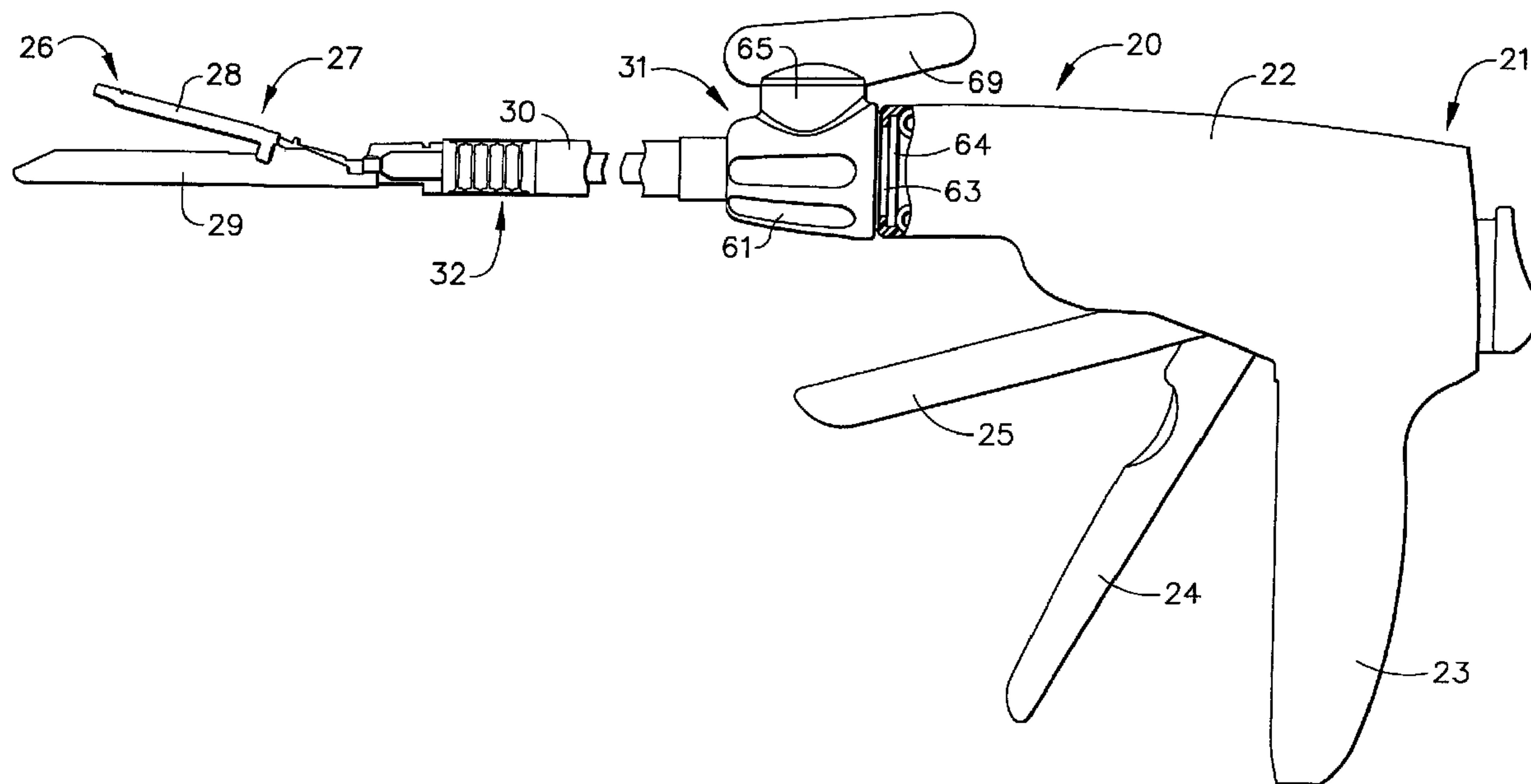




(22) Date de dépôt/Filing Date: 1997/05/09
 (41) Mise à la disp. pub./Open to Public Insp.: 1997/11/13
 (45) Date de délivrance/Issue Date: 2007/01/16
 (30) Priorité/Priority: 1996/05/13 (US08/645,355)

(72) Inventeur/Inventor:
HUITEMA, THOMAS, US
 (73) Propriétaire/Owner:
ETHICON ENDO-SURGERY, INC., US
 (74) Agent: OGILVY RENAULT LLP/S.E.N.C.R.L.,S.R.L.

