the external threading **1724** configured to engage with the internal threading **1754** of the anchor screw **1402**. The inner sheath **1770** may include external threading **1772** that is configured to engage with corresponding internal threading of the screw head **1648** of the actuation screw **1404**. The inner sheath **1770** may form a tight interference fit with the magnetic core **1412**. In some cases, the magnetic core **1412** may be glued into or otherwise adhered to the inner sheath **1770**.

[0140] The system **1400** may be implemented without the inner sheath **1770**. In such an implementation, the magnetic core **1412** may be directly coupled to the actuation screw **1404** and then disposed within a hollow interior defined by the actuation screw **1404**.

[0141] The magnetic core **1412** is coupled to the actuation screw **1404** such that rotation of the magnetic core **1412** causes corresponding rotation of the actuation screw **1404**. When the magnetic core **1412** is magnetically coupled to a magnet or electromagnet of an EMC, the magnetic core **1412** may be rotated without directly contacting any component of the system **1400**. The remote rotation of the magnetic core **1412** causes corresponding rotation of the actuation screw **1404** and may thereby cause the actuation screw **1404** to screw out of and into the anchor screw **1402**. As described herein, the coupler **1408** serves as an anti-rotation assembly that enables the distraction plate **1406** to remain rotationally stationary when the actuation screw **1404** is screwed out of and into the anchor screw **1402**.

[0142] FIG. **18** is a cross-sectional perspective view of the system **1400** for performing a distraction histogenesis surgical procedure. The cross-sectional view of FIG. **18** enables further viewing of the inner sheath **1770** that may be disposed around the magnetic core **1412**. The magnetic core **1412** may be arranged such that each pole of the magnetic core **1412** runs an entire longitudinal length of the magnetic core **1412**.

[0143] FIG. **19** is a cross-sectional perspective view of the system **1400** for performing a distraction histogenesis surgical procedure. The cross-sectional in FIG. **19** is cut through a portion of the magnetic core **1412**, actuation screw **1404**, and anchor screw **1402**. FIG. **19** illustrates wherein the system **1400** does not include an inner sheath (see **1770** at FIG. **17**) disposed around the magnetic core **1412**. Instead, the magnetic core **1412** is disposed directly within a hollow interior defined by a sidewall of the actuation screw **1404**.

[0144] FIGS. **20** and **21** illustrate views of the system **1400** without the distraction plate (see **1406** first illustrated in FIG. **14**). FIG. **20** is a perspective view of the system **1400** and FIG. **21** is a cross-sectional perspective view of the system **1400**. The system **1400** may be utilized with or without the distraction plate (see **1406**) according to patient needs. In some cases, the system **1400** may be installed without the distraction plate, and then the distraction plate may be later added based on patient progression. In other cases, the system **1400** may be installed with the distraction plate, and then the distraction plate may be later removed based on patient progression.

[0145] The cross-sectional view of FIG. **21** illustrates wherein the inner sheath **1770** is disposed around the magnetic core **1412** only at a proximal end of the magnetic core **1412**. The inner sheath **1770** may be glued to the magnetic core **1412** or otherwise adhered to the magnetic core **1412**. The external threading **1772** of the inner sheath **1770** may then be utilized to couple the magnetic core to the screw head **1648** of the actuation screw **1404**.

[0146] FIG. **22** is a straight-on side view of a system **2200** for performing a distraction histogenesis surgical procedure, and then actuating distraction and retraction of a device through a magnetic coupling. The system **2200** includes a distraction device **2202** for performing a distraction histogenesis surgical procedure. The system **2200** additionally includes an external magnetic controller (EMC) **2204** that forms a magnetic coupling with a magnet of the distraction device **2202**.

[0147] In the example illustrated in FIG. **22**, the distraction device **2202** is like the system **100** first described in connection with FIG. **1**. However, the distraction device **2202** of the system **1400** may include a distraction plate and include components similar to the system **800** first described in connection with FIG. **8**. Likewise, the system **1400** may include a distraction device **2202** including a magnetic core and include components similar to the system **1400** first described in connection with FIG. **14**. The EMC **2204** may be utilized in connection with any of the magnetic devices described herein, including at least the devices **100**, **800**, **1400** first described in connection with FIGS. **1**, **8**, and **14**, respectively.

[0148] FIG. **23** is a perspective view of the system **2200** for performing a distraction histogenesis surgical procedure, and then actuating distraction and retraction of a device through a magnetic coupling. The EMC **2204** may include a bottom plate **2306** configured to rest against a patient. The EMC **2204** may additionally include a dial **2308** to enable a machine or human user to rotate an external magnet of the EMC **2204**.

[0149] FIG. **24** is an overhead perspective view of the EMC **2204** for actuating distraction and retraction of a device through a magnetic coupling. The EMC **2204** may additionally include external markers, including a positive rotational marker **2410** indicating the direction to rotate the dial **2308** to distract an actuation screw, i.e., the direction to turn the dial **2308** to unscrew the actuation screw from the corresponding anchor screw. The EMC **2204** may additionally include a negative rotational marker **2412** indicating the direction to rotate the dial **2308** to retract the actuation screw, i.e., the direction to turn the dial **2308** to screw the actuation screw further into the corresponding anchor screw.

[0150] FIG. **25** is a cross-sectional aerial top-down view of the EMC **2204** for actuating distraction and retraction of a device through a magnetic coupling. The EMC **2204** includes an external magnet **2514** that comprises at least two poles having opposite polarity. As described herein, the external magnet **2514** is described as being "external" because it may be located external to patient tissue and still form a magnetic coupling with a magnetic device implanted inside the patient.

[0151] The external magnet **2514** includes at least a first pole **2516** and a second pole **2518** that are located adjacent to one another. The external magnet **2514** may include additional poles, including for example, four poles, six poles, eight poles, and so forth. In some cases, it may be desirable to include a higher quantity of poles to provide increased granularity when rotating the external magnet **2514**.

[0152] The quantity of poles of the EMC **2204** may match the quantity of poles in a corresponding magnet of a device for performing a distraction histogenesis surgical procedure (see, e.g., the plate magnet **112** first described in connection with FIG. **1**; the plate magnet **912** first described in connection with FIG. **9**; or the magnetic core **1412** first described in connection with FIG. **14**). The poles of the magnet of the device (see, e.g., **100**, **800**, or **1400**) may alternate in polarity like pie slices around the magnet. Likewise, the poles of the external magnet **2514** of the EMC **2204** may alternate in polarity like pie slices around the external magnet **2514**.

[0153] FIG. **26** is a cross-sectional perspective view of the system **2200** for performing a distraction histogenesis surgical procedure, and then actuating distraction and retraction of a device through a magnetic coupling. As shown in FIG. **26**, a magnetic coupling is formed between the external magnet **2514** of the EMC **2204** and a corresponding magnet of the distraction device **2202**.

[0154] In the example implementation illustrated in FIG. **26**, the magnet of the distraction device **2202** includes two poles, including a North pole and a South pole. Likewise, the external magnet **2514** of the EMC **2204** includes two poles, including a North pole and a South pole. The opposite polarities attract between the magnet of the distraction device **2202** and the external magnet **2514** of the EMC **2204**. This forms a magnetic coupling between the distraction device **2202** and the EMC **2204** that may be established even through numerous layers of intervening materials. The magnetic coupling may be sufficiently strong to be maintained through material layers such as periosteum, fat, fascia, skin, fabric, medical bandaging, and so forth.

[0155] FIGS. **27**A-**27**C are schematic illustrations of an EMC **2204** including an external magnet **2514**. The EMC **2204** may be manually actuated by a user or automatically actuated by an electronic controller in communication with a motor.

[0156] FIG. **27**A is a schematic illustration of an aerial top-down view of the EMC **2204**. The EMC **2204** is configured to be magnetically coupled to the systems described herein, including any of the devices **100**, **800**, **1400** first described in connection with FIGS. **1**, **8**, and **14**, respectively.

[0157] The EMC **2204** incudes a housing that comprises the dial **2308** that may be rotated clockwise and counterclockwise. In the example illustrated in FIG. **27**, the dial **2308** may be rotated clockwise to rotate in a positive **2410** direction, which would further distract an actuation screw, and thus unscrew the actuation screw from a corresponding anchor screw to lift the actuation screw away from the

anchor screw. The dial **2308** may be rotated counterclockwise in a negative **2412** direction, which would retract the actuation screw, and thus further screw the actuation screw into the corresponding anchor screw.

