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(54) RATCHET HANDLE

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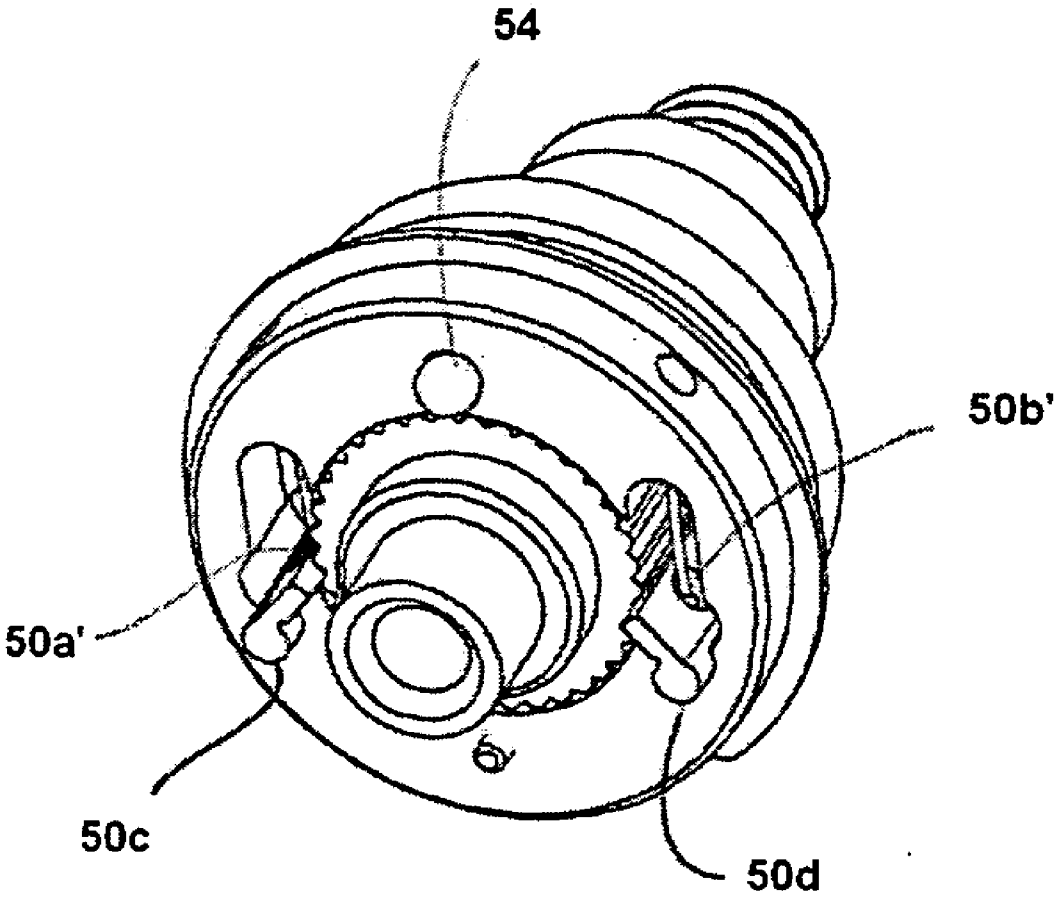
(57) **ABSTRACT**

A surgical ratchet assembly includes a handle, a driver, a ratcheting mechanism and a locking mechanism. The driver is received within the handle in a rotatable relationship with respect thereto. The ratcheting mechanism is interposed between the handle and the driver. Unlocking of the locking mechanism enables ready disassembly of the assembly for cleaning and component sterilization. A superelastic biasing means is used. The cap reverser further prevents rotation beyond the depressions therein.



