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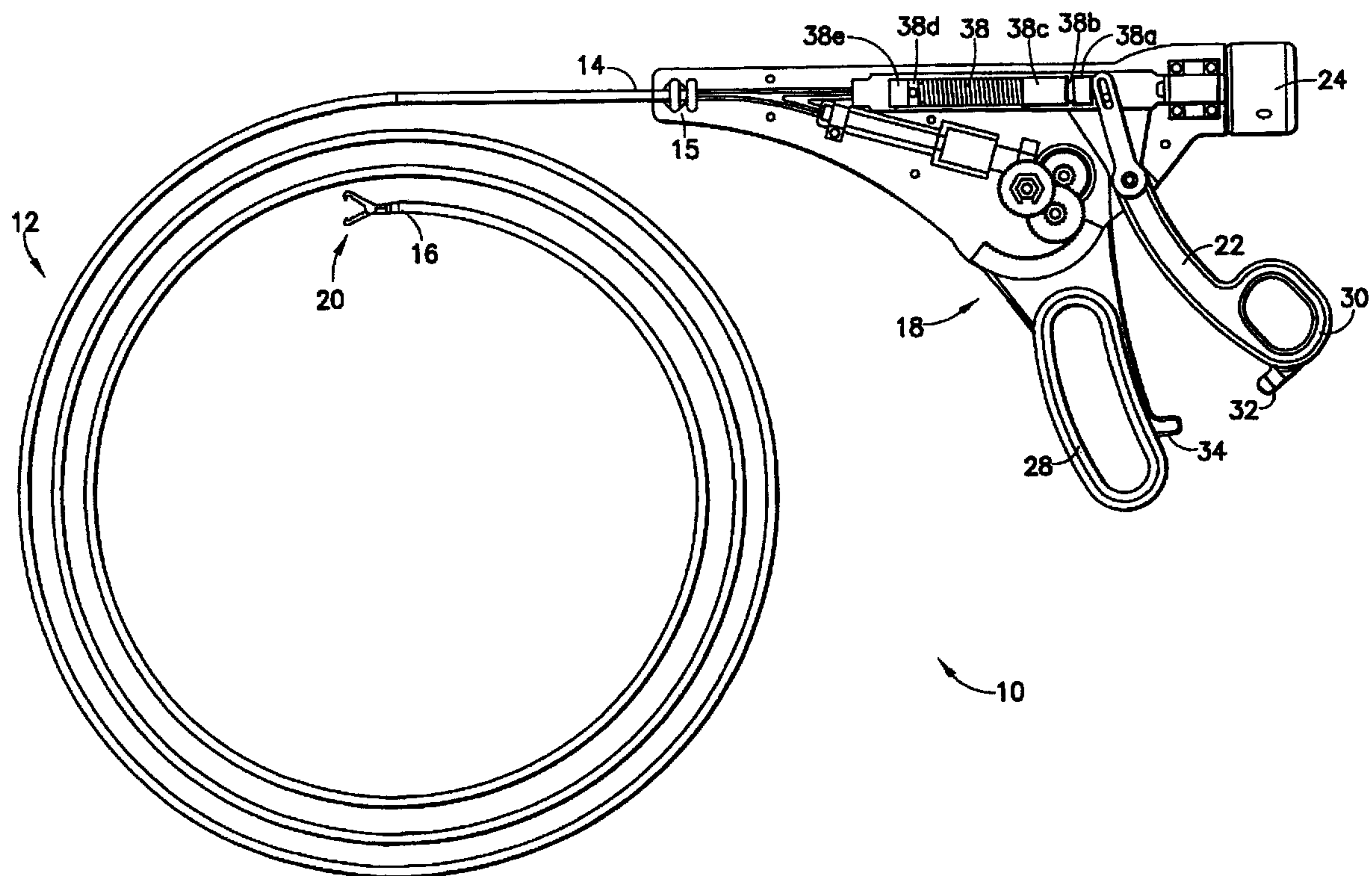
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(54) Titre : APPLICATEUR D'AGRAFES ENDOSCOPIQUES ET ELEMENT DE COMMANDE FILETE

(54) Title: ENDOSCOPIC CLIP APPLIER WITH THREADED CLIP



(57) Abrégé/Abstract:

A flexible endoscopic clip applier includes a flexible coil with a manual actuator coupled to one end and a jaw assembly coupled to the other end. A store of clips is arranged adjacent to the jaw assembly and a clip pusher is arranged adjacent to the store of clips. The actuator includes a lever for opening and closing the jaws, a knob for rotating the jaw assembly, and a crank for dispensing clips. The knob and the lever are coupled to a single control member which extends through the coil to a joiner where it is joined to a pair of pull wires coupled to the jaws. The crank is coupled to a second control member which is threaded along a distal portion. The threaded portion engages a threaded member near the pusher and is coupled to the pusher such that rotation of the threaded control member by the crank causes the pusher to be moved distally.

1 ABSTRACT OF THE DISCLOSURE

2

3 A flexible endoscopic clip applier includes a flexible
4 coil with a manual actuator coupled to one end and a jaw
5 assembly coupled to the other end. A store of clips is
6 arranged adjacent to the jaw assembly and a clip pusher is
7 arranged adjacent to the store of clips. The actuator
8 includes a lever for opening and closing the jaws, a knob for
9 rotating the jaw assembly, and a crank for dispensing clips.
10 The knob and the lever are coupled to a single control member
11 which extends through the coil to a joiner where it is joined
12 to a pair of pull wires coupled to the jaws. The crank is
13 coupled to a second control member which is threaded along a
14 distal portion. The threaded portion engages a threaded
15 member near the pusher and is coupled to the pusher such that
16 rotation of the threaded control member by the crank causes
17 the pusher to be moved distally.

1 ENDOSCOPIC CLIP APPLIER WITH THREADED CLIP
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78 BACKGROUND OF THE INVENTION
9

10 1. Field of the Invention

11 This invention relates broadly to surgical instruments.
12 Particularly, this invention relates to flexible endoscopic
13 instruments for use through an endoscope. More particularly,
14 this invention relates to a surgical clip applier which is
15 adapted for use through an endoscope and may be used to clamp
16 and/or suture, ducts, vessels, and other tissues, to anchor a
17 tissue, or to attach a foreign body to a tissue.

18
19 2. State of the Art

20 Surgical clips are generally used to apply clamping force
21 to ducts, vessels, and other tissues. In addition, surgical
22 clips are particularly useful in controlling bleeding of a
23 tissue in lieu of suturing or stapling where suturing or
24 stapling is difficult.

1

2 Surgical clips are typically applied to tissue by clip
3 appliers. All of the currently available surgical multi-
4 firing clip appliers are substantially rigid devices intended
5 to extend through a trocar port or through an incision to a
6 surgical site requiring application of a clip. The devices
7 have been rigid because a stiff pushing element has been
8 required in order to exert the required pushing force to move
9 the clip over the tissue.

10

11 There is a substantial need for a flexible clip applier,
12 particularly one insertable through a lumen of an endoscope.
13 The ability to apply clips through an endoscope would permit
14 myriad minimally invasive surgical solutions to medical
15 problems, especially those of the gastrointestinal tract.
16 However, it is accepted theory that the transmitted force
17 required to advance or form a clip over tissue cannot be
18 produced in the distal end of a long flexible device that is
19 commonly constructed with a metal tubular coil, or polymer
20 tube, such as an endoscopic device or catheter.

21

22 Generally a flexible endoscopic device (e.g., a biopsy
23 forceps device) includes an outer tubular member, typically
24 being constructed of a metal tubular coil or a polymer tube

1 which is poor in transmitting forces that impart tensile
2 stresses to the outer tubular member, a control element
3 longitudinally movable relative to the tubular member, an end
4 effector coupled to the distal ends of both the tubular member
5 and the control element such that relative movement of the
6 control element and the tubular member causes operation of the
7 end effector, and a handle which moves the control element
8 relative to the handle. This type of flexible endoscopic
9 instrument is limited in the amount of pushing force it can
10 generate for several reasons. First, compression of a
11 flexible control element (pushing element) tends to cause the
12 pushing element to buckle within the outer flexible sheath of
13 the device. If a relatively larger diameter flexible pushing
14 element is used such that it better resists buckling, the
15 pushing element may impart too much stiffness to permit it to
16 flex as it bends with the endoscopic instrument. Second, a
17 flexible pushing element of larger diameter is subject to
18 greater frictional forces within the outer sheath, which
19 reduces the force transmitted from the handle to the end
20 effector. If the flexible pushing element is made relatively
21 smaller in diameter, it is subject to kinking, which will
22 result in little to no force being transmitted to the distal
23 end. Kinking is especially a problem in endoscopic
24 instruments, because the endoscope and its lumen may be

1 extended through a tortuous path. For most flexible devices,
2 especially metal coils, the outer sheath begins to stretch
3 when force is applied to the pushing element. This reduces or
4 eliminates the force and relative movement of the pushing
5 element. For these reasons and others, mechanical application
6 of a relatively large distal end pushing force, and
7 particularly clip application, have been absent from the
8 capability of flexible endoscopic tools.

9
10 In addition, it is important that the tissue about which
11 a clip is to be applied be substantially compressed. While
12 the jaws apply a clamping force which compresses the tissue,
13 large clamping forces are difficult to achieve because of the
14 dimensions of the relatively small jaw assembly. That is, the
15 dimensions are such that the lever arm between a pivot of the
16 jaw assembly and each jaw tang is relatively short, limiting
17 the mechanical leverage of the jaw assembly.

18
19 Our previous application 10/396,962, which is hereby
20 incorporated by reference herein in its entirety, discloses a
21 flexible clip applier that includes a ratchet mechanism
22 adapted to locate a clip pusher to a known location after
23 deployment of a clip. In addition, the clip applier includes
24 a flexible housing into which a train of clips may be

1 chambered. The flexible housing does not elongate when
2 subject to tensile forces. In addition, the jaw assembly is
3 adapted to have relatively high mechanical leverage which
4 facilitates tissue compression prior to application of a clip.

5
6 Since the development of the clip applier disclosed in
7 serial number 10/396,962, we have developed an improved
8 flexible endoscopic clip applier which is the subject of the
9 instant application.

10
11 SUMMARY OF THE INVENTION

12
13 It is therefore an object of the invention to provide a
14 flexible endoscopic clip applier.

15
16 It is also an object of the invention to provide a
17 flexible endoscopic clip applier capable of dispensing
18 multiple clips.

19
20 It is another object of the invention to provide a
21 flexible endoscopic clip applier which limits the amount of
22 force which can be applied to the jaws of the device.

1 It is still another object of the invention to provide a
2 flexible endoscopic clip applier which limits the amount of
3 force which can be applied to the jaws of the device while
4 adjusting for relative changes in the length of the outer
5 sheath due to tortuosity of the path of the endoscope.

6
7 It is a further object of the invention to provide a
8 flexible endoscopic clip applier which has two jaws which are
9 rotatable about different axes to improve the mechanical
10 advantage of the jaws.

11
12 It is also an object of the invention to provide a
13 flexible endoscopic clip applier which dispenses clips via
14 smooth movement of a manual actuator.

15
16 It is an additional object of the invention to provide a
17 flexible endoscopic clip applier which has an actuator that
18 dispenses clips precisely one at a time.

19
20 Another object of the invention is to provide a flexible
21 endoscopic clip applier which uses a single control wire to
22 open and close jaws as well as to rotate them about the
23 longitudinal axis.

1 A further object of the invention is to provide a
2 flexible endoscopic clip applier having improved jaws.

3

4 An additional object of the invention is to provide a
5 flexible endoscopic clip applier which prevents the accidental
6 dispensing of the penultimate clip when the device is moved
7 away from the ultimate clip after it is applied.

8

9 It is yet another object of the invention to provide a
10 flexible endoscopic clip applier which forms clips as they are
11 dispensed.

12

13 It is even another object of the invention to provide a
14 flexible endoscopic clip applier having a handle having a
15 resistance force which is substantially constant during a
16 cycle of forming and applying a clip.

17

18 Yet another object of the invention is to provide a clip
19 applier with clip-forming jaws which indicate a tissue
20 fixation point for the applied clip.

21

22 Even another object of the invention is to provide a clip
23 applier with a mechanism which stably advances clips through a
24 coil and into an end effector.

1

2 A further object of the invention is to provide an
3 endoscopic clip applier which can fire a clip only when the
4 jaws of the applier are closed.

5

6 Another object of the invention is to provide an
7 endoscopic clip applier which can fire only one clip at a
8 time, i.e. between closing and opening the jaws.

9

10 An additional object of the invention is to provide an
11 endoscopic clip applier which provides a visual indication to
12 the practitioner of the number of clips which are left in the
13 applier.

14

15 Still another object of the invention is to provide an
16 endoscopic clip applier which stops operating after all of the
17 clips have been dispensed.

18

19 In accord with these objects, which will be discussed in
20 detail below, a flexible endoscopic clip applier according to
21 the invention has a relatively long flexible coil (or tube)
22 having a proximal end and a distal end. As used herein, the
23 term proximal end means the end closest to the practitioner
24 and the term distal means the end closest to the patient. A

1 manual actuator is coupled to the proximal end of the coil and
2 a pair of jaws is coupled to the distal end of the coil. A
3 store of clips is disposed inside the coil adjacent to the
4 jaws. The interiors of the jaws form anvils for bending a
5 clip as it is pushed from the store into the closed jaws. The
6 manual actuator has three controls: a lever for opening and
7 closing the jaws, a knob for rotating the jaws (and a distal
8 portion of the coil) about the longitudinal axis of the coil,
9 and a crank for dispensing a clip. The lever and knob are
10 coupled to a single first control member which extends through
11 the coil to a point proximal of the store of clips. The crank
12 is coupled to a second control member which extends through
13 the coil up to a point adjacent to the store of clips and is
14 threaded along a distal portion thereof.

15

16 According to the presently preferred embodiment, the
17 lever is coupled to a force limiter which prevents too much
18 force from being applied to the jaws when closing them. The
19 force limiter also effectively adjusts for the relative
20 changes in the length of the outer sheath with respect to the
21 jaw control member. The knob is coupled to the first control
22 member via a spline coupling. The crank is coupled to the
23 second control member via a transmission and an energy storage
24 device, e.g. a flywheel.

1

2 The first control member terminates proximal of the store
3 of clips and is coupled to a joiner which is coupled to a pair
4 of pull wires. The pull wires extend on opposite sides of the
5 store of clips, each being coupled to one of the jaws.

6

7 According to the invention, the coil is bifurcated
8 proximal of the store of clips and the two portions of the
9 coil are joined by a rigid member having four bores, one of
10 which is threaded. The rigid member is disposed distal of the
11 joiner and the first control member extends into one of the
12 bores of the rigid member. In this way, rotation of the first
13 control member causes the rigid member to rotate which causes
14 the distal portion of the coil and the jaws to rotate about
15 the longitudinal axis. This helps orient the jaws properly
16 before closing the jaws on a tissue to be clipped. The two
17 pull wires extend through two other bores in the rigid member
18 and the threaded portion of the second control member
19 threadably engages the threaded bore of the rigid member. In
20 this way, when the threaded control member is rotated (by the
21 crank), it is translated distally. The distal end of the
22 threaded control member is coupled to a clip pusher. The clip
23 pusher is arranged adjacent to the proximally closest clip in
24 the store of clips which are axially arranged one after the

1 other. When the threaded control member is translated
2 distally, the store of clips is moved distally until the
3 ultimate clip (the one at the distal end of the store) enters
4 the closed jaws and is applied to tissue through the bending
5 of its ends by the interior anvils of the jaws.

6
7 The transmission and the pitch of the threads on the
8 threaded portion of the second control member are arranged
9 such that exactly one rotation of the crank causes exactly one
10 clip to be dispensed. The crank is preferably provided with a
11 detent lock which must be engaged to release the crank and
12 which automatically stops the crank after one rotation.

13
14 Further according to the invention, the jaws are
15 identical hermaphroditic jaws which are respectively rotatably
16 coupled on offset axes to a clevis at the distal end of the
17 distal coil. Each jaw has a distal tooth and a proximal tang.
18 The tang is coupled to one of the pull wires and lies on one
19 side of the longitudinal axis. The distal tooth of that jaw
20 lies on the opposite side of the longitudinal axis, which
21 prevents side-to-side misalignment of the jaws when they are
22 closed.

1 The store of clips is housed in a "garage" which is
2 coupled to the clevis and extends proximally therefrom. The
3 garage is a substantially rigid rectilinear structure which
4 keeps the clips properly aligned and allows them to be
5 smoothly pushed out of the garage into the closed jaws. The
6 distal portion of the garage is provided with a pair of biased
7 stops which prevent the penultimate clip from moving out of
8 the garage when the applicator is moved away from the ultimate
9 clip after it has been applied. In an alternate embodiment,
10 the stops are made part of the clevis rather than the garage.

11

12 According to presently preferred embodiments, the crank
13 is located on both sides of the manual actuator to accommodate
14 left hand and right hand use. A counter mechanism is coupled
15 to the crank and indicates the number of clips remaining in
16 the garage. The detent lock is engagable by the lever so that
17 the crank can only be operated when the jaws are closed. The
18 crank is also provided with a ratchet mechanism so that it can
19 only be rotated in one direction. The counter also includes a
20 stop which prevents the crank from being rotated after all of
21 the clips have been dispensed.

22

23 Additional objects and advantages of the invention will
24 become apparent to those skilled in the art upon reference to

1 the detailed description taken in conjunction with the
2 provided figures.

3
4 BRIEF DESCRIPTION OF THE DRAWINGS

5
6 Fig. 1 is a partially disassembled side elevation view of
7 a surgical clip applier according to the invention, shown with
8 the lever and the jaws in an open position;

9
10 Fig. 2 is a partially disassembled perspective view of
11 the manual actuator shown with the lever in the open position;

12
13 Fig. 3 is a longitudinal sectional view of the manual
14 actuator shown with the lever in the open position;

15
16 Fig. 3A is a view similar to Fig. 3 but showing the force
17 absorbing spring in a compressed state;

18
19 Fig. 4 is a longitudinal sectional view of the manual
20 actuator shown with the lever in the closed position;

21
22 Fig. 4A is a view similar to Fig. 4 showing the force
23 absorbing spring in a compressed state;

1 Fig. 4B is a schematic view of a first alternate force
2 absorber arrangement;

3

4 Fig. 5 is a perspective view of the manual actuator
5 showing the crank;

6

7 Fig. 6 is a sectional view through the crank illustrating
8 the locking detent;

9

10 Fig. 7 is a broken partially disassembled view
11 illustrating the coils, the jaws, and the distal end of the
12 manual actuator;

13

14 Fig. 8 is a broken partially transparent perspective view
15 of the control members, the joiner, the rigid member, one of
16 the pull wires, the pusher, a portion of the garage and a
17 portion of a clip;

18

19 Fig. 9 is a plan view of the rigid member;

20

21 Fig. 10 is a plan view of the joiner;

22

1 Fig. 11 is a broken partially transparent perspective
2 view of the threaded control member, the pusher, a portion of
3 a clip, and one of the pull wires;

4
5 Fig. 12 is a perspective view of the pusher;

6
7 Fig. 13 is a partially cut away perspective view of the
8 garage, the clevis, the jaws and a clip in the applied
9 configuration;

10
11 Fig. 14 is a perspective view of the garage;

12
13 Fig. 15 is an enlarged broken perspective view of the
14 distal end of the garage illustrating the biased stops;

15
16 Fig. 16 is a broken plan view illustrating the clevis and
17 portions of the jaws, pull wires, garage, and clips;

18
19 Fig. 17 is a broken partially transparent perspective
20 view illustrating the clevis and portions of the jaws, pull
21 wires, garage, and clips;

22
23 Fig. 18 is a broken perspective view of the clevis, open
24 jaws and portions of a pull wire and garage;

1

2 Fig. 19 is a distal end view looking into the open jaws;

3

4 Fig. 20 is a broken side elevational view of the clevis,
5 closed jaws, and an applied clip;

6

7 Fig. 21 is a perspective end view of the closed jaws,
8 clevis, and the garage;

9

10 Fig. 22 is a broken longitudinal section illustrating the
11 jaws closed, the clevis and a distal portion of the garage,
12 with no clips;

13

14 Fig. 23 is a view similar to Fig. 22 but with three
15 clips;

16

17 Fig. 24 is a plan view of the interior of a jaw;

18

19 Fig. 25 is a perspective view of the interior of a jaw;

20

21 Fig. 26 is a side elevational view of the clevis;

22

23 Fig. 27 is a distal end view of the clevis;

24

1 Fig. 28 is a schematic side elevation view in partial
2 section of an alternate embodiment of "self-pushing" threaded
3 clips coupled to a threaded control member;

4

5 Fig. 28a is a longitudinal sectional view of a self-
6 pushing clip;

7

8 Fig. 28b is an end view of the clip of Fig. 28a;

9

10 Fig. 29 is a perspective view of a shepard's crook;

11

12 Fig. 30 is a proximal end view of a presently preferred
13 embodiment of the manual actuator;

14

15 Fig. 31 is a side elevation view of the presently
16 preferred embodiment of the manual actuator;

17

18 Fig. 32 is an exploded perspective view of the presently
19 preferred embodiment of the manual actuator;

20

21 Fig. 33 is a view similar to Fig. 31 with the crank
22 transparent to illustrate the ratchet mechanism;

23

1 Fig. 34 is an enlarged view of the transmission and
2 counter gears;

3
4 Fig. 35 is a view similar to Fig. 34 with the
5 transmission gears removed showing the connection between the
6 crank shaft and the counter gear;

7
8 Fig. 36 is an exploded perspective view of the presently
9 preferred embodiment of the manual actuator showing the detent
10 lock engagable by the lever;

11
12 Fig. 37 is an enlarged view of the lock mechanism of Fig.
13 36;

14
15 Fig. 38 is a partially disassembled perspective view of a
16 manual actuator having an alternate embodiment of a force
17 limiting spring assembly using a shuttle element;

18
19 Fig. 39 is a broken enlarged view of the spring assembly
20 of Fig. 38;

21
22 Fig. 40 is an enlarged perspective view of an
23 hermaphroditic part used to form the shuttle element;

24

1 Fig. 41 is a view similar to Fig. 38 showing an alternate
2 embodiment of a force limiting device in the form of a spring-
3 hinged lever;

4
5 Fig. 42 is a perspective view of the spring-hinged lever;

6
7 Fig. 43 is an enlarged perspective view of an
8 hermaphroditic part used to form a ball joint coupling between
9 the control member and the spring-hinged lever;

10
11 Fig. 44 is a view similar to Fig. 20 but of an alternate
12 jaw embodiment; and

13
14 Fig. 45 is a view similar to Fig. 18 but of the alternate
15 jaw embodiment of Fig. 44.

16
17 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

18
19 Turning now to Fig. 1, a flexible endoscopic clip applier
20 10 according to the invention has a relatively long flexible
21 coil (or tube) 12 having a proximal end 14 and a distal end
22 16. As used herein, the term "proximal" means closest to the
23 practitioner and the term "distal" means closest to the
24 patient. A manual actuator 18 is coupled to the proximal end

1 14 of the coil 12 and a pair of jaws 20 is coupled to the
2 distal end 16 of the coil 12. The coil is preferably a flat
3 wire coil having a friction reducing outer sheath (not shown).
4 The invention will be described in detail referring to each of
5 its major components starting at the proximal end and working
6 toward the distal end.

7
8 The Manual Actuator

9
10 A first embodiment of a manual actuator is shown in Figs.
11 1-6. A presently preferred embodiment of the manual actuator
12 is shown in Figs. 30-37 and described in detail below.

13
14 The manual actuator 18 of Figs. 1-6 has three controls:
15 a lever 22 for opening and closing the jaws 20, a knob 24 for
16 rotating the jaws 20 (and a distal portion of the coil 12)
17 about the longitudinal axis of the coil, and a crank 26 for
18 dispensing a clip. It will be appreciated that the manual
19 actuator 18 has a generally pistol shape which is similar to
20 other endoscopic actuators. A finger grip 28 is provided
21 opposite the lever 22 which has a thumb grip 30. Engaging
22 hooks 32, 34 on the lever and the finger grip allow the lever
23 to be locked as shown in Figure 4. Those skilled in the art
24 will further appreciate that the general operation of the clip

1 applier 10 involves closing the jaws (optionally by locking
2 the lever 22), delivering the jaws 20 through the lumen of an
3 endoscope to the surgical site, opening the jaws as shown in
4 Fig. 1, positioning the jaws 20 through movement of the coil
5 12 and rotation of the knob 24 so that tissue to be clipped is
6 located between the jaws, locking the lever 22 to close the
7 jaws on the tissue, turning the crank 26 to apply a clip, and
8 then releasing the jaws from the clip and tissue.

9
10 Turning now to the details of the manual actuator 18 and
11 with continued reference to Figs. 1-6, and Fig. 3 in
12 particular, the lever 22 and the knob 24 are coupled to a
13 single first control member 36. The lever 22 is rotatable
14 about axle 23 and coupled to the control member 36 via a force
15 limiting mechanism 37. The force limiting mechanism includes
16 spring 38, a proximal coupler 38a, a force limiter cap 38b, a
17 force limiting cup 38c, an overload nut 38d, a distal coupler
18 38e, and an overload shaft 38f. The overload shaft 38f is
19 coupled to overload nut 38d and extends inside the spring 38
20 and partially into the force limiting cup 38c.

21
22 The lever 22 is coupled to the distal end of the spring
23 38 by a linkage 44 seen best in Figure 2. In particular, the
24 linkage 44 includes a U-shaped member 44a which fits over the

1 spring 38 and its associated elements 38a-38f. A pin 44b
2 couples the proximal end of the U-shaped member 44a to a slot
3 22a in the upper part of the lever 22 and a second pin 44c
4 couples the distal end of the U-shaped member 44a to the
5 overload nut 38d.

6

7 With the provided arrangement, movement of the lever 22
8 towards the finger grip 28 causes the linkage 44 to move
9 proximally which moves the overload nut 38d proximally. The
10 overload nut 38d in turn pushes against the spring 38 moving
11 it proximally. The spring 38 pushes against the cup 38c which
12 presses against the limiter cap 38b which in turn presses
13 against the proximal coupling 38a. Since the proximal
14 coupling 38a is affixed to the control member 36, proximal
15 movement of the proximal coupling 38a causes proximal movement
16 of the control member 36. Effectively, then, the entire force
17 limiting assembly 37 is moving proximally and pulls the
18 control member 36 proximally.

19

20 If at any time during the closing of the jaws the tension
21 on the control member 36 exceeds a predetermined force limit
22 of the spring 38 (e.g., seventeen pounds), the spring force of
23 the spring 38 will be overcome such that the spring 38 will
24 compress and the overload shaft 38f and the overload nut 38d

1 will move away from the distal coupler 38e without moving the
2 control member 36 as seen in Fig. 3A. In this force overload
3 situation, the shaft 38f is received into the hollow 38c' of
4 the overload cup 38c.

5
6 Fig. 3A shows the force limiting spring 38 in the
7 compressed position during closing of the jaws. This will
8 occur when the control member 36 is pulled beyond the distance
9 normally necessary to close the jaws (e.g. when the jaws are
10 prevented from closing all the way because they are
11 surrounding a very thick or very hard tissue, or if the
12 tortuosity of the path of the coil causes an effective
13 lengthening of the coil, effective shortening of the control
14 member 36, thereby increasing the stroke of the lever 22,
15 shortening the stroke required to close the jaws). The spring
16 38 prevents the jaws, the tissue and/or the control member 36
17 from being damaged due to excessive loads while allowing the
18 lever 22 to be fully actuated to the latched position.

19
20 If, after the lever 22 has moved to a position as shown
21 in Fig. 4 where the jaws have been closed, excessive force is
22 applied to the control member 36 (e.g., while delivering the
23 jaws to the surgical site through a tortuous endoscopic path),
24 the force limiting mechanisms 37 will also operate to prevent

1 damage to the control member 36. In particular, as seen in
2 Fig. 4A, if the control wire is pulled distally after the jaws
3 have been closed, and the force on the control wire 36 exceeds
4 the predetermined limit of spring 38, the proximal coupling
5 38a which is fixedly coupled to the control member 36 will be
6 moved distally against the cap 38b and the force limiting cup
7 38c. The force limiting cup, in turn will move distally,
8 compressing the spring 38 against the nut 38d which is fixed
9 in place because of its linkage to lever 22 which is locked.

10
11 In either case, when the lever 22 is released, the spring
12 38 will decompress by linkage 44 causing the nut 38d to move
13 distally until it abuts the distal coupling 38e (which is
14 coupled to the control member 36). The distal movement of the
15 nut 38d causes distal movement of the distal coupling 38e
16 which is coupled to the control member 36 causing the control
17 member 36 to move distally.

18
19 According to the presently preferred embodiment, the
20 spring is always compressed when the lever 22 is moved to the
21 locked position.

22
23 To permit rotation of the control member 36, the knob 24
24 is coupled to the control member 36 via a spline 40 mounted in

1 a shaft bearing 24a held by a clamp 24b. The proximal end of
2 the control member 36 is bent into a shepherd's crook 36a
3 which slidably engages the spline 40 coupled to the knob 24.
4 A shepherd's crook is illustrated in Fig. 29. Rotation of the
5 knob 24 thus causes rotation of the control member 36.

