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An agency of Industry Canada

CA 2495763 C 2011/05/17

(11)(21) 2 495 763

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(86) Date de dépôt PCT/PCT Filing Date: 2003/06/06
(87) Date publication PCT/PCT Publication Date: 2004/03/11
(45) Date de délivrance/Issue Date: 2011/05/17
(85) Entrée phase nationale/National Entry: 2005/02/16
(86) N° demande PCT/PCT Application No.: US 2003/017965
(87) N° publication PCT/PCT Publication No.: 2004/019797
(30) Priorité/Priority: 2002/08/28 (US10/230,040)

(51) Cl.Int./Int.Cl. *A61B 17/82* (2006.01)

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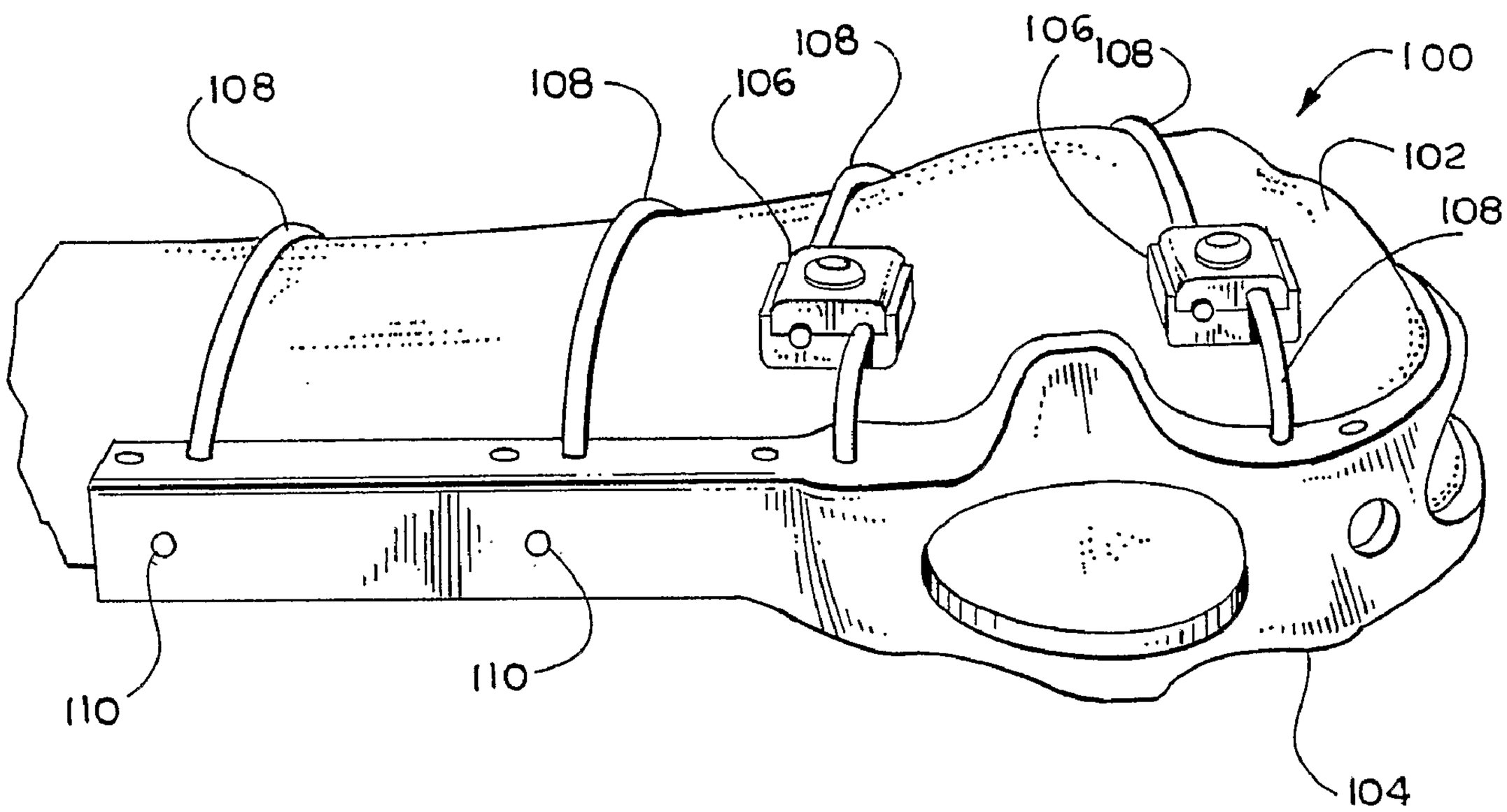
(54) Titre : SYSTEMES, PROCEDES ET APPAREILS POUR LE SERRAGE ET LE DESSERRAGE D'UN CABLE CHIRURGICAL ORTHOPEDIQUE

(54) Title: SYSTEMS, METHODS AND APPARATUSES FOR CLAMPING AND RECLAMPING AN ORTHOPEDIC SURGICAL CABLE



(57) Abrégé/Abstract:
Systems, methods and apparatus relating to orthopedic cable clamps are disclosed, especially a surgical cable clamp for clamping and reclamping an orthopedic surgical cable used in conjunction with an orthopedic implant device, a bone, and/or bone implant or structure. The surgical cable clamp does not damage the orthopedic surgical cable when then the surgical cable is operated or clamped with respect to the surgical cable. While the surgical cable is operated or in use, tension can be maintained on the

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(11)(21) 2 495 763

(13) C

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(57) Abrégé(suite)/Abstract(continued):
orthopedic surgical cable. Furthermore, the surgical cable clamp can be reused along with the same surgical cable when the surgical cable clamp is unclamped and reclamped with respect to the orthopedic implant device, a bone, and/or bone implant or structure. Such systems, methods, and apparatuses are particularly useful for surgeons installing an orthopedic surgical cable within a patient's body, and attempting to tension and retension the orthopedic cable with respect to the installation of an orthopedic implant device, a bone, and/or bone implant or structure in the patient's body.

ABSTRACT

Systems, methods and apparatus relating to orthopedic cable clamps are disclosed, especially a surgical cable clamp for clamping and reclamping an orthopedic surgical cable used in conjunction with an orthopedic implant device, a bone, and/or bone implant or structure. The surgical cable clamp does not damage the orthopedic surgical cable when then the surgical cable is operated or clamped with respect to the surgical cable. While the surgical cable is operated or in use, tension can be maintained on the orthopedic surgical cable. Furthermore, the surgical cable clamp can be reused along with the same surgical cable when the surgical cable clamp is unclamped and reclamped with respect to the orthopedic implant device, a bone, and/or bone implant or structure. Such systems, methods, and apparatuses are particularly useful for surgeons installing an orthopedic surgical cable within a patient's body, and attempting to tension and retension the orthopedic cable with respect to the installation of an orthopedic implant device, a bone, and/or bone implant or structure in the patient's body.

SYSTEMS, METHODS AND APPARATUSES FOR CLAMPING AND RECLAMPING AN ORTHOPEDIC SURGICAL CABLE

FIELD OF THE INVENTION

The invention relates generally to systems, methods, and apparatuses related to orthopedic cable clamps, and more specifically to systems, methods, and apparatuses for clamping and reclamping an orthopedic surgical cable used in conjunction with an orthopedic implant device, a bone, and/or bone implant or structure.

BACKGROUND OF THE INVENTION

In an orthopedic surgical procedure, surgically implanted orthopedic cables are frequently used to secure bones together, or otherwise used to tie or fit other parts of the body together. An orthopedic cable is typically a thin length of cable that is manufactured from a biocompatible material such as cobalt chromium alloy, or stainless steel, or another similar type of material. Generally, an orthopedic cable is wrapped around an affected area of a patient's bone structure and then secured with a device such as a cable crimping device in order to stabilize the bone, secure fractures, stabilize trauma, install other devices to the bone, and for other purposes. Conventional orthopedic cable products utilize a device such as a cable crimping device to crimp the orthopedic cable in order to secure the cable

with a specific tension around the affected area of a patient's body with a specific tension. However, crimping the cable typically causes damage to the cable and renders the cable unsuitable for re-use in an orthopedic procedure. It is not uncommon for an orthopedic cable to be replaced during the same surgical procedure when the tension on the orthopedic cable is insufficient and the cable must be retightened to obtain a sufficient tension. Since the orthopedic cable is damaged due to the crimping procedure, the orthopedic cable must be replaced. Replacing the orthopedic cable during a surgical procedure is time consuming for the surgeon and increases costs due to the wastage of the orthopedic cable.

In other instances, the conventional orthopedic cable product or portions of the product must also be replaced as well. In order to save time, manufacturers have designed single-use devices to secure the position of an orthopedic cable in a patient's body. These single-use devices cannot be reused and must be discarded if the orthopedic cable is initially tensioned and changes the tension or position of the surgical cable must be made later. Replacing the conventional orthopedic cable product or portions of the product during a surgical procedure is time consuming for the surgeon and increases costs due to the wastage of materials.

For example, one conventional orthopedic cable product utilizes a deformable sleeve or tube around the orthopedic cable. The metal sleeve or tube is then deformed by a screw that compresses the parts of the sleeve or tube around the cable. The metal sleeve or tube is deformed or crushed, and thus cannot be reused. Furthermore, the orthopedic cable may become deformed or crushed, and may not be suitable for re-use. In either event, once the surgical cable has been set to a desired position or tension, and for any reason becomes necessary to re-position or re-tension the surgical cable, then the metal sleeve or tube of the conventional orthopedic cable product must be replaced as well as the surgical cable.

In some instances, a conventional orthopedic cable product and an orthopedic cable are used in conjunction with an orthopedic device, a

patient's bone, bone implant, or other structure. For example, an orthopedic device such as a trochanteric grip, can be secured to the exterior surface of a patient's femur using one or more orthopedic cables and corresponding conventional orthopedic cable products or devices. Each time an orthopedic cable is tensioned with respect to the patient's femur, the trochanteric grip becomes further secured to the exterior of the patient's femur. However, as each orthopedic cable is tensioned, other previously tensioned orthopedic cables may loosen, or the position of the orthopedic device may shift. In either instance, previously tensioned orthopedic cables may have to be re-tensioned or re-positioned with respect to the trochanteric grip and the patient's femur. Conventional orthopedic cable products or devices used to secure the position of the orthopedic cables may have to be replaced along with the orthopedic cables that have become damaged or crushed due to the installation of the orthopedic cable products or devices.

At least one conventional orthopedic cable product utilizes a releasable lever operated cable clamp to apply a clamping force to an orthopedic cable. The conventional orthopedic cable product tensions the cable to a desired tension, and a crimp is swaged onto the cable to hold the tension. Then the lever operated cable clamp releases the clamping force, and the cable clamp is removed from the cable. This type of conventional orthopedic cable product is not implantable within a patient's body. For example, the lever operated cable clamp is a separate component from the crimp, and is too large for implanting in a body. Such products utilizing a non-implantable clamp add to the complexity and time for performing relatively delicate surgical procedures.

In some circumstances, conventional orthopedic cable products or devices offset the positioning of an orthopedic cable, creating a nonalignment of the orthopedic cable with respect to the surgical cable clamp when securing the clamp and cable to a patient's bone or body. This can, among other things, eventually loosen the desired tension in the cable, or alter the desired positioning of the cable and/or surgical cable

clamp, or cause the cable and/or surgical cable clamp to create an undesired stress or force on a specific portion of the patient's bone or body.

SUMMARY OF THE INVENTION

Systems, methods, and apparatuses according to various embodiments of the invention address some or all of the above issues and combinations thereof. They do so by providing a surgical cable clamp for clamping and reclamping an orthopedic surgical cable used in conjunction with an orthopedic implant device, a bone, and/or bone implant or structure. The surgical cable clamp does not damage the orthopedic surgical cable when then the surgical cable clamp is operated or clamped with respect to the surgical cable. While the surgical cable is operated or in use, a tension can be maintained on the orthopedic surgical cable. Furthermore, the surgical cable clamp can be reused along with the same surgical cable when the surgical cable clamp is unclamped and reclamped with respect to the surgical cable, while retensioning the surgical cable with respect to the orthopedic implant device, a bone, and/or bone implant or structure. Such systems, methods, and apparatuses are particularly useful for surgeons installing an orthopedic surgical cable within a patient's body, and attempting to tension and retension the orthopedic cable with respect to the installation of an orthopedic implant device, a bone, and/or bone implant or structure in the patient's body.

One aspect of systems, methods, and apparatuses according to various embodiments of the invention, focuses on apparatuses for clamping and reclamping an orthopedic cable for installation in a patient's body. For purposes of this document, such apparatuses are each known as a "surgical cable clamp." A surgical cable clamp permits a surgeon to save time and reduce wastage during a surgical procedure by providing the option to reuse both a surgical cable clamp and orthopedic surgical cable that have been initially installed and tensioned. The surgeon may find that later during the same surgical procedure, the surgical cable clamp

and orthopedic surgical cable should be retensioned, and the surgical cable clamp permits the surgeon to reclamp the orthopedic cable with respect to the installation of an orthopedic implant device, a bone, and/or bone implant or structure in a patient's body.

Another aspect of systems, methods, and apparatuses according to various embodiments of the invention, focuses on systems for clamping and reclamping an orthopedic cable for installation of a device in a patient's body. A surgical cable clamp permits a surgeon to save time and reduce wastage during a surgical procedure by providing the option to reuse both a surgical cable clamp and orthopedic surgical cable that have been used to initially install a device within a patient's body. The surgeon may find that later during the same surgical procedure, the surgical cable clamp and orthopedic surgical cable should be retensioned, or the device must be repositioned with respect to the patient's body. The surgical cable clamp permits the surgeon to reclamp the orthopedic cable with respect to installation of the device in the patient's body.

According to another aspect of the invention, systems and apparatuses according to various embodiments of the invention include in a combination with an orthopedic cable, apparatus for clamping and reclamping an orthopedic cable for installation with respect to a patient's body. The apparatus includes a clamping body adapted to positioning with respect to a patient's body, and an orthopedic cable. The apparatus further includes a clamping mechanism adapted to secure the orthopedic cable to the clamping body, secure a first tension in the orthopedic cable, release the tension in the orthopedic cable; and re-secure the orthopedic cable relative to the clamping body to secure another tension in the orthopedic cable.

According to yet another aspect of the invention, systems and apparatuses according to various embodiments of the invention can include an orthopedic cable and a surgical cable clamp. The surgical cable clamp includes a clamping body and a clamping mechanism. The clamping body is adapted to receive a portion of the orthopedic cable. The

clamping mechanism is adapted to contact a portion of the clamping body, create a compression force on the portion of the orthopedic cable to secure the orthopedic cable relative to the clamping body with a first tension, release the compression force on the portion of the orthopedic cable so that the orthopedic cable can be released relative to the clamping body, and create a second compression force on the portion of the orthopedic cable to re-secure the orthopedic cable relative to the clamping body with a second tension.

According to yet another aspect of the invention, systems and apparatuses according to various embodiments of the invention can include an orthopedic cable, a surgical cable clamp, and a device. The device includes a surgical cable clamp with a clamping body and clamping mechanism. The clamping body is adapted to receive a portion of the orthopedic cable. The clamping mechanism is adapted to contact a portion of the clamping body, create a compression force on the portion of the orthopedic cable to secure the orthopedic cable relative to the device with a first tension, release the compression force on the portion of the orthopedic cable so that the orthopedic cable can be released relative to the clamping body, and create a second compression force on the portion of the orthopedic cable to re-secure the orthopedic cable relative to the device with a second tension.

According to yet another aspect of the invention, systems and apparatuses according to various embodiments of the invention can include a combination of an orthopedic surgical cable and clamp. The combination includes an orthopedic surgical cable, a clamping body, a clamping mechanism, and a force application member. The clamping body is adapted to be installed relative to a bone in a patient, in order to apply a force to the bone. The clamping body is further adapted to restrain a first portion of the orthopedic surgical cable. The clamping mechanism is adapted to cooperate with the clamping body to capture a second portion of the orthopedic surgical cable between the clamping mechanism and the clamping body. It may be a separate piece or be part of the clamping

body. The force application member connects to the clamping body and clamping mechanism. It is adapted to be manipulated such as by rotation in order to force the clamping body and clamping mechanism to grip the second portion of the orthopedic surgical cable in a manner whereby the force and consequent gripping are subject to gradual control by rotation or manipulation of the force application member and the gripping does not cause nonalignment of the clamp relative to the orthopedic surgical cable. The orthopedic surgical cable and clamp are adapted to allow the orthopedic surgical cable to be tensioned and secured by the clamp at a first tension, and to allow the orthopedic surgical cable to be subsequently tensioned and secured by the clamp at a second tension without loss of tension due to twisting or nonalignment of the clamp relative to the orthopedic surgical cable.

According to yet another aspect of the invention, systems and apparatuses according to various embodiments of the invention can include a combination of an orthopedic surgical cable and clamp. The combination includes an orthopedic surgical cable, a clamping body, a clamping mechanism, and a force application member. The orthopedic surgical cable is adapted to be installed relative to a bone in a patient, in order to apply a force to the bone. The clamping body is adapted to receive a first portion and a second portion of the orthopedic surgical cable. The clamping mechanism can be part of the clamping body or a separate piece. It is adapted to cooperate with the clamping body to capture the first portion and the second portion of the orthopedic surgical cable between the clamping mechanism and the clamping body. The force application member connects to the clamping body and clamping mechanism, and is adapted to be manipulated in order to force the clamping body and clamping mechanism to grip the first and second portions of the orthopedic surgical cable. It does this so that the force and consequent gripping are subject to gradual control by rotation or manipulation of the force application member. Furthermore, the gripping does not cause twisting or nonalignment of the clamp relative to the

orthopedic surgical cable. Accordingly, the orthopedic surgical cable and clamp allow the orthopedic surgical cable to be tensioned and secured by the clamp at a first tension, and also to allow the orthopedic surgical cable to be subsequently tensioned and secured by the clamp at a second tension without loss of tension due to twisting or nonalignment of the clamp relative to the orthopedic surgical cable.

According to yet another aspect of the invention, systems and apparatuses according to various embodiments of the invention can include a combination of an orthopedic surgical cable and clamp. The combination includes an orthopedic surgical cable, a clamping body, a clamping mechanism, and a force application member. The orthopedic surgical cable is adapted to be installed relative to a bone in a patient, in order to apply a force to the bone. The clamping body is adapted to receive a first portion of the orthopedic surgical cable. The clamping mechanism, which can be part of the clamping body or a separate piece, is adapted to cooperate with the clamping body to capture a second portion of the orthopedic surgical cable between the clamping mechanism and the clamping body. The force application member connects to the clamping body and clamping mechanism, and is adapted to be activated in order to force the clamping body and clamping mechanism to grip the first and second portions of the orthopedic surgical cable so that the force and consequent gripping are subject to gradual control by the force application member and the gripping does not cause twisting or nonalignment of the clamp relative to the orthopedic surgical cable. Accordingly, the orthopedic surgical cable and clamp allow the orthopedic surgical cable to be tensioned and secured by the clamp at a first tension, and also to allow the orthopedic surgical cable to be subsequently tensioned and secured by the clamp at a second tension without loss of tension due to twisting or nonalignment of the clamp relative to the orthopedic surgical cable.

A particular method for clamping and reclamping a surgical cable according to one aspect of systems and apparatuses of various embodiments of the invention includes mounting a portion of a surgical

cable to the surgical cable clamp; applying a force to the portion of the surgical cable so that the surgical cable is secured relative to the surgical cable clamp with a first tension in the surgical cable; releasing the force on the portion of the surgical cable so that the surgical cable can be repositioned relative to the surgical cable clamp; and applying a second force to the surgical cable so that the surgical cable is again secured relative to the surgical cable clamp.

Another particular method for clamping and reclamping a surgical cable according to one aspect of systems and apparatuses of various embodiments of the invention includes securing a first portion of a surgical cable with a surgical cable clamp so that the first portion of the surgical cable is restrained relative to the surgical cable clamp; wrapping a remaining portion of the surgical cable around a part of a patient's body; connecting an extended portion of the surgical cable to the surgical cable clamp; applying a force to the extended portion of the surgical cable so that the surgical cable is secured relative to the surgical cable clamp with a first tension in the surgical cable; releasing the force on the extended portion of the surgical cable so that the surgical cable can be repositioned relative to the surgical cable clamp; and applying another force to the surgical cable so that the surgical cable is again secured relative to the surgical cable clamp.

Another particular method for using a surgical cable clamp with an orthopedic surgical cable for installation of a device with respect to a patient's body according to one aspect of systems and apparatuses of various embodiments of the invention includes restraining a first portion of a surgical cable with a surgical cable clamp so that the first portion of the surgical cable is restrained relative to the surgical cable clamp; connecting the surgical cable to a device; wrapping a remaining portion of the surgical cable around a part of a patient's body; connecting an extended portion of the surgical cable to the surgical cable clamp; applying a force to the extended portion of the surgical cable so that the surgical cable and the device are secured relative to the surgical cable clamp with a first tension

in the surgical cable; releasing the force on the extended portion of the surgical cable so that the surgical cable or device can be repositioned relative to the surgical cable clamp; and applying another force to the surgical cable so that the surgical cable and device are again secured relative to the surgical cable clamp.

Another particular method for using a surgical cable clamp with an orthopedic surgical cable for installation with respect to a patient's body according to one aspect of systems and apparatuses of various embodiments of the invention includes using a surgical cable clamp in combination with an orthopedic surgical cable to mount a portion of the orthopedic surgical cable to the surgical cable clamp; and to apply a force to the portion of the orthopedic surgical cable so that the orthopedic surgical cable is secured relative to the surgical cable clamp with a first tension in the orthopedic surgical cable. The method includes reusing the surgical cable clamp in combination with the orthopedic surgical cable to release the force on the portion of the orthopedic surgical cable so that the surgical cable can be repositioned relative to the surgical cable clamp; and to apply a second force to the orthopedic surgical cable so that the orthopedic surgical cable is again secured relative to the surgical cable clamp.

Another particular method for using a surgical cable clamp with an orthopedic surgical cable for installation with respect to a patient's body according to one aspect of systems and apparatuses of various embodiments of the invention includes installing an orthopedic surgical cable in a patient's body using a clamp that allows the tension in the cable to be adjusted and gradually tensioned. The method includes providing an orthopedic surgical cable and a surgical cable clamp. The surgical cable clamp includes a clamping body, a clamping mechanism, and a force application member. The method also includes mounting the surgical cable clamp relative to a bone in a patient's body, and restraining a first portion of the orthopedic surgical cable relative to the clamping body. A second portion of the orthopedic surgical cable is captured between the

clamping mechanism and the clamping body. Next, the force application member connects to the clamping body and the clamping mechanism. The method includes gripping the second portion of the orthopedic surgical cable between the clamping body and clamping mechanism by rotating or manipulating the force application member in a first direction so that the gripping is subject to gradual control by rotation or manipulation of the force application member and the gripping does not cause twisting or nonalignment of the clamp relative to the orthopedic surgical cable, thus maintaining a first tension in the orthopedic surgical cable. The method also includes releasing the first tension in the orthopedic surgical cable by rotating or manipulating the force application member in an opposing direction to the first direction so that the orthopedic surgical cable can be repositioned between the clamping mechanism and the clamping body; and gripping the second portion of the orthopedic surgical cable between the clamping body and clamping mechanism by rotating or manipulating the force application member in the first direction so that consequent gripping is subject to gradual control by rotation or manipulation of the force application member and the gripping does not cause twisting or nonalignment of the clamp relative to the orthopedic surgical cable, thus maintaining a second tension in the orthopedic surgical cable.

Another particular method for using a surgical cable clamp with an orthopedic surgical cable for installation with respect to a patient's body according to one aspect of systems and apparatuses of various embodiments of the invention includes providing an orthopedic surgical cable and a surgical cable clamp. The surgical cable clamp includes a clamping body, a clamping mechanism, and a force application member. The method also includes mounting the clamping body to a bone in a patient's body; connecting a first portion of the orthopedic surgical cable to the clamping body; wrapping a remaining portion of the orthopedic surgical cable around a part of a patient's bone; connecting a second portion of the orthopedic surgical cable to the clamping body; and capturing the first portion and second portion of the orthopedic surgical cable between the

clamping body and clamping mechanism. Next, the force application member connects to the clamping body and clamping mechanism. The method also includes gripping the first and second portions of the orthopedic surgical cable between the clamping body and the clamping mechanism by rotating or manipulating the force application member in a first direction so that the consequent gripping is subject to gradual control by the threaded force application member and the gripping does not cause twisting or nonalignment of the clamp relative to the orthopedic surgical cable, thus maintaining a first tension in the orthopedic surgical cable; releasing the first tension in the orthopedic surgical cable by rotating or manipulating the threaded force application member in a second direction so that the orthopedic surgical cable can be repositioned between the clamping mechanism and the clamping body; and gripping the first and second portions of the orthopedic surgical cable between the clamping body and the clamping mechanism by rotating or manipulating the force application member in the first direction so that the consequent gripping is subject to gradual control by the force application member and the gripping does not cause twisting or nonalignment of the clamp relative to the orthopedic surgical cable, thus maintaining a second tension in the orthopedic surgical cable.

Yet another particular method for using a surgical cable clamp with an orthopedic surgical cable for installation with respect to a patient's body according to one aspect of systems and apparatuses of various embodiments of the invention includes providing an orthopedic surgical cable and a surgical cable clamp. The surgical cable clamp includes a clamping body, a clamping mechanism, and a force application member. The method includes mounting the surgical cable clamp to a bone in the patient's body; restraining a first portion of the orthopedic surgical cable with the surgical cable clamp; wrapping a remaining portion of the orthopedic surgical cable around a part of the patient's bone; capturing an extended portion of the orthopedic surgical cable between the clamping body and the clamping mechanism; and gripping the extended portion of

the orthopedic surgical cable between the clamping body and the clamping mechanism by activating the force application member so that the consequent gripping is subject to gradual control by the force application member and the gripping does not cause twisting or nonalignment of the clamp relative to the orthopedic surgical cable, thus maintaining a first tension in the orthopedic surgical cable. The method further includes deactivating the force application member so that the first tension can be released and the orthopedic surgical cable can be repositioned between the clamping mechanism and the clamping body; and gripping the extended portion of the orthopedic surgical cable between the clamping body and the clamping mechanism together by activating the force application member so that the clamping body and clamping mechanism grip the extended portion of the orthopedic surgical cable in a manner whereby the force and consequent gripping are subject to gradual control by the force application member and the gripping does not cause twisting or nonalignment of the clamp relative to the orthopedic surgical cable, thus maintaining a second tension in the orthopedic surgical cable.

Objects, features and advantages of various systems, methods, and apparatuses according to various embodiments of the invention include:

(1) providing the ability to clamp and reclamp an orthopedic surgical cable without damaging the cable and creating the need to replace the cable;

(2) providing the ability to reuse a surgical cable clamp during the same surgical procedure;

(3) providing the ability to reuse the orthopedic surgical cable when the surgical cable clamp initially clamps the cable, and the cable needs to be retensioned or repositioned;

(4) providing the ability to reposition a device in a patient's body by reusing a surgical cable clamp and orthopedic surgical cable that have been initially used and tensioned, by retensioning the surgical cable by reclamping the cable with the surgical cable clamp;

(5) providing the ability to implant a device in a patient's body for clamping and reclamping a surgical cable; and

(6) providing the ability to tension and retension an orthopedic surgical cable without twisting or nonalignment of the surgical cable clamp relative to the orthopedic surgical cable.

Other objects, features and advantages of various aspects and embodiments of systems, methods, and apparatuses according to the invention are apparent from the other parts of this document.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1a is a perspective view of a structure that includes a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 1b is another perspective view of a structure that includes a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 1c is another perspective view of a structure that includes a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 2 is an exploded perspective view of another structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIGs. 3a-c illustrate a sequence for a method for using the surgical cable clamp shown in FIG. 2.

FIG. 4a illustrates an exploded perspective view of another structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 4b illustrates a cross-sectional view of the surgical cable clamp shown in FIG. 4a.

FIGs. 5a-d illustrate a sequence of another method for using a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 6 is an exploded perspective view of another structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 7 is an exploded perspective view of another structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 8a is another view of a structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 8b is a cross-sectional view of the surgical clamp shown in FIG. 8a in a clamped position.

FIG. 9a is another view of a structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 9b is a cross-sectional view of the surgical cable clamp shown in FIG. 9a.

FIG. 10a is another view of a structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 10b is a cross-sectional view of the surgical cable clamp shown in FIG. 10a.

FIG. 11a is another view of a structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 11b is a cross-sectional view of the surgical cable clamp shown in FIG. 11a.

FIG. 12a is another view of a structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 12b is the surgical cable clamp shown in FIG. 12a in a clamped position.

FIG. 13a is another view of a structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 13b is a side exploded view of the surgical cable clamp shown in FIG. 13a.

FIG. 14a is another view of a structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 14b is a side exploded view of the surgical cable clamp shown in FIG. 14a.

FIG. 15a is another view of a structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 15b is an isometric view of the surgical cable clamp shown in FIG. 15a in an unclamped position cross section view.

FIG. 16a is another view of a structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 16b is an exploded perspective view of the surgical cable clamp shown in FIG. 16a.

FIG. 17a is another view of a structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 17b is an exploded perspective view of the surgical cable clamp shown in FIG. 17a.

FIG. 18a is another view of a structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 18b is a cross-sectional view of the surgical cable clamp shown in FIG. 18a.

FIG. 19a is another view of a structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 19b is a cross-sectional view of the surgical cable clamp shown in FIG. 19a.

FIG. 20a is another view of a structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 20b is a cross-sectional view showing the clamp position of the surgical cable clamp shown in FIG. 20a.

FIG. 21a is another view of a structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 21b is a cross-sectional view showing the clamp position of the surgical cable clamp shown in FIG. 21a

FIG. 22a is another view of a structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 22b is a cross-sectional view showing clamp position of the surgical cable clamp shown in FIG. 22a.

FIG. 23a is another view of a structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 23b is cross-sectional view of the surgical cable clamp shown in FIG. 23a.

FIG. 24a is another view of a structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 24b is a cross-sectional view showing clamp position of the surgical cable clamp shown in FIG. 24a

FIG. 25a is another view of a structure for a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 25b is an exploded perspective view of the surgical cable clamp shown in FIG. 25a.

FIG. 26 is a perspective view of a structure of a surgical cable clamp in accordance with various embodiments of the invention.

FIG. 27 is an exploded perspective view of the surgical cable clamp shown in FIG. 26.

FIG. 28 is a cross-sectional side view of the surgical cable clamp shown in FIG. 26.

FIGs. 29a-c illustrate a sequence for a method for using the surgical cable clamp shown in FIGs. 26-28.

DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

Systems, methods, and apparatuses according to various embodiments of the invention address some or all of the above issues and combinations thereof. They do so by providing a surgical cable clamp for clamping and reclamping an orthopedic surgical cable used in conjunction with an orthopedic implant device, a bone, and/or bone implant or structure. The surgical cable clamp does not damage the orthopedic surgical cable when then the surgical cable clamp is operated or clamped

with respect to the surgical cable. While the surgical cable is operated or in use, a tension can be maintained on the orthopedic surgical cable. Furthermore, the surgical cable clamp can be reused along with the same surgical cable when the surgical cable clamp is unclamped and reclamped with respect to the surgical cable, while retensioning the surgical cable with respect to the orthopedic implant device, a bone, and/or bone implant or structure. Such systems, methods, and apparatuses are particularly useful for surgeons installing an orthopedic surgical cable within a patient's body, and attempting to tension and retension the orthopedic cable with respect to the installation of an orthopedic implant device, a bone, and/or bone implant or structure in the patient's body.

FIG. 1a is a perspective view of a preferred environment for a surgical cable clamp in accordance with various embodiments of the invention. A preferred environment **100** shown in FIG. 1a is the proximal end of a human femur bone **102** in conjunction with a trochanteric grip **104** for use in a total hip replacement surgical procedure. In a first embodiment of the invention, a surgical cable clamp is a stand alone-type clamp **106** for securing the position of an orthopedic surgical cable **108** relative to a portion of the trochanteric grip **104** and a patient's femur bone **102**. In a second embodiment of the invention, a surgical cable clamp is a device-incorporated clamp **110** for securing the position of an orthopedic surgical cable **108** relative to a portion of the trochanteric grip **104** and a patient's femur bone **102**. The device-incorporated clamp **110** utilizes a portion of the trochanteric grip **104** or other prefabricated orthopedic device for clamping the orthopedic surgical cable **108**.

Typically, a trochanteric grip **104** is secured at the proximal end of a patient's femur bone **102** during a total hip replacement procedure. One or more orthopedic surgical cables **108** can be utilized to secure the trochanteric grip **104** into a position relative to the proximal end of a patient's femur bone **102**. When a force is applied to a surgical cable clamp **106, 110**, the surgical cable clamp **106, 110** compresses the orthopedic surgical cable **108**, thus securing the orthopedic surgical cable

108 into a position relative to the trochanteric grip **104** and patient's femur **102**.

If necessary, the orthopedic surgical cable **108** can be loosened or otherwise retensioned by applying another force to the surgical cable clamp **106, 110** to relieve the compression force on the orthopedic surgical cable **108** applied by the surgical cable clamp **106, 110**. The orthopedic surgical cable **108** can then be retensioned by hand or by way of a tensioning device (not shown) so that the orthopedic surgical cable **108** is at a desired tension or position. Yet another force can then be applied to the surgical cable clamp **106, 110** to create another compression force on the orthopedic surgical cable **108** which can then maintain the desired tension or position of the orthopedic surgical cable **108**. Depending upon the location of the orthopedic surgical cable **108** relative to the trochanteric grip **104** and the patient's femur bone **102** or other bone, either and/or both the stand alone-type clamp **106** or the device-incorporated clamp **110** may be used to secure the position and tension of the orthopedic surgical cable **108** as shown.

A surgical cable clamp in accordance with the invention can have other configurations as shown and described in FIGs. 1b, 1c, 4, and 6-28. A surgical cable clamp can be either a stand alone-type clamp device or a device incorporated-type clamp device. Furthermore, as one skilled in the art will recognize, a surgical cable clamp can be fashioned as a single or multiple component-type clamp. In any configuration, a surgical cable clamp is used to secure a tension and, if necessary, secure another tension in an orthopedic surgical cable without need for replacing the original surgical cable. A surgical cable clamp in accordance with the invention can be used with other prefabricated orthopedic devices, such as a bone plate, that utilize orthopedic surgical cables for securing the device to a bone or another part of a patient's body. Finally, even though a surgical cable clamp in accordance with the invention is shown in FIG. 1a used in conjunction with an orthopedic surgical cable and a trochanteric grip, a surgical cable clamp can be utilized with one or more surgical

cables, or incorporated into another type of orthopedic device to be secured to a portion of a patient's body such as a bone or another body structure.

FIG. 1b is a perspective view of a structure including a surgical cable clamp in accordance with the invention. The structure shown in FIG. 1b is a trochanteric grip **112** that can be installed adjacent to the proximal end of a human femur bone (similar to that shown in FIG. 1a as **102**) for use in a total hip replacement surgical procedure. In another embodiment of the invention, a surgical cable clamp is a device-incorporated clamp **114** for securing the position of an orthopedic surgical cable (not shown) relative to a portion of the trochanteric grip **112** and a patient's femur bone. The device-incorporated clamp **114** utilizes a portion of the trochanteric grip **112** or other prefabricated orthopedic device for clamping the orthopedic surgical cable.

Similar to **104** in FIG. 1a, the trochanteric grip **112** is secured at the proximal end of a patient's femur bone during a total hip replacement procedure. One or more orthopedic surgical cables can be utilized to secure the trochanteric grip **112** into a position relative to the proximal end of a patient's femur bone. When a force is applied to a device-incorporated clamp **114**, the device-incorporated clamp **114** compresses the orthopedic surgical cable, thus securing the orthopedic surgical cable into a position relative to the trochanteric grip **112** and patient's femur.