(54) Titre : MECANISME DE TRANSMISSION D'ARTICULATION POUR INSTRUMENTS CHIRURGICAUX
 (54) Title: ARTICULATION TRANSMISSION MECHANISM FOR SURGICAL INSTRUMENTS



(57) Abrégé/Abstract:

An articulating surgical instrument which has an articulation transmission assembly for remotely articulating an end effector of the instrument is disclosed. The articulation transmission assembly includes a detent housing mounted on the instrument with a plurality of detent teeth. A compressible deck with a plurality of ratchet deck teeth is matingly coupled with the teeth of the detent housing when the assembly is in a first locked position. An actuator is fitted on the detent housing for applying a rotational force on the deck. A drive member is in communication with the deck for translating rotational movement of the deck into axial movement of an elongated transmission member which is attached to the drive member. When a rotational force is applied to the actuator, the deck compresses to decouple the teeth of the deck from the teeth in the detent housing. The decoupling of the teeth reduces the rotational force necessary to rotate the deck and consequently the drive member which moves the elongated transmission member axially to effect articulation. Consequently, the ratcheting rotation of the deck from the first locked position to a second locked position, and therefore the articulation of the end effector from a first position to a second position angled from the first position, is significantly facilitated.

- 23 -

ARTICULATION TRANSMISSION MECHANISM
FOR SURGICAL INSTRUMENTS

ABSTRACT

An articulating surgical instrument which has an articulation transmission assembly for remotely articulating an end effector of the instrument is disclosed. The articulation transmission assembly includes a detent housing mounted on the instrument with a plurality of detent teeth. A compressible deck with a plurality of ratchet deck teeth is matingly coupled with the teeth of the detent housing when the assembly is in a first locked position. An actuator is fitted on the detent housing for applying a rotational force on the deck. A drive member is in communication with the deck for translating rotational movement of the deck into axial movement of an elongated transmission member which is attached to the drive member. When a rotational force is applied to the actuator, the deck compresses to decouple the teeth of the deck from the teeth in the detent housing. The decoupling of the teeth reduces the rotational force necessary to rotate the deck and consequently the drive member which moves the elongated transmission member axially to effect articulation. Consequently, the ratcheting rotation of the deck from the first locked position to a second locked position, and therefore the articulation of the end effector from a first position to a second position angled from the first position, is significantly facilitated.

20

ARTICULATION TRANSMISSION MECHANISM
FOR SURGICAL INSTRUMENTS5 Background of the Invention

This invention relates to surgical instruments for performing various surgical procedures, especially endoscopic surgical procedures. In particular, it relates to the instrument mechanism which allows the surgeon to precisely position the instrument at
10 the endoscopic surgical site conveniently and with a high degree of confidence.

During a surgical procedure, particularly an endoscopic surgical procedure, access to the surgical site within the body cavity may be provided through openings of a small diameter made in the body wall. An instrument frequently used to provide this
15 access is the trocar. The trocar is an assembly which includes an obturator and a cannula. The obturator has a sharp tip which is used to puncture the body wall to provide the access opening. The obturator slides within the cannula, which is a hollow, cylindrical sleeve. When the obturator has punctured the body wall, the obturator is removed from the cannula. The cannula, however, remains in place
20 within the opening made in the body wall by the obturator. Consequently, the cannula provides a cylindrical passageway to gain access to the surgical site within the body cavity.

Accordingly, a characteristic feature of many endoscopic surgical instruments
25 is a long cylindrical shaft which can slide through the trocar cannula. At the business end of the shaft, which is the end of the instrument coming into contact with tissue at the surgical site within the body cavity, an "end effector" is provided to manipulate the tissue in some way to carry out a desired surgical procedure. The business end, including the end effector, must likewise be capable of sliding through the trocar
30 cannula. At the opposite end of the shaft, there is an actuator operatively connected to the business end to remotely control the performance of the end effector. The actuator is conveniently housed in a frame which may include a pistol grip handle with one or more pivoting triggers. Alternatively, the actuator may include a lever, or the

END-277

combination of a pivoting trigger and a lever. The actuator is activated when the surgeon pivots the trigger or depresses the lever. These actions in turn cause the end effector to perform its desired function.