6
7 It should be noted that in the force limiting mechanism
8 37, the distal coupling 38e and the proximal coupling 38a are
9 assembled in such a way as to allow clearance with the rest of
10 the force limiting assembly 37. This clearance allows for
11 ease of rotation since and friction created by the preloaded
12 spring 38 is not translated into torsional resistance.

13
14 Fig. 4B shows a first alternate embodiment of a force
15 limiting mechanism 137. Here, the coil 112 is provided with a
16 proximal bushing 113. The manual actuator or handle 118 is
17 provided with a recess 119 which is dimensioned to receive the
18 bushing 113, a washer/spacer 115, and a compression spring 138
19 therebetween. Those skilled in the art will appreciate that
20 if, during closing of the jaws, an obstacle prevents the jaws
21 from closing fully, the proximal force applied to the control
22 member 136 will be applied to the distal clevis 182, the coil
23 112, and the handle 118. The handle will exert an equal and
24 opposite force in the distal direction against the washer

1 spacer 113. As a result, when the spring force of the
2 compression spring 138 is exceeded, the proximal end of the
3 coil will move the bushing 113 against the spring 138.

4
5 Still referring to Figs. 1-6, and particularly Fig. 4,
6 the crank 26 is coupled to a transmission 46 which is coupled
7 to a second control member 48. More particularly, the
8 transmission includes an input spur gear 47 which is coupled
9 to the crank, a step-up spur gear 49 coupled to the input spur
10 gear, and a crown gear 50 which is coupled to the step-up spur
11 gear. The crown gear engages a pinion 52 coupled to a
12 cylinder 54 having a keyed interior which engages the second
13 control member 48 which is provided with a shepherd's crook
14 48a (also as illustrated in Fig. 29) at or near its proximal
15 end. The cylinder 54 is mounted on two bearings 55, 57 which
16 are held by clamps 55a, 57a. The second control member 48 (as
17 discussed in detail below with reference to Figs. 8-11) is
18 threaded along a distal portion thereof. From the discussion
19 which follows, it will be appreciated that the length of the
20 cylinder 54 is sufficient to allow distal movement of the
21 second control member 48 until all of the clips have been
22 dispensed. According to the presently preferred embodiment,
23 the control member 48 is made from 17-7 PH stainless steel
24 wire.

1

2 According to the presently preferred embodiment, an
3 energy storing flywheel 56 is coupled to the cylinder 54.
4 Alternatively, the flywheel and cylinder could be a single
5 molded part. The flywheel smoothes the operation of the crank
6 which would otherwise require the application of increasing
7 force through its rotation, as in the beginning of its
8 rotation, the control member is causing a clip to be advanced,
9 whereas at the end of its rotation, the control member is
10 causing the clip to be formed by pushing it against an anvil
11 in the end effectors (as discussed in more detail below).
12 Those skilled in the art will appreciate that in order to be
13 effective, the flywheel is preferably provided with a
14 relatively large rotational mass for energy storage. When the
15 flywheel is spun (rotated) by rotation of the crank, a certain
16 amount of energy is invested which increases the kinetic
17 energy (mass x velocity) of the flywheel. Some of this energy
18 is lost over time to friction; however, some of the energy
19 used to spin the flywheel is stored in the form of kinetic
20 energy. Later, it is possible to retrieve this energy through
21 direct mechanical translation. In the case of the present
22 invention, when the crank 26 is first rotated, the control
23 member 48 offers little resistance (as the clips are moving
24 forward easily) and most of the energy applied to the crank is

1 used to put the flywheel 56 in rotation. Near the end of the
2 crank's rotation, torsional resistance is built up by the
3 control member 48 because it is near the end of the cycle
4 where the clip is being bent into its final shape. At this
5 point, the kinetic energy in the flywheel is released and
6 eases the remainder of the crank cycle. Preferably, according
7 to the invention, the flywheel 56 is chosen so that the force
8 which is applied to the crank 26 is substantially even (e.g.,
9 does not change by more than 25%) over the entire movement of
10 the crank 26 necessary to dispense a single clip.

11

12 As seen best in Figs. 5 and 6, the crank 26 is provided
13 with a detent lock 58 which must be released before the crank
14 26 can be turned and which automatically locks the crank 26
15 after one rotation. Preferably, the crank 26 is also provided
16 with a ratchet mechanism (not shown) which prevents it from
17 being rotated backwards. The crank is also preferably
18 provided with a lock (not shown) which prevents it from being
19 turned until the jaws are closed. The crank may also be
20 provided with a revolution counter (not shown) which can be
21 coupled to the input spur gear and which counts the number of
22 times the crank has been rotated and thus indicates the number
23 of clips which have been dispensed. The revolution counter
24 may also be used to prevent the crank from rotating after all

1 of the clips have been dispensed. Ideally, the crank is also
2 provided with a lockout mechanism which prevents it from being
3 rotated twice without opening and closing the jaws between
4 rotations of the crank.

5
6 According to the embodiment illustrated in Figs. 5 and 6,
7 the crank 26 has a plurality of spaced apart peripheral finger
8 grips 26a and a knurled outer periphery 26b. The crank handle
9 26c is optionally removable so that the crank can be rotated
10 like a knob if desired. The detent lock 58 includes a push
11 button 58a having a flange 58b, a lock pin 58c having a flange
12 58d and a spring 58e. The lock pin 58c is disposed in a
13 stepped bore 58f and is biased by the spring 58e into the
14 stepped bore 26d in the crank 26. When the button 58a is
15 pressed, the lock pin 58c is moved against the spring 58e and
16 out of the bore 26d, freeing the crank to rotate.

17
18 According to an exemplary embodiment, the transmission
19 causes the second control member to be rotated 58.1875
20 revolutions when the crank is turned one revolution. The
21 pitch of the threads on the control member result in the
22 control member advancing 0.285 inches when the crank is turned
23 one revolution. The gears and the thread pitch are selected
24 for a particular clip length. According to the presently

1 preferred embodiment, it is only necessary to change the crown
2 gear (by increasing or decreasing the number of teeth) to
3 accommodate clips of different length.

4
5 As illustrated in Figs. 1-4 and 4a, the distal end of the
6 manual actuator 18 has a pair of vertical slots 15 which
7 capture a coil connector (not shown) that is attached to the
8 proximal end of the coil.

9
10 The Control Members

11
12 Referring now to Figs. 7-10, the control members 36, 48
13 extend through a flexible coil 12 coupled to the distal end of
14 the manual actuator 18. According to the invention, the coil
15 12 has two parts: a proximal part 12a and a distal part 12b
16 which are coupled to each other by a rigid member 60. The
17 rigid member 60 is substantially cylindrical having a center
18 portion 60-1 of larger diameter than the end portions 60-2,
19 60-3. The end portions 60-2, 60-3 are dimensioned to fit
20 inside the coils 12a, 12b and the central portion 60-1 is
21 dimensioned to have an outer diameter substantially the same
22 as the outer diameter of the coils 12a, 12b. The rigid member
23 60 has four bores 60a-60d. One of the bores, 60d, is threaded
24 and engages the threaded portion of the second control member

1 48. Because the rigid member 60 is fixed relative to the
2 coils 12a, 12b, it will be appreciated that this threaded
3 engagement causes the second control member 48 to move
4 distally through the rigid member 60 when it is rotated by the
5 crank 26 (Fig. 2).

6

7 Two of the other holes, 60a and 60b, in the rigid member
8 60 allow the passage of a pair of pull wires 62, 64 which are
9 described in more detail below with reference to Figs. 16 and
10 17. The proximal ends of the pull wires are coupled to a
11 joiner 66 which has four bores 66a-66d. One pull wire is
12 coupled to bore 66a and the other is coupled to bore 66b. The
13 first control member 36 extends through and is coupled to the
14 bore 66c, and the threaded control member 48 freely passes
15 through the bore 66d. In this manner, longitudinal movement
16 of the first control member 36 causes longitudinal movement of
17 the pull wires 62, 64. The portion 36a of the control member
18 36 which extends through the joiner 66 extends into the bore
19 60c of the rigid member 60. The length of this portion 36a is
20 sufficient to engage the bore 60c throughout the range of
21 movement of the control member 36. In this manner, rotation
22 of the control member 36 with the knob 24 (Fig. 1) causes
23 rotation of the rigid member 60 which causes rotation of the
24 distal portion 12b of the coil 12 which results in rotation of

1 the jaws 20 and the store of clips about the longitudinal axis
2 of the coil.

3

4 As seen best in Fig. 8, the control members 36 and 48 are
5 protected by a dual lumen flexible sheath 68 inside the
6 proximal portion 12a of the coil 12. The sheath 68 reduces
7 friction between the control members and the interior of the
8 coil. The sheath 68 also prevents buckling or kinking of the
9 control members. It should also be noted that a friction-
10 reducing sheath is preferably provided along the entire
11 exterior surface of the coil to reduce friction between the
12 coil and the lumen of the endoscope through which it is
13 delivered and to protect the lumen of the endoscope from
14 damage.

15

16 According to a presently preferred embodiment, both
17 control members have smaller diameters in their distal
18 portions to add flexibility and larger diameters in the
19 proximal portions to optimize torque transmission.

20

21 The Pusher

22

23 Turning now to Figures 11-13, the distal end of the
24 threaded control member 48 is coupled to a clip pusher 70. As

1 seen best in Fig. 12, the pusher 70 is a generally rectilinear
2 member having an off-axis bore 70a intersected by a notch 70b.
3 A pair of inwardly curved distally extending fingers 70c, 70d
4 are separated from a distal mouth 70e by shoulders 70f, 70g.
5 As seen best in Fig. 11, the distal end of the threaded
6 control member 48 extends through the bore 70a and is coupled
7 to a cylinder 72 which is captured in the notch 70b. The
8 cylinder 72 may be crimped or welded to the control member 48.
9 The coupling of the pusher and the control member is such that
10 the control member can freely rotate relative to the pusher.
11 As seen best in Fig. 11, the distal end 48b of the control
12 member 48 is sharpened to a point and the distal end of the
13 throughbore 70a is provided with a conical wall 70h. The apex
14 angle of the conical wall 70h is larger than the apex angle of
15 the point 48b. From the foregoing, those skilled in the art
16 will appreciate that when the control member 48 is rotated, it
17 moves distally, pushing the pusher distally. It will also be
18 appreciated that the frictional engagement of the control
19 member 48 with the pusher 70 is limited to the small area of
20 engagement of the point 48b with the apex of the cone 70h.

21

22 As seen best in Fig. 13, the clip pusher 70 is arranged
23 adjacent to the proximally closest clip 74 in the store of
24 clips 76 which are axially arranged one after the other

1 proximal to the jaw assembly 20. When the control member 48
2 is translated distally, the store of clips 76 is moved
3 distally until the ultimate clip 78 (the one at the distal end
4 of the store) enters the closed jaws and is applied to tissue
5 through the bending of its ends by the interior anvils of the
6 jaws. Fig. 13 shows the jaws open after the clip 78 was
7 applied.

8

9 As seen best in Fig. 11, the clip 74 (which is identical
10 to all of the other clips) has a proximal tail 74a which is
11 engaged by the mouth 70e and shoulders 70f, 70g of the pusher
12 70. The fingers 70c and 70d constrain the clip from vertical
13 movement and allow the pusher to lightly grab the clip, which
14 facilitates clip loading during assembly. Additional details
15 of the clip may be appreciated upon review of previously
16 incorporated U.S. Serial No. (Docket ISD-083).

17

18 Those skilled in the art will appreciate that the
19 arrangement of threads could be changed while still achieving
20 the same or similar results. For example, rather than
21 arranging the threaded control member to advance distally,
22 threads could be supplied on the pusher with the threaded
23 control member being translationally stationary. In this

1 arrangement, rotation of the threaded control member causes
2 the pusher to be translated along the control member.

3
4 The Garage

5
6 As seen best in Figs. 13 and 16, the store of clips 76 is
7 housed in a garage 80 inside the distal portion 12b of the
8 coil 12 proximal to the jaw assembly 20. Details of the
9 garage 80 are seen in Figs. 14-17. The garage 80 generally
10 comprises a plurality of parallel side walls 80a-80l and pair
11 of distally extending fingers 80m, 80n which are orthogonal to
12 the side walls. Each side wall has a plurality of outwardly
13 directed spacers, e.g. 80c-1, 80c-2, 80c-3, 80c-4. These
14 spacers engage the interior of the coil and assure space
15 between the coil and the garage for the passage of the pull
16 wires 62, 64 (see Fig. 16). Formation of the outwardly
17 directed spacers results in narrow strips, e.g. 80ab, 80bc,
18 80cd, etc., which add flexibility to the garage. The
19 flexibility at the distal end of the instrument can be
20 important in cases where the endoscope is retroflexed. As
21 seen best in Fig. 16, when the clips are arranged in the
22 garage, the abutment of one clip against another lies in this
23 narrowed region. Thus the clips can flex at their abutment.

24

1 As seen best in Fig. 15, the distally extending fingers
2 80m, 80n each have an outwardly extending distal lip 80m-1,
3 80n-1 and an inwardly extending proximal stop 80m-2, 80n-2.
4 The fingers 80m, 80n help orient the garage relative to the
5 clevis. The distal lips help the garage engage the clevis as
6 described below and the proximal stops prevent unwanted
7 movement of the penultimate clip as described below. Opposite
8 pairs of parallel fingers 80p and 80q are arranged in spaced
9 apart planes orthogonal to the planes of the fingers 80m, 80n.
10 These fingers 80p, 80q extend from a proximal collar 80r and
11 engage the clevis as seen best in Fig. 17, described in detail
12 below.

13

14 According to the presently preferred embodiment, the
15 garage is made from a single piece of stamped and folded
16 stainless steel.

17

18 Unlike our earlier clip appliers, there is no need to
19 chain the clips together so that they can be pulled back.
20 There is also no need to pull any of the clips back at any
21 time.

22

1 The Jaw Assembly

2

3 Figs. 17-27 illustrate details of the jaw assembly 20
4 which includes a clevis 82 and a pair of jaws 84, 86. The
5 jaws are hermaphroditic mating jaws, i.e. the jaws are
6 identical and arranged to mate with each other. Each has a
7 proximal tang 84a, 86a, a plurality of side teeth 84b, 86b,
8 which are offset one half pitch from each other on opposite
9 sides of the longitudinal axis of the jaw, a distal tooth 84c,
10 86c, and a mounting hole 84d, 86d. The jaws are coupled to
11 the clevis via their mounting holes. As seen best in Fig. 27,
12 the clevis 82 has two off-axis bosses 82a, 82b upon which the
13 jaws are mounted and held in place by rivets. The distal ends
14 of the pull wires 62, 64 are bent into dogs-legs which are
15 coupled to respective tangs 84a, 86a of the jaws. It will
16 thus be appreciated that distal movement of the pull wires
17 will cause the jaws to open as shown in Figs. 18 and 19 and
18 proximal movement of the pull wires will cause the jaws to
19 close as shown in Figs. 20 and 21. The use of offset bosses
20 increases the mechanical advantage of the jaws. The clevis
21 also is provided with a pair of stops 82e, 82f (best seen in
22 Fig. 26) which engage ears 84a-1, 86a-1 on the tangs of the
23 jaws and which allow the jaws to be deflected 45-60 degrees
24 off axis when they are closed and which also allows for an

1 approximately ten degree over-rotation of the jaws. This
2 allows the closed jaws to traverse a tortuous path through the
3 lumen of an endoscope.

4

5 As seen best in Fig. 19, the proximal tang and the distal
6 tooth of each jaw lie on opposite sides of the longitudinal
7 axis of the jaw assembly. This arrangement provides stability
8 to the end effector arrangement. In particular, there is a
9 certain amount of clearance between the jaws and the clevis so
10 that the jaws can rotate easily open and closed. This
11 clearance may allow the jaws to rock horizontally on the
12 clevis creating the possibility of jaw misalignment. In the
13 illustrated embodiment, the jaws are forced toward each other
14 horizontally as they are being closed rather than away from
15 each other. This is because the forming anvils act in
16 opposition to the horizontal moments generated by the pull
17 wires.

18

19 The interior surfaces of the distal teeth are forming
20 anvils which cause the two tines of the clip to be bent
21 through approximately 90-180° as shown in Figs. 20 and 23. In
22 particular, as seen in Fig. 19 and 21, the distal teeth define
23 two curvature paths, parallel to each other. This allows the
24 two tines of the clip to be bent into parallel semi-circles.

1 The distal teeth also function as a tissue fixation point
2 indicator as the point(s) where the teeth meet are adjacent
3 the location where the tines of the clips pierce the tissue.
4

5 As seen best in Fig. 23, after the distal-most (ultimate)
6 clip 78 has been applied, the adjacent or penultimate clip 78a
7 is held by the stops 80m-2 and 80n-2 in the garage 80 and the
8 tines of the clip 78a embrace the tail of the clip 78. When
9 the jaws are opened, the jaw assembly can be moved away from
10 the ultimate clip 78 without releasing the penultimate clip
11 78a. As seen best in Fig. 18, with the jaws open, the tines
12 of the penultimate clip 78a are shielded by distal fins 82c,
13 82d of the clevis 82. However, if the clevis is dimensioned
14 differently, these fins 82c, 82d are not necessary because the
15 tines of the clip will not extend out of the clevis until it
16 is being applied. Other illustrations of the clevis (e.g.
17 Fig. 26) do not show the fins.
18

19 As shown in Fig. 17, the garage mates with the clevis in
20 three places in order to secure the garage relative to the
21 clevis. A distal mating is obtained with distal lips 80m-1
22 and 80n-1 engaging lips 82e and 82f of clevis 82 (shown best
23 in Fig. 22). A proximal mating is obtained with fingers 80p
24 and 80q engaging lateral recesses or bores 82g, 82h. The

1 third mating is provided by sandwiching the proximal collar
2 80r between the clevis core and the distal end of the coil.

3

4 Alternate Embodiment, Self-Pushing Clip

5

6 Referring now to Figs. 28-30, alternate embodiments of a
7 clip 301 and a clip advancement mechanism are shown. The clip
8 301 has substantially the same configuration as the clip
9 described above except that it has a threaded hole 301a in its
10 proximal end. Fig. 28 shows a plurality of clips 301-304
11 threadably mounted on the threaded end 148a of rotatable
12 control member 148. The control member 148 is similar to the
13 control member 48 described above except that it is mounted in
14 a way that it does not translate relative to the coil or the
15 actuator. In particular, control member 148 is mounted in a
16 thrust collar 310 set in a thrust bearing 312 which is located
17 between the proximal and distal coils (not shown). When the
18 control member 148 is rotated, the clips 301-304 which cannot
19 rotate because of the garage (not shown) are translated
20 through the garage because of their threaded engagement with
21 the control member.

22

1 The Presently Preferred Manual Actuator

2
3 Figs. 30-37 illustrate the presently preferred manual
4 actuator 418. Similar reference numerals, increased by 400,
5 refer to similar parts to the manual actuator 18 of Figs. 1-6.
6 The manual actuator 418 includes a lever 422, a knob 424, and
7 a crank 426. According to a first aspect of this embodiment,
8 a second crank 426' is provided on the opposite side of the
9 actuator. As seen best in Figs. 30 and 32, the "cranks" 426,
10 426' are knurled and do not have crank handles like the crank
11 26. Like the actuator 18, and as seen in Figs. 31-33, the
12 actuator 418 is provided with a finger grip 428 and a lever
13 422 having a thumb grip 430. Engaging hooks 432, 434 allow
14 the lever to be releasably locked in the closed position as
15 shown in Fig. 32.

16
17 As seen best in Fig. 32, a polygonal crank shaft 500
18 extends transversely through the actuator 418 and is engaged
19 on opposite ends by the cranks 426, 426'. The crank shaft 500
20 is surrounded by a cylindrical structure 502, 504 on opposite
21 sides of the actuator 418. According to a second aspect of
22 this embodiment, one of the cylinder structures 504 is
23 provided with a plurality of ratchet teeth 506, and as seen in
24 Fig. 33, the crank 426' has a peripheral post 508 upon which a

1 ratchet pawl 510 is mounted. Those skilled in the art will
2 appreciate that the ratchet and pawl prevent both cranks 426,
3 426' from being rotated backward, i.e., clockwise in the
4 illustrated embodiment.

5

6 According to a third aspect of this embodiment, as seen
7 best in Figs. 34 and 35, the transmission 446 is coupled to a
8 counter gear 512. In this embodiment, the transmission gears
9 are arranged slightly differently than in the embodiment of
10 Figs. 1-6. In particular, the crank shaft 500 is coupled to a
11 small hub gear 514 which engages the counter gear 512 as shown
12 in Fig. 35. The crank shaft is also coupled to an input spur
13 gear 447 which drives a step up spur gear 449 which is flipped
14 over as compared to the gear 49 shown in Fig. 4. The spur
15 gear 449 drives the crown gear 450 which is coupled to the
16 pinion 452. The pinion 452 is coupled to the cylinder 454
17 which in turn is coupled to the flywheel 456.

18

19 The counter gear 512 is provided with indicia 516,
20 preferably on both sides, and a standing rib 518. The body of
21 the actuator 418 is provided with at least one, but preferably
22 two windows 520, 522 (see Figs. 31-33, 36 and 37) through
23 which the indicia 516 of the counter gear can be viewed (one
24 at a time). The illustrated counter is for use with a store

1 of five clips. When the garage is full, the portion of the
2 counter between the standing rib 518 and the numeral "4" is
3 visible through the window. In order to accommodate space for
4 the standing rib, the number of teeth on the counter gear is
5 chosen so that one rotation of the hub gear causes slightly
6 less than 1/5 rotation of the counter gear. As clips are
7 dispensed, the counter gear rotates clockwise counting down
8 the number of clips remaining. When there are "0" clips
9 remaining, the "0" indicia is visible through the window. In
10 addition, when in this position, the standing rib 518 abuts a
11 structure inside the actuator, e.g. a wall of the window
12 opening. This prevents the counter gear and the cranks from
13 advancing further. Preferably, the counter gear 512 is
14 provided with an index hole 524 which is used to properly
15 orient the gear during assembly.

16

17 Those skilled in the art will appreciate that means other
18 than the standing rib 518 could be used to stop rotation. For
19 example, the threads on the control member 48 can be arranged
20 to run out upon dispensing the last clip. Alternatively, a
21 bump can be provided on the control member 48 at a location to
22 be stopped by engaging the rigid member 60 upon dispensing the
23 last clip. Still another alternative is to arrange the pusher
24 70 to engage and lock on the detent fingers 80m, 80n after the

1 last clip has been fired. The purpose of the stop is to
2 prevent the pusher from entering the jaws and to indicate that
3 all of the clips have been used.

4

5 According to a fourth aspect of this embodiment and as
6 illustrated in Figs. 36 and 37, the crank detent lock 458 is
7 engaged by the lever 422 such that the crank can only be
8 turned when the jaws are closed. In particular, the floor of
9 the previously identified cylindrical structure 502 is
10 provided with a ramp 526 which rises to a step 528. The crank
11 426 and/or the crank shaft 500 are/is coupled to a leaf spring
12 530 which extends generally radially out from the axis of the
13 crank shaft and terminates with an upturned lip 532. Figs. 36
14 and 37 illustrate the crank/crank shaft in the locked position
15 with the leaf spring 530 lying adjacent the step 528. If the
16 crank were operated to dispense a clip, rotation of the crank
17 would be stopped by the leaf spring 530 hitting the step 528.

18

19 The lever 422 has a tongue 534 with a lifting ramp 536 at
20 its end. A mouth 538 opens into the cylindrical structure 502
21 adjacent to the step 528. The tongue 534 is arranged so that
22 it enters the mouth 538 when the lever 422 is moved to the
23 closed position, closing the jaws. When the tongue 534 enters
24 the mouth 538, the lifting ramp 536 engages the upturned lip

1 532 and raises the leaf spring 530 above the step 528. In
2 this position, the leaf spring and the step no longer impede
3 rotation of the cranks, and a clip may be dispensed. Rotation
4 of the crank moves the leaf spring down the ramp 526 onto the
5 floor of the cylindrical structure where it is free to move
6 around in a complete rotation. The tongue 534 is provided
7 with a lower recess 540 which allows the leaf spring 530 to
8 pass under it at the end of a single rotation of the crank, at
9 which point the spring will once again abut the step 528. The
10 tongue 534 is resilient enough so that the recess 540 can pass
11 over the upturned lip 532 when the lever 422 is moved back to
12 open the jaws. Thus, the crank will move exactly one rotation
13 after the jaws are closed and will not move again until the
14 jaws are opened and then closed again.

15

16 Alternate Embodiments of Force Limiting Springs

17

18 Figs. 38-40 illustrate a first alternate embodiment of a
19 force limiting spring in a manual actuator 600 which in other
20 respects is substantially the same as the actuator described
21 above. The actuator 600 has a thumb lever 602 which is
22 coupled to a linkage 604. The distal end of the linkage 604
23 engages the distal end of a spring 606. A washer 608 is
24 located adjacent the proximal end of the spring 606 and a

1 "shuttle" 610 is located proximal of the washer 608 and abuts
2 a stop wall 611 on the linkage 604. The control member 612
3 extends through the linkage 604, the spring 606, the washer
4 608, and is coupled to the shuttle 610. The shuttle 610 is
5 composed of two identical pieces illustrated in Fig. 40. Each
6 piece 610 is generally semi-cylindrical, has a pair of locking
7 nubs 610a, 610b and a pair of nub-receiving sockets 610c,
8 610d. The interior of the piece 610 has an off center wire
9 engaging tongue 610e and each end is provided with an axial
10 half bore 610f, 610g. From the foregoing, those skilled in
11 the art will appreciate that when a control wire is placed
12 between the two pieces of the shuttle and they are pressed
13 together, the control wire will be bent into an S shape by the
14 two tongues 610e and the shuttle will be fixed relative to the
15 control wire.

16
17 With the foregoing in mind, it will also be appreciated
18 that when the lever 602 is moved from the open position (Fig.
19 39) toward the closed position shown in Fig. 38, the linkage
20 604 moves the spring 606 and washer 608 proximally against the
21 shuttle 610 pulling the control wire 612 proximally until the
22 control wire can be pulled no more, or until a predetermined
23 tension is placed on the wire. At that point, further closure
24 of lever 602 continues to move the linkage 604 and spring 606

1 proximally. However, because the wire 612, washer 608, and
2 shuttle 610 will not move (or because the spring constant is
3 less than the tension on the wire), the spring 606 begins to
4 compress between the linkage 604 and the washer 608 and
5 remains compressed when the lever is locked. The amount of
6 compression will depend on the tortuosity of the path of the
7 control wire. According to the presently preferred
8 embodiment, there is always some spring compression when the
9 lever is locked as shown in Fig. 38. When the lever 602 is
10 released, at first, the linkage 604 will move distally
11 relative to the washer and shuttle and the spring will expand.
12 Eventually, the stop wall 611 on the linkage 604 will reach
13 the shuttle 610 and push the shuttle distally, thereby causing
14 the control wire 612 to move distally.

15

16 It will be appreciated by those skilled in the art that
17 the function of the washer 608 is to provide a positive
18 interference between the spring 606 and the shuttle 610. One
19 manner of providing the positive interference is to partially
20 close the end of spring 606 by bending the end of the spring
21 606 into an "e" shape. Alternatively, the end of the spring
22 wire can be flattened and broadened to interfere with the
23 shuttle. It will also be appreciated by those skilled in the
24 art that instead of providing a stop wall 611 on the linkage

1 604 for the shuttle 610, the lever 602 can be arranged to
2 directly push the shuttle (and hence wire 612) distally upon
3 the release of the lever from the closed position.

4
5 Figs. 41-43 illustrate a second alternate embodiment of a
6 force limiting spring in a manual actuator 700 which in other
7 respects is substantially the same as the actuator described
8 above. The actuator 700 has a thumb lever 702 which is formed
9 in two parts 702a, 702b coupled to each other by a torsion
10 spring 706. As seen best in Fig. 42, the upper part 702b of
11 the lever 702 has a socket 702c for receiving a ball 710
12 coupled to the control wire (not shown) and two spaced apart
13 legs 702d, 702e. The lower part 702a of the lever has an
14 upper finger 702f which extends between the legs 702d, 702e.
15 The torsion spring 706 is mounted on a pivot post 703 which
16 extends through the upper finger 702f and the legs 702d, 702e.
17 The back of the spring 706a engages the back of the finger
18 702f and the front of the spring 706b engages the upper part
19 of the lever 702b. The ball is made of two identical pieces
20 illustrated in Fig. 43. The piece is generally hemispherical
21 but is similar to the previously described shuttle in that it
22 has a pair of locking nubs 710a, 710b and a pair of nub-
23 receiving sockets 710c, 710d. The interior of the piece 710
24 has an off center wire engaging tongue 710e and a pair of

1 diametrically opposed half bores 710f, 710g are provided
2 coaxial with the tongue 710e. From the foregoing, those
3 skilled in the art will appreciate that when a control wire is
4 placed between the two pieces of the ball and they are pressed
5 together, the control wire will be bent into an S shape by the
6 two tongues 710e and the ball will be fixed relative to the
7 control wire.