If necessary, the orthopedic surgical cable can be loosened by applying another force to the device-incorporated clamp **114** to relieve the compression force on the orthopedic surgical cable applied by the device-incorporated clamp **114**. The orthopedic surgical cable can then be retensioned by hand or by way of a tensioning device (not shown) so that the orthopedic surgical cable is at a desired tension or position. Yet another force can then be applied to the device-incorporated clamp **114** to create another compression force on the orthopedic surgical cable which can then maintain the desired tension or position of the orthopedic surgical cable. Depending upon the location of the orthopedic surgical cable

relative to the trochanteric grip **112** and the patient's femur bone or other bone, the device-incorporated clamp **114** may be used to secure the position and secure the tension of the orthopedic surgical cable.

FIG. 1c is a perspective view of another structure including a surgical cable clamp in accordance with the invention. The structure shown in FIG. 1c is a bone plate **116** that can be installed adjacent to a human bone for use in an orthopedic surgical procedure. In another embodiment of the invention, a surgical cable clamp is a device-incorporated clamp **118** for securing the position of an orthopedic surgical cable (not shown) relative to a portion of the bone plate **116** and a patient's bone. The device-incorporated clamp **118** utilizes a portion of the bone plate **116** or other prefabricated orthopedic device for clamping the orthopedic surgical cable.

The bone plate **116** is adjacent to a patient's bone during an orthopedic surgical procedure. One or more orthopedic surgical cables can be utilized to secure the bone plate **116** into a position relative to the patient's bone. When a force is applied to a device-incorporated clamp **118**, the device-incorporated clamp **118** compresses the orthopedic surgical cable, thus securing the orthopedic surgical cable into a position relative to the bone plate **116** and patient's bone.

If necessary, the orthopedic surgical cable can be loosened by applying another force to the device-incorporated clamp **118** to relieve the compression force on the orthopedic surgical cable applied by the device-incorporated clamp **118**. The orthopedic surgical cable can then be retensioned by hand or by way of a tensioning device (not shown) so that the orthopedic surgical cable is at a desired tension or position. Yet another force can then be applied to the device-incorporated clamp **118** to create another compression force on the orthopedic surgical cable which can then maintain the desired tension or position of the orthopedic surgical cable. Depending upon the location of the orthopedic surgical cable relative to the bone plate **116** and the patient's bone or other bone, the

device-incorporated clamp **118** may be used to secure the position and secure the tension of the orthopedic surgical cable.

The device-incorporated clamps **114, 118** of FIGs. 1b and 1c are preferred embodiments of the invention. Other embodiments of the invention can also be used in the structure shown in FIGs. 1b and 1c to accomplish similar functions in accordance with the invention.

FIG. 2 is a perspective view of an embodiment of a stand alone-type clamp **200** similar to that shown as **106** in FIG. 1a. The embodiment of the stand alone-type clamp **200** shown here includes an upper clamping body **202**, a clamping bolt **204**, and a lower clamping body **206**.

The upper clamping body **202** in this embodiment is rectangularly-shaped and has a relatively flat profile with a generally rounded upper surface **208** and a generally flat lower surface **210**. On a lateral side **212** between the upper surface **208** and lower surface **210**, a pair of semi-circular cable channels **214** are machined in the lower surface **210**. The cable channels **214** are sized to receive the width of an orthopedic surgical cable (not shown) and are machined through the width of the upper clamping body **202** along the lower surface **210** to the opposing lateral side. Through the upper surface **208**, a bolt hole **216** for receiving the clamping bolt **204** is machined through the thickness of the clamping body **202** to the lower surface **210**. Note that the upper clamping body **202** can have numerous other shapes and configurations in accordance with the invention.

The clamping bolt **204** in this embodiment is shaped similar to a conventional machine screw with a socket head **218**, a threaded body **220**, and blunt point **222**. The socket head **218** includes a recess **224** sized to receive a hexagonal-shaped tightening instrument (not shown) for tightening and untightening the clamping bolt **204** to a desired tension. Alternatively, the external shape of the socket head **218** can be shaped for tightening with a wrench-type instrument (not shown) for tightening and untightening a corresponding geometrically-shaped socket head. The threaded body **220** is sized to diametrically fit within the bolt hole **216** of

the upper clamping body, and includes one or more threads **226** sized to receive corresponding threads of the lower clamping body **206**. Note that the clamping bolt **204** may have numerous other shapes and configurations in accordance with the invention.

The lower clamping body **206** is rectangularly-shaped and has a C-shaped profile with a generally rounded lower surface **228** and a generally flat upper surface **230** sized to receive the lower surface **210** of the upper clamping body **202**. On a lateral side **232** between the lower surface **228** and upper surface **230**, a pair of semi-circular cable channels **234** are machined in the upper surface **230**. The cable channels **234** are sized to receive the width of an orthopedic surgical cable (not shown) and are machined through the width of the lower clamping body **206** along the upper surface **230** to the opposing lateral side. Each cable channel **234** includes a series of grooves **236** or ridges machined in the length of the cable channel **234** of the lower clamping body **206**. A series of corresponding grooves (not shown) or ridges is also machined in the length of the cable channel **214** of the upper clamping body **202**.

Through the upper surface **230**, a threaded bolt hole **238** for receiving the clamping bolt **204** is machined through the thickness of the lower clamping body **206** to the lower surface **228**. Note that the lower clamping body **206** can have numerous other shapes and configurations in accordance with the invention.

When the threaded bolt hole **236** is concentrically aligned with the bolt hole **216** of the upper clamping body **202**, ends **240** of the upper clamping body **202** fit within recesses **242** of the lower clamping body, thus assisting alignment of the semi-circular-shaped cable channels **214** of the upper clamping body **202** with the semi-circular-shaped cable channels **234** of the lower clamping body **206** to form a pair of circular-shaped cable holes for the stand alone-type clamp **200**. In this configuration, the series of grooves **236** of the lower clamping body **206** and corresponding grooves (not shown) of the upper clamping body **202** align with each other to decrease the width of the circular hole formed by the alignment of the

cable channels **214, 234**. Furthermore, when the upper clamping body is aligned with the lower clamping body clamping bolt **204**, the clamping bolt **204** can be inserted through the bolt hole **216** and then torqued to engage the threads of the threaded bolt hole **238** of the lower clamping body **206**.

A surgical cable clamp such as a stand alone-type clamp **200** can be manufactured from titanium, stainless steel, cobalt chromium alloy, or another similar type of material. An example of a stand alone-type clamp **200** measures approximately 0.3 inches (7.6 mm) in width perpendicular to the orientation of the surgical cable, approximately 0.2 inches (5.1 mm) in height, and approximately 0.5 inches in length (12.7 mm) parallel with the orientation of the surgical cable when the upper clamping body and lower clamping body are aligned together. An example of a clamping bolt is a conventional #8 machine screw made from titanium, stainless steel, cobalt chromium alloy, or a similar type of material that is compatible with material of the upper and lower clamping body. In some instances, the clamping bolt may be coated with an implantable coating designed to reduce frictional contact with other components of the clamp. Furthermore, an example of a surgical cable that can be used with the stand alone-type clamp **200** is typically a cobalt chromium or stainless steel cable measuring approximately 0.04 to 0.08 inches (1.0 to 2.0 mm) in diameter.

The stand alone-type clamp **200** is a preferred embodiment of a surgical cable clamp. The embodiments shown in FIGs. 1b, 1c, 4, and 6-28 are other embodiments of the invention that can also be used in the preferred environment shown in FIG. 1a. Other embodiments of a surgical cable clamp can be used in the preferred environment and other similar type environments to accomplish similar functions in accordance with the invention.

FIGs. 3a-c illustrate a sequence for a method for using the surgical cable clamp shown in FIGs. 1a and 2. The particular embodiment shown in this sequence utilizes a stand alone-type surgical cable clamp, shown in

FIG. 2 as **200**. Other embodiments of a surgical cable clamp can be utilized with the method illustrated in FIGs. 3a-c.

In FIG. 3a, a surgical cable clamp **300** in accordance with the invention is shown adjacent to an orthopedic device such as a trochanteric grip **302**. The trochanteric grip **302** is aligned with a proximal end of a patient's femur bone **304** in accordance with a hip replacement procedure. When the trochanteric grip **302** is to be secured to the patient's femur **304**, the surgical cable clamp **300** is positioned in a desired position adjacent to the trochanteric grip **302** to receive an orthopedic surgical cable **306**. Typically, the surgical cable clamp **300** is preassembled prior to the sequence. Similar to the cable clamp in FIG. 2, the surgical cable clamp **300** includes an upper clamping body **308**, a clamping bolt **310**, and a lower clamping body **312**, and can be preassembled as described in FIG. 2. A relatively smaller diameter end **314** of a predetermined length of surgical cable **306** is inserted into and pulled through a first cable channel **316** or hole of the surgical cable clamp **300** formed by the assembly and alignment of the upper clamping body **308** with the lower clamping body **312**. A bead **318** on a relatively larger diameter end of the surgical cable **306** secures the relatively larger diameter end of surgical cable **306** adjacent to the surgical cable clamp **300** when the length of the surgical cable **306** is pulled through the first cable channel **316** or hole.

As shown in FIG. 3b, the relatively smaller diameter end **314** of the surgical cable **306** is inserted through a corresponding cable channel **320** or hole in the trochanteric grip **302** and wrapped around the thickness of the patient's femur **304**. When the relatively smaller diameter end **314** of the surgical cable **306** is nearly around the patient's femur **304**, the relatively smaller diameter end **314** is inserted through a second cable channel **322** or hole of the surgical cable clamp **300**.

As shown in FIG. 3c, the relatively smaller diameter end **314** of the surgical cable **306** is manually pulled through the second cable channel **322** or hole or with a cable tensioning device (not shown) until a desired tension in the surgical cable **306** is attained. When the surgical cable **306**

is pulled to a desired tension, the clamping bolt **310** is tightened with a hexagonal-shaped tightening instrument (not shown) until a compression force between the upper clamping body **308** and lower clamping body **312** maintains the desired tension on the surgical cable **306**. Any excess length of surgical cable can be trimmed with a cutting instrument (not shown).

In some instances, a cable tensioning device (not shown) can be used to tighten the surgical cable **306** to a predetermined tension. A tightening instrument with a corresponding hexagonal-shaped head or driver such as a "T-handled driver" with a hex head to match the shape of the clamping bolt can then be used to tighten the clamping bolt **310** to a preset torque while measuring the tension on the surgical cable with the cable tensioning device as the clamping bolt **310** is tightened. A suitable cable tensioning device can be a device or system that applies a tension to a surgical cable, maintains the tension on the surgical cable until the tightening instrument can be used to tighten the clamping bolt of the surgical cable clamp, measures the tension in the surgical cable, and releases the surgical cable when the clamping bolt has secured the surgical cable.

More than one surgical cable **306** may be needed to secure an orthopedic device such as a trochanteric grip **302** or bone plate to a patient's femur **304**. The above sequence can repeat as needed until the trochanteric grip or other orthopedic device is secured to the patient's femur or bone. After tensioning one or more surgical cables **306** to the patient's femur with one or more corresponding surgical cable clamps **300**, previously tensioned surgical cables may tend to loosen or otherwise require additional tension to sufficiently secure the orthopedic device such as a trochanteric grip **302** to the patient's femur **304**. If necessary, the tension on a previously tensioned surgical cable can be released by applying an untightening force to the clamping bolt **310** with the hexagonal-shaped tightening instrument, releasing the compression force between the upper clamping body **308** and lower clamping body **312**, thus releasing

the compression and tension on the surgical cable **306**. The surgical cable **306** is then retensioned manually or by use of the cable tensioning device. When the desired tension is reached, a tightening force is applied to the clamping bolt **310** in order to create a sufficient compression force between the upper clamping body **308** and the lower clamping body **312** to maintain the desired tension in the surgical cable **306**, and secure the position of the surgical cable **306** relative to the surgical cable clamp **300**.

Tensioning and retensioning of one or more surgical cables **306** may occur more than once during a surgical procedure until all of the surgical cables **306** are sufficiently tensioned to maintain the position of the surgical cables **306**, bone plate and or trochanteric grip **302** relative to the patient's femur **304**. The sequence described above with respect to FIGs. 3a-c can be repeated as necessary to accomplish this.

Preferably, the surgical cable clamp illustrated in FIGs. 3a-c and in other figures can be preassembled prior to installation or use. Preassembly of a surgical cable clamp can include assembling component parts of the surgical cable clamp together with, or without, an orthopedic surgical cable so that a user such as a surgeon can rapidly install or use the surgical cable clamp. In many cases, preassembly of the surgical cable clamp with an orthopedic surgical cable saves time during a surgical procedure when installing or using the surgical cable clamp.

FIGs. 4a-b illustrate another embodiment of a surgical cable clamp in accordance with the invention. FIG. 4a is a perspective view of an embodiment of a device-incorporated clamp **400** similar to that shown as **110** in FIG. 1a; and FIG. 4b illustrates a cross-sectional view of the embodiment shown in FIG. 4a. The embodiment of the device-incorporated clamp **400** shown here includes a device body **402**, a clamping bolt **404**, and a clamping body **406**.

The device body **402** in this embodiment is a bone plate such as a portion of a trochanteric grip with a relatively flat lower surface **408** and a relatively flat upper surface **410**. Typically, the lower surface **408** is adjacent to a patient's bone or other structure, while the upper surface **410**

remains exposed. On a lateral side **412** of the device body **402**, a pair of cable holes **414** sized to receive the ends of an orthopedic surgical cable (not shown) are machined through the width of the device body **402** to the opposing lateral side. Between the lower surface **408** and upper surface **410**, a bolt hole **416** for receiving the clamping bolt **404** is machined through the thickness of the device body **402**. In the lower surface **408**, a recess **418** for receiving a portion of the clamping body **406** is concentrically positioned with the bolt hole **416**. Note that the device body **402** can have numerous other shapes and configurations for receiving the clamping body **406** and clamping bolt **404** in accordance with the invention.

The clamping bolt **404** in this embodiment is shaped similar to a conventional machine screw with a socket head **420**, a threaded body **422**, and blunt point **424**. The socket head **420** is sized to receive a hexagonal-shaped tightening instrument (not shown) for tightening and untightening a corresponding socket-shaped head. Alternatively, the external shape of the socket head **420** can be shaped for tightening with a wrench-type instrument (not shown) for tightening and untightening a corresponding geometrically-shaped socket head **420**. The threaded body **422** includes one or more threads **426** sized to engage corresponding threads machined in the clamping body **406**. The blunt point **424** of the clamping bolt **404** is sized to fit within the bolt hole **416** in the upper surface **410** of the device body **402**. Note that the clamping bolt **404** may have numerous other shapes and configurations in accordance with the invention.

The clamping body **406** is shaped like a wingnut, but can also be shaped similar to the upper clamping body shown in FIG. 2. Typically, the clamping body **406** includes a rounded upper surface **428**, a generally flat lower surface **430**, a pair of semi-circular channels **432** in the lower surface **430**, and a bolt hole **434** through the thickness of the clamping body **406** between the upper surface **428** and the lower surface **430**. Each channel **432** can include a series of grooves (not shown) or ridges machined in the length of the channel **432** of the clamping body **406**. A series of

corresponding grooves (not shown) or ridges can also be machined in the length of a corresponding channel (not shown) of the device body **402**. The clamping body **406** is sized to fit within the recess **418** in the lower surface **408** of the device body **402**. When the clamping body **406** is positioned within the recess **418**, the bolt hole **434** of the clamping body **406** is concentric with the threaded bolt hole **416** of the device body **402**, thus providing a receiving hole for the clamping bolt **404**. Note that the clamping body **406** and corresponding recess **418** can have numerous other shapes and configurations in accordance with the scope of the invention.

A surgical cable clamp such as a device-incorporated clamp **400** can be manufactured from titanium, stainless steel, cobalt chromium alloy, or another similar type of material. An example of a device-incorporated clamp **400** measures approximately 0.3 inches (7.6 mm) across the width of the clamping body perpendicular to the orientation of the surgical cable, and approximately 0.25 inches (6.4 mm) across the diameter of the clamping body perpendicular to the orientation of the surgical cable. An example of a suitable clamping bolt for the device-incorporated clamp is a #8 machine screw made from titanium, stainless steel, cobalt chromium alloy, or a similar type of material that is compatible with material of the device body and clamping body. In some instances, the clamping bolt may be coated with an implantable coating designed to reduce frictional contact with other components of the clamp or device.

The device-incorporated clamp **400** in FIG. 4 is one embodiment of a surgical cable clamp. The embodiment shown in FIG. 4 is an embodiment of the invention that can be used with the structure shown in the preferred environment shown in FIG. 1. Other embodiments of a surgical cable clamp can also be used in the preferred environment and other similar type environments to accomplish similar functions in accordance with the invention.

FIGs. 5a-d illustrate a sequence for a method for using a surgical cable clamp shown in FIGs. 1b and 1c. The particular embodiment shown

in this sequence utilizes a device-incorporated clamp, similar to that shown in FIG. 1b as **114** and FIG. 1c as **118**. Other embodiments of a surgical cable clamp can be utilized with the method illustrated in FIGs. 5a-d.

As shown in FIG. 5a, a surgical cable clamp **500** is shown incorporated into an orthopedic device such as trochanteric grip **502**. The trochanteric grip **502** is aligned with a proximal end of a patient's femur bone **504** in accordance with a hip replacement procedure. When the trochanteric grip **502** is to be secured to the patient's femur **504**, the surgical cable clamp **500** is positioned in a position adjacent to the patient's femur **504** to receive a surgical cable **506**. Similar to the embodiments shown in FIGs. 1b and 1c, the surgical cable clamp **500** includes a device body, i.e. a portion of the trochanteric grip **502**, a clamping bolt **508** and an upper clamping body **510**. Typically, the orthopedic device such as a trochanteric grip **502** has an upper surface **512** with a recess **514** sized to receive the upper clamping body **510**. The trochanteric grip **502** also has a threaded bolt hole **516** machined through the recess **514** and sized to receive the clamping bolt **508**. A relatively smaller diameter end **518** of a predetermined length of surgical cable **506** is inserted into and pulled through a first cable hole **520** in a lateral side of the trochanteric grip **502**. A bead **522** on the relatively larger diameter opposing end of the surgical cable **506** secures the opposing end of surgical cable **506** adjacent to the trochanteric grip **502** as shown in FIG. 5b. Preferably, the components of a surgical cable clamp **500** can be preassembled with the orthopedic device prior to the surgical procedure, or otherwise assembled together with the surgical cable **506** during the sequence.

After the surgical cable **506** is wrapped around the thickness of the patient's femur **504**, the relatively smaller diameter end **518** of the surgical cable **506** is inserted through a second cable hole **524** of the trochanteric grip **502**.

As shown in FIG. 5c, the relatively smaller diameter end **518** and the length of the of the surgical cable **506** is pulled through the second cable

hole **524** until a desired tension in the surgical cable **506** is attained. When the surgical cable **506** is pulled to a desired tension, the clamping bolt **508** is mounted through the upper clamping body **510** and tightened into the threaded bolt hole **516** with a tightening instrument (not shown) with a corresponding hexagonal-shaped head or driver such as a "T-handled driver" with a hex head to match the shape of the clamping bolt **508** until the compression force between the upper clamping body **510** and the recess **514** maintains a desired tension on the surgical cable **506**. Any excess length of surgical cable **506** can be trimmed with a cutting instrument (not shown).

FIG. 5d illustrates a detailed cutaway cross-sectional view of the surgical cable clamp **500** and trochanteric grip **502** shown in FIGs. 5a-c. As described above and shown here, the upper clamping body **510** is secured to the device body, i.e. a portion of the trochanteric grip **502**, with the clamping bolt **508**. The position of the surgical cable **506** with respect to the trochanteric grip **502** is maintained by the downward force of the upper clamping body **510** and the clamping bolt **508**. A series of corresponding grooves (not shown) or ridges can be machined in the recess **514** of the trochanteric grip **502** adjacent to the position of the surgical cable **506** in order to increase frictional contact on the surgical cable **506**.

In most instances, a cable tensioning device (not shown) can be used to tighten the surgical cable **506** to a predetermined tension. The cable tensioning device can be configured to maintain a tension on the surgical cable **506** as well as to measure the tension on the surgical cable **506** until the cable **506** is secured by the clamping bolt **508**

More than one surgical cable **506** may be needed to secure an orthopedic device such as a trochanteric grip **502** to a patient's femur **504** or another bone. After tensioning one or more surgical cables **506** to the patient's femur **504** or other bone with one or more corresponding surgical cable clamps **500**, previously tensioned surgical cables may tend to loosen or otherwise require additional tension to sufficiently secure the orthopedic

device such as a trochanteric grip **502** to the patient's femur **504** or other bone. If necessary, the tension on a previously tensioned surgical cable can be released by applying a force to the clamping bolt **508** with the hexagonal-shaped tightening instrument, releasing the compression force between the upper clamping body **510** and recess **514**, thus releasing the tension from the surgical cable **506**. The surgical cable **506** is then retensioned manually or by use of the cable tensioning device. When the desired tension is reached, a tightening force is applied to the clamping bolt **508** in order to create a sufficient compression force between the upper clamping body **510** and the recess **514** to maintain the desired tension in the surgical cable **506**, and secure the position of the surgical cable **506** relative to the surgical cable clamp **500**.

Tensioning and retensioning of one or more surgical cables may occur more than once during a surgical procedure until all of the surgical cables are sufficiently tensioned to maintain the position of the orthopedic device such as a trochanteric grip **502** relative to the patient's femur **504** or other bone. The sequence described above with respect to FIGs. 5a-d can be repeated as necessary to accomplish this.

There are multiple shapes and structures for a surgical cable clamp in accordance with various embodiments of the invention. Without limiting the scope of the invention, the following FIGs. 6-29 are intended to illustrate and describe several embodiments of a surgical cable clamp in accordance with the invention. The surgical cable clamps in each of the embodiments shown in FIGs. 6-29 accomplish similar functions to the embodiments such as the stand alone-type clamp and device-incorporated clamp shown and described above in FIGs. 1-5.

FIG. 6 is a perspective view of another embodiment of a surgical cable clamp **600**. The embodiment of the surgical cable clamp **600** shown here includes a clamping body **602**, a clamping bolt **604**, and a corresponding nut **606**.

The clamping body **602** in this embodiment has a generally rounded cap-like configuration with a relatively flat upper surface **608** and a

relatively flat lower surface **610**. On a circular lateral side **612** of the clamping body **602**, a pair of cable holes **614** sized to receive the ends of an orthopedic surgical cable (not shown) are machined through the width of the clamping body **602** to the opposing lateral side. Through the upper surface **608**, a bolt hole **616** for receiving the clamping bolt **604** is machined through the thickness of the clamping body **602** to the lower surface **610**. A pair of opposing recesses **618** for receiving a portion of the corresponding nut **606** are located on the lateral side **612** of the clamping body **602** opposing one another, and extend from the lower surface **610** towards the upper surface **608**. The clamping body **602** includes a concentric nut hole (not shown) in the lower surface **610** sized to receive the width of the corresponding nut **606**, and concentrically aligned with the bolt hole **616** through the clamping body **602**.

The clamping bolt **604** in this embodiment is shaped similar to a conventional machine screw with a socket head **620**, a threaded body **622**, and blunt point **624**. The socket head **620** is sized to receive a tightening instrument (not shown) for tightening and untightening a corresponding socket-shaped head. Alternatively, the external shape of the socket head **620** can be shaped for tightening with a wrench-type instrument (not shown) for tightening and untightening a corresponding geometrically-shaped socket head **620**. The threaded body **622** includes one or more threads **626** sized to receive the corresponding nut **606**. The blunt point **624** of the clamping bolt **604** is sized to fit within the bolt hole **616** of the clamping body **602** and to receive the corresponding nut **606**.

The corresponding nut **606** is shaped similar to a conventional wingnut with a rounded body **628** and one or more wings **630** extending from opposing lateral sides of the rounded body **628**. The rounded body **628** is sized to fit within the concentric nut hole (not shown) in the lower surface **610** of the clamping body **602**. A threaded receiving hole **632** is machined through a central portion of the rounded body **630** from an upper side **634** to an opposing lower side **636**. Each of the wings **630** is sized to

fit within the corresponding opposing recesses **618** in the lateral side **612** of the clamping body **602**.

FIG. 7 is an exploded perspective view of another embodiment of a surgical cable clamp similar to that shown in FIG. 6 as **600**. The embodiment of the surgical cable clamp **700** shown here includes a clamping body **702**, a clamping bolt **704**, and a corresponding nut **706**, and operates in a similar manner as the embodiment in FIG. 6. The clamping body **702** has a generally rectangular-shaped configuration, while the clamping bolt **704** and associated nut **706** have similar shapes as those shown and described in FIG. 6. The surgical cable clamp **700** shown operates in a substantially similar manner as the clamp shown in FIG. 6 as **600**.

FIGs. 8a-b illustrate another embodiment of a surgical cable clamp in accordance with the invention. FIG. 8a shows a cross-sectional view of an embodiment of a surgical cable clamp in an unclamped position, and FIG. 8b shows the clamp of FIG. 8a in a clamped position. This surgical cable clamp **800** includes an upper clamping body **802**, a lower clamping body **804**, and a clamping bolt **806**. Both the upper clamping body **802** and lower clamping body **804** are each generally wedge-shaped. The upper clamping body **802** has an angled surface **808** configured to correspond with a similarly angled surface **810** of the lower clamping body **804** when the clamping bodies are fit together along a relatively flat interface **812**. Both the upper clamping body **802** and the lower clamping body each have a corresponding machined bolt hole **814a, 814b** through their center portions. The clamping bolt **806** fits within the bolt holes **814a,b** when the upper clamping body **802** is aligned with the lower clamping body **804** as shown in FIG. 8a. The clamping bolt **806** may be threaded to correspond with threads of a corresponding nut **816** or with threads machined within the bolt hole **814b** of the lower clamping body **804**. At least one cable hole **818a** is machined in a lateral side **820** of the lower clamping body **804**, and a corresponding cable hole **818b** is machined in a lateral side **822** of the upper clamping body **802**. The cable

holes **818a,b** are sized to receive an orthopedic surgical cable **824** when the cable holes **818a,b** are aligned as shown in FIG. 8a.

When the upper clamping block **802** is slightly offset from the lower clamping block **804** along the interface **812** and the clamping bolt **806** is tightened, then the surgical cable clamp **800** clamps the surgical cable **824** as shown in FIG. 8b. Utilizing this configuration, a user can apply a desired tension to the surgical cable **824**, and then clamp the surgical cable **824** by offsetting the upper clamping block **802** from the lower clamping block **804**. The compression force of the upper clamping body **802** upon the surgical cable **824** at the interface **812**, and the surgical cable **824** against the lower clamping body **804**, secures the position of the surgical cable **824** relative to the surgical cable clamp **800**. By tightening and untightening the clamping bolt **806** and offsetting or aligning the clamping bodies **802, 804**, the surgical cable clamp **800** can clamp and unclamp the orthopedic surgical cable **824**.

FIGs. 9a-b illustrate another embodiment of a surgical cable clamp in accordance with the invention. FIG. 9a is a perspective exploded view of a surgical cable clamp; and FIG. 9b is a cross-sectional view of the surgical cable clamp shown in FIG. 9a. In this embodiment, a surgical cable clamp **900** includes an upper clamping body **902**, a clamping bolt **904**, and a lower clamping body **906**. The upper clamping body **902** is generally flat and annularly-shaped, and configured to fit within a corresponding recess **908** in the lower clamping body **906**. The lower clamping body **906** is generally block-shaped with the recess **908** machined through a portion of the top surface, and the clamping bolt **904** has a similar shape as the clamping bolt shown and described in FIG. 6. A bolt hole **910** machined through a central portion of the upper clamping body **902** is configured to receive the clamping bolt **904**, while a threaded bolt hole **912** is machined in the lower portion of the lower clamping body **906** within the recess **908**.

The clamping bolt **904** is threaded to correspond with threads machined within the threaded bolt hole **912**. Two cable holes **914** are

machined in a lateral side **916** of the lower clamping body **906**. The cable holes **914** are sized to receive an orthopedic surgical cable (not shown) to be clamped and reclamped by the surgical cable clamp **900**.

When an orthopedic surgical cable is inserted within either or both of the cable holes **914**, the upper clamping body **902** can be inserted within the recess **908** of the lower clamping body **906** as shown in FIG. 9b. Then the upper clamping body **902** is secured within the recess **908** by the clamping bolt **904** mounted within the bolt hole **910** and threaded within bolt hole **912**. The compression force of the upper clamping body **902** upon the surgical cable secures the position of the surgical cable relative to the lower clamping body **906**. By tightening and untightening the clamping bolt **904**, the surgical cable clamp **900** can clamp and unclamp the orthopedic surgical cable as needed when tensioning the orthopedic surgical cable as desired. A series of grooves (not shown) or ridges can be machined on the lower surface of the upper clamping body to increase the friction or grip on the surgical cable.

FIGs. 10a-b illustrate another embodiment of a surgical cable clamp in accordance with the invention. FIG. 10a is a perspective exploded view of a surgical cable clamp; and FIG. 10b is a cross-sectional view of the surgical cable clamp shown in FIG. 10a. In this embodiment, a surgical cable clamp **1000** includes a upper clamping body **1002**, a lower clamping body **1004**, and a clamping bolt **1006**. The upper clamping body **1002** is generally C-shaped with a lower recess **1008** sized to receive the generally rectangular-shaped lower clamping body **1004**. When fit together, the lower clamping body **1004** integrally fits with the upper clamping body **1002** as shown in FIG. 10b. The clamping bolt **1006** fits within a bolt hole **1010** machined through the central portion of the upper clamping body **1002**, and has a similar shape as the clamping bolt shown and described in FIG. 6. A threaded bolt hole **1012** machined in the lower clamping body **1004** is sized to receive threads of the clamping bolt **1006**. Two cable channels **1014** are machined in the lower portion of a lateral side **1016** of the upper clamping body **1002**. These cable channels **1014** correspond

with cable channels **1018** machined in an upper portion of the lower clamping body **1004**. When the upper clamping body **1002** and lower clamping body **1004** are integrally fit together, the cable channels **1014, 1018** align with each other. The cable channels **1014, 1018** are sized to receive an orthopedic surgical cable (not shown) to be clamped and reclamped by the surgical cable clamp **1000**. A series of grooves (not shown) or ridges can be machined within the cable channels **1014, 1018** to increase the friction or grip on the surgical cable.

When an orthopedic surgical cable is inserted within either or both of the cable holes, the upper clamping body **1002** is fit together with the lower clamping body **1004**, and then the upper clamping body **1002** is secured to the lower clamping body **1004** by the clamping bolt **1006**. The compression force of the upper clamping body **1002** upon the surgical cable secures the position of the cable relative to the lower clamping body **1004**. By tightening and untightening the clamping bolt **1006**, the surgical cable clamp **1000** can clamp and unclamp the orthopedic surgical cable as needed when tensioning the orthopedic surgical cable as desired.

FIGs. 11a-b illustrate another embodiment of a surgical cable clamp in accordance with the invention. FIG. 11a is a perspective exploded view of a surgical cable clamp; and FIG. 11b is a cross-sectional view showing clamp position of the surgical cable clamp shown in FIG. 11a. The embodiment of a surgical cable clamp **1100** shown here includes a clamping body **1102**, a clamping bolt **1104**, and a corresponding nut **1106**, and operates in a similar manner as the embodiment in FIG. 6. The clamping body **1102** has a generally block-shaped configuration with a recess **1108** in the lower surface, while the clamping bolt **1104** has a similar shape as the clamping bolt shown and described in FIG. 6. The corresponding nut **1106** is annular shaped with a wedge-shaped cross-section, configured to fit within the circular-shaped recess **1108** in the clamping body **1102**. A bolt hole **1110** machined through the central portion of the clamping body **1102** corresponds with a threaded bolt hole **1112** in the corresponding nut **1106**. When the clamping body **1102** and

the corresponding nut **1106** are aligned, the clamping bolt mounts through the bolt hole **1110** and threads into the threaded bolt hole **1112** of the corresponding nut **1106**. Two cable holes **1114** are machined in a lateral side **1116** of the clamping body **1102**. Each cable hole **1114** extends along a portion of the lateral edge of the recess **1108** within the clamping body **1102**, and through to the opposing lateral side of the clamping body **1102**.

When an orthopedic surgical cable is inserted within either or both the cable holes **1114**, the clamping body **1102** can then be fit together with the corresponding nut **1106**. The corresponding nut **1106** is secured to the clamping body **1102** by the clamping bolt **1104**. The compression force of the corresponding nut **1106** upon the surgical cable secures the position of the cable relative to the clamping body **1102**. By tightening and untightening the clamping bolt **1104**, the surgical cable clamp **1100** can clamp and unclamp the orthopedic surgical cable as needed when tensioning the orthopedic surgical cable as desired.

FIGs. 12a-b illustrate another embodiment of a surgical cable clamp in accordance with the invention. FIG. 12a is a side view of the surgical cable clamp in an unclamped position, and FIG. 12b is a side view of the surgical cable clamp in FIG. 12a in a clamped position. In this embodiment, a surgical cable clamp **1200** includes a upper clamping body **1202**, a lower clamping body **1204**, and a spring **1206**. The upper clamping body **1202** is configured to hingably fit together with the lower clamping body **1204** via a hinge **1208**. Together, the upper clamping body **1202** connected to the lower clamping body **1204** form a C-shaped device. A cable support **1210** connects to the upper clamping body **1202**, while a corresponding cable support **1212** connects to the lower clamping body **1204**. Each of the cable supports **1210, 1212** is eye bolt-shaped. When the clamp **1200** is in an unclamped position as shown in FIG. 12a, the cable supports **1210, 1212** align with each other, as well as with a cable hole **1214** adjacent to the hinge **1208** and between adjacent ends of the upper clamping body **1202** and lower clamping body **1204**.

The spring **1206** mounts between and connects the upper clamping body **1202** and lower clamping body **1204**, adjacent to the hinge **1208**. When the clamp **1200** is in a clamped position as shown in FIG. 12b, the spring **1206** maintains the upper clamping body **1202** and lower clamping body **1204** in a spaced apart relation that offsets the alignment of the cable supports **1210, 1212**. For example, when an orthopedic surgical cable **1216** is mounted through the cable hole **1214** and through each of the aligned cable supports **1210, 1212** as shown in FIG. 12a, the surgical cable clamp **1200** does not provide any clamping force upon the cable **1216**. However, as shown in FIG. 12b, when the upper clamping body **1202** and lower clamping body **1204** are extended away from each other, the offset alignment of the cable supports **1210, 1212** causes the surgical cable clamp **1200** to slightly offset or "clamp" the cable **1216**, thus securing the position of the surgical cable **1216** relative to the surgical cable clamp **1200**. By compressing or extending the upper and lower clamping bodies **1202, 1204** together or away from each other, the surgical cable clamp **1200** can clamp and unclamp the orthopedic surgical cable **1216** as needed when tensioning the orthopedic surgical cable **1216** as desired.

FIGs. 13a-b illustrate another embodiment of a surgical cable clamp in accordance with the invention. FIG. 13a is a cross-sectional view of the surgical cable clamp in a clamped position, and FIG. 13b is an exploded side view of the surgical cable clamp in FIG. 13a in an unclamped position. In this embodiment, a surgical cable clamp **1300** includes a upper clamping body **1302**, a lower clamping body **1304**, and a pair of clamping bolts **1306**. The wedge-shaped upper clamping body **1302** is configured to integrally fit within a corresponding recess **1308** of the lower clamping body **1304**. Together, the upper clamping body **1302** and lower clamping body **1304** form a general block-shape. The clamping bolts **1306** each have a similar shape as the clamping bolt shown and described in FIG. 6. A set of bolt holes **1310** in the upper clamping body **1302** correspond with threaded bolt holes **1312** in the lower clamping body **1304**. Each of the bolt holes **1310, 1312** is sized to receive the clamping bolts **1306**.