[0158] FIG. **27**B is a schematic illustration of a straight-on cross-sectional view of the EMC **2204**. The EMC **2204** includes the external magnet **2514** that includes a first polarity **2518** and a second polarity **2518**. Like the magnet of an actuation screw, the external magnet **2514** is arranged such that each of the first polarity **2516** and the second polarity **2518** are located at the ends of the external magnet **2514**. The external magnet **2514** may include a cylindrical geometry as shown in FIG. **27**B, and in this implementation, the first polarity **2516** and the second polarity **2518** run the entire length of cylindrical geometry.

[0159] FIG. **27**C is a schematic illustration of a straight-on cross-sectional view of the EMC **2204**, wherein the EMC further includes a microcontroller and driver **2720** that is in electronic communication with a motor **2722**. The motor **2722** is mechanically coupled to the external magnet **2514** such that rotation of the motor **2722** may cause rotation of the external magnet **2514**.

[0160] FIG. **28** is a schematic illustration of a straight-on cross-sectional view of an EMC **2804** that includes one or more electromagnets **2824***a*, **2824***b*. The EMC **2804** may include a microcontroller and driver **2820** in electronic communication with the electromagnets **2824***a*, **2824***b*. The EMC **2804** may additionally include a power amplifier **2822** in electronic communication with the electromagnets **2824***a*, **2824***b* and the microcontroller and driver **2820**, wherein the power amplifier **2822** powers a coil of the electromagnets **2824***a*, **2824***b*.

[0161] FIGS. **29**A-**29**F are schematic illustrations of a system **2900** for driving an implant magnet **2912** of a distraction device with an EMC **2804** that includes electromagnets. FIGS. **29**A-**29**F include a schematic illustration of a cross-sectional straight-on side view of the EMC **2804**, and additionally include an aerial top-down view of the implant magnet **2912** of the distraction device to provide context to the current rotational position of the implant magnet **2912**.

[0162] The system **2900** includes the implant magnet **2912**, which is a component of a distraction device and is implanted in a patient. The implant magnet **2912** may include the plate magnet **112** of the distraction device first illustrated in connection with FIG. **1**. The implant magnet **2912** may include the plate magnet **912** of the distraction device first illustrated in connection with FIG. **8**. The implant magnet **2912** may include the magnetic core **1412** of the distraction device first illustrated in connection with FIG. **14**. The implant magnet **2912** includes at least a first pole **2914** and a second pole **2916**. The implant magnet **2912** may include more than two poles, and may specifically include four, six, eight, or more poles.

[0163] The system **2900** is arranged such that the EMC **2804** includes a two-pole electromagnet **2902** comprising a first coil **2920** and a second coil **2922**. The EMC **2804** includes a Hall effect sensor or Hall effect array **2924** configured to track a current orientation of the implant magnet **2912** of the distraction device. The system **2900** may be implemented with a two pole electromagnet **2902** that is connected as shown in FIGS. **29**A-**29**F. The system **2900** may alternatively be implemented with a two pole electromagnet **2902** that comprises two separate (non-connected) electromagnets.

[0164] The schematic illustrations of FIGS. **29**A-**29**F describe a principle of traveling waves that enable granular rotation of the implant magnet **2912** by engaging the two-pole electromagnet **2902** of the EMC **2804**. The two-pole electromagnet **2902** may be arranged as an array around the implant magnet **2912** when the EMC **2804** is placed on the patient's skin to form a magnetic coupling with the implant magnet **2912**.

[0165] FIG. **29**A illustrates an initiation orientation for the system **2900**. The two-pole electromagnet **2902** includes the first coil **2920** and the second coil **2922**. The EMC **2804** further includes the Hall effect sensor or Hall effect array **2924** to track the current rotational orientation of the implant magnet **2912**. The first coil **2920** and the second coil **2922** are located at approximately the junction between the first pole **2914** and the second pole **2916** of the implant magnet **2912**.

[0166] FIG. **29**B illustrates a zero degree rotation orientation for the system **2900**, wherein all components of the system are in the same configuration as described in connection with the initiation orientation of FIG. **29**A.

[0167] FIG. **29**C illustrates a 90 degree rotation orientation for the system **2900**. The implant magnet **2912** has rotated 90 degrees relative to the initiation orientation illustrated in FIG. **29**A. The second coil **2922** is engaged.

[0168] FIG. **29**D illustrates a 180 degree rotation orientation for the system **2900**. The implant magnet **2912** has rotated 180 degrees relative to the initiation orientation illustrated in FIG. **29**A. The second coil **2922** is engaged.

[0169] FIG. **29**E illustrates a 270 degree rotation orientation for the system **2900**. The implant magnet **2912** has rotated 270 degrees relative to the initiation orientation illustrated in FIG. **29**A. The second coil **2922** is engaged.

[0170] FIG. **29**F illustrates a 360 degree rotation orientation for the system **2900**. The implant magnet **2912** has the same rotational position as the initiation orientation illustrated in FIG. **29**A. The first coil **2920** and the second coil **2922** are engaged.

[0171] FIG. **30** is a schematic illustration of a straight-on cross-sectional view of an EMC **2804** comprising an electromagnet. The EMC **2804** may be utilized in connection with any of the devices described herein, including any of the devices **100**, **800**, or **1400** first described in connection with any of FIG. **1**, **8**, or **14**, respectively. The EMC **2804** may be used in connection with any of the methods, systems, or described herein. The electromagnet-based EMC **2804** illustrated in FIG. **30** is interchangeable with the magnet-based EMC **2204** first illustrated in FIG. **22**, as long as the electromagnet-based EMC **2804** is suitable for use based on a particular patient's health history.

[0172] The EMC **2804** may include housing components similar or identical to the housing components associated with the magnet-based EMC **2204** first illustrated in connection with FIG. **22**. The electromagnet-based EMC **2804** includes an electromagnet comprising a rod **3020**, a coil **3022** wrapped around the rod **3020**, and a battery **3024**. The coil **3022** may be driven by a power amplifier and controller by a microcontroller.

[0173] FIGS. **31**A-**31**C are schematic cross-sectional aerial top-down views of exemplary magnets that may be utilized in connection with any of the devices described herein, including, for example, the devices **100**, **800**, or **1400** first described in connection with FIG. **1**, **8**, or **14**, respec-

tively. FIGS. **31**A-**31**C each illustrate an aerial top-down view of a top of a magnet **3112** or cross-sectional slice of the magnet **3112**.

[0174] FIG. **31**A illustrate an example wherein the magnet **3112** includes two poles, including a first pole **3114** including a first polarity and a second pole **3116** including a second polarity. The first polarity is opposite to the second polarity. The poles **3114**, **3116** are adjacent to one another in the cross-sectional slice such that each of the poles **3114**, **3116** comprises a half-circle cross-sectional geometry.

[0175] FIG. **31**B illustrates an example wherein the magnet **3112** includes four poles, including two of a first pole **3114***a*, **3114***b* each having a first polarity. The magnet **3112** further includes two of a second pole **3116***a*, **3116***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 **3114***a*, **3114***b* is adjacent to two of the second pole **3116***a*, **3116***b*. The poles are further arranged such that each of the poles **3114***a*, **3114***b*, **3116***a*, **3116***b* comprises a circular sector (pie slice) cross-sectional geometry.

[0176] FIG. **31**C illustrates an example wherein the magnet **3112** includes eight poles, including four of a first pole **3114***a*, **3114***b*, **3114***c*, **3114***d* each having a first polarity. The magnet **3112** further includes four of a second pole **3116***a*, **3116***b*, **3116***c*, **3116***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 **3114***a*, **3114***b*, **3114***c*, **3114***d* is adjacent to two of the second pole. Likewise, any of the second pole **3116***a*, **3116***b*, **3116***c*, **3116***d* is adjacent to two of the first pole. The poles are further arranged such that each of the poles **3114***a*-**3114***d*, **3116***a*-**3116***d* comprises a circular sector (pie slice) cross-sectional geometry.

[0177] The devices **100**, **800**, **1400** 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, any of the external magnetic controllers **1404** described herein may include an external 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. 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 external magnetic controller. 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.