8

9 With the foregoing in mind, it will be appreciated that
10 when the lever 702 is moved from an open position toward the
11 closed position shown in Fig. 41, the upper part 702b of the
12 lever and the control wire (not shown) are moved proximally
13 until the control wire cannot be pulled further. At this
14 point, the upper part 702b of the lever remains stationary.
15 However, in order to reach a fully closed lever position, the
16 lower lever part 702a can continue to rotate about the pivot
17 axle 703 and cause the finger 702f to exert force against the
18 back part 706a of the spring 706, thereby causing the spring
19 finger 706b to spread away from spring finger 706a and top
20 lever part 702b. When the lever is eventually released from
21 its fully closed position, at first the force of finger 702f
22 against the spring is released and the ball 710 and wire will
23 not move. Eventually, when spring finger 706b hits the top

1 lever part 702b, the entire lever, the ball 710 and the
2 control wire is moved distally.

3

4 Pre-loaded Clip Ejector

5

6 In the presently preferred embodiment, at least a distal
7 portion of the flexible coil (in this case the distal coil
8 12b) is pre-loaded to provide sufficient columnar stiffness.

9 When the jaws 84, 86 are closed, the pull wire(s) increase the
10 load between the clevis and the nut. After the clip is
11 deployed, the pull wires are actuated distally to open the
12 jaws. The force of the compressed clip train, and if
13 necessary, the force from the pull wires is sufficient to
14 overcome the pre-load of the distal coil so that the jaws and
15 clevis move away from the tines of the clip, which have been
16 compressed against the forming anvils of the jaws. An
17 alternate embodiment of this concept provides oblong holes in
18 the jaws for attachment to the bosses on the clevis. When the
19 jaws are closed, the pull wires move the jaws proximally with
20 respect to the clevis. When the pull wires are released from
21 tension and actuated distally, the jaws are also able to move
22 distally with respect to the clevis to release the compressive
23 load on the tines of the clip.

24

1 According to an alternative embodiment, the distal coil
2 12b is pre-loaded to spring distally. When the jaws 84, 86
3 are closed, the pull wire(s) 62 pull against the distal coil,
4 shortening the distal coil against its pre-load. After the
5 clip is dispensed, the jaws are opened. When the jaws are
6 opened, the pre-load on the distal coil causes the clevis 82,
7 jaws 84, 86, and garage 80 all to move a slight distance
8 distally. At the same time, the clips do not move, as they
9 are freely disposed in the garage which is moving over them.
10 This action has the effect of separating the distal anvils on
11 the jaws from the tines on the formed clip, thereby easing the
12 opening of the jaws.

13

14 The pre-loading of the distal coil provides the coil with
15 sufficient columnar strength to allow for tangential bites,
16 prevents buckling during jaw closure, and provides reaction
17 force to overcome frictional forces as the jaws open.

18

19 Alternate Jaw Embodiment

20

21 Figs. 44 and 45 illustrate an alternate embodiment of
22 jaws 184, 186 which are substantially the same as the jaws 84,
23 86 but for their mounting holes 184d, 186d. In this
24 embodiment, the mounting holes 184d, 186d are not circular.

1 They are oblate or "slotted". This allows the jaws to slide
2 distally and proximally as they are opened and closed. Thus,
3 when the jaws are closed as shown in Fig. 44, they are pulled
4 proximally. In this position, the clip is fired into the
5 closed jaws which act as forming anvils as described above.
6 When the jaws are opened as shown in Fig. 45, they slide
7 distally away from the formed clip separating the distal
8 anvils on the jaws from the tines on the formed clip, thereby
9 easing the opening of the jaws.

10
11 There have been described and illustrated herein several
12 embodiments of a flexible endoscopic clip applier. While
13 particular embodiments of the invention have been described,
14 it is not intended that the invention be limited thereto, as
15 it is intended that the invention be as broad in scope as the
16 art will allow and that the specification be read likewise.
17 Thus, while the coils of the invention have been described as
18 being formed from flat stock, it will be appreciated that the
19 stock can be of circular or other cross-section. Also, while
20 particular materials have been described as preferred in
21 making various of the elements of the invention, it will be
22 appreciated that other materials can be utilized. Further,
23 while the invention has been described as utilizing a gear
24 arrangement which provides a specific number of turns to a

1 wire control element for advancing the clips, it will be
2 appreciated that other gear arrangements which provide the
3 same or different numbers of turns of the wire control element
4 can be provided. Further, while the invention has been
5 disclosed in conjunction with two different kinds of end
6 effectors, i.e. the jaws and the clip pusher, other components
7 of the invention may be used with different end effectors. It
8 will therefore be appreciated by those skilled in the art that
9 yet other modifications could be made to the provided
10 invention without deviating from its spirit and scope as
11 claimed.
12

What is claimed is:

1. An endoscopic clip applier, comprising:

a tube having a proximal end and a distal end;

a control member having a proximal end and a distal end and extending through said tube, said control member being threaded along at least a portion thereof;

an actuator coupled to said proximal end of said tube;

at least one clip, said clip having a deformable tine and a threaded portion, said threaded portion being threadably coupled to the threaded portion of said control member, wherein

rotation of said actuator causes rotation of said control member and translation of said at least one clip.

2. The clip applier according to claim 1, wherein:

said at least one clip includes a plurality of clips arranged one behind the other, each being threadably coupled to said control member.

3. The clip applier according to claim 1, wherein:

said at least one clip has two deformable tines.

4. The clip applier according to claim 3, wherein:

said threaded portion of said clip lies between said two deformable tines.

5. An endoscopic clip, comprising:

a threaded base portion;

a first deformable tine extending from said base portion;

and

a second deformable tine extending from said base portion.

6. The endoscopic clip according to claim 5, wherein:

said first and second tines are substantially parallel.

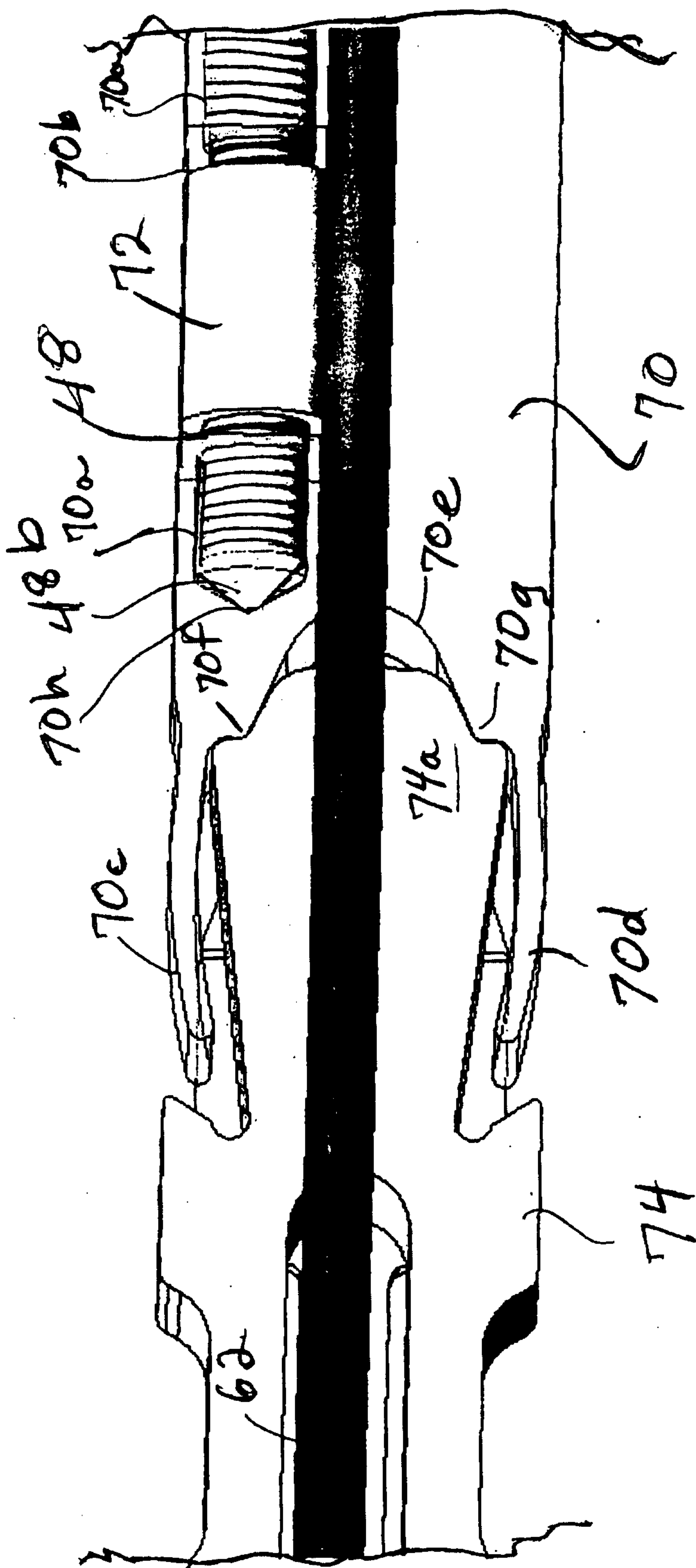


Fig. 11

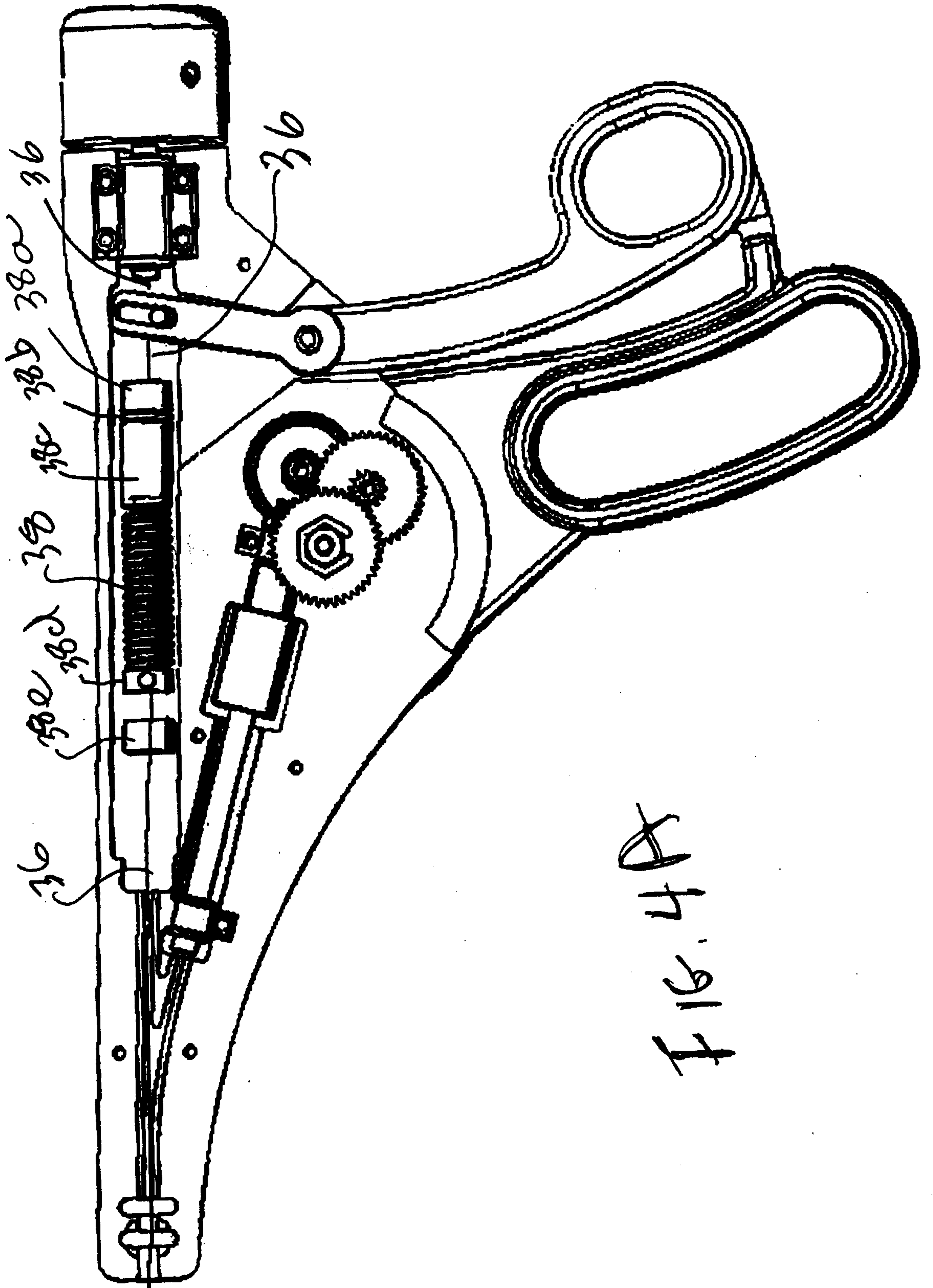


Fig. 4A

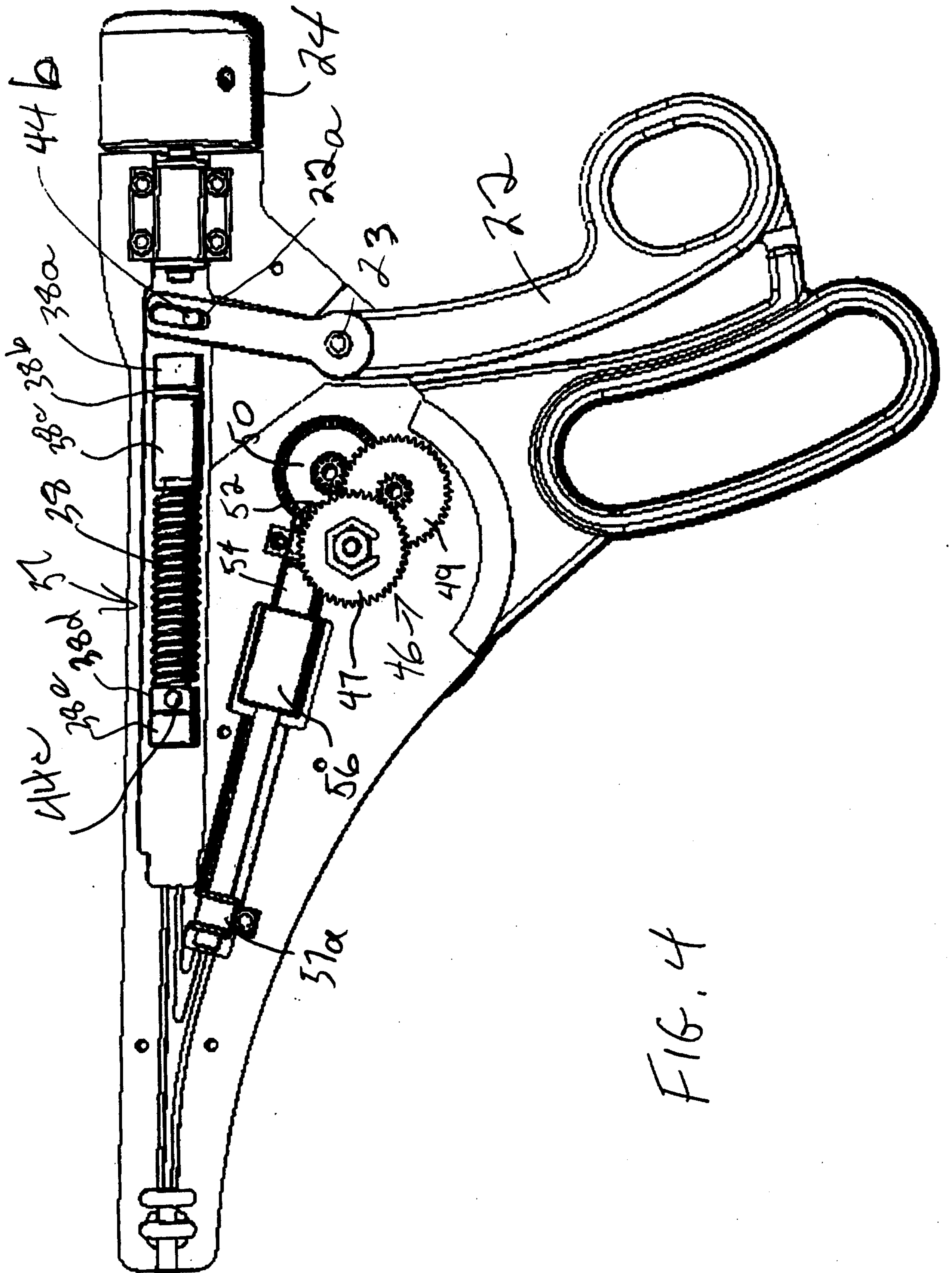


FIG. 4

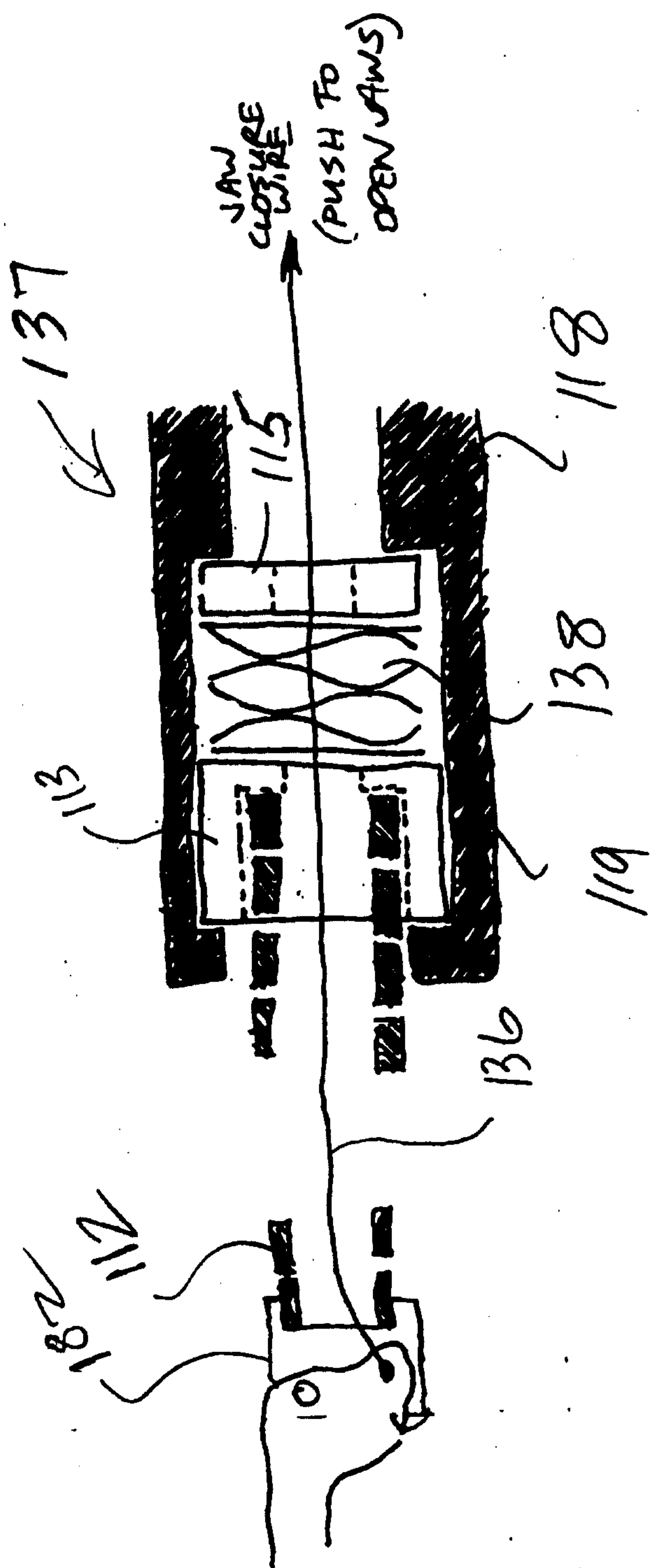


FIG. 4B

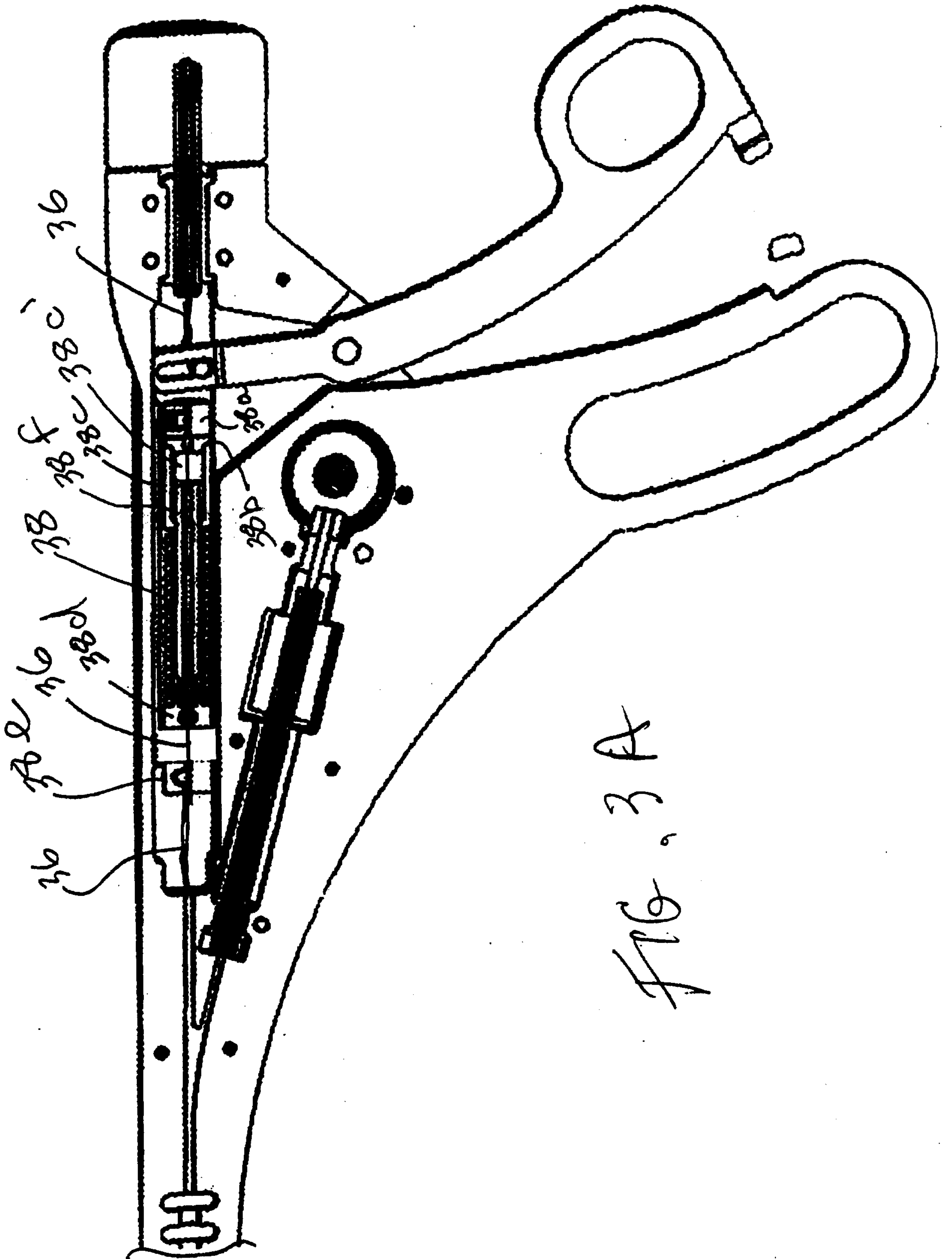
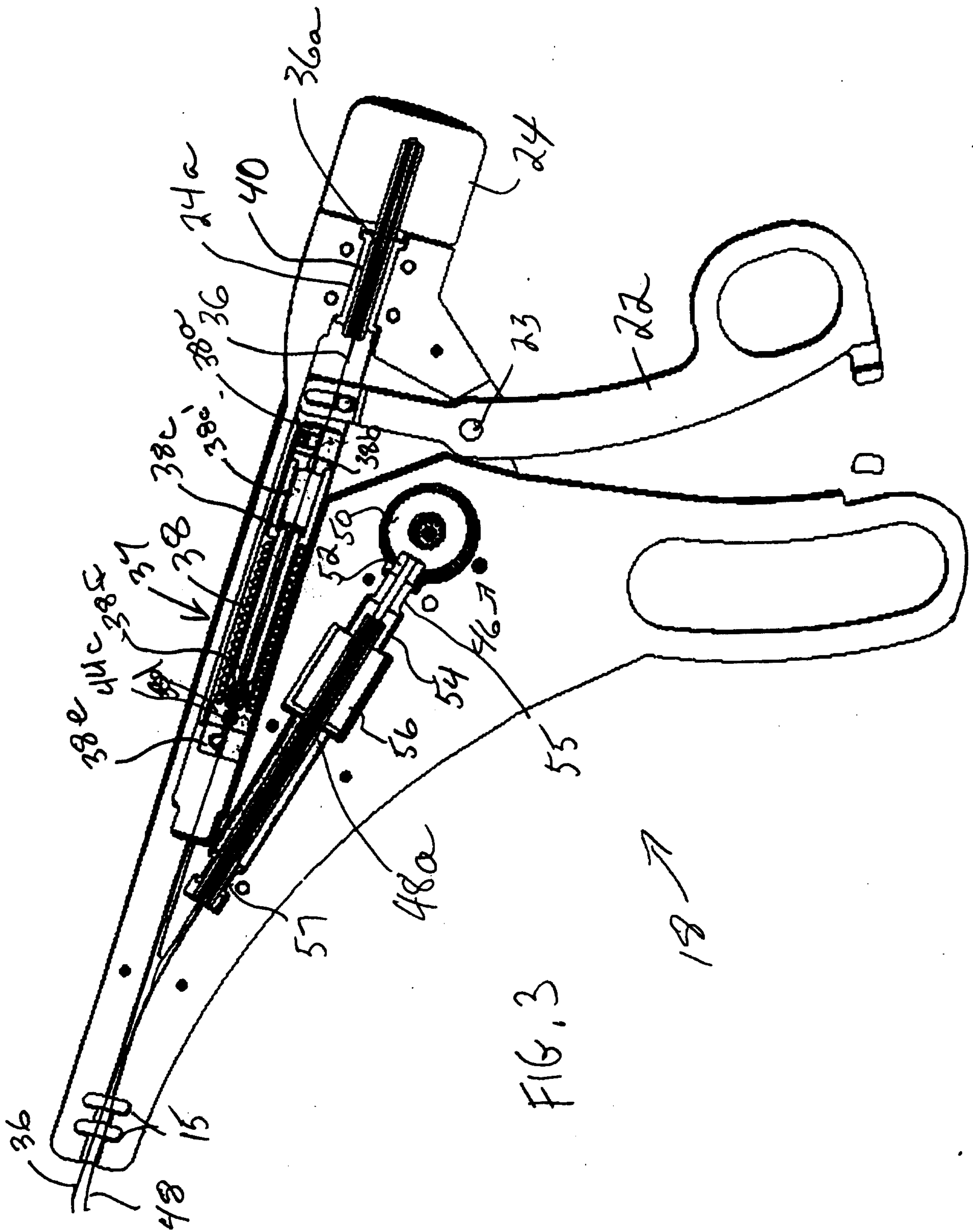
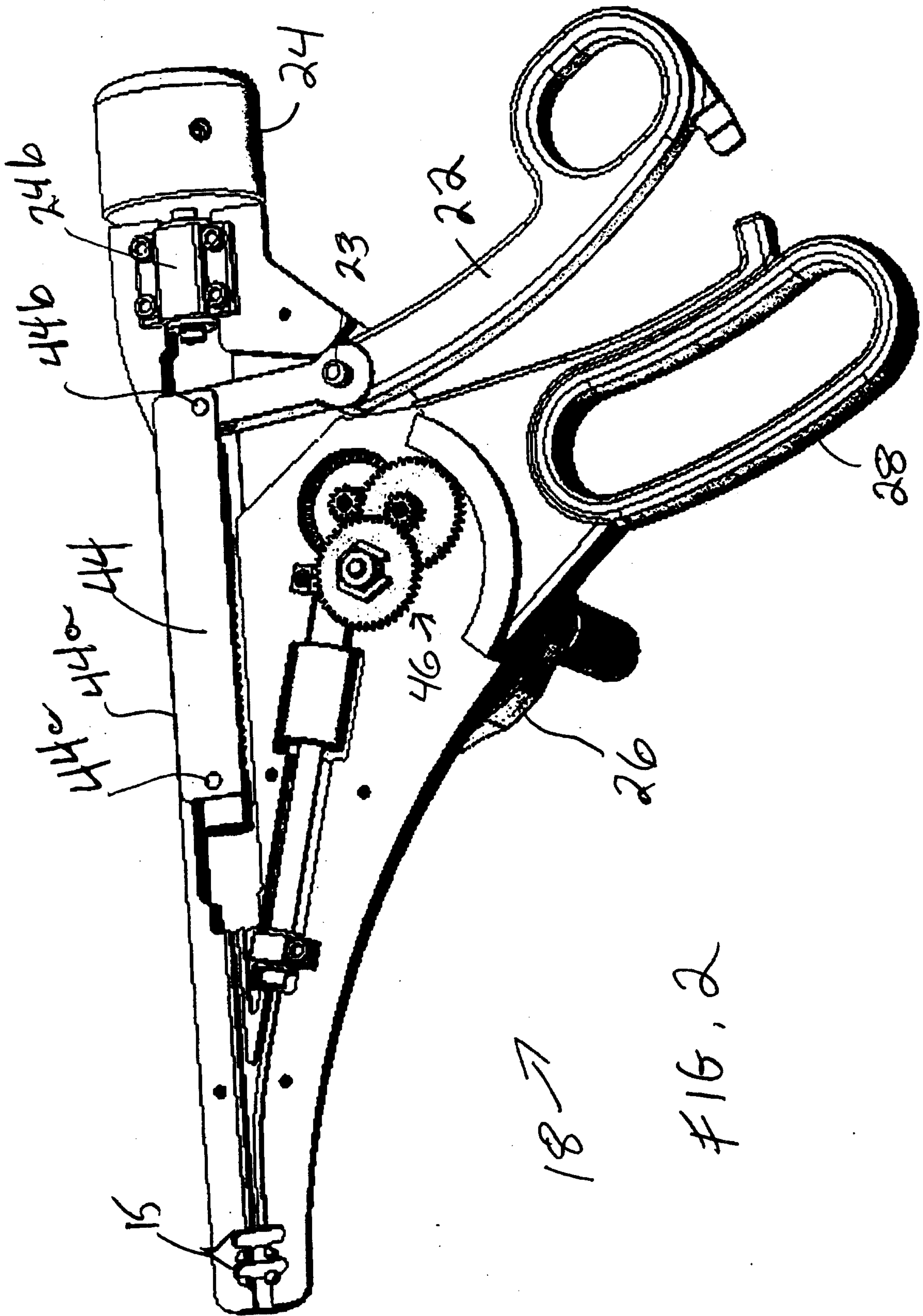