At least one cable hole **1314** is machined in a lateral side **1316** of the lower clamping body **1304**. At an interface between the upper clamping body **1302** and lower clamping body **1304**, a second cable hole **1318** is formed when the upper clamping body **1302** fits together with the lower clamping body **1304**. For example, a tip portion **1320** of the upper clamping body **1302** can be a concave-shaped tip, and the recessed portion **1322** of the lower clamping body **1304** can be a concave-shaped recess that corresponds to the tip portion of the upper clamping body **1302** to form a second cable hole **1318**. The cable hole **1310** and second cable hole **1318** are sized to receive an orthopedic surgical cable (not shown) to be clamped and reclamped by the surgical cable clamp **1300**.

When an orthopedic surgical cable is inserted within either or both the cable hole **1310** and second cable hole **1318**, the upper clamping body **1302** can then be secured together with the lower clamping body **1304** by the clamping bolts **1306**. The compression force of the upper clamping body **1302** upon the surgical cable secures the position of the cable relative to the lower clamping body **1304**. By tightening and untightening the clamping bolts **1306**, the surgical cable clamp can clamp and unclamp the orthopedic surgical cable as needed when tensioning the orthopedic surgical cable as desired. A series of grooves (not shown) or ridges to increase the friction or grip on the surgical cable can be machined within the second cable hole **1318** by machining the upper clamping body **1302** and/or lower clamping body **1304**.

FIGs. 14a-b show another embodiment of a surgical cable clamp in accordance with the invention. FIG. 14a is a side view of the surgical cable clamp in a clamped position, and FIG. 14b is a side view of the surgical cable clamp in FIG. 14a in an unclamped position. In this embodiment, a surgical cable clamp **1400** includes an upper clamping body **1402**, a lower clamping body **1404**, and a clamping bolt **1406**. The upper clamping body **1402** is configured to hingably fit together with the lower clamping body **1404** via a hinge **1408**. Together, the upper clamping body **1402** and lower clamping body **1404** form a V-shape. A bolt hole

1410 in the upper clamping body **1402** adjacent to an unhinged end corresponds with a threaded bolt hole **1412** in the lower clamping body **1404** adjacent to its unhinged end. Each of the bolt holes **1410, 1412** are sized to receive the clamping bolt **1406**. The clamping bolt **1406** has a similar shape as the clamping bolt shown and described in FIG. 6.

At least one cable hole **1414** is machined in a lateral side **1416** of the upper clamping body **1402**. At an interface between the upper clamping body **1402** and lower clamping body **1404**, a second cable hole **1418** is formed when the upper clamping body **1402** fits together with the lower clamping body **1404**. For example, a recessed portion **1420** of the upper clamping body **1402** can be a concave-shaped cable channel, and a recessed portion **1422** of the lower clamping body **1404** can be a concave-shaped cable channel that corresponds to the recessed portion **1420** of the upper clamping body **1402** to form a second cable hole **1418**. The cable hole **1410** and second cable hole **1418** are sized to receive an orthopedic surgical cable (not shown) to be clamped and reclamped by the surgical cable clamp **1400**.

When an orthopedic surgical cable is inserted within either or both the cable hole **1410** and second cable hole **1418**, the upper clamping body **1402** can then be secured together with the lower clamping body **1404** by the clamping bolt **1406**. The compression force of the upper clamping body **1402** upon the surgical cable secures the position of the cable relative to the lower clamping body **1404**. By tightening and untightening the clamping bolt **1406**, the surgical cable clamp **1400** can clamp and unclamp the orthopedic surgical cable as needed when tensioning the orthopedic surgical cable as desired. A series of grooves (not shown) or ridges to increase the friction or grip on the surgical cable can be machined within the second cable hole **1418** by machining the upper clamping body **1402** and/or lower clamping body **1404**.

FIGs. 15a-b illustrate another embodiment of a surgical cable clamp in accordance with the invention. FIG. 15a is a cross-sectional view of the surgical cable clamp in a clamped position, and FIG. 15b is an exploded

side view of the surgical cable clamp in FIG. 15a in an unclamped position. In this embodiment, a surgical cable clamp **1500** includes an upper clamping body **1502**, a lower clamping body **1504**, and a pair of clamping bolts **1506**. The lower clamping body **1504** forms an inverted T-shape and integrally fits within a corresponding recess **1508** in the lower portion of the upper clamping body **1502**. The clamping bolts **1506** fit within a pair of respective bolt holes **1510** machined through portions of the upper clamping body **1502** and within corresponding threaded bolt holes **1512** machined in the lower clamping body **1504**. Note that the clamping bolts **1506** each have a similar shape as the clamping bolt shown and described in FIG. 6. At least one cable hole **1514** is machined in a lateral side **1516** of the upper clamping body **1502**. A second cable hole **1518** is formed when the upper clamping body **1502** is fit together with the lower clamping body **1504**. For example, a tip portion **1520** of the T-shaped lower clamping body **1504** can have a concave-shaped tip and a corresponding recessed portion **1522** in the upper clamping body **1502** can be a concave-shaped portion that forms a second cable hole **1518** when the upper clamping body **1502** is integrally fit together with the lower clamping body **1504**. The cable hole **1510** and second cable hole **1518** are sized to receive an orthopedic surgical cable (not shown) to be clamped and reclamped by the surgical cable clamp **1500**.

One or more springs **1524** may be positioned between the upper clamping body **1502** and the lower clamping body **1504** to assist with the disassembly of the upper clamping body **1502** from the lower clamping body **1504**. In the example shown, the springs **1524** are concentrically positioned around the clamping bolts **1506**, and are configured to compress when the lower clamping body **1502** is compressed within the recess **1508** of the upper clamping body as shown in FIG. 15a.

When an orthopedic surgical cable is inserted within either or both the cable hole **1510** and second cable hole **1518**, the lower clamping body **1504** can then be fit together with the upper clamping body **1502**, and then the lower clamping body **1504** is secured to the upper clamping body **1502**

by the clamping bolts **1506**. The compression force of the lower clamping body **1504** upon the surgical cable secures the position of the cable relative to the upper clamping body **1502**. By tightening and untightening either or both of the clamping bolts **1506**, the surgical cable clamp **1500** can clamp and unclamp the orthopedic surgical cable as needed when tensioning the orthopedic surgical cable as desired. A series of grooves (not shown) or ridges to increase the friction or grip on the surgical cable can be machined within the second cable hole **1518** by machining the upper clamping body **1502** and/or lower clamping body **1504**.

FIGs. 16a-b show another embodiment of a surgical cable clamp in accordance with the invention. FIG. 16a is a cross-sectional view of the surgical cable clamp in a clamped position, and FIG. 16b is a isometric or perspective view of the surgical cable clamp in FIG. 16a in an unclamped position. In this embodiment, a surgical cable clamp **1600** includes an upper clamping body **1602**, a lower clamping body **1604**, and a clamping bolt **1606**. The cone-shaped lower clamping body **1604** is configured to integrally fit within a corresponding recess **1608** machined in the lower portion of the upper clamping body **1602**. The clamping bolt **1606** fits within a bolt hole **1610** machined through a central portion of the upper clamping body **1602**, and within a threaded bolt hole **1612** machined in a central portion of the lower clamping body **1604**. Note that the clamping bolt **1606** has a similar shape as the clamping bolt shown and described in FIG. 6. At an interface between the lateral sides **1614** of the lower clamping body **1604** and the lateral sides **1616** of the recess **1608**, cable clamping areas **1618** are formed when the lower clamping body **1604** is integrally fit within the recess **1608** of the upper clamping body **1602**. For example, the lateral sides **1616** of the recess **1608** can each have a pair of concave-shaped recessed portions that are adjacent to the lower clamping body **1604**, when the lower clamping body **1604** is fit into the recess **1608**. The cable clamping areas **1618** are sized to receive an orthopedic surgical cable (not shown) to be clamped and reclamped by the surgical cable clamp **1600**. Thus, when the lower clamping body **1604** is drawn upwards

and into the recess **1608** of the upper clamping body **1602**, the cable clamping areas **1618** are restricted by the lateral sides **1614** of the lower clamping body **1604**.

Cable holes **1620** machined in a lateral side **1622** of the upper clamping body **1602** and through to the opposing later side further align with the cable clamping areas **1618** to permit an orthopedic surgical cable (not shown) to mount through the upper clamping body **1602**. When an orthopedic surgical cable is inserted into either or both cable holes **1620** and within either or both corresponding cable clamping areas **1618**, the lower clamping body **1604** can then be secured to the upper clamping body **1602** by the clamping bolt **1606**. The compression force of the lower clamping body **1604** upon the surgical cable secures the position of the cable relative to the upper clamping body **1602**. By tightening and untightening the clamping bolt **1606**, the surgical cable clamp **1600** can clamp and unclamp the orthopedic surgical cable as needed when tensioning the orthopedic surgical cable as desired. A series of grooves (not shown) or ridges to increase the friction or grip on the surgical cable can be machined within the along the lateral sides of the lower clamping body **1604** adjacent to the cable clamping areas **1618**.

FIGs. 17a-b illustrate another embodiment of a surgical cable clamp in accordance with the invention. FIG. 17a is a cross-sectional view of the surgical cable clamp in a clamped position, and FIG. 17b is an isometric view or perspective view of the surgical cable clamp in FIG. 17a. In this embodiment, a surgical cable clamp **1700** includes a upper clamping body **1702**, a lower clamping body **1704**, and a clamping bolt **1706**. The lower clamping body **1702** is a tapered wedge-shape configured to integrally fit within a corresponding recess **1708** machined in the lower portion of the upper clamping body **1704**. The clamping bolt **1706** mounts through a bolt hole **1710** machined through a central portion of the upper clamping body **1702**, and within a threaded bolt hole **1712** machined in the lower clamping body **1704**. The clamping bolt **1706** may be threaded to correspond with threads machined within bolt hole **1712**. Note that the clamping bolt **1706**

has a similar shape as the clamping bolt shown and described in FIG. 6. Two cable holes **1714** are machined in a lateral side **1716** of the lower clamping body **1704**. At an interface between the upper clamping body **1702** and lower clamping body **1704**, a cable clamping area **1718** is formed when the lower clamping body **1704** is integrally fit together with the upper clamping body **1702**. At least one of the cable holes **1714** aligns with the cable clamping area **1718**. The cable clamping area **1718** is sized to receive an orthopedic surgical cable to be clamped and reclamped by the surgical cable clamp **1700**. Thus, when the lower clamping body is drawn upwards and into the recess of the upper clamping body, the cable clamping area **1718** is further restricted by the lower clamping body **1704**.

At least one ball spring **1720** is connected to the lower clamping body **1704** and configured to extend between the upper clamping body **1702** and the lower clamping body **1704**. The ball spring **1720** assists with the assembly of the lower clamping body **1704** with the upper clamping body **1702**. When the surgical cable clamp **1700** is assembled as shown in FIG. 17a, the ball spring **1720** compresses when the lower clamping body **1704** is initially drawn upward within the recess **1708** of the upper clamping body **1702**. Conversely, the ball spring **1720** extends into a corresponding ball recess **1722** machined in an opposing lateral side **1724** of the recess **1708** when a predetermined position is reached by the lower clamping body **1704** with respect to the upper clamping body **1702**. When the predetermined position is attained, the ball spring **1720** provides a physical stop preventing an undesired release of cable tension caused by the clamping bolt **1706** possibly backing out while in use.

When an orthopedic surgical cable **1726** is inserted within either or both cable clamping areas, the lower clamping body **1704** can then be secured to the upper clamping body **1702** by the clamping bolt **1706**. The compression force of the lower clamping body **1704** upon the surgical cable **1726** secures the position of the cable **1726** relative to the upper clamping body **1702**. By tightening and untightening the clamping bolt **1706**, the surgical cable clamp **1700** can clamp and unclamp the

orthopedic surgical cable **1726** as needed when tensioning the orthopedic surgical cable **1726** as desired.

FIGs. 18a-b show another embodiment of a surgical cable clamp in accordance with the invention. FIG. 18a is an exploded isometric view of the surgical cable clamp in an unclamped position, and FIG. 18b is a cross-sectional view showing the clamp position of the surgical cable clamp in FIG. 18a. In this embodiment, a surgical cable clamp **1800** includes a clamping body **1802** and a collet **1804**. The clamping body **1802** is configured to fit together with the collet **1804** so that the collet **1804** compresses a portion of the clamping body **1802**. The clamping body **1802** includes a pair of extended legs **1806a,b**. A cable clamping area **1808** is formed between the extended legs **1806a,b**, while opposing cable channels **1810** are machined on the interior lateral sides of each leg **1806a,b**. The cable channels **1810** and cable clamping areas **1808** are sized to receive the diameter of an orthopedic surgical cable to be clamped and reclamped by the surgical cable clamp **1800**. A cable hole **1812** machined through the clamping body **1802** is also sized to receive the diameter of an orthopedic surgical cable to be clamped and reclamped by the surgical cable clamp **1800**.

When an orthopedic surgical cable is inserted within the cable clamping area **1808** and within the cable channels **1810**, the extended legs **1806a,b** can then be compressed towards each other with the collet **1804**. The compression force of the collet **1804** upon the extended legs **1806a,b** applies a compression force on the surgical cable, thus securing the position of the cable relative to the clamping body **1802**. By tightening and untightening the collet **1804**, the surgical cable clamp **1800** can clamp and unclamp the orthopedic surgical cable as needed to secure or unsecure the tension in the cable as desired. A series of grooves (not shown) or ridges to increase the friction or grip on the surgical cable can be machined within the cable channels **1810** by machining the interior lateral sides of each leg **1806a,b**. Other configurations of sizes and shapes for a

collet **1804** or similar shaped body or device can be used in accordance with the invention.

FIGs. 19a-b show another embodiment of a surgical cable clamp in accordance with the invention. FIG. 19a is an exploded isometric view of the surgical cable clamp in an unclamped position, and FIG. 19b is a cross-sectional view showing the clamp position of the surgical cable clamp in FIG. 19a. In this embodiment, which is similar to the embodiment shown in FIG. 18, a surgical cable clamp **1900** includes a clamping body **1902** and a collet **1904**. However, in this embodiment, the collet **1904** is configured to thread onto the clamping body **1902**, rather than a slip fit, so that the collet **1904** compresses a portion of the clamping body **1902**. The clamping body **1902** includes a pair of extended legs **1906a,b**. A cable clamping area **1908** is formed between the extended legs **1906a,b**, while opposing cable channels **1910** are machined on the interior lateral sides of each leg **1906a,b**. The cable channels **1910** and cable clamping area **1908** are sized to receive the diameter of an orthopedic surgical cable to be clamped and reclamped by the surgical cable clamp **1900**. A cable hole **1912** machined through the clamping body **1902** is also sized to receive the diameter of an orthopedic surgical cable to be clamped and reclamped by the surgical cable clamp **1900**.

When an orthopedic surgical cable is inserted within the cable clamping area **1908** and within the cable channels **1910**, the extended legs **1906a,b** can then be compressed towards each other with the collet **1904**. The compression force of the collet **1904** upon the extended legs **1906a,b** applies a compression force on the surgical cable, thus securing the position of the cable relative to the clamping body **1902**. By tightening and untightening the collet **1904**, the surgical cable clamp **1900** can clamp and unclamp the orthopedic surgical cable as needed when tensioning the orthopedic surgical cable as desired. A series of grooves (not shown) or ridges to increase the friction or grip on the surgical cable can be machined within the cable channels **1910** by machining the interior sides of each leg **1906a,b**.

Note that the collet **1904** can be a cylindrically-shaped compression piece sized to fit on the ends of the extended legs **1906a,b**. Alternatively, the collet **1904** can be a cylindrically-shaped threaded piece with corresponding threads configured on the exterior of the extended legs **1906a,b** to receive the threaded collet **1904**. Other configurations of sizes and shapes for a collet **1904** or similar shaped body or device can be used in accordance with the invention.

FIG. 20a is another embodiment of a surgical cable clamp in accordance with the invention. FIG. 20a is a perspective exploded view of a surgical cable clamp in an unclamped position; and FIG. 20b is a cross-sectional view showing the clamp position of the surgical cable clamp shown in FIG. 20a. In this embodiment, a surgical cable clamp **2000** includes a upper clamping body **2002**, a lower clamping body **2004**, and a clamping bolt **2006**. The upper clamping body **2002** is generally disc-shaped with a pair of cable channels **2008** machined in along the lower portion and sized to receive a diameter of an orthopedic surgical cable **2010** to be clamped and reclamped by the surgical cable clamp **2000**. The lower clamping body **2004** is also generally disc-shaped and integrally fits with the upper clamping body **2002** as shown in FIG. 20b. The clamping bolt **2006** fits within a bolt hole **2012** machined through the central portion of the upper clamping body **2002**, and has a similar shape as the clamping bolt shown and described in FIG. 6. A threaded bolt hole **2014** machined in the lower clamping body **1004** is sized to receive threads of the clamping bolt **2006**.

When an orthopedic surgical cable is inserted between the upper clamping body **2002** and the lower clamping body **2004**, and within at least one cable channel **2008**, then the upper clamping body **2002** can be secured to the lower clamping body **2004** by the clamping bolt **2006**. The compression force of the upper clamping body **2002** upon the surgical cable **2010** secures the position of the cable **2010** relative to the lower clamping body **2004**. By tightening and untightening the clamping bolt **2006**, the surgical cable clamp **2000** can clamp and unclamp the

orthopedic surgical cable **2010** as needed when tensioning the orthopedic surgical cable **2010** as desired. A series of grooves (not shown) or ridges can be machined within the cable channels **2008** and/or along the opposing side of the lower clamping body **2004** to increase the friction or grip on the surgical cable.

FIGs. 21a-b is another embodiment of a surgical cable clamp in accordance with the invention. FIG. 21 illustrates a perspective view of a surgical cable clamp in a clamped position; and FIG. 21b illustrates a cross-sectional view showing the clamp position of the surgical cable clamp shown in FIG. 21a also in a clamped position. In this embodiment, a surgical cable clamp **2100** includes a upper clamping body **2102**, a lower clamping body **2104**, and a clamping bolt **2106**. The upper clamping body **2102** is generally wedge-shaped. The lower clamping body **2104** is generally disc-shaped with a corresponding wedge-shaped taper between an upper surface **2108** and lateral surface **2110** of the body **2104**. The upper clamping body **2102** integrally fits with the lower clamping body **2104** as shown in FIG. 21b. The clamping bolt **2106** fits within a bolt hole **2112** machined through the central portion of the upper clamping body **2102**, and has a similar shape as the clamping bolt shown and described in FIG. 6. A threaded bolt hole **2114** machined in the tapered portion of the lower clamping body **1004** is sized to receive threads of the clamping bolt **2006**.

A cable hole **2116** and a cable channel **2118** are machined through the lateral side **2110** of the lower clamping body **2104**, and each is sized to receive a diameter of an orthopedic surgical cable **2120** to be clamped and reclamped by the surgical cable clamp **2100**. The cable channel **2118** is machined along the tapered portion of the lower clamping body **2104**, permitting the upper clamping body **2102** to contact a portion of the surgical cable **2120** when the cable **2120** is mounted within the cable channel **2118**.

When an orthopedic surgical cable is inserted between the upper clamping body **2102** and the lower clamping body **2104**, and within the

cable channel **2118**, then the upper clamping body **2102** can be secured to the lower clamping body **2104** by the clamping bolt **2106**. The compression force of the upper clamping body **2102** upon the surgical cable **2120** secures the position of the cable **2120** relative to the lower clamping body **2104**. By tightening and untightening the clamping bolt **2106**, the surgical cable clamp **2100** can clamp and unclamp the orthopedic surgical cable **2120** as needed when tensioning the orthopedic surgical cable **2120** as desired. A series of grooves (not shown) or ridges can be machined within the cable channel **2118** and/or along the opposing side of the upper clamping body **2102** to increase the friction or grip on the surgical cable.

FIGs. 22a-b are another embodiment of a surgical cable clamp in accordance with the invention. FIG. 22a illustrates a cross-sectional view of a surgical cable clamp in an unclamped position; and FIG. 22b illustrates a cross-sectional view showing the clamp position of the surgical cable clamp shown in FIG. 22a. In this embodiment, a surgical cable clamp **2200** includes a upper clamping body **2202** and a lower clamping body **2204**. The upper clamping body **2202** is generally a cylindrically-shaped tube with slotted lateral sides **2206**. The lower clamping body **2204** is generally spherically-shaped with slots **2208** in its lateral sides **2210** that correspond with slots **2212** in the upper clamping body **2202**. The upper clamping body **2202** integrally fits with the lower clamping body **2204** as shown in FIGs. 22a-b. Conventional material joining methods and processes can be used to fit the upper clamping body **2202** with the lower clamping body **2204**, or alternatively, the bodies **2202, 2204** can be molded or otherwise formed from a single piece or material.

A cable hole **2214** is machined through the lower clamping body **2204** to receive a diameter of an orthopedic surgical cable **2216** to be clamped and reclamped by the surgical cable clamp **2200**. A cable channel **2218** in the upper clamping body **2202** is aligned with the cable hole **2214**, and is also configured to receive a diameter of an orthopedic surgical cable **2216**. The cable channel **2218** permits the upper clamping

body **2202** to contact a portion of the surgical cable **2216** when the cable **2216** is mounted within the cable channel **2218**.

When an orthopedic surgical cable is inserted within the cable hole **2214** and mounted within the cable channel **2218**, the cable clamp **2200** can be inserted into a cavity **2220** of an orthopedic device **2222** as shown in FIG. 22a. This movement causes a compression force to be applied to the exterior of the lower clamping body **2204** causing the lateral sides **2206** of the upper clamping body **2202** to move inward towards the surgical cable **2216** as shown in FIG. 22b. The compression force of the upper clamping body **2202** upon the surgical cable **2216** secures the position of the cable **2216** relative to the lower clamping body **2204**. When a user inserts or removes the lower clamping body from the cavity **2220**, the surgical cable clamp **2200** clamps or unclamps the orthopedic surgical cable **2216** as needed when tensioning the orthopedic surgical cable **2216** as desired. A series of grooves (not shown) or ridges can be machined within the cable channel **2218** and/or along the opposing sides of the upper clamping body **2202** to increase the friction or grip on the surgical cable.

FIGs. 23a-b are another embodiment of a surgical cable clamp in accordance with the invention. FIG. 23a illustrates a cross-sectional view of a surgical cable clamp in an unclamped position; and FIG. 23b illustrates a cross-sectional view showing the clamp position of the surgical cable clamp shown in FIG. 23a. In this embodiment, a surgical cable clamp **2300** includes a clamping body **2302**. The clamping body of this embodiment is a single molded or manufactured piece, but could be fabricated in multiple pieces similar to the embodiment shown in FIG. 22. The clamping body **2302** is generally a wedge-shaped tube with slotted lateral sides **2304**. A cable hole **2306** is machined through the clamping body **2302** to receive a diameter of an orthopedic surgical cable **2308** to be clamped and reclamped by the surgical cable clamp **2300**. The cable hole **2306** permits the clamping body **2302** to contact a portion of the surgical cable **2308** when the cable **2308** is mounted within the cable hole **2306**.

When an orthopedic surgical cable **2308** is inserted within the cable hole **2306**, the cable clamp **2300** can be inserted into a cavity **2310** of an orthopedic device **2312** as shown in FIG. 23a. This movement causes a compression force to be applied to the exterior of the clamping body **2302** causing the lateral sides **2304** of the clamping body **2302** to move inward towards the surgical cable **2308** as shown in FIG. 23b. The compression force of the clamping body **2302** upon the surgical cable **2308** secures the position of the cable **2308** relative to the clamping body **2302**. When a user inserts or removes the lower clamping body from the cavity **2310**, the surgical cable clamp **2300** clamps or unclamps the orthopedic surgical cable **2308** as needed when tensioning the orthopedic surgical cable **2308** as desired. A series of grooves (not shown) or ridges can be machined within the cable hole **2306** and/or along the opposing sides of the upper clamping body **2302** to increase the friction or grip on the surgical cable.

FIGs. 24a-b illustrate another embodiment of a surgical cable clamp in accordance with the invention. FIG. 24a shows a perspective view of a surgical cable clamp, and FIG. 24b shows a cross-sectional view of the surgical cable clamp shown in FIG. 24a. In this embodiment, a surgical cable clamp **2400** includes a clamping body **2402**, and a clamping mechanism **2404**. The clamping body **2402** is geometrically shaped with at least one clamping cable hole **2406** machined through the thickness of the body **2402**. The clamping cable hole **2406** shown includes a machined out portion **2408** that permits the size of the corresponding clamping cable hole **2406** to be slightly reduced when the clamping body **2402** is compressed. In the configuration shown, the clamping body **2402** has an upper portion **2410** and a lower portion **2412** adjacent to the machined out portion **2408** of the cable hole **2406**. The clamping mechanism **2404** is a C-shaped ring that fits within a ridge **2414** that is machined partially around the exterior sides of the upper portion **2410** and lower portion **2412** of the clamping body **2402**.

The clamping cable hole **2406** is sized to receive a diameter of an orthopedic surgical cable **2416** to be clamped and reclamped by the

surgical cable clamp **2400**. When the upper portion **2410** of the clamping body **2402** is compressed towards the lower portion **2412** of the clamping body, the cable hole **2406** compresses slightly to contact a portion of the surgical cable **2416** when the cable **2416** is mounted within the cable hole **2406**.

When an orthopedic surgical cable **2416** is inserted between the upper portion **2410** of the clamping body **2402** and the lower portion **2412** of the clamping body **2104**, and within the clamping cable hole **2406**, then the upper portion **2410** can be secured with respect to the lower clamping body **2412** by positioning the clamping mechanism **2404** within the ridge **2414** and activating the clamping mechanism **2404**. The compression force of the clamping mechanism **2404** upon the upper **2410** and lower portions **2412** of the clamping body **2402** compresses the interior sides of the cable hole **2406** upon the surgical cable **2416**, while securing the position of the cable **2416** relative to the clamping body **2402**. By tightening and untightening the clamping mechanism **2404**, the surgical cable clamp **2400** can clamp and unclamp the orthopedic surgical cable **2416** as needed when tensioning the orthopedic surgical cable **2416** as desired. A series of grooves (not shown) or ridges can be machined within the cable hole **2406** to increase the friction or grip on the surgical cable.

Note that the clamping mechanism **2404** can be a material having elastic-like or shape-memory properties, such as nitinol, a memory metal, a material activated by temperature change or heat, a material activated by a force, a material activated by an electrical current, or a material activated by a magnetic force. Other metals, plastics, alloys, composites, or other materials can be used within a clamping mechanism to provide the desired effects. When activated or otherwise in use, the clamping mechanism **2404** is designed to apply a compression force to the clamping body **2402**. In the configuration shown in FIGs. 24a-b, the clamping mechanism **2404** compresses the upper **2410** and lower portions **2412** of the clamping body **2402** towards each other, reducing the diameter of the cable hole **2406** and clamping a surgical cable within the cable hole **2406**. When the

clamping mechanism **2404** is deactivated or otherwise not in use, the clamping mechanism **2404** does not apply a compression force to the clamping body **2402**, and the diameter of the cable hole **2406** returns to a normal, unreduced size or position.

FIGs. 25a-b illustrate another embodiment of a surgical cable clamp in accordance with the invention. FIG. 25a is a perspective exploded view of a surgical cable clamp; and FIG. 25b is a cross-sectional view of the surgical cable clamp shown in FIG. 25a. The embodiment of a surgical cable clamp **2500** shown here includes a clamping body **2502**, and a clamping mechanism **2504**. The clamping body **2502** has a generally block-shaped configuration with a circular-shaped recess **2506** in the upper surface, while the clamping nut **2504** is disc shaped to correspondingly fit within the recess **2506** of the clamping body **2502**. Typically, the clamping mechanism **2504** is threaded to fit corresponding threads machined in the lateral sides **2508** of the recess **2506**. When the clamping body **2502** and the clamping mechanism **2504** are aligned, the clamping mechanism **2504** mounts to the clamping body **2502** with preferably a quarter radial turn of the clamping mechanism **2504** with respect to the clamping body **2502**. Other embodiments can provide additional or less threading to secure the clamping mechanism **2504** to the clamping body **2502** using less than or greater than a quarter radial turn. One or more cable holes **2510** are machined in a lateral side **2512** of the clamping body **2502**. Each cable hole **2510** extends along and through a portion of the recess **2506** within the clamping body **2502**, and through to the opposing lateral side of the clamping body **2502**.

When an orthopedic surgical cable **2514** is inserted within the cable hole **2510** as shown, the clamping body **2502** can then be fit together with the clamping mechanism **2504**. The clamping mechanism **2504** is secured to the clamping body **2502** by threading the clamping mechanism **2504** into the recess **2506**. The compression force of the clamping mechanism **2504** upon the surgical cable **2514** secures the position of the cable **2514** relative to the clamping body **2502**. By tightening and untightening the

clamping mechanism **2504**, the surgical cable clamp **2500** can clamp and unclamp the orthopedic surgical cable **2514** as needed when tensioning the orthopedic surgical cable as desired. A series of grooves (not shown) or ridges can be machined along and within the cable hole **2510** and/or the opposing side of the clamping mechanism **2504** to increase the friction or grip on the surgical cable.

FIGs. 26-28 illustrate a surgical cable clamp in accordance with various embodiments of the invention. FIG. 26 is a perspective view of a structure of a surgical cable clamp in accordance with various embodiments of the invention. The cable clamp **2600** includes a clamping body **2602**, a clamping mechanism **2604**, and a force application member **2606**. A preferred environment for the cable clamp **2600** is a portion of a patient's body such as a bone **2608** in conjunction with an orthopedic surgical cable **2610** for use in a surgical procedure. Typically, the orthopedic surgical cable **2610** is adapted to be installed relative to a bone in a patient, in order to apply a force to the bone. The force applied to the bone or portion of a patient's body can be tension or compression. In the embodiment shown here, the force applied to the patient's bone is compression. Similar to other embodiments of the invention described above, the surgical cable clamp **2600** can be a stand alone-type clamp for securing the position of an orthopedic surgical cable **2610** relative to a portion of a patient's body such as a patient's bone **2610**. Alternatively, an embodiment of the surgical cable clamp **2600** can also be a device-incorporated clamp, similar to the embodiment shown in FIGs. 4a-b, for securing the position of an orthopedic surgical cable **2610** relative to a portion of a prefabricated orthopedic device such as a trochanteric grip and a patient's bone **2610**. The device-incorporated clamp utilizes a portion of the trochanteric grip or other prefabricated orthopedic device for clamping the orthopedic surgical cable **2610**.

In many embodiments, one or more orthopedic surgical cables **2610** can be utilized to secure a prefabricated orthopedic device such as a trochanteric grip into a position relative to an end of a patient's bone **2608**.

When a force is applied to a surgical cable clamp **2600**, the surgical cable clamp **2600** compresses the orthopedic surgical cable **2610**, thus securing the orthopedic surgical cable **2610** into a position relative to the prefabricated orthopedic device such as a trochanteric grip and patient's bone.

If necessary, the orthopedic surgical cable **2610** can be loosened or otherwise retensioned by applying another force to the surgical cable clamp **2600** to relieve the compression force on the orthopedic surgical cable **2610** applied by the surgical cable clamp **2600**. The orthopedic surgical cable **2610** can then be retensioned by hand or by way of a tensioning device (not shown) so that the orthopedic surgical cable **2610** is at a desired tension or position. Yet another force can then be applied to the surgical cable clamp **2600** to create another compression force on the orthopedic surgical cable **2610** which can then maintain the desired tension or position of the orthopedic surgical cable **2610**. Depending upon the location of the orthopedic surgical cable **2610** relative to the prefabricated orthopedic device such as a trochanteric grip and the patient's bone **2610**, either and/or both the stand alone-type clamp or the device-incorporated clamp may be used to secure the position and tension of the orthopedic surgical cable **2610** as shown.

The surgical cable clamp **2600** shown in FIGs. 26-29 also provides clamping and reclamping of an orthopedic surgical cable without twisting or nonalignment of the clamp **2600** relative to the orthopedic surgical cable. As described in greater detail below, orientation of the orthopedic surgical cable with respect to the clamp **2600** permits the orthopedic surgical cable to be gripped by the clamp **2600** and the cable tensioned without causing twisting or nonalignment of the clamp **2600** relative to the orthopedic surgical cable. Furthermore, orientation of the orthopedic surgical cable with respect to the clamp **2600** permits the orthopedic surgical cable to be subsequently tensioned and secured by the clamp **2600** at a second tension without loss of tension due to twisting or nonalignment of the clamp **2600** relative to the orthopedic surgical cable.

FIG. 27 is an exploded perspective view of the surgical cable clamp shown in FIG. 26. FIG. 28 is a cross-sectional side view of the surgical cable clamp shown in FIG. 26. Generally, the clamping body **2602** is adapted to restrain a first portion of the orthopedic surgical cable **2610** to the clamping body **2602**. The clamping body **2602** includes a cable channel **2612** in an upper surface **2614**, an opposing lower surface **2616**, a threaded force application member receiving hole **2618**, a cable hole **2620**, and a groove **2622** in a side surface **2624**. The cable channel **2612** includes at least one ridge **2626** that can grip a portion of an associated orthopedic surgical cable **2608** between the clamping body **2602** and clamping mechanism **2604**. The opposing lower surface **2616** mounts to a portion of a patient's body such as a bone **2608**.

Typically, the clamping mechanism **2604** is adapted to cooperate with the clamping body **2602** to capture a second portion of the orthopedic surgical cable **2610** between the clamping mechanism **2604** and the clamping body **2602**. The clamping mechanism **2604** includes a cable channel **2628** in a lower surface **2630**, a force application member receiving hole **2632**, and an arm **2634** adapted to engage the groove **2622** in the side surface **2624** of the clamping body **2602**. The clamping body **2602** and clamping mechanism **2604** correspondingly fit together so that the arm **2634** of the clamping mechanism **2604** engages the groove **2622** in the side surface **2624** of the clamping body **2602**, and the cable channels **2612, 2628** of the respective clamping body **2602** and clamping mechanism **2604** correspondingly mate together to accommodate a portion of the orthopedic surgical cable **2610** between the clamping body **2602** and clamping mechanism **2604**. The cable channel **2628** includes at least one ridge (not shown) similar to ridge **2626** that can grip a portion of an associated orthopedic surgical cable **2610** between the clamping body **2602** and clamping mechanism **2604**.

Note that in some embodiments in accordance with the invention, the clamping body **2602** and clamping mechanism **2604** can be integrated into a single piece similar to that shown in FIGs. 1B and 1C. In other

embodiments, the clamping body **2602** may be incorporated into an orthopedic device such as a bone plate or trochanteric grip similar to those shown in FIGs. 1B and 1C. Alternatively, the clamping mechanism **2604** may be incorporated into an orthopedic device such as a bone plate or trochanteric grip similar to those shown in FIGs. 1B and 1C.

The force application member **2606** connects to the clamping body **2602** and clamping mechanism **2604**. Generally, the force application member **2606** is adapted to be rotated or otherwise manipulated in order to force the clamping body **2602** and clamping mechanism **2604** to grip the second portion of the orthopedic surgical cable **2610** in a manner whereby the force and consequent gripping are subject to gradual control by rotation or manipulation of the force application member **2606** and the gripping does not cause twisting or nonalignment of the clamp **2600** relative to the orthopedic surgical cable **2610.** For example, the force application member **2606** can be adapted to force the clamping body **2602** and clamping mechanism **2604** towards each other. Alternatively, the force application member **2606** can be adapted to force the clamping body **2602** and clamping mechanism **2604** apart or away from each other.