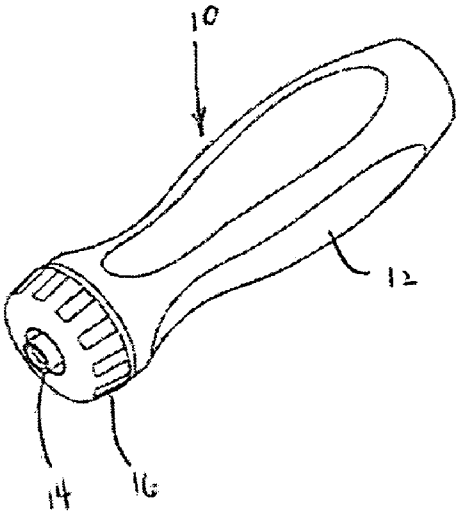


Fig. 1

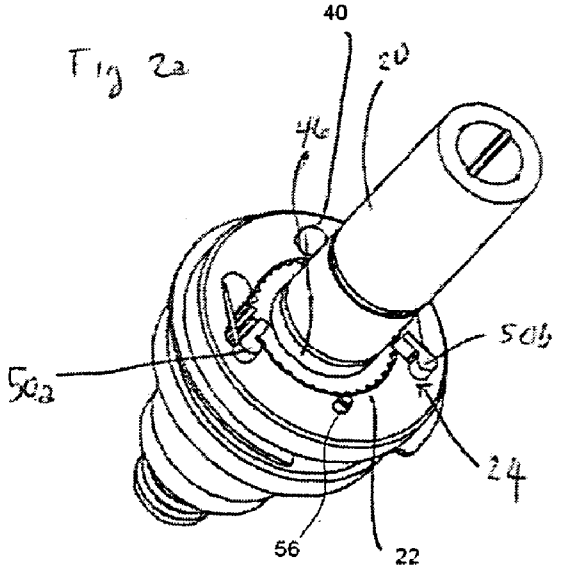


Fig 2a

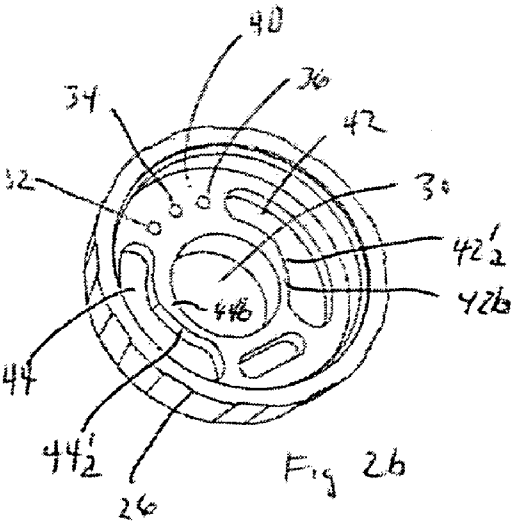


Fig 2b

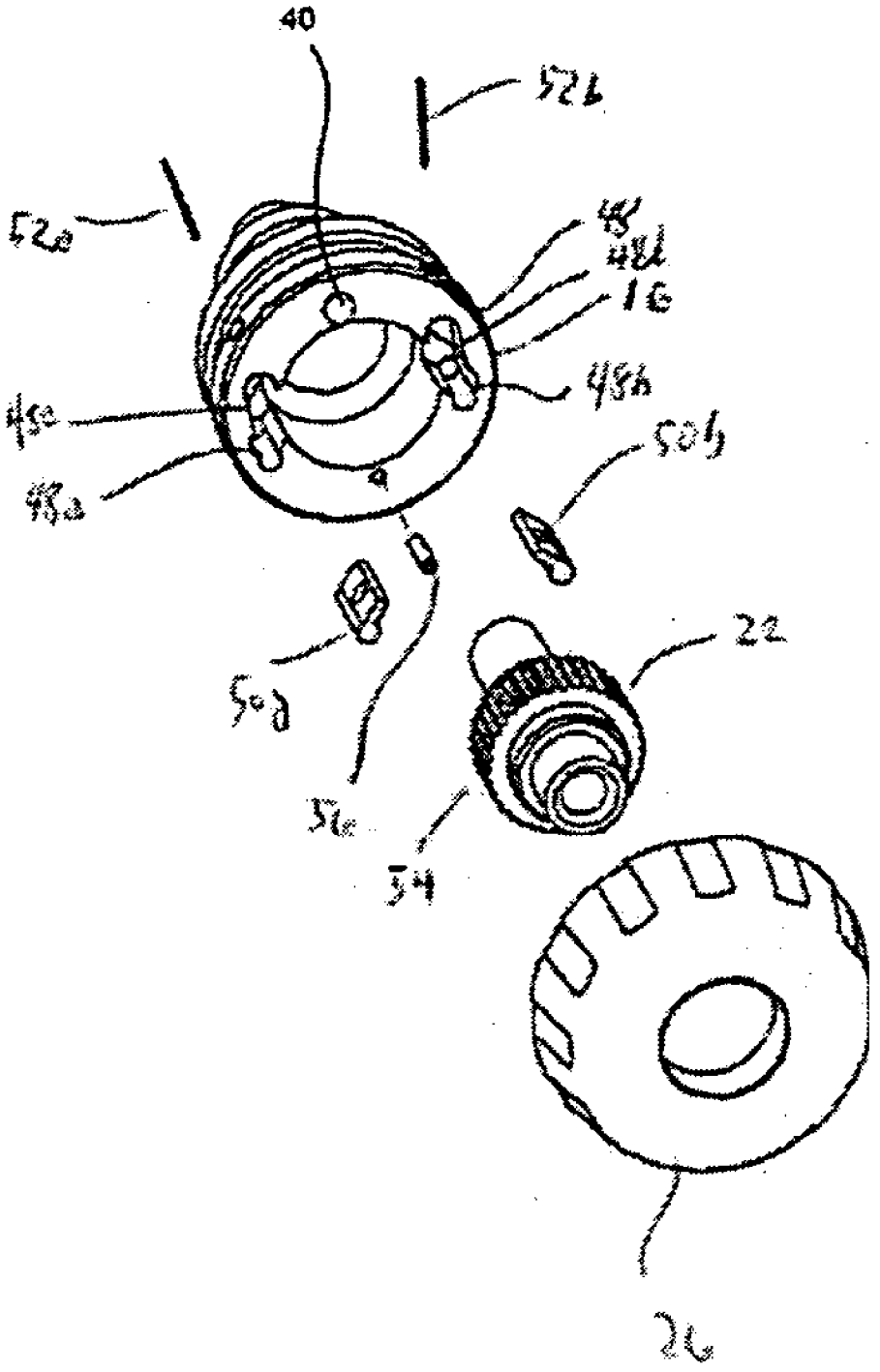


FIG. 3

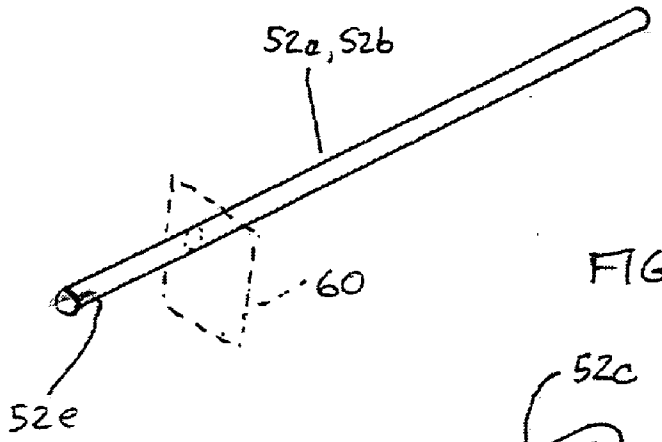


FIG 4a

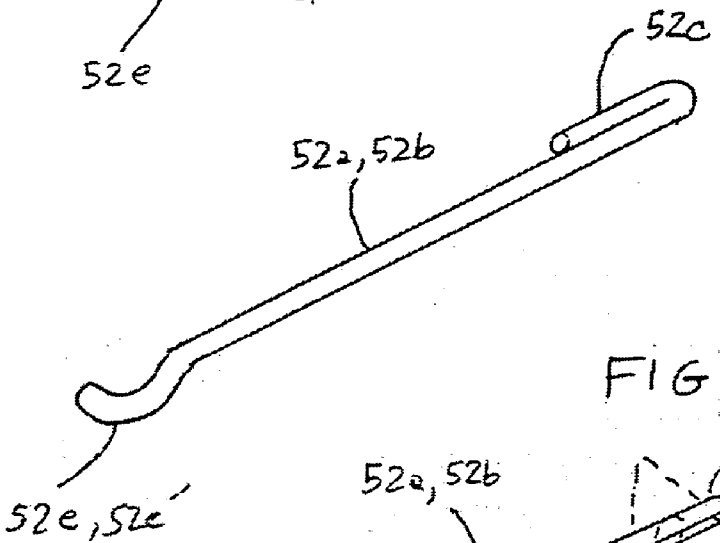


FIG 4b

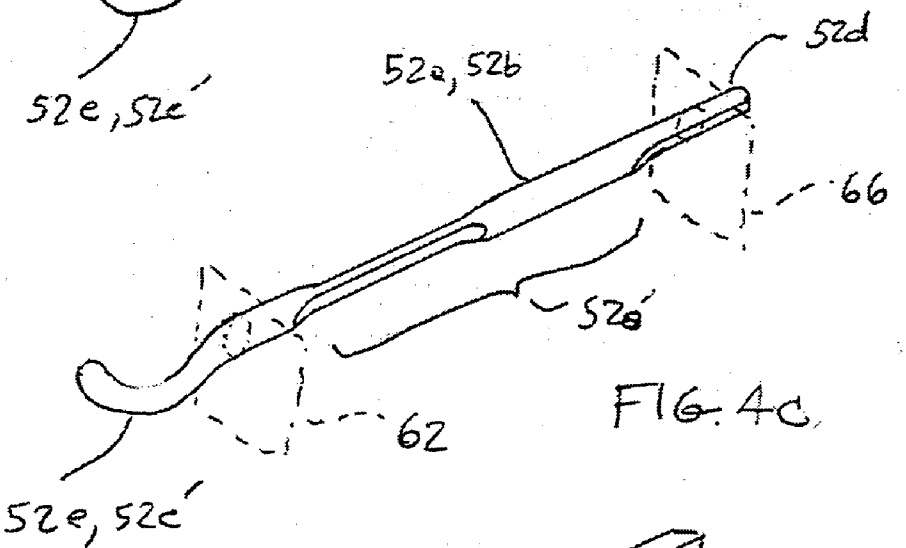


FIG. 4c

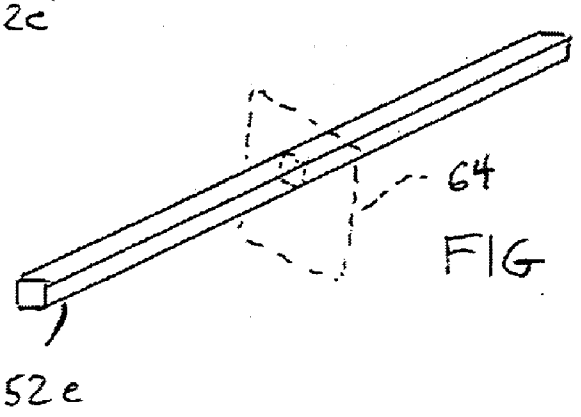


FIG 4d

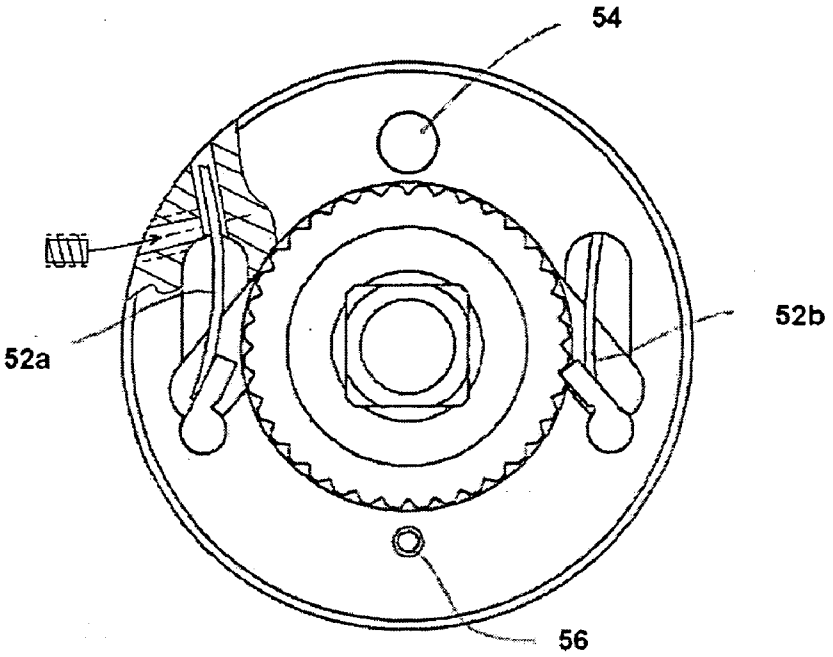


FIG. 5a

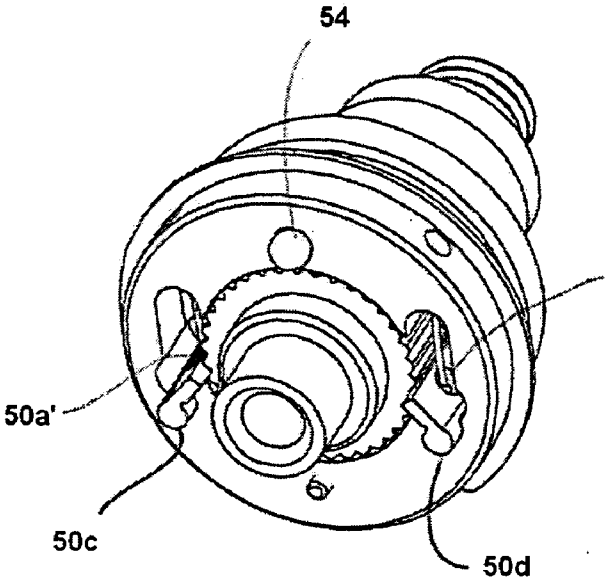


FIG. 5b

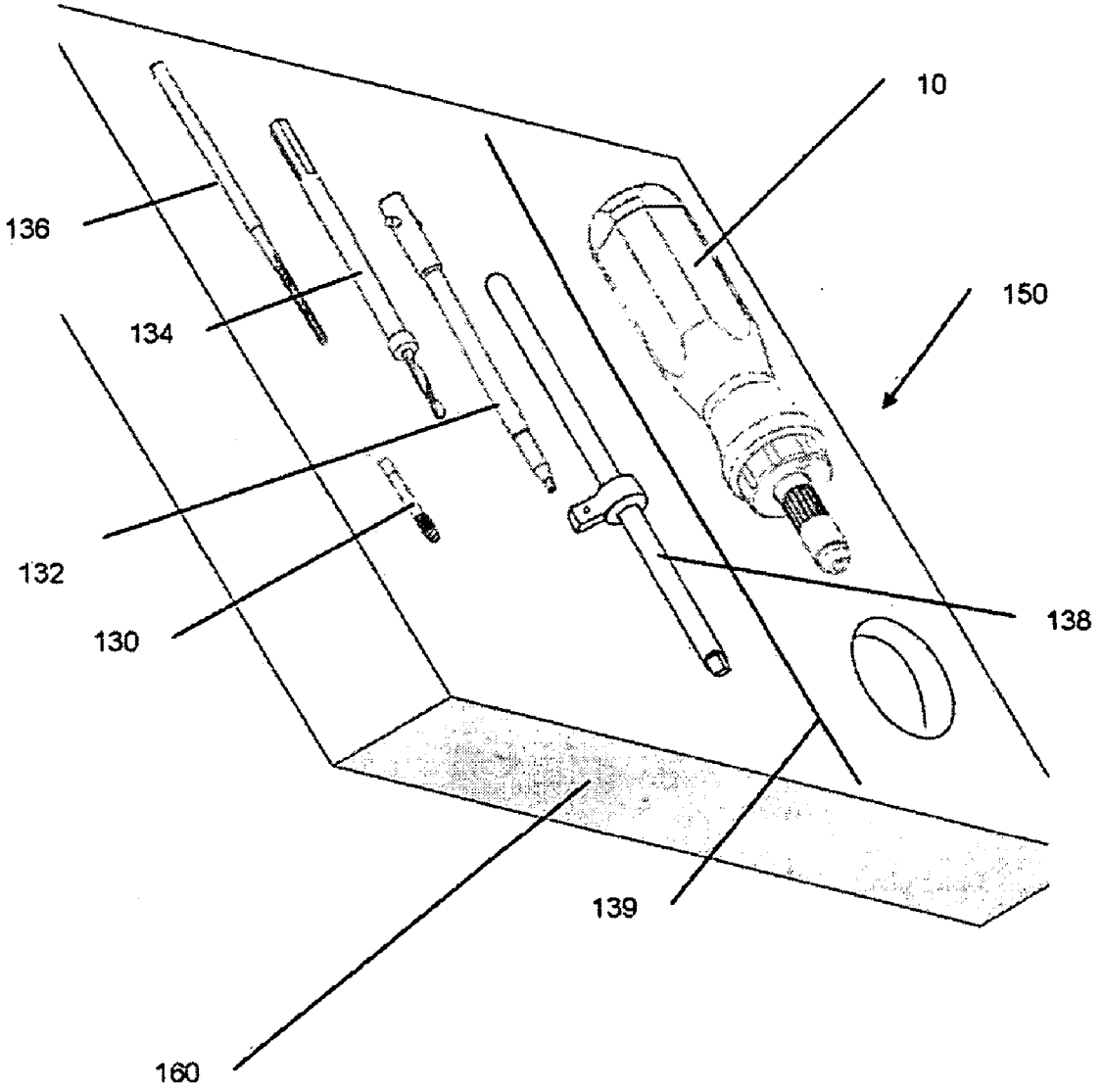


FIG. 6

RATCHET HANDLE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional patent application, Ser. No. 60/678,245, of the same name, filed on May 5, 2005, the content of which is incorporated herein by reference thereto.

BACKGROUND OF THE INVENTION

[0002] This invention relates to drivers for rotary surgical cutting tools, and, more particularly, to drivers used in maxillo-facial, neuro, dental and orthopedic surgery, including reamer drivers.

[0003] Screwdrivers and other hand-held tools are often utilized to insert, remove and/or adjust fasteners attached to various items. The tool is used to rotate the fasteners into or out of apertures in the items to properly position the fasteners with respect to the items. The rotation is controlled such that there is relatively free rotation in one direction and driven, locked rotation in the opposite direction.