[0178] FIGS. **32**A-**32**C are schematic illustrations depicting the magnetic coupling between a magnet **3212** of an actuation screw (see, e.g., **104**, **804**, **1404**), and an external magnet **2514** of an EMC **2204**. As shown in FIG. **32**A, a first polarity **3214** of the magnet **3212** of the actuation screw establishes a magnetic attraction with the second polarity **2518** of the external magnet **2514**. In the example illustrated in FIGS. **32**A-**32**C, the first polarity **3214** of the magnet **3212** is a North polarity, and the second polarity **2518** of the external magnet **2514** is a South polarity. Similarly, the second polarity **3216** of the magnet **3212** establishes a magnetic attraction with the first polarity **2516** of the external magnet **2514**. In the example illustrated in FIGS. **32**A-**32**C, the second polarity **3216** of the magnet **3212** is a South polarity, and the first polarity **2516** of the external magnet **2514** is a North polarity. It should be appreciated that the polarities may be altered, and the polarities illustrated in FIGS. **32**A-**32**B are exemplary only.

[0179] As shown in FIG. **32**B, rotation of the external magnet **2514** of the EMC **2204** in a clockwise direction causes synchronous rotation of the magnet **3212** of the actuation screw due to the magnetic attraction of the corresponding magnetic poles. A patient or healthcare provider may thus place the EMC **2204** externally on the patient, establish the magnetic attraction between the EMC **2204** and the magnet **3212**, and then distract or retract the actuation screw by rotating the external magnet **2514** of the EMC **2204**.

[0180] As shown in FIG. **32**C, rotation of the external magnet **2514** of the EMC **2204** in a counterclockwise direction causes synchronous rotation of the magnet **3212** of the actuation screw due to the magnetic attraction of the corresponding magnetic poles. A patient or healthcare provider may thus place the EMC **2204** externally on the patient, establish the magnetic attraction between the EMC **2204** and the magnet **3212**, and then distract or retract the actuation screw by rotating the external magnet **2514** of the EMC **2204**.

[0181] FIG. **33** is a schematic illustration of a distraction configuration **3300** for distracting or retracting a patient tissue after installation of a device **3302** for performing a distraction histogenesis surgical procedure. The device **3302** may include any of the suitable devices described herein, including, for example, any of the devices **100**, **800**, **1400** first described in any of FIG. **1**, **8**, or **14**, respectively.

[0182] The distraction configuration **3300** includes an anchor screw anchored into a patient tissue substrate **3304**. In the case of a periosteal distraction procedure, the patient tissue substrate **3304** may include bone tissue. However, the distraction configuration **3302** may be implemented on other patient tissue types. The distraction configuration **3300** includes a magnet of an actuation screw disposed in between the patient tissue substrate **3304** and a second patient tissue **3306**. In the case of the periosteal distraction procedure, the patient tissue substrate **3304** may include the bone tissue, and the second patient tissue **3306** may include a periosteum layer. The distraction configuration **3300** includes the EMC **2204**, **2804** located external to at least the second patient tissue **3306**. In the case of a periosteal distraction procedure, the EMC **2204**, **2804** may be located externally to the periosteum layer and may additionally be located externally to other layers such as connective tissue, fat, muscle, skin, and so forth.

[0183] The systems, methods, and devices described herein enable a healthcare provider to install a device for performing a distraction histogenesis procedure, and then fully close up the patient's skin barrier after installation. A user may then distract or retract the system by forming a magnetic attraction between the magnet coupled to an actuation screw, and the external magnet of the EMC **2204**, **2804**. This magnetic attraction enables the user to distract or retract the actuation screw over time without reopening the patient's skin barrier. This reduces the likelihood of infection and significantly improve patient outcomes.

[0184] FIGS. **34**A and **34**B are schematic illustrations of a distraction configuration **3400** for performing a periosteal

distraction surgical procedure on patient tissue. FIG. **34**A illustrates wherein a device is fully retracted. FIG. **34**B illustrates wherein the device is partially distracted. FIGS. **34**A-**34**B specifically illustrate wherein the distraction device does not include a distraction plate.

[0185] The systems, methods, and devices described herein may be utilized to perform various distraction histogenesis procedures on various tissue types, including a variety of soft tissues. The systems, methods, and devices described herein may specifically be utilized to perform a periosteal distraction surgical procedure as depicted in FIGS. **34**A-**34**B. The distraction configuration **3400** for a periosteal distraction procedure includes anchoring the anchor screw into a bone **3402** of a patient, and then fully screwing the actuation screw into the anchor screw. A periosteum **3404** may be pulled over a magnet coupled to the actuation screw, and the skin **3406** of the patient may be fully sutured shut to reduce the likelihood of infection. After the distraction device is installed, a user may place the EMC **2204**, **2804** on the patient's skin over the actuation screw. When the EMC **2204**, **2804** forms a magnetic attraction with the magnet coupled to the actuation screw, the user may rotate the dial of the EMC **2204**, **2804** to synchronously rotate the actuation screw within the anchor screw. The user may thereby distract or retract the actuation screw within the anchor screw. As shown in FIG. **34**B, when the actuation screw is partially distracted from the anchor screw, the periosteum **3404** and skin **3406** layers of the patient will be lifted away from the bone **3402** of the patient. This may trigger regeneration of bone tissue.

[0186] The distraction configuration **3400** may be performed utilizing any of the devices described herein. The distraction configuration **3400** may be performed utilizing the system **100** first described in connection with FIG. **1**, wherein an anchor screw **102** is configured to receive an actuation screw **104** that includes a plate magnet **112** attached to the actuation screw **104**. The plate magnet **112** may serve to stretch a second tissue layer up and away from the patient tissue substrate.

[0187] The distraction configuration **3400** may be performed utilizing the system **1400** first described in connection with FIG. **14**, and specifically the implementation without the distraction plate as illustrated in FIGS. **20**-**21**, wherein an anchor screw **1402** is configured to receive an actuation screw **1404** that is coupled to a magnetic core **1412**. The magnetic core **1412** may serve to stretch a second tissue layer up and away from the patient tissue substrate.

[0188] FIGS. **35**A and **35**B are schematic illustrations of a distraction configuration **3500** for performing a periosteal distraction surgical procedure on patient tissue. FIG. **35**A illustrates wherein a device is fully retracted. FIG. **35**B illustrates wherein the device is partially distracted. FIGS. **35**A-**35**B specifically illustrate wherein the distraction device includes a distraction plate.

[0189] The systems, methods, and devices described herein may be utilized to perform various distraction histogenesis procedures on various tissue types, including a variety of soft tissues. The systems, methods, and devices described herein may specifically be utilized to perform a periosteal distraction surgical procedure as depicted in FIGS. **35**A-**35**B. The distraction configuration **3500** for a periosteal distraction procedure includes anchoring the anchor screw into a bone **3402** of a patient, and then fully screwing the actuation screw into the anchor screw. A periosteum **3404** may be pulled over a magnet coupled to the actuation screw, and the skin **3406** of the patient may be fully sutured shut to reduce the likelihood of infection. After the distraction device is installed, a user may place the EMC **2204**, **2804** on the patient's skin over the actuation screw. When the EMC **2204**, **2804** forms a magnetic attraction with the magnet coupled to the actuation screw, the user may rotate the dial of the EMC **2204**, **2804** to synchronously rotate the actuation screw within the anchor screw. The user may thereby distract or retract the actuation screw within the anchor screw. As shown in FIG. **35**B, when the actuation screw is partially distracted from the anchor screw, the periosteum **3404** and skin **3406** layers of the patient will be lifted away from the bone **3402** of the patient. This may trigger regeneration of bone tissue.

[0190] The distraction configuration **3500** may be performed utilizing the system **800** first described in connection with FIG. **8**, wherein an anchor screw **802** is configured to receive an actuation screw **804** that is coupled to a plate magnet **812** and coupled to a distraction plate **806**. The plate magnet **812** and the distraction plate **806** may each serve to stretch a second tissue layer up and away from the patient tissue substrate. In some cases, the distraction plate may be secured to an osteotomized tissue such that the osteotomized tissue is also distracted away from the bone **3402** when the distraction plate is distracted away from the bone **3402**.

[0191] The distraction configuration **3500** may be performed utilizing the system **1400** first described in connection with FIG. **14**, wherein an anchor screw **1402** is configured to receive an actuation screw **1404** that is coupled to a magnetic core **1412** and may optionally additionally be coupled to a distraction plate (not shown in FIGS. **14**-**15**). The magnet **1412** and the distraction plate (if utilized) may each serve to stretch a second tissue layer up and away from the patient tissue substrate. In some cases, the distraction plate may be secured to an osteotomized tissue such that the osteotomized tissue is also distracted away from the bone **3402** when the distraction plate is distracted away from the bone **3402**.

