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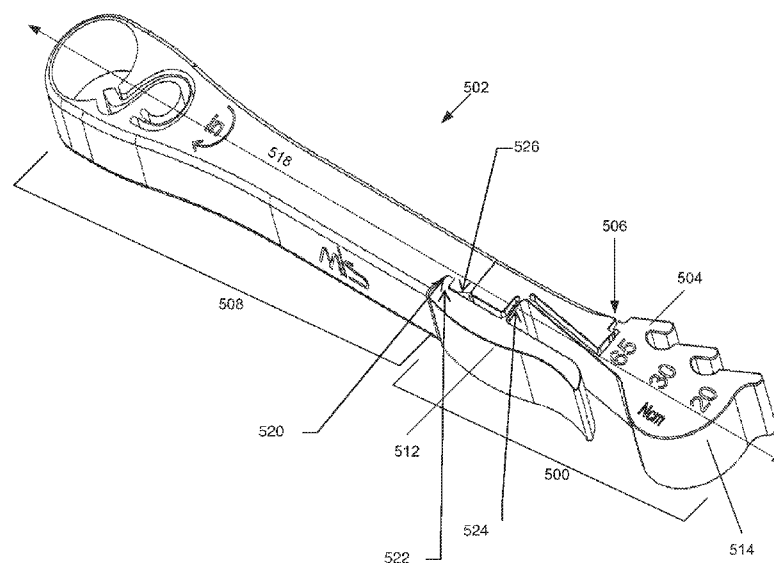


FIG. 5A

(57) Abstract: A dental torque exerting ratchet wrench (206) including: a distal ratchet wrench portion (402, 404, 422, 424) configured for engaging a driver (108); a proximal handle portion (214, 500, 600, 700, 806) comprising: a torque-setting component structured to indicate when a selected torque is exerted onto the driver (108) upon rotation of the wrench (1020, 106, 206, 302, 502), the torque setting component (218, 400) including: at least two portions formed with an interfering geometry (506) between them; an elastic element which connects said at least two portions to each other, said elastic element configured to deform in response to increasing torque to provide for one of said portions to overcome said interfering geometry (506) when said selected torque is reached; wherein said at least two portions and said elastic element constitute a single piece.



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DENTAL TORQUE WRENCH

RELATED APPLICATIONS

This application claims the benefit of priority under 35 USC §119(e) of U.S. Provisional Patent Application No. 62/617,236 filed January 14, 2018, the contents of which are incorporated
5 herein by reference in their entirety.

FIELD AND BACKGROUND OF THE INVENTION

The present invention, in some embodiments thereof, relates to a dental torque wrench, and, more particularly, but not exclusively, to a dental torque wrench configured for indicating a
10 predefined torque set by a one-piece torque setting component.

US publication number US5337638 A to Coss et al. discloses “An improved torque wrench for procedures requiring the application of precise small torques. The wrench includes a handle pivotally connected to a cam member rigidly attached to a driving head. The handle breaks out of alignment with the extending cam member upon application of an adjustable torque limit. A spring-
15 biased plunger within the handle normally holds a rigid ball within an elliptical indent in the cam member. Application of the torque limit on the handle forces the ball out of the indent and onto an angled surface before a projecting flange of the handle contacts the cam member and limits the further pivot of the handle. The angled surface provides a reaction force to the ball sufficient to maintain the handle in a pivoted position. The handle pivots a noticeably large angle of 30° before
20 the flange contacts the cam member.” (Abstract)

EP publication number EP1147858 A3 to Allen et al. discloses “A torque wrench of the type that “break” upon achieving a pre-selected maximum. The mechanism used to limit torque is adapted such that excessive wear is avoided and torque preselection remains within acceptable tolerances. This is achieved by providing a roller cam-follower to contact the surface of a cam-like
25 surface mitigating any wear of the surface and/or the cam follower. The wrench is also adapted so that the break in applied torque, which characterizes such wrenches, is readily apparent to the user of the wrench by an appreciable change in the alignment between the wrench body and the component engaging section.” (Abstract)

SUMMARY OF THE INVENTION

Following are some examples of exemplary embodiments of the invention. embodiments may also include features selected from different examples.

Example 1. A dental torque exerting ratchet wrench comprising:

a distal ratchet wrench portion configured for engaging a driver;

a proximal handle portion comprising:

a torque-setting component structured to indicate when a selected torque is exerted onto the driver upon rotation of the wrench, the torque setting component comprising:

5 at least two portions formed with an interfering geometry between them;

an elastic element which connects said at least two portions to each other, said elastic element configured to deform in response to increasing torque to provide for one of said portions to overcome said interfering geometry when said selected torque is reached;

wherein said at least two portions and said elastic element constitute a single piece.

10

Example 2. The wrench according to example 1, wherein said elastic element comprises a living hinge.

Example 3. The wrench according to example 2, wherein said living hinge is configured to
15 be flexed to allow at least one of said two portions to move with respect to the other portion.

Example 4. The wrench according to any of the preceding examples, wherein said proximal handle portion is manufactured using a single mold.

20 Example 5. The wrench according to any of the preceding examples, wherein said at least two portions and said elastic element of the torque-setting component are formed from a single piece of material.

Example 6. The wrench according to any of the preceding examples, wherein said elastic
25 element defines a direct extension of said two portions.

Example 7. The wrench according to any of the preceding examples, wherein said two portions of the torque setting component are formed with a spacing therebetween, said spacing large enough to provide for movement of at least one of said two portions with respect to the other until
30 said interfering geometry is encountered.

Example 8. The wrench according to example 7, wherein said movement comprises at least one of lateral movement and pivoting of at least one of said portions with respect to the other.

Example 9. The wrench according to any of the preceding examples, wherein said interfering geometry comprises a protrusion formed in one of said two portions and a respective recess formed in the other, said recess defining a step to be overcome by said protrusion.

5 Example 10. The wrench according to any of the preceding examples, wherein said proximal handle portion comprises at least one finger-rest location shaped and sized to be engaged by user's finger.

10 Example 11. The wrench according to example 10, wherein said proximal handle portion comprises multiple designated finger-rest locations, each location setting a different torque to be exerted by the distal ratchet wrench portion.

15 Example 12. The wrench according to any of the preceding examples, wherein said proximal handle portion comprises a selection knob including a finger rest that is movable between a plurality of locations configured along said handle portions, each location setting a different torque to be indicated by the interference mechanism reflecting the torque applied by the distal ratchet wrench portion when a user applies force at the finger rest.

20 Example 13. The wrench according to example 12, wherein said knob includes a torque indication.

 Example 14. The wrench according to any of the preceding examples, wherein said wrench is configured to indicate one or more torque magnitudes selected from the range of 20-70 Ncm.

25 Example 15. The wrench according to any of the preceding examples, wherein a length of said wrench along its longitudinal axis is long enough to maintain an indication of said torque setting component outside the mouth of the patient.

30 Example 16. The wrench according to any of the preceding examples, wherein said distal ratchet wrench portion and said proximal handle portion are formed as a single piece.

 Example 17. The wrench according to any of examples 1-15, wherein said proximal handle portion is attached to said distal ratchet wrench portion by a removable coupling.

Example 18. The wrench according to example 17, wherein said proximal portion is formed of a polymer material.

Example 19. The wrench according to example 17 or example 18, wherein said distal
5 portion is formed of metal.

Example 20. The wrench according to any of examples 17-19, wherein said coupling comprises one or more pins received within respective holes.

10 Example 21. The wrench according to any of examples 17-20, wherein said coupling is structured to allow detaching of said proximal handle portion only by axially pulling said proximal handle portion away from said distal ratchet wrench portion.

Example 22. The wrench according to any of examples 17-21, comprising an elastically
15 loaded clamp interlocking said distal portion and said proximal portion.

Example 23. The wrench according to example 2 or example 3, comprising an insert which is locatable adjacent said living hinge for adjusting a bending length and/or bending location of said living hinge.

20 Example 24. A dental torque exerting ratchet wrench kit comprising:
a distal ratchet wrench portion configured for engaging a driver;
a plurality of proximal handle portions, each proximal handle portion configured to engage said distal ratchet wrench portion, each proximal handle portion pre-configured to indicate, when engaged with said distal ratchet wrench portion, a different selected torque when said selected
25 torque is exerted by said distal ratchet wrench portion.

Example 25. The kit according to example 24, wherein each of said proximal handle portions comprises a single-piece torque setting component.

30 Example 26. A dental kit comprising:
a torque exerting ratchet wrench;
an implant to be implanted in an oral cavity by application of a pre-defined torque;

wherein said wrench is structured to indicate said pre-defined torque when said predefined torque is applied by said wrench directly onto the implant or via a driver coupled to the implant.

Example 27. A dental torque exerting ratchet wrench comprising:

a distal ratchet wrench portion configured for engaging a driver;

a proximal handle portion comprising:

a movable frame comprising a plurality of scale markings indicating torque magnitudes;

a pointing indicator having a tip;

wherein said handle is configured to deform such that said frame can move with respect to said pointing indicator in response to a change in torque exerted by said distal ratchet wrench portion due to user force applied at said handle, such that said tip points to a scale marking indicating the exerted torque.

Example 28. A wrench according to example 27, wherein said tip and said frame define at least one interfering geometry therebetween, which prevents further movement of said frame with respect to said indicator, each geometry corresponding to a deflection of said indicator relative to said frame by a given torque,

wherein at least part of said handle portion deforms under application of user force to overcome said interfering geometry and allow further relative movement of said frame relative to said indicator.

Unless otherwise defined, all technical and/or scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which the invention pertains. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of embodiments of the invention, exemplary methods and/or materials are described below. In case of conflict, the patent specification, including definitions, will control. In addition, the materials, methods, and examples are illustrative only and are not intended to be necessarily limiting.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

Some embodiments of the invention are herein described, by way of example only, with reference to the accompanying drawings. With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion

of embodiments of the invention. In this regard, the description taken with the drawings makes apparent to those skilled in the art how embodiments of the invention may be practiced.

In the drawings:

FIG. 1 is a flowchart of a general method of using a torque exerting ratchet wrench to place
5 an implant in a jawbone, according to some embodiments;

FIGs. 2A-2B are two exploded views of a dental assembly for placing an implant in a jawbone using a torque exerting ratchet wrench, according to some embodiments;

FIG. 3 is a flowchart of a method of using a ratchet wrench comprising a one-piece torque setting component, according to some embodiments;

10 FIGs. 4A-4C schematically illustrate operation of a one-piece torque setting component comprising two portions formed with an interfering geometry between them and connected by an elastic element, according to some embodiments;

Fig. 4D schematically illustrates a one-piece torque setting component having two torque settings, in accordance with some embodiments of the invention;

15 FIGs. 5A-D show a torque exerting ratchet wrench comprising a plurality of finger-rest locations, each location pre-configured to set a different torque (figure 5A), and several views of a proximal handle portion of such wrench (figures 5B-D), according to some embodiments;

FIGs. 6A-6C are several views of a torque exerting ratchet wrench comprising a plurality of torque indication locations, each pre-configured to set a different torque, and a selection knob that is
20 movable between the locations, according to some embodiments;

FIGs. 6D-6E are a perspective view and a side view of a torque exerting wrench with a variable torque setting and display, in accordance with some embodiments of the invention;

FIG. 7A illustrates a proximal handle portion of a torque exerting ratchet wrench, the handle portion comprising a needle for pointing at a set torque and a frame movable with respect to the
25 needle, according to some embodiments;

FIG. 7B illustrates a proximal handle portion of a torque exerting ratchet wrench, the handle portion comprising a needle for pointing at a set torque and for geometrically interfering with a frame movable with respect to the needle, according to some embodiments of the invention;

FIGs. 8A-8B illustrate a slidable sleeve for adjusting torque exerted by the ratchet wrench by
30 affecting flexure of an elastic element of the torque setting component, according to some embodiments;

FIG. 9 is a graphical representation of the relation between the deformation of the wrench and the applied torque, according to some embodiments of the invention; and

FIGs. 10A-10B illustrate a location of a break point in accordance with some embodiments of the invention.

DESCRIPTION OF SPECIFIC EMBODIMENTS OF THE INVENTION

5 The present invention, in some embodiments thereof, relates to a dental torque wrench, and, more particularly, but not exclusively, to a dental torque wrench configured for indicating a predefined torque magnitude set by a one-piece torque setting component. In some embodiments, the wrench is used during placing of an implant in the jawbone of a patient. Optionally, the wrench engages an implant driver for applying torque onto the implant to screw it into the jawbone.
10 Alternatively or additionally, the wrench is used for screwing in a screw-retained superstructure into the implant. In such cases the wrench optionally engages a screwdriver for applying torque onto the connecting screw. These are examples; in some exemplary embodiments of the invention, the wrench is used for rotation or tightening of other dental implements and/or implants.

 An aspect of some embodiments relates to a dental torque exerting ratchet wrench which is
15 configured for indicating a pre-configured torque via a torque-setting component in which portions that are movable with respect to each other and an elastic element that couples between the portions are formed out of the same element and/or otherwise in a permanently fixed relationship.

 In some embodiments, the torque setting component is manufactured from a single piece of material. In some embodiments, the torque setting component is molded using a single mold and
20 then optionally machined and/or cut. Optionally, a proximal handle portion of the wrench, which includes the torque setting component, constitutes a single piece and is attachable to a distal wrench portion thereof. Optionally, the complete wrench (including the distal ratchet wrench end portion) constitutes a single piece.

 In some embodiments, the torque setting component comprises at least two portions formed
25 with an interfering geometry between them, and an elastic element extending between the two portions. In some embodiments, the elastic element is a direct extension of the two portions. In an example, the interfering geometry comprises a protrusion formed in one portion and a respective recess formed in the other, the recess defining a “step” to be overcome by the protrusion. An elastic element in the form of a living hinge extends between the two portions.