FIG. 3A





18 →

FIG. 2

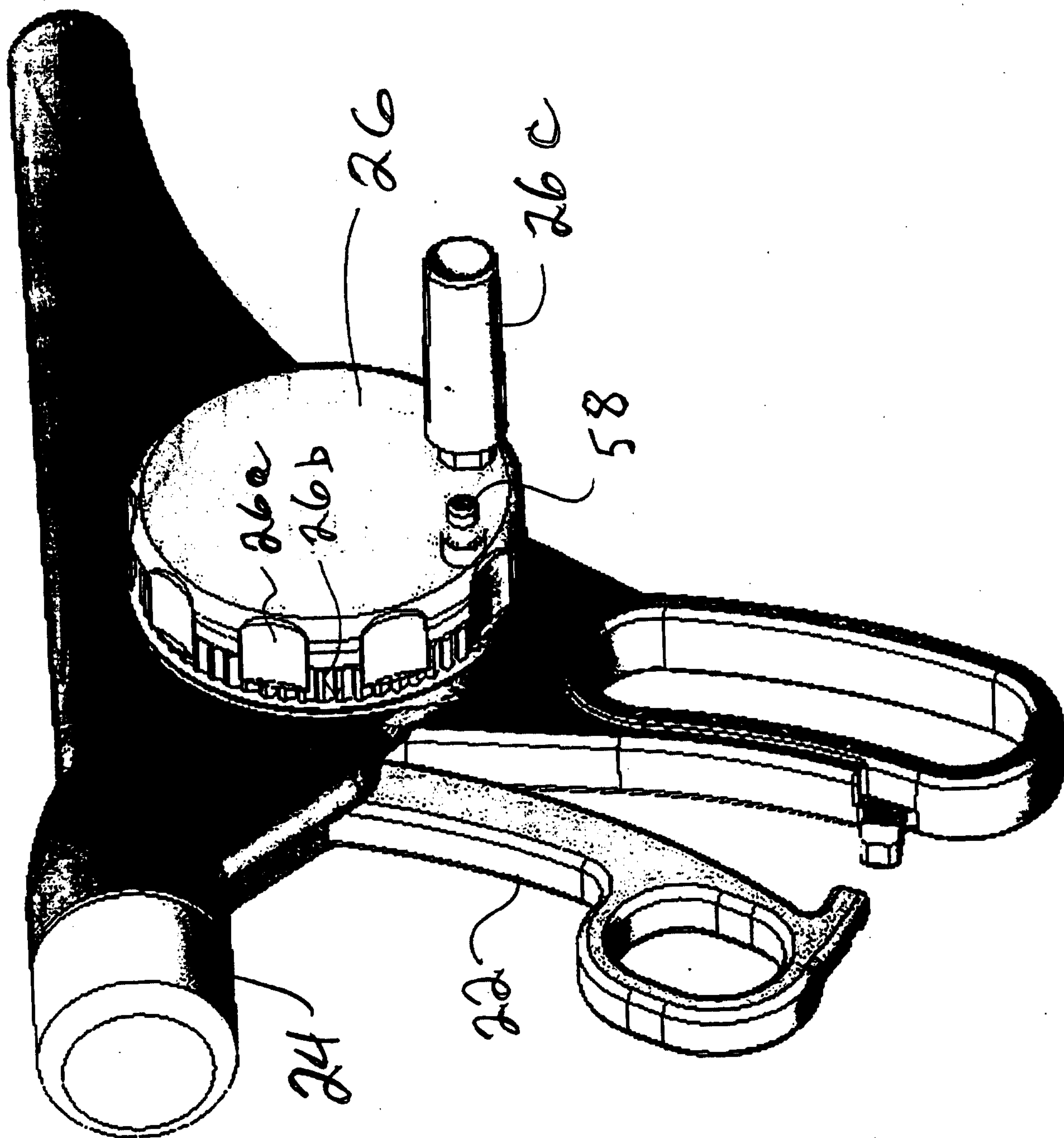
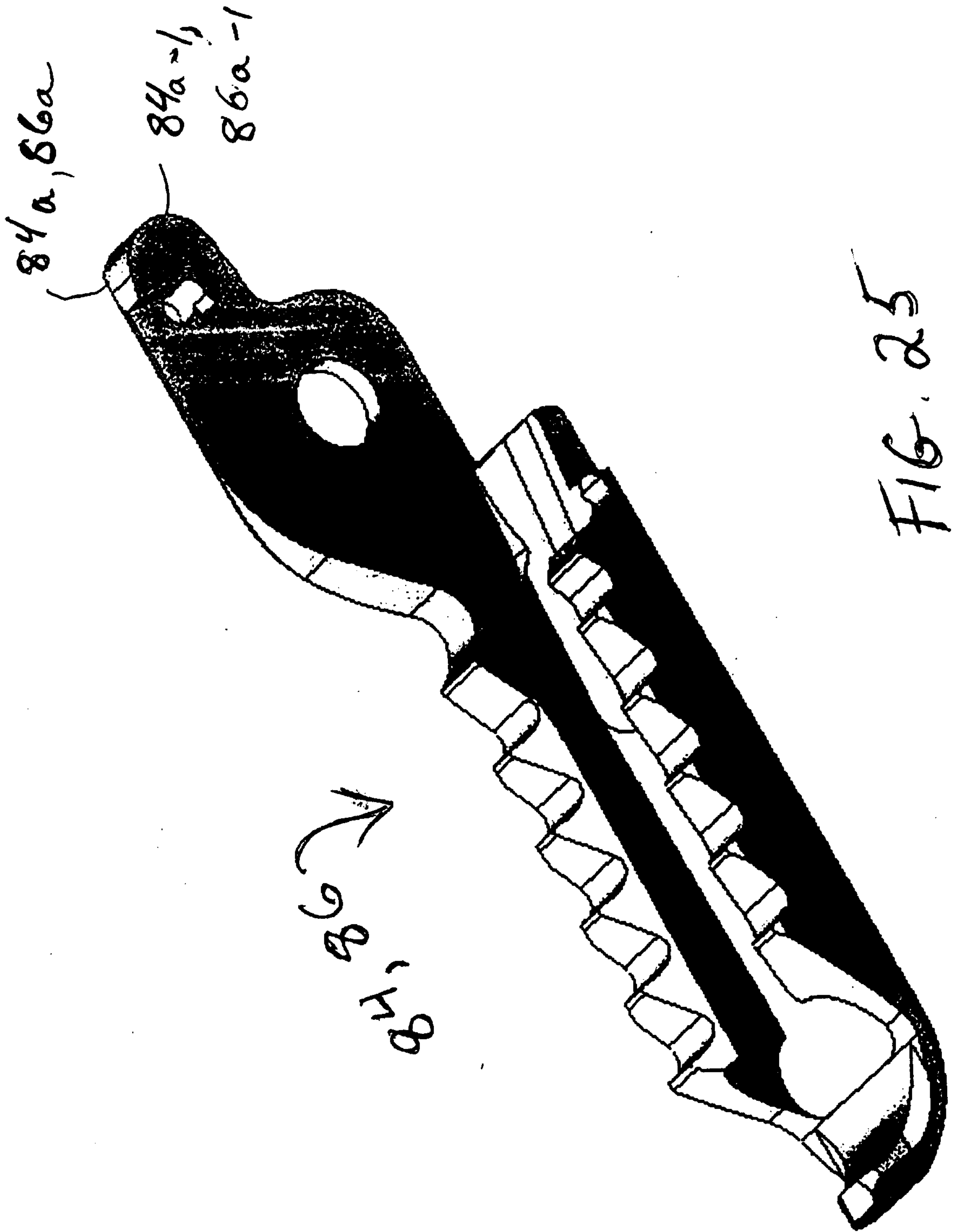
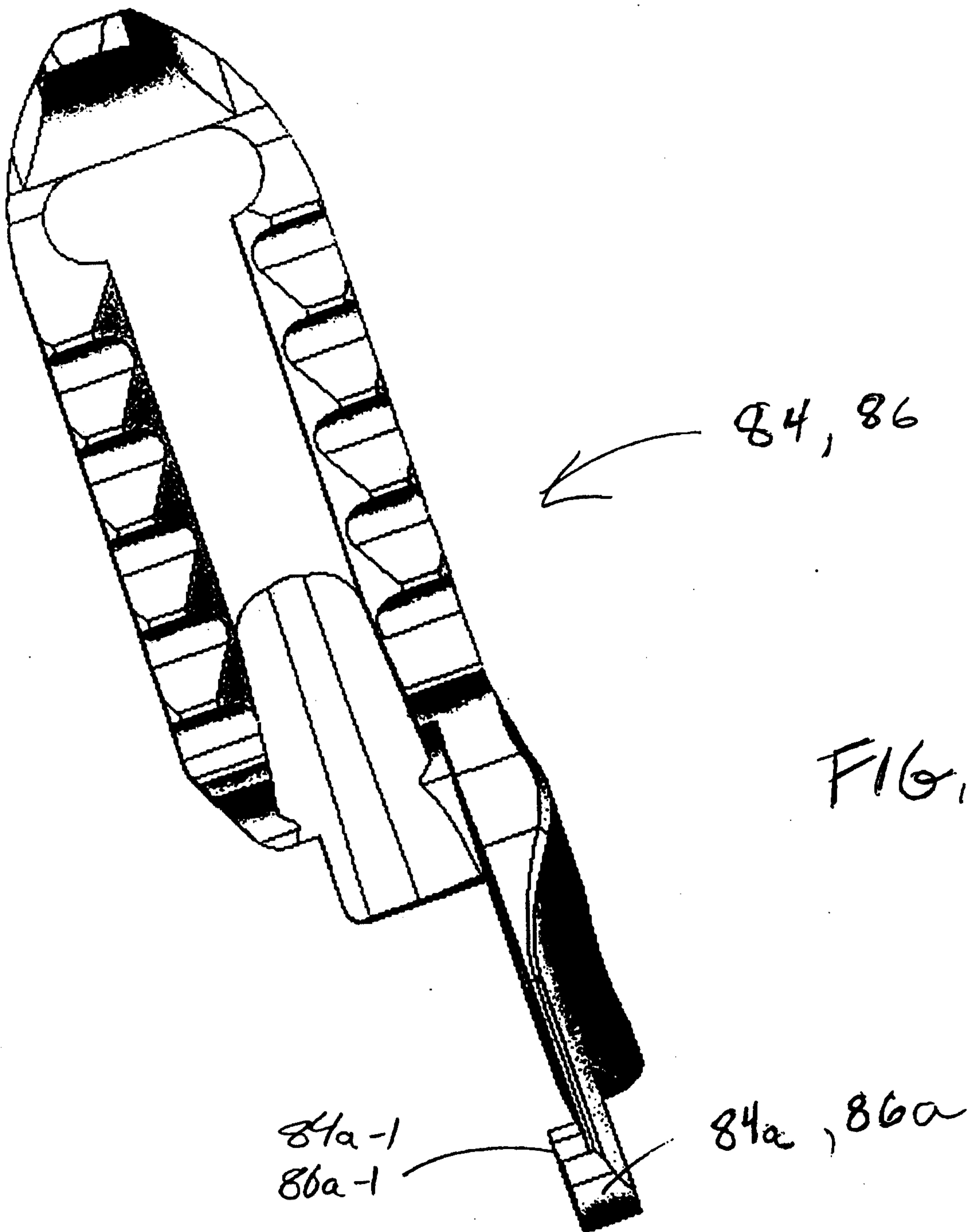


FIG. 5





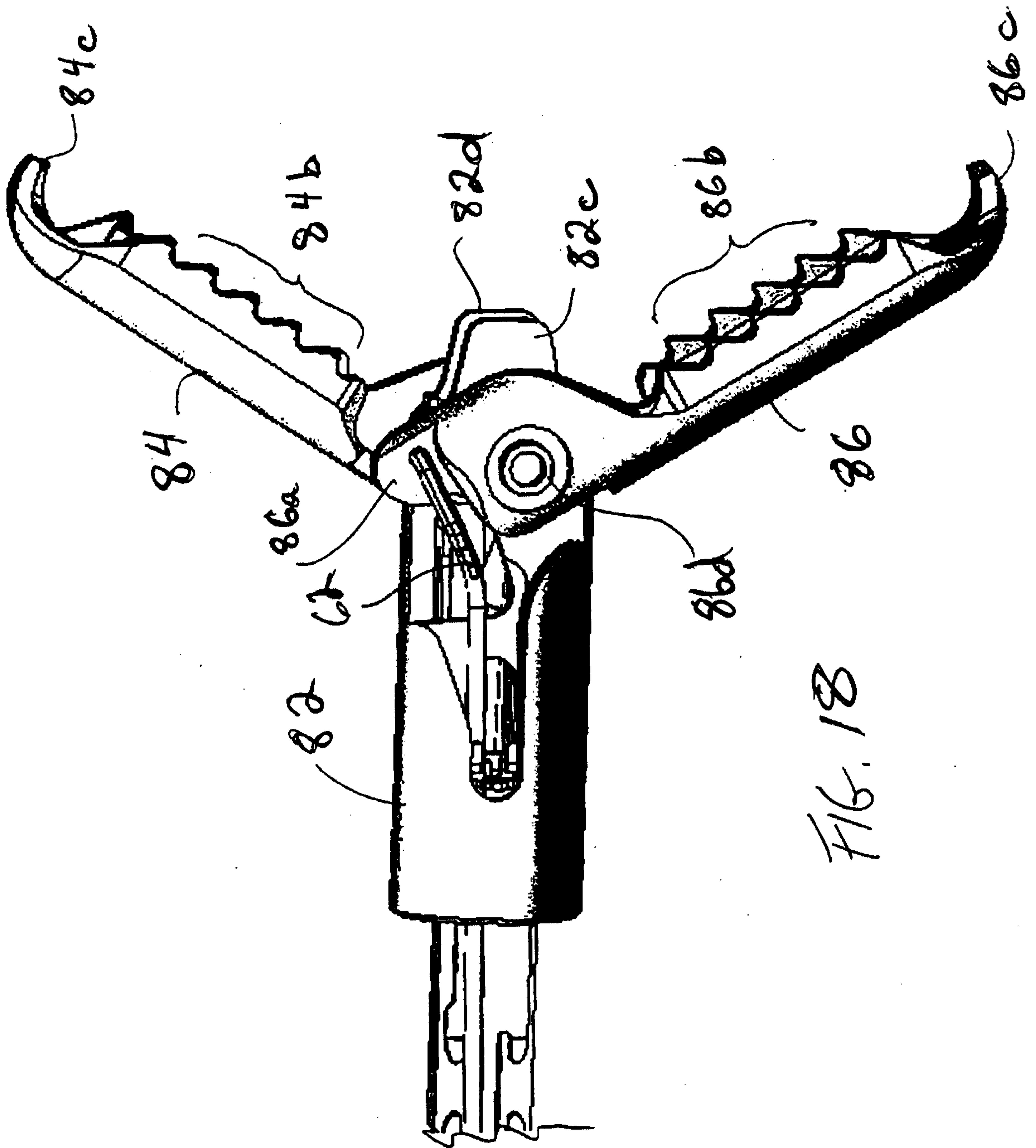


FIG. 18

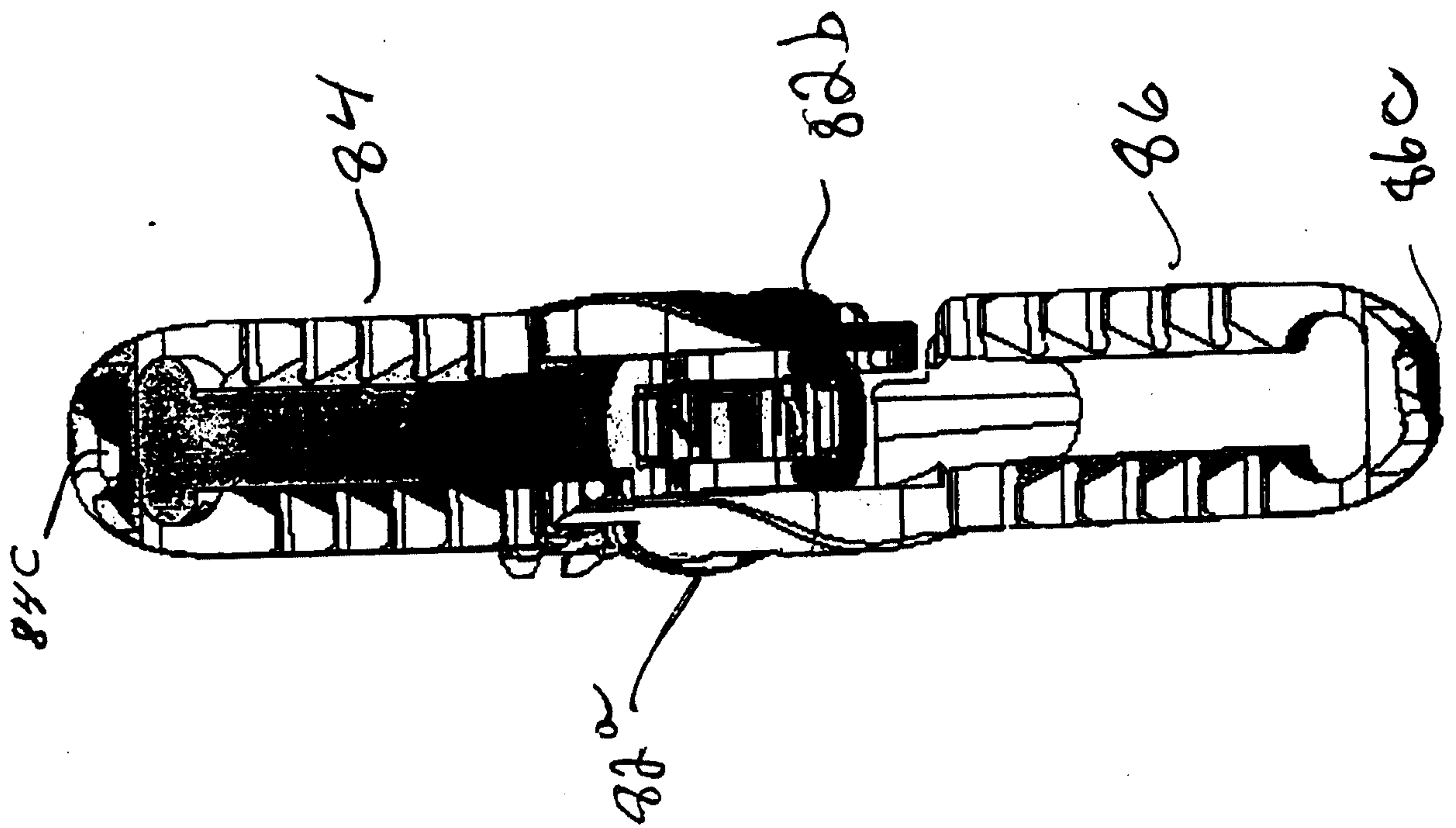


FIG. 19

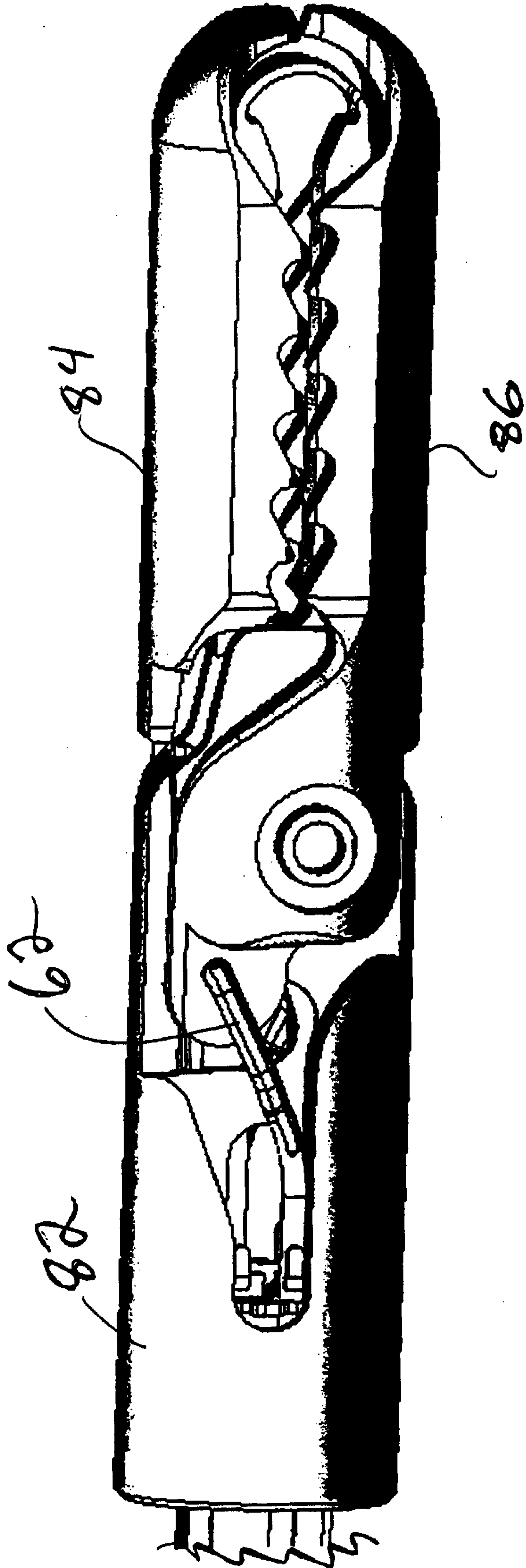
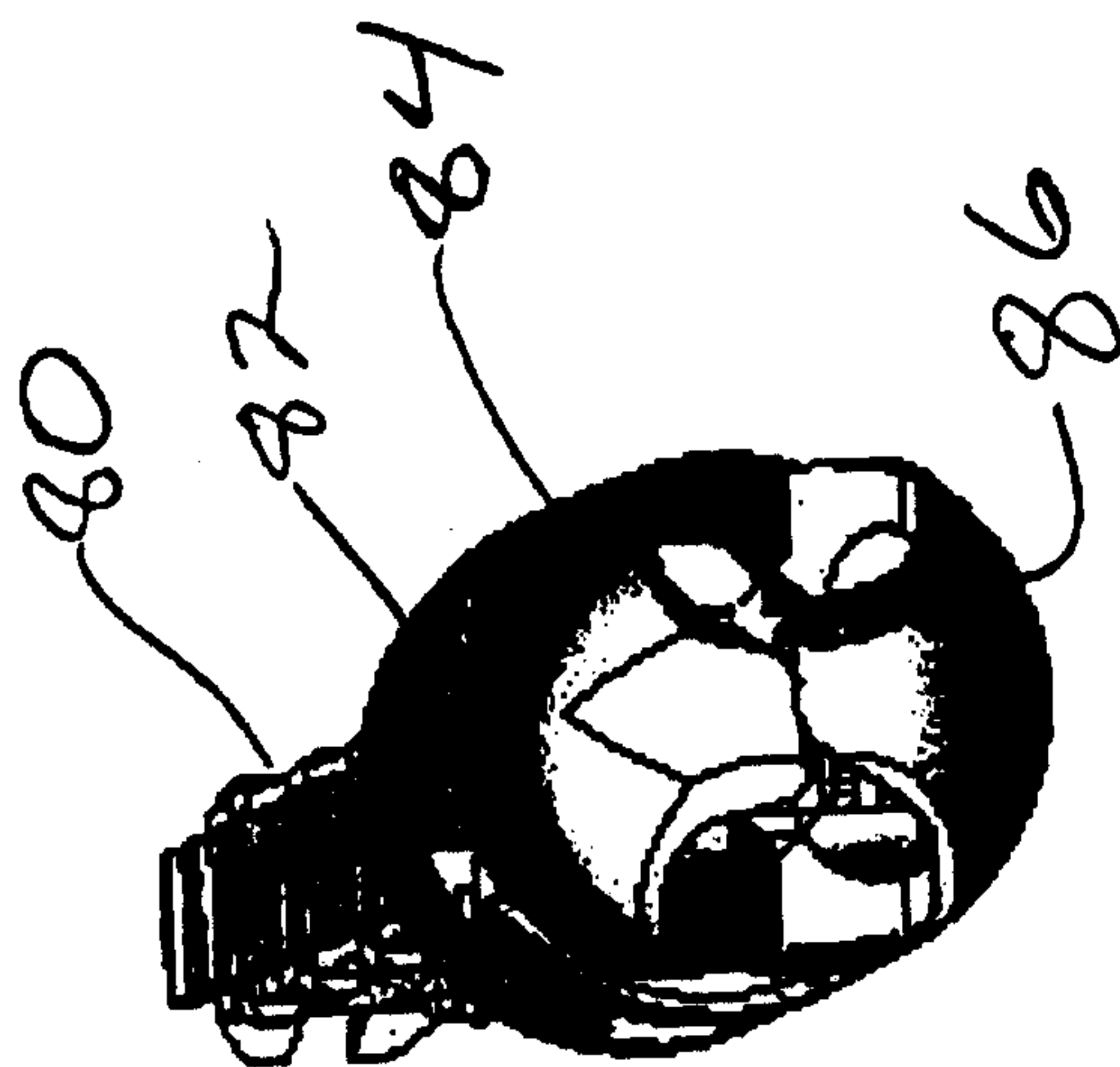