[0192] FIGS. **36**A and **36**B are schematic illustrations of a distraction configuration **3600** for performing an osteotomy distraction surgical procedure on patient tissue. FIG. **36**A illustrates wherein a device is fully retracted. FIG. **36**B illustrates wherein the device is partially distracted. The distraction configuration **3600** may be performed with or without a distraction plate. If the distraction plate is utilized, then the osteotomized tissue may be secured to the distraction plate. If the distraction plate is not utilized, then the osteotomized tissue may be secured to another component of the distraction device, such as the actuation screw or the coupler.

[0193] The systems, methods, and devices described herein may be utilized to perform various distraction histogenesis procedures on various tissue types, including a variety of soft tissues. The systems, methods, and devices described herein may specifically be utilized to perform an osteotomy distraction surgical procedure as depicted in FIGS. **36**A-**36**B. The distraction configuration **3600** for an osteotomy distraction procedure includes anchoring the anchor screw into a bicortical bone **3402** of a patient, cutting out a portion of the nearside/proximal bone (i.e., the osteotomized tissue), anchoring a portion of the device to the osteotomized tissue, and fully screwing the actuation screw into the anchor screw. A periosteum **3404** may be pulled

over a magnet coupled to the actuation screw, and the skin **3406** of the patient may be fully sutured shut to reduce the likelihood of infection. In another embodiment, the periosteum **3404** may be placed undeath the magnet coupled to the actuation screw. After the device is installed, a user may place the EMC **2204**, **2804** on the patient's skin over the actuation screw. When the EMC **2204**, **2804** forms a magnetic attraction with the magnet coupled to the actuation screw, the user may rotate the dial of the EMC **2204**, **2804** to synchronously rotate the actuation screw within the anchor screw. The user may thereby distract or retract the actuation screw within the anchor screw. As shown in FIG. **36**B, when the actuation screw is partially distracted from the anchor screw, the periosteum **3404** and skin **3406** layers of the patient will be lifted away from the bone **3406** of the patient, and the osteotomized tissue will likewise lift away from the anchoring bone tissue. This may trigger regeneration of bone, vascular or other soft tissue.

[0194] The distraction configuration **3600** may be performed utilizing the system **100** first described in connection with FIG. **1**, wherein an anchor screw **102** is configured to receive an actuation screw **104** that includes a plate magnet **112** attached to the actuation screw **104**. The plate magnet **112** may serve to stretch a second tissue layer up and away from the patient tissue substrate. The osteotomized bone tissue may be anchored to one or more of the plate magnet **112** or the actuation screw **104**.

[0195] The distraction configuration **3600** may be performed utilizing the system **800** first described in connection with FIG. **8**, wherein an anchor screw **802** is configured to receive an actuation screw **804** that is coupled to a plate magnet **812** and may optionally additionally be coupled to a distraction plate **806**. The plate magnet **812** and the distraction plate **806** (if utilized) may each serve to stretch a second tissue layer up and away from the patient tissue substrate. The osteotomized tissue may be anchored to the distraction plate **806**.

[0196] The distraction configuration **3600** may be performed utilizing the system **1400** first described in connection with FIG. **14**, wherein an anchor screw **1402** is configured to receive an actuation screw **1404** that is coupled to a magnetic core **1412** and may optionally additionally be coupled to a distraction plate (not shown in FIGS. **14-15**). The magnetic core **1412** and the distraction plate (if utilized) may each serve to stretch a second tissue layer up and away from the patient tissue substrate. The osteotomized tissue may be anchored to the distraction plate if utilized. The osteotomized tissue may be anchored to one or more of the coupler or the actuation screw if the distraction plate is not utilized.

[0197] FIGS. **37**A-**37**C are schematic flow chart diagrams of a method **3700** for performing a distraction histogenesis surgical procedure. The method **3700** described in FIGS. **37**A-**37**C refers to steps for performing a periosteal distraction procedure to distract a periosteum layer away from a bone tissue layer. However, the method **3700** may be easily modified to perform similar steps on other tissue types.

[0198] The method **3700** includes planning at **3702** a distraction device position and marking patient skin to indicating skin incision site. The method **3700** includes creating at **3704** a longitudinal incision down to patient bone tissue to prepare for placement of anchor screw. The method **3700** includes drilling at **3706** a pilot hole into patient bone tissue to prepare for placement of anchor screw. The method **3700** includes inserting at **3708** the anchor screw into the pilot hole. The method **3700** includes inserting at **3710** an actuation screw (i.e., magnetic lifter) into the anchor screw until the actuation screw touches the surface of the anchor screw, and without tightening the actuation screw down onto the anchor screw. The method **3700** includes closing at **3712** the periosteum and skin over the top of the actuation screw. The method **3700** includes holding at **3714** the external magnetic controller on to the patient skin. The method **3700** includes rotating at **3718** the dial on the external magnetic controller based on its indication to distract or retract the patient tissue.

[0199] FIGS. **38**A-**38**E are schematic block diagrams of a method **3800** for performing a distraction histogenesis surgical procedure utilizing the systems and devices described herein. In FIGS. **38**A-**38**E, the method **3800** is being performed on a tibia bone of a patient as an exemplary use-case. It should be appreciated that the systems, methods, and devices described herein may be utilized on alternative bones and tissues as deemed appropriate. The systems described herein may be utilized to perform a periosteal distraction procedure as described in connection with FIGS. **38**A-**38**E. The systems described herein may additionally be utilized to perform distraction histogenesis procedures on other tissue types.

[0200] The method **3800** may begin with planning a distraction plate position at **3802** and marking the patient's skin to indicate an incision location. This step is only necessary if the healthcare provider determines that a distraction plate would improve patient outcomes based on the patient's unique health circumstances. In some cases, the healthcare provider may determine that a distraction plate is not necessary, and that the patient may benefit from only the use of an anchor screw and actuation screw for distracting and retracting the patient's tissue.

[0201] The method **3800** includes creating at **3804** a longitudinal or transverse skin incision and a transverse incision of the patient's periosteum layer. The method **3800** includes inserting at **3806** a periosteal elevator to prepare subperiosteal tunnel on both sides of the incision. The method **3800** is such that on a distal end of the patient's bone, the periosteal elevator is inserted for a whole length of the distraction plate. The method **3800** is such that on a proximal end of the patient's bone, the periosteal elevator is inserted for a half-length of the distraction plate. The method **3800** includes inserting at **3812** the entire distraction plate under the periosteum on the distal side. The method **3800** includes pulling at **3814** the distraction plate back under the periosteum on the proximal side. The method **3800** include aligning at **3816** the central threaded hole of the distraction plate with the incision through the periosteum. The method **3800** includes inserting at **3818** a drill sleeve into the central threaded hole of the distraction plate. The method **3800** includes drilling at **3820** a hole into the patient's bone, wherein a drill bit is disposed through the drill sleeve. The method **3800** includes removing at **3822** the drill sleeve and inserting the anchor screw through the central threaded hole of the distraction plate and into the pilot hole drilled into the patient's bone. The method **3800** includes driving at **3824** a preassembled anchor screw and actuation screw through central threaded hole of distraction plate and into pilot hole drilled into patient bone tissue by utilizing cannulated driver until the actuation screw is located flush into the distraction plate, and wherein a magnet is coupled to the actuation

screw. The method **3800** includes closing at **3826** patient tissue over the device to reduce a likelihood of infection. The method **3800** includes placing at **3828** an external magnetic controller over the device and establishing a magnetic coupling between the magnet coupled to the actuation screw (installed within the patient) and an external magnet of the external magnetic controller. The method **3800** includes rotating at **3830** the external magnet of the external magnetic controller to cause synchronous rotation of the magnet coupled to the actuation screw.

[0202] FIG. **39** is a schematic block diagram of a system **3900** for remotely monitoring and controlling a distraction device. The system **3900** may be utilized in connection with any of the systems, methods, or devices described herein. The system **3900** may specifically be utilized in connection with any of the distraction devices described herein.

[0203] The system **3900** includes a health management server **3902** that processes operations for a health management platform **3906**. The health management server **3902** renders a graphical user interface (GUI) that is made accessible by way of the health management platform **3906**. The health management platform **3906** is made accessible to one or more personal devices **3914** by way of a computer-executed application, web browser, or other means. The health management platform **3906** may be accessed with a personal device **3914** that is in communication with a network, such as wide area network, local area network, the Internet, and so forth.