30 In some embodiments, during operation, rotation of a proximal end of the handle portion moves one of the portions with respect to the other, as permitted by flexure of the living hinge, until the protrusion overcomes the “step” (optionally due, at least in part, to deformation of the elastic element), resulting in a “break point” indicating that a pre-defined torque is exerted by the distal end of the wrench onto the driver. Optionally, at the “break point”, an alignment between the two

portions changes (as compared to the initial rest state). Optionally, at the “break point”, overcoming the interfering geometry results in tactile (mechanical “break” feel), audible (click or snap) and/or visible (change in alignment) indications, so that a user acknowledges that the pre-configured torque magnitude was reached.

5 In some embodiments, a length of the wrench is selected to be sufficient to provide for the “break” to occur outside the mouth of the patient, such as by maintaining the torque setting component outside the mouth of the patient.

10 It is a particular feature of some embodiments of the invention that the wrench is sized and the interfering geometry is located at a location such that the breakpoint is outside of a patient’s mouth, where such indications may be more detectable by a user. For example, the breakpoint is within 50%, 30%, 20%, 10% or intermediate percentages of the length of the wrench, from the proximal side of the wrench.

15 Some potential advantages of a wrench comprising a single-piece torque setting component may include reducing a risk of mechanical failure, breakage or detachment of parts, which may occur in structures involving multiple parts, specifically parts that are required to move with respect to each other. Since no external or additional elements are involved, use and manufacturing of the wrench may be simplified.

20 In some embodiments, the wrench is configured to indicate multiple discrete torques, for example by the proximal handle portion comprising multiple finger-rest locations, each finger-rest location positioned a different distance from the interfering geometry so as to result in a different torque being exerted by the distal end of the wrench at the point of overcoming the interference. Optionally, the proximal handle portion comprises a selection element, optionally including a finger rest, movable between different torque setting locations configured along the proximal handle portion. Optionally, the selection element includes a display of the breaking torque. Optionally or 25 alternatively, torque is marked on the wrench in positions aligned with a movable finger rest.

 In some embodiments, the wrench is configured to indicate one or more torque magnitudes selected from the range of 15-75 Ncm, 10-90 Ncm, 20-65 Ncm, or intermediate, higher or lower torque magnitudes.

30 In some embodiments, the wrench enables rotation even beyond the point of overcoming the interference, so as to apply torque that is higher than the torque indicated by the “break point”.

 In some exemplary embodiments of the invention, a plurality of break points are provided, so that once one torque threshold is passed, a further “break” is experienced when a second, higher threshold is passed.

In some exemplary embodiments of the invention, the interference geometry acts as an indicator of applied torque.

In some exemplary embodiments of the invention, an indicator of applied torque is provided, for example, a portion which extends from the wrench body and which moves relative to a portion to which torque is applied. Optionally, the indicator does not move, rather the portion to which torque is applied by the user moves relative to the rest of the wrench and the indicator.

In some exemplary embodiments of the invention, the torque break point of the interference geometry is modified by a sleeve, optionally slidable, and which is mounted on or adjacent the elastic element, thereby increasing and/or decreasing the effective resilience of the elastic element, by changing the portion of the element which may deform.

In some exemplary embodiments of the invention, the breaking involves two forces, a deflection force, associated with deformation of a part of the wrench absent any interference and an interference overcoming force, which is an added force required to overcome the interference, once reached. Various ratios between these forces may be provided (e.g., in different embodiments), including, for example, high deflection force and low interference force, which may be used if the interference overcoming is used for indication. In another example, deflection force is low, which may be useful where the interference is used to differentiate clearly between two states of the wrench.

An aspect of some embodiments relates to a modular dental torque exerting ratchet wrench, comprising a replaceable proximal handle portion which is pre-configured to indicate when a selected torque is exerted by the distal ratchet wrench end of the tool. In some embodiments, a kit is provided, including a distal ratchet wrench portion and a plurality (e.g. 2, 3, 4, 5) of proximal handle portions, each pre-configured with a selected torque or multiple selected torques to be indicated.

Optionally, the portions are color coded, for example, to match a color of a dental implement with which they are used (e.g., implant or screw or structure to be attached using a screw). Optionally, a kit is provided with color coded wrenches and color coded screws. Optionally, a same screw design is provided as two screws each with a different color, to indicate a different use of the screw, for example, for use with a temporary superstructure or a permanent superstructure. The superstructures may be color coded to match.

An aspect of some embodiments relates to a torque exerting ratchet wrench in which the exerted torque is indicated by a frame that is movable with respect to an indicator such as a pointing needle. In some embodiments, the frame comprises scale markings indicating one or more torque magnitudes, and in response to rotation of the wrench (so as to exert torque at the distal end) the frame moves with respect to the needle, such that the needle points to the torque magnitude

currently being exerted by the distal end of the wrench. Optionally, the needle interferes geometrically with a portion of the frame, so as to provide a tactile and/or audible and/or visible change when such interference is reached and/or overcome. Optionally, a plurality of interference geometries are provided on the frame and/or on the indicator.

5 In some exemplary embodiments of the invention, the frame and indicator are positioned so as to be viewed from above a plane which is perpendicular to a driving rotation axis.

An aspect of some embodiments of the invention relates to a dental torque wrench in which passing a preset torque level causes a change in the geometry of a proximal 50% part of the wrench and/or portion designed to extend out of a patient's mouth.

10 Before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not necessarily limited in its application to the details of construction and the arrangement of the components and/or methods set forth in the following description and/or illustrated in the drawings and/or the Examples. The invention is capable of other embodiments or of being practiced or carried out in various ways.

15 Before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not necessarily limited in its application to the details set forth in the following description or exemplified by the Examples. The invention is capable of other embodiments or of being practiced or carried out in various ways.

Referring now to the drawings, **FIG.1** is a flowchart of a general method of using a torque exerting ratchet wrench to place an implant in a jawbone, according to some embodiments.

20 In some embodiments, a decision is made by a dentist, orthodontist, dental surgeon and/or other medical personnel to place an implant in a jawbone (100). It may be decided to place an implant as a part of a dental restoration process. The implant may serve as support for permanent dental fixtures and/or superstructures such as a prosthetic, a bridge, a crown, a bar, a denture, or temporary, such as a cover screw, a healing cap, an impression coping, a scan post.

25 In some embodiments, a bore is formed in the jawbone for receiving the implant (102). In some embodiments, to form the bore, the bone is exposed by cutting the gum above it, and introducing a drill to then drill a bore of a selected depth, diameter and/or other characteristics. In some embodiments, the bore is formed with an internally threaded surface. Optionally, the internal thread is generated according to implant specification, such as to match a certain pitch, diameter, length and/or other parameters of the implant to be received within the bore. Alternatively, the bore is formed with a smooth internal surface, in which case a self-tapping implant may produce the thread upon its insertion.

Optionally, the implant is then placed in the bore and a (optionally initial) driving of the implant into the bore is performed (104), for example using the drill (e.g. a motor drill) and/or by manual screwing. Alternatively, the implant is introduced and placed in the bore using a dental torque wrench for example as described herein, by connecting a driver to the wrench (106) (e.g. a screwdriver for an abutment screwing or an implant driver, such as an implant driver designed to fit a selected implant) and then connecting the implant to the driver (108). Optionally, the driver serves for both picking up the implant from its box or package and then for tightening the implant in the bore.

In some embodiments, once the implant is at least partially inserted into the bore (110), the wrench is used for tightening the implant. Optionally, for example as further described herein, the user selects a magnitude of torque to be exerted by the wrench onto the implant (112). In some embodiments, selection of torque is performed by one or more of: picking up a wrench that is pre-configured to exert the selected torque; replacing a proximal handle portion of the wrench with one that is pre-configured to exert the select torque; adjusting a proximal handle portion of the wrench to a torque selected out of a plurality of pre-configured torque magnitudes to be exerted by the wrench.

As can be appreciated, when attaching implants to the jaw bone and/or building and/or connecting structures in the mouth, there may be guidelines (e.g., for efficacy and/or safety) as to the allowed torque levels to be applied. For example, different screws may have a maximum allowed torque and/or a minimal required torque, for example, to ensure removability and/or prevent damage to the screw or structure attached to the screw and/or ensure sealing and/or a desired degree of deformation. In another example, different implants may require exertion of different magnitudes of torque in order to be properly screwed into the bore. Torque that is too high might damage the jawbone and/or the implant, for example mechanically deform the implant; in some cases, a torque that is too low might result in a non-stable, loose implant which is at risk of detaching from the bone. In some embodiments, the specific level of torque required is affected by the mouth anatomy of the patient. For example, it may be desirable to apply at least 50-60 Ncm to drive an implant, but no more than 65-75 Ncm. In some cases, the mouth anatomy of the patient modifies the actual handling of a torque wrench and hence the applied torque and/or interfere with an identification of the applied torque. In some exemplary embodiments of the invention, a torque wrench is provided to indicate that a desired torque level is reached and/or to indicate when a threshold is passed.

In some embodiments, the torque required for screwing of implants does not exceed 65 Ncm, 70 Ncm, 75 Ncm or intermediate, higher or lower magnitudes. In some embodiments, a torque of between 15-30 Ncm is applied for attachment of screws for abutments. Some examples include a torque of 15-20 Ncm for gold screws, impression copings, scan posts, healing caps; a torque of

about 30 Ncm for screws that are not formed of gold, for example, Titanium and Cobolt-Chrome. Such screws may have a maximum or generally specific indication of torque to be used, such as 15, 20, 30 Ncm or intermediate values (e.g., due to screw material and/or screw mechanical properties and/or properties of structures that are being screwed or attached using the screw, for example lower torques for temporary rather than permanent superstructure attachment). Implants may have, for example, an indication of a torque not to be exceeded (e.g., as implants are usually screwed to a desired geometry and not against a stop), for example, between 65 and 75 Ncm, though other numbers may be provided.

In some embodiments, the user rotates the wrench to exert torque onto the implant, thereby screwing the implant into the bone. Optionally, the user continues to rotate the wrench until the selected torque is indicated (114). In some embodiments, the wrench is configured to provide an indication that the selected torque had been reached. Such indication may be provided in the form of a tactile and/or audible and/or visible indication. In some embodiments, the selected torque is indicated by a mechanical “break point”, beyond which at least a portion of the proximal handle portion of the wrench is no longer directly aligned with a more distal portion of the wrench.

Optionally, to exert a higher (or increasing) torque than the indicated torque, the user may continue rotating the wrench past the break point.

In some embodiments, the wrench is used for removal of an implant from a jawbone. Optionally, when unscrewing an implant, indicating and/or limiting the torque is not required.

It should be noted that the application contemplates the rotational driving of various implants and implements. In particular, implants may be in direct contact with bone (e.g., be a bone implant) or be used to attach machine made parts (e.g., be a screw, an abutment or other dental fixture). Implements may include various dental tools, for example, implant drivers and screw drivers.

FIGs. 2A-B are two exploded side views of a dental assembly for placing an implant in a jawbone using a torque exerting ratchet wrench, according to some embodiments.

The figures show an exemplary construction in which a cover screw 208 is mounted on an implant 200, which has been implanted in jawbone 202, using a screwdriver 204 that is coupled to a torque exerting ratchet wrench 206, according to some embodiments. Optionally, for example as shown herein, the cover screw 208 is used as a cap on the head of the implant for protecting the implant, for example until a reconstructed crown is mounted on the implant.

In some embodiments, wrench 206 comprises an elongate body 210 including a distal portion 212 for insertion into the mouth and a proximal handle portion 214 which remains, at least in part, outside the patient’s mouth. In some embodiments, distal portion 212 ends with a ratchet ring spanner 216 shaped and sized for fittingly engaging a head of screwdriver 204. Alternatively, in

some embodiments an implant driver is used instead of a screwdriver, for example when implanting implant 200 into jawbone 202. The implant driver is configured for manual insertion of the implant and may also have an adaptor for connecting with a motor.

In some embodiments, proximal handle portion 214 comprises a torque setting component 218 for example as further described herein and ends with a finger rest location 220 (see figure 2B). Optionally, the finger rest location includes a non-smooth surface 222 (for example a ridged or bumpy surface) for enhancing friction with the finger upon contact. In some embodiments, finger rest location 220 is defined along a perimeter of a bulge at the proximal end of proximal handle portion 214. The bulge is optionally circular in general cross-section.

A potential advantage of such a bulge and/or non-smooth surface is that it helps guide a user's finger to rest in a known location and thus apply a torque with a known correspondence to the torque sensed by the interfering geometry. Various tactile-intuitive shapes may be used, for example, bumps and recesses (e.g., finger-tip sized recesses).

In some embodiments, proximal handle portion 214 comprises one or more markings 226 for indicating a pre-configured torque that the wrench is structured to indicate upon reaching the mechanical "break point". Marking 226 can be a number, for example, as shown and/or a colored section, for example, in the shape of a circle adjacent the number, as shown.

FIG. 3 is a flowchart of a method of using a ratchet wrench comprising a one-piece torque setting component, according to some embodiments.

In some embodiments, when using the wrench to apply torque to an implant, a user (e.g. dentist, dental surgeon, and/or other) inserts the distal portion of the wrench into the mouth to the location of the implant that needs to be fastened in place, and places their finger on the proximal handle portion of the wrench, for example at the finger-rest location (300).

The user then rotates the wrench to exert torque onto the implant. The torque increases with rotation, until reaching the "break point" which indicates the pre-configured torque. In some embodiments, the "break point" occurs when sufficient rotation leads to overcoming resistance that is produced by an interfering geometry of a torque-setting component of the wrench (302).

In some embodiments, the "break point" is characterized by an audible click indication. In some embodiments, the user senses a snap or fracture like feeling at their finger when overcoming the resistance at the pre-configured torque.

In some embodiments, the torque setting component that produces the break is comprised of a single piece of material shaped into at least two portions that have an interfering geometry between them (for example a protrusion and respective recess), and an elastic element extending between the two portions. In some embodiments, the elastic element is configured to flex as the torque increases

from the initiation of rotation of the wrench, increasingly bending until the resistance that is produced by the interfering geometry is overcome, at which point the elastic element deforms enough so that one portion slides past the other, possibly deforming the proximal of the wrench relative to the distal end of the wrench (the “break point”).