FIG. 20



F16.21

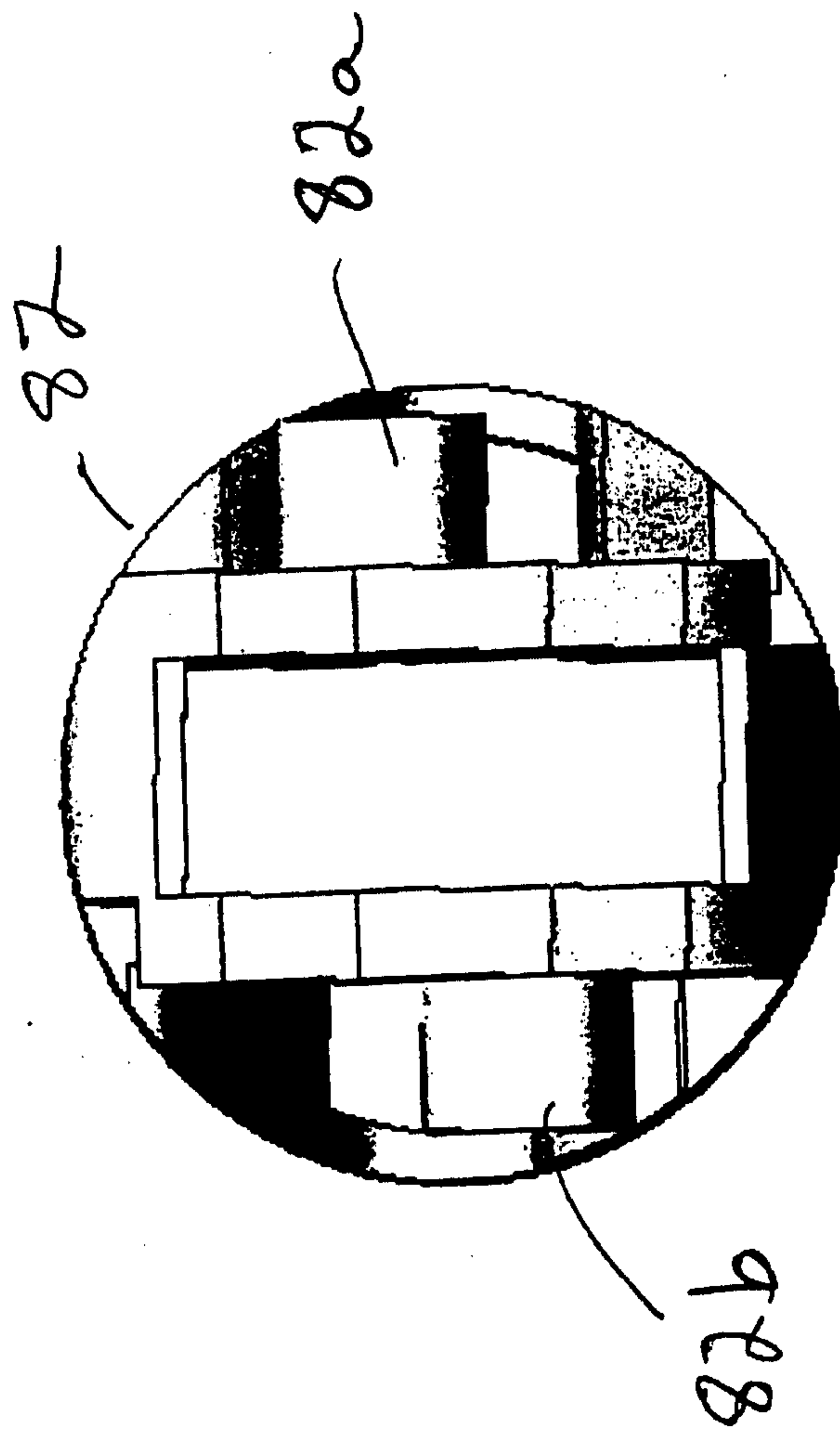


FIG. 27

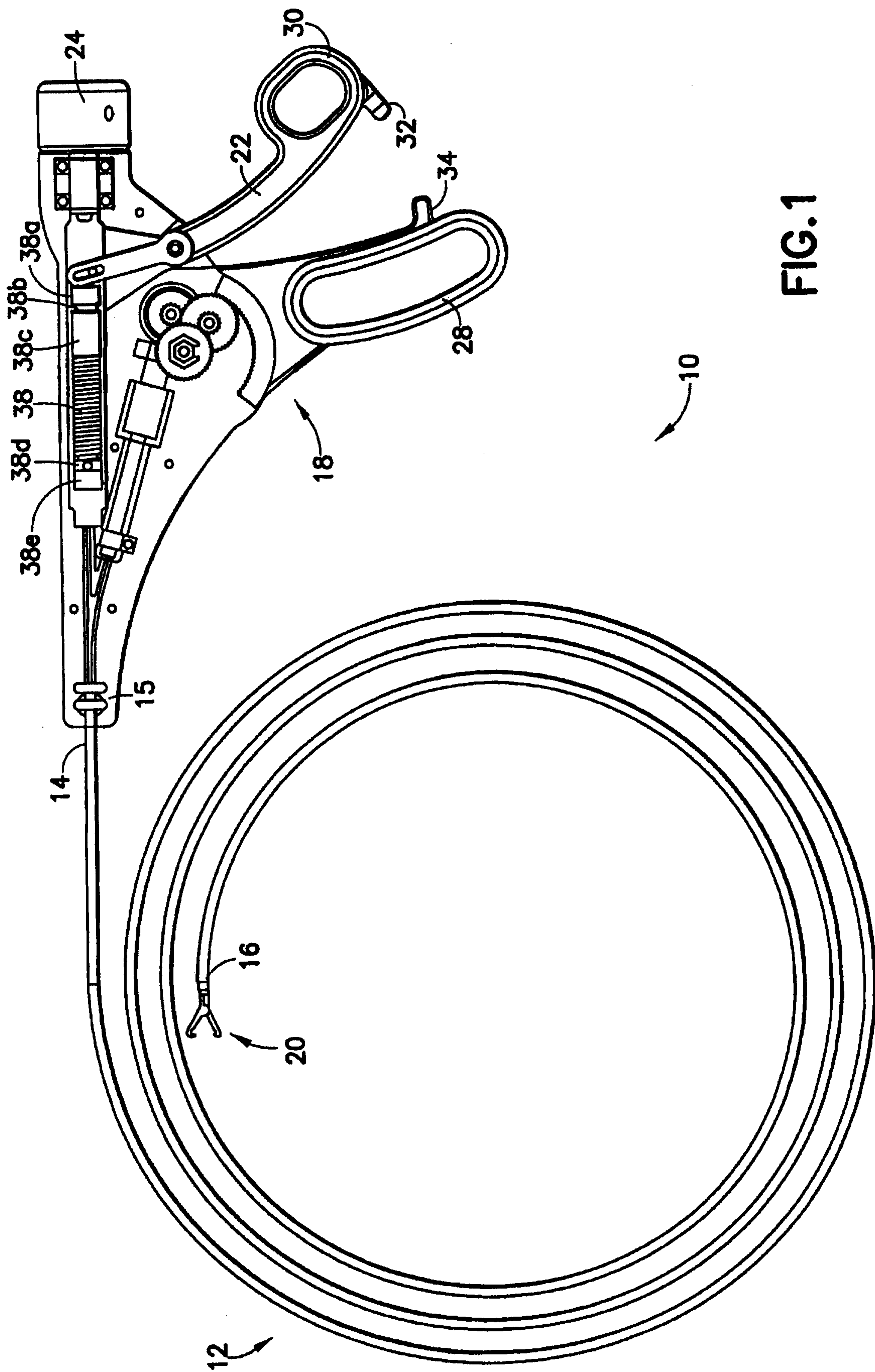


FIG.1

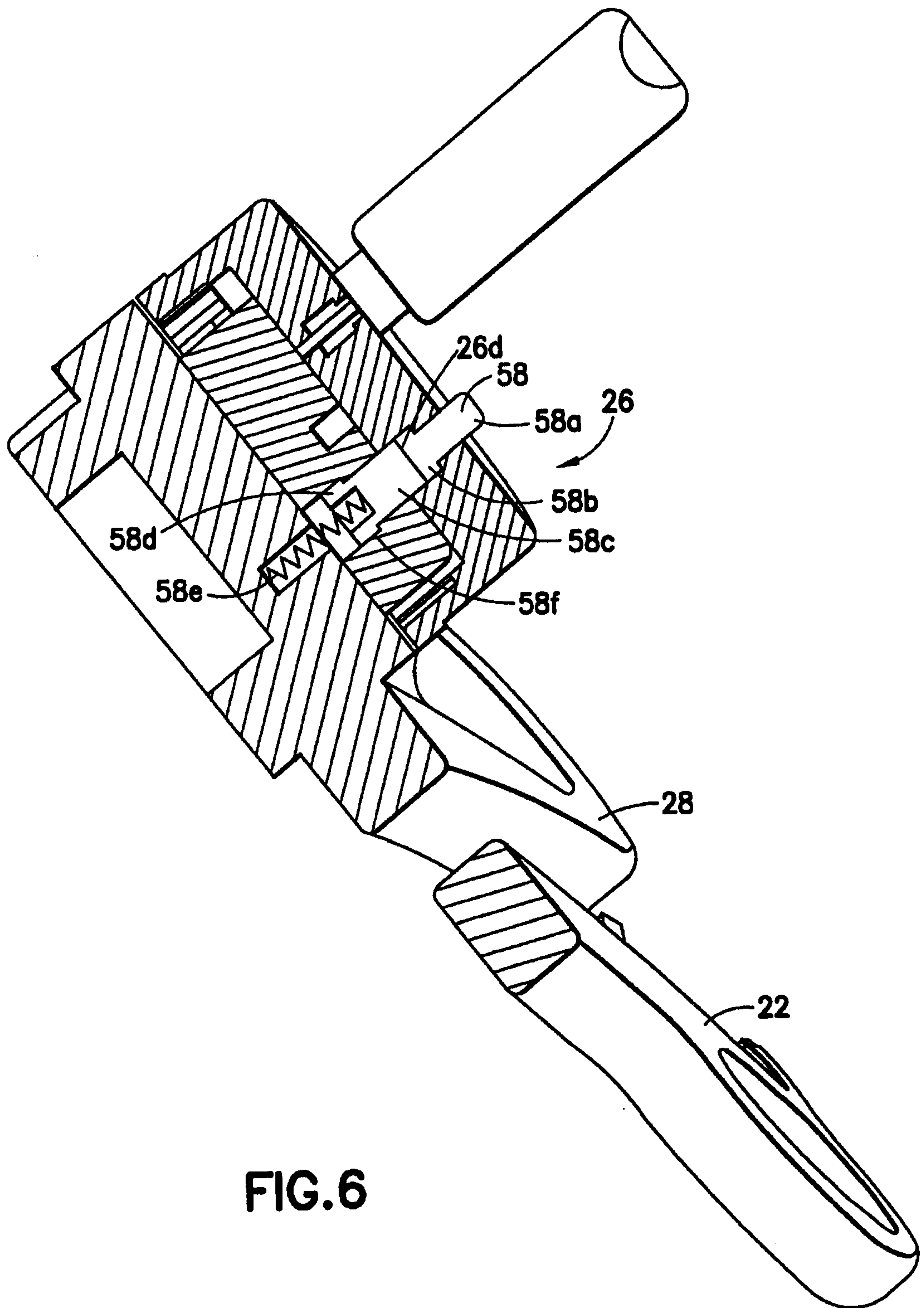


FIG. 6

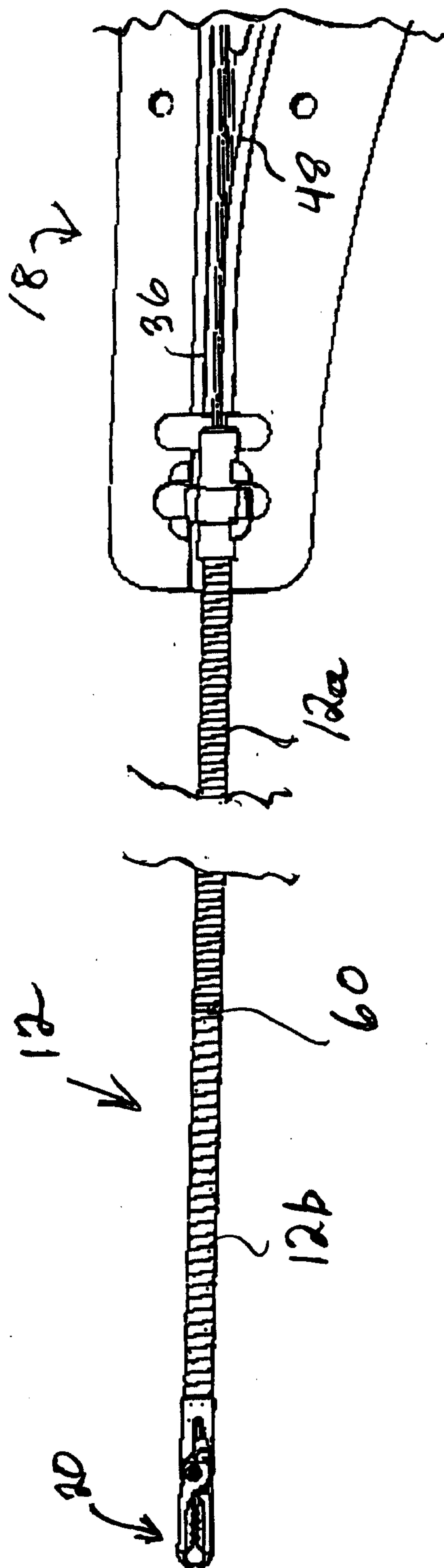
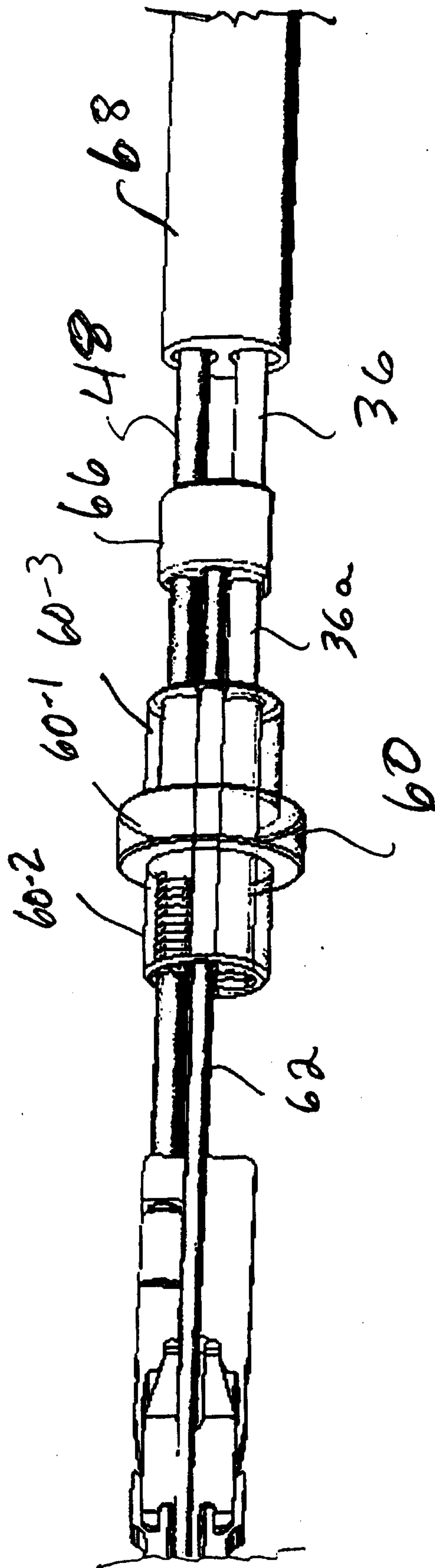
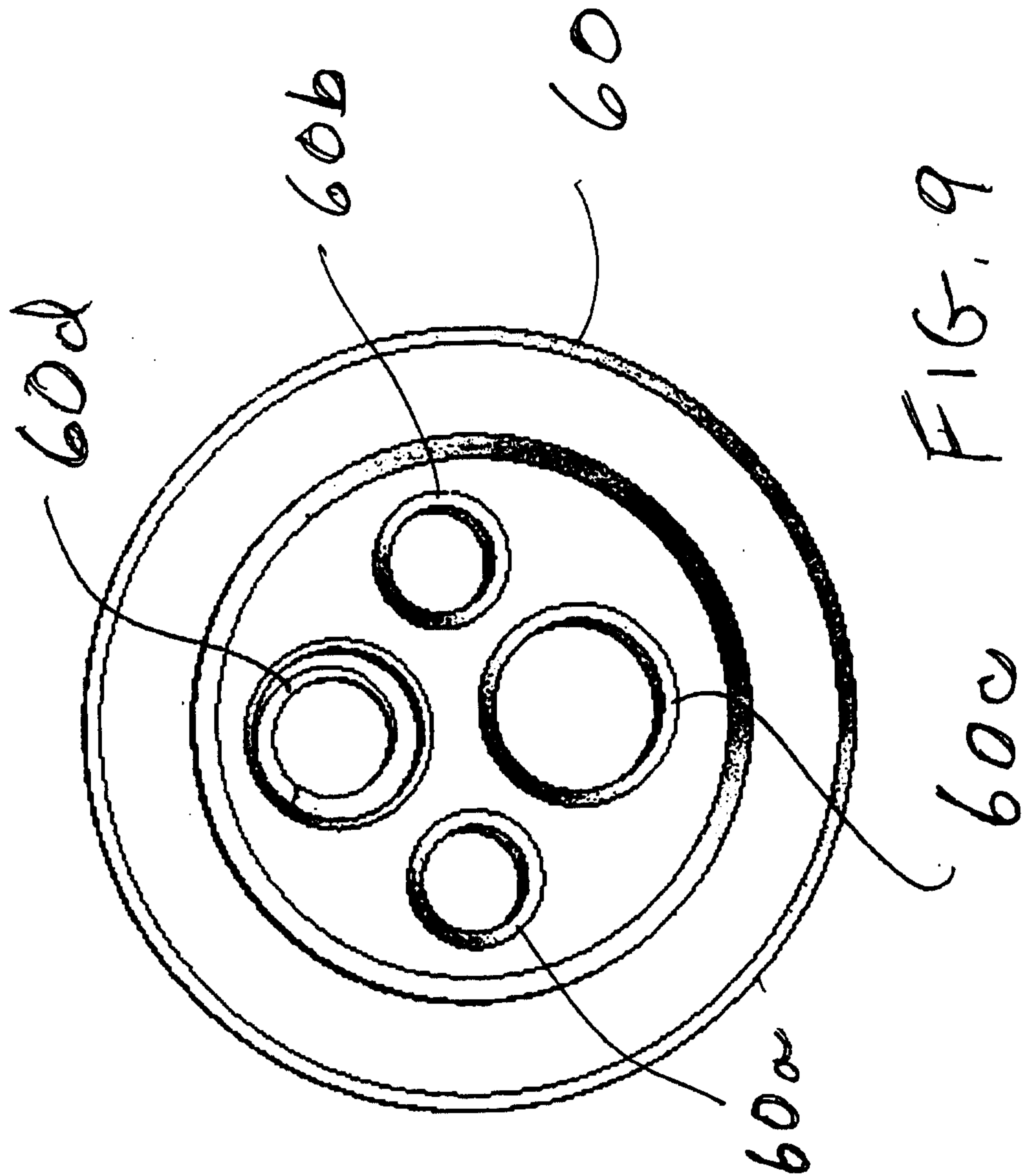
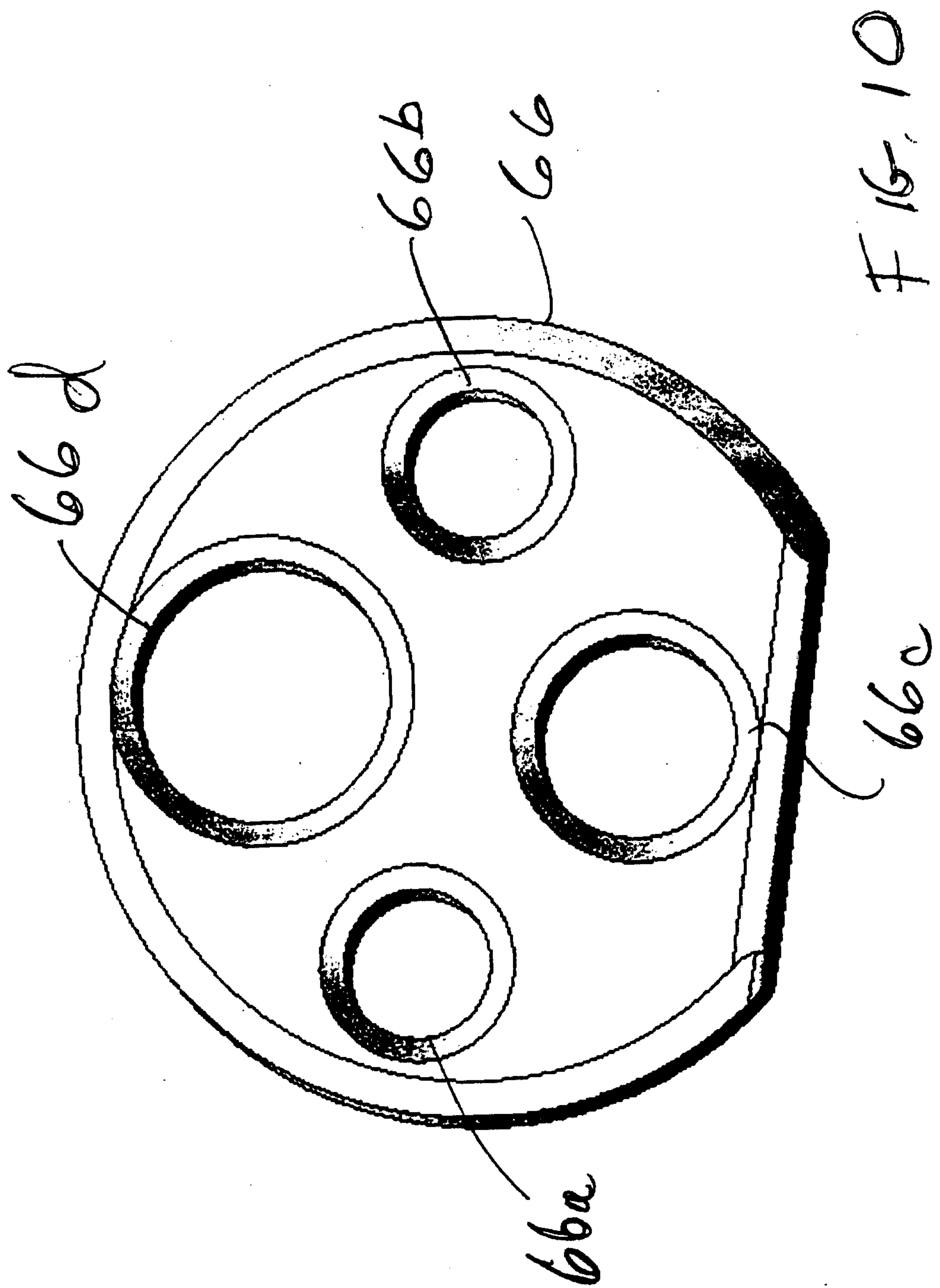