[0204] The health management server **3902** may optionally include an artificial intelligence and/or machine learning (AI/ML) engine **3904**. The AI/ML engine **3904** is trained upon a set of training data. The AI/ML engine **3904** may be trained to assess data output by any of the EMC **2204**, **2804**, a temperature sensor **3916**, a biomarker sensor **3918**, and/or a camera **3920** to monitor the status of a distraction device and determine whether there is a likely issue with the patient. The AI/ML engine **3904** 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 an automated fixator adjustor that may be integrated into the EMC **2204**, **2804**.

[0205] The health management platform **3906** may include modules for providing information regarding data monitoring **3908**, adjustment calculation **3910**, provider communication **3912**, and so forth. The health management platform **3906** may be rendered on an application that is run on a personal device **3914**, such as a mobile phone, a tablet, or other personal computer. The health management platform **3906** may be rendered on a web browser that is accessible by way of a personal device **3914** connected to the Internet or LoRaWAN.

[0206] Patients, healthcare providers, administrators, and other users may access the health management platform **3906** with a personal device **3914** to view up-to-date data provided by any of the temperature sensor **3916**, biomarker sensor **3918**, or camera **3920**. Additionally, the health management platform **3906** provides current and past information regarding adjustment calculations **3910** for a fixator that is currently or was previously fixated to a patient. The adjustment calculations **3910** may be utilized to change or maintain protocols to be implemented by an automated fixator adjustor integrated into the EMC **2204**, **2804**. The health management platform **3912** provides a means for secure bidirectional communication with patients and healthcare providers by way of the provider communication **3912** module. The health management platform **3912** additionally provides a means for secure bidirectional communication with devices such as the EMC **2204**, **2804**, temperature sensor **3916**, biomarker sensor **3918**, and the camera **3920**.

[0207] The EMC **2204**, **2804** may be automated to engage the magnetic and cause distraction or retraction without manual user intervention. The EMC **2204**, **2804** may include one or more processors configured to execute instructions stored in non-transitory computer readable storage medium. The processors of the EMC **2204**, **2804** may receive instructions from any of the health management server **3902**, a locally stored memory device with the EMC **2204**, **2804**, or from another source such as the personal device **3914**. The EMC **2204**, **2804** 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 **3902** by way of the health management platform **3906**.

[0208] The EMC **2204**, **2804** may include one or more Bluetooth® low energy chips and/or near-field communication chips that enable the EMC **2204**, **2804** may wirelessly communicate with personal devices **3914** by way of Bluetooth® or near-field communication. The EMC **2204**, **2804** may further be equipped with Wi-Fi® or LoRaWAN capability that enables the EMC **2204**, **2804** to wirelessly communicate with the health management server **3902** directly.

[0209] The EMC **2204**, **2804** may be automated to rotate the magnet and cause distraction or retraction of implant without manual user intervention. The EMC **2204**, **2804** may include one or more processors configured to execute instructions stored in non-transitory computer readable storage medium. The processors of the EMC **2204**, **2804** may receive instructions from any of the health management server **3902**, a locally stored memory device with the external magnetic controller **1700**, or from another source such as the personal device **3914**. The EMC **2204**, **2804** 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 **3902** by way of the health management platform **3906**, or through the personal device **3914**.

[0210] The temperature sensor **3916** may be temporarily installed within a patient to monitor the real-time internal temperature of the patient. Data output by the temperature sensor **3916** may be assessed to determine if patient tissue is inflamed or if the patient may have an infection at the surgical site.

[0211] The biomarker sensor **3918** may be temporarily installed within a patient to monitor the real-time presence of certain biomarkers. The biomarker sensor **3918** 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 **3918** may be utilized to determine if the patient likely has an infection at the surgical site and requires additional care.

[0212] The camera **3920** 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. In some cases, a personal device **3914** comprising a camera communicates with the health management server **3902** by way of a computer-executed application. The health management server **3902** executes the application and may communicate directly with the camera **3920** to receive images and other data captured by the camera **3920**. In some cases, the camera **3920** may integrated with any of the systems described herein and may capture up-to-date pictures of a fixator installed on a patient.

[0213] The EMC **2204**, **2804** comprises one or more processors configured to execute instructions stored in non-transitory computer readable storage medium. The processors of the EMC **2204**, **2804** may receive instructions from any of the health management server **3902**, a locally stored memory device with the EMC **2204**, **2804**, or from another source such as the personal device **3914**. A healthcare provider may amend the adjustment protocol by communicating with the health management server **3902** by way of the health management platform **3906**.

[0214] The EMC **2204**, **2804** may include one or more Bluetooth® low energy chips and/or near-field communication chips that enable the EMC **2204**, **2804** to wirelessly communicate with personal devices **3914** by way of Bluetooth® or near-field communication. The EMC **2204**, **2804** may further be equipped with Wi-Fi® or LoRaWAN capability that enables the EMC **2204**, **2804** to wirelessly communicate with the health management server **3902** directly.

[0215] The temperature sensor **3916**, biomarker sensor **3916**, and camera **3920** may include separate components that individually communicate with the health management server **3902** over a network connection. In other implementations, one or more of the temperature sensor **3916**, the biomarker sensor **3918**, or the camera **3920** may be integrated into the EMC **2204**, **2804**.

[0216] The personal device **3914** is any personal computing device that can communicate with the health management server **3902**. The personal device **3914** may include a smart phone, a tablet, a laptop, a personal computer, virtual or augmented reality device, and so forth. The personal devices **3914** may communicate with the health management server **3902** by way of a local area network (LAN) connection, a wide area network (WAN) connection, or another network connection.

[0217] The personal device **3914** may include an application installed thereon for enabling streamlined communication with the health management server **3902**. 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 **3902**, the EMC **2204**, **2804**, the temperature sensor **3916**, the biomarker sensor **3918**, or the camera **3920**. 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.

[0218] Referring now to FIG. **40**, a block diagram of an example computing device **4000** is illustrated. Computing device **4000** may be used to perform various procedures, such as those discussed herein. Computing device **4000** 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 **4000** 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.

[0219] Computing device **4000** includes one or more processor(s) **4012**, one or more memory device(s) **4004**, one or more interface(s) **4006**, one or more mass storage device (s) **4008**, one or more Input/output (I/O) device(s) **4010**, and a display device **4030** all of which are coupled to a bus **4012**. Processor(s) **4012** include one or more processors or controllers that execute instructions stored in memory device(s) **4004** and/or mass storage device(s) **4008**. Processor(s) **4012** may also include diverse types of computer-readable media, such as cache memory.

[0220] Memory device(s) **4004** include various computer-readable media, such as volatile memory (e.g., random access memory (RAM) **4014**) and/or nonvolatile memory (e.g., read-only memory (ROM) **4016**). Memory device(s) **4004** may also include rewritable ROM, such as Flash memory.

[0221] Mass storage device(s) **4008** 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. **40**, a particular mass storage device **4008** is a hard disk drive **4024**. Various drives may also be included in mass storage device(s) **4008** to enable reading from and/or writing to the various computer readable media. Mass storage device(s) **4008** include removable media **4026** and/or non-removable media.

[0222] I/O device(s) **4010** include various devices that allow data and/or other information to be input to or retrieved from computing device **4000**. Example I/O device (s) **4010** include cursor control devices, keyboards, keypads, microphones, monitors, touchscreen devices, or other display devices, speakers, printers, network interface cards, modems, and the like.

[0223] Display device **4030** includes any type of device capable of displaying information to one or more users of computing device **4000**. Examples of display device **4030** include a monitor, display terminal, video projection device, and the like.

[0224] Interface(s) **4006** include various interfaces that allow computing device **4000** to interact with other systems, devices, or computing environments. Example interface(s) **4006** may include any number of different network interfaces **4020**, such as interfaces to local area networks (LANs), wide area networks (WANs), wireless networks, and the Internet. Other interface(s) include user interface **4018** and peripheral device interface **4022**. The interface(s) **4006** may also include one or more user interface elements **4018**. The interface(s) **4006** 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.

[0225] Bus **4012** allows processor(s) **4012**, memory device(s) **4004**, interface(s) **4006**, mass storage device(s) **4008**, and I/O device(s) **4010** to communicate with one another, as well as other devices or components coupled to bus **4012**. Bus **4012** represents one or more of several types of bus structures, such as a system bus, PCI bus, IEEE bus, USB bus, and so forth.