5 In some embodiments, when the exerted torque is below the pre-configured torque, rotation of the wrench forces one of the two portions of the torque setting component against the other portion, at the interfering geometry. The first portion continues to move with respect to the second portion until the pre-configured torque is reached, at which point the first portion overcomes the interference, producing the click. In some embodiments, after the pre-configured torque is surpassed
10 and indicated by the “break”, the first portion rests against second portion. Optionally, an alignment between the first and second portion changes at the “break”. For example, the first portion may change position from a linear alignment with respect to the second portion (and optionally with respect to the rest of the elongate body of the wrench) to a position in which the first portion is at an angle of, for example, between 10-30 degrees, for example, between 10-15 degrees, for example,
15 about 12 degrees, with respect to a long axis of the second portion.

In some embodiments, the proximal handle portion of the wrench which comprises the torque setting component remains outside the mouth at all times. Some potential advantages of the “break” occurring outside the mouth may include reducing a risk of damage to tissue by minimizing movement inside the mouth; providing a visible indication to the user that the “break point” had
20 been reached; and, in some embodiments, allowing for replacement of the proximal handle portion by a different one, such as one that is pre-configured with a different torque limit, without disengaging what is being driven, from the patient.

In some embodiments, a user may choose to continue exerting torque beyond the indicated torque level, by continuing to rotate the wrench even after the “break point” (304). A user may
25 decide to continue exerting torque beyond the indicated level in situations such as removal of an implant, or when additional tightening is required to fit the implant to a certain anatomy of the patient. A potential advantage of the deformation location of the wrench being outside the patient’s mouth, as in some embodiments of the invention is that such deformation does not interfere with parts of the oral cavity and does not prevent further force application.

30 In some embodiments, the pre-configured torque is set to a maximal torque, and the “break” indication is provided as a safety mechanism for indicating a torque limit that the user should not exceed. In an example, the pre-configured torque is set to a maximal level of 65-70 Ncm. In other applications other maximum torque levels are set, for example, 15, 20, 25, 30, 35, 50, 55, 60, 65, 70, 75, 80 Ncm, or intermediate or smaller or larger torques.

In some exemplary embodiments of the invention, once a break is passed, the wrench is prevented from going back to a previous state where there is no break indication. In one example, the geometry of the interference at the break resists forces (if any) elastically applied by the deformation of the wrench, caused by the break.

5 **FIGs. 4A-C** schematically illustrate operation of a one-piece torque setting component comprising two portions formed with an interfering geometry between them and connected by an elastic element, according to some embodiments.

10 In the example of a torque setting component 400 as shown herein, a first portion 402 is positioned opposite a second portion 404. The two portions are formed with an interfering geometry, in this example comprising a protrusion 406 extending from first portion 402, and a respective recess 408 formed in second portion 404. While in this example a rectangular protrusion is shown, other interfering geometries are also contemplated, for example a bulge and a respective indentation or two partially overlapping bulges.

15 In some embodiments, an elastic element extends between the two portions. In this example, the elastic element comprises a living hinge 414. Other examples may include a spring, a coil and/or a bendable beam. In some embodiments, the elastic element couples the two portions to each other in a manner that provides for at least some movement of the portions with respect to each other, and limits other movement. In this example, hinge 414 extends from a corner of distal face 416 of first portion 402 to a corner of distal face 418 of second portion 404. In operation, hinge 414 is
20 configured to flex to allow for a lateral movement and a slight pivot of first portion 402 with respect to second portion 404, while optionally maintaining portions 402, 404 in a same plane. In some embodiments, hinge 414 bends (as shown for example in figure 4B) until the interfering geometry is overcome at the “break point”, and then deforms back to a non-flexed configuration.

25 In some exemplary embodiments of the invention, hinge 414 is selected to operate away from its limit of elasticity, so it may be reused. In some embodiments, hinge 414 operates past this limit, for example, permanently deforming once “broken”. This may assist in preventing reuse or ignoring the passing of a torque limit. In some exemplary embodiments of the invention, hinge 414 has a relatively low resilience, for example, so deflection past the interference point (e.g., assuming there is no actual interference) requires less than 50%, 20%, 10% or intermediate percentages of the
30 force required to actually overcome the interference. In some embodiments, such deflection requires more force, for example, at least 100%, 170%, 250%, 300%, 500% or more or intermediate percentages of the force required to overcome the interference.

Fig. 7B shows an example system where the deflection force may be substantially larger than the interference overcoming force, while Fig. 4A-4C may be implemented in an opposite design, where the deflection force is small.

In some embodiments, the two portions are formed with a spacing 410 between them, which is large enough to provide for at least one of the portions to move with respect to the other. Optionally, one portion moves while the other remains static. In the shown example, applying of a pushing force 412 onto first portion 402, such as during rotation of the wrench, moves first portion 402 with respect to second portion 404. Optionally, portion 402 moves laterally until protrusion 406 encounters a wall of recess 408 (as shown for example in figure 4B). As the applying of pushing force 412 continues (as shown for example in figure 4C), portion 402 slightly pivots, and protrusion 406 overcomes the wall, (overcoming the step), and the “break” is produced.

In some embodiments, a shape and/or size and/or position of the interfering geometry is selected according to the pre-configured torque that is indicated by the “break”.

In some embodiments, the two portions and the elastic element that couples between them, altogether defining the torque setting component, are comprised of a single piece of material. In some embodiments, the torque setting component is machined, as a whole, out of a single element, for example when it is made of metal, such as titanium or steel. In some embodiments, the torque setting component is manufactured by injection molding, using a single mold, for example when it is made of plastic.

In some exemplary embodiments of the invention, the proximal portion and distal portion of the wrench are formed of different base materials. For example, the distal portion may be metal, while a proximal portion may be plastic and/or otherwise be formed of a low-cost and/or low-wearing material. This may be useful for disposable torque setting elements optionally paired with screws or tailor-made implants or implements.

In some embodiments, the elastic element (in this example, the living hinge) is a direct extension of the two portions, and no additional fastening or fixation means are used for holding the two portions and the elastic element together. A potential advantage of a unitary, single-piece torque setting component may include reducing a risk of breakage, wear and/or detachment of components. Since the wrench is used inside the mouth, at least in part, using a mechanism that is detachment-proof may provide increased safety. Another potential advantage may include simplifying use, for example during cleaning (e.g sterilizing) of the wrench, as no components need to be taken apart and less or no residue collects in between portions of the wrench, for example as compared to torque wrenches that are comprised of multiple (for example two or more) independent components (for example portions of the wrench, fixations, elastic elements of the wrench, etc).

Fig. 4D schematically illustrates a one-piece torque setting component 420 having two torque settings, in accordance with some embodiments of the invention. In this example, a single protrusion 426 on a portion 422 can successively interfere geometrically with two recesses 428 and 429 on a portion 424. The size and/or location and/or other geometrical parameters of the recesses can be selected to provide desired torque settings.

In one example, one torque setting indicates reaching a desired maximum value and a second setting indicates a safety limit. In another example, one setting indicates reaching a desired lower limit and the other indicates reaching a higher limit.

Optionally, protrusion 426 is shaped to interfere properly with both recesses 428 and 429. Optionally, elastic element 434 is selected to elastically (or non-elastically) deform for both interference positions. More than two recesses can be provided, for example, three, four or more. Optionally or alternatively, a plurality of protrusions may be provided. In general, other interference geometries with successive interference break points may be used.

It is a particular feature of some implementations of the designs of Figs. 4A-4D that they allow the inference geometry and the break point of the wrench to be at a proximal side of the wrench. This may be due, for example, to the use of a single component, which allows better tolerances and also smaller forces (e.g., between 0.5 and 10 Newtons, for example, between 2 and 4 Newtons) to be used to overcome the interference.

While Figs. 4A-4D show designs where there is no substantial deformation of the wrench itself before overcoming the interference geometry, this need not be the case. For example, providing a greater circumferential (e.g., in direction of rotation) space between 406 and 404, will allow the wrench to deform before the interference therebetween prevents further movement.

FIGs. 5A-D show a torque exerting ratchet wrench comprising a plurality of finger-rest locations, each location pre-configured to set a different torque (figure 5A), and several views of a proximal handle portion of such wrench (figures 5B-D), according to some embodiments.

In some embodiments, a proximal handle portion 500 of wrench 502 comprises a plurality (e.g. 2, 3, 4, 5 or more) of finger rest locations 504. In some embodiments, by placing the finger on a selected finger rest location, a maximum different torque is exerted by the distal end of the wrench onto the implant before the break. In the example shown herein, three finger rest locations indicate three different torques, 20, 30 and 65 Ncm. In some embodiments, the wrench is configured to apply one or more torque magnitudes selected from the range of 10-100 Ncm, 20-80 Ncm, 15-75 Ncm, 20-75 Ncm, or intermediate, higher or lower ranges. In some exemplary embodiments of the invention, finger rest locations 504 are designed to encourage resting of a finger thereon.

A potential advantage of a wrench including designated finger rest locations that provide for discrete selection of the torque to be exerted by the wrench may include facilitating use and promoting safety, as the user selects one of the designated torques and during operation receives a clear tactile, audible and visible indication when that torque had been reached.

It is noted that in some embodiments of the invention the finger rests are sized and/or shaped (e.g., including a short depression for a fingertip) to each include only a narrow range of comfortable positions, thereby constraining the length of the lever (and optionally torque) applied by the finger to such range. In some embodiments, there are multiple comfortable positions, but tactile feedback (e.g., protrusion vs. depression) guides the finger to one or more particular selected positions.

Optionally, the magnitude of exerted torque decreases as the distance of the finger rest location 504 from the interfering geometry 506 increases.

In some exemplary embodiments of the invention, each finger rest is between 2 and 5 mm in length.

In some embodiments, proximal handle portion 500 is configured to detach from a distal portion 508 of the wrench. In some embodiments, the proximal handle portion is detached before (or after) use and replaced by a different proximal handle portion, such as one including different torque value(s) to be exerted. Such detaching may be used in other embodiments as well.

In some embodiments, a detachable coupling between proximal handle portion 500 and distal portion 508 comprises, for example, one or more pins received within respective holes 510 (see figure 5B), and/or other coupling designs, for example, screw connection, ball joint and one or more clamp.

In some embodiments, as shown for example in figure 5A, a wing 512 extends distally from proximal handle portion 500. In some embodiments, a proximal part of wing 512 acts as a stop that limits further pushing of the proximal end 514 of the handle (on which the finger rest locations 504 are configured), after the interfering geometry is overcome (that is, beyond the "break point"). In some embodiments, a distal part of wing 512 extends partially into distal portion 508 of the wrench, and may provide countering resistance upon pulling of the proximal handle portion 500 away from the distal portion 508. A potential advantage of increasing resistance may include reducing a risk of unwanted detachment of the two portions from each other.

In some embodiments, the coupling between the proximal handle portion and the distal handle portion of the wrench is configured to limit movement of the portions with respect to each other, for example allowing for separation only along a long axis 518 of the wrench, such as by pulling the portions with respect to each other (to separate between them) or pushing the portions

with respect to each other (to connect the portions together). A potential advantage of limiting respective movement of the two portions may include reducing a risk of unwanted detachment. Another potential advantage may include providing for an uninterrupted transfer of the torque moment from the proximal end of the wrench to the distal end.

5 In general it is noted that two different designs may be used for interfering geometries. In a first design, the interference geometry is before the elastic element, so that applying force to a finger rest could conceivably continue bending the elastic element (and wing 512 may stop it). In a second design, the elastic element is deformed towards (rather than away) from the interference geometry, potentially using part of the interference geometry itself to stop movement of the
10 previously interfering portions. The second design may be less amenable to providing a large angle “break”. In other designs the elastic element and interference geometry are not in a simple order, for example, the elastic element underlying or overlaying the interference geometry. In some exemplary embodiments of the invention, the design, for example, as shown, has a substantially fixed cross-section when viewed from above. This may assist in forming by molding or machining.

15 In some exemplary embodiments of the invention, wing 512 acts as a lever to selectively lock or unlock proximal portion 500 from distal portion 508, by selecting moving away two interfering elements 520 and 522 (e.g., it may function as a clamp). Optionally, a spring 524 serves to elastically urge wing 512 to a locked configuration. A slope 526 may serve to allow snap connection by guiding element 522 so as to open wing 512 to an unlocked configuration. Optionally,
20 clamping or locking is provided by the wing and/or spring being attached to a distal part of the wrench, while an interference geometry is provided on the proximal side of the wrench.

A potential advantage of a modular wrench may include the ability to replace a proximal handle portion while the tool is at least partially inside the mouth and the distal end of the wrench remains engaged with the implant. Optionally, in such situation, various torque magnitudes can be
25 applied to the same implant (for example at different stages of implantation) without the need to detach the wrench from the implant, remove it from the mouth and reinsert a different wrench.

Alternatively, in some embodiments, the wrench is unitary. Optionally, the complete wrench is formed of a single piece of material.

In some embodiments, the wrench is configured for indicating a single torque magnitude.
30 Optionally, if a modular wrench is used, the same distal portion 508 can be used with a plurality of proximal handle portions 500, for example each configured for indicating a different torque magnitude.

Alternatively, the wrench is pre-configured for indicating a plurality (e.g. 2, 3, 5, 7 or intermediate higher or lower number) of torque magnitudes. Optionally, a user selects which torque to apply by placing their finger on the designated finger rest location.

In some embodiments, a tailored wrench is provided, configured for indicating one or more
5 torques selected in accordance with a specific implant to be implanted. In some embodiments, the tailored wrench (optionally disposable or including a disposable torque setting section, optionally with permanently pre-fixed settings) and implant are provided together in kit form.

FIGs. 6A-C are several views of a torque exerting ratchet wrench comprising a plurality of torque indication locations, each pre-configured to set a different torque, and a selection knob that is
10 movable between the locations, according to some embodiments.