FIG. 7



F/16.8





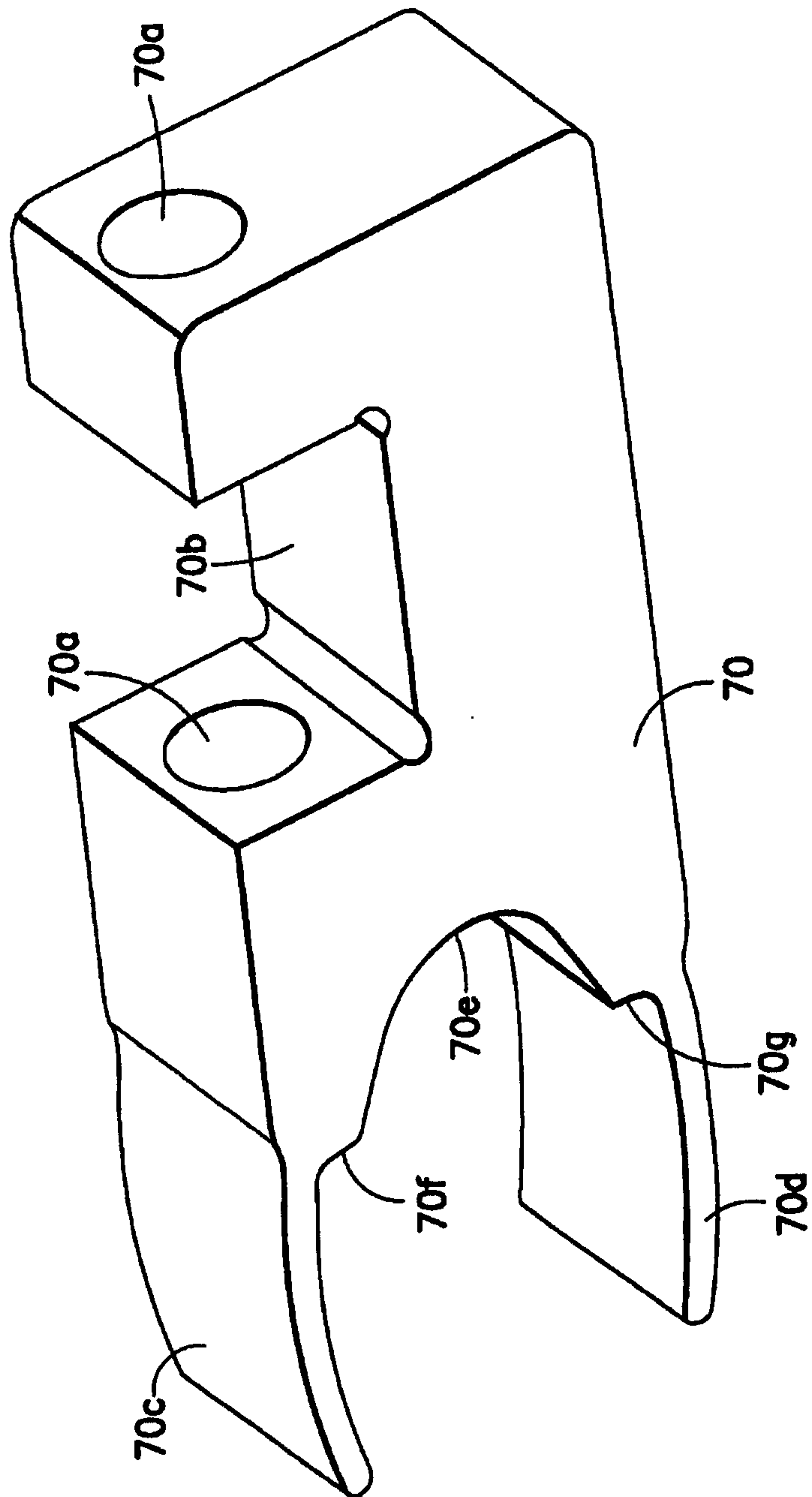


FIG. 12

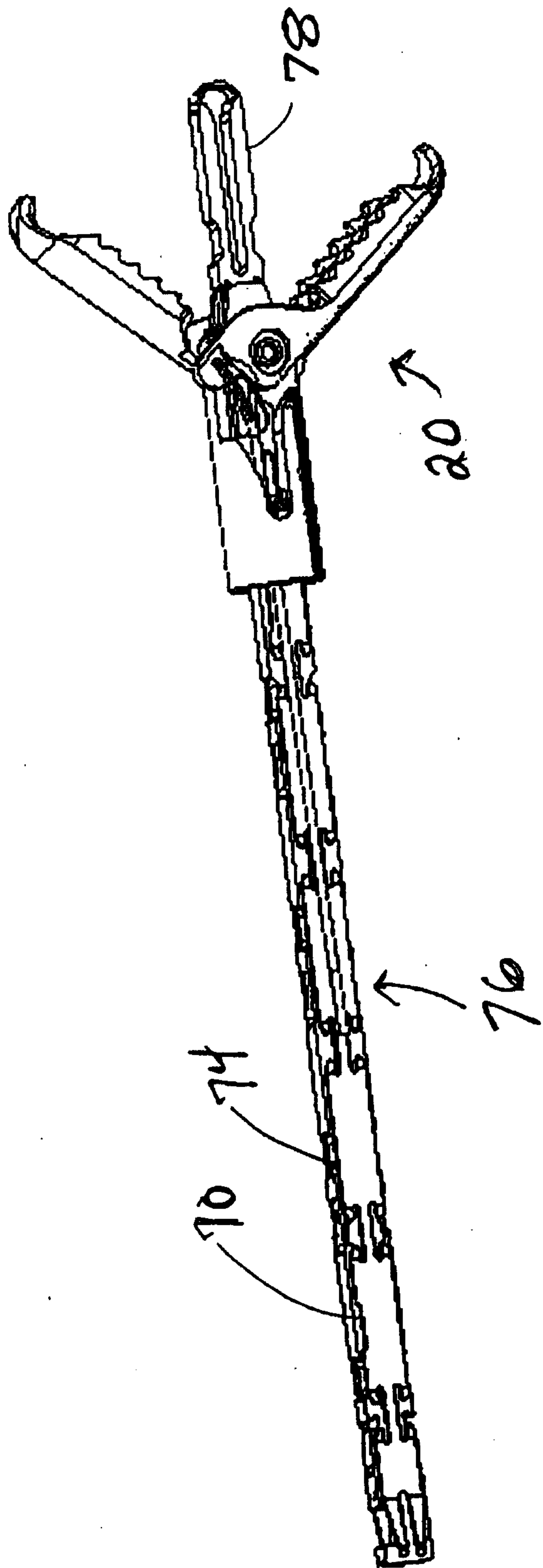
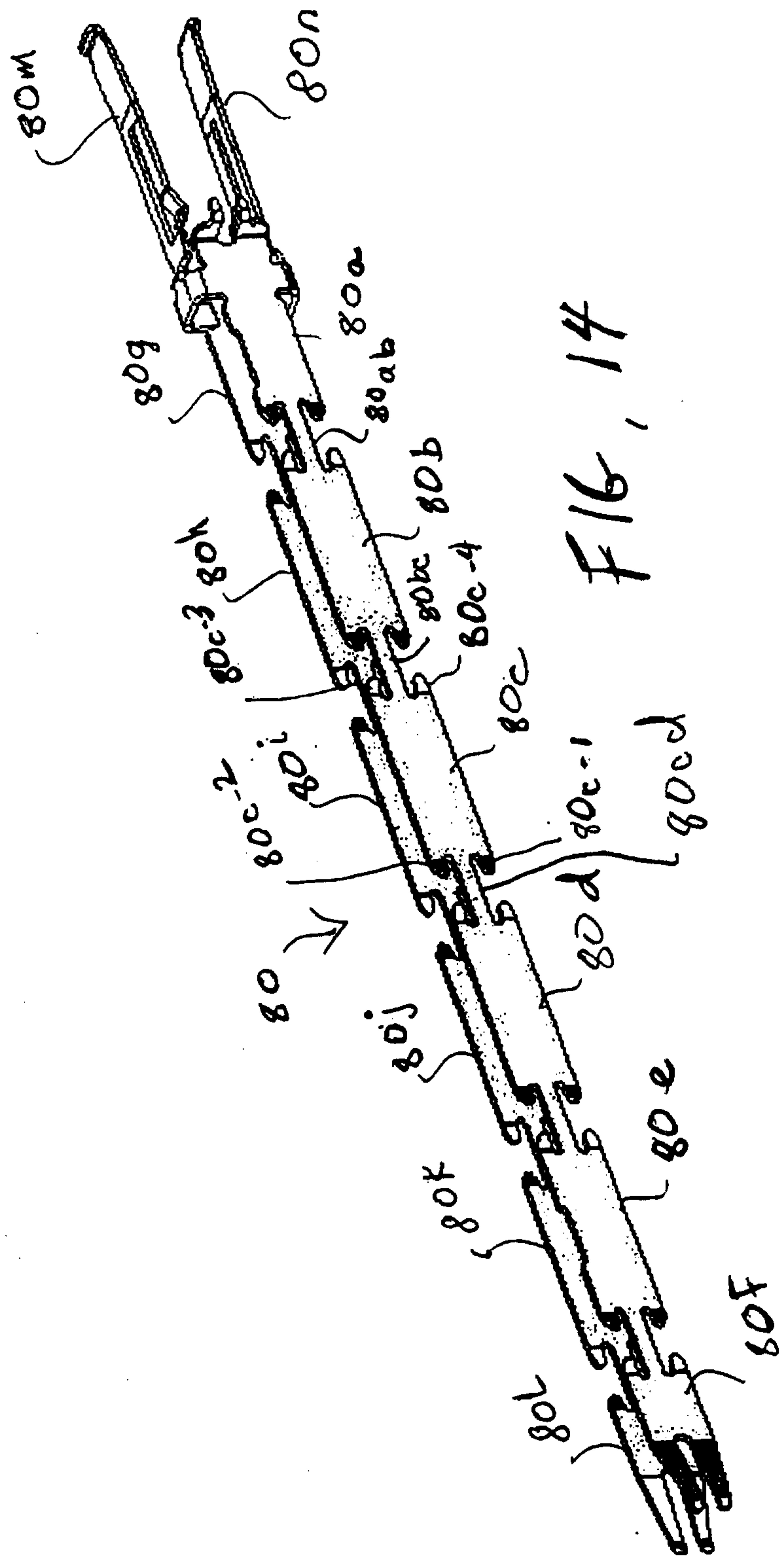
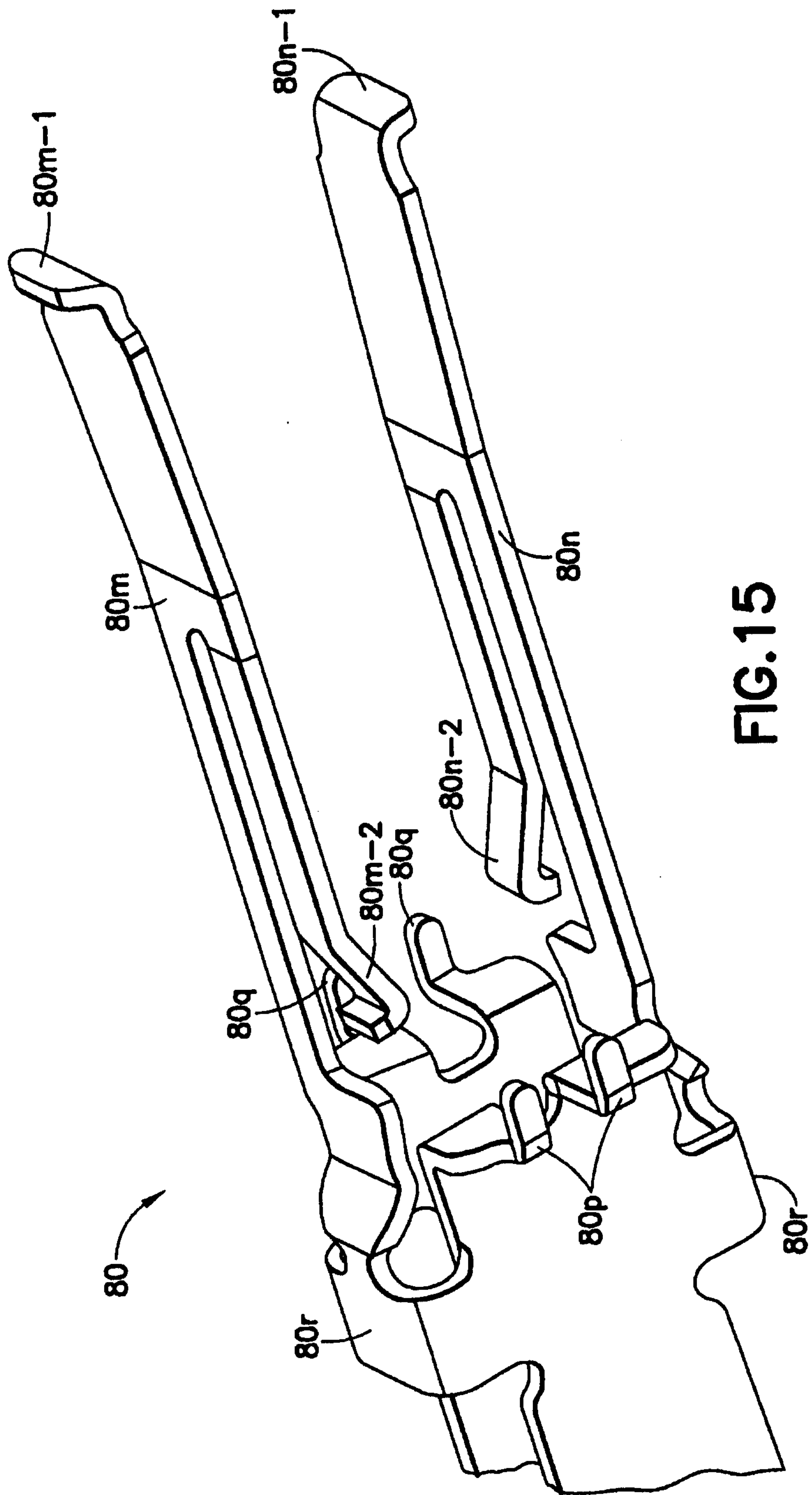
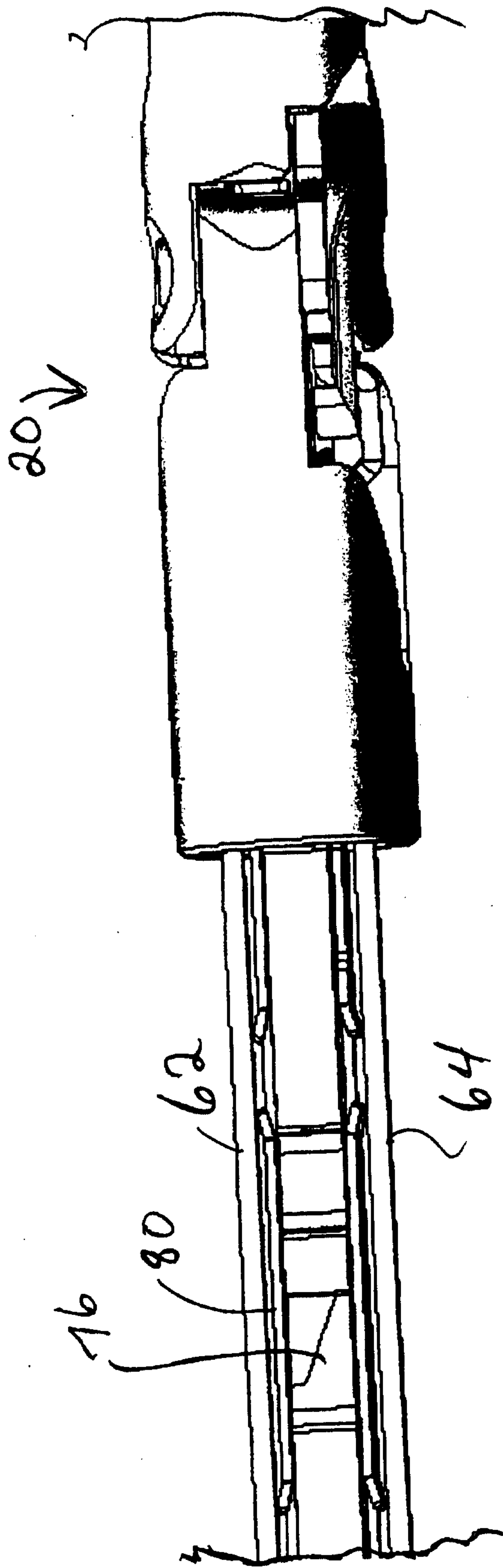


FIG. 13



F16, 14





16, 16

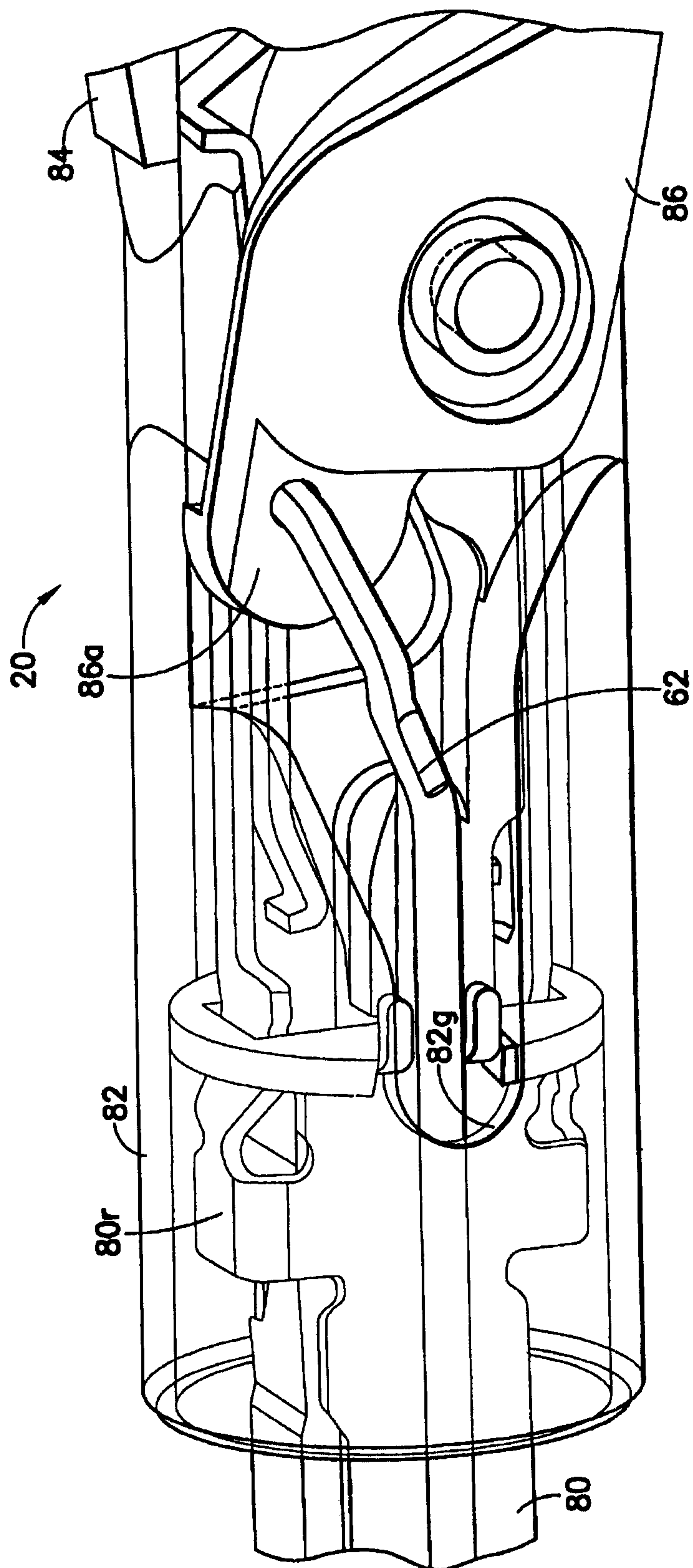
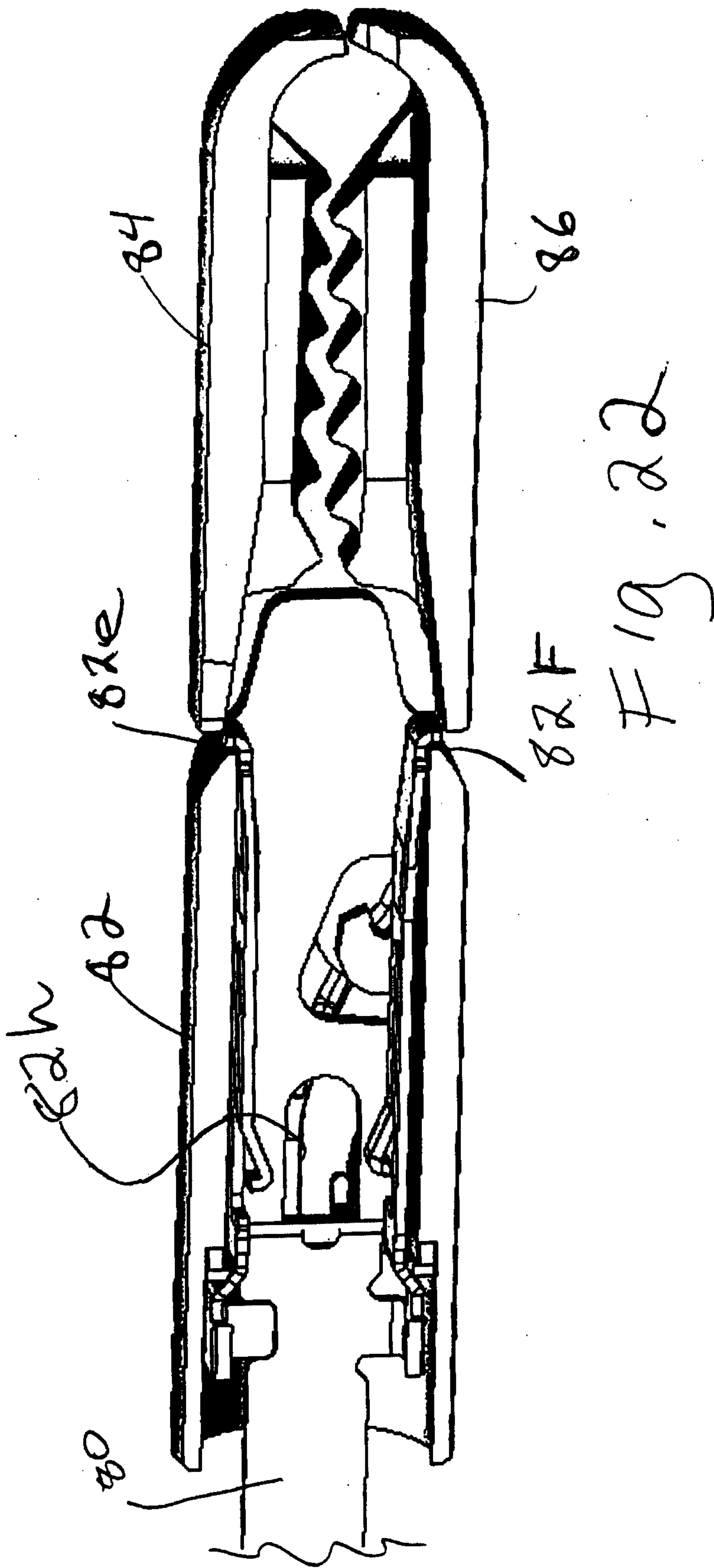
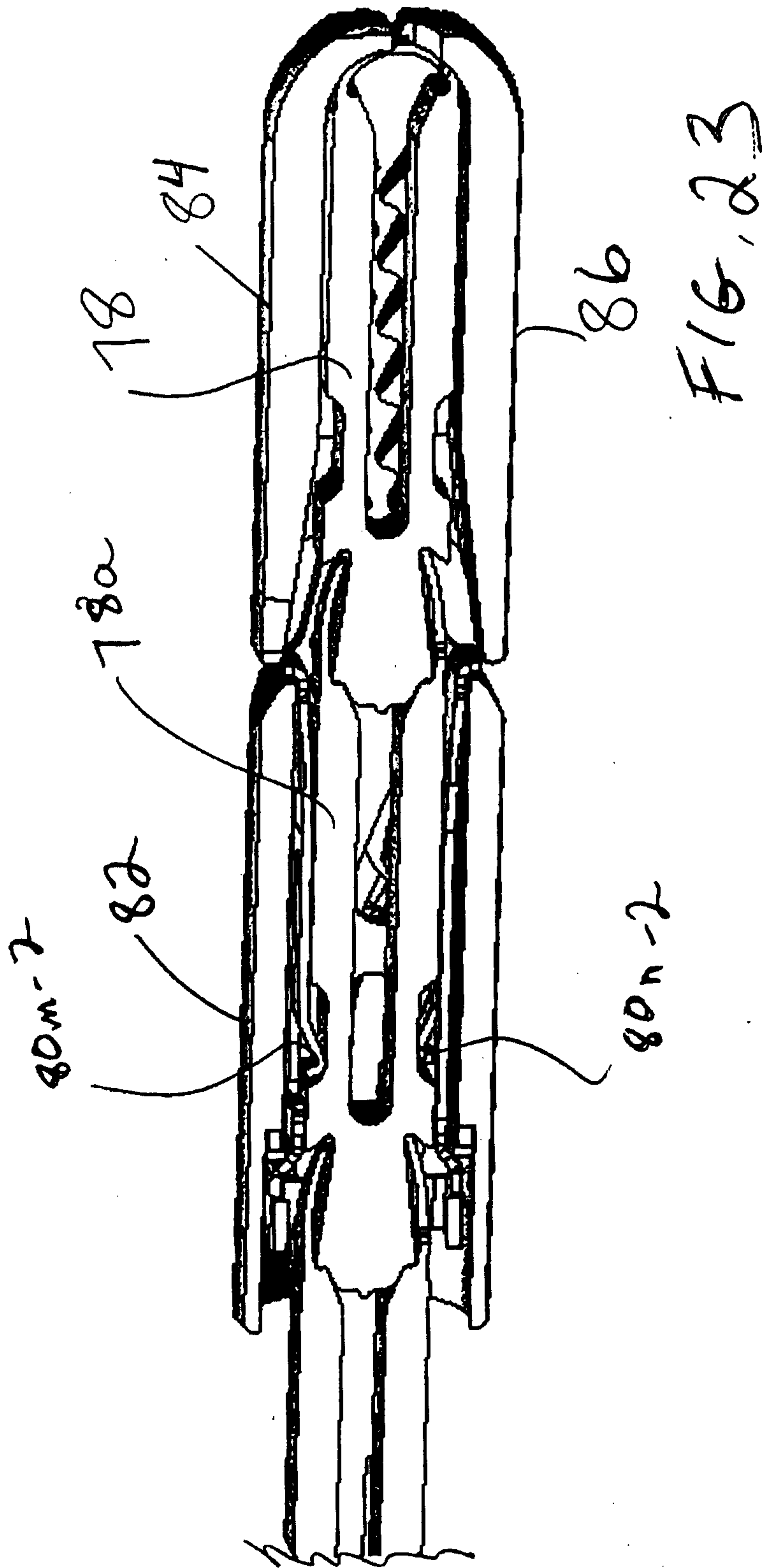


FIG. 17





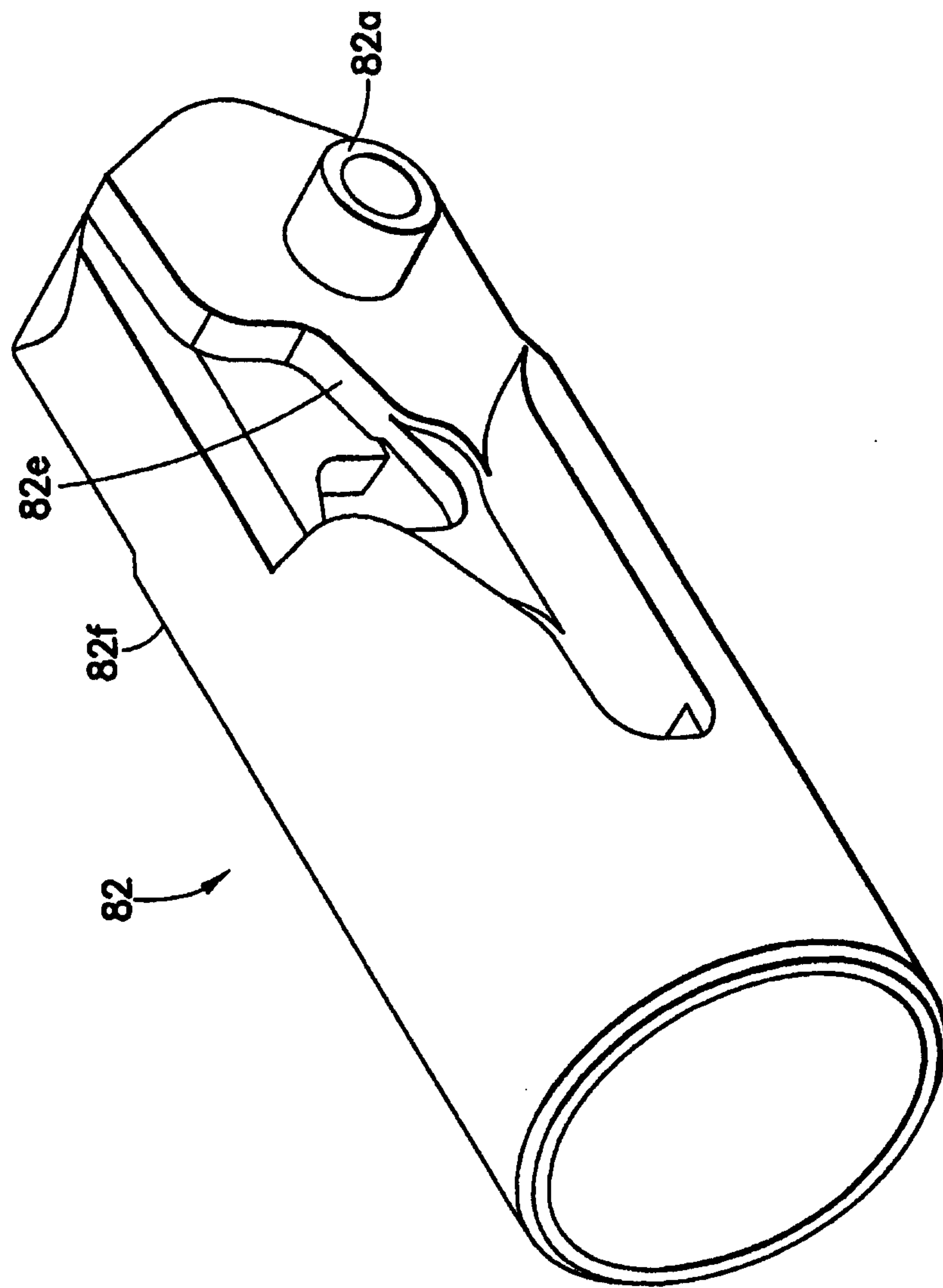
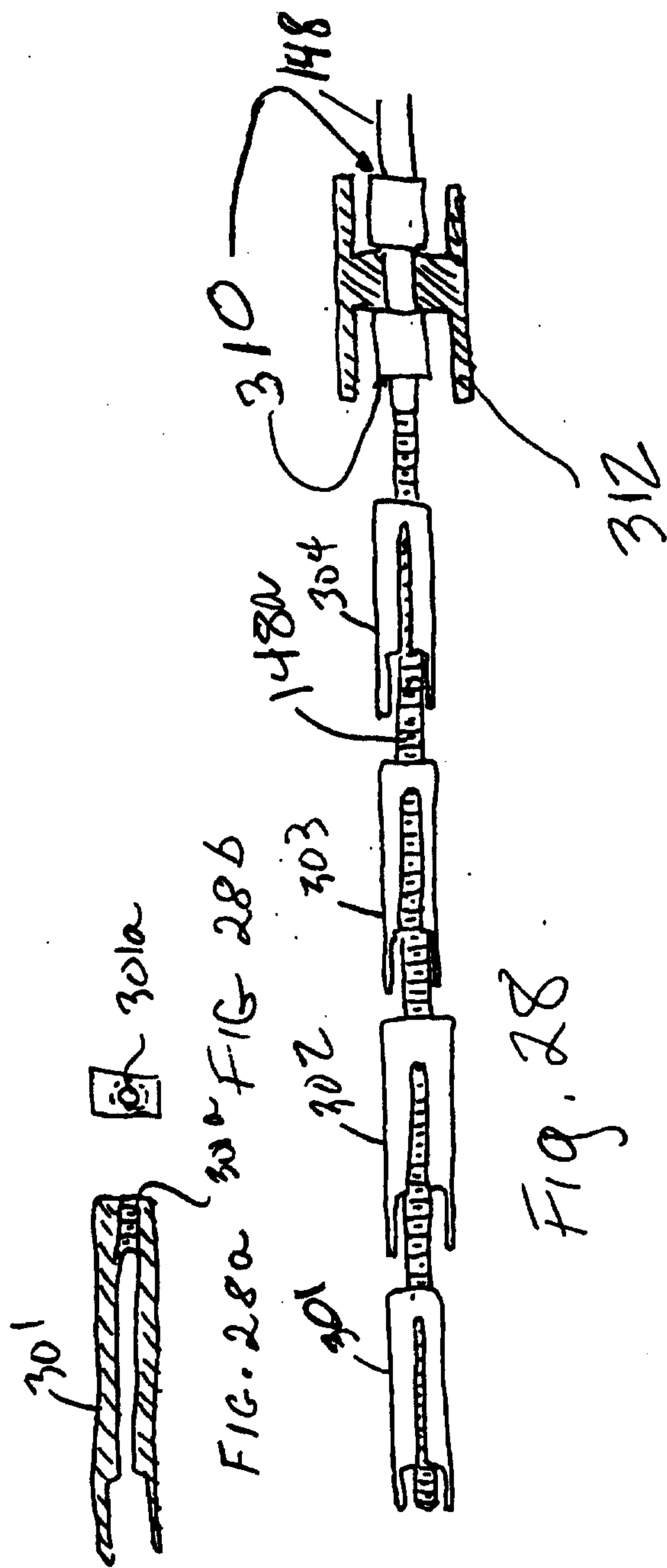
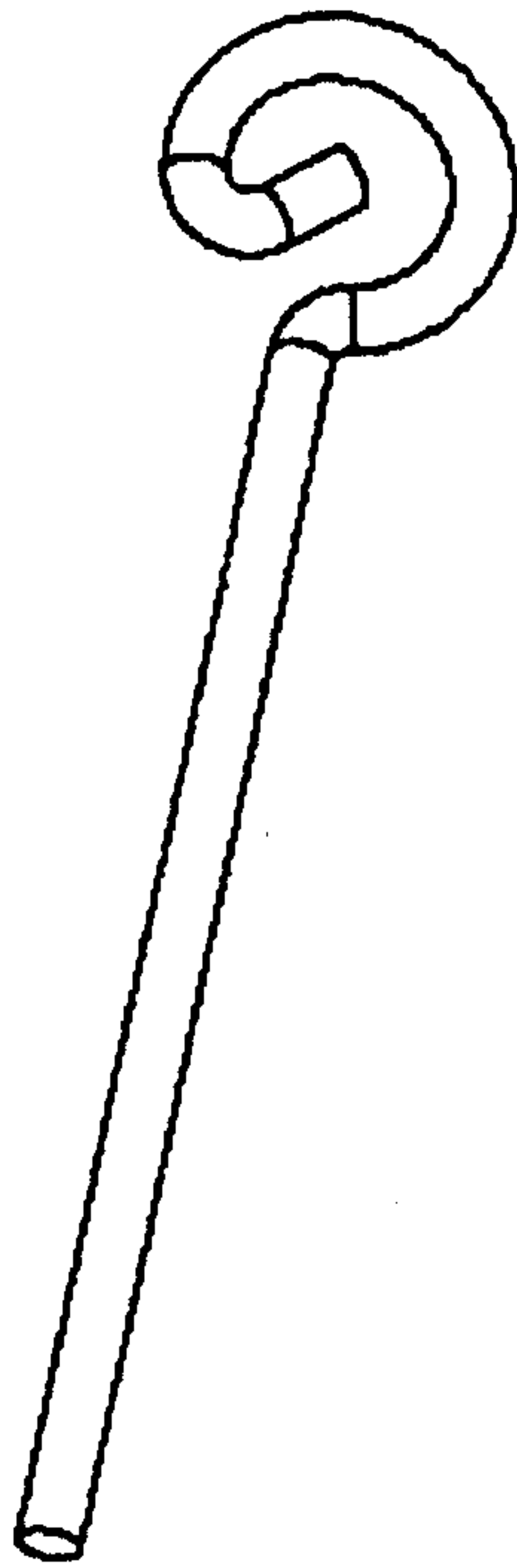