[0004] Ratcheting mechanisms of this type take various forms, such as those disclosed in U.S. Pat. Nos. 5,613,585; 5,619,891; 5,778,743; 5,873,288; and 5,943,755, the contents of which are incorporated herein by reference thereto and relied upon. In each of these mechanisms, a pair of pawls are disposed within a housing for the tool. The pawls are selectively engageable and disengageable from a toothed gear disposed within the tool housing in order to enable the gear to rotate in a specified direction when adjusting, inserting or removing a fastener However, while tools incorporating ratcheting mechanisms of this type are useful in adjusting, inserting and removing fasteners from various items, the mechanisms also have certain drawbacks. For example, due to the large spacing of the teeth on the gear, ratchet tools must often be rotated more than approximately 10 degrees in order to advance the ratcheting mechanism to the next locking position. In situations where precise movements of a fastener are necessary, the tools incorporating mechanisms of the above-referenced type with gears of this size are not suitable as these mechanisms are very "coarse" and do not allow for precise movements of the fastener.

[0005] Further, the prior art ratcheting mechanisms generally include a large number of parts assembled within the housing in order to complete the ratcheting mechanism, the complexity increasing the time and expense necessary for manufacturing tools incorporating these prior art ratcheting mechanisms.

[0006] Therefore, what is needed is a simpler mechanism with fewer parts of simpler form.

SUMMARY OF THE INVENTION

[0007] A surgical ratchet assembly includes a handle, a driver, a ratcheting mechanism and a locking mechanism. The driver is received within the handle in a rotatable relationship with respect thereto. The ratcheting mechanism is interposed between the handle and the driver. The ratcheting mechanism includes a pawl which can be selectively locked out of engagement with a toothed hub via a reverser. A pair of pawls is preferred. A locking mechanism releasably holds the handle to the ratchet mechanism. Cantilever springs bias the pawl into engagement with the toothed hub.

[0008] In a feature of the invention, the cantilever springs are made of super-elastic material, thereby providing lasting, reliable activation of the pawls and long life to the ratchet.

[0009] In another feature, the cantilever form and the use of nickel-titanium in the construction of the cantilever springs enables the spring to exert a nearly constant biasing force biasing the pawl into engagement with the hub.

[0010] In another feature, the narrow form of the springs permit the bulk of the ratchet mechanism to be reduced without sacrificing strength or reliability.

[0011] In another feature, the cantilever springs enter the assembly from the side of the housing, thus permitting maintenance and/or replacement without having to disassemble the housing assembly (e.g., removing the reverser is not necessary to access the springs).

[0012] In another feature, the reverser includes a position in which both pawls are in an engaged position, thus locking the ratchet mechanism against free movement in either direction.

[0013] The object of the invention is to provide a ratchet that is easy to operate and does so reliably.

[0014] Another object of the invention is to provide a simpler mechanism with fewer parts as no mounting pin is required for the biasing springs.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] **FIG. 1** is a perspective view of the ratchet handle of the invention.

[0016] **FIG. 2***a* is a perspective view of the ratchet mechanism of the invention, showing the workings therein.

[0017] **FIG. 2***b* is a perspective view of the cap reverser reverser of the invention.

[0018] **FIG. 3** is an exploded view of the ratchet mechanism of the invention

[0019] **FIG. 4***a* is a perspective view of an alternate spring of the invention.