The force application member **2606** shown in this embodiment includes a threaded portion **2636** along a portion of the member **2606**. Other embodiments of a force application member in accordance with the invention can be threadless. The force application member receiving hole **2618** of the clamping body **2602** and the force application member receiving hole **2632** of the clamping mechanism **2604** can each include a respective threaded portion (not shown) that is adapted to receive the threaded portion **2636** of the force application member **2606**. The force application member **2606** connects to the respective force application member receiving holes **2618, 2632** of the clamping body **2602** and clamping mechanism **2604**. When rotated or otherwise manipulated, the force application member **2606** forces the clamping body **2602** and clamping mechanism **2604** to grip the portion of cable **2610** within the cable channels **2612, 2628** and between the clamping body **2602** and

clamping mechanism **2604**. Preferably, at least a portion of either or both of the receiving holes **2618, 2632** includes a threaded portion (not shown) adapted to permit the force application member **2606** to force the clamping body **2602** and clamping mechanism **2604** to grip the portion of cable **2610** within the cable channels **2612, 2628** and between the clamping body **2602** and clamping mechanism **2604**. In most embodiments, the orthopedic surgical cable **2610** and clamp **2600** are adapted to allow the orthopedic surgical cable **2610** to be tensioned and secured by the clamp **2600** at a first tension, and further adapted to allow the orthopedic surgical cable **2610** to be subsequently tensioned and secured by the clamp **2600** at a second tension without loss of tension due to twisting or nonalignment of the clamp **2600** relative to the orthopedic surgical cable **2610**.

In alternative embodiments, different configurations of a force application member can be used in lieu of the force application member **2606** shown in this embodiment. In alternative embodiments, a force application member is typically made from a material having elastic-like or shape-memory properties, such as nitinol, a memory metal, a material activated by temperature change or heat, a material activated by a force, a material activated by an electrical current, or a material activated by a magnetic force. Other metals, plastics, alloys, composites, or other materials can be used within a clamping mechanism to provide the desired effects. Examples of a force application member are similar to those disclosed in U.S. Patent Application Serial No. 10/230,040, the contents of which have incorporated herein by reference. Generally, the force application member connects to the clamping body **2602** and clamping mechanism **2604**. The force application member is adapted to be activated in order to force the clamping body **2602** and clamping mechanism **2604** to grip first and second portions of the orthopedic surgical cable **2610** in a manner whereby the force and consequent gripping are subject to gradual control by the force application member and the gripping does not cause twisting or nonalignment of the clamp **2600** relative to the orthopedic surgical cable **2610**.

FIGs. 29a-c illustrate a surgical procedure to use the cable clamp **2600** of FIGs. 26-28. The procedure illustrated in FIGs. 29a-c is similar to the procedure illustrated in FIGs. 3a-c. The particular embodiment shown in the sequence of FIGs. 29a-c utilizes a stand alone-type surgical cable clamp, shown in FIG. 26 as **2600**. Other embodiments of a surgical cable clamp **2600**, such as a device-incorporated surgical cable clamp, can be utilized with a method similar to that illustrated in FIGs. 5a-d.

In FIG. 29a, a surgical cable clamp **2700** in accordance with the invention is shown adjacent to an orthopedic device such as a trochanteric grip **2702**. The trochanteric grip **2702** is aligned with a proximal end of a patient's femur bone **2704** in accordance with a hip replacement procedure. When the trochanteric grip **2702** is to be secured to the patient's femur **2704**, the surgical cable clamp **2700** is positioned in a desired position adjacent to the trochanteric grip **2702** to receive an orthopedic surgical cable **2706**. Typically, the surgical cable clamp **2700** is preassembled prior to the sequence, and mounted relative to a bone in a patient's body. Similar to the cable clamp in FIGs. 26-28, the surgical cable clamp **2700** includes a clamping body **2708**, a force application member **2710**, and a clamping mechanism **2712**, and can be presassembled as described in FIGs. 26-28. A first portion of the orthopedic surgical cable **2706** is restrained relative to the clamping body **2702**. Typically, a relatively smaller diameter end **2714** of a predetermined length of surgical cable **2706** is inserted into and pulled through a first cable hole **2716** or channel of the surgical cable clamp **2700** formed by the assembly and alignment of the clamping body **2708** with the clamping mechanism **2712**. A bead **2718** on a relatively larger diameter end of the surgical cable **2706** restrains the relatively larger diameter end of surgical cable **2706** adjacent to the surgical cable clamp **2700** when the length of the surgical cable **2706** is pulled through the first cable hole **2716** or channel. Note that the bead **2718** can be preformed by severing or melting a portion of the cable with an arc, and forming the bead at the end of the cable while the severed or melted cable remains hot. This

procedure provides a bead of consistent size and placement relative to the centerline of the cable. Other shapes or configurations of a bead, such as a fitting, can be utilized in accordance with various embodiments of the invention.

As shown in FIG. 29b, the relatively smaller diameter end **2714** of the surgical cable **2706** is inserted through a cable hole **2720** or channel in the trochanteric grip **2702** and wrapped around the thickness of the patient's femur **2704**. When the relatively smaller diameter end **2714** of the surgical cable **2706** is nearly around the patient's femur **2704**, the relatively smaller diameter end **2714** is inserted through a second cable hole **2722** or channel of the surgical cable clamp **2700**.

A second portion of the orthopedic surgical cable **2706** is captured between the clamping mechanism **2704** and the clamping body **2702**. As shown in FIGs. 29b-c, the relatively smaller diameter end **2714** of the surgical cable **2706** is manually pulled through the second cable hole **2722** or channel with a cable tensioning device (not shown) until a desired tension in the surgical cable **2706** is attained. The force application member **2710** is connected to the clamping body **2702** and the clamping mechanism **2704** via a series of respective force application member holes **2724, 2726** in each of the clamping body **2702** and the clamping mechanism **2704**. When the surgical cable **2706** is pulled to a desired tension, the force application member **2710** is tightened or otherwise rotated or manipulated in a first direction with a hexagonal-shaped tightening instrument (not shown) until the second portion of the orthopedic surgical cable **2706** is gripped between the clamping body **2702** and clamping mechanism **2704** so that the gripping is subject to gradual control by rotation or manipulation of the force application member **2710** and the gripping does not cause twisting or nonalignment of the clamp **2700** relative to the orthopedic surgical cable **2706**, thus creating a first tension in the orthopedic surgical cable **2700**. Any excess length of surgical cable can be trimmed with a cutting instrument (not shown).

In some instances, a cable tensioning device (not shown) can be used to tighten the surgical cable **2706** to a predetermined tension. A tightening instrument with a corresponding hexagonal-shaped head or driver such as a "T-handled driver" with a hex head to match the shape of the clamping bolt can then be used to tighten the force application member **2710** to a preset torque while measuring the tension on the surgical cable with the cable tensioning device as the force application member **2710** is tightened. A suitable cable tensioning device can be a device or system that applies a tension to a surgical cable, maintains the tension on the surgical cable until the tightening instrument can be used to tighten the clamping bolt of the surgical cable clamp, measures the tension in the surgical cable, and releases the surgical cable when the clamping bolt has secured the surgical cable.

If desired, the first tension in the orthopedic surgical cable **2706** can be released by rotating or manipulating the force application member in an opposing direction to the first direction so that the orthopedic surgical cable can be repositioned between the clamping mechanism and the clamping body. The second portion of the orthopedic surgical cable is gripped between the clamping body and clamping mechanism by rotating or manipulating the threaded force application member in the first direction so that consequent gripping is subject to gradual control by rotation or manipulation of the force application member and the gripping does not cause twisting or nonalignment of the clamp relative to the orthopedic surgical cable, thus creating a second tension in the orthopedic surgical cable.

More than one surgical cable **2706** may be needed to secure an orthopedic device such as a trochanteric grip **2702** or bone plate to a patient's femur **2704**. The above sequence can repeat as needed until the trochanteric grip or other orthopedic device is secured to the patient's femur or bone. After tensioning one or more surgical cables **2706** to the patient's femur with one or more corresponding surgical cable clamps **2700**, previously tensioned surgical cables may tend to loosen or otherwise require additional tension to

sufficiently secure the orthopedic device such as a trochanteric grip **2702** to the patient's femur **2704**.

If necessary, the tension on a previously tensioned surgical cable can be released by applying an untightening force to the force application member **2710** with the hexagonal-shaped tightening instrument, releasing the compression force between the clamping body **2708** and clamping mechanism **2712**, thus releasing the compression and tension on the surgical cable **2706**. The surgical cable **2706** is then retensioned manually or by use of the cable tensioning device. When the desired tension is reached, a tightening force is applied to the force application member **2710** in order to create a sufficient compression force between the clamping body **2708** and the clamping mechanism **2712** to maintain the desired tension in the surgical cable **2706**, and secure the position of the surgical cable **2706** relative to the surgical cable clamp **2700**.

Tensioning and retensioning of one or more surgical cables **2706** may occur more than once during a surgical procedure until all of the surgical cables **2706** are sufficiently tensioned to maintain the position of the surgical cables **2706**, bone plate and or trochanteric grip **2702** relative to the patient's femur **2704**. The sequence described above with respect to FIGs. 29a-c can be repeated as necessary to accomplish this.

Preferably, the surgical cable clamp **2700** illustrated in FIGs. 29a-c and in other figures can be preassembled prior to installation or use. Preassembly of a surgical cable clamp can include assembling component parts of the surgical cable clamp together with, or without, an orthopedic surgical cable so that a user such as a surgeon can rapidly install or use the surgical cable clamp. In many cases, preassembly of the surgical cable clamp with an orthopedic surgical cable saves time during a surgical procedure when installing or using the surgical cable clamp.

While the above description contains many specifics, these specifics should not be construed as limitations on the scope of the invention, but merely as exemplifications of the disclosed embodiments. Those skilled in

the art will envision many other possible variations that within the scope of the invention as defined by the claims appended hereto.

CLAIMS:

1. A combination of an orthopedic surgical cable and clamp, comprising:

an orthopedic surgical cable for installation relative to a bone in a patient, in order to apply a force to the bone;

the clamp having a clamping body for receiving a first portion of the orthopedic surgical cable; and a clamping mechanism for cooperating with the clamping body to capture a second portion of the orthopedic surgical cable between the clamping mechanism and the clamping body; and

a force application member connected to the clamping body and clamping mechanism for forcing the clamping body and clamping mechanism to grip the first and second portions of the orthopedic surgical cable in a manner whereby the force and consequent gripping are subject to gradual control by the force application member and for maintaining alignment of the clamp relative to the orthopedic surgical cable;

whereby the orthopedic surgical cable and clamp allow the orthopedic surgical cable to be tensioned and secured by the clamp at a first tension, and further allow the orthopedic surgical cable to be subsequently tensioned and secured by the clamp at a second tension without loss of tension due to nonalignment of the clamp relative to the orthopedic surgical cable.

2. The combination of claim 1, wherein:

the force applied by the orthopedic cable to the bone is compression.

3. The combination of claim 1, wherein:

the orthopedic surgical cable includes a larger end of the cable which is restrained by the cooperation of the clamping body and the clamping mechanism.

4. The combination of claim 3, wherein the larger end of the cable is a bead formed at an end of the cable.

5. The combination of claim 1, wherein:

the force application member is for forcing the clamping body and clamping mechanism towards each other.

6. The combination of claim 1, wherein:

the force application member is for forcing the clamping body and clamping mechanism apart from each other.

7. The combination of claim 1, wherein:

the clamping body and the clamping member are integrated into a single piece.

8. The combination of claim 1, wherein:

the clamping body is an orthopedic device which is a trochanteric grip or a bone plate.

9. The combination of claim 1, wherein:

the clamping member is an orthopedic device which is a trochanteric grip or a bone plate.

10. The combination of claim 1, wherein:

the force application member is an elastic member, a shape-memory member, a memory metal member, a heat activated member, a force activated member, an electrically-activated member, or a magnetically-activated member.

11. A combination of an orthopedic surgical cable and clamp, comprising:

an orthopedic surgical cable for installation relative to a bone in a patient, in order to apply a force to the bone;

the clamp having a clamping body for receiving a first portion of the orthopedic surgical cable; and a clamping mechanism for cooperating with the clamping body to capture a second portion of the orthopedic surgical cable between the clamping mechanism and the clamping body; and

a force application member connected to the clamping body and clamping mechanism for forcing the clamping body and clamping mechanism to grip the first and second portions of the orthopedic surgical cable in a manner whereby the force and consequent gripping are subject to gradual control by the force application member;

whereby the orthopedic surgical cable and clamp allow the orthopedic surgical cable to be tensioned and secured by the clamp at a first tension, and further allow the orthopedic surgical cable to be subsequently tensioned and secured by the clamp at a second tension.

12. The combination of claim 11, wherein:

the force applied by the orthopedic cable to the bone is tension.

13. The combination of claim 11, wherein:

the orthopedic surgical cable includes a larger end of the cable which is restrained by the cooperation of the clamping body and the clamping mechanism.

14. The combination of claim 13, wherein the larger end of the cable is a fitting mounted to an end of the cable.

15. The combination of claim 11, wherein:

the force application member is for forcing the clamping body and clamping mechanism towards each other.

16. The combination of claim 11, wherein:

the force application member is for forcing the clamping body and clamping mechanism apart from each other.

17. The combination of claim 11, wherein:

the clamping body and the clamping member are integrated into a single piece.

18. The combination of claim 11, wherein:

the clamping body is an orthopedic device which is a trochanteric grip or a bone plate.

19. The combination of claim 11, wherein:

the clamping member is an orthopedic device which is a trochanteric grip or a bone plate.

20. The combination of claim 11, wherein:

the force application member is an elastic member, a shape-memory member, a memory metal member, a heat activated member, a force activated member, an electrically-activated member, or a magnetically-activated member.

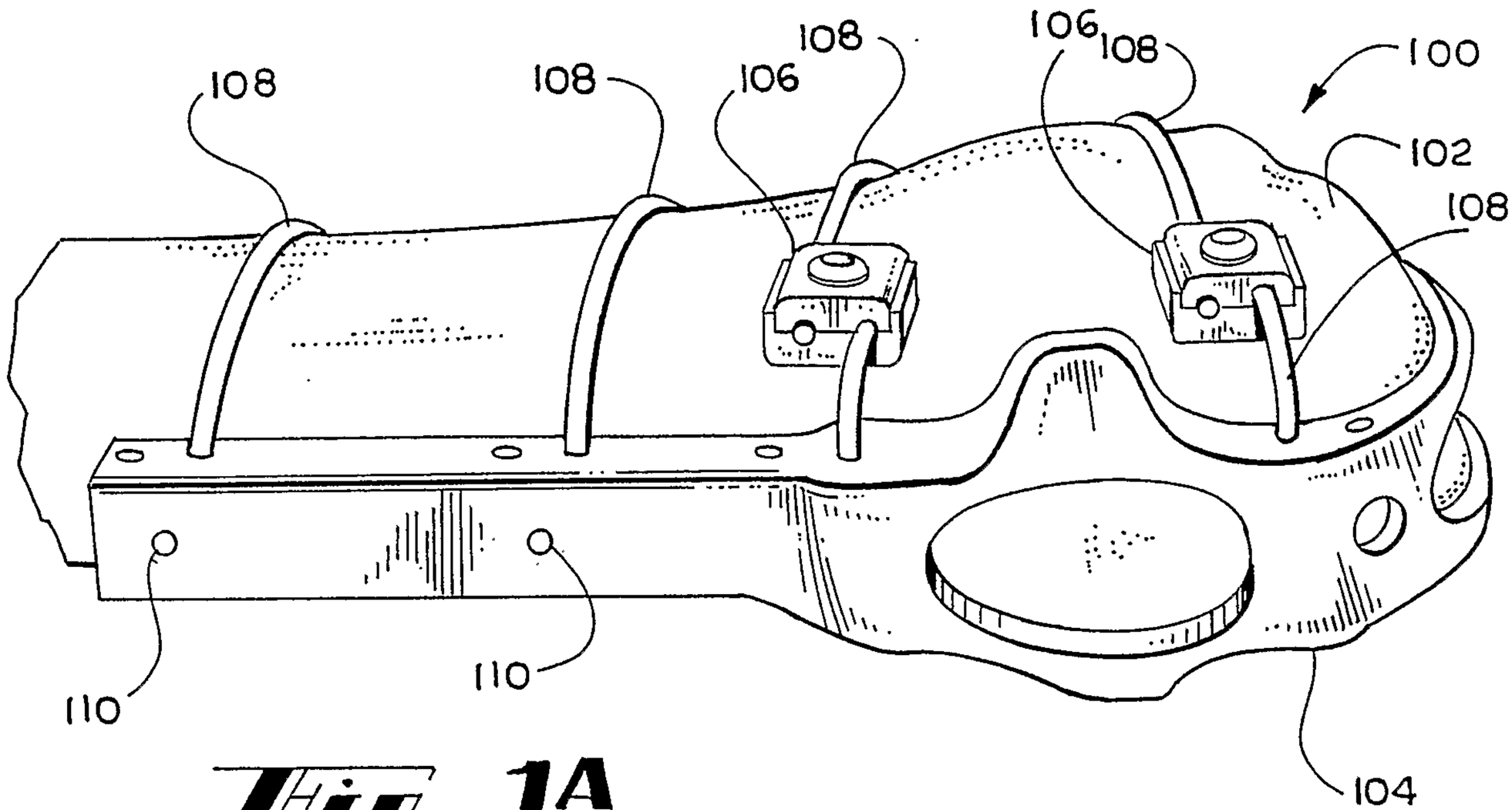


Fig_1A

Fig_6

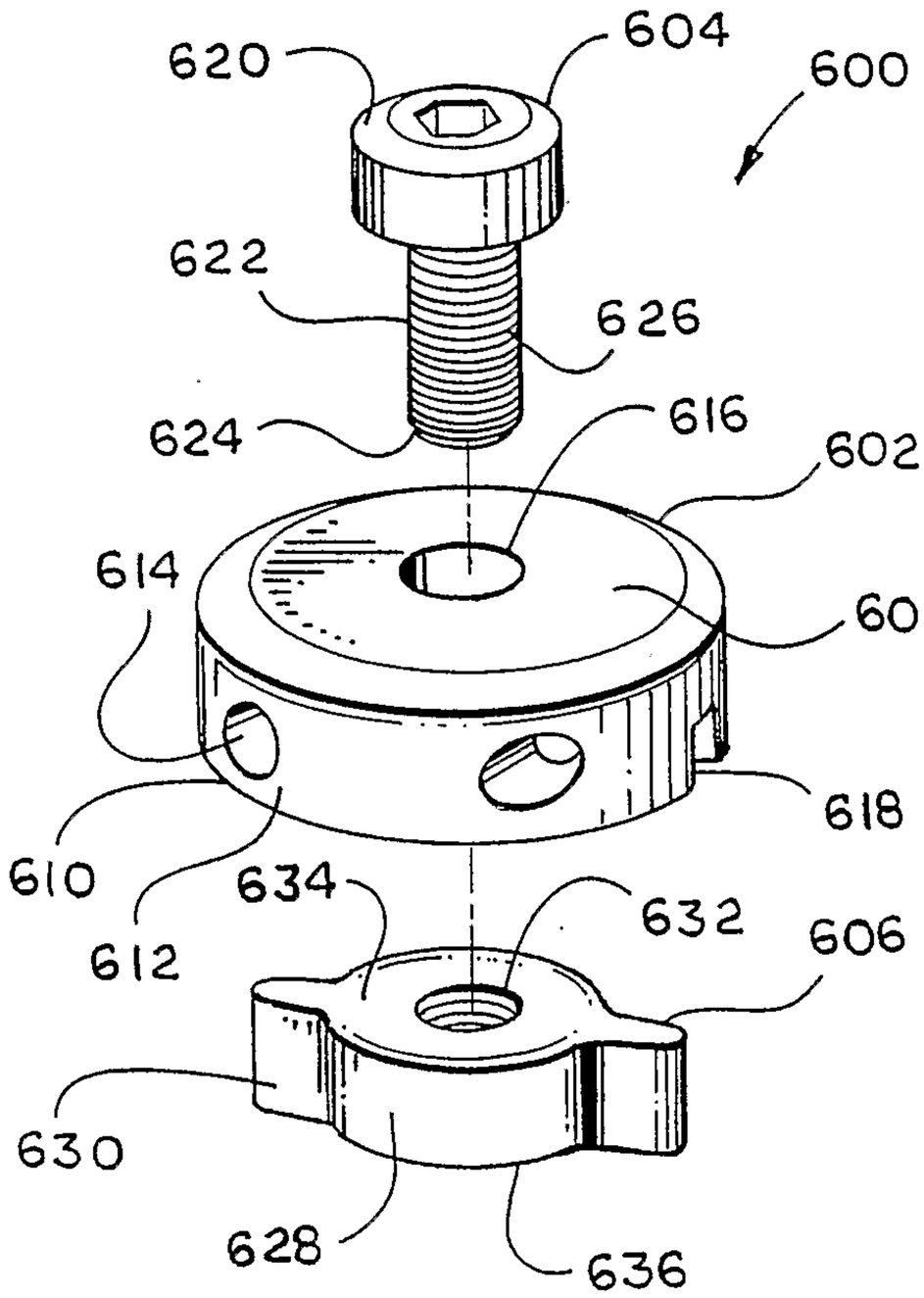
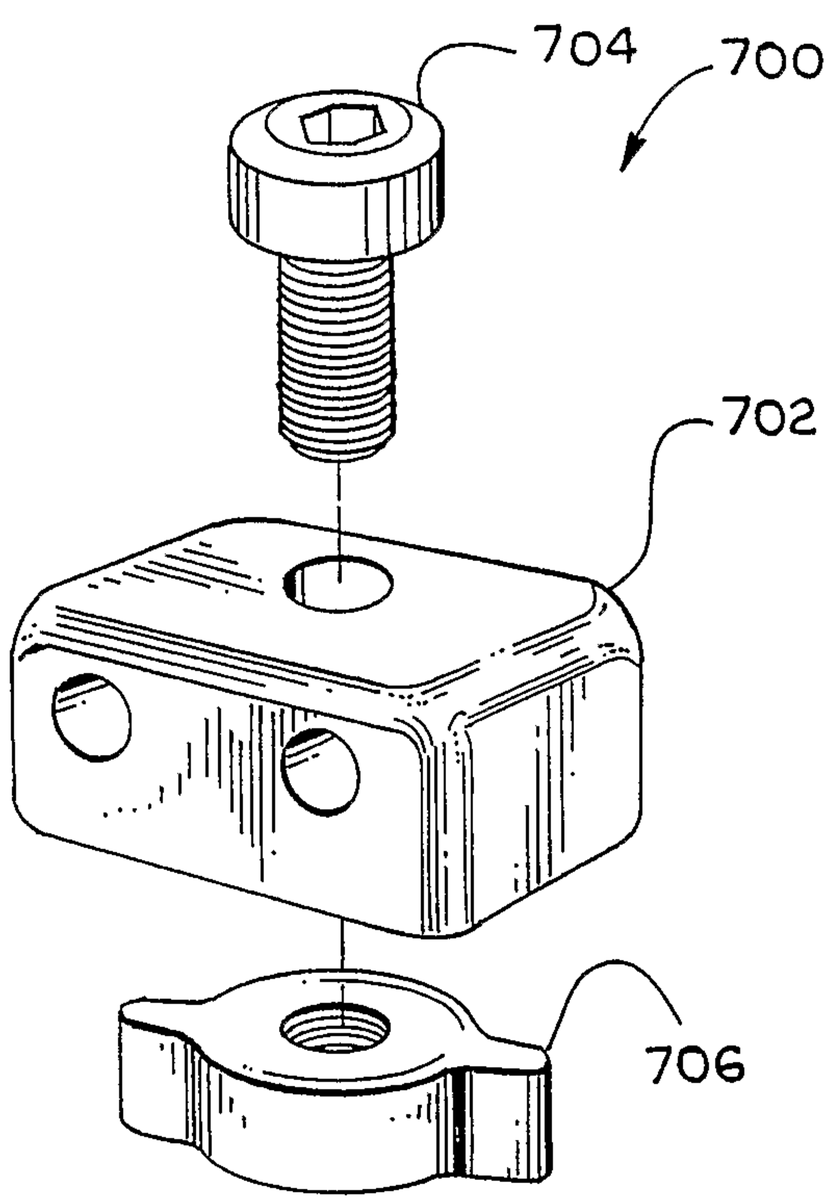


Fig_7



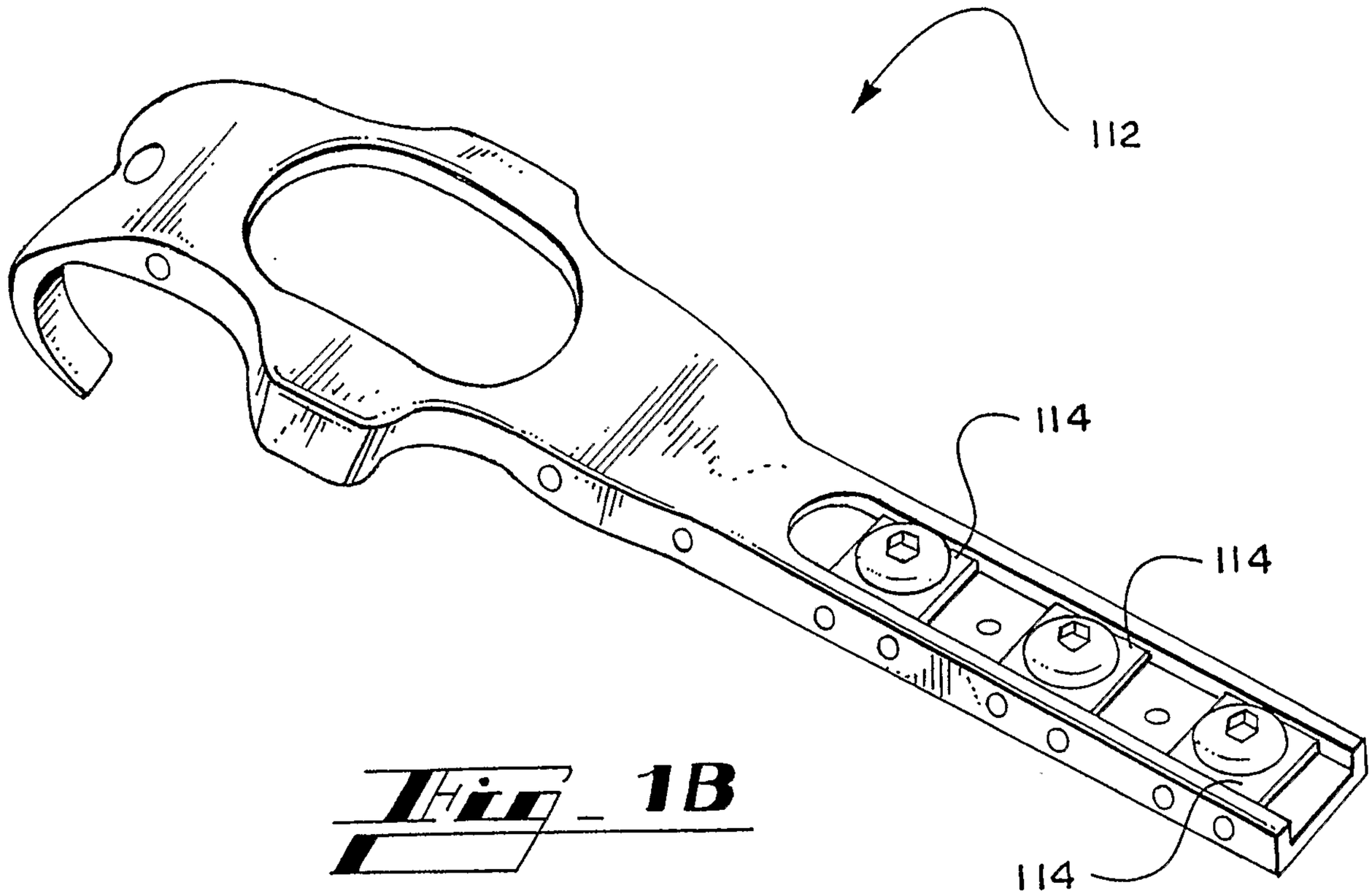


Fig_1B

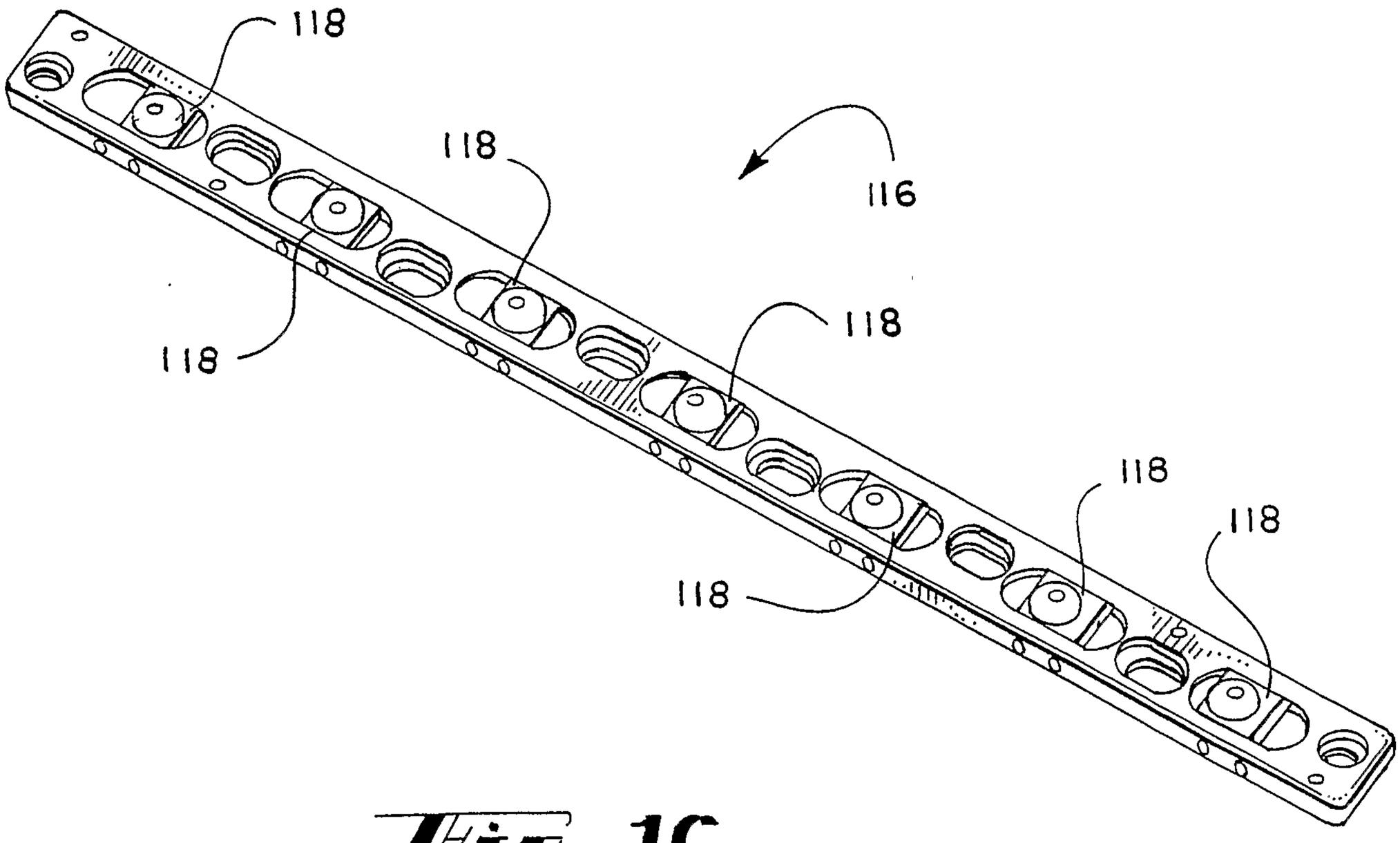


Fig_1C

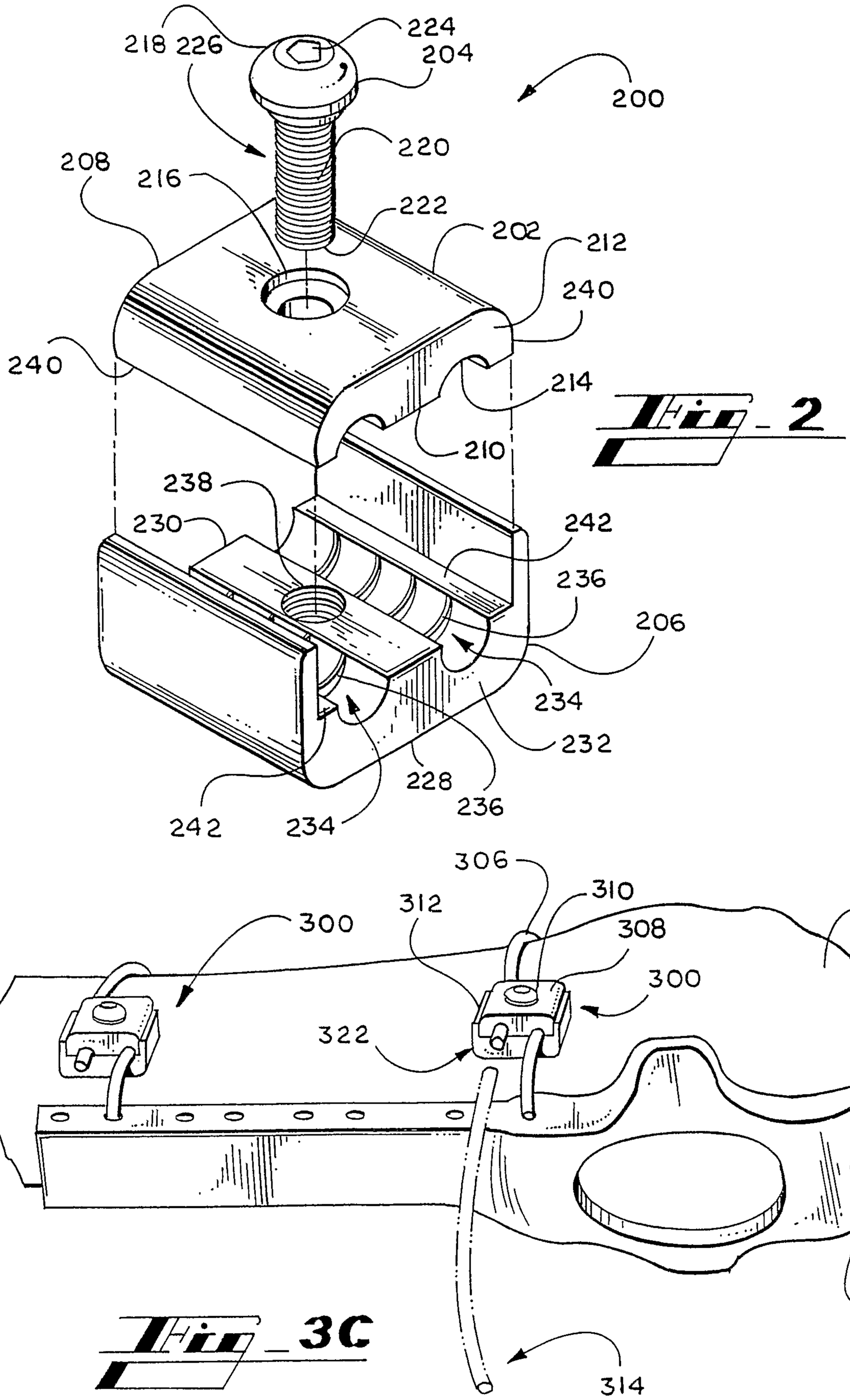

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Fig. 2

Fig. 3C

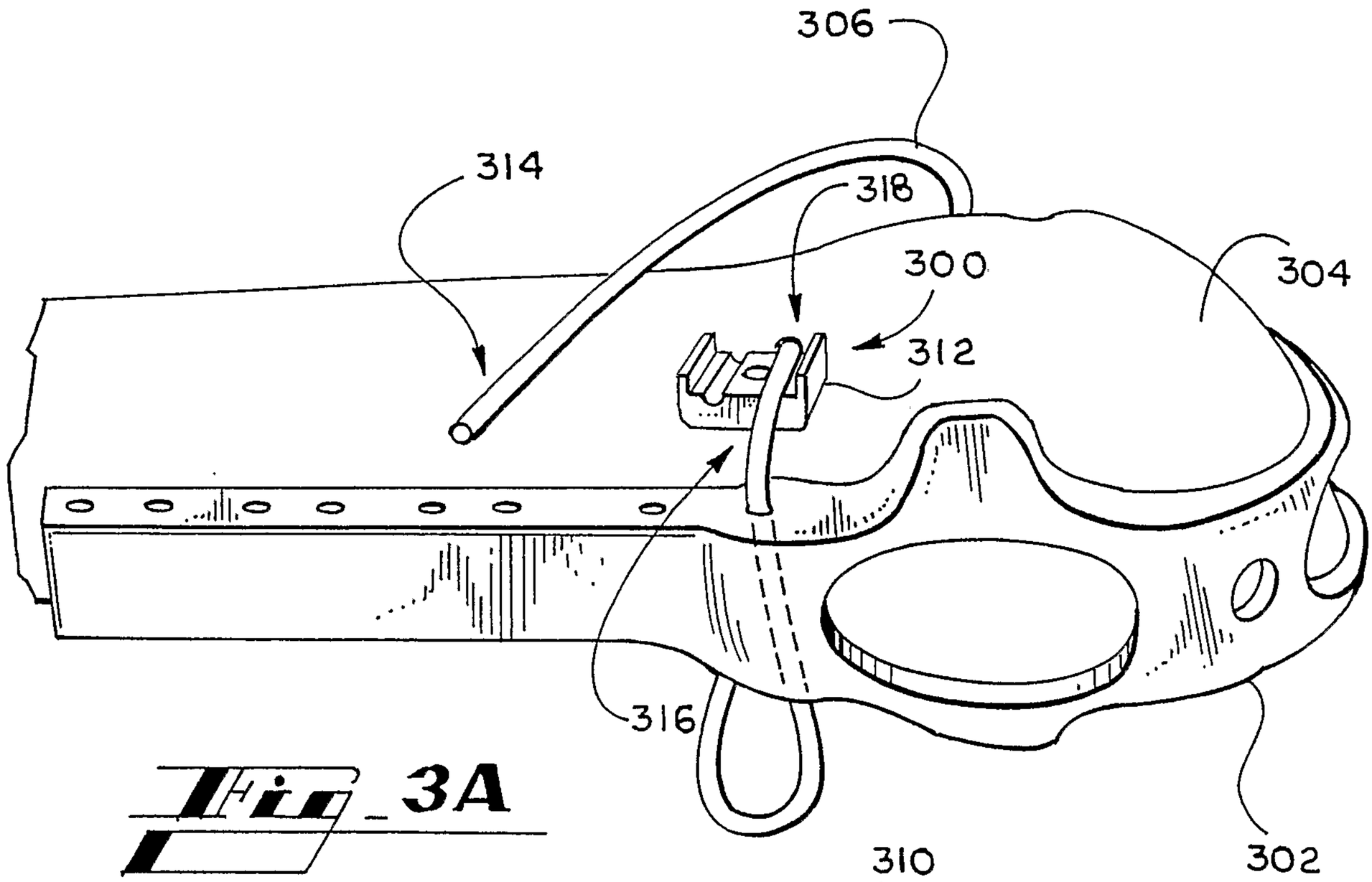
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Fig_3A