In some embodiments, a proximal handle portion 600 of the wrench is structured to provide for selection of a torque magnitude to be exerted by the wrench. Optionally, the torque magnitude is selected out of multiple discrete torque magnitudes.

It is a particular feature of some embodiments of the invention that selection of the torque is
15 by selecting a finger resting location and not (necessarily) by modifying a mechanical characteristic of the force transmission mechanism or of a break mechanism.

In the exemplary configuration shown herein, proximal handle portion 600 includes a selection knob 602 which movable (for example, slidable) between a plurality of torque indication locations, each location pre-configured to set a different torque to be exerted by a distal end of the
20 wrench onto the implant. In some embodiments, the torque is indicated by markings 604. Optionally, the pre-configured torque magnitudes are from the range of 10-70 Ncm, 20-50 Ncm, 5-100 Ncm or intermediate, higher or lower torque magnitudes.

In some embodiments, in use, a user moves selection knob 602 (for example sliding it along track 606) to a desired torque, and then places their finger on the knob when pushing (rotating) the
25 wrench. Optionally, the user stops moving the wrench when reaching the “break point” at the desired torque. Alternatively, the user continues moving the wrench to exert increasing torque, beyond the selected torque.

Optionally, knob 602 is frictionally engaged with track 606, for example, by matching interfering small protrusions on the track and the knob. This may assist in preventing inadvertent
30 repositioning of knob 602. Optionally or alternatively, a clamp, spring loaded pin or other locking mechanism is provided.

Figs. 6D and 6E show an alternative design, in which the torque setting is displayed on a display portion 624 of a knob 622 (optionally instead of on a handle portion 620. Fig. 6E is a side view showing two states of position of knob 622.

Optionally, the display is mechanical. In one embodiment, knob 622 includes an internal cylinder 628 which rotates (as indicated by rotation of a reference line 630) due to friction and/or intermeshing with a track 626 when knob 622 is slid along track 626. As cylinder 628 rotates, different printed indications on its surface serve as display 624. Optionally, a transparent window or an opening 632 is provided on a top surface of knob 622.

A potential advantage of this design is that it allows a more continuous setting and/or indication of torque.

In both handles 600 and 620, one or more stops may be defined (e.g., as geometrically interfering elements) along track 606 and 626, which interfere with sliding of knob 622, thereby defining natural stopping points which a user can sense in a tactile manner (e.g., due to increased resistance). In the design of handle 626, such a stop may be defined instead or in addition in cylinder 628.

FIG. 7A illustrates a proximal handle portion 700 of a torque exerting ratchet wrench, the handle portion comprising a needle or other indicator 702 for pointing at a torque indication and a frame 704 movable with respect to the needle, according to some embodiments.

In some embodiments, in use, needle 702 remains linearly aligned with respect to a more distal body portion 706 of the wrench, while frame 704 moves with respect to the needle in response to increasing torque exerted by the distal end of the wrench, so that the needle points out the exerted torque by pointing out to a scale marking 708 on the frame 704.

In some exemplary embodiments of the invention, the deformation of frame 704 relative to indicator 702 generates an angular movement of between 2 and 20 degrees, for example, between 3 and 10 degrees, over the allowed and/or desired range torque levels.

In some embodiments, a length of the wrench is selected to be sufficient so as to have the needle and frame outside the patient's mouth, allowing the user clear visual access to the scale markings on the frame and the tip of the needle. In some embodiments, an alignment between the needle and the frame is structured so that the user can identify the scale marking and needle tip when looking at the proximal handle portion directly. Optionally, the wrench is designed for a view from above (e.g., patient is sitting and doctor is above. Alternatively or additionally, the wrench is designed for view from both sides, to allow viewing when the dentist operates on the mandible or the maxillae (where the wrench would be flipped).

In some exemplary embodiments of the invention, part of frame 704 is made thicker (e.g., at 710), so as to control the location and degree of deformation response to user applied force. For example, it may be useful that deformation is distanced from a finger rest location 712, so as to reduce variability in indicated torque due to variability in exact finger rest location. For example, if

there is an expected finger rest location range of 1 cm, the distance may be selected to be at least 2 cm, so as to reduce variability to less than 50%.

In some exemplary embodiments of the invention, thickening 710 is used as a stop, to mechanically interfere with indicator needle 702 if too much force is applied. This may assist in maintaining deformation in an elastic range. Contact between needle 702 and frame 710 may also generate an audible (e.g., metal on metal or polymer “click”) and/or tactile indication to a user.

In some exemplary embodiments of the invention, finger rest 712 includes a finger rest recess. Alternatively, a preferred finger resting location is indicated to a user by flatness or a slight protrusion at location 712.

Fig. 7B shows a variation 720 of the handle of Fig. 7A, in which one or more interference geometries (e.g., protrusions) 722, 724 are provided as well, to interfere with indicator 702.

In use, when a user applies force, frame 704 deforms, indicating current torque, until an interference point is reached. Then a user is required to apply additional force, which does not change the relative positions of needle 702 and frame 704, until sufficient deformation of needle 702 and/or frame 704 and/or protrusion 722, 724 occurs, the interference is overcome and needle 702 can continue its motion. In some exemplary embodiments of the invention, the degree of interference is small, so as to provide a tactile and/or audible and/or visible indication, but not substantially restrict movement. This may be achieved by requiring a relatively small force to overcome the interference, as compared to the force needed to move frame 704 relative to indicator 702, absent the interference.

In some exemplary embodiments of the invention, the locations of the perturbations are aligned with numerical indicators (or indications such as “min” and “max”). Optionally, the indication of indicator 702 is only approximate between at least some of protrusions 722, 724.

In some exemplary embodiments of the invention, protrusions 722 and 724 are designed so that release of the force by the user allows the indicator 702 to slide past them back to its resting position relative to the frame. This may be, for example, due to a sloped shape on the protrusion on the trailing side and/or due to the force applied by the frame deformation being sufficient to overcome the interference.

In some exemplary embodiments of the invention, one or more of the perturbations 722, 724 prevent movement of indicator 702 past or back, for example, giving a visual indication of the passing of a threshold. and/or giving a tactile feedback when a threshold is reached.

FIGs. 8A-B illustrate a slidable sleeve for adjusting torque exerted by the ratchet wrench by affecting flexure of an elastic element of the torque setting component, according to some embodiments.

In some embodiments, torque exerted by the wrench is adjusted by affecting one or more properties of an elastic element of the torque setting component. In this example, a bending length of an elastic element in the form of a living hinge 800 is adjustable using a band or sleeve 802 that is positioned to hold hinge 800 to a side wall 804 of the proximal handle portion 806, the sleeve
5 configured to be moved (e.g. slide) along the length of the living hinge. By moving sleeve 802 in the direction of arrow 808, shown in figure 8A, a bending length of the hinge is shortened, and in turn the proximal end 810 needs to be pushed (rotated) further in order to overcome the interfering geometry, which in this example comprises a protrusion 812 and respective recess 814. Since a higher pushing force needs to be applied to overcome the interference, the torque exerted by a distal
10 end of the wrench onto the implant at the “break point” (of overcoming the interference) is increased. In another example an insert (not shown, optionally made of a polymer or metal) is inserted between hinge 800 and other parts of the proximal end, preventing bending of the hinge at such insertion location.

A potential advantage of a wrench comprising a torque adjusting element such as the sleeve
15 may include the ability to set, using a single proximal handle portion, a desired torque to be indicated by the “break point”. Such configuration may further provide for selecting continuous (increasing) torque magnitudes according to the need, as opposed to selecting from discrete pre-defined torque magnitudes.

FIG. 9 is a graphical schematic representation of the relation between the deformation of the
20 wrench and the applied torque, according to some embodiments of the invention.

Reference 900 is a line corresponding to device 720 of Fig. 7B. Initially, displacement increases in a manner corresponding to the applied torque, as both deformation and torque are a function of the force applied by a user’s finger. At 904, protrusion 724 is met, which prevents further deformation and requires the force applied (and therefore torque applied) to increase until the
25 interference between indicator 702 and protrusion 724 is overcome. After such overcoming, the needed applied force goes down 906, until protrusion 722 is met, which requires a greater force (and therefore resulting torque) to be applied, as indicated at 908.

Reference 920 and 928 represent the behavior of a device 420, such as shown in Fig. 4B. Reference 920 shows the general behavior at a first finger rest, closer to the proximal end and
30 reference 928 shows the general behavior at a second finger rest, closer to the distal end. As can be seen, a same interference geometry results in a lower applied torque when the finger rest is further from the distal, driving, end.

Referring specifically to line 920, reference 922 indicates the initial force application by a user. While reference 922 shows a deformation, in some embodiments, no deformation is possible until a step is overcome.

At 924, a first interference point is reached. As can be seen the applied torque goes up, as the user applies more force, but the wrench does not deform until the interference is overcome and then there is a large deformation.

There is a reduction in the force, and then when a second interference point (if any) is reached, at 926 a greater force is needed to overcome it and the applied torque increases correspondingly. The amount of deformation at each interference geometry (e.g., as indicated by the width of 924 and 926 and the torque level between 924 and 926 depend on, for example, the stiffness of the elastic element and/or the degree of deformation required to overcome the interference geometries (e.g., recesses 428, 429).

It is noted that, in general, increasing the distance of the finger-rest location from the interfering geometry implies increasing a distance of the point where the force is applied, thus increasing the leverage. This means that for a same force (and nearly the same torque, as the lever between the finger rest and the distal end is similar for all finger rest positions), a higher torque and force are applied to the interference geometry, so that a same interference geometry is breached at a lower applied force. It is noted there is some difference in the applied torque to the driven end. The following formulas may be used to describe the relationship between torque setting, finger position and the applied torque.

Taking

L_0 =distance between distal driving point and the break location;

M_0 =torque applied at distal driving point;

L_1, L_2, L_3, L_n = distances between the break location and corresponding finger rest location

M_s = torque at which a break happens;

F = force actually applied by user's finger

$$(eq\ 1)\ M_s = M_0 * (L_0 + L_n) / L_n;$$

And

$$(eq\ 2)\ M_0 = F * (L_0 + L_n)$$

Figs 10A-10B illustrate the effect of break point location on the geometry of a wrench, in accordance with some embodiments of the invention.

Fig. 10A schematically shows a design 1000 in which a break point 1006 between a distal part 1002 and a proximal part 1004 is nearer the distal tip of the wrench.

5 Fig. 10B schematically shows a design 1020 in which a break point 1026 between a distal part 1022 and a proximal part 1024 is nearer the proximal tip, for example as shown in Fig. 2A and 2B.

As can be seen, a same amount of angular break has a greater effect on the overall wrench geometry (assuming distal part 1002, 1022 is fixed in the mouth) when the break is near the distal tip. This can have two negative effects. First, there is more of a chance of proximal part 1004 contacting structures in the mouth than part 1024. Second, the fact that a break occurred is less visible in design 1000, as a user may not know if the break occurred or if the wrench simply rotated a bit more. In design 1020, the break is desirably outside of the mouth or at least nearer the lips and more visible.

15 A particular advantage of some of the interference designs shown herein is that relatively little force is needed to overcome them (or they can be so designed) allowing sufficient force to be applied by a user even if the breakpoint is nearer the proximal end and experiences a shorter lever to amplify user applied force.

In some exemplary embodiments of the invention, wrench 1020 is between 4 and 20 cm long. In some exemplary embodiments of the invention, the break point is between 5 and 15 cm from the distal end and/or between 1 and 10 cm from the proximal end.

The terms "comprises", "comprising", "includes", "including", "having" and their conjugates mean "including but not limited to".

The term "consisting of" means "including and limited to".

25 The term "consisting essentially of" means that the composition, method or structure may include additional ingredients, steps and/or parts, but only if the additional ingredients, steps and/or parts do not materially alter the basic and novel characteristics of the claimed composition, method or structure.

Throughout this application, various embodiments of this invention may be presented in a range format. It should be understood that the description in range format is merely for convenience and brevity and should not be construed as an inflexible limitation on the scope of the invention. Accordingly, the description of a range should be considered to have specifically disclosed all the possible subranges as well as individual numerical values within that range. For example, description of a range such as from 1 to 6 should be considered to have specifically disclosed

subranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from 3 to 6 etc., as well as individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies regardless of the breadth of the range.

Whenever a numerical range is indicated herein, it is meant to include any cited numeral
5 (fractional or integral) within the indicated range. The phrases “ranging/ranges between” a first indicate number and a second indicate number and “ranging/ranges from” a first indicate number “to” a second indicate number are used herein interchangeably and are meant to include the first and second indicated numbers and all the fractional and integral numerals therebetween.

As used herein the term "method" refers to manners, means, techniques and procedures for
10 accomplishing a given task including, but not limited to, those manners, means, techniques and procedures either known to, or readily developed from known manners, means, techniques and procedures by practitioners of the chemical, pharmacological, biological, biochemical and medical arts.

As used herein, the term “treating” includes abrogating, substantially inhibiting, slowing or
15 reversing the progression of a condition, substantially ameliorating clinical or aesthetical symptoms of a condition or substantially preventing the appearance of clinical or aesthetical symptoms of a condition.

It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment.
20 Conversely, various features of the invention, which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable subcombination or as suitable in any other described embodiment of the invention. Certain features described in the context of various embodiments are not to be considered essential features of those embodiments, unless the embodiment is inoperative without those elements.