[0020] **FIG. 4***b* is a perspective view of another alternate spring of the invention.

[0021] **FIG. 4***c* is a perspective view of still another alternate spring of the invention.

[0022] **FIG. 4***d* is a perspective view of still another alternate spring of the invention.

[0023] **FIG. 5***a* is a top view showing the positioning of the biasing means against the pawls of the invention.

[0024] **FIG. 5***b* is a perspective view showing the positioning of the biasing means against the pawls of the invention.

[0025] **FIG. 6** is a perspective view of a kit of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0026] This invention has structural similarities to U.S. Pat. No. 6,817,458 to Gauthier, and WO 2004/096069,

PCT/IB2004/001244, the contents of both of which are incorporated herein by reference and relied upon

[0027] Referring now to **FIG. 1**, the ratchet handle **10** of the invention is shown, including essentially a handle portion **12**, a coupling end **14**, and a housing assembly **16** in which is disposed a drive spindle **20** having a toothed hub **22**.

[0028] Referring now to **FIGS. 2***a* and **2***b,* a ratchet mechanism **24** is disposed between the toothed hub **22** and the handle **12**, in order to enable a user to selectively torque fasteners (not shown), in a desired direction dependent on the position of a reverser **26**. The reverser **26** is a cap-shaped structure having an internal aperture **30** and position selection holes **32**, **34** and **36** which pass through a wall **38** of the cap. A crest of a ball detent **40** in the housing **48** enters into such holes **32**, **34**, or **36** to retain the reverser **26** in the desired position (neutral, locked counterclockwise, free rotating clockwise, and vice-versa). Arcuate cutouts **42** and **44** are located on opposite sides of the aperture **30** and are formed to include corresponding cam surfaces **42***a* and **44***a*. These cam surfaces **42***a* and **44***a* are disposed on an arcuate cam structure **42***b* and **44***b* which passes between a centering shoulder **46** and each pawl **50***a* and **50***b* such that, the adjacent pawl **50***a* or **50***b* may be cammed in or out of engagement with teeth **54** on the toothed hub **22**. The pawls **50***a* and **50***b* are held in functional relationship by their generally circular stem **50***c* and **50***d,* respectively, in arcuate end surfaces **48***a* and **48***b* of slots **48***c* and **48***d* of a housing **48**, into which the pawls are disposed. Elongated, slender wire springs **52***a* and **52***b* (which can have a circular cross-section, oval cross-section, an uncut rectangular cross-section, even polygonal cross section, as typically results from a rolled or extruded manufacturing process and not cut, flat sheet processing), preferably made of Nickel-Titanium alloy (a.k.a., "nitinol", from the laboratory that developed it, the Nickel/Titanium/Naval Ordinance Laboratory), a super-elastic, shape memory material, are fixed (using, for example, set screws, or by press fitting, or by a staking operation in the housing, and optionally using a mating nickel-titanium alloy component such as a collet device) in holes **49***a* and **49***b,* so as to act as cantilever springs, to urge the pawls **50***a* and **50***b* against the teeth **54** of the hub **22**. Nitinol alloys have the unusual ability to recover a preset shape, even after drastic distortion. Composition is typically 55%-56% Nickel and 44%-45% Titanium, but slight adjustments of this ratio can significantly impact the properties of the material. There are two primary but overlapping categories of Nitinol. "SuperElastic" alloys are characterized by extraordinary kink resistance and flexibility. The Nitinol Wire used in the invention is a super-elastic alloy which can be strained eight to ten times more than ordinary spring steel without permanent deformation. It can be rather severely compressed, bent or otherwise distorted, but returns to its original shape. This impressive "memory" takes advantage of stress-induced martensitic transformation. In other words, a material is super-elastic when, if sufficient stresses are applied, such materials exhibit martensitic activation/transformation (i.e., deform from an austenitic crystal structure to a stress-induced structure postulated to be martensitic in nature), returning thence to the austenitic state when the stress is removed. The alternate crystal structures described give the alloy super-elastic or pseudo-elastic properties. Poisson's Ratio for nitinol is about 0.3, but this ratio significantly increases up to approximately 0.5 or more when the shape memory alloy is stretched beyond its initial elastic limit. It is at this point that stress-induced martensite is said to occur, i.e., the point beyond which the material is permanently deformed and thus incapable of returning to its initial austenitic shape. Note that although Nickel-Titanim alloys are currently preferred, inexpensive super-elastic steel alloys are now known and of course may be used. The wire used herein has an annealed temper that is straight in shape. A new memory is imparted to the Nitinol wire by restraining the material in exactly the shape required and heating to a temperature above 932° F. (500° C.) for a minimum of five minutes. The shape will be set upon cooling and will exhibit the same flexibility and resistance to deformation as the original wire. And it can be repeatedly retrained to achieve new shapes.