[0226] 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 **4000** and are executed by processor(s) **4012**. 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

[0227] The following examples pertain to further embodiments.

[0228] Example 1 is a system for performing a distraction histogenesis surgical procedure. The system includes an anchor screw comprising a hollow interior defined by a sidewall. The system includes an actuation screw comprising: a magnet comprising a first pole and a second pole; and a screw shaft attached to the magnet. The system is such that the screw shaft is configured to be disposed within the hollow interior defined by the sidewall of the anchor screw.

[0229] Example 2 is a system as in Example 1, wherein the anchor screw comprises: external threading on an external surface of the sidewall; and internal threading on an internal surface of the sidewall.

[0230] Example 3 is a system as in any of Examples 1-2, wherein the screw shaft of the actuation screw comprises magnet external threading, and wherein the magnet external threading corresponds with the internal threading of the anchor screw.

[0231] Example 4 is a system as in any of Examples 1-3, wherein the magnet external threading engages with the internal threading of the anchor screw such that the actuation screw moves up or down along a longitudinal axis of the anchor screw in response to rotation of the magnet.

[0232] Example 5 is a system as in any of Examples 1-4, wherein the magnet comprises a bottom surface attached to the screw shaft; wherein the magnet comprises a top surface located opposite to the bottom surface; and wherein the first pole is located adjacent to the second pole such that each of the first pole and the second pole is disposed at the top surface of the magnet.

[0233] Example 6 is a system as in any of Examples 1-5, further comprising an external magnetic controller comprising an external magnet configured to magnetically engage with the magnet of the actuation screw, wherein the external magnet comprises: a first external pole configured to magnetically attract to the first pole of the magnet liter; and a second external pole configured to magnetically attract to the second pole of the actuation screw.

[0234] Example 7 is a system as in any of Examples 1-6, wherein the external magnet comprises a bottom surface configured to be disposed adjacent to an external tissue of a patient; wherein the first external pole is located adjacent to the second external pole such that each of the first external pole and the second external pole is disposed at the bottom surface of the external magnet.

[0235] Example 8 is a system as in any of Examples 1-7, wherein the first pole of the actuation screw is located adjacent to the second pole of the actuation screw such that each of the first pole and the second pole is disposed at a top surface of the magnet; wherein the top surface of the magnet is configured to magnetically engage with the bottom surface of the external magnet in response to magnetic attraction between the first external pole and the first pole, and further in response to magnetic attraction between the second external pole and the second pole.

[0236] Example 9 is a system as in any of Examples 1-8, wherein rotation of the external magnet causes rotation of the actuation screw in response to magnetic attraction between: the first external pole of the external magnet and the first pole of the actuation screw; and the second external pole of the external magnet and the second pole of the actuation screw.

[0237] Example 10 is a system as in any of Examples 1-9, wherein the first pole of the actuation screw and the first external pole of the external magnetic controller comprise opposite polarity; and wherein the second pole of the actuation screw and the second external pole of the external magnetic controller comprise opposite polarity.

[0238] Example 11 is a system as in any of Examples 1-10, wherein rotation of the external magnet of the external magnetic controller causes rotation of the magnet of the actuation screw, in response to establishing an attraction between the external magnet and the magnet.

[0239] Example 12 is a system as in any of Examples 1-11, wherein the anchor screw is configured to be screwed into a tissue of a patient and remain stationary within the tissue of the patient; and wherein the screw shaft is configured to rotate within the hollow interior of the anchor screw to cause the actuation screw to move up or down along a longitudinal axis of the anchor screw and relative to a position of the anchor screw.

[0240] Example 13 is a system as in any of Examples 1-12, wherein the anchor screw is configured to be screwed into a bone tissue of a patient and remain stationary within the bone tissue of the patient; wherein the magnet of the actuation screw is configured to be disposed adjacent and underneath a periosteum of the patient; and wherein the screw shaft is configured to rotate within the hollow interior of the anchor screw to cause the actuation screw to move up or down along a longitudinal axis of the anchor screw and relative to a position of the anchor screw, to cause distraction or retraction of the periosteum of the patient.

[0241] Example 14 is a system as in any of Examples 1-13, wherein the anchor screw is configured to be screwed into a first tissue of a patient; and wherein a position of the actuation screw relative to a longitudinal axis of the anchor

screw is adjusted and maintained by rotating the screw shaft within the hollow interior of the anchor screw.

[0242] Example 15 is a system as in any of Examples 1-14, wherein the position of the actuation screw is optimized and adjusted to cause distraction or retraction of a second tissue of the patient.

[0243] Example 16 is a system as in any of Examples 1-15, further comprising an external magnetic controller configured to cause rotation of the actuation screw, wherein the external magnetic controller comprises: an external magnet configured to magnetically engage with the magnet of the actuation screw; a motor driver; a power source comprising a battery or external power source; a processor; and a motor in mechanical communication with the external magnet and configured to rotate the external magnet; wherein the processor is in electronic communication with the motor and causes the motor to rotate the external magnet according to a schedule via the motor driver.

[0244] Example 17 is a system as in any of Examples 1-16, wherein the external magnetic controller further comprises an antenna for receiving instructions over a network, and wherein the instructions comprise the schedule.

[0245] Example 18 is a system as in any of Examples 1-17, wherein the external magnetic controller further comprises one or more of a temperature sensor, a biomarker sensor, or a camera.

[0246] Example 19 is a system for performing a distraction histogenesis surgical procedure. The system includes an external magnetic controller comprising an external magnet. The system includes an anchor screw comprising a hollow interior defined by a sidewall. The system includes an actuation screw comprising: a magnet comprising a first pole and a second pole; and a screw shaft attached to the magnet. The system is such that the screw shaft is configured to be disposed within the hollow interior defined by the sidewall of the anchor screw. The system is such that the external magnet is configured to magnetically engage with the magnet of the magnetic lifter such that rotation of the external magnet causes rotation of the actuation screw.

[0247] Example 20 is a method for performing a distraction histogenesis surgical procedure. The method includes installing an anchor screw in a first tissue of a patient, wherein the anchor screw comprises a hollow interior defined by a sidewall. The method includes installing an actuation screw within the hollow interior of the anchor screw, wherein the actuation screw comprises: a magnet comprising a first pole and a second pole; and a screw shaft attached to the magnet. The method includes causing an external magnet to magnetically engage with the magnet of the actuation screw. The method includes rotating the external magnet to cause rotation of the magnet, and thereby adjust a position of the actuation screw along a longitudinal axis of the anchor screw.

[0248] Example 21 is a system. The system includes an anchor screw comprising a hollow interior defined by a sidewall, wherein the anchor screw comprises internal actuation threading attached to an interior surface of the sidewall and further comprises external anchor threading attached to an exterior surface of the sidewall. The system includes an actuation screw comprising a screw shaft that comprises external actuation threading. The system includes a magnet coupled to the actuation screw. The system is such that the external actuation threading of the screw shaft corresponds with the internal actuation threading of the anchor screw. The system is such that rotation of the magnet causes synchronous rotation of the actuation screw.

[0249] Example 22 is a system as in Example 21, wherein the rotation of the magnet causes the synchronous rotation of the actuation screw and thereby causes the actuation screw to screw into or out of the hollow interior defined by the sidewall of the anchor screw.

[0250] Example 23 is a system as in any of Examples 21-22, further comprising a distraction plate coupled to the actuation screw, wherein the distraction plate is axially coupled to the actuation screw such that: the distraction plate lifts away from the anchor screw in response to the synchronous rotation of the actuation screw causing the actuation screw to screw out of the hollow interior of the anchor screw; the distraction plate lowers toward the anchor screw in response to the synchronous rotation of the actuation screw causing the actuation screw to screw into the hollow interior of the anchor screw.

[0251] Example 24 is a system as in any of Examples 21-23, further comprising a coupler that couples the distraction plate to the actuation screw, wherein the coupler permits the actuation screw to rotate independently of the distraction plate such that the distraction plate remains rotationally stationary in response to the synchronous rotation of the actuation screw causing the actuation screw to screw into or out of the hollow interior of the anchor screw.

[0252] Example 25 is a system as in any of Examples 21-24, further comprising: a distraction plate comprising a threaded hole that comprises internal threading; and a coupler comprising a coupler sidewall defining a hollow interior, wherein the coupler comprises external threading attached to an exterior surface of the coupler sidewall; wherein the internal threading of the threaded hole of the distraction plate corresponds with the external threading of the coupler.