WHAT IS CLAIMED IS:

1. A dental torque exerting ratchet wrench comprising:
a distal ratchet wrench portion configured for engaging a driver;
a proximal handle portion comprising:
a torque-setting component structured to indicate when a selected torque is exerted onto the driver upon rotation of the wrench, the torque setting component comprising:
at least two portions formed with an interfering geometry between them;
an elastic element which connects said at least two portions to each other, said elastic element configured to deform in response to increasing torque to provide for one of said portions to overcome said interfering geometry when said selected torque is reached;
wherein said at least two portions and said elastic element constitute a single piece.
2. The wrench according to claim 1, wherein said elastic element comprises a living hinge.
3. The wrench according to claim 2, wherein said living hinge is configured to be flexed to allow at least one of said two portions to move with respect to the other portion.
4. The wrench according to any of the preceding claims, wherein said proximal handle portion is manufactured using a single mold.
5. The wrench according to any of the preceding claims, wherein said at least two portions and said elastic element of the torque-setting component are formed from a single piece of material.
6. The wrench according to any of the preceding claims, wherein said elastic element defines a direct extension of said two portions.
7. The wrench according to any of the preceding claims, wherein said two portions of the torque setting component are formed with a spacing therebetween, said spacing large enough to provide for movement of at least one of said two portions with respect to the other until said interfering geometry is encountered.
8. The wrench according to claim 7, wherein said movement comprises at least one of lateral movement and pivoting of at least one of said portions with respect to the other.

9. The wrench according to any of the preceding claims, wherein said interfering geometry comprises a protrusion formed in one of said two portions and a respective recess formed in the other, said recess defining a step to be overcome by said protrusion.

10. The wrench according to any of the preceding claims, wherein said proximal handle portion comprises at least one finger-rest location shaped and sized to be engaged by user's finger.

11. The wrench according to claim 10, wherein said proximal handle portion comprises multiple designated finger-rest locations, each location setting a different torque to be exerted by the distal ratchet wrench portion.

12. The wrench according to any of the preceding claims, wherein said proximal handle portion comprises a selection knob including a finger rest that is movable between a plurality of locations configured along said handle portions, each location setting a different torque to be indicated by the interference mechanism reflecting the torque applied by the distal ratchet wrench portion when a user applies force at the finger rest.

13. The wrench according to claim 12, wherein said knob includes a torque indication.

14. The wrench according to any of the preceding claims, wherein said wrench is configured to indicate one or more torque magnitudes selected from the range of 20-70 Ncm.

15. The wrench according to any of the preceding claims, wherein a length of said wrench along its longitudinal axis is long enough to maintain an indication of said torque setting component outside the mouth of the patient.

16. The wrench according to any of the preceding claims, wherein said distal ratchet wrench portion and said proximal handle portion are formed as a single piece.

17. The wrench according to any of claims 1-15, wherein said proximal handle portion is attached to said distal ratchet wrench portion by a removable coupling.

18. The wrench according to claim 17, wherein said proximal portion is formed of a polymer material.

19. The wrench according to claim 17 or claim 18, wherein said distal portion is formed of metal.

20. The wrench according to any of claims 17-19, wherein said coupling comprises one or more pins received within respective holes.

21. The wrench according to any of claims 17-20, wherein said coupling is structured to allow detaching of said proximal handle portion only by axially pulling said proximal handle portion away from said distal ratchet wrench portion.

22. The wrench according to any of claims 17-21, comprising an elastically loaded clamp interlocking said distal portion and said proximal portion.

23. The wrench according to claim 2 or claim 3, comprising an insert which is locatable adjacent said living hinge for adjusting a bending length and/or bending location of said living hinge.

24. A dental torque exerting ratchet wrench kit comprising:

a distal ratchet wrench portion configured for engaging a driver;

a plurality of proximal handle portions, each proximal handle portion configured to engage said distal ratchet wrench portion, each proximal handle portion pre-configured to indicate, when engaged with said distal ratchet wrench portion, a different selected torque when said selected torque is exerted by said distal ratchet wrench portion.

25. The kit according to claim 24, wherein each of said proximal handle portions comprises a single-piece torque setting component.

26. A dental kit comprising:

a torque exerting ratchet wrench;

an implant to be implanted in an oral cavity by application of a pre-defined torque;

wherein said wrench is structured to indicate said pre-defined torque when said predefined torque is applied by said wrench directly onto the implant or via a driver coupled to the implant.

27. A dental torque exerting ratchet wrench comprising:

a distal ratchet wrench portion configured for engaging a driver;

a proximal handle portion comprising:

a movable frame comprising a plurality of scale markings indicating torque magnitudes;

a pointing indicator having a tip;

wherein said handle is configured to deform such that said frame can move with respect to said pointing indicator in response to a change in torque exerted by said distal ratchet wrench portion due to user force applied at said handle, such that said tip points to a scale marking indicating the exerted torque.

28. A wrench according to claim 27, wherein said tip and said frame define at least one interfering geometry therebetween, which prevents further movement of said frame with respect to said indicator, each geometry corresponding to a deflection of said indicator relative to said frame by a given torque,

wherein at least part of said handle portion deforms under application of user force to overcome said interfering geometry and allow further relative movement of said frame relative to said indicator.

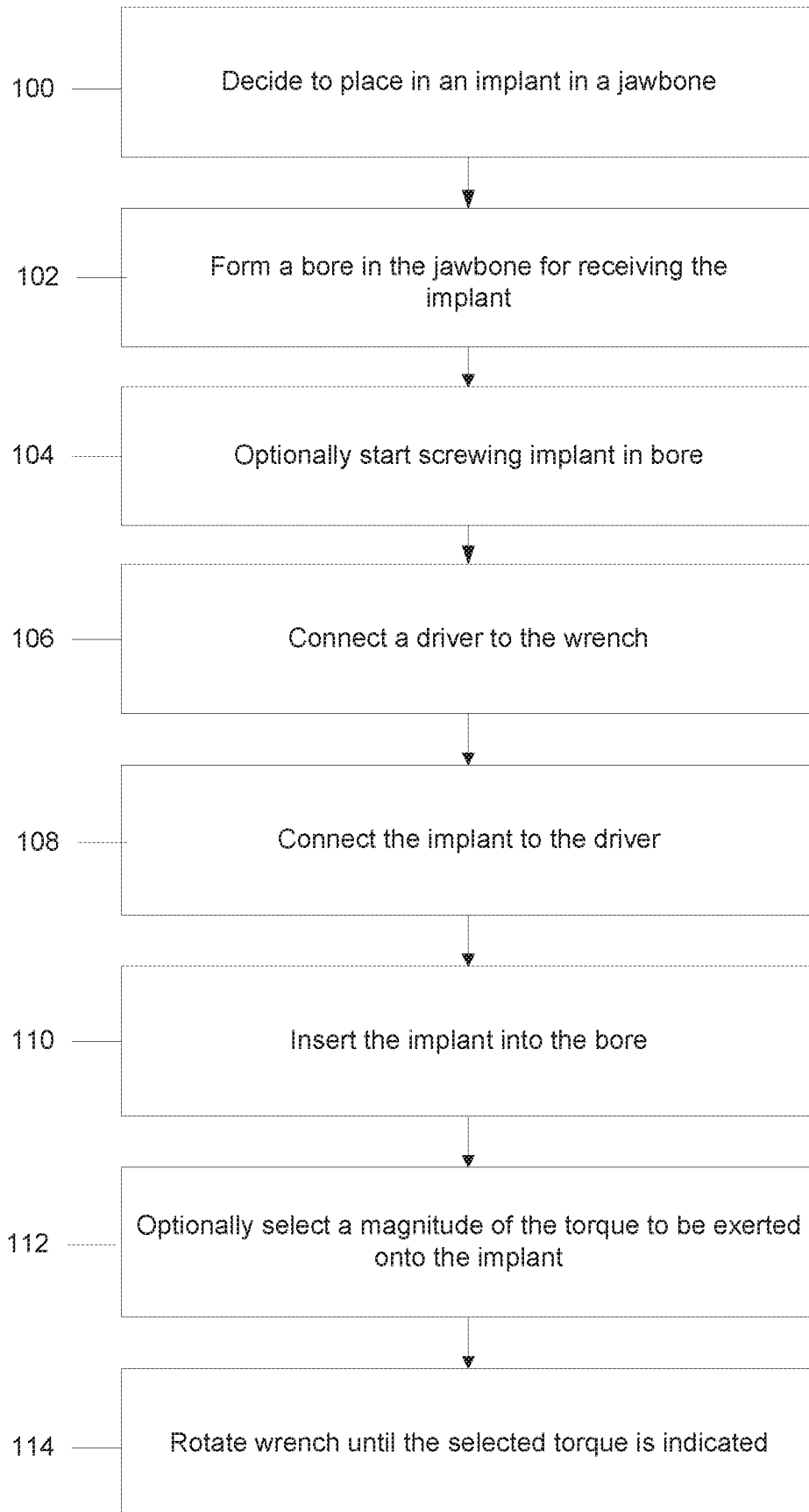


FIG. 1

FIG. 2A

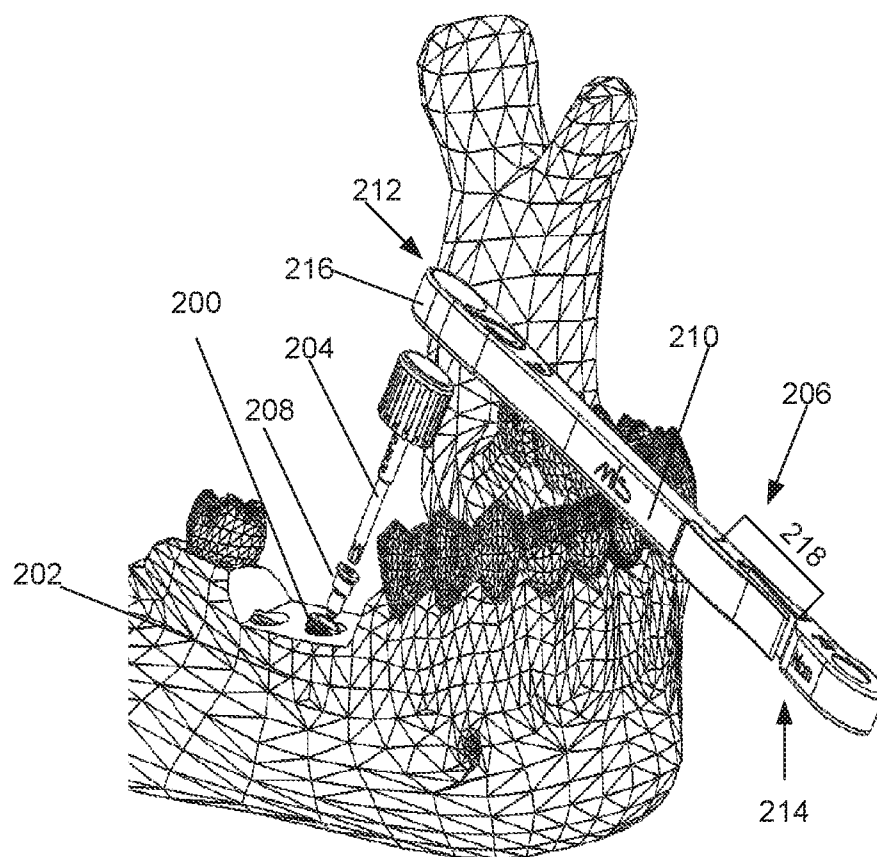
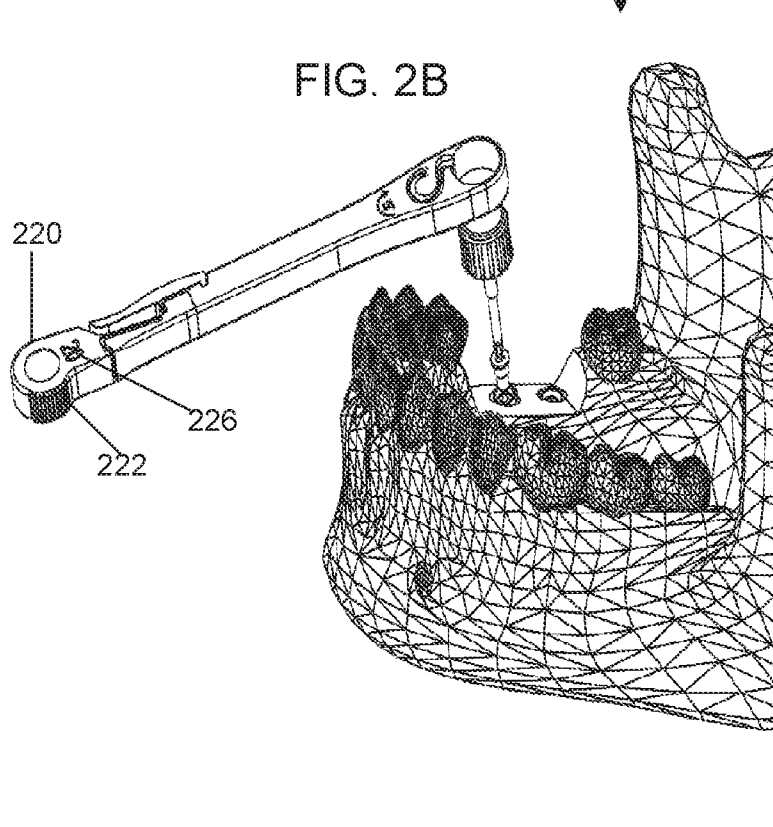