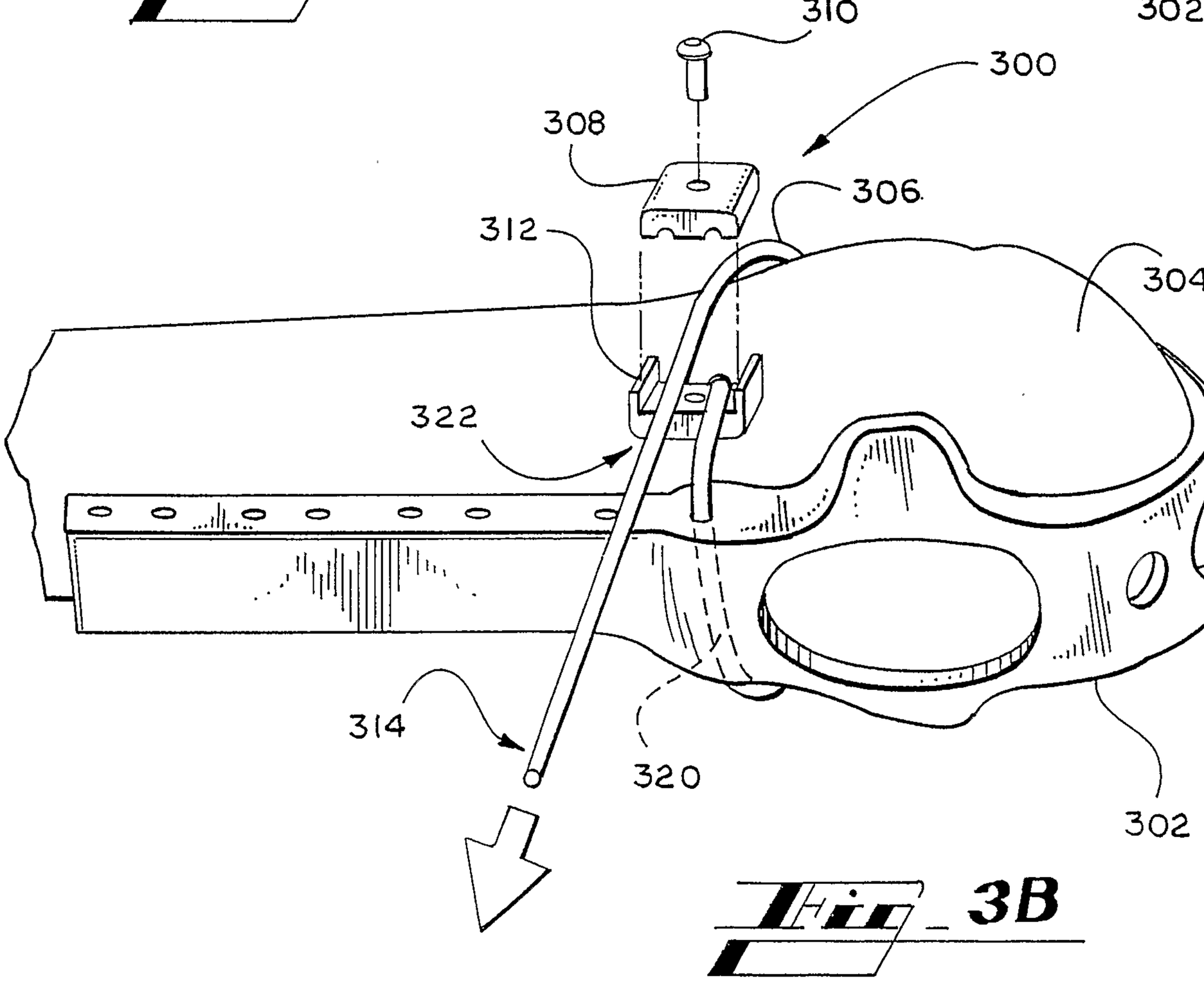
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Fig_3B

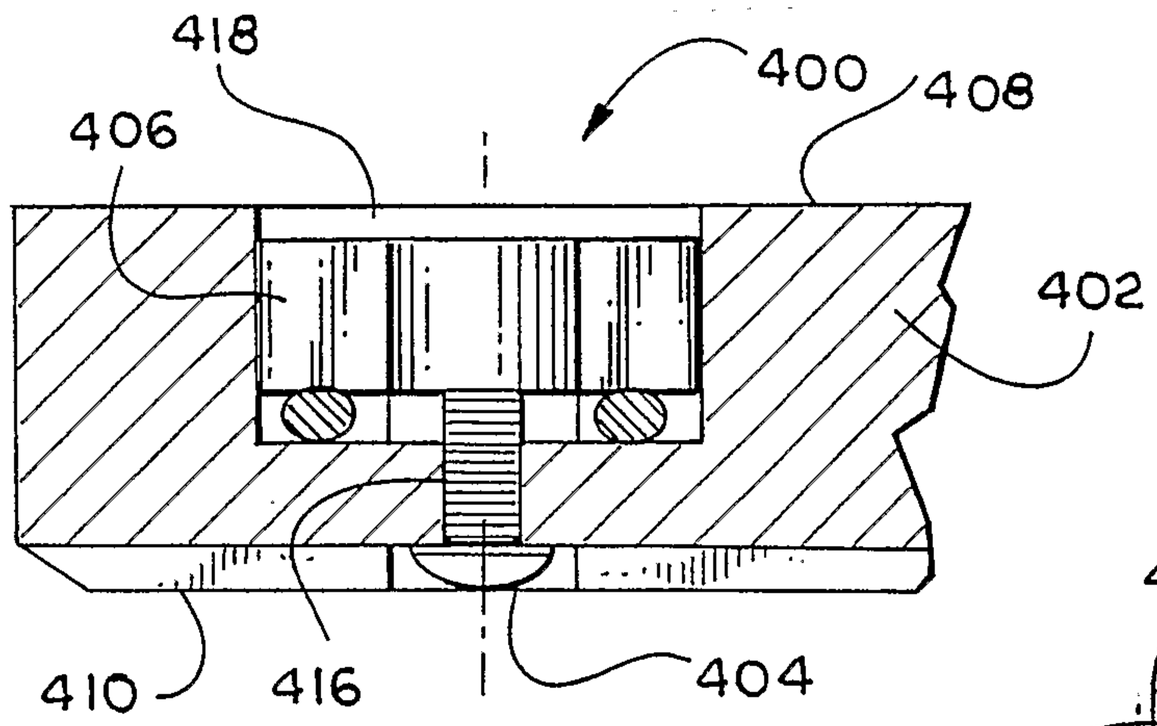

Fig_4B

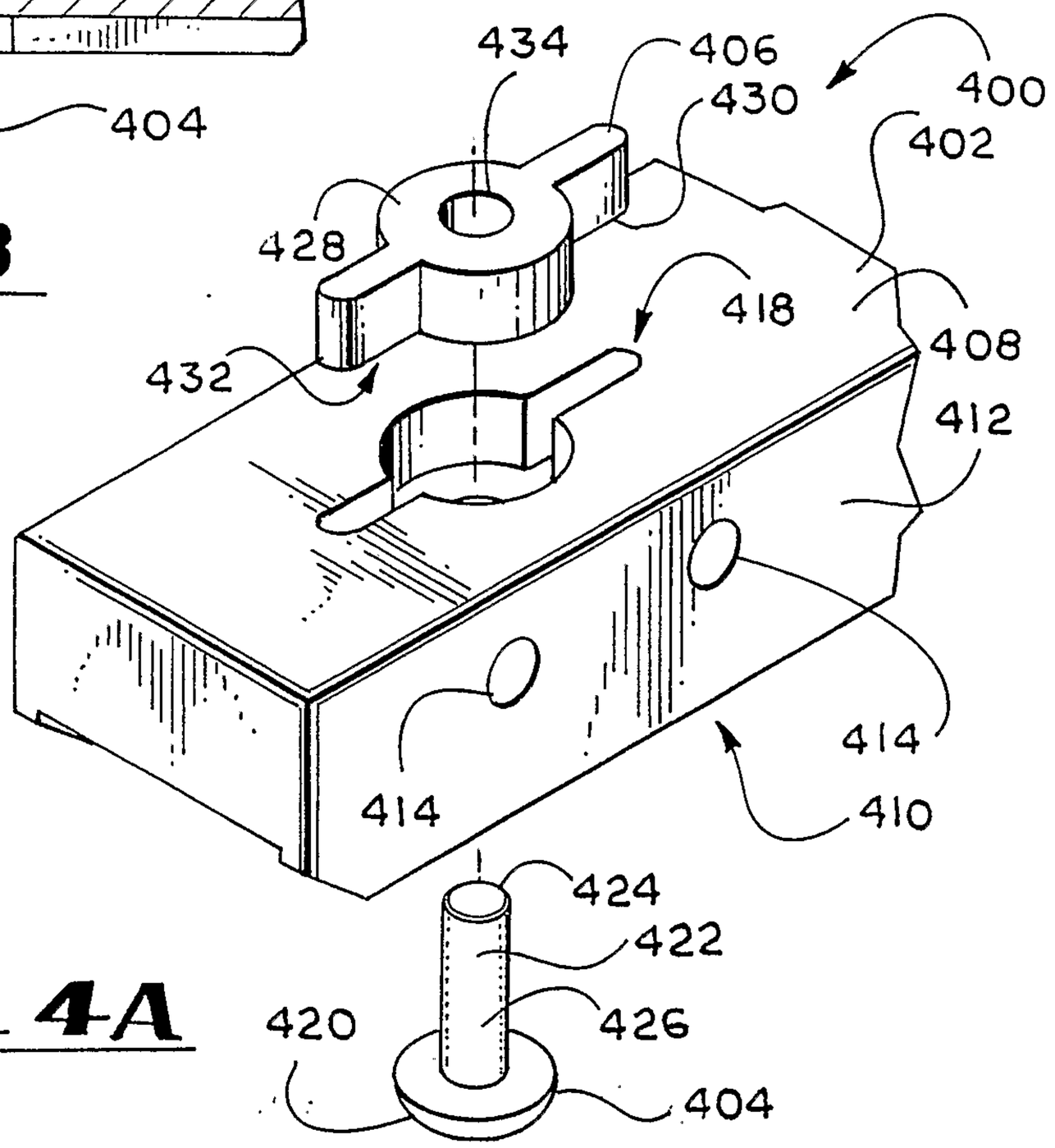

Fig_4A

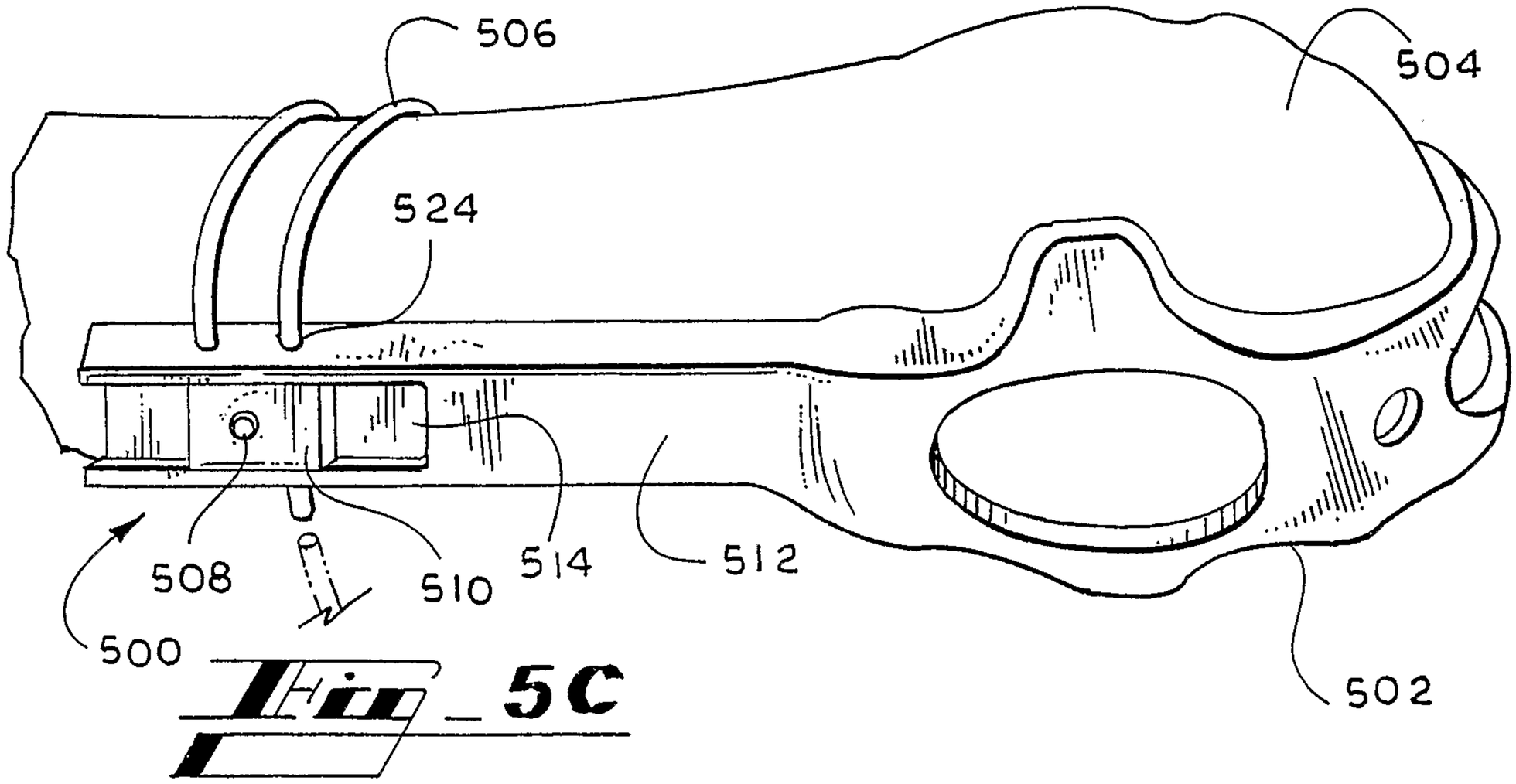

Fig_5C

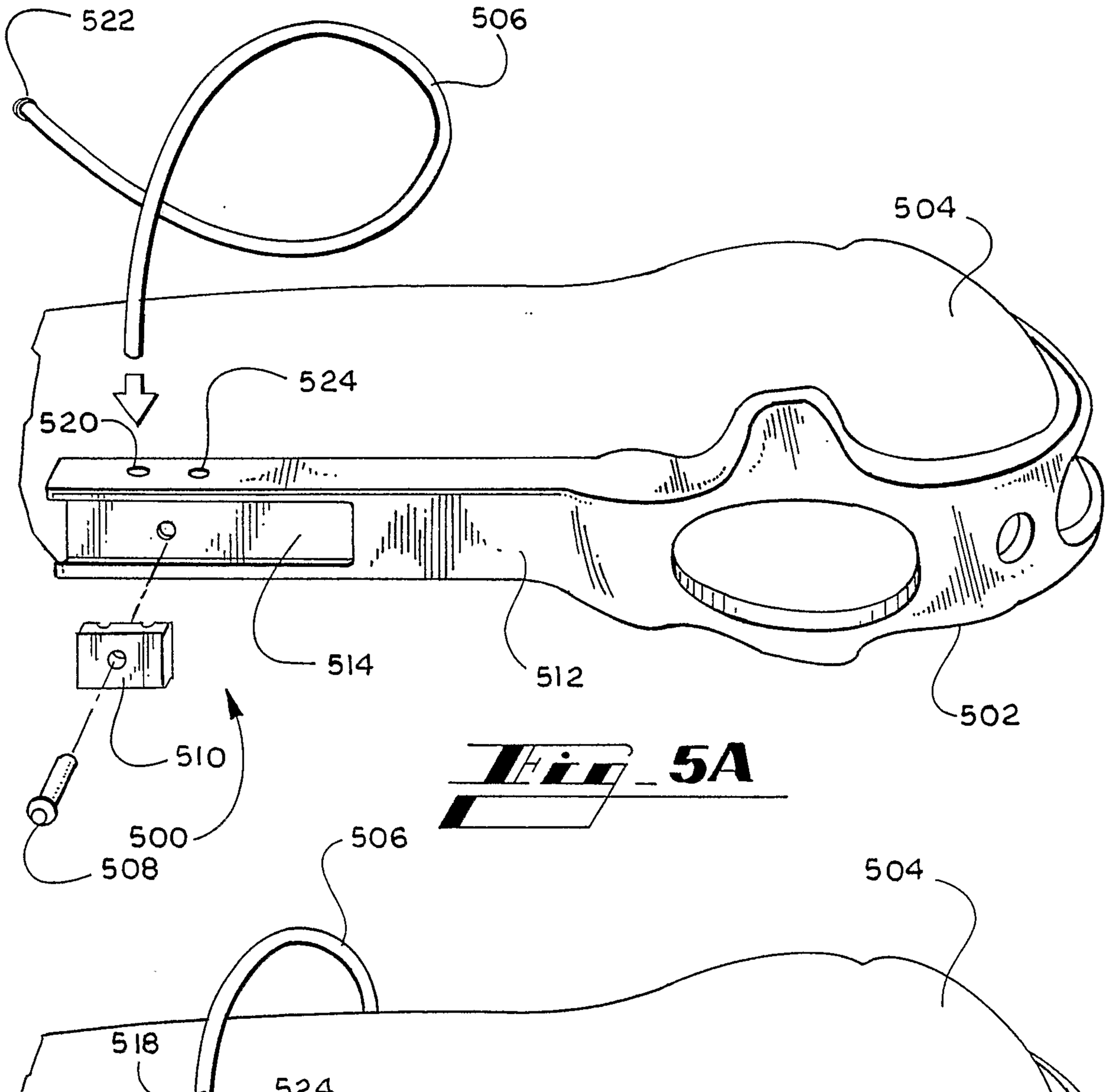
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Fig_5A

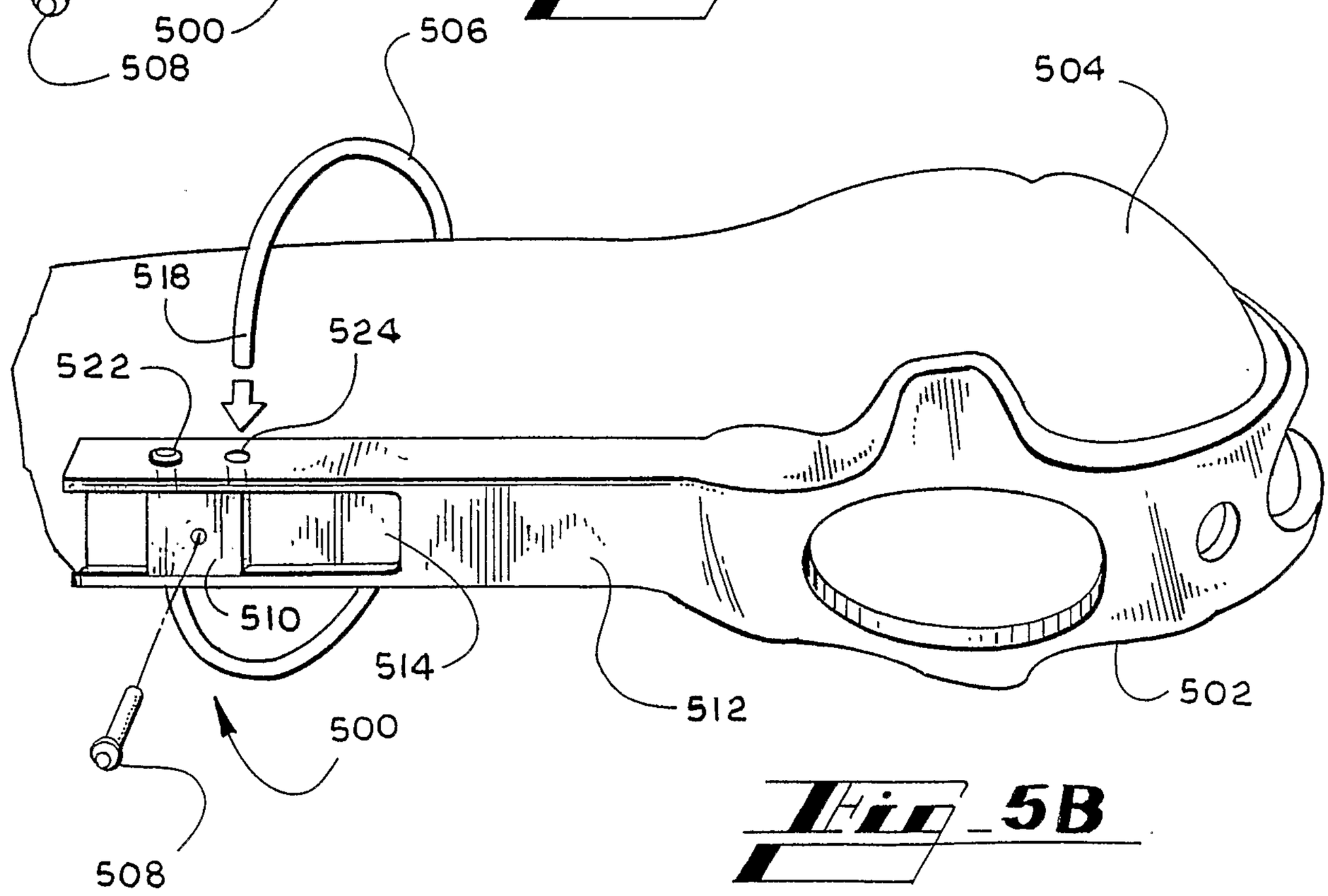
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Fig_5B

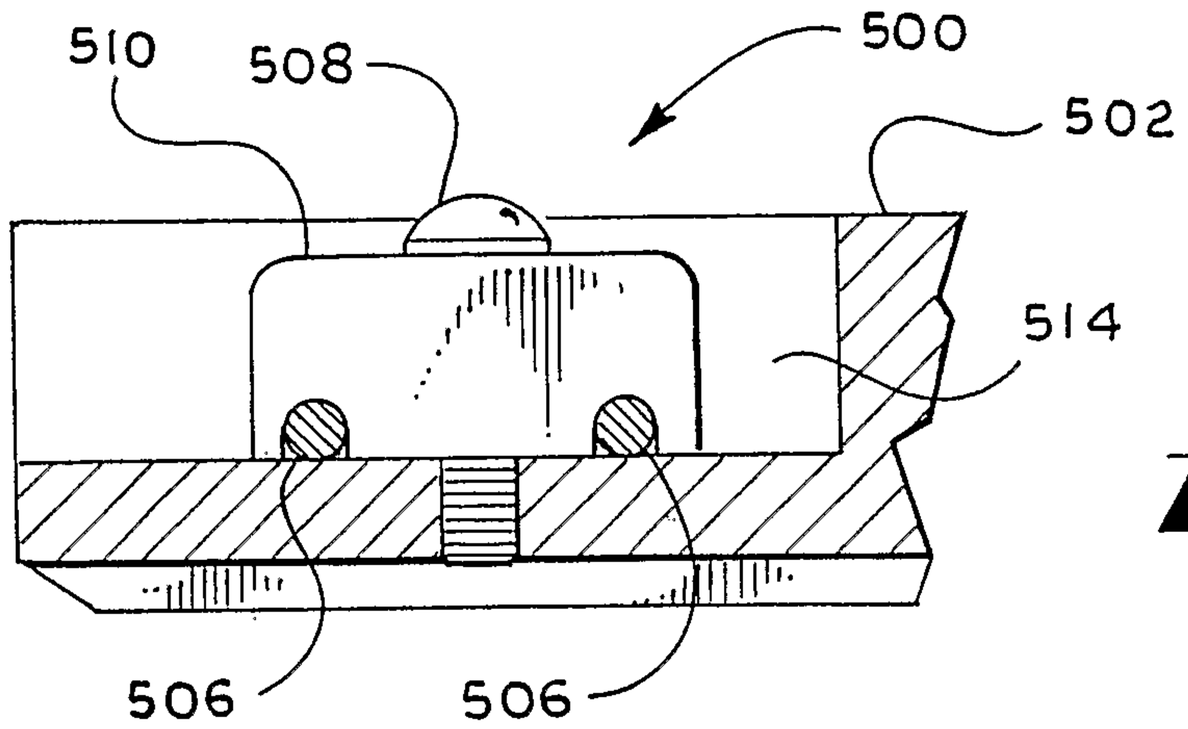


Fig_5D

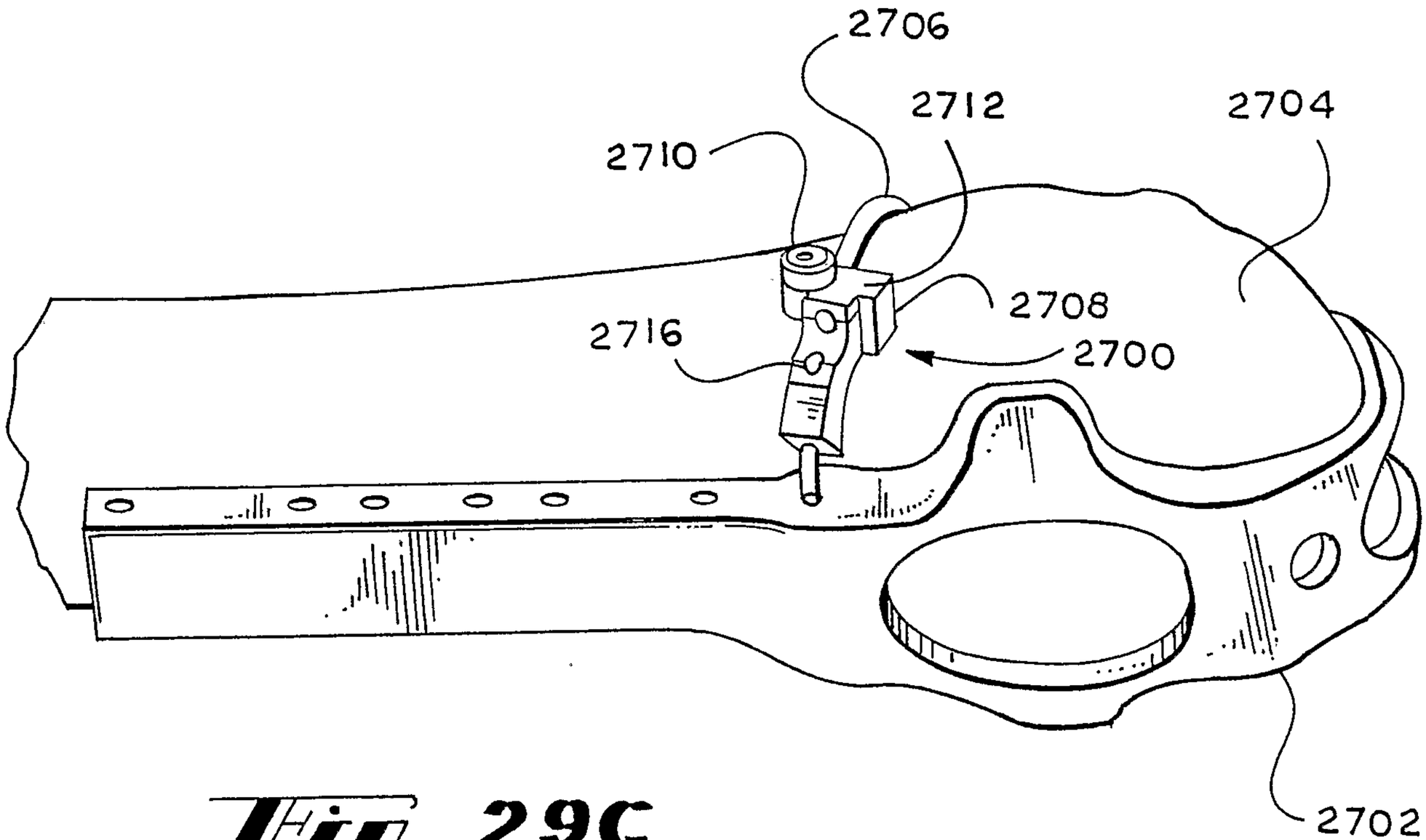


Fig_29C

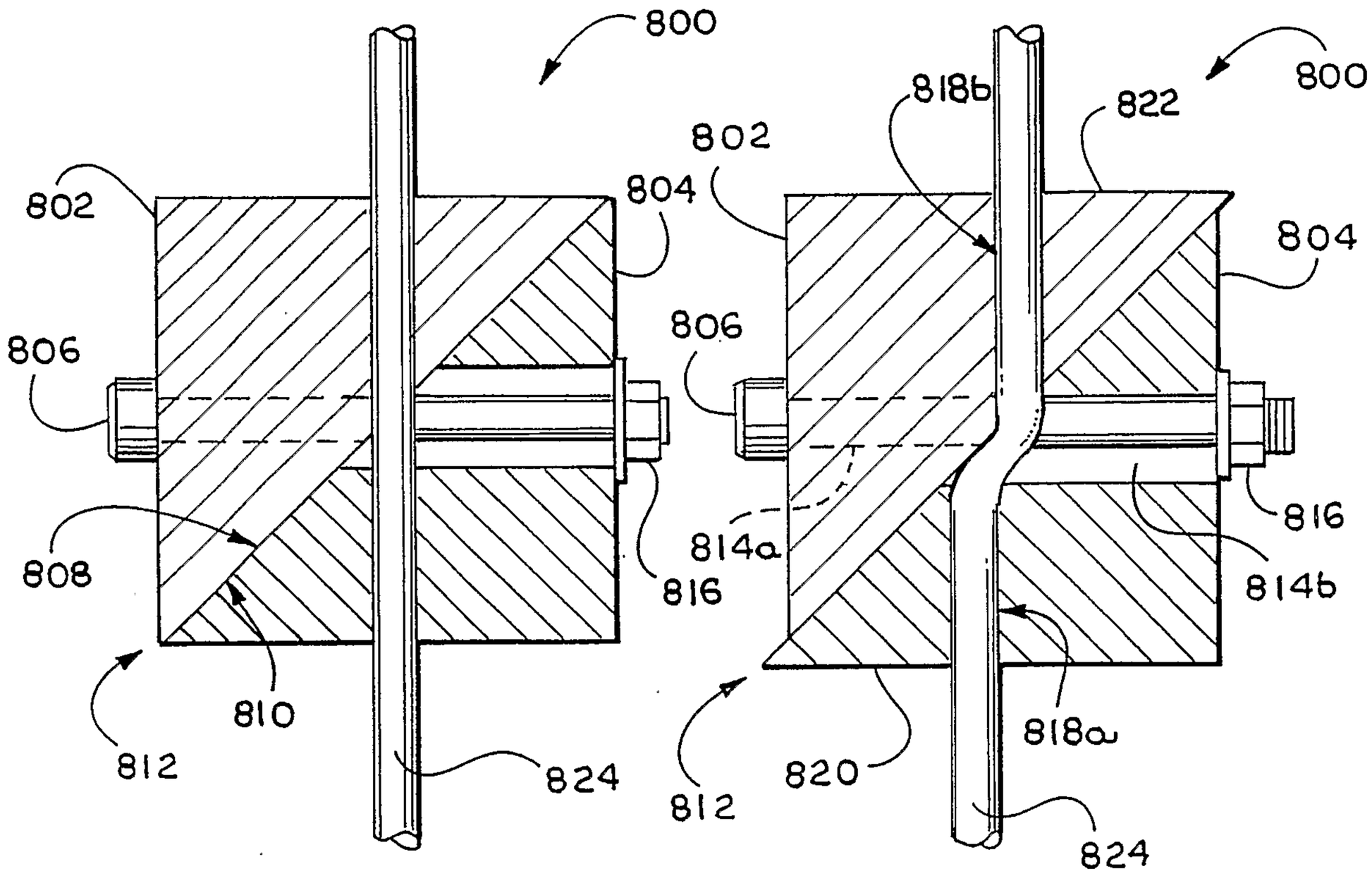
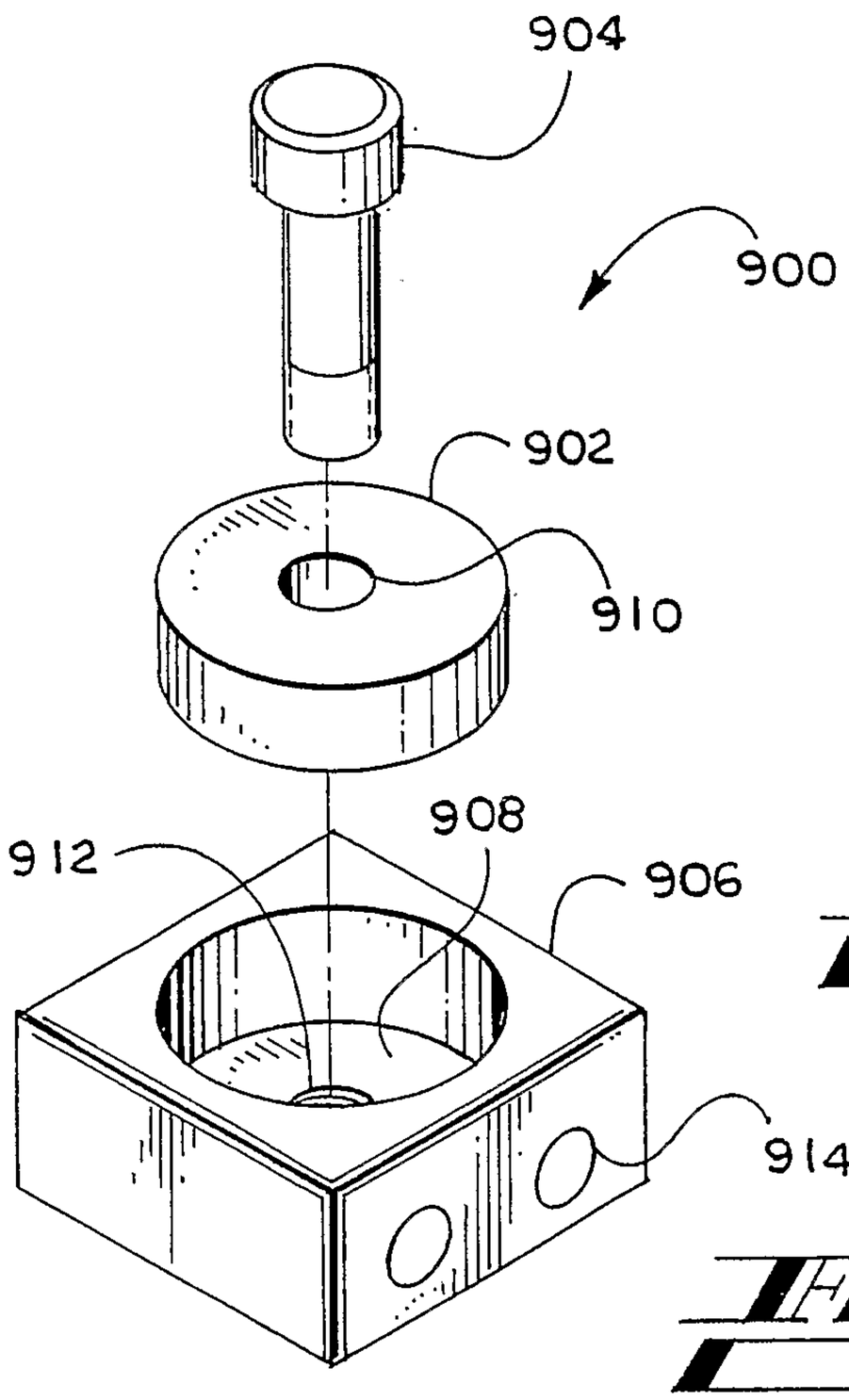