[0253] Example 26 is a system as in any of Examples 21-25, wherein the coupler further comprises a smooth surface on the interior surface of the coupler sidewall.

[0254] Example 27 is a system as in any of Examples 21-26, wherein the screw shaft of the actuation screw further comprises a smooth portion that does not comprise the external actuation threading; and wherein the coupler is configured to couple the actuation screw to the distraction plate such that: the coupler is screwed into the threaded hole of the distraction plate by interfacing the external threading of the coupler with the internal threading of the threaded hole; and the actuation screw is disposed within the hollow interior of the coupler such that the smooth portion of the screw shaft of the actuation screw rotates freely within the hollow interior of the coupler.

[0255] Example 28 is a system as in any of Examples 21-27, wherein the coupler is configured to couple the actuation screw to the distraction plate such that: the distraction plate is axially coupled to the actuation screw such that the distraction plate lifts away from the anchor screw in response to the synchronous rotation of the actuation screw causing the actuation screw to screw out of the hollow interior of the anchor screw; the distraction plate is axially coupled to the actuation screw such that the distraction plate lowers toward the anchor screw in response to the synchronous rotation of the actuation screw causing the actuation screw to screw into the hollow interior of the anchor screw; and the distraction plate is not rotationally coupled to the actuation screw such that the distraction plate remains

rotationally stationary in response to the synchronous rotation of the actuation screw causing the actuation screw to screw out of or into the hollow interior of the anchor screw.

[0256] Example 29 is a system as in any of Examples 21-28, wherein the magnet comprises: a circular cross-sectional geometry; a first pole comprising a first polarity; and a second pole comprising a second polarity; wherein the first polarity is opposite to the second polarity; and wherein the circular cross-sectional geometry comprises each of the first pole and the second pole such that each of the first pole and the second pole comprises a half-circle cross-sectional geometry.

[0257] Example 30 is a system as in any of Examples 21-29, wherein the magnet comprises: a circular cross-sectional geometry; a plurality of a first pole comprising a first polarity; and a plurality of a second pole comprising a second polarity; wherein the first polarity is opposite to the second polarity; wherein the circular cross-sectional geometry comprises the plurality of the first pole and the plurality of the second pole arranged in an alternating orientation such that each of the plurality of the first pole is adjacent to two of the plurality of second pole, and further such that each of the plurality of the second pole is adjacent to two of the plurality of the first pole; and wherein each of the plurality of the first pole and each of the plurality of the second pole comprises a circular sector cross-sectional geometry.

[0258] Example 31 is a system as in any of Examples 21-30, wherein the magnet comprises a plate magnet comprises a top surface and a bottom surface, wherein the bottom surface is coupled to the actuation screw, and wherein each of a first polarity and a second polarity of the magnet is present on the top surface.

[0259] Example 32 is a system as in any of Examples 21-31, wherein the magnet comprises an elongated magnetic core disposed within a hollow interior defined by the actuation screw.

[0260] Example 33 is a system as in any of Examples 21-32, wherein the magnet is a component of the actuation screw, and wherein the magnet comprises an elongated magnetic core forming a component of the actuation screw.

[0261] Example 34 is a system as in any of Examples 21-33, further comprising an external magnetic controller comprising an external magnet configured to magnetically engage with the magnet, wherein rotation of the external magnet comprises synchronous rotation of the magnet, and thereby further causes the synchronous rotation of the actuation screw.

[0262] Example 35 is a system as in any of Examples 21-34, wherein the external magnet comprises a bottom surface configured to be disposed adjacent to an external tissue of a patient; wherein a first external pole of the external magnet is located adjacent to a second external pole of the external magnet such that each of the first external pole and the second external pole is disposed at the bottom surface of the external magnet.

[0263] Example 36 is a system as in any of Examples 21-35, wherein a first pole of the magnet is located adjacent to a second pole of the magnet such that each of the first pole and the second pole is disposed at a top surface of the magnet; and wherein the top surface of the magnet is configured to magnetically engage with the bottom surface of the external magnet in response to establishing a magnetic attraction between the magnet and the external magnet.

[0264] Example 37 is a system as in any of Examples 21-36, wherein the anchor screw is configured to be screwed into a tissue of a patient and remain stationary within the tissue of the patient; and wherein the screw shaft of the actuation screw is configured to rotate within the hollow interior of the anchor screw to cause the actuation screw to move up or down along a longitudinal axis of the anchor screw and relative to a position of the anchor screw.

[0265] Example 38 is a system as in any of Examples 21-37, wherein the anchor screw is configured to be screwed into a bone tissue of a patient and remain stationary within the bone tissue of the patient; wherein the magnet is configured to be disposed underneath a periosteum of the patient; wherein the rotation of the magnet causes the synchronous rotation of the actuation screw such that rotation of the magnet in a first direction causes the actuation screw to distract out of the anchor screw and thereby cause distraction of the periosteum of the patient; and wherein the rotation of the magnet causes the synchronous rotation of the actuation screw such that rotation of the magnet in a second direction causes the actuation screw to retract into the anchor screw and thereby cause retraction of the periosteum of the patient.

[0266] Example 39 is a system as in any of Examples 21-38, wherein the anchor screw is configured to be screwed into a tissue substrate of a patient; and wherein a position of the actuation screw relative to a longitudinal axis of the anchor screw is adjusted and maintained by rotating the screw shaft within the hollow interior of the anchor screw.

[0267] Example 40 is a system as in any of Examples 21-39, further comprising an external magnetic controller configured to form a magnetic coupling with the magnet, wherein the external magnetic controller comprises: an external magnet configured to form the magnetic coupling with the magnet; a processor; and a motor in mechanical communication with the external magnet, wherein the motor causes rotation of the external magnet, which thereby causes synchronous rotation of the magnet in response to establishing the magnetic coupling, and which further thereby causes the synchronous rotation of the actuation screw; wherein the processor is in electronic communication with the motor and causes the motor to rotate the external magnet according to a schedule.

[0268] Example 41 is a system as in any of Examples 21-40, further comprising an external magnetic controller configured to form a magnetic coupling with magnet, wherein the magnet is an implant magnet installed within a patient, and wherein the external magnetic controller comprises: one or more electromagnets with coils configured an electromagnet configured to form the magnetic coupling with the implant magnet; one or more power amplifiers or coil drivers; one or more Hall effect sensors or Hall effect array configured to read a magnetic position of the implant magnet; and a processor; wherein the processor causes actuation of the one or more electromagnets to form the magnetic coupling with the implant magnet and cause synchronized rotation of the implant magnet via the power drivers with feedback from the one or more Hall effect sensors or Hall effect array.

[0269] Example 42 is a system as in any of Examples 21-41, wherein the external magnetic controller further comprises an antenna for receiving instructions over a network, and wherein the instructions comprise the schedule.

[0270] Example 43 is a system as in any of Examples 21-42, wherein the external magnetic controller further comprises one or more of a temperature sensor, a biomarker sensor, or a camera.

[0271] Example 44 is a system for performing a distraction histogenesis surgical procedure, the system comprising: an external magnetic controller comprising an external magnet; and a device configured to be implanted within a patient. The device includes an anchor screw comprising a hollow interior defined by a sidewall, wherein the anchor screw comprises internal actuation threading attached to an interior surface of the sidewall and further comprises external anchor threading attached to an exterior surface of the sidewall. The device includes an actuation screw comprising a screw shaft that comprises external actuation threading. The device includes a magnet coupled to the actuation screw. The device is such that the external actuation threading of the screw shaft corresponds with the internal actuation threading of the anchor screw. The system is such that rotation of the external magnet causes synchronous rotation of the magnet in response to forming a magnetic coupling between the external magnet and the magnet. The device is such that the synchronous rotation of the magnet causes synchronous rotation of the actuation screw.

[0272] 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.

[0273] 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 system for performing a distraction histogenesis surgical procedure, the system comprising:

an anchor screw comprising a hollow interior defined by a sidewall, wherein the anchor screw comprises internal actuation threading attached to an interior surface of the sidewall and further comprises external anchor threading attached to an exterior surface of the sidewall;

an actuation screw comprising a screw shaft that comprises external actuation threading; and

a magnet coupled to the actuation screw;

wherein the external actuation threading of the screw shaft corresponds with the internal actuation threading of the anchor screw; and

wherein rotation of the magnet causes synchronous rotation of the actuation screw.