FIG. 26





F16.29

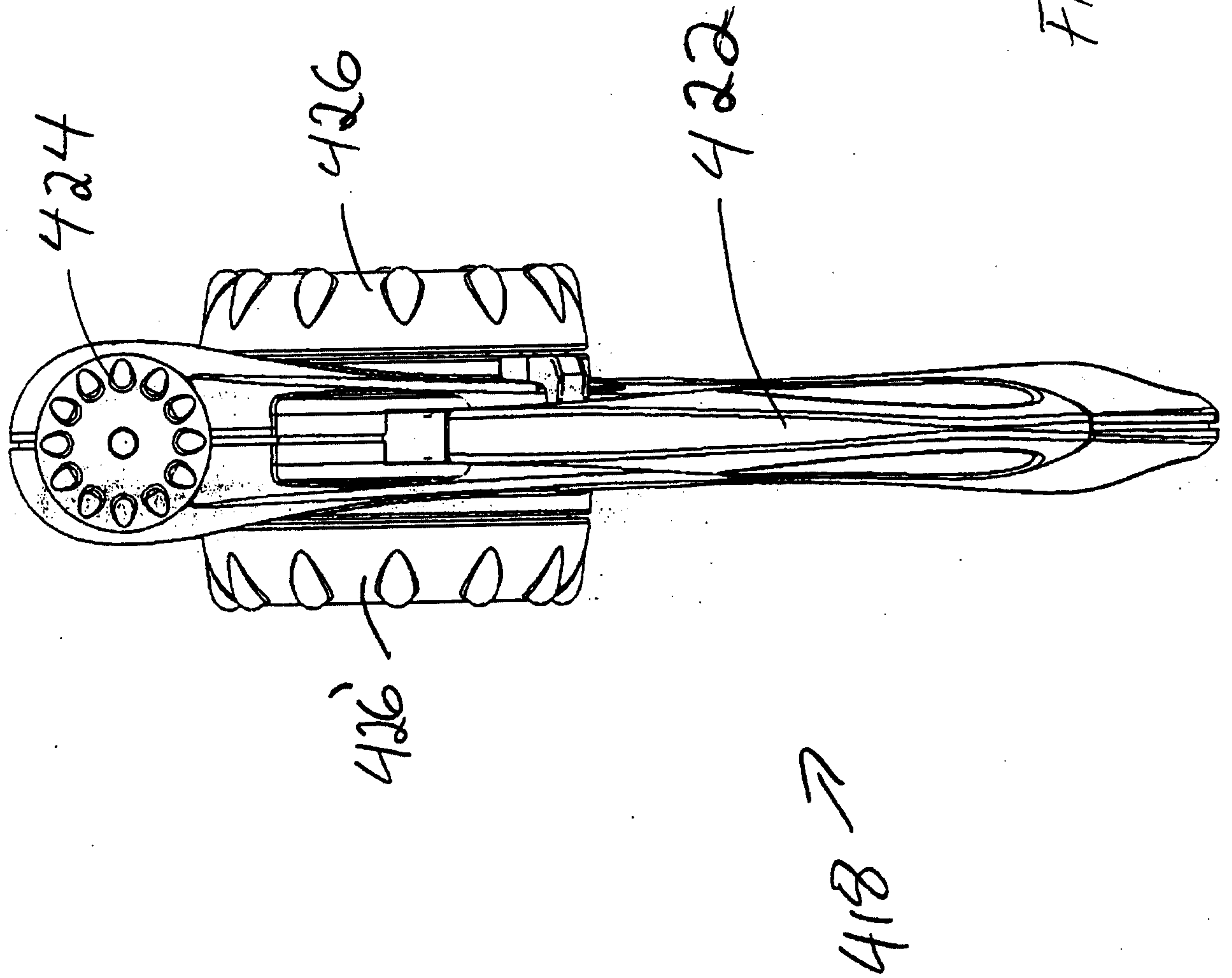


FIG. 30

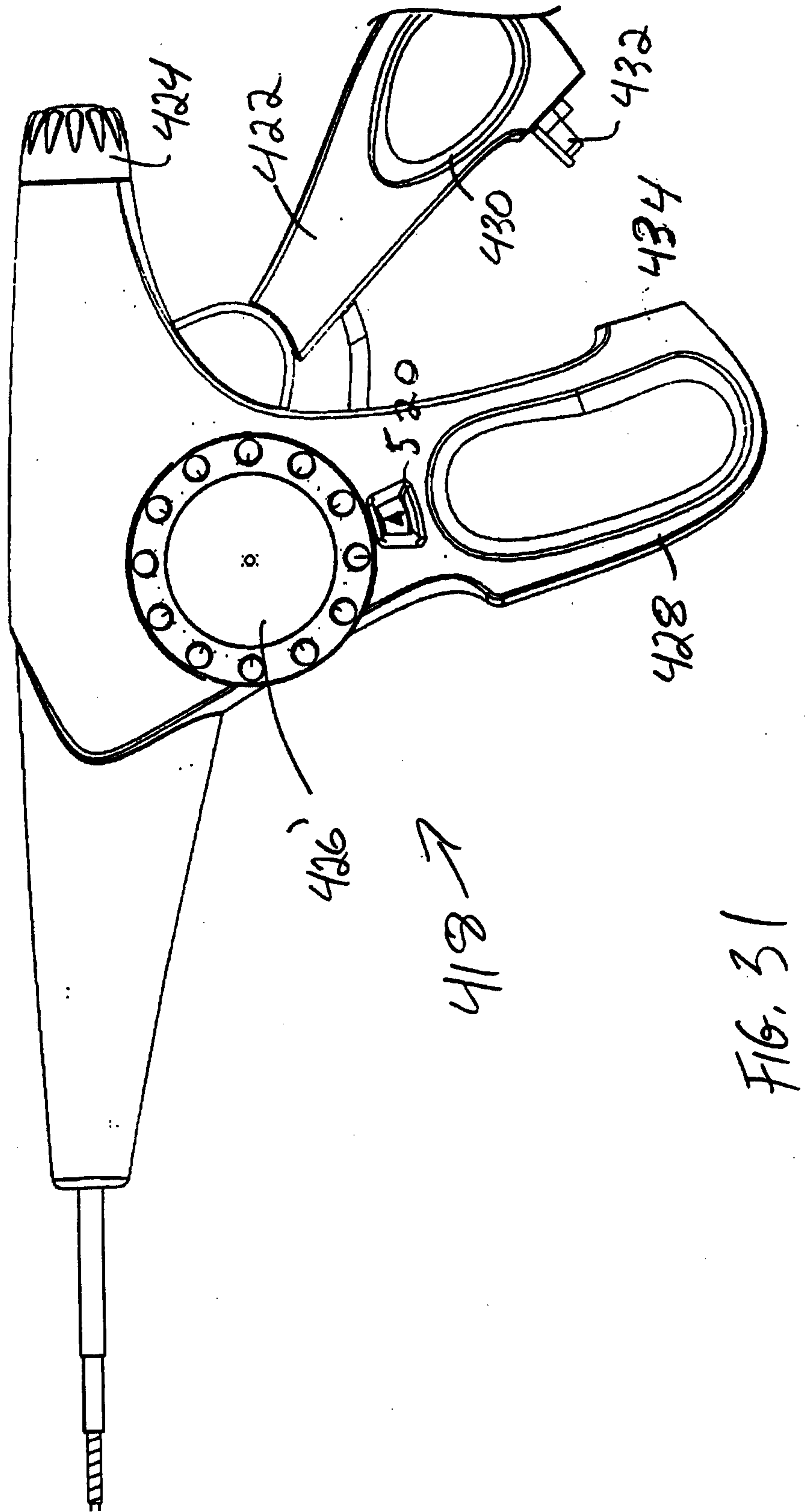
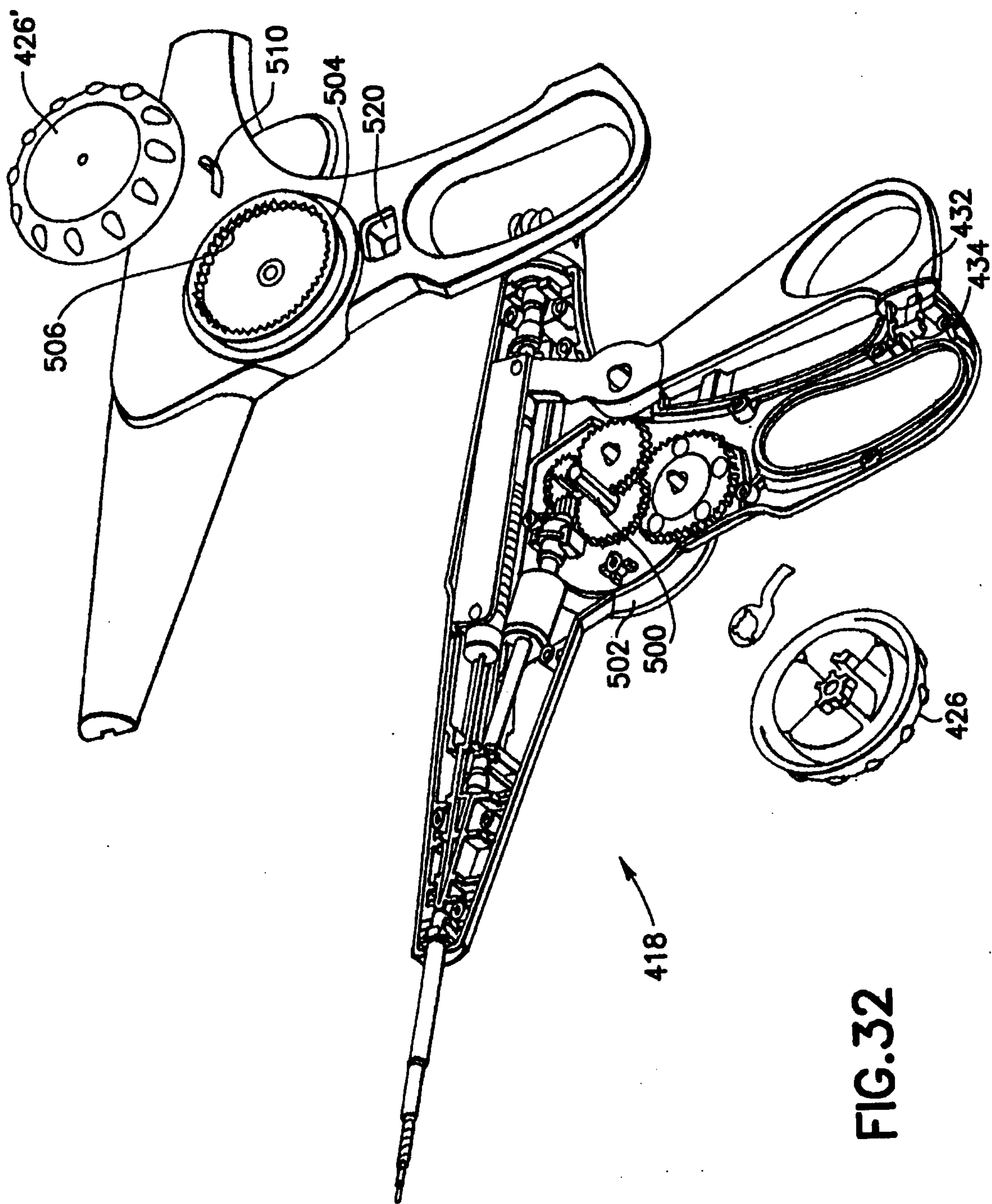


FIG. 31



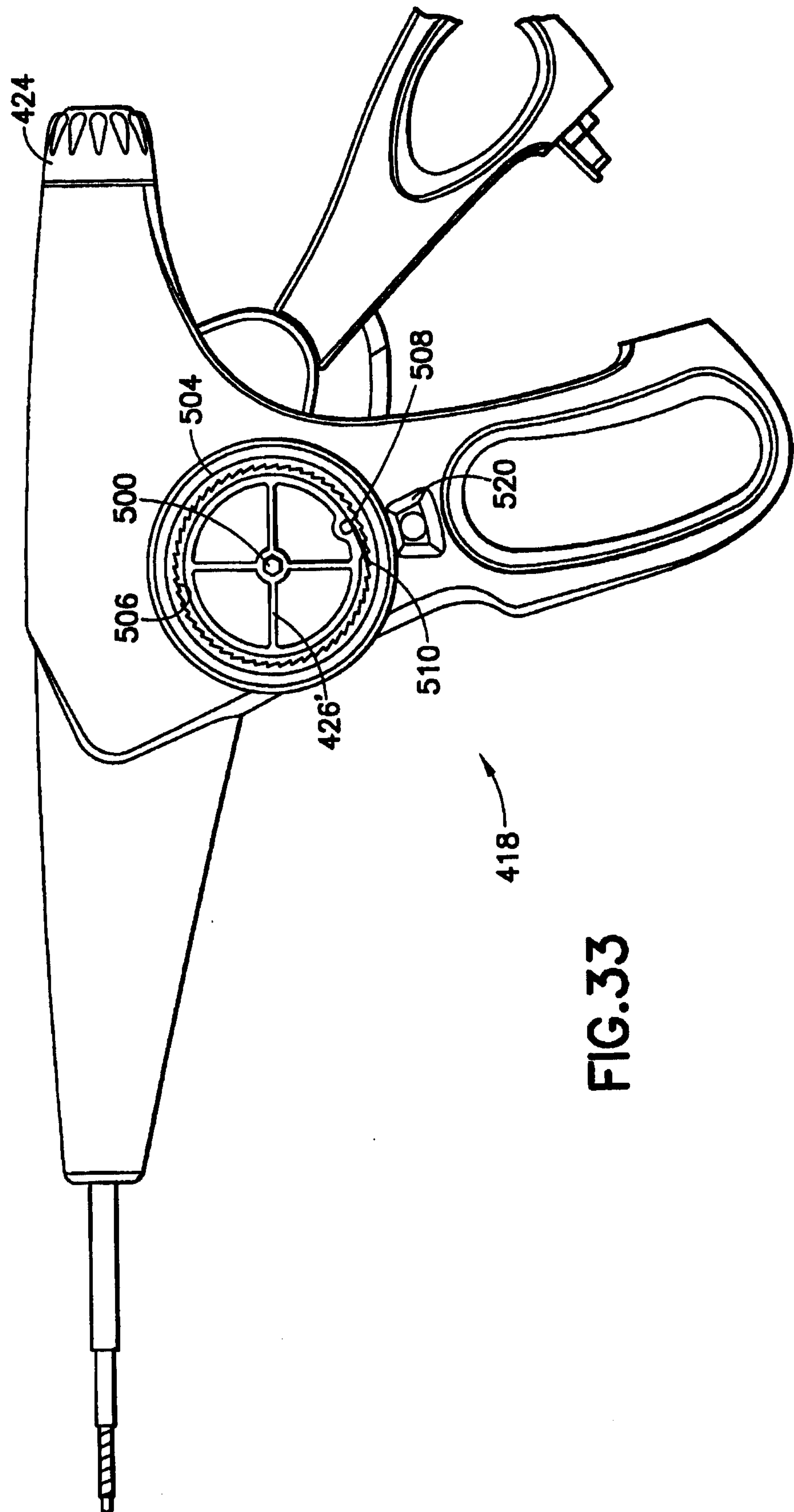


FIG. 33

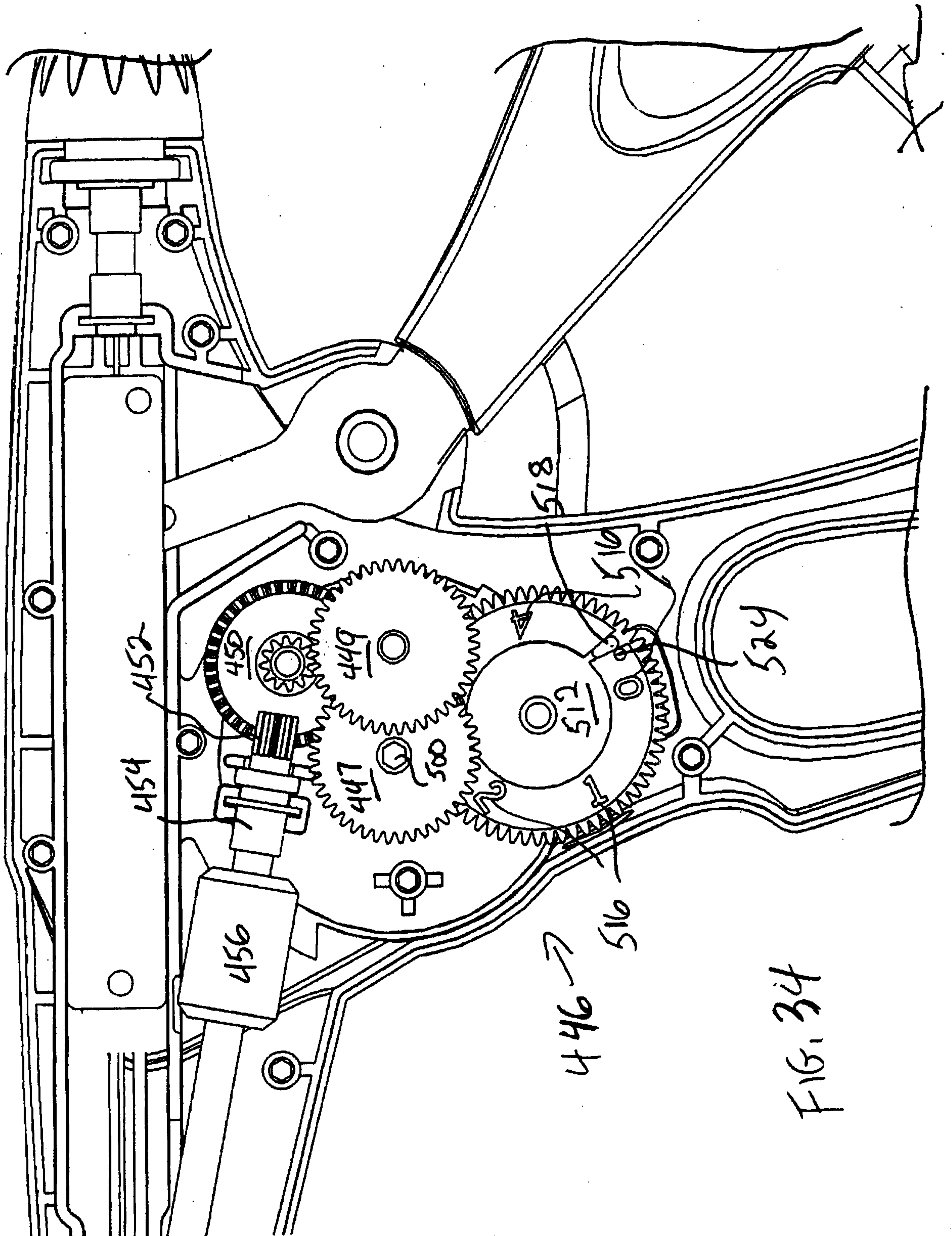


FIG. 34

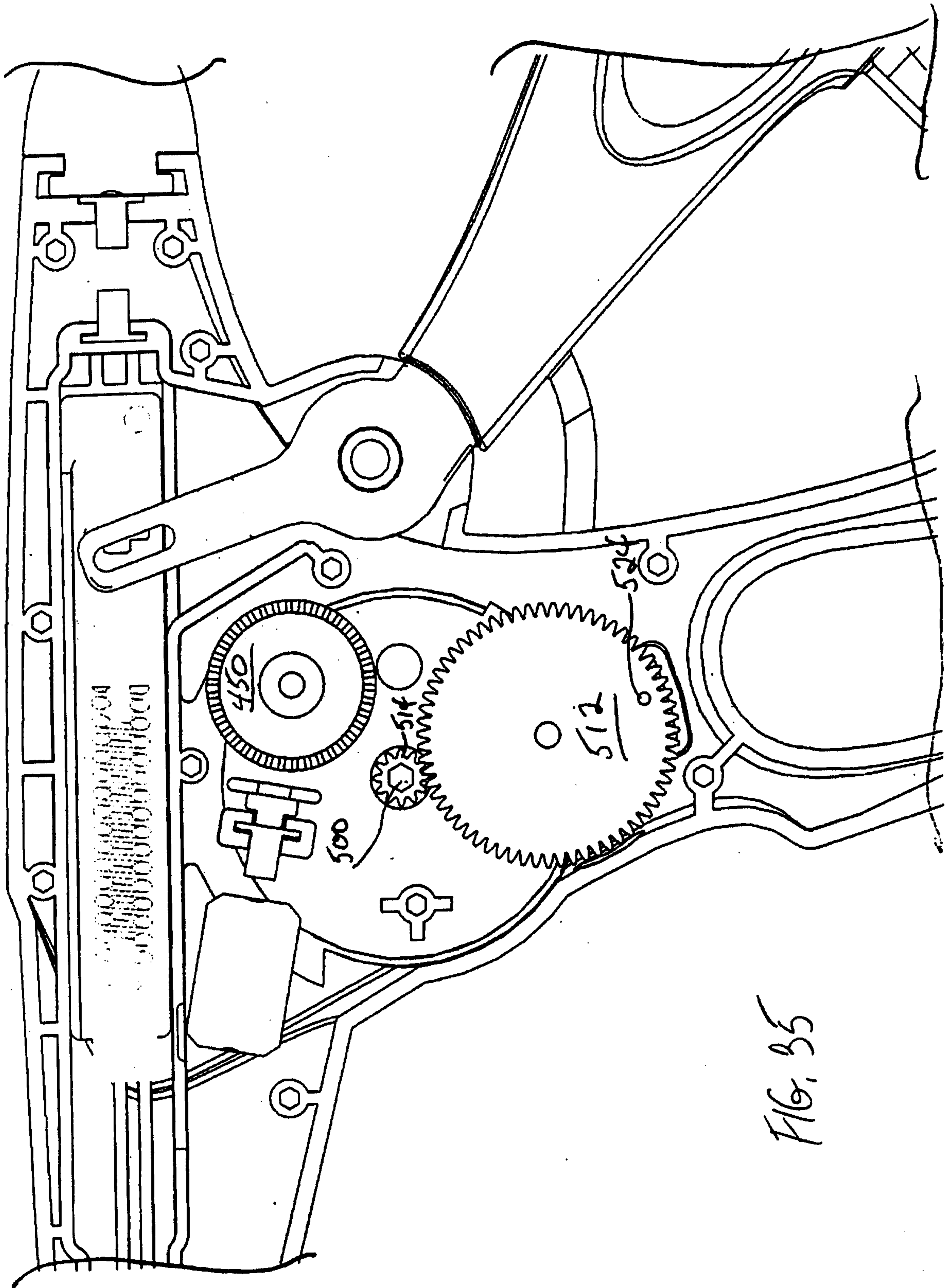
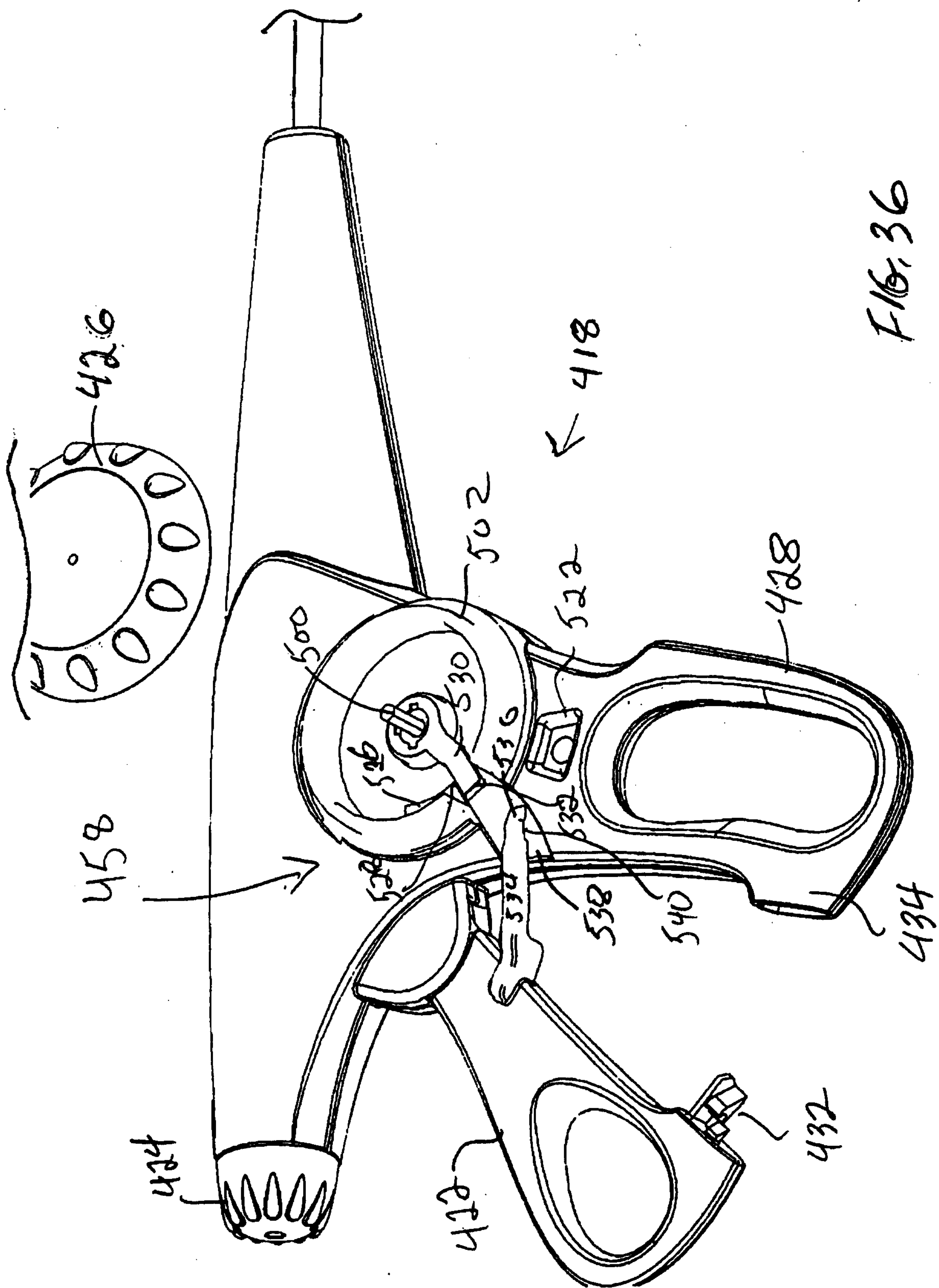


FIG. 35



F16.36

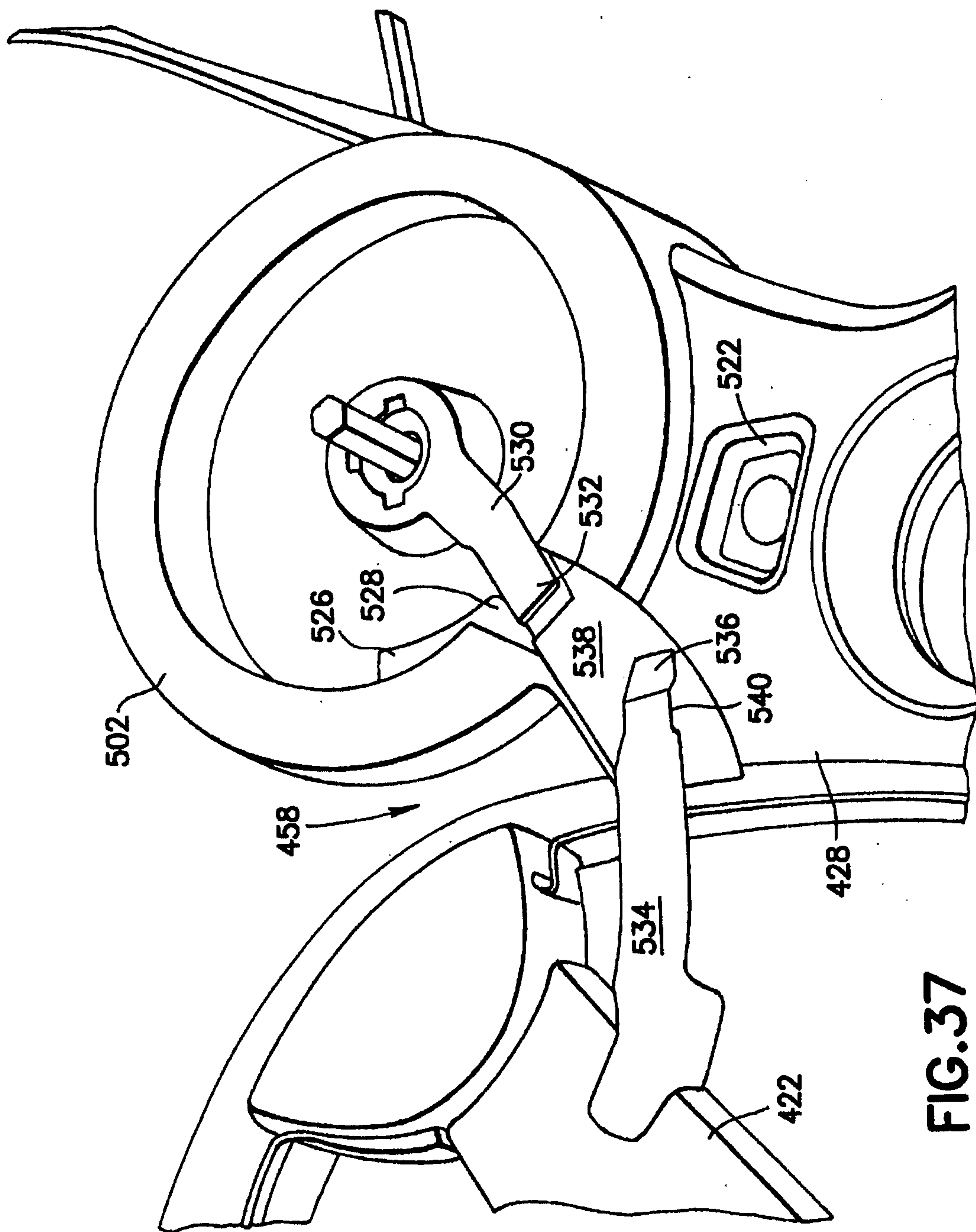
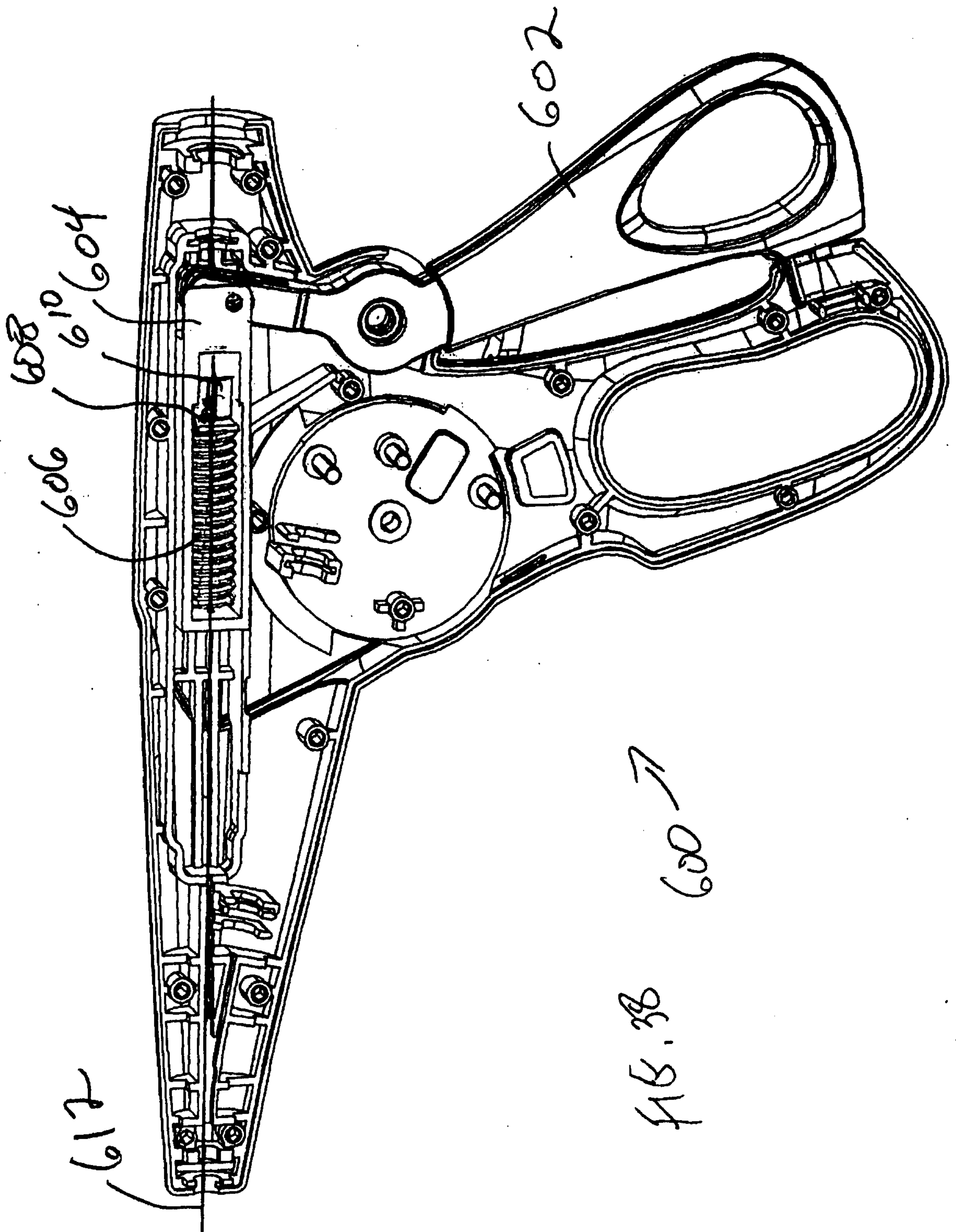