Fig_ 8A

Fig_ 8B



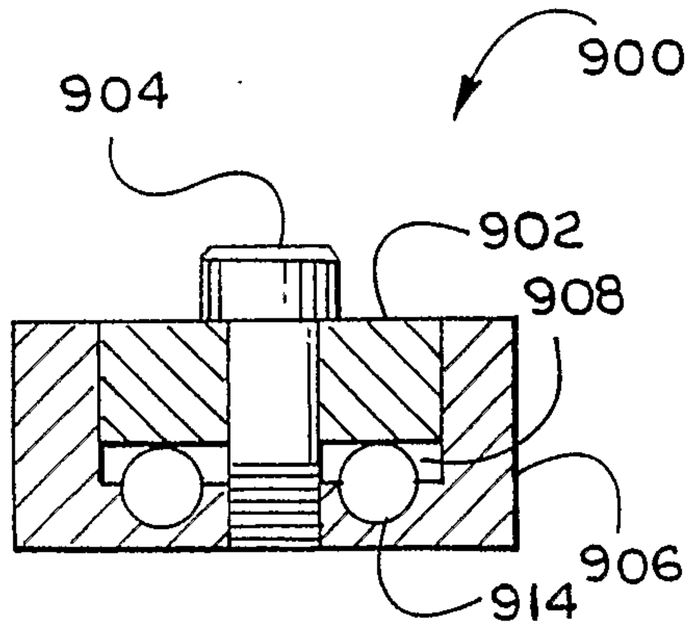


Fig_ 9B

Fig_ 9A

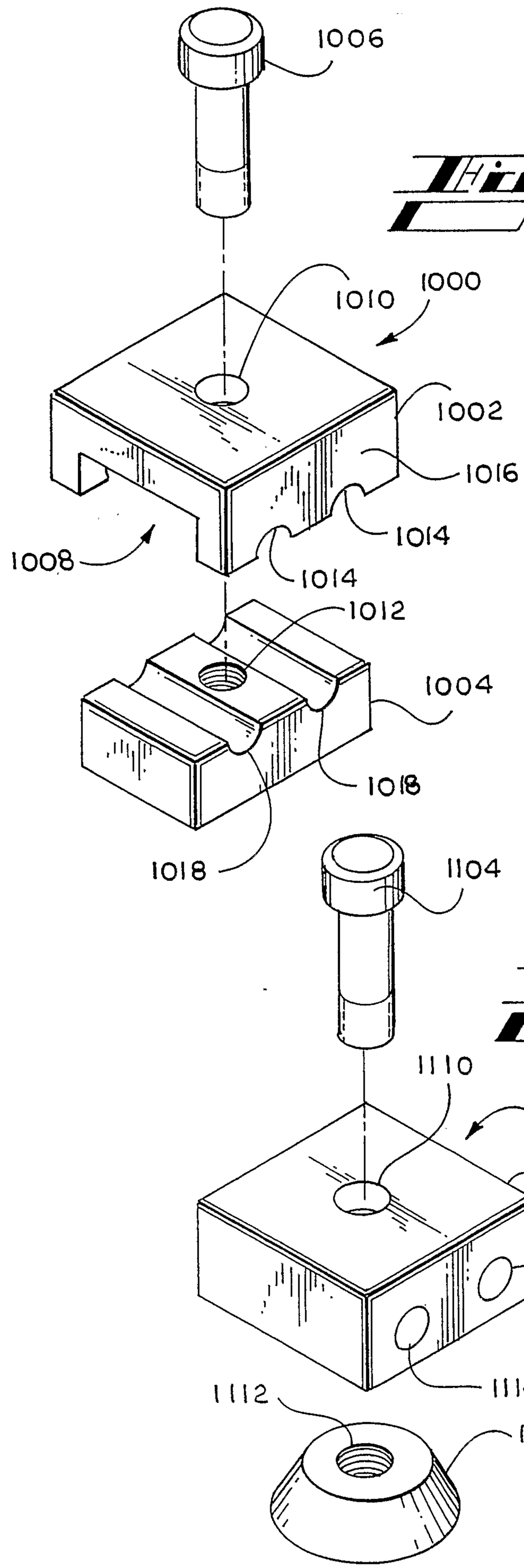


Fig_10A

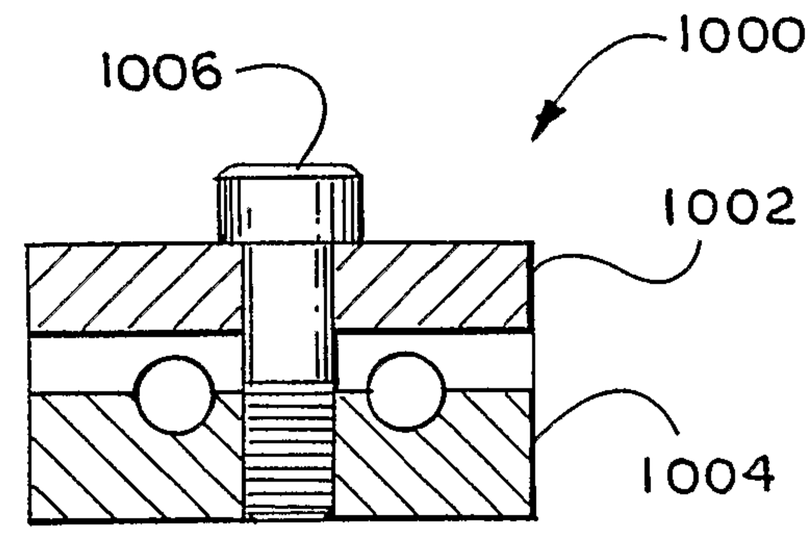


Fig_10B

Fig_11A

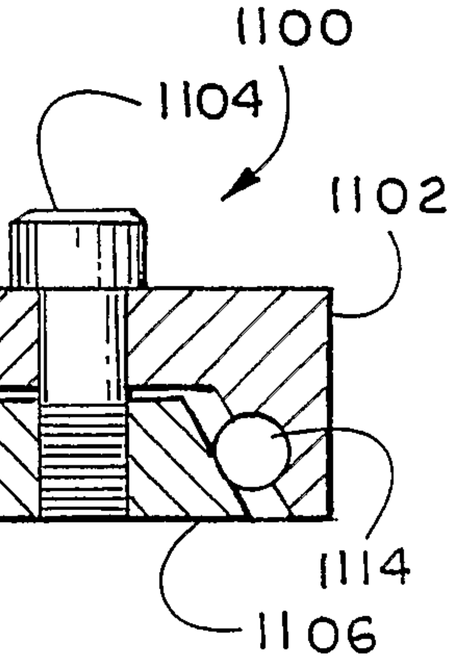


Fig_11B

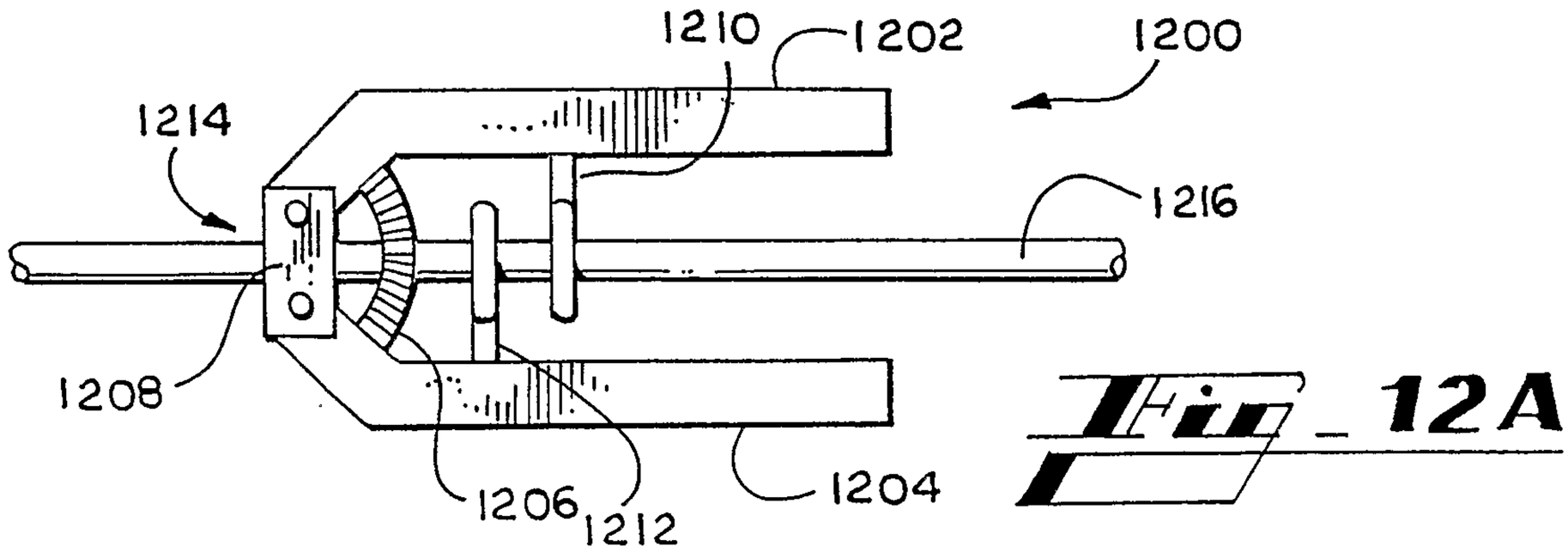


Fig_12A

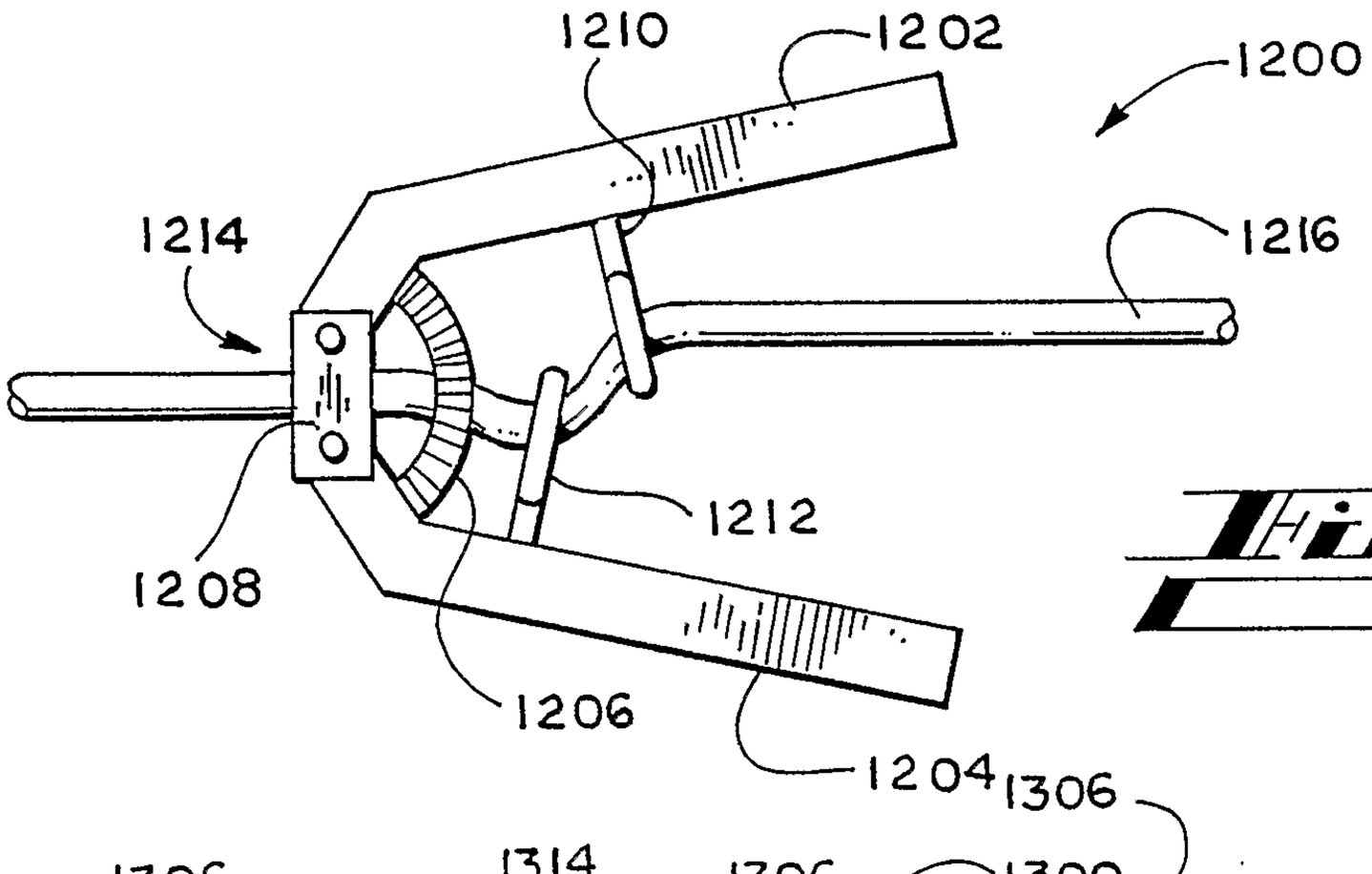


Fig_12B

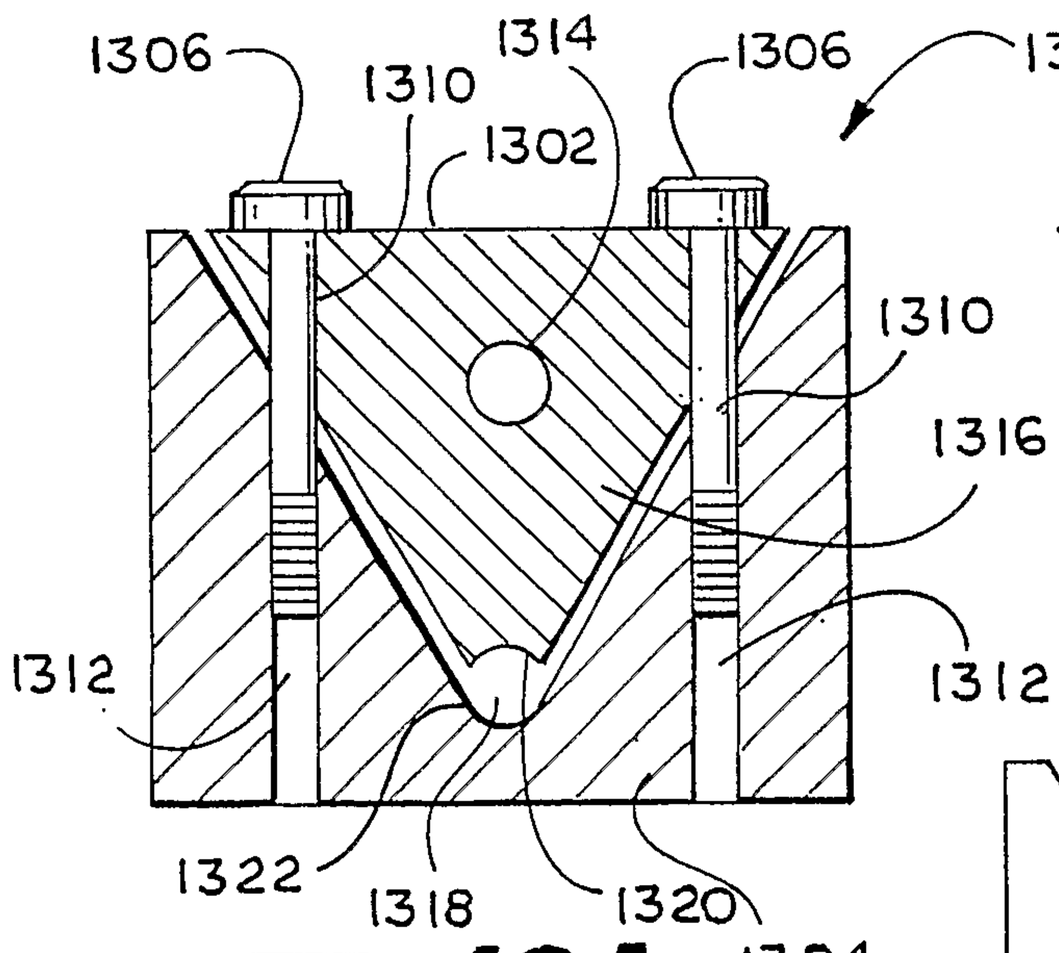


Fig_13A

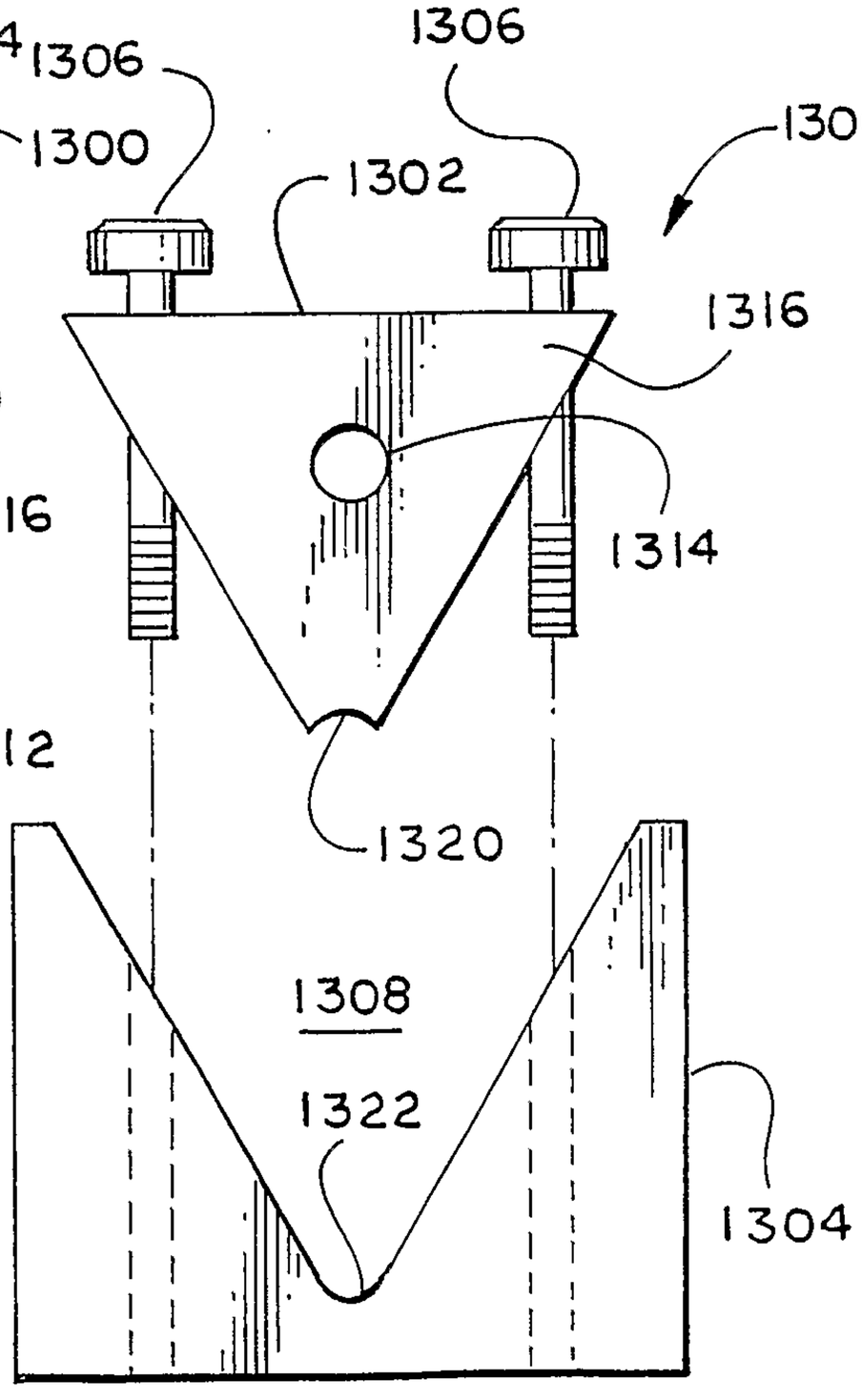


Fig_13B

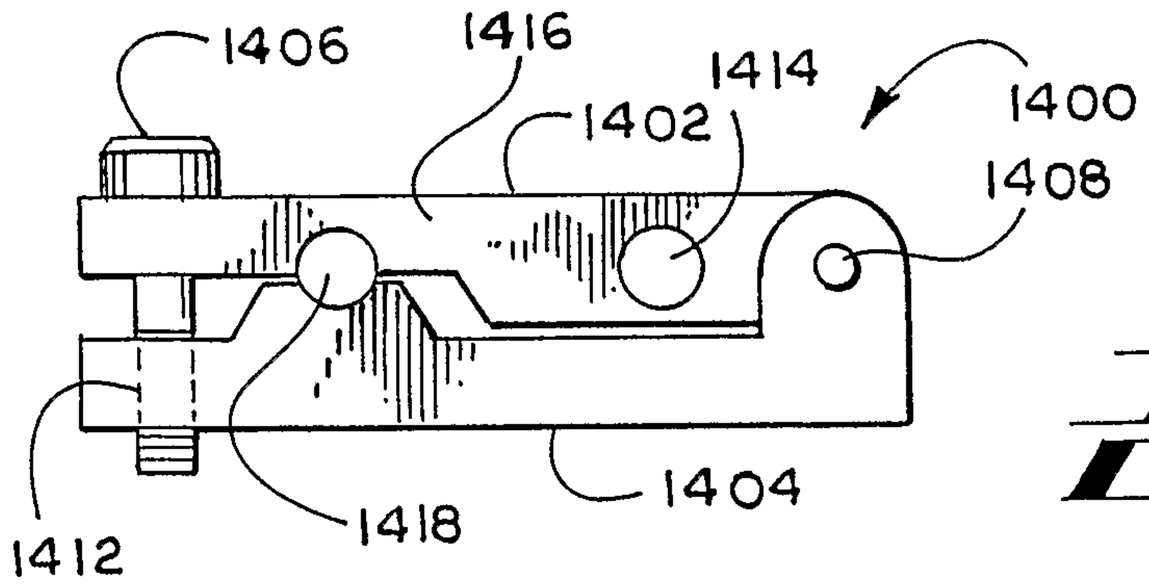


Fig_14A

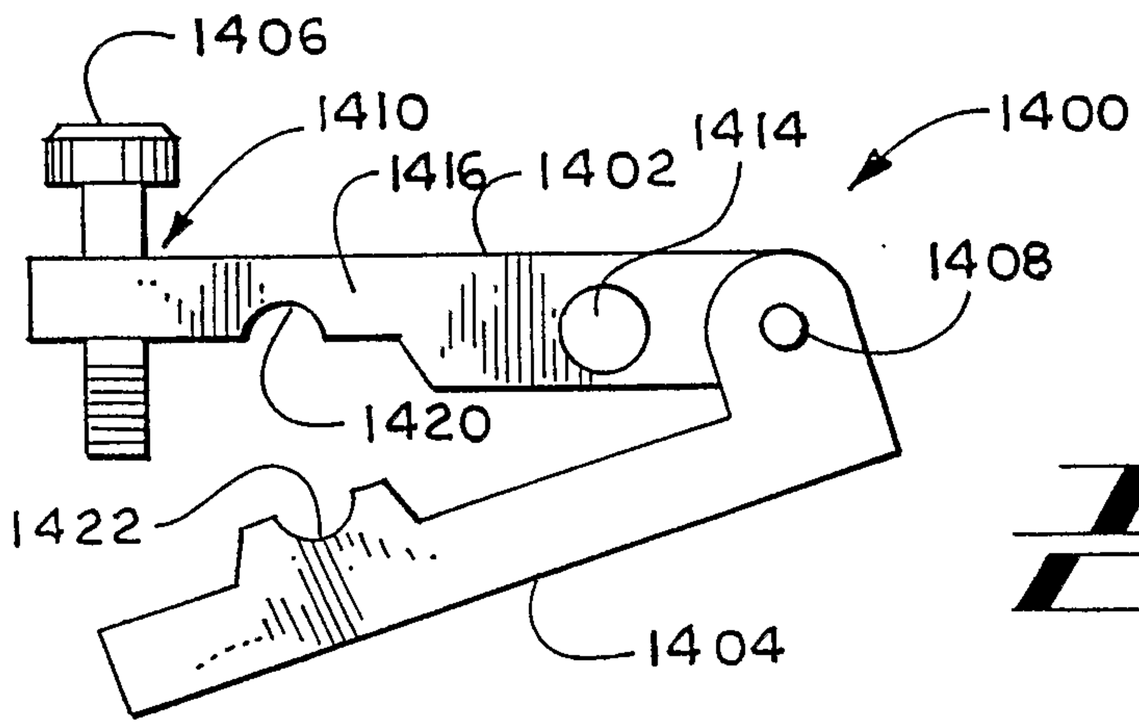