2. The system of claim **1**, wherein the rotation of the magnet causes the synchronous rotation of the actuation screw and thereby causes the actuation screw to screw into or out of the hollow interior defined by the sidewall of the anchor screw.

3. The system of claim **2**, further comprising a distraction plate coupled to the actuation screw, wherein the distraction plate is axially coupled to the actuation screw such that:

the distraction plate lifts away from the anchor screw in response to the synchronous rotation of the actuation screw causing the actuation screw to screw out of the hollow interior of the anchor screw;

the distraction plate lowers toward the anchor screw in response to the synchronous rotation of the actuation screw causing the actuation screw to screw into the hollow interior of the anchor screw.

4. The system of claim **3**, further comprising a coupler that couples the distraction plate to the actuation screw, wherein the coupler permits the actuation screw to rotate independently of the distraction plate such that the distraction plate remains rotationally stationary in response to the synchronous rotation of the actuation screw causing the actuation screw to screw into or out of the hollow interior of the anchor screw.

5. The system of claim **1**, further comprising:

a distraction plate comprising a threaded hole that comprises internal threading; and

a coupler comprising a coupler sidewall defining a hollow interior, wherein the coupler comprises external threading attached to an exterior surface of the coupler sidewall;

wherein the internal threading of the threaded hole of the distraction plate corresponds with the external threading of the coupler.

6. The system of claim **5**, wherein the coupler further comprises a smooth surface on the interior surface of the coupler sidewall.

7. The system of claim **6**, wherein the screw shaft of the actuation screw further comprises a smooth portion that does not comprise the external actuation threading; and

wherein the coupler is configured to couple the actuation screw to the distraction plate such that:

the coupler is screwed into the threaded hole of the distraction plate by interfacing the external threading of the coupler with the internal threading of the threaded hole of the distraction plate; and

the actuation screw is disposed within the hollow interior of the coupler such that the smooth portion of the screw shaft of the actuation screw rotates freely within the hollow interior of the coupler.

8. The system of claim **7**, wherein the coupler is configured to couple the actuation screw to the distraction plate such that:

the distraction plate is axially coupled to the actuation screw such that the distraction plate lifts away from the anchor screw in response to the synchronous rotation of the actuation screw causing the actuation screw to screw out of the hollow interior of the anchor screw;

the distraction plate is axially coupled to the actuation screw such that the distraction plate lowers toward the anchor screw in response to the synchronous rotation of the actuation screw causing the actuation screw to screw into the hollow interior of the anchor screw; and

the distraction plate is not rotationally coupled to the actuation screw such that the distraction plate remains rotationally stationary in response to the synchronous rotation of the actuation screw causing the actuation screw to screw out of or into the hollow interior of the anchor screw.

9. The system of claim 1, wherein the magnet comprises:
a circular cross-sectional geometry;
a first pole comprising a first polarity; and
a second pole comprising a second polarity;
wherein the first polarity is opposite to the second polarity; and
wherein the circular cross-sectional geometry comprises each of the first pole and the second pole such that each of the first pole and the second pole comprises a half-circle cross-sectional geometry.

10. The system of claim 1, wherein the magnet comprises:
a circular cross-sectional geometry;
a plurality of a first pole comprising a first polarity; and
a plurality of a second pole comprising a second polarity;
wherein the first polarity is opposite to the second polarity;
wherein the circular cross-sectional geometry comprises the plurality of the first pole and the plurality of the second pole arranged in an alternating orientation such that each of the plurality of the first pole is adjacent to two of the plurality of second pole, and further such that each of the plurality of the second pole is adjacent to two of the plurality of the first pole; and
wherein each of the plurality of the first pole and each of the plurality of the second pole comprises a circular sector cross-sectional geometry.

11. The system of claim 1, wherein the magnet comprises a plate magnet comprises a top surface and a bottom surface, wherein the bottom surface is coupled to the actuation screw, and wherein each of a first polarity and a second polarity of the magnet is present on the top surface.

12. The system of claim 1, wherein the magnet comprises an elongated magnetic core disposed within a hollow interior defined by the actuation screw.

13. The system of claim 1, wherein the magnet is a component of the actuation screw, and wherein the magnet comprises an elongated magnetic core forming a component of the actuation screw.

14. The system of claim 1, further comprising an external magnetic controller comprising an external magnet configured to magnetically engage with the magnet, wherein rotation of the external magnet comprises synchronous rotation of the magnet, and thereby further causes the synchronous rotation of the actuation screw.

15. The system of claim 14, wherein the external magnet comprises a bottom surface configured to be disposed adjacent to an external tissue of a patient;
wherein a first external pole of the external magnet is located adjacent to a second external pole of the external magnet such that each of the first external pole and the second external pole is disposed at the bottom surface of the external magnet.

16. The system of claim 15, wherein a first pole of the magnet is located adjacent to a second pole of the magnet such that each of the first pole and the second pole is disposed at a top surface of the magnet; and
wherein the top surface of the magnet is configured to magnetically engage with the bottom surface of the external magnet in response to establishing a magnetic attraction between the magnet and the external magnet.

17. The system of claim 1, wherein the anchor screw is configured to be screwed into a tissue of a patient and remain stationary within the tissue of the patient; and
wherein the screw shaft of the actuation screw is configured to rotate within the hollow interior of the anchor screw to cause the actuation screw to move up or down along a longitudinal axis of the anchor screw and relative to a position of the anchor screw.

18. The system of claim 1, wherein the anchor screw is configured to be screwed into a bone tissue of a patient and remain stationary within the bone tissue of the patient;
wherein the magnet is configured to be disposed underneath a periosteum of the patient;
wherein the rotation of the magnet causes the synchronous rotation of the actuation screw such that rotation of the magnet in a first direction causes the actuation screw to distract out of the anchor screw and thereby cause distraction of the periosteum of the patient; and
wherein the rotation of the magnet causes the synchronous rotation of the actuation screw such that rotation of the magnet in a second direction causes the actuation screw to retract into the anchor screw and thereby cause retraction of the periosteum of the patient.

19. The system of claim 1, wherein the anchor screw is configured to be screwed into a tissue substrate of a patient; and
wherein a position of the actuation screw relative to a longitudinal axis of the anchor screw is adjusted and maintained by rotating the screw shaft within the hollow interior of the anchor screw.

20. The system of claim 1, further comprising an external magnetic controller configured to form a magnetic coupling with the magnet, wherein the external magnetic controller comprises:
an external magnet configured to form the magnetic coupling with the magnet;
a processor; and
a motor driver in mechanical communication with the external magnet, wherein the motor causes rotation of the external magnet, which thereby causes synchronous rotation of the magnet in response to establishing the magnetic coupling, and which further thereby causes the synchronous rotation of the actuation screw;
wherein the processor is in electronic communication with the motor and causes the motor to rotate the external magnet according to a schedule and via the motor driver.

21. The system of claim 1, further comprising an external magnetic controller configured to form a magnetic coupling with the magnet, wherein the external magnetic controller comprises:
one or more electromagnets configured to form the magnetic coupling with the magnet;
a Hall effect sensor configured to read a magnetic position of the magnet;
one or more power drivers; and
a processor;
wherein the processor controls synchronized actuation of the one or more electromagnets to form the magnetic coupling with the magnet and cause synchronized rotation of the magnet via the one or more power drivers with feedback from the Hall effect sensor.

22. The system of claim 20, wherein the external magnetic controller further comprises an antenna for receiving instructions over a network, and wherein the instructions comprise the schedule.

23. The system of claim **20**, wherein the external magnetic controller further comprises one or more of a temperature sensor, a biomarker sensor, or a camera.

24. A system for performing a distraction histogenesis surgical procedure, the system comprising:

an external magnetic controller comprising an external magnet; and

a device configured to be implanted within a patient, wherein the device comprises:

an anchor screw comprising a hollow interior defined by a sidewall, wherein the anchor screw comprises internal actuation threading attached to an interior surface of the sidewall and further comprises external anchor threading attached to an exterior surface of the sidewall;

an actuation screw comprising a screw shaft that comprises external actuation threading; and

a magnet coupled to the actuation screw;

wherein the external actuation threading of the screw shaft corresponds with the internal actuation threading of the anchor screw;

wherein rotation of the external magnet causes synchronous rotation of the magnet in response to forming a magnetic coupling between the external magnet and the magnet; and

wherein rotation of the magnet causes synchronous rotation of the actuation screw.

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