[0029] Referring to **FIGS. 3***a* to **3***d,* suitable wire springs **52***a* and **52***b* may have a circular cross-section **60**, oval cross-section **62**, and uncut rectangular cross-section **64**, even polygonal cross section **66**, as typically results from a rolled or extruded manufacturing process and not cut flat sheet processing which creates stress risers which limit the functional life of the spring. In addition, the length of the spring **52***a,* and **52***b* may be processed so that the cross-section varies in bending moment of inertia along its length **52'**, then enabling further control of the biasing forces applied to the pawl **50***a* and **50***b*. With spring material such as super-elastic Nitinol or super-elastic steels, controlled processing of the spring **52***a* or **52***b* in order to vary and control the bending moment of inertia requires that the spring be formed in an annealed state, prior to heat treating to activate super-elastic properties. Further, where the cross-section is varied in form along the length **52***a'* of the spring **52***a* or **52***b* in a non-symmetrical manner, then, a portion of the end **52***c* of the spring may be turned up and then against itself, in order to create a feature by which the spring can be held during processing of the non-symmetrical forming of the spring and to enable fixing of the spring in the desired orientation (the orientation that provides the deflection and force characteristics desired). Orientation can be achieved as well via use of a non-round aperture in the housing **46** into which the end **52***c* is fixed. The spring **52***a* or **52***b* may alternatively be deformed at an end **52***d* to create a feature from which an orientation convention can key off of. Of course, the fixing device (e.g., fastener) must also key off of the non-symmetrical end to orient the spring **52***a* or **52***b* properly in the housing **46**. In any case, after processing, the cross-section should have overall width dimensions that are substantially the same across the centerline of the wire.

[0030] U.S. Pat. No. 5,683,404 to Johnson, entitled "Clamp and Method for its Use", the content of which is incorporated herein by reference thereto, further discusses shape memory materials that are "pseudo-elastic", defining these materials to be super-elastic, because of their ability to exhibit super -elastic/pseudo-elastic recovery characteristics at room temperature.

[0031] Thus, a user is able to select which pawl **50***a* or **50***b* is engaged, thereby selecting the direction in which the ratchet handle **10** freely rotates which respect to the spindle **20** and the direction in which the pawls **50***a* or **50***b* lock the teeth **54** as well as the direction in which the pawls are positioned such that the spindle **20** is free to rotation in the opposite direction. The position of the reverser **26** with respect to the housing assembly **16** is determined by a

frictional or interference engagement of a ball-detent **40** in one of the holes **32**, **34**, or **36**.

[0032] Referring now to **FIG. 4**, an exploded view of the ratchet mechanism **24** of the invention includes the housing **48**, the pawls **50***a* and **50***b*, the cantilever springs **52***a* and **52***b*, a stop pin **56** (which engages an elongated slot **58** of the reverser **26**), the toothed hub **22**, and the reverser **26**. The stop pin **56** is press fit into the housing **48** so as to be fixed therein.

[0033] Referring now to **FIGS. 5***a* and **5***b* the cantilever springs **52***a* and **52***b* bias the pawls **50***a* and **50***b* against the teeth **54** of the hub **22** wherein the extremeties **52***e* of such springs are disposed in recesses **50***a'* and **50***b'* of the pawls. The form of the spring **52***a* and **52***b* may be curved in a section **52***e'*, in order to minimize wear on the pawls **50***a* and **50***b*.

[0034] The springs **52***a* and **52***b* are secured to the housing **48** at the first end and free to deflect at the second end. Thus, unlike U.S. Pat. No. 6,817,458 to Gauthier, the biasing members are the cantilevered springs **52***a* and **52***b* and not torsional springs. Further, as already mentioned, the cantilever bar of the invention is optionally made of Nitinol, a super-elastic titanium alloy allowing high flexibility and providing a more constant spring force biasing the pawls **50***a* and **50***b* against the teeth **54** of the hub **22**. A constant biasing force provides smoother ratcheting by avoiding drastic variation in biasing force against the teeth **54**, which, if not substantially constant, would cause intermittent dragging of the pawl as it passes from one tooth position to another.

[0035] In addition, to further prevent the reverser **26** from rotating past the depressions therein (ref. column 6, line 6, Gauthier '458), the stop pin **56**, which is separate from the biasing members **52***a* and **52***b*, engages a slot in the cap reverser, similar to Tiede, U.S. Pat. No. 5,613,585 (see column 3, line 25 thereof), the content of which is incorporated herein by reference and relied upon.

[0036] Referring now to **FIG. 6** , the kit **150** is shown, including the ratchet **10**, tools **130**, **132**, **134**, **136**, a T-bar **138** and a guide pin **139**. The components of the kit **150** are organized in a case **160** having recesses into which the ratchet and the tools may be conveniently stored until use. A selection of surgical fasteners and, optionally, bone plates and other hardware, as well as ancillary tools may be conveniently stored until needed in a particular surgical protocol.

[0037] In an advantage of the invention, the cantilever form of the springs **52***a* and **52***b*, together with the fact that the springs are made of super-elastic material provide a lasting, reliable activation of the pawls **50***a* and **50***b* and long life to the ratchet.

[0038] In another advantage, the cantilever form of the springs **52***a* and **52***b* and the use of nickel-titanium in the construction of the cantilever springs enables the springs to exert a nearly constant biasing force biasing the pawls so as to engage them with the hub **22**.

[0039] In another advantage, the narrow form of the springs **52***a* and **52***b* permit the bulk of the ratchet mechanism to be reduced without sacrificing strength or reliability.