FIG. 2B



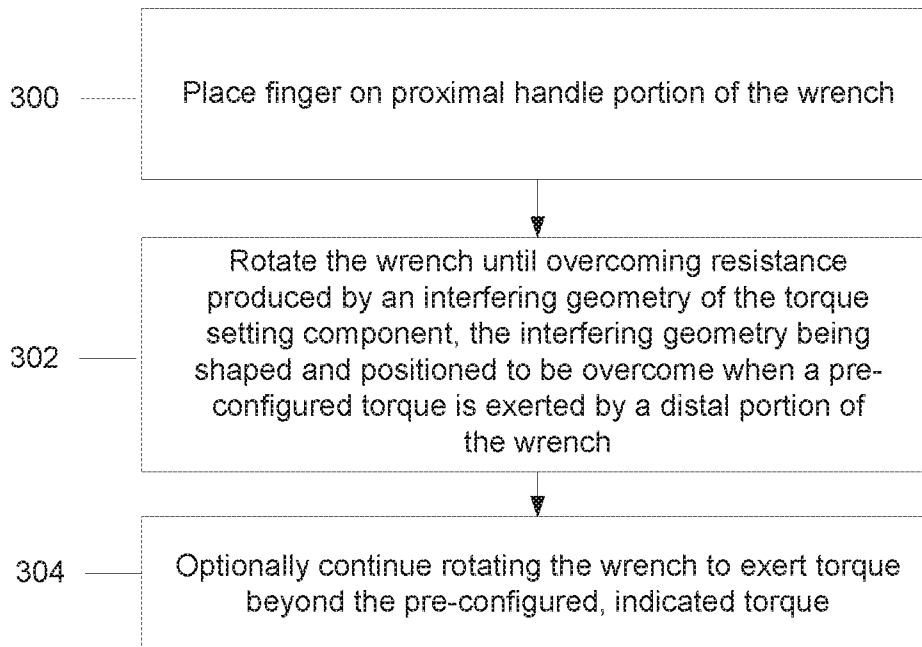


FIG.3

FIG. 4A

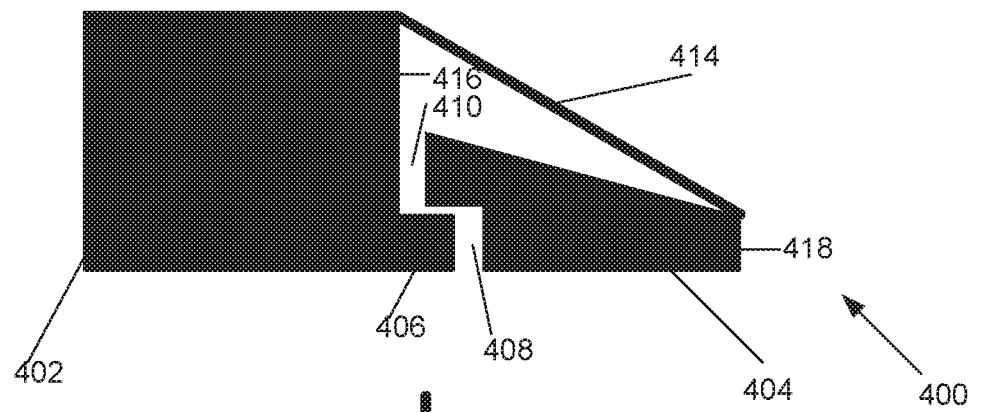


FIG. 4B

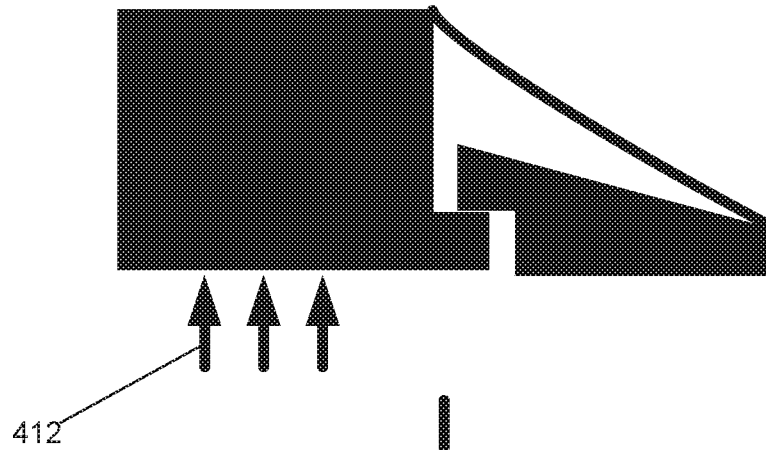
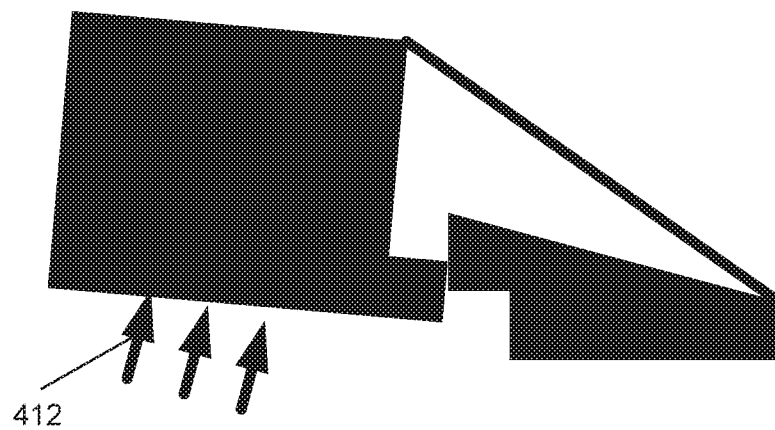