Fig_14B

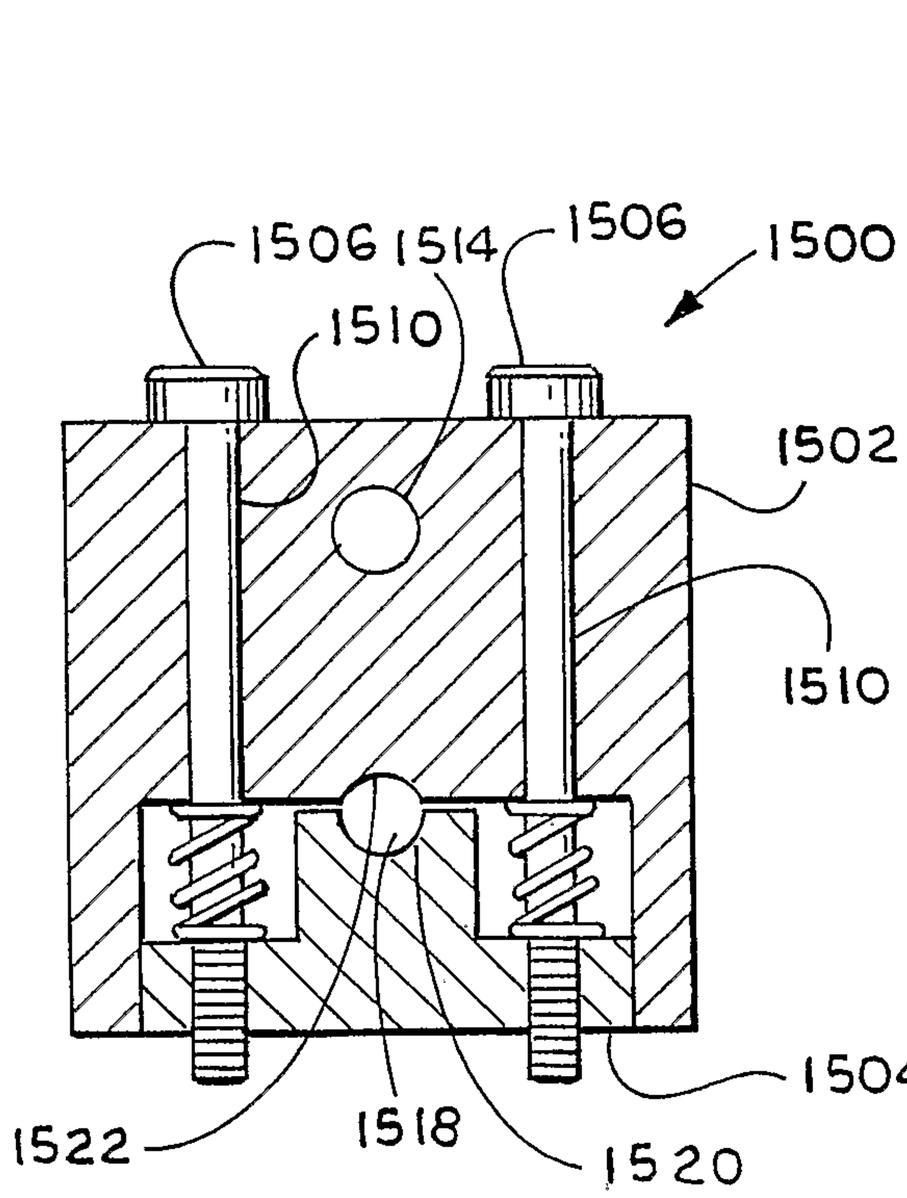


Fig_15A

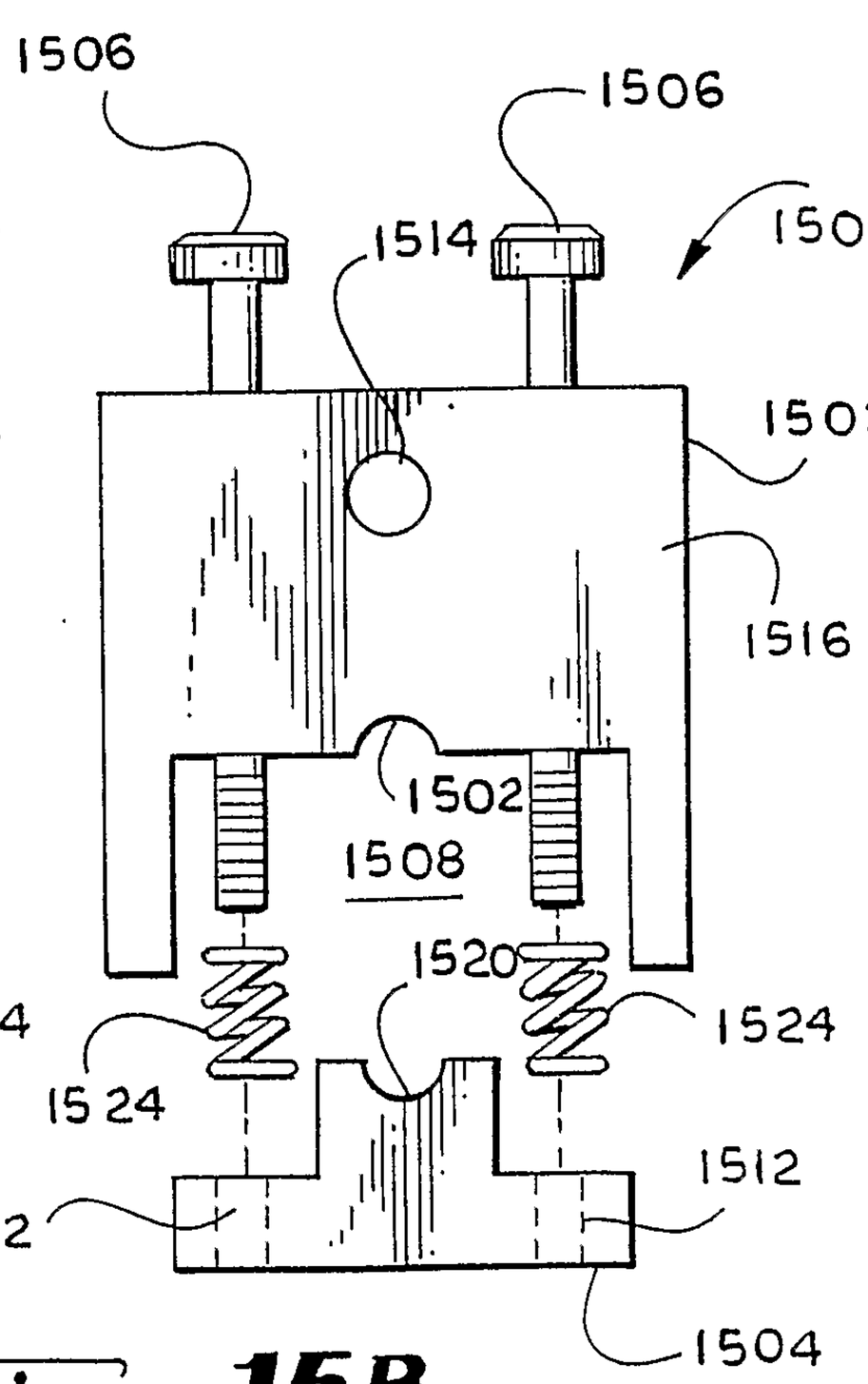


Fig_15B

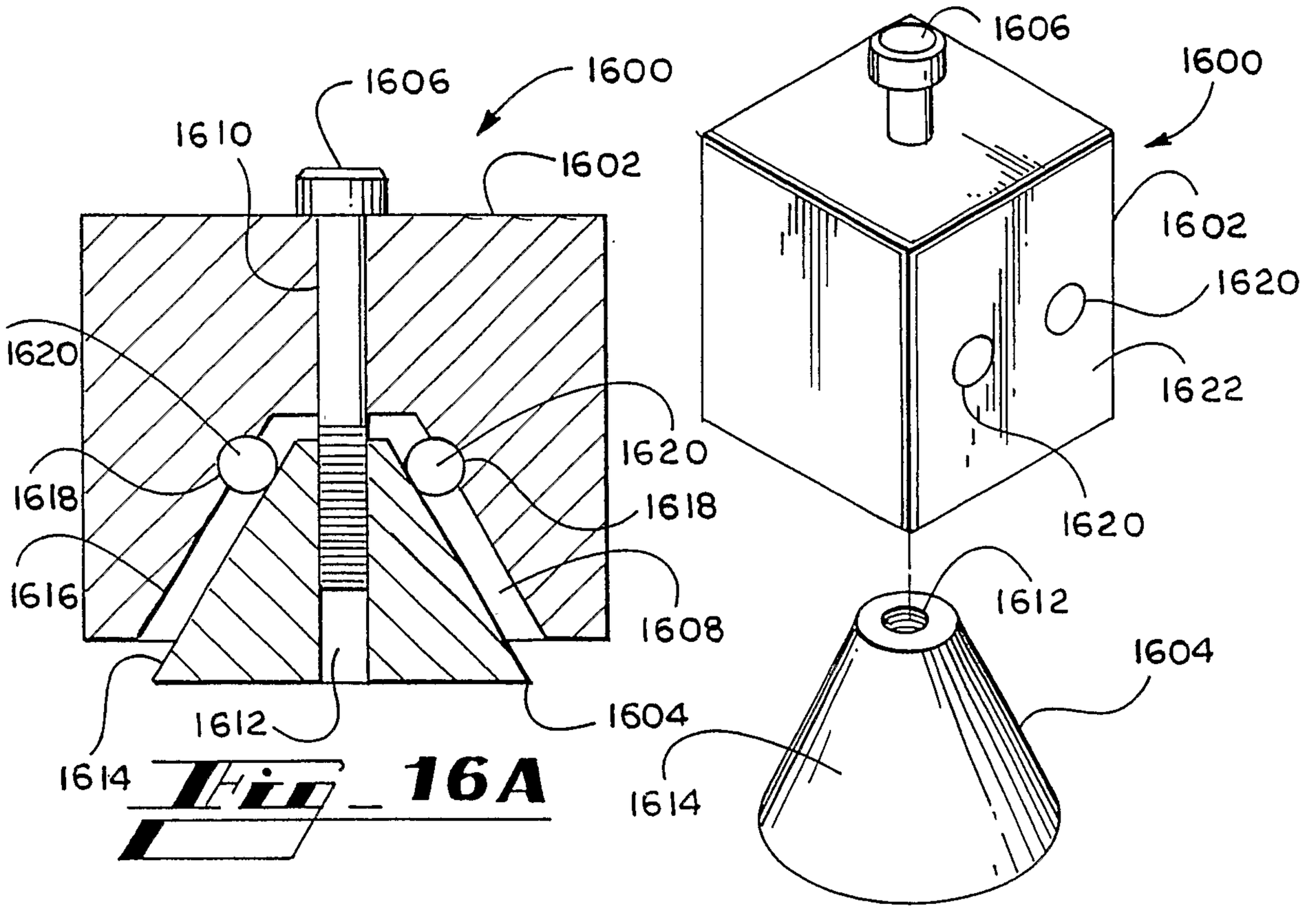


Fig_16A

Fig_16B

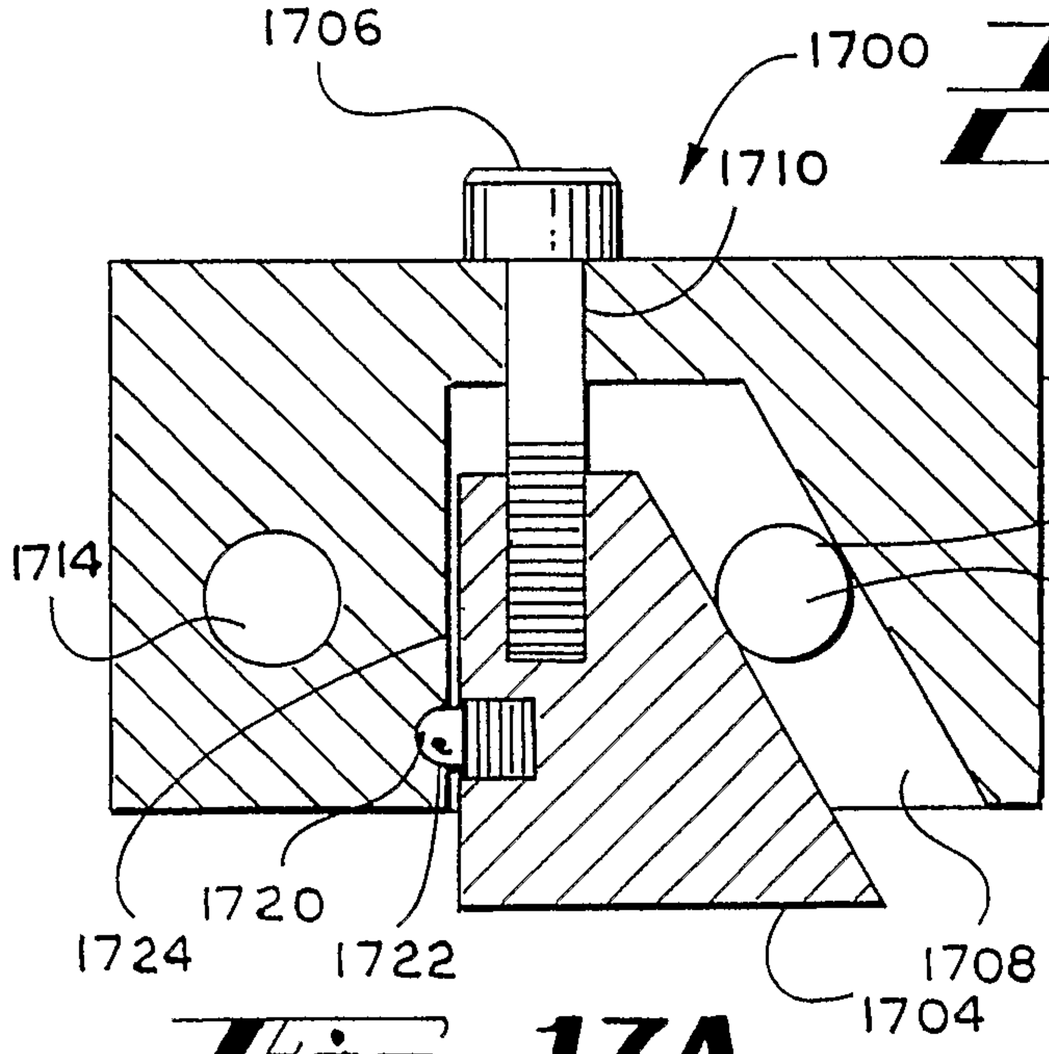


Fig_17A

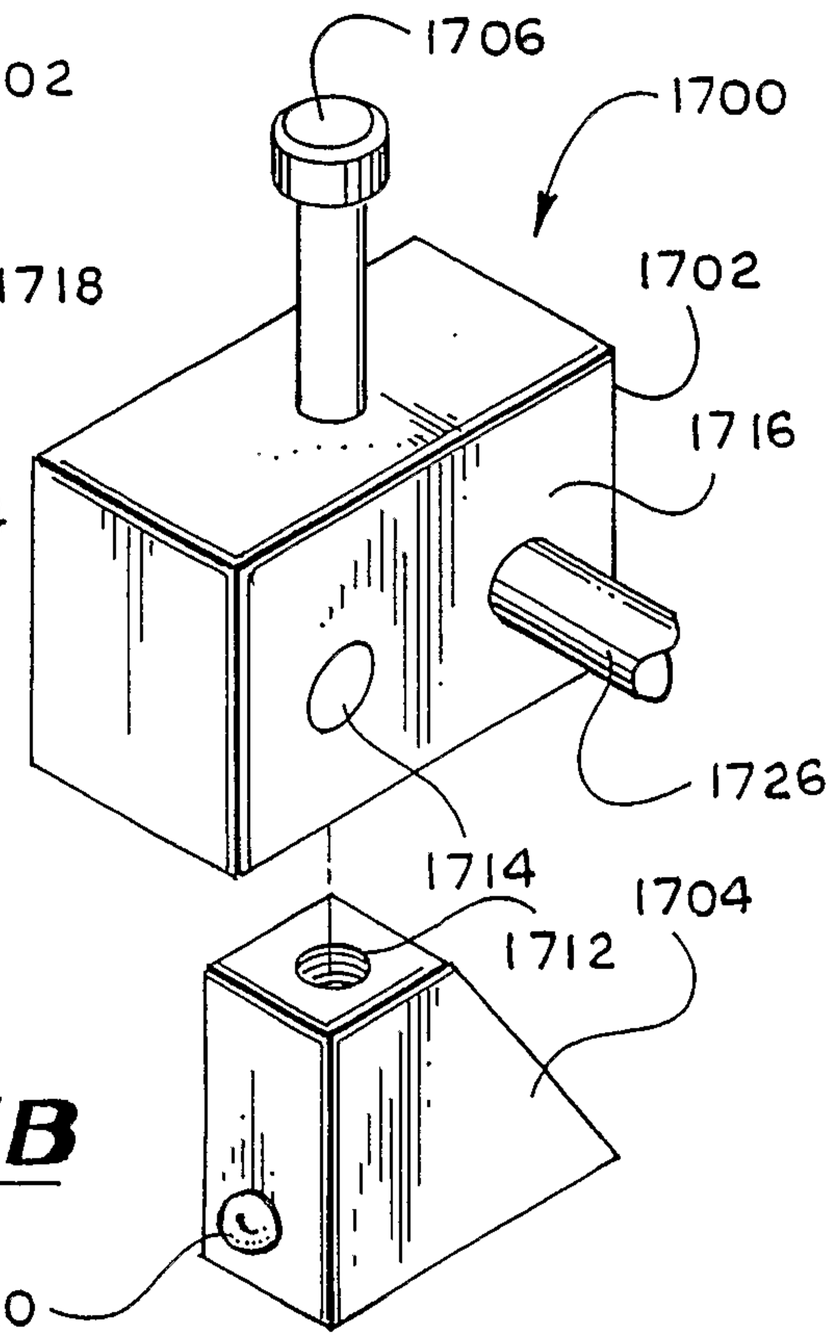
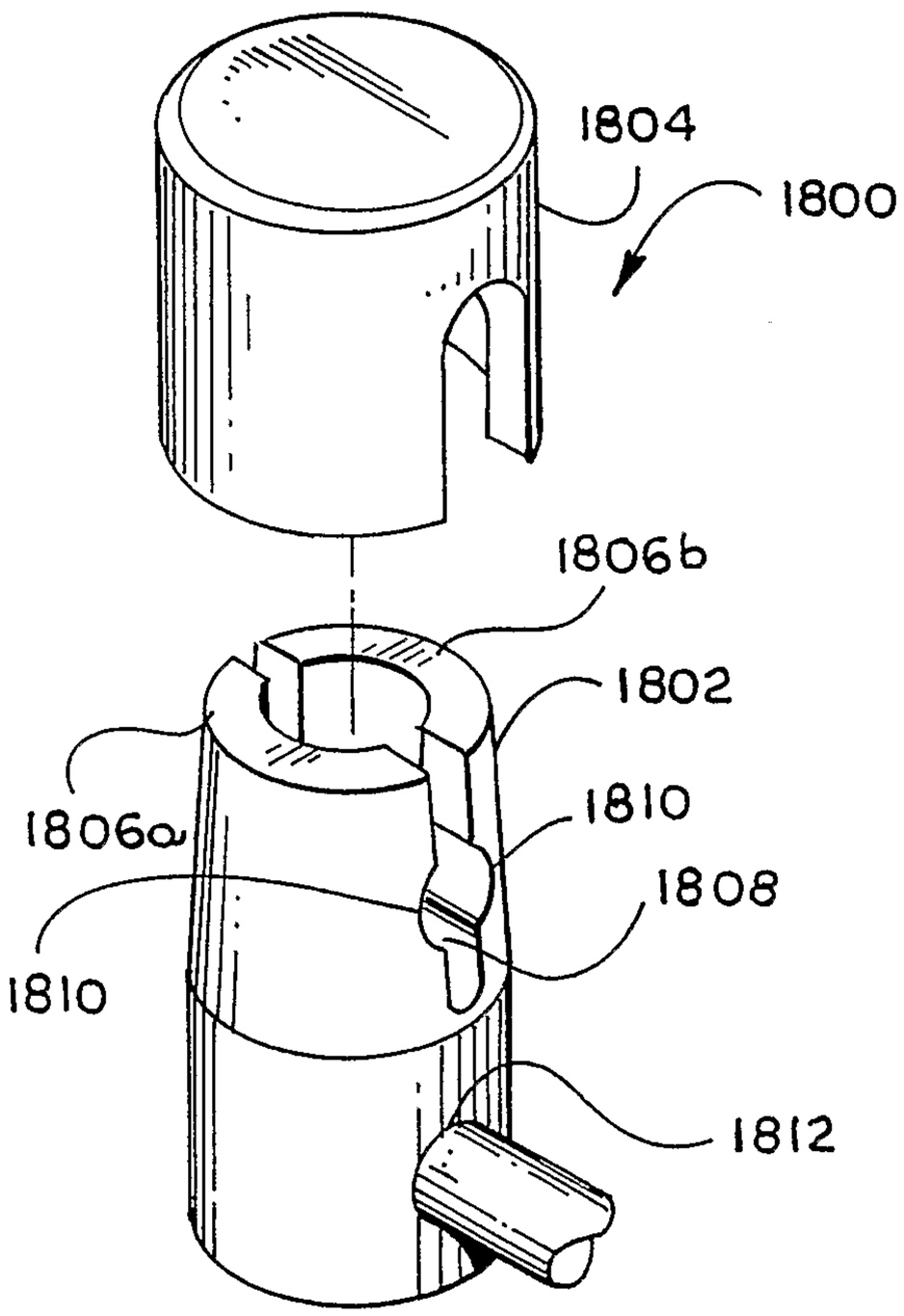


Fig_17B



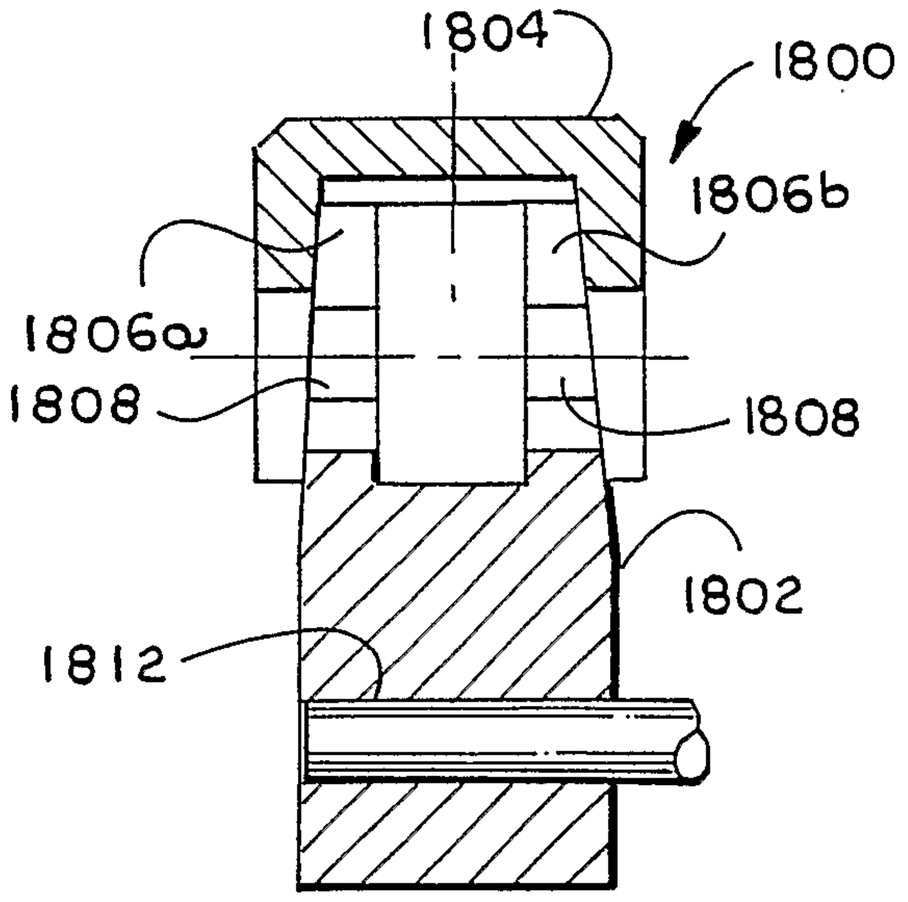


Fig_18B

Fig_18A

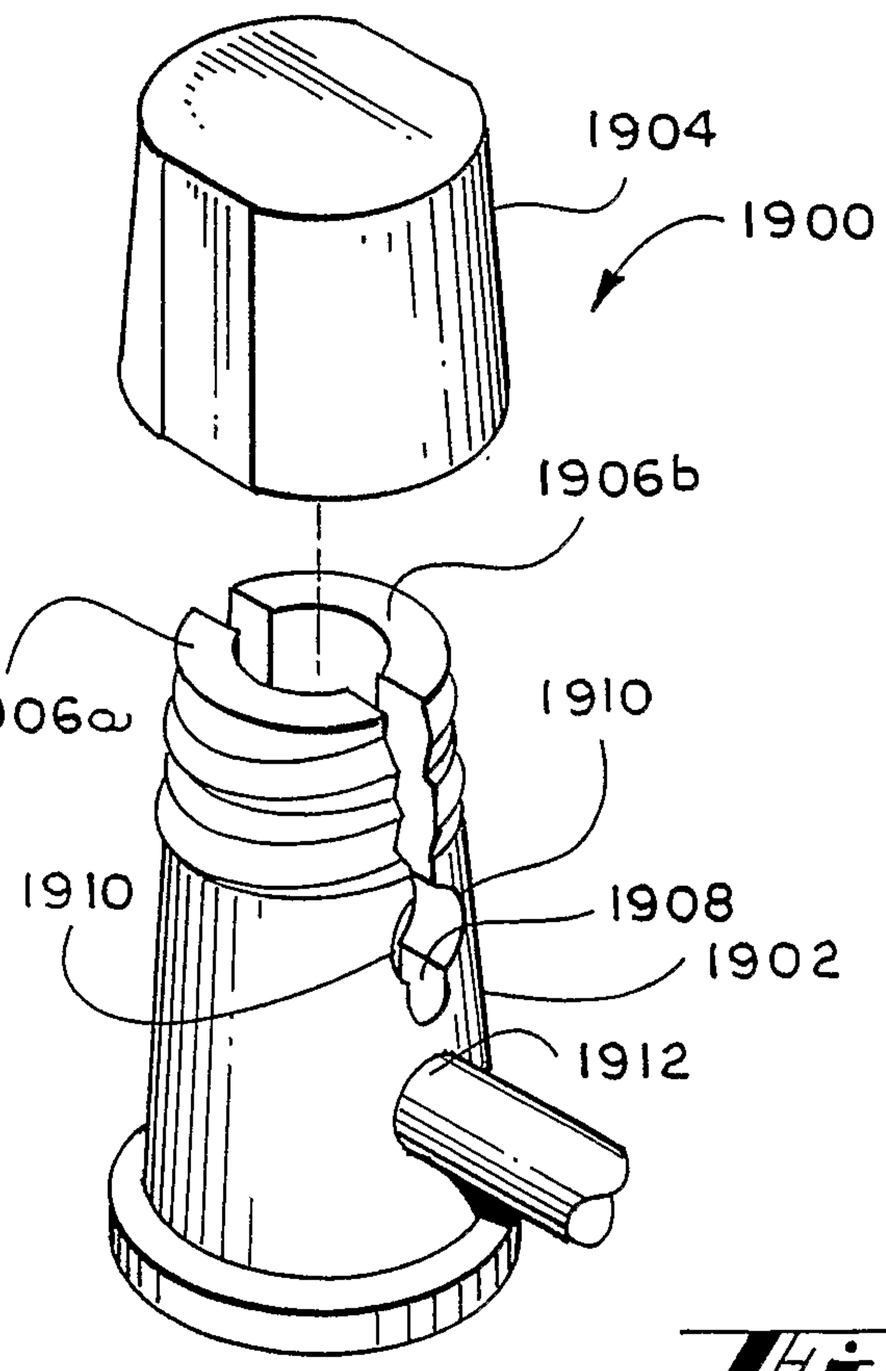


Fig_19B

Fig_19A

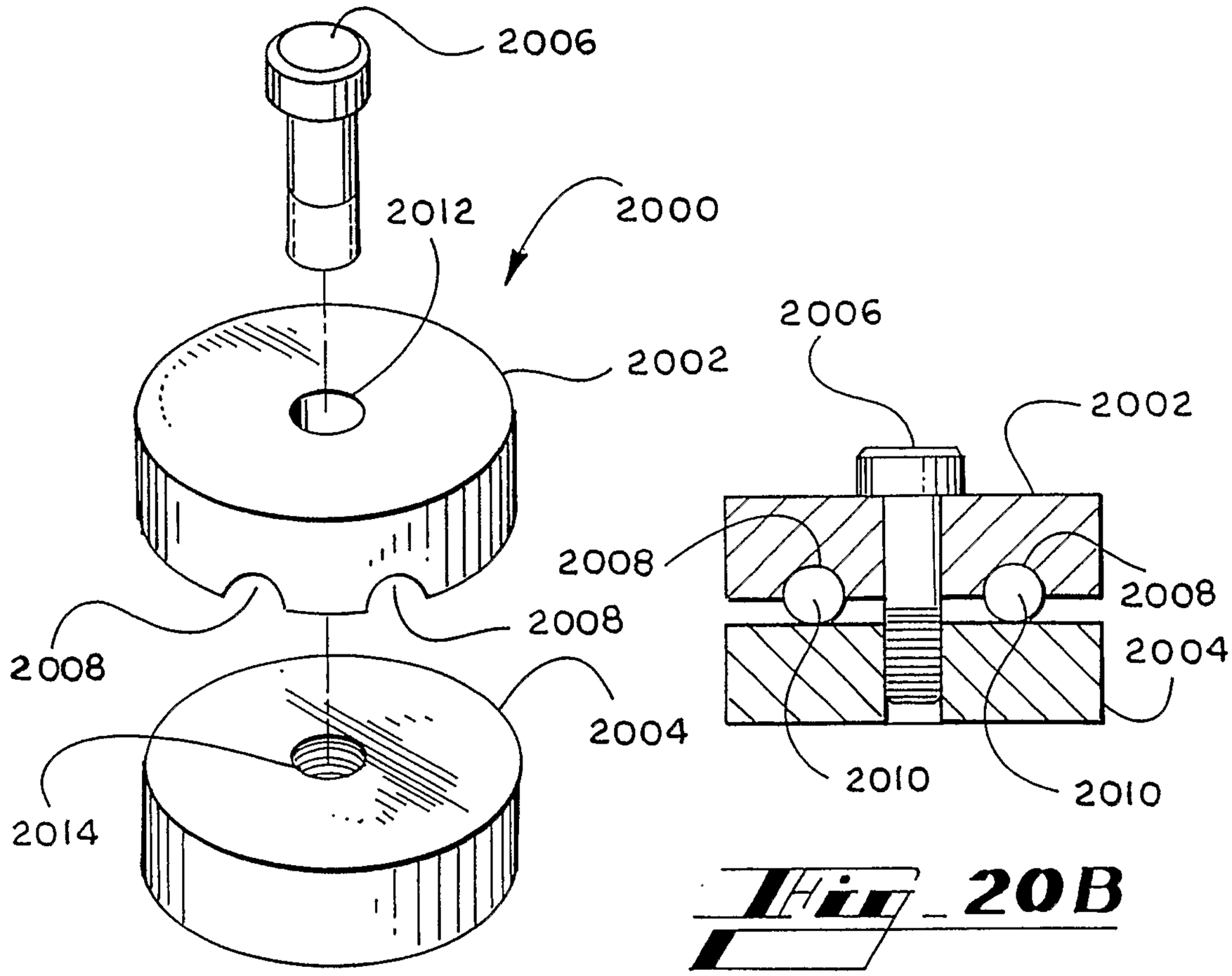
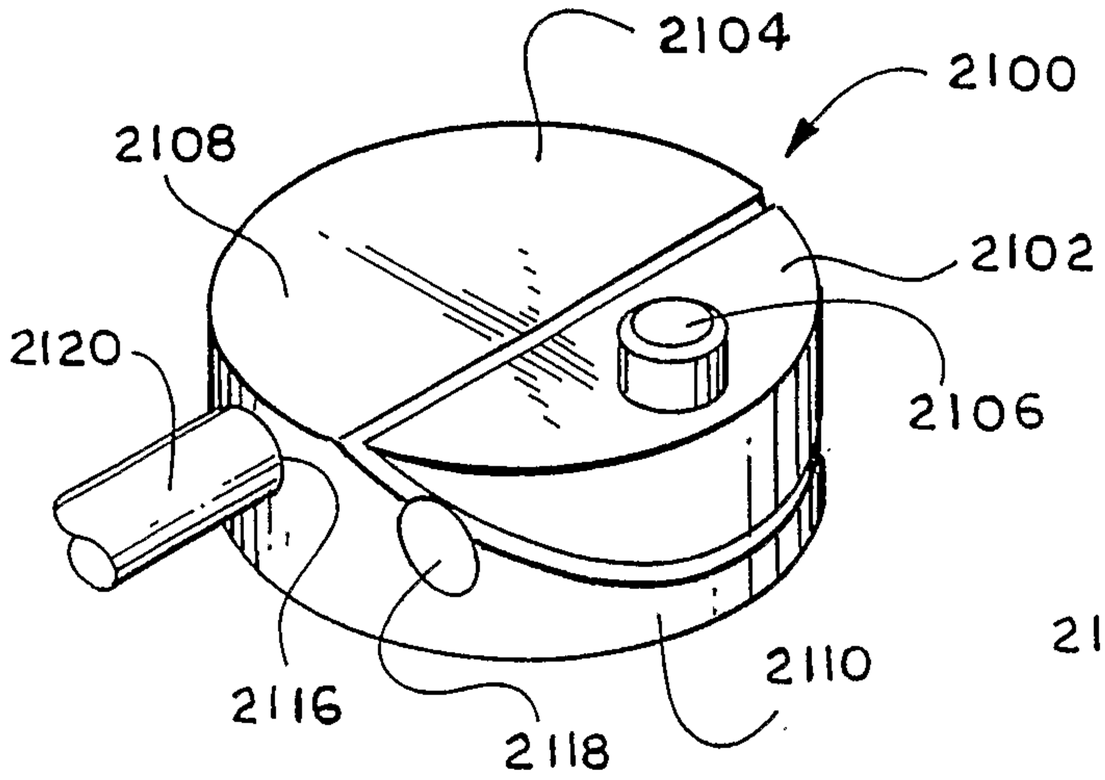