5 Before the surgeon can actuate the end effector to manipulate tissue to perform a desired surgical procedure, the end effector must be carefully positioned at the desired location within the endoscopic surgical site. It also must be positioned at a proper orientation if, for example, staples must be fired in a certain direction to properly fasten the tissue. Therefore, endoscopic surgical instruments typically
10 include mechanisms to enable the surgeon to vary the orientation and positioning of the end effector at the business end of the instrument. Of course, the mechanisms must be operable at or near the frame of the instrument so that the surgeon can easily manipulate and control these mechanisms while gripping the instrument with his hand.

15 Often, it may be desirable to rotate the end effector of an endoscopic surgical instrument about the long axis of the shaft of the instrument to vary the orientation of the end effector. Accordingly, many endoscopic surgical instruments include a knob or dial on or adjacent the frame which, when actuated by the surgeon's hand, rotates the shaft of the instrument and correspondingly rotates the end effector.

20 Another critical feature of certain endoscopic instruments is the ability to pivot the end effector so that the end effector is positioned at an "articulated" position relative to the long axis of the shaft. Consequently, endoscopic instruments often include an articulation knob or dial on or near the frame for remotely articulating the
25 end effector for precise positioning of the end effector within the endoscopic surgical site. Numerous examples of these articulation mechanisms for endoscopic surgical instruments abound. For example, the reader is encouraged to review U.S. Patent Nos. 4,728,020; 4,869,414; 5,312,023; 5,326,013; 5,330,502; 5,374,277; 5,381,943; 5,383,888; 5,403,342; 5,405,344; 5,409,498; 5,411,519, 5,417,203 and
30 5,456,684. Articulating mechanisms for pivoting the end effector are also described

in U.S. Patent Nos. 5,601,224 and 5,626,432.

Also of interest is U.S. Patent No. 5,632,432, which describes a mechanism for bending the end effector of an endoscopic instrument through a flexible portion of the shaft.

5 Although articulating endoscopic surgical instruments are now freely available in commerce and have been described in the literature, the mechanisms which control articulation typically have a significant drawback. When the end effector of the instrument is articulated to a desired position, the end effector is often pushed against the tissue before
10 the end effector is manipulated to perform the desired surgical function. In some cases, the surgeon intentionally uses the articulated end effector to push against the tissue because the surgeon desires to retract or dissect tissue to provide sufficient space within the site for accurately manipulating the end effector to perform the surgical function. Unfortunately, what often
15 occurs when a force is applied to the end effector in an articulated position is that the end effector is forced from its desired articulated position. In other words, the end effector “unwinds” from its desired articulated position, and may shift to another undesired articulated position or revert back to its original, unarticulated position. Obviously, this is a nuisance
20 which would be desirable to overcome.

In addition, when resistance to movement from an articulated position is provided in the articulation assembly to maintain proper positioning (as described in U.S. Patent No. 5,601,224 discussed above), a corresponding resistance must likewise be provided when the surgeon
25 articulates the end effector to its desired articulated position. In other words, the surgeon must apply a greater force or torque on the articulation knob or dial in order to provide a corresponding increase in the resistance of the end effector to movement from the articulated position.

Furthermore, if too great a force is applied to the end effector in an articulated position, not only may the end effector unwind, but also the components of the articulation assembly may break, leading to a catastrophic failure.

5 Accordingly, a surgical instrument is needed which characteristically includes an end effector at the business end of the shaft which is capable of being remotely articulated to properly position the end effector. The ability to remotely articulate the end effector is especially important for endoscopic surgical instruments, which characteristically include an elongated cylindrical shaft separating the frame of the
10 instrument from the end effector. Significantly, the mechanism for articulation would desirably resist movement of the end effector in an articulated position when a force is applied to the end effector. Additionally, resistance would be provided without requiring excessive force to position the end effector from an unarticulated to an articulated position. Furthermore, it would be desirable if a fail safe mechanism to
15 prevent component breakage were provided which could reset the articulation assembly if too great a force were applied to the articulated end effector.

Summary of the Invention

20 In its broadest sense, the invention is an articulating surgical instrument which comprises an articulation transmission assembly. The articulation transmission assembly remotely articulates an end effector of the instrument. The articulation transmission assembly has a detent housing, a compressible deck, an actuator and a drive member. Each of these components of the articulation transmission assembly
25 will now be described briefly.

The detent housing is mounted on the instrument. It contains a plurality of detent teeth in the housing.

The compressible deck contains a plurality of ratchet teeth on the deck. The deck teeth are matingly coupled with the detent teeth of the detent housing when the articulation transmission assembly is in a first lock position.

5 The actuator is fitted on the detent housing. It applies a rotational force on the deck. When such a rotational force is applied to the deck by the actuator, the deck compresses. As the deck compresses, the deck teeth decouple from the detent teeth. The decoupling of the teeth facilitate ratcheting rotation of the deck from the first locked position to a second locked position.

10

Finally, the drive member of the articulation transmission assembly is in communication with the deck. It translates rotational movement of the deck into axial movement of an elongated transmission member which is attached to the drive member.

15

The articulation transmission assembly of the surgical instrument of this invention provides the surgeon with the ability to remotely articulate the end effector of the instrument. Rotation of the actuator provides axial movement of the elongated transition member to articulate the end effector.

20

Significantly, rotation of the actuator of the articulation transmission assembly decouples the teeth of the deck from the detent housing to significantly reduce the resistance to rotation. Consequently, when rotational resistance is reduced, the desired articulation of the end effector is more readily facilitated. If a rotational force is not applied to the actuator, the articulation transmission assembly rests in a locked position. When the end effector is in a locked, articulated position, a greater force must be applied on the end effector to decouple the teeth and consequently change the articulated position because the deck will not be subjected to compression resulting from rotation of the actuator. Therefore, when the surgeon wants to rotate the actuator for articulation, the resistance to rotation is significantly less than the

25

30

END-277

resistance which must be overcome when a force is applied to the articulated end effector.

5 In addition, the articulation transmission assembly of the surgical instrument provides for ratcheting rotation of the end effector. Since force can be applied to decouple the teeth of the deck from the teeth in the detent housing, the amount of total force which the components of the articulation transmission assembly is subjected can be limited. Consequently, the articulation transmission assembly of this invention provides a fail-safe mechanism to prevent component breakage.

10

In a preferred embodiment of this invention, an articulating surgical instrument particularly adapted for endoscopic surgery is provided. The instrument comprises a frame which includes a hand grip for gripping and manipulating the instrument at a first end of the instrument. An elongated endoscopic shaft extends from the frame.
15 The shaft has a longitudinal axis. The instrument has an end effector in communication with the shaft at an opposite end of the instrument for manipulating tissue to carry out a desired surgical function. The end effector is movable to provide articulation of the end effector from a first position parallel to the shaft longitudinal axis to a second position angled from this axis.

20

The preferred instrument has an articulation transmission assembly adjacent the frame for remotely articulating the end effector from the first position to the second position. This articulation transmission assembly includes a nozzle and an articulation body. The nozzle is coupled to the shaft and secured to the frame. It has a body with
25 a bore extending through it generally parallel to the shaft longitudinal axis. It also has a detent housing extending from the nozzle body. The detent housing contains a plurality of detent teeth in the housing. The articulation body is mounted within the detent housing of the nozzle body for rotational movement from a plurality of locked positions spaced between a plurality of unlocked positions. The articulation body

END-277

includes a deck, a drive member and a lever. A brief description of these components will now be set forth.

5 The deck has a pair of spaced-apart deck halves separated by mutually-opposed first and second detents. Each of the deck halves has a plurality of deck teeth. The deck teeth are positioned for interacting relationship with the detent teeth of the detent housing. When the articulation body is in one of the locked positions, the deck teeth mesh with the detent teeth. In contrast, when the articulation body is in one of the unlocked positions, the deck teeth do not mesh with the detent teeth.

10

The drive member of the articulation body is coupled to the deck. The drive member descends into the bore of the nozzle body. It has first and second elongated transmission members attached to it. These transmission members extend through the bore into the shaft for remotely articulating the end effector in response to actuation of the articulation transmission assembly.

15

Finally, the lever of the articulation transmission assembly is secured to the articulation body for rotating the articulation body within the detent housing of the nozzle. The lever includes a cap fitted on the detent housing. The cap contains a slot within the cap for receiving the first and second detents of the deck halves so that the deck halves of the deck are attached to the cap.

20

Significantly, when a rotating force is applied to the lever of the articulation transmission assembly, the slot in the cap urges the first and second detents toward each other. In so doing, the deck teeth are withdrawn from the detent teeth, and rotation of the articulation body within the detent housing from the locked positions to the unlocked positions is therefore facilitated.

25

The preferred embodiment of the instrument of this invention is particularly adapted for endoscopic surgery because it facilitates the remote articulation of the end

30

effector adjacent the frame of the instrument. In addition, the use of the slot in the cap of the lever to urge together the deck halves to withdraw the teeth of the deck from the teeth in the detent housing is a simple and effective mechanism for reducing the rotational forces which the surgeon must apply to the lever when he wants to articulate the end effector. In effect, the spaced-apart deck halves of the articulation body provide a compressible deck assembly within the articulation body. When the lever is rotated, the walls of the slot apply a compressive force on the first and second detents of the deck halves to urge the deck halves together. Thus, the deck teeth are readily withdrawn from the detent teeth.

10

In the most preferred embodiment of this invention, the end effector of the surgical instrument of this invention is a surgical fastening assembly, and the instrument is an articulating surgical stapler particularly adapted for endoscopic surgery. The surgical fastening assembly has an elongated anvil facing an elongated channel for receiving a staple cartridge. The surgical fastening assembly is capable of clamping tissue, and then firing staples into the clamped tissue.

15

The instrument of this invention can be used in any surgical application where it is desirable to remotely articulate an end effector of the instrument to better position the end effector at the surgical site. Remote articulation is particularly desired for endoscopic surgical applications, although it may also be desirable for conventional, open surgical procedures.

20

Brief Description of the Preferred Embodiment

25

Figure 1 is a foreshortened side elevational view of the preferred articulating surgical stapler of this invention. A portion of the frame of the stapler has been exposed to show the attachment of the articulation transmission assembly of the stapler to the frame.

30

END-277

Figure 2 is a plan view of the stapler of Figure 1 illustrating the remote articulation of the surgical fastening assembly of the stapler in response to the actuation of the articulation transmission assembly.

5 Figure 3 is an exploded isometric view of the articulation transmission assembly of the stapler of Figure 1.

Figure 4 is a side elevation view of the lever cap of the articulating transmission assembly of Figure 3.

10

Figure 5 is a bottom view of the lever cap of Figure 4.

Figure 6 is a plan view of the articulation body of the articulation transmission assembly of Figure 3.

15

Figure 7 is a side elevational view of the articulation body of Figure 6.

Figure 8 is a front elevational view of the articulation body of Figure 6.

20 Figure 9 is a plan view of the nozzle of the articulation transmission assembly of Figure 3.

Figure 10 is a side elevational view of the nozzle of Figure 9.

25 Figure 11 is a plan view of the articulation transmission assembly of the stapler of Figure 1 in which the articulation body of the assembly is shown in a locked position. The lateral sides of the lever cap have been truncated to illustrate the internal details of the assembly. The top of the lever cap has been further sectioned away to illustrate the interface between the cap and the articulation body.

30

END-277

Figure 12 is a transverse section of the articulation transmission assembly generally taken along line 12-12 of Figure 11. The articulation body of the assembly is shown in the locked position to prevent the surgical fastening assembly of the stapler from changing articulation angle.

5

Figure 13 is a transverse section of the articulation transmission assembly of Figure 12 in which the articulation body of the assembly has been rotated from the locked position to an unlocked position for articulation of the surgical fastening assembly of the stapler.

10

Figure 14 is a plan view similar to Figure 11 except that the articulation body has been rotated to the unlocked position.

Detailed Description of the Preferred Embodiment

15

Referring initially to Figure 1, there is shown the preferred articulating endoscopic stapler 20 of this invention. At a first proximal end 21, the stapler has a frame 22 adapted to enable the user to grip and manipulate the stapler. The frame has a stationary hand grip 23 for placement in the palm of the user's hand, and pivotally mounted clamping and firing triggers, 24 and 25, for remotely clamping tissue and firing staples into the clamped tissue, respectively.

20

At an opposite distal 26 end of the stapler 20 there is the end effector in the form of a surgical fastening assembly 27. The surgical fastening assembly has an elongated anvil 28 facing an elongated channel 29 adapted to receive a surgical cartridge containing a plurality of staples therein (surgical cartridge not shown). Extending from the frame 22 of the stapler and coupling the frame to the surgical fastening assembly 27 is an elongated endoscopic shaft 30.

25

- 11 -

The preferred actuation assembly within the frame of the stapler for remotely clamping tissue and firing staples into the clamped tissue in response to pivotal counterclockwise rotation of the clamping and firing triggers is described in U.S. Patent
5 Nos. 5,465,895 and 5,553,765. The preferred clamping mechanism within the surgical fastening assembly to urge the anvil from a first position spaced from the elongated channel to a second position adjacent the channel is described in U.S. Patent No. 5,662,667.

10 Referring to Figures 1 and 2, the preferred articulating stapler 20 has an articulation transmission assembly 31 coupling the frame 22 to the elongated endoscopic shaft 30 of the stapler. When the articulation transmission assembly is rotated, it causes the remote articulation of the surgical fastening assembly 27 of
15 the stapler. The elongated endoscopic shaft contains a flexible neck 32 enabling the articulation of the surgical fastening assembly 27 of the stapler. The flexible neck has first and second flexible neck portions, 33 and 34, which receive first and second elongated flexible transmission bands, 35 and 36. Upon
20 rotation of the articulation transmission assembly, one of the first and second flexible transmission bands is moved forwardly and the other band is moved rearwardly. In response to the reciprocating movement of the bands within the first and second flexible neck portions of the flexible neck, the flexible neck
25 bends to provide articulation. A further description of the flexible neck in an articulating endoscopic stapler is described in U.S. Patent No. 5,632,453.

The component parts of the articulation transmission assembly 31 are illustrated in Figure 3. The major components
30 of the assembly are an actuator 37, an articulation body 38 and a nozzle 39. Rotational movement of the actuator 37 causes

corresponding rotation of the articulation body 38 within the nozzle 39. The first and second elongated transmission bands, 35 and 36, consequently reciprocate axially in opposite directions parallel to the longitudinal axis of the endoscopic shaft 30 of the stapler to cause the remote articulation of the surgical fastening assembly through the
5 flexible neck of the endoscopic shaft.

Referring specifically to Figure 3 in combination with Figures 6-8, a detailed illustration of the articulation body 38 is provided. The articulation body has a deck 40 consisting of first and second spaced-apart, semicircular deck halves, 41 and 42.
10 The deck halves are mutually opposed to each other and essentially represent mirror images of each other. The first and second deck halves have protruding from their surfaces mutually opposed first and second detents, 43 and 44. Each deck half has a set of deck teeth 45 spaced about 180° from the set of deck teeth on the other deck half.

15

The articulation body also has a generally circular base 46. The base has a pair of rotation stops 47 descending from its surface as well as a pair of finger recesses 48. The base 46 flexibly supports the deck 40 on two sets of beams. First inner and outer flexible beams, 49 and 50, extend upwardly from the base and are integrally
20 attached to the first deck half 41. Likewise, second inner and outer flexible beams, 51 and 52, extend upwardly from the base and are integrally attached to the second deck half 42. The first and second outer flexible beams, and the first and second inner flexible beams, are displayed in mutually opposed relationship.

25

Again focusing on Figure 3 and Figures 6-8, the articulation body 38 further includes a drive gear 53 descending from the base 46. The drive gear has a flared opening 54 through it, and a lower pivot 55. Within the flared opening of the drive gear, there is a firing rod orifice 56 for receiving the firing rod 57 enabling the firing of staples into the clamped tissue in response to pivotal rotation of the firing trigger
30 (see Figure 12). Coring cavities 58 are embedded in the base for manufacturing

optimization. The drive gear is coupled to a pair of drive racks, 59 and 60, on the flexible elongated transmission bands, 35 and 36, to effect the desired reciprocating movement of the bands.

5 The nozzle 39 of the articulation transmission assembly is specifically illustrated in Figure 3 in combination with Figures 9 and 10. The nozzle has a nozzle body 61. The nozzle body has an axial bore 62 extending through it for receiving the drive gear 53 of the articulation body 38. The bore provides a continuous opening axially from the frame into the elongated endoscopic shaft, and therefore the firing rod
10 57 and other operative components of the stapler can communicate with the surgical fastening assembly 27 from the frame 22. The nozzle body also has a frame groove 63 and flange 64 to fasten the body of the articulation transmission assembly to the frame (see Figure 1).

15 Extending from the nozzle body 61 of the nozzle 39 is a detent housing 65. Within the housing, there is an annular array of detent teeth 66. Spaced from the detent teeth is a detent housing floor 67. The floor 67 is displayed adjacent to the nozzle body 61. It has a pair of ledges 78 which interact within the rotation stops 47 of the articulation body to limit the degree of rotation. When the articulation body is
20 inserted into the detent housing, the base of the articulation body sits on the floor within the detent housing, and the deck teeth 45 of the first and second deck halves, 41 and 42, of the deck 40 are aligned with the detent teeth 66 of the detent housing to provide an essentially continuous surface. Additionally, when the articulation body is inserted, the lower pivot 55 of the drive gear 53 is received in a pivot hole 68 located
25 interiorly within the nozzle body adjacent to the axial bore 62 (see Figure 12).

Figure 3 in combination with Figures 4 and 5 illustrate the actuator 37 of the articulation transmission assembly. The actuator consists of a lever arm 69, a circular cap 70 and a pair of retaining fingers 71. The lever arm is mounted on the top of the cap. The pair of retaining fingers descend downwardly from the underside of the cap.
30

Each of the retaining fingers has a retaining clip 72. The retaining fingers are received within the finger recesses 48 of the articulation body 38. The underside of the cap (Figure 5) has a slot depression 73 embedded within the cap. The slot depression is bounded by a pair of parallel slot walls 74 and diagonal flats 75.

5 Pressure points 76 are consequently provided at the junction between the parallel walls and the diagonal flats.

The first and second detents, 43 and 44, of the deck halves of the articulation body are inserted into the slot depression 73 within the underside of the circular cap

10 70. Accordingly, the parallel slot walls 74 frictionally contact the first and second detents of the deck, thus securing the actuator 37 to the articulation body 38. Further, when the articulation body is inserted into the detent housing 65 of the nozzle body 61 so that the articulation body is retained when the firing rod 57 is received through the firing rod orifice 56 of the drive gear 53, the cap 70 is secured onto the detent housing

15 when the cap rests on an actuator cap lid 77 of the detent housing.

Advantageously, each of the three significant components of the articulation transmission assembly, namely the actuator, articulation body and nozzle, are injection molded components. The preferred material of construction for each of the

20 components is a glass fiber-reinforced amorphous polyamide, sold commercially under the trade name Grivory GV-4H by EMS - American Grilon as of the date upon which the application which matured into this patent was filed.

Referring now to Figures 11 and 12, there is shown the articulation

25 transmission assembly 31 of the stapler 20 when the assembly is in a locked position. In this locked position, the deck teeth 45 of the articulation body 38 are matingly coupled to, and mesh with, the detent teeth 66 of the detent housing 65. This engagement of the deck and detent teeth fixes the articulation position of the surgical fastening assembly 27 of the stapler. The slot depression 73 within the underside of

the cap 70 of the actuator 37 frictionally receives the first and second detents, 43 and 44, of the deck 40.