FIG. 4C



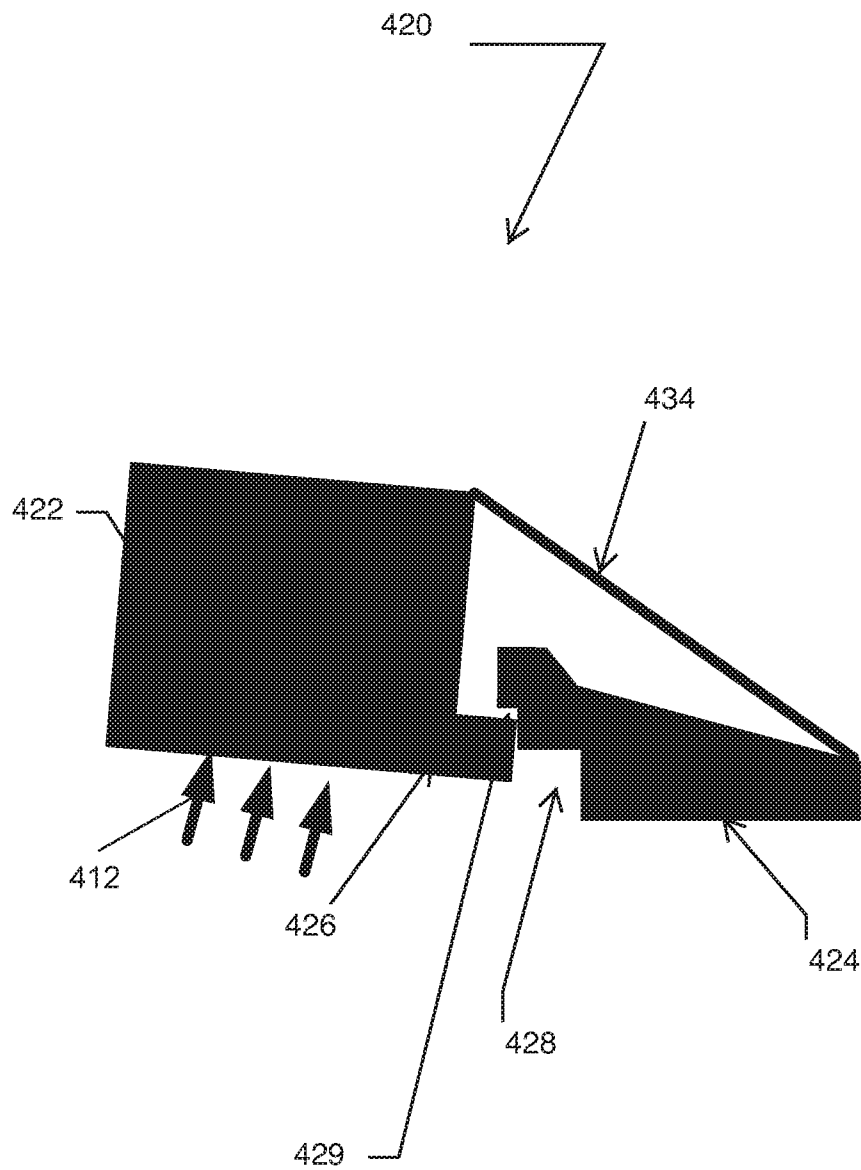


Fig. 4D

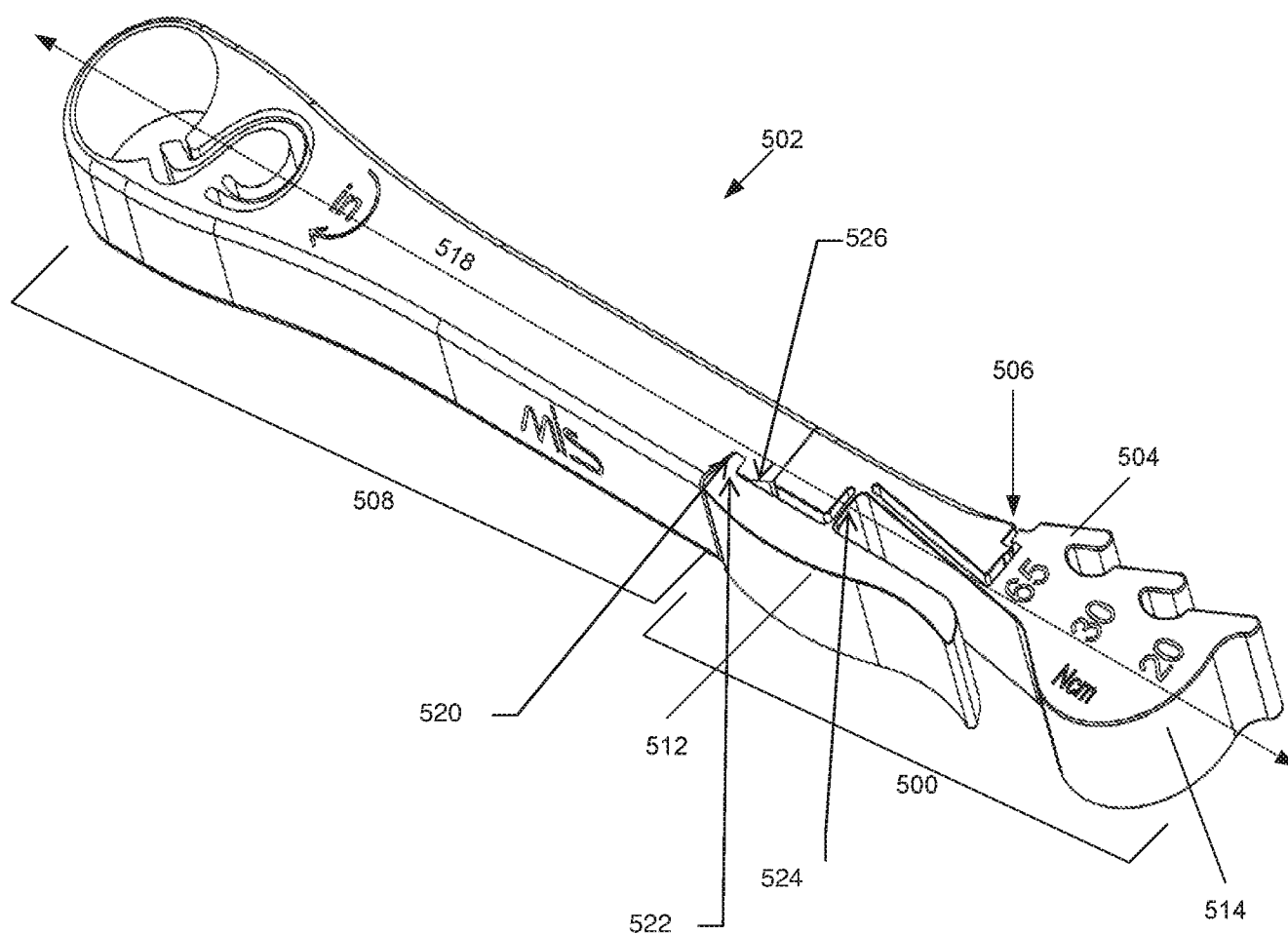
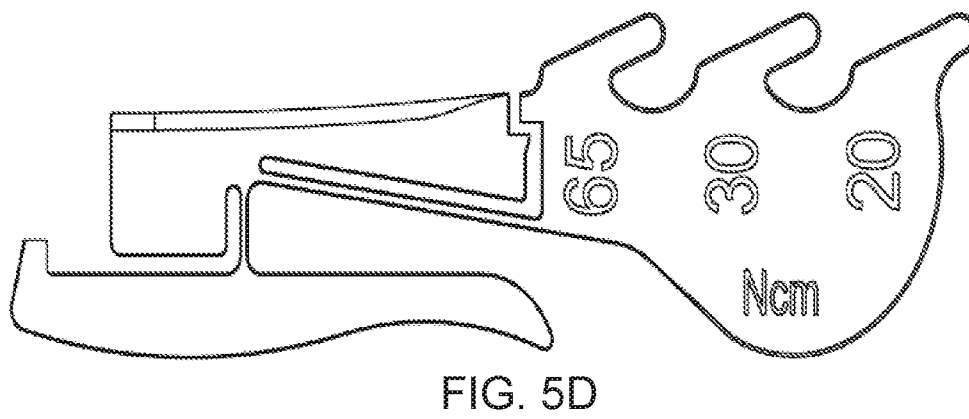
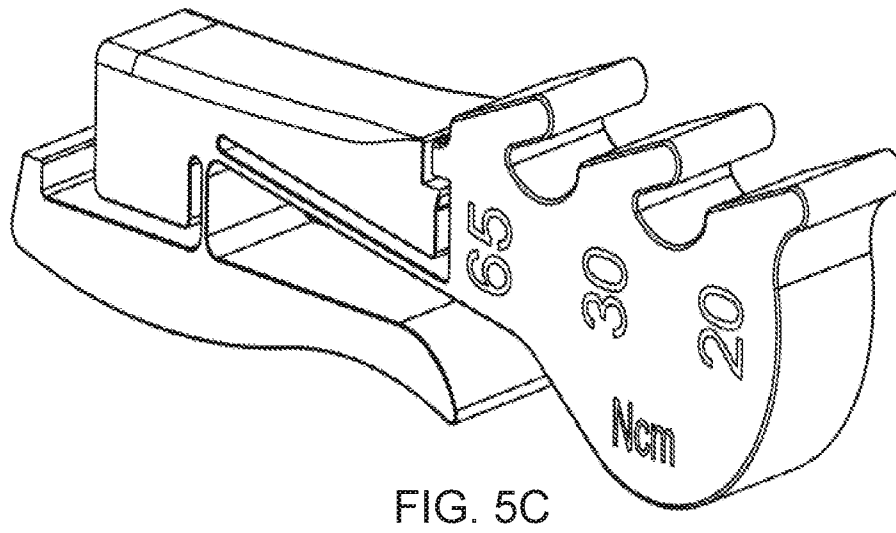
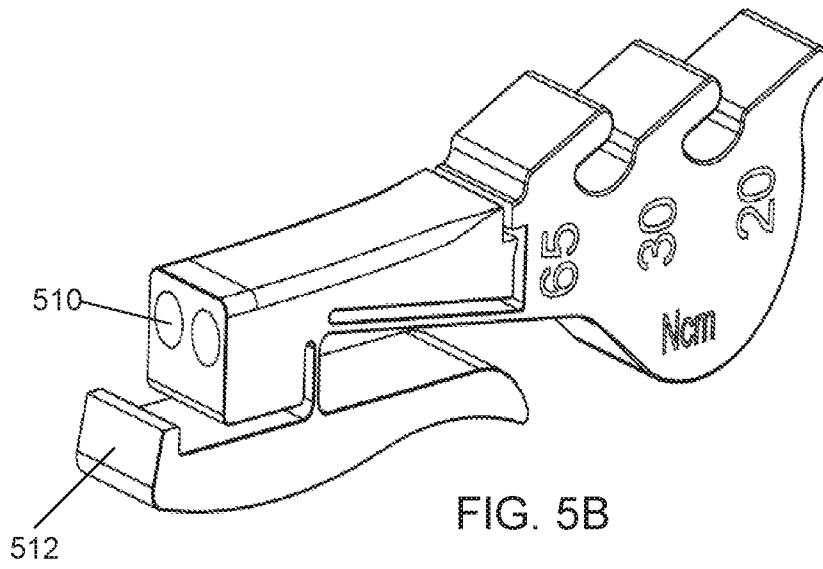
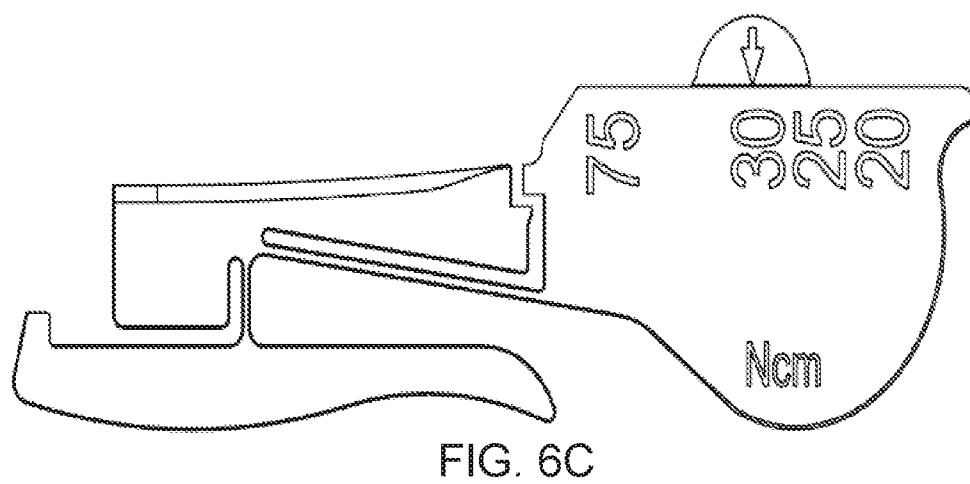
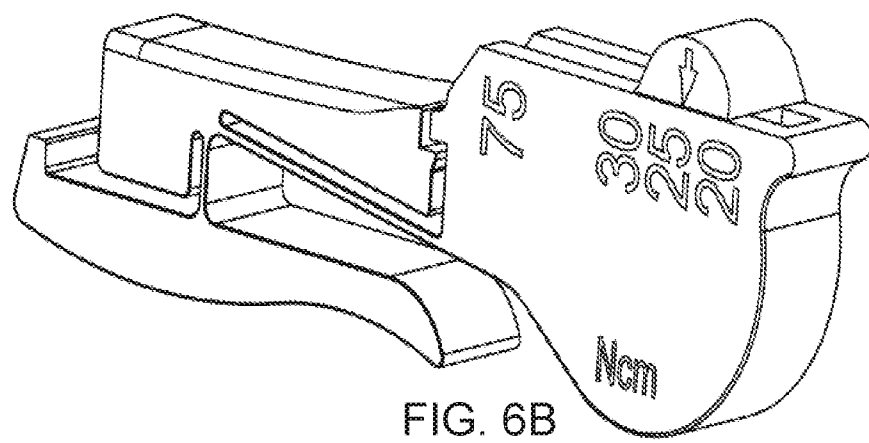
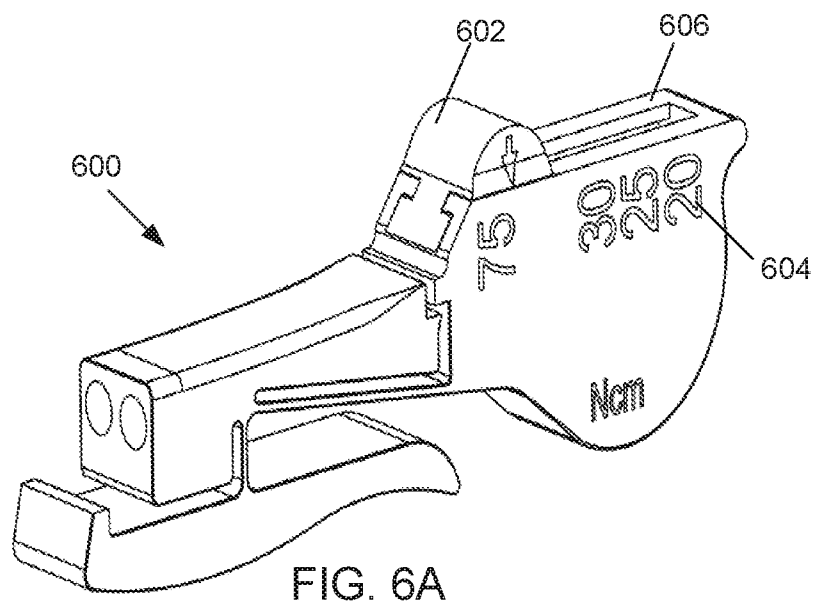


FIG. 5A





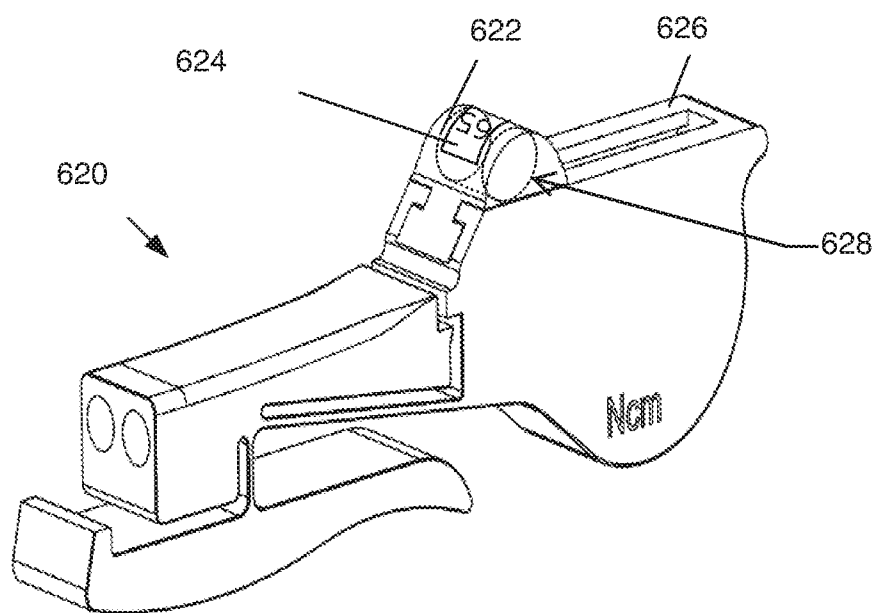


Fig. 6D

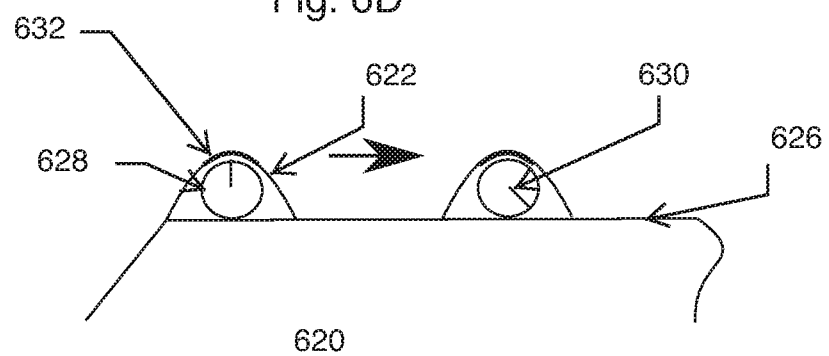


Fig. 6E

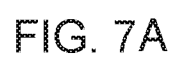


FIG. 7A

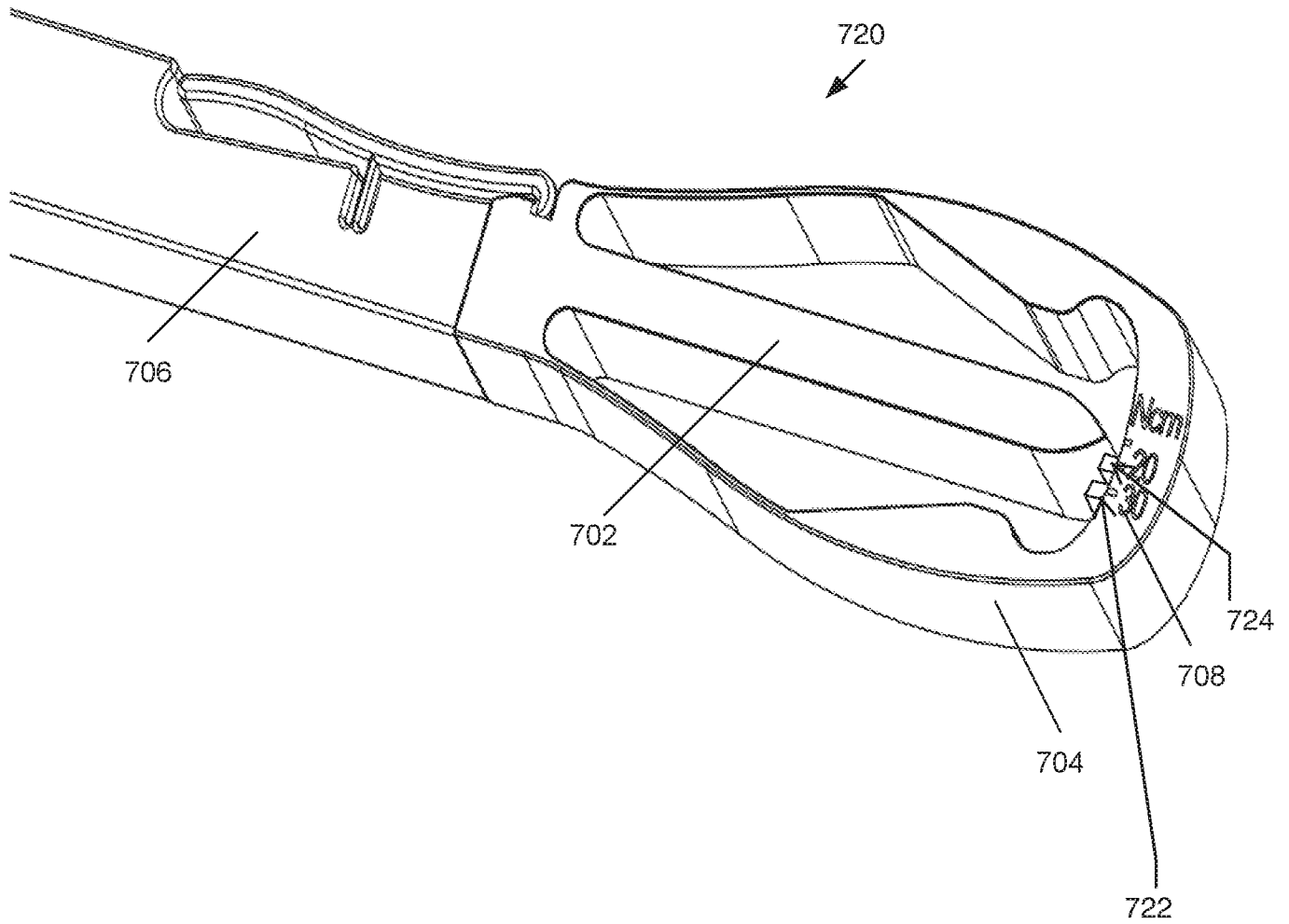


FIG. 7B

FIG. 8A

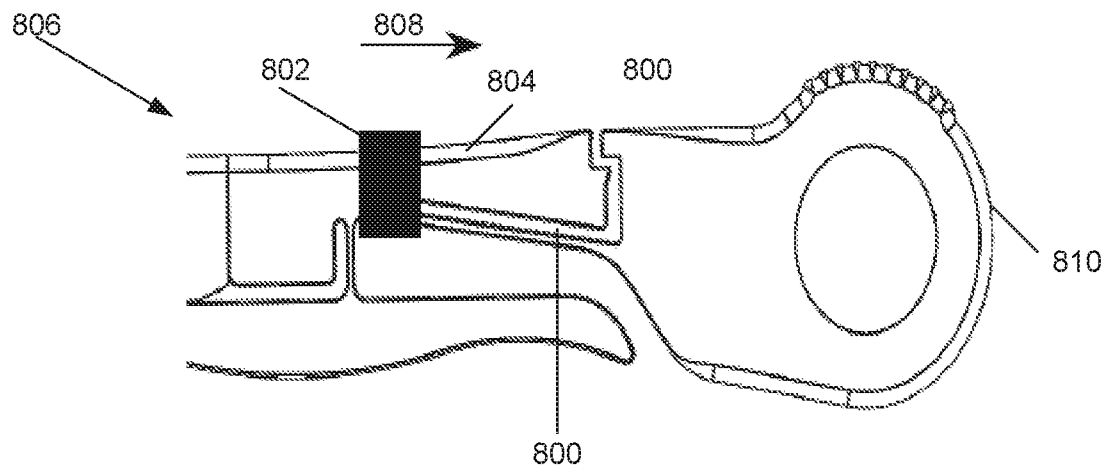
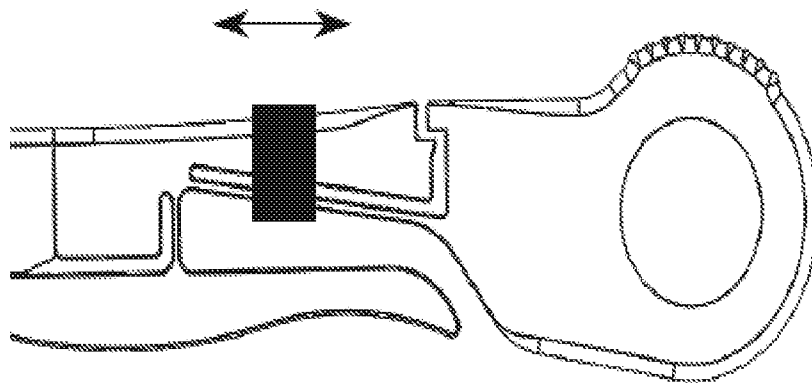