Fig_20B

Fig_20A



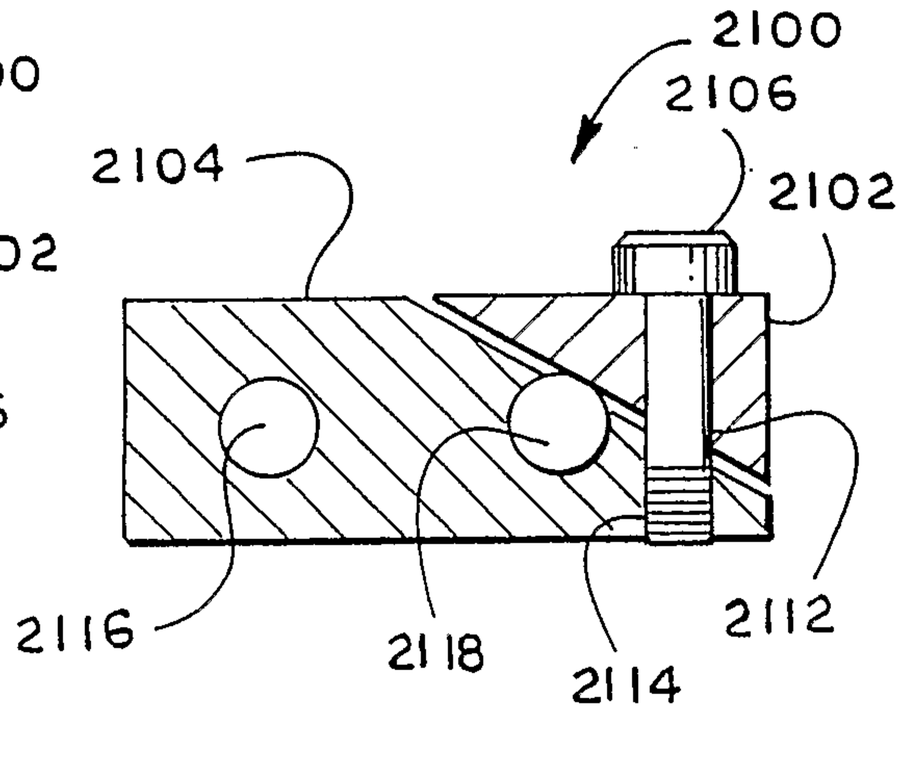


Fig_21A

Fig_21B

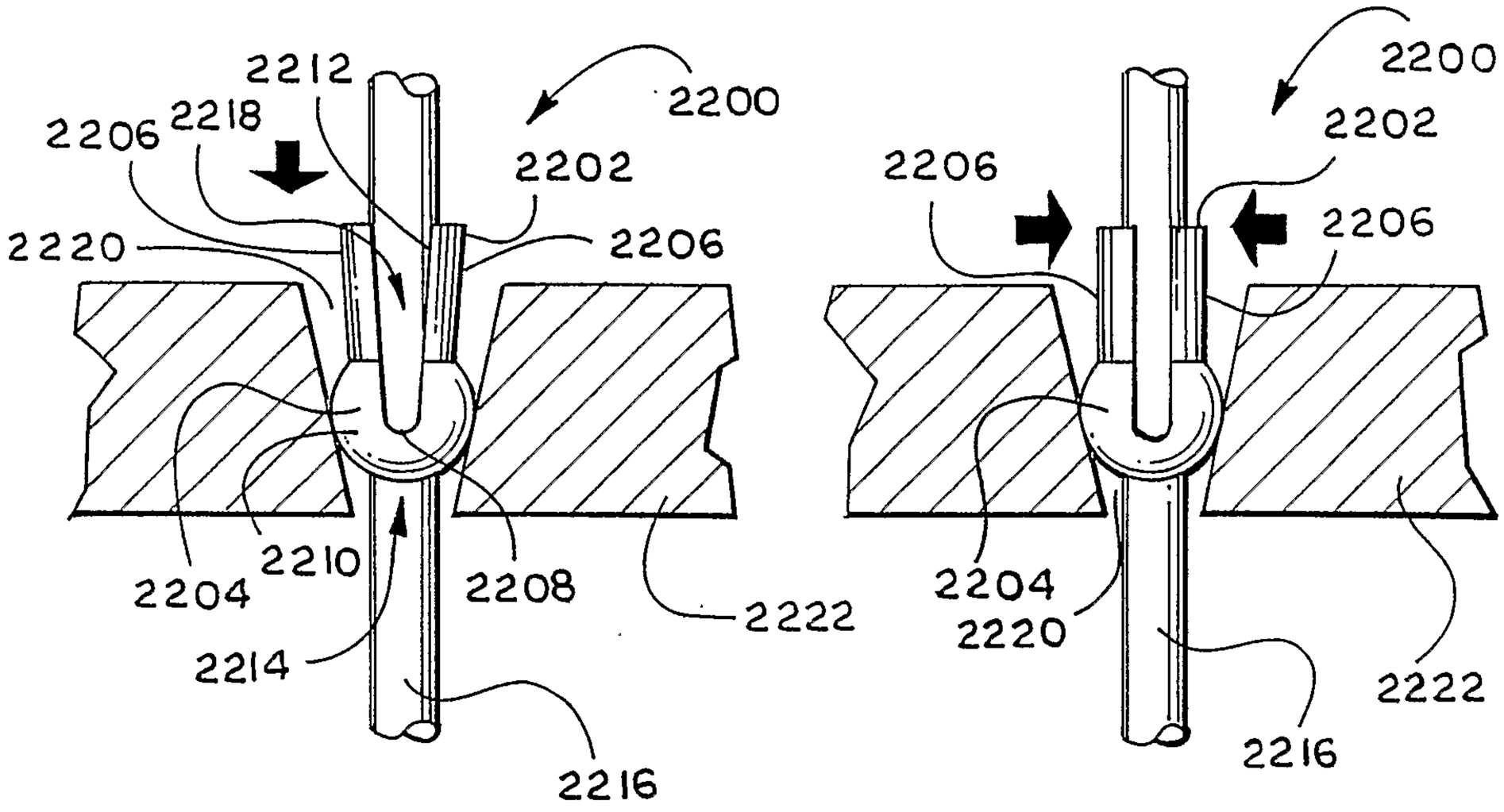


Fig_22A Fig_22B

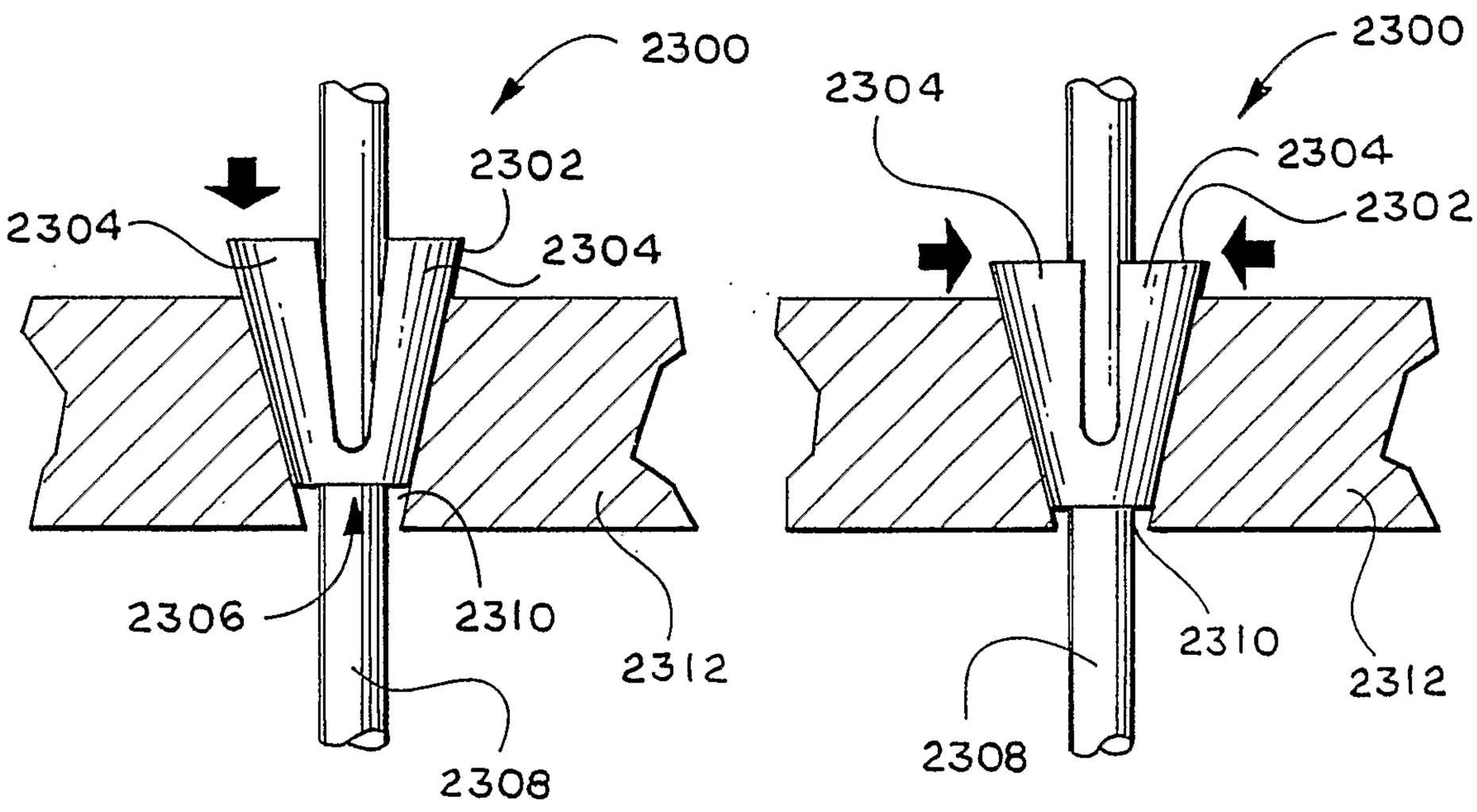


Fig_23A Fig_23B

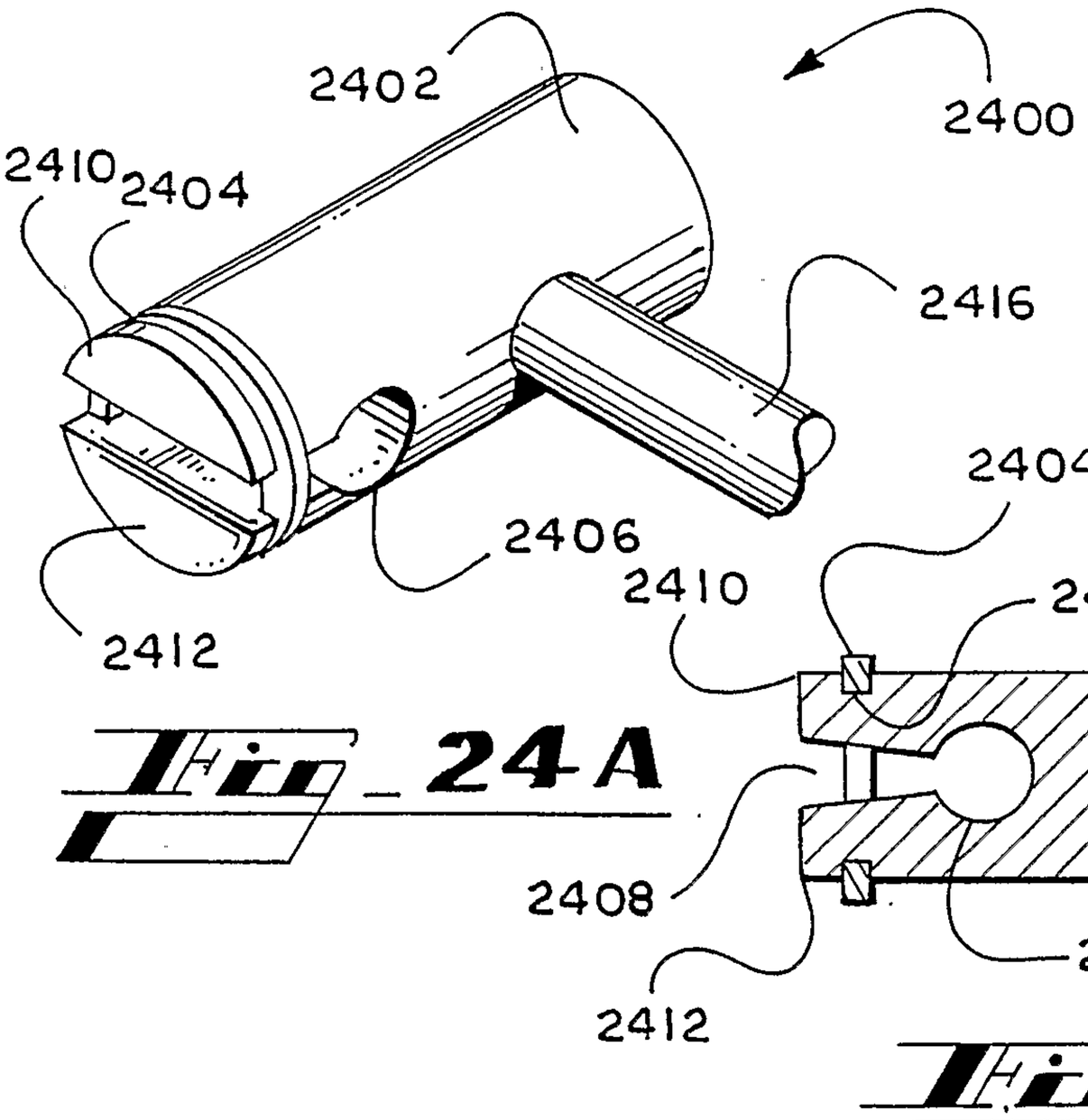


Fig_24A

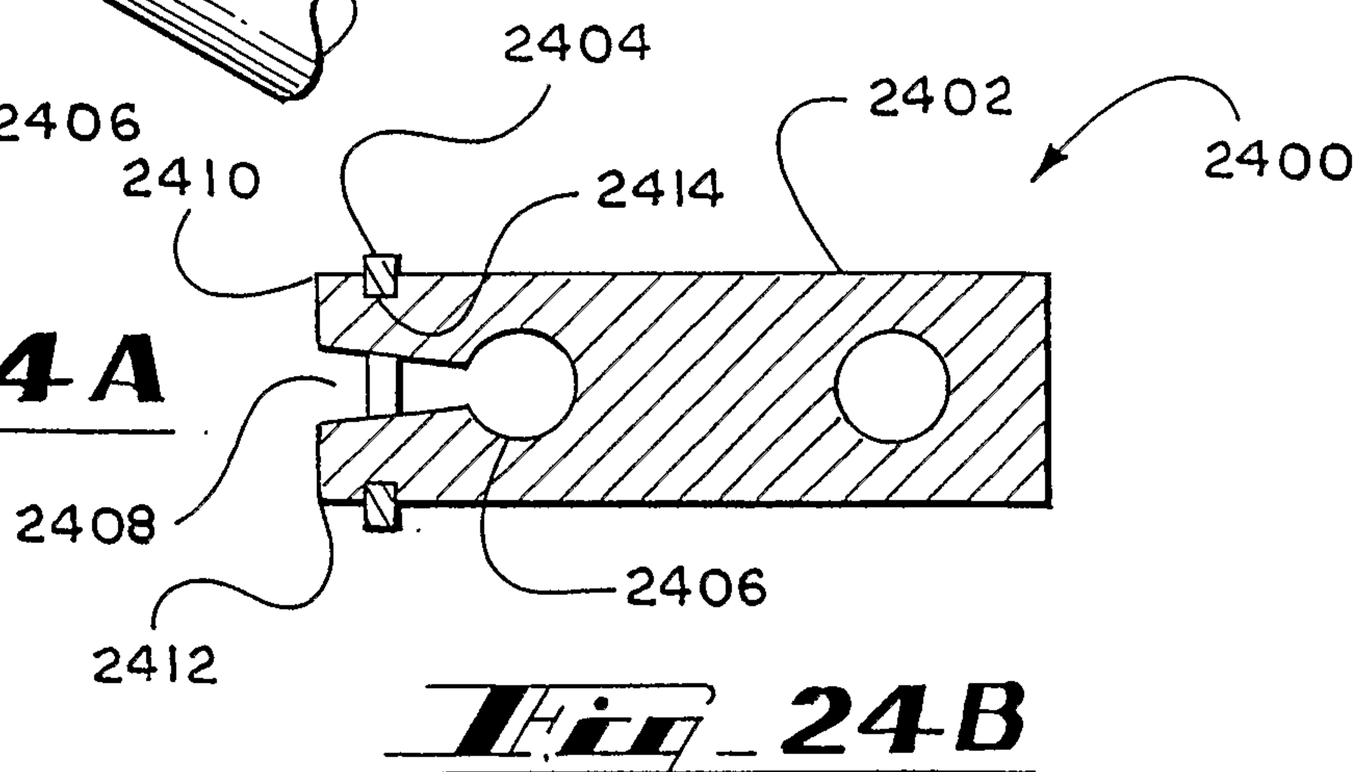
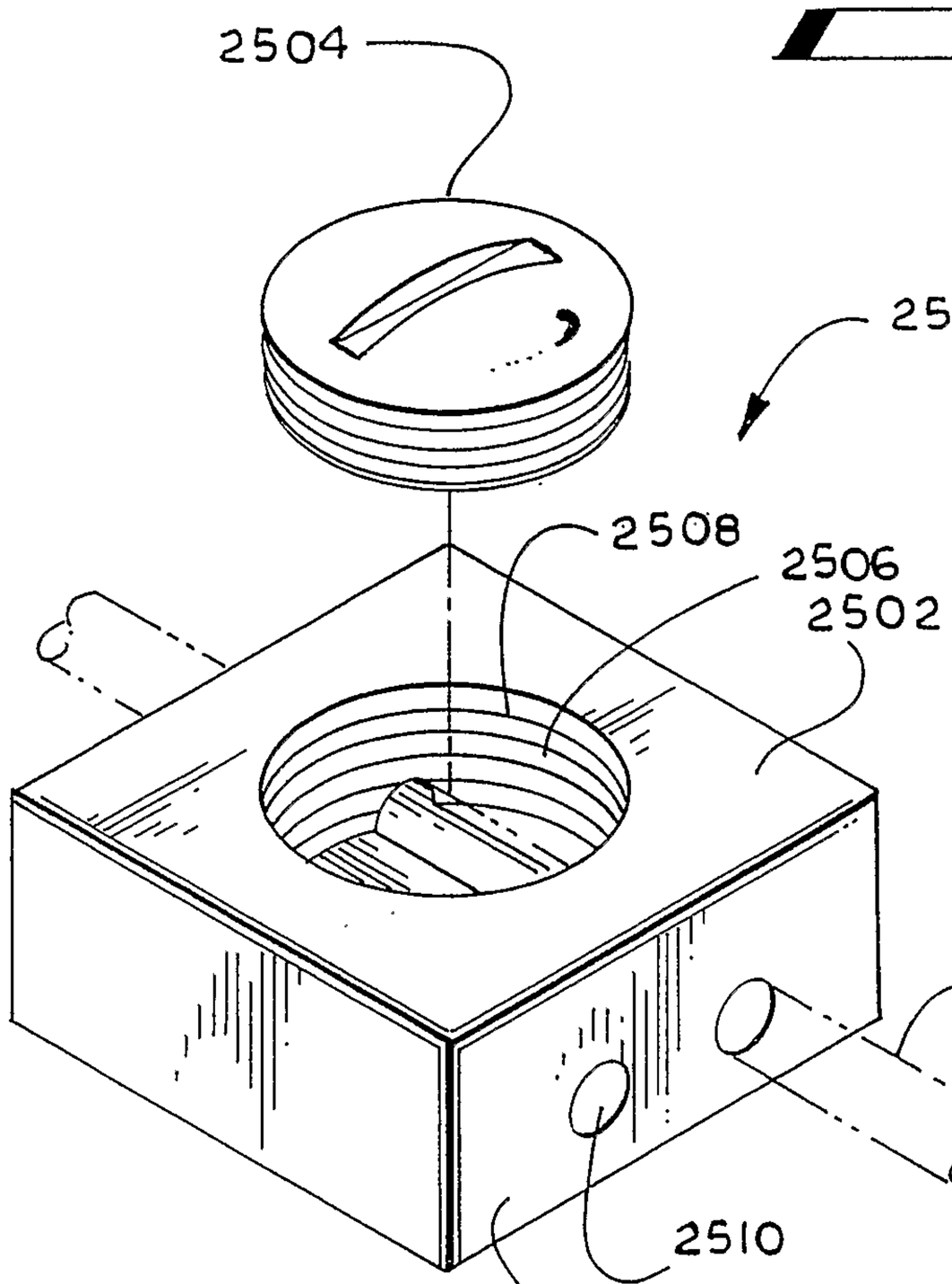


Fig_24B



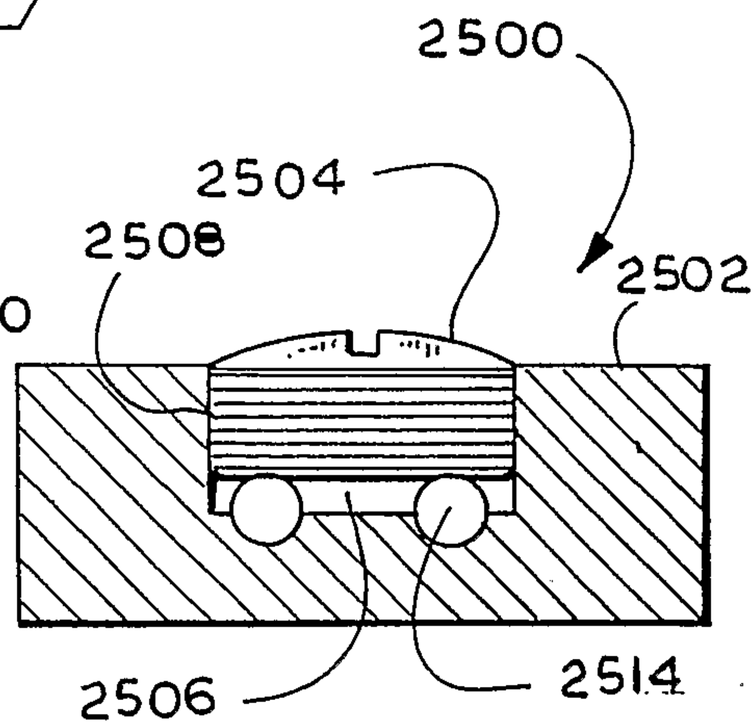


Fig_25A

Fig_25B

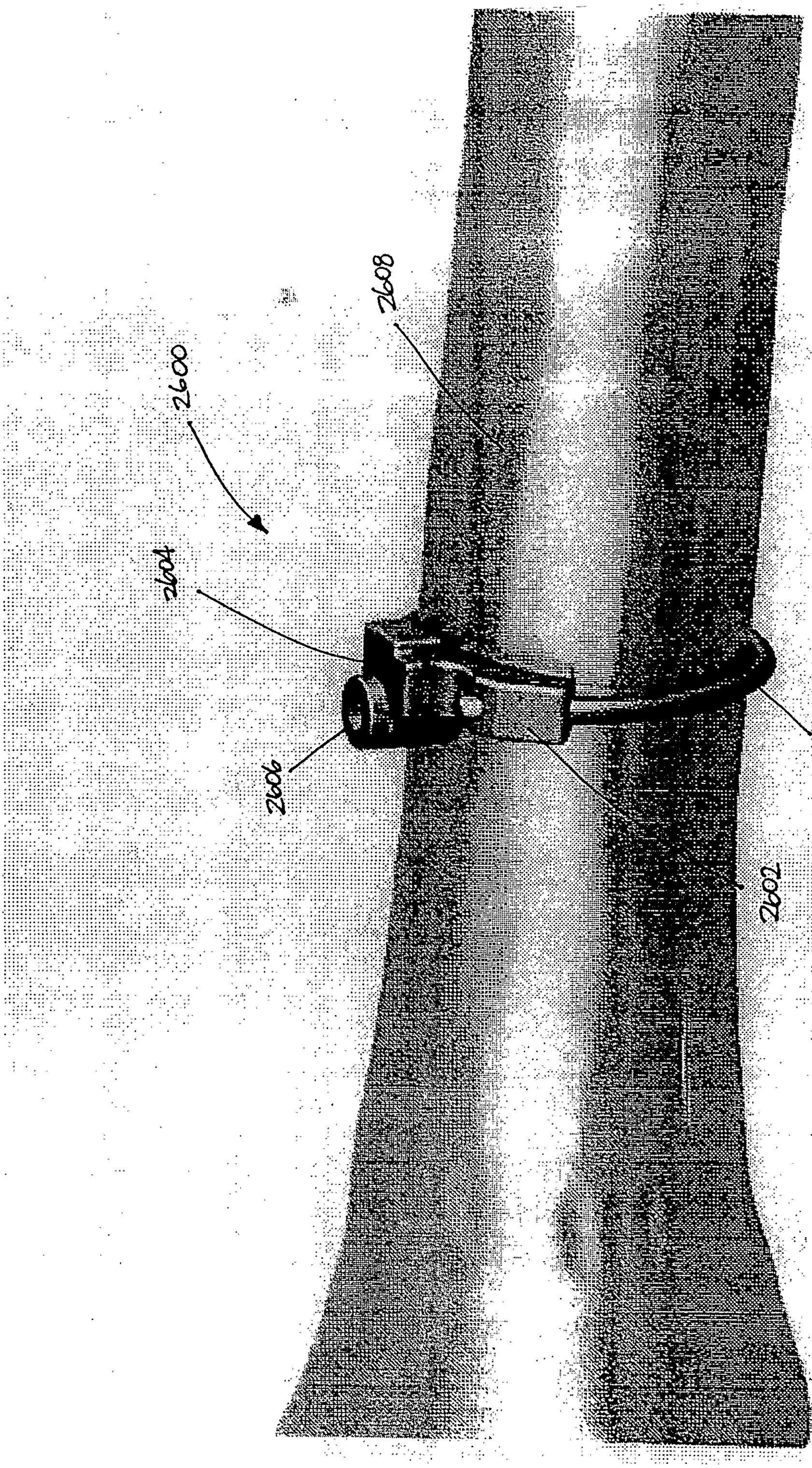


FIG. 26

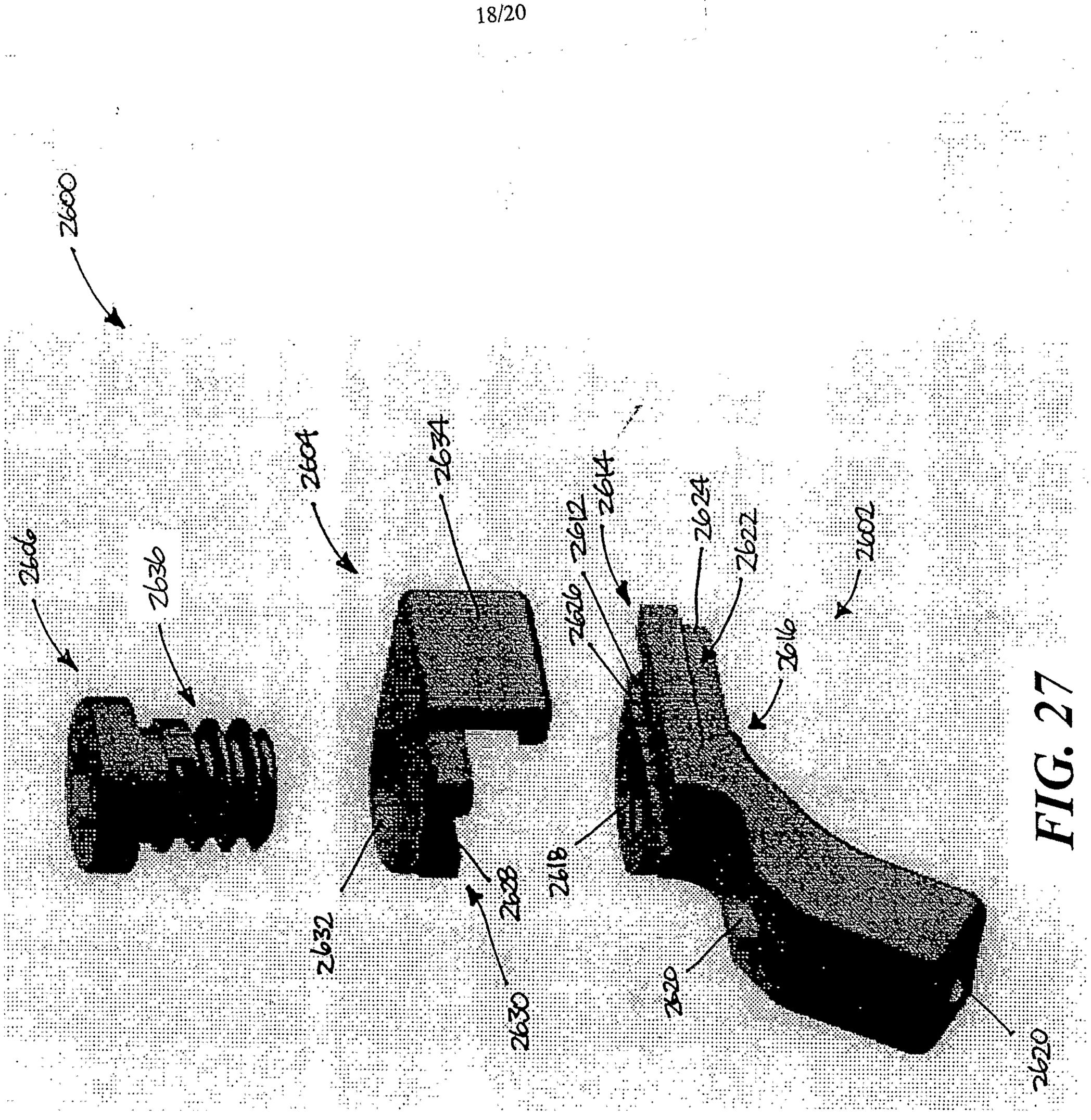

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FIG. 27

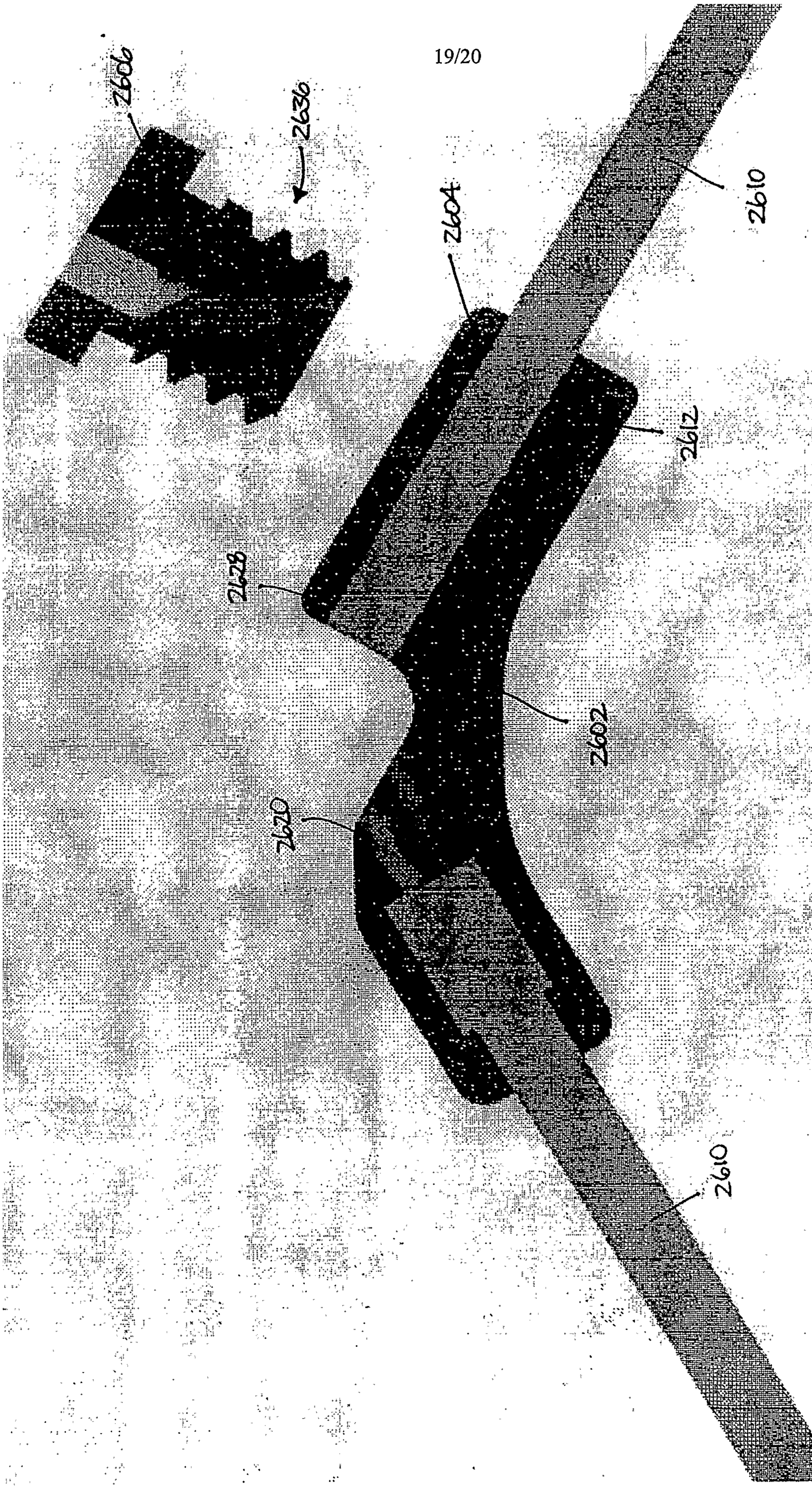


FIG. 28

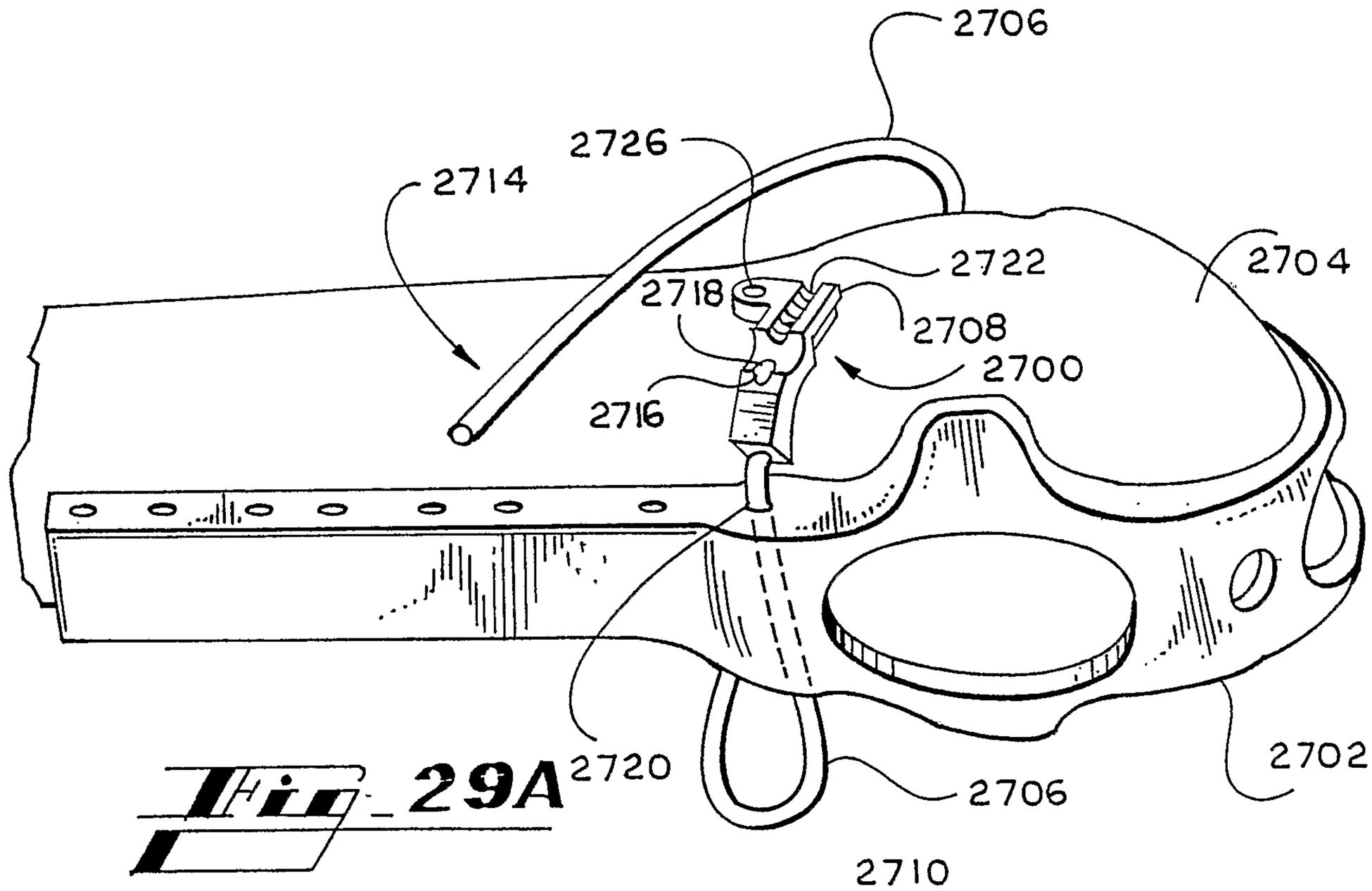


Fig. 29A

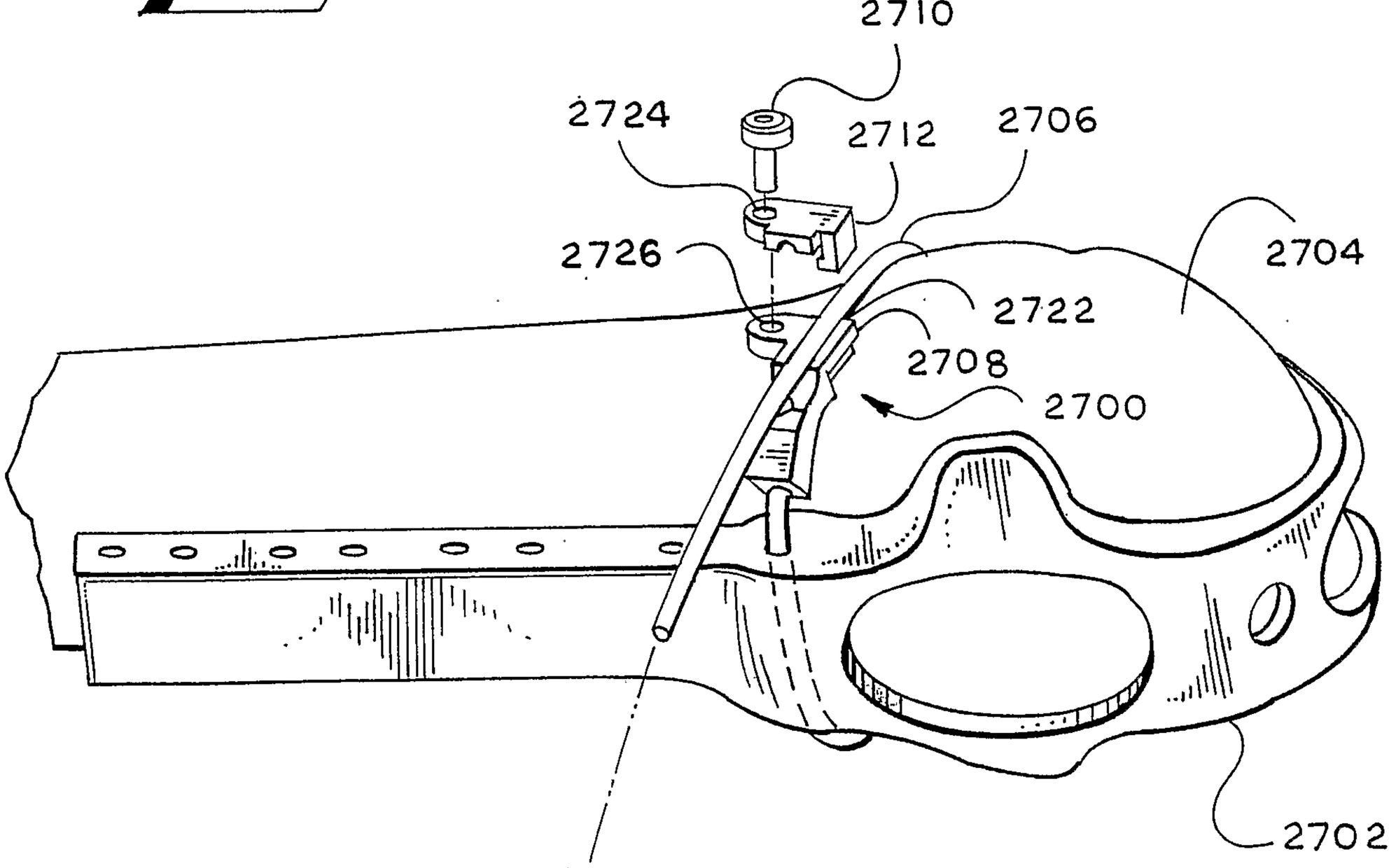
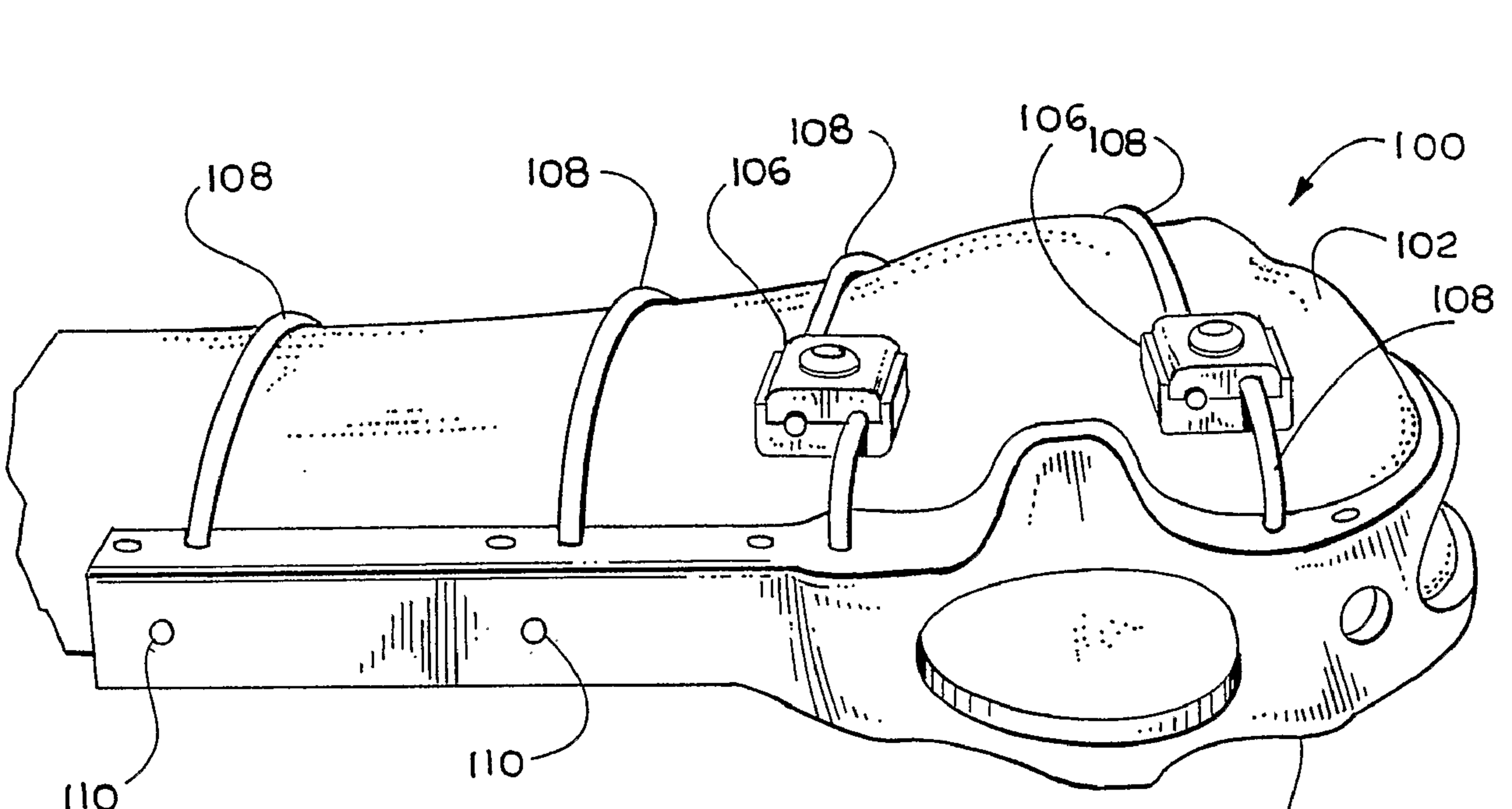


Fig. 29B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