[0040] In another advantage, the cantilever springs **52***a* and **52***b* enter the housing **48** from the side of the housing, thus permitting maintenance and/or replacement of such springs without having to disassemble the housing assembly **16** (e.g., removing the reverser is not necessary to access the springs).

[0041] In another advantage, the reverser **26** includes a position in which both pawls **50***a* and **50***b* are in an engaged position, thus locking the ratchet mechanism against free movement in either direction.

[0042] The object of the invention is to provide a ratchet **10** that is easy to operate and does so reliably.

[0043] Another object of the invention is to provide a simpler mechanism with fewer parts as no mounting pin is required for the biasing springs **52***a* or **52***b*.

[0044] Although the term "driver" may be used herein, this term is meant to encompass taps, guide pins, screwdrivers, reamer drivers and any tool which needs to be fastened and held, even rotated, in a controlled manner.

[0045] Multiple variations and modifications are possible in the embodiments of the invention described here. Although certain illustrative embodiments of the invention have been shown and described here, a wide range of modifications, changes, and substitutions is contemplated in the foregoing disclosure. In some instances, some features of the present invention may be employed without a corresponding use of the other features. Accordingly, it is appropriate that the foregoing description be construed broadly and understood as being given by way of illustration and example only, the spirit and scope of the invention being limited only by the appended claims.

What is claimed is:

1. A ratcheting tool having a ratcheting mechanism comprising:

(a) a housing;

(b) at least one pawl pivotally disposed in the housing; and

(c) at least one cantilever wire spring engaged with the at least one pawl to bias the pawl into engagement with corresponding ratchet teeth, wherein the spring enters through an aperture in a side of the housing.

2. The ratcheting tool of claim 1, wherein the spring is fixed via a fastening device in the side of the housing.

3. The ratcheting tool of claim 1, wherein the spring is fixed via a staking operation in the side of the housing.

4. The ratcheting tool of claim 1, wherein the spring is slender and substantially straight.

5. The ratcheting tool of claim 1, wherein the spring is made of a super-elastic material.

6. The ratcheting tool of claim 1, wherein the spring is made of a super-elastic material.

7. The ratcheting tool of claim 2, wherein the spring is made of a super-elastic material.

8. The ratcheting tool of claim 3, wherein the spring is made of a super-elastic material.

9. The ratcheting tool of claim 4, wherein the spring is made of a super-elastic material.

10. The ratcheting tool of claim 5, wherein the spring is made of Nitinol.

11. The ratcheting tool of claim 1, further including a reverser disposed in a structure to rotate with respect to the housing.

12. The ratcheting tool of claim 11, wherein the reverser is adapted to selectively move the at least one pawl into and out of engagement with teeth on a toothed hub to select between positive torque throughput of the ratchet handle and free-rotation.

13. The ratcheting tool of claim 11, wherein the reverser is adapted to selectively move the at least one pawl into and out of engagement with the ratchet teeth to enable the selection between positive torque throughput of the ratchet handle and free-wheeling.

14. The ratcheting tool of claim 13, wherein the ratcheting tool includes at least two opposed pawls against which the reverser reacts to selectively move one pawl out of engagement with the teeth while the other is permitted to engage the teeth, thereby enabling reversing of the direction of ratcheting and positive throughput.

15. The ratcheting tool of claim 11, in which the housing including at least one slot including a generally arcuate end circumscribing an angle of greater than 180 degrees.

16. The ratcheting tool of claim 15, wherein at least one pawl is disposed in the at least one slot, the pawl including a generally circular stem at one end that is rotatably engaged within the arcuate end of the slot.

17. The ratcheting tool of claim 16, wherein the reverser includes a at least one recess aligned with and disposed at least partially above the at least one slot in the housing and selectively engageable with the at least one pawl, and further, wherein a stop pin, fixed to the housing, engages a slot in the reverser to limit the rotational movement of the reverser between two positions.

18. A ratcheting tool having a ratcheting mechanism comprising:

(a) a housing;

(b) at least one pawl pivotally disposed in the housing; and

(c) at least one cantilever wire spring engaged with the at least one pawl to bias the pawl into engagement with corresponding ratchet teeth; wherein the housing includes a pair of slots, each slot including a generally arcuate end circumscribing an angle of greater than 180 degrees; wherein a pair of pawls are disposed in the pair of slots, each pawl including a generally circular stem at one end that is rotatably engaged within the arcuate end of the slot; wherein the ratcheting tool includes a reverser disposed in a structure to rotate with respect to the housing, the reverser being adapted to selectively move the at least one pawl into and out of engagement with teeth on a toothed hub to select between positive torque throughput of the ratchet handle and free-rotation and wherein the reverser includes at least one recesse aligned with and disposed at least partially above the at least one slot in the housing and selectively engageable with the at least one pawl, and further, wherein a stop pin, fixed to the housing, engages a slot in the reverser to limit the rotational movement of the reverser between two positions.

19. A kit for surgical use, the kit including a surgical ratchet including a ratcheting mechanism a housing, at least one pawl pivotally disposed in the housing; and at least one cantilever wire spring made of super-elastic material and engaged with the at least one pawl to bias the pawl into engagement with corresponding ratchet teeth, tools for use with the ratchet, a selection of surgical fasteners and a case having recesses into which the ratchet and the tools may be conveniently stored until use.

* * * * *