Referring now to Figures 13 and 14, there is shown the articulation
5 transmission assembly in an unlocked position. In the unlocked position, the deck
teeth are decoupled and disengaged from the detent teeth. The unlocked positions of
the articulation transmission assembly are spaced between the locked positions of the
assembly. When a rotational force is applied to the lever arm 69 of the cap 70, the
10 pressure points 76 at the junction between the diagonal flats 75 and the parallel slot
walls 74 urge the first and second detents, 43 and 44, of the deck toward each other.
As the detents are urged toward each other, the first and second deck halves, 41 and
42, of the deck are effectively compressed toward each other to enable the withdrawal
of the deck teeth from engagement with the detent teeth within the detent housing of
the nozzle. When the deck and detent teeth are withdrawn and decoupled from each
15 other, each tooth on the sets of deck teeth will snap into engagement with a respective
tooth on the array of detent teeth unless additional rotational force is applied to the
lever arm of the actuator. If additional force is applied, the pressure points within the
slot depression of the cap will continue to urge the deck halves toward each other, and
ratcheting rotation will occur and continue until the rotational force is released.

20

Accordingly, ratcheting rotation of the articulation transmission assembly is
provided, correspondingly causing articulation of the surgical fastening assembly in a
plurality of discrete positions angled from the longitudinal axis of the endoscopic shaft
of the stapler. The compression of the deck in response to rotational movement of the
25 lever reduces the force the user must apply to articulate the surgical fastening assembly
relative to the force which must be overcome to cause an articulation of the surgical
fastening assembly when pressure is applied directly to the surgical fastening
assembly.

Furthermore, when the articulation body 38 is rotated in a first direction in response to rotational movement of the actuator 37 to cause articulation of the surgical fastening assembly in that first direction, a rotational position will be reached where the rotational stops 47 of the base 46 of the articulation body abut the pair of ledges 78 protruding from the floor 67 of the detent housing 65. Consequently, further rotational movement of the articulation body in the first direction, and further articulation of the surgical fastening assembly in that first direction, is prevented. Consequently, the interaction of the rotation stops with the pair of ledges on the floor of the detent housing acts to limit the degree of rotational movement of the articulation body, and thus the degree of articulation of the surgical fastening assembly of the stapler.

Although this invention has been described in connection with its most preferred embodiment, numerous additional embodiments will become readily apparent to those skilled in the art. For example, although the invention has been described in connection with an articulating endoscopic stapler, the invention is equally applicable to conventional open surgical instruments. Additionally, although the invention has been described in connection with an articulation transmission assembly which provides for remote articulation of a surgical fastening assembly, it is equally applicable to an instrument which provides remote articulation of a different kind of end effector. Accordingly, the preferred embodiment described in connection with this detailed description is intended to illustrate the invention only, and is not in any way intended to limit the scope or spirit of the claimed invention.

25

- 17 -

CLAIMS:

1. An articulating instrument adapted for endoscopic surgery, said instrument comprising:
- 5 a) a frame including a hand grip for gripping and manipulating said instrument at a first end of said instrument;
 - b) an elongated endoscopic shaft extending from said frame, said shaft having a longitudinal axis;
 - 10 c) an end effector in communication with said shaft at an opposite end of said instrument for manipulating tissue to carry out a desired surgical function, said end effector being movable to provide articulation of said end effector from a first position generally parallel to said shaft longitudinal axis to a second position angled from
15 said shaft longitudinal axis; and
 - d) an articulation transmission assembly adjacent said frame for remotely articulating said end effector from said first position to said second position, said articulation transmission assembly including:
 - 20 i) a nozzle coupled to said shaft and secured to said frame, said nozzle having a nozzle body with a bore extending therethrough generally parallel to said shaft longitudinal axis, and a detent housing extending from said nozzle body, said detent housing containing a plurality
25 of detent teeth therein;
 - ii) an articulation body rotatably mounted within said detent housing of said nozzle body for rotational movement from a plurality of locked positions spaced between a plurality of unlocked positions, said
30 articulation body including:
 - a) a deck therein, said deck including first and second spaced-apart deck halves, said first deck half having a first detent attached thereto and said second deck half having a second detent attached thereto in mutual

- 18 -

opposition to said first detent, said first and second deck halves separated by said mutually-opposed first and second detents, each of said deck halves