FIG. 8B



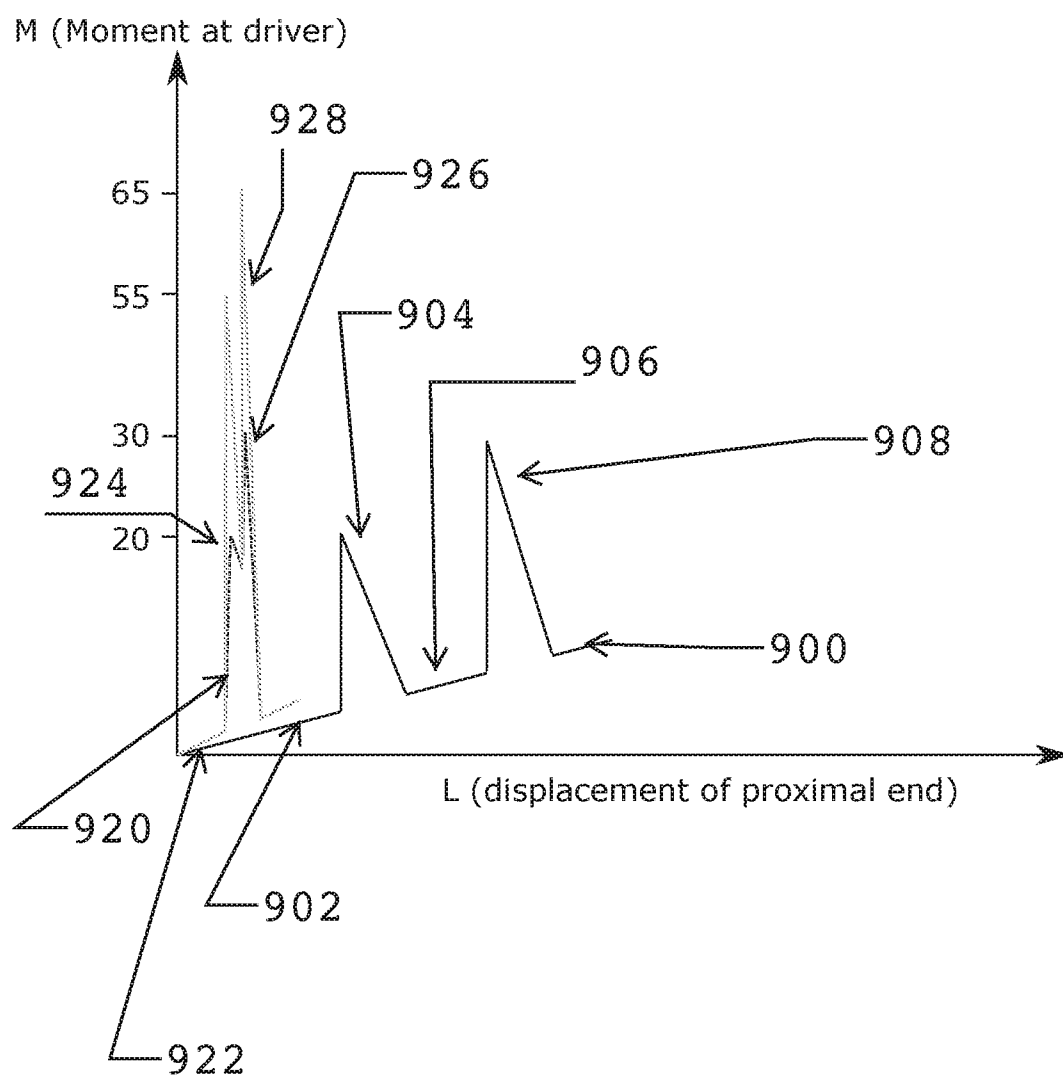


FIG. 9

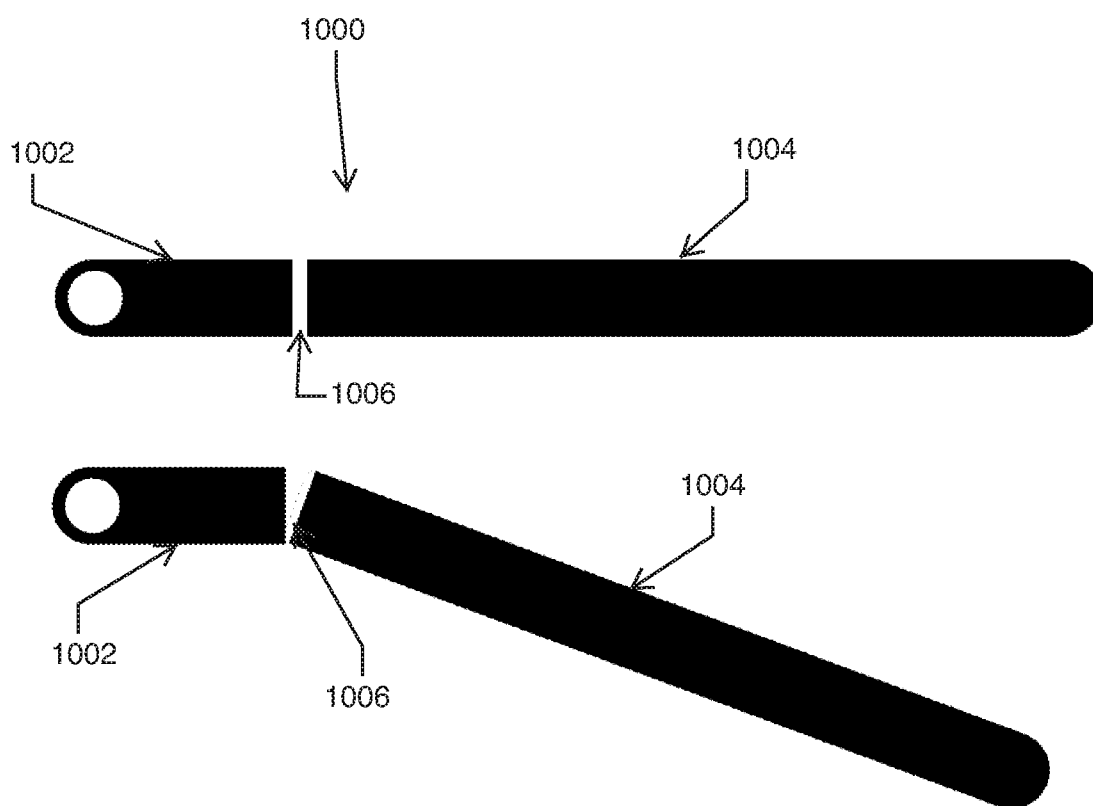


FIG. 10A

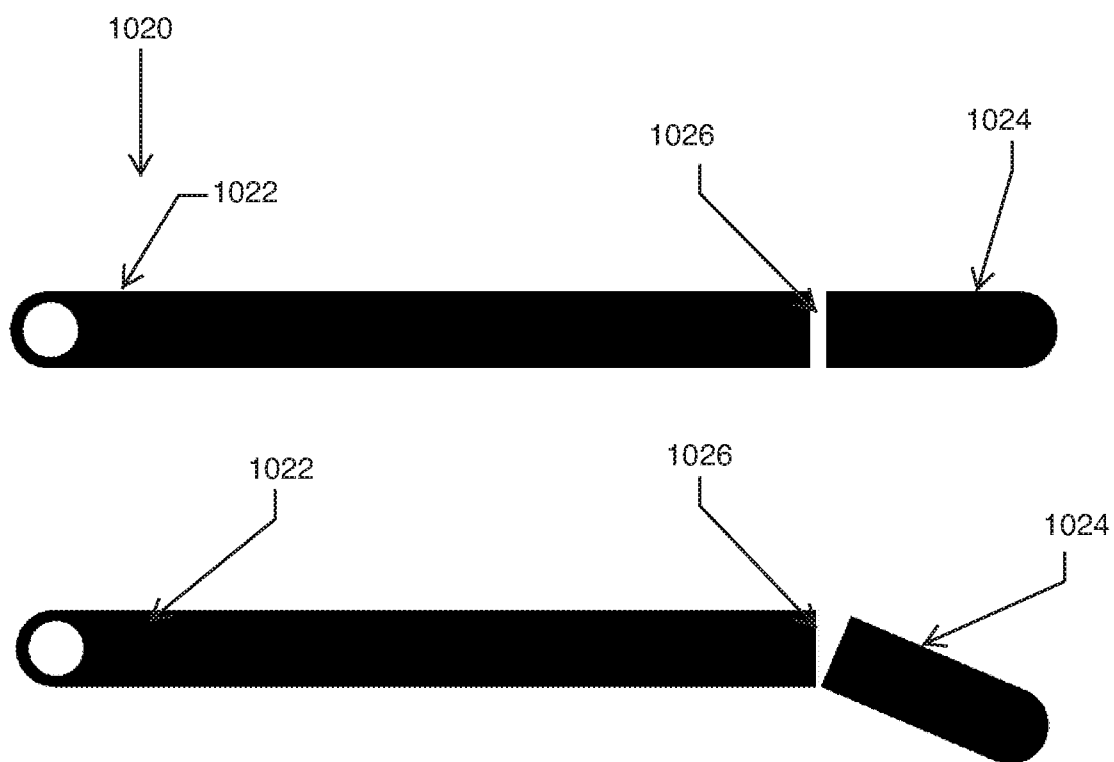


FIG. 10B

INTERNATIONAL SEARCH REPORT

International application No
PCT/IL2018/051297

A. CLASSIFICATION OF SUBJECT MATTER

INV. B25B13/46 A61C8/00 A61B17/88 B25B23/142 A61C1/18
A61B90/00

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B25B A61B A61C

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 472 131 A2 (LAWRIE-FUSSEY THOMAS WILLIAM [GB]) 4 July 2012 (2012-07-04)	1-8,10, 11, 14-16,23
A	figures 8-13	9,12,13
X	KR 2004 0029512 A (COWELL MEDI CO LTD) 8 April 2004 (2004-04-08) figure 2	26
A	US 5 337 638 A (COSS RONALD G [US] ET AL) 16 August 1994 (1994-08-16) cited in the application figures 3,4	1



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

26 February 2019

Date of mailing of the international search report

08/05/2019

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
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Authorized officer

Hartnack, Kai

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL2018/051297

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-16, 23, 26

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-16, 23, 26

A dental torque exerting ratchet wrench comprising: a distal ratchet wrench portion configured for engaging a driver; and a proximal handle portion, characterized by a torque-setting component structured to indicate when a selected torque is exerted onto the driver upon rotation of the wrench, the torque setting component comprising: at least two portions formed with an interfering geometry between them; an elastic element which connects said at least two portions to each other, said elastic element configured to deform in response to increasing torque to provide for one of said portions to overcome said interfering geometry when said selected torque is reached; wherein said at least two portions and said elastic element constitute a single piece.

2. claims: 17-22, 24, 25

A dental torque exerting ratchet wrench comprising: a distal ratchet wrench portion configured for engaging a driver; and a proximal handle portion, characterized in that said proximal handle portion is attached to said distal ratchet wrench portion by a removable coupling; and in particular a plurality of proximal handle portions, each proximal handle portion configured to engage said distal ratchet wrench portion, each proximal handle portion pre-configured to indicate, when engaged with said distal ratchet wrench portion, a different selected torque when said selected torque is exerted by said distal ratchet wrench portion.

3. claims: 27, 28

A dental torque exerting ratchet wrench comprising: a distal ratchet wrench portion configured for engaging a driver; and a proximal handle portion, characterized by a movable frame comprising a plurality of scale markings indicating torque magnitudes; a pointing indicator having a tip; wherein said handle is configured to deform such that said frame can move with respect to said pointing indicator in response to a change in torque exerted by said distal ratchet wrench portion due to user force applied at said handle, such that said tip points to a scale marking indicating the exerted torque.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IL2018/051297

Patent document cited in search report	Publication date	Patent family member(s)	Publication date	
EP 2472131	A2	04-07-2012	EP 2472131 A2	04-07-2012
		GB 2486729 A		27-06-2012
		GB 2511451 A		03-09-2014

KR 20040029512	A	08-04-2004	NONE	

US 5337638	A	16-08-1994	NONE	