FIG.37



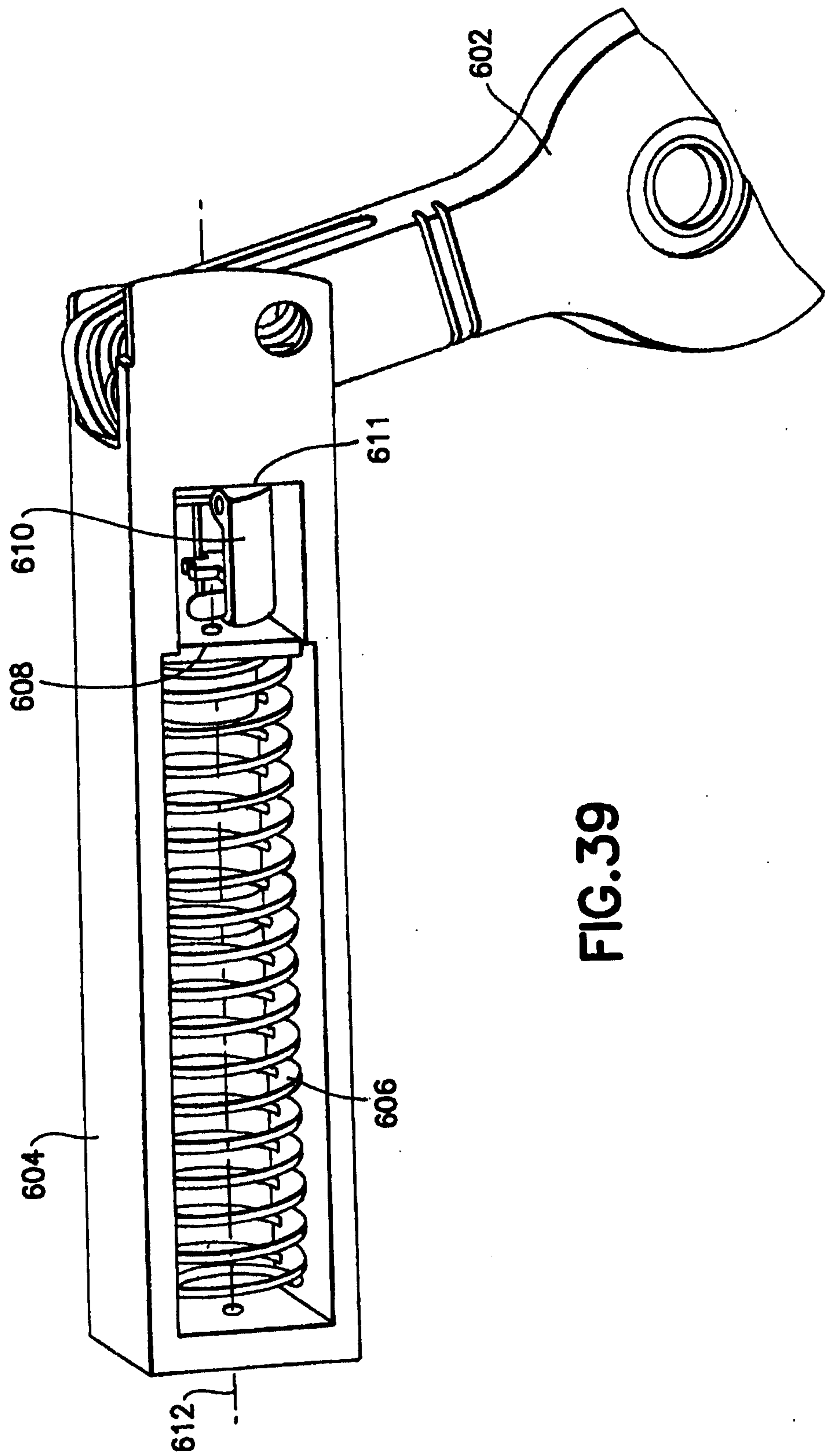


FIG. 39

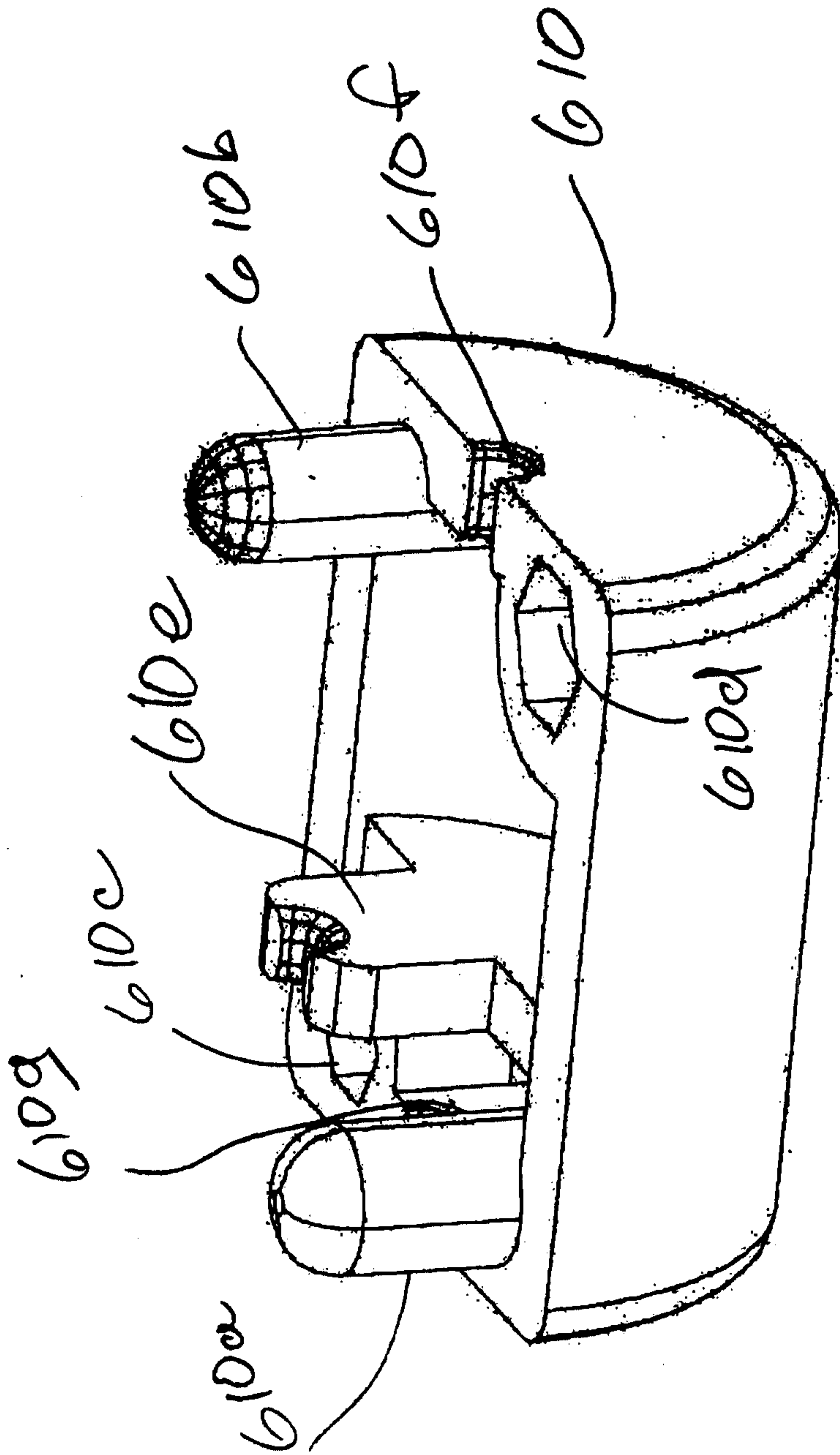
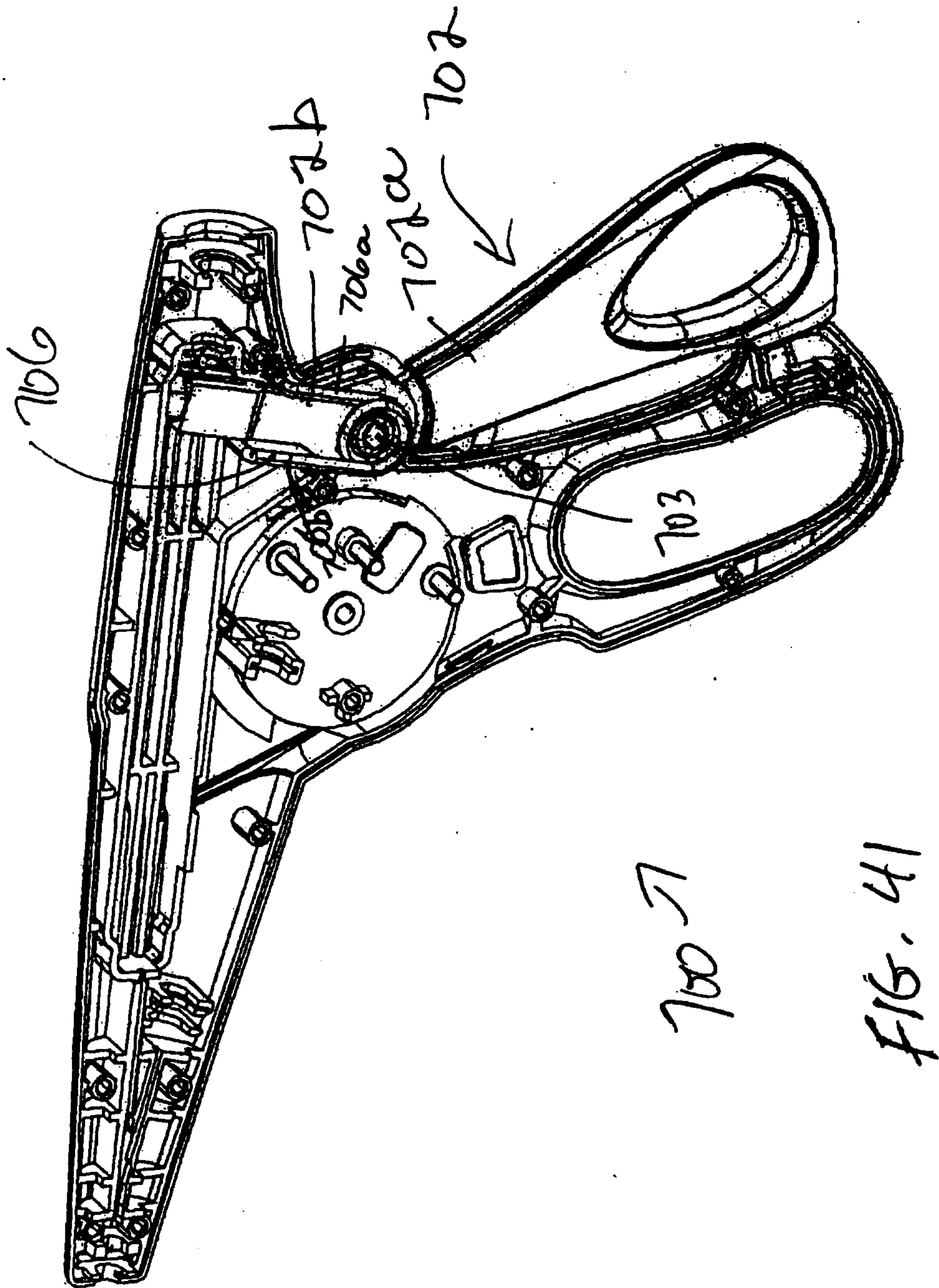


FIG. 40



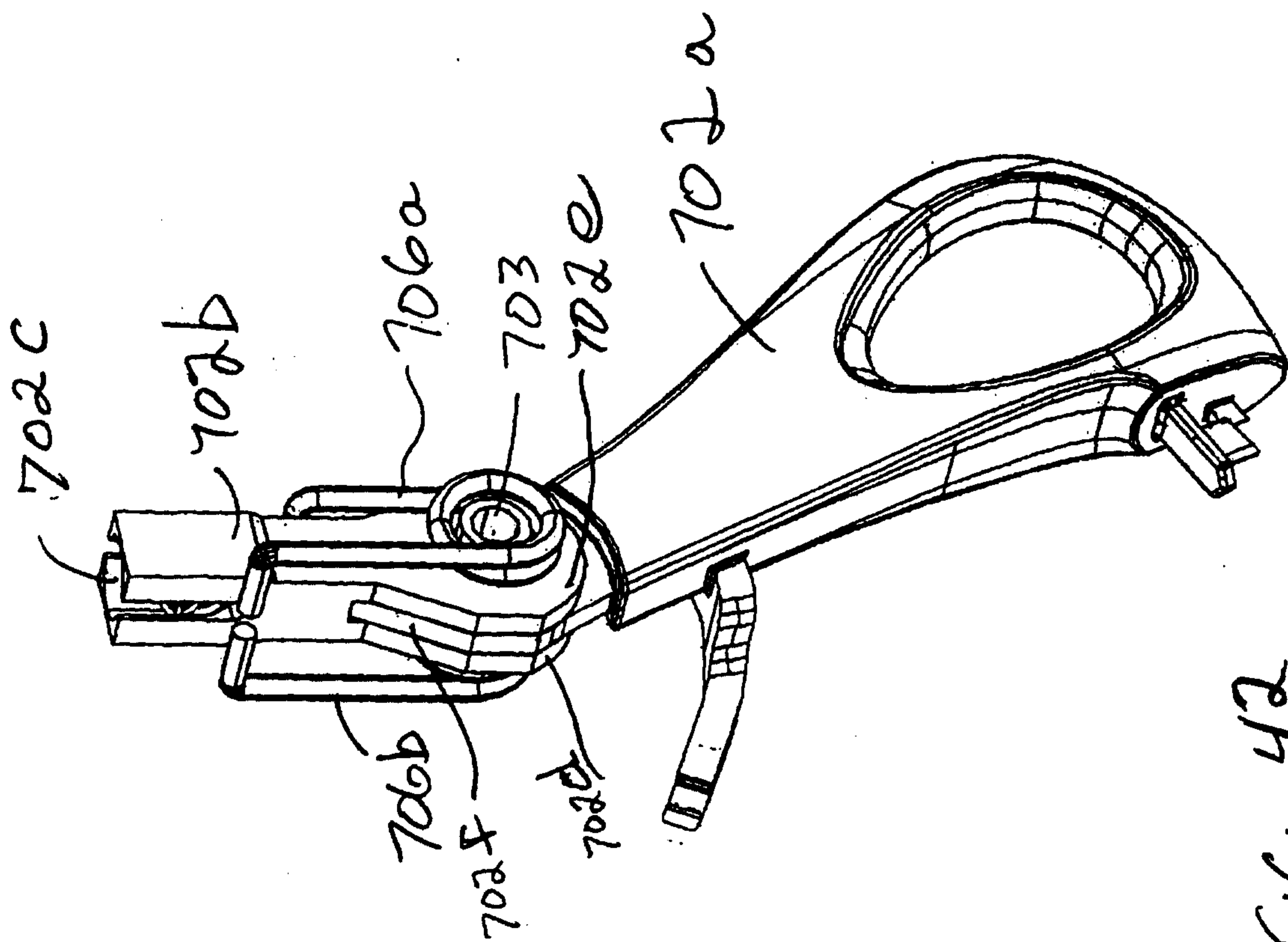


FIG. 42

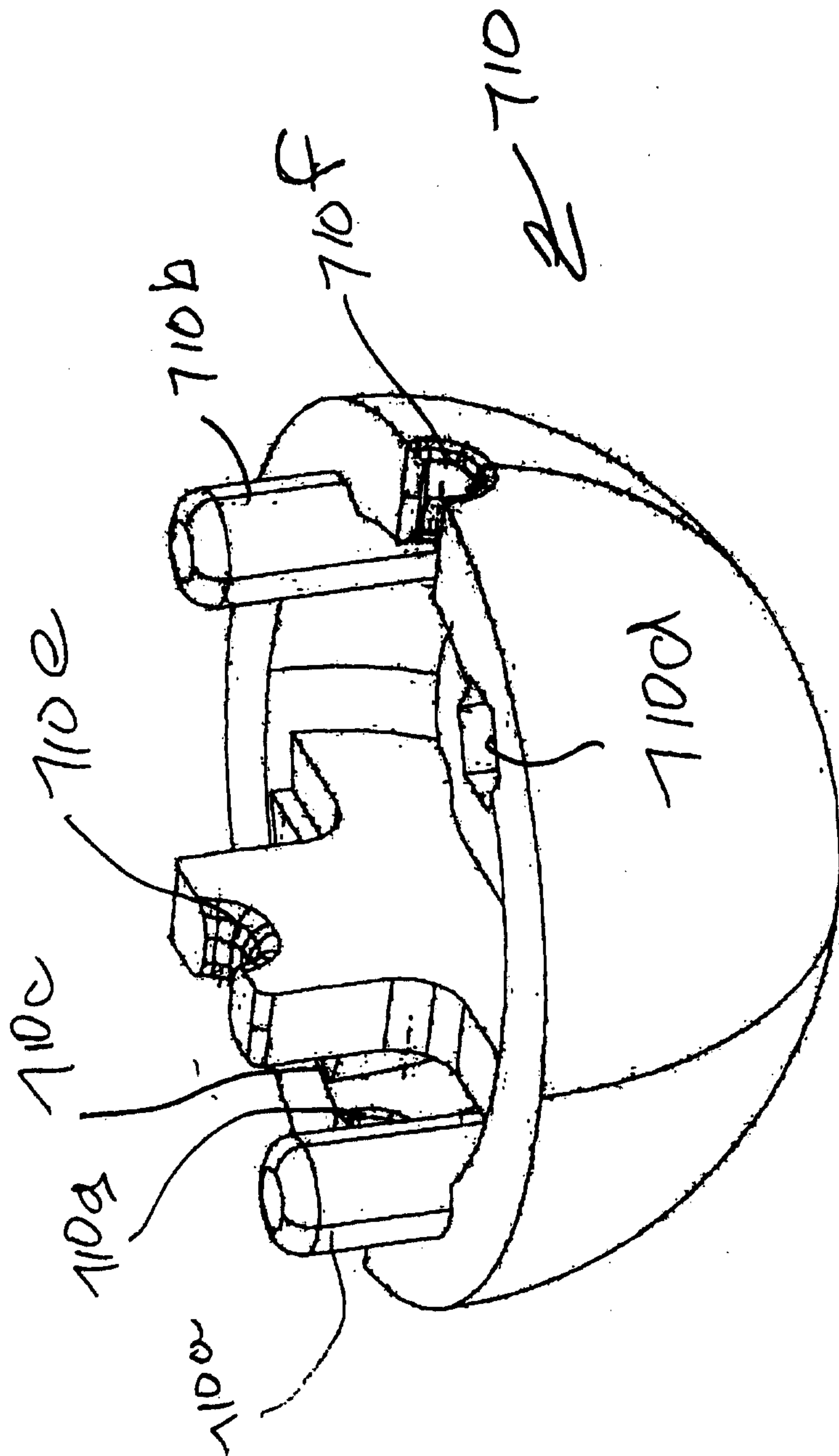


FIG. 43

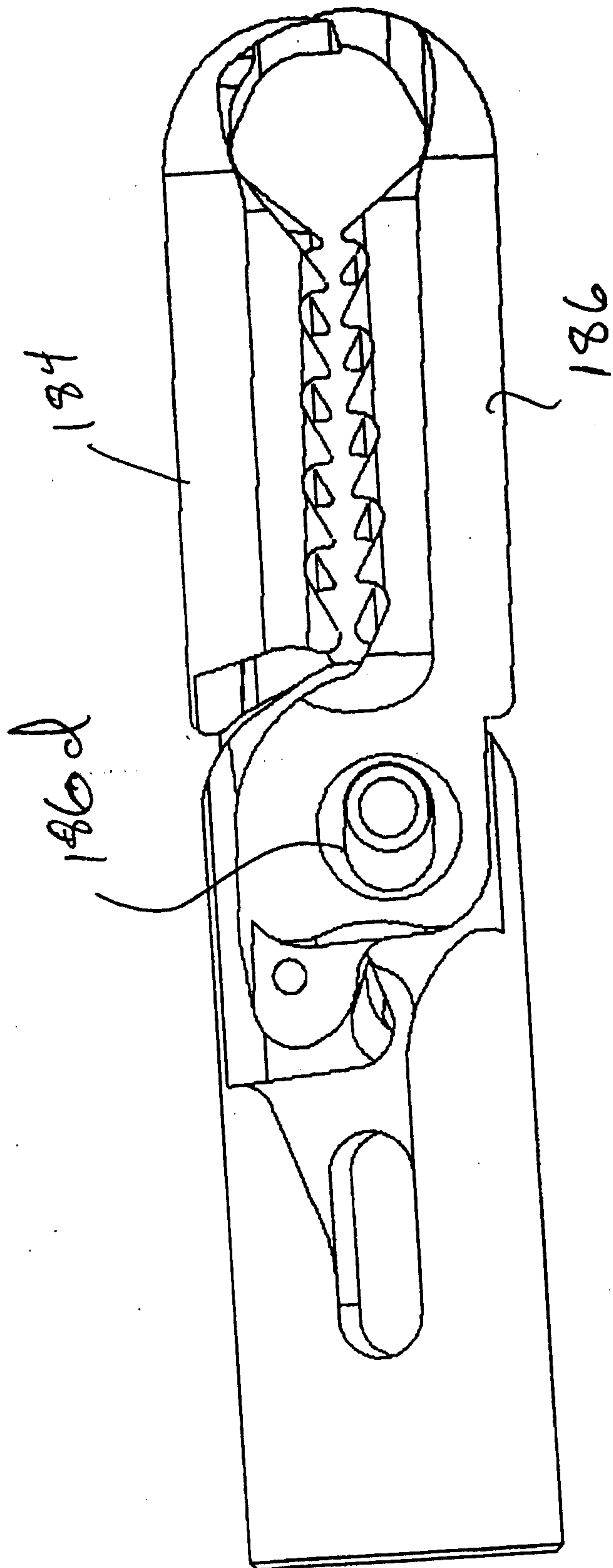


FIG. 44

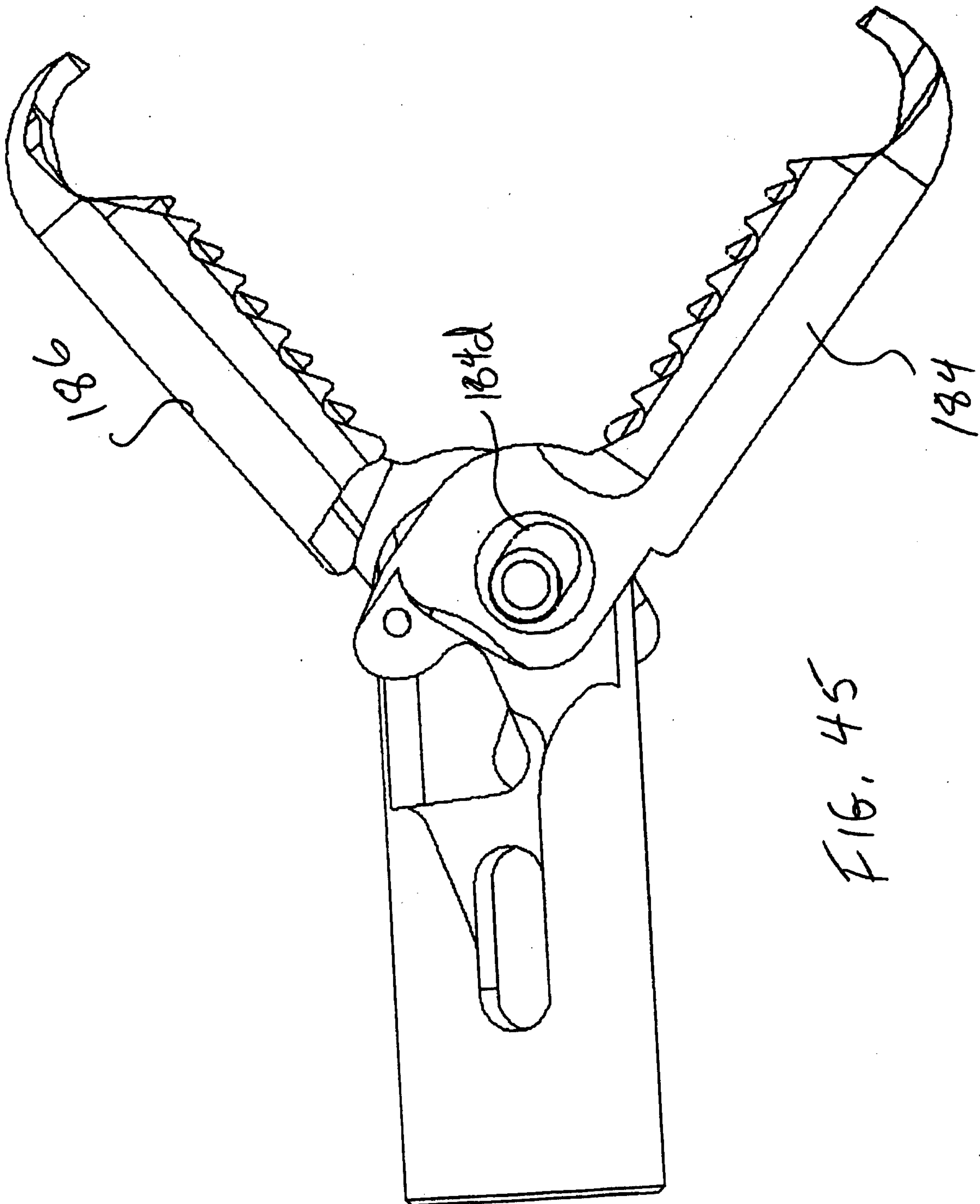


FIG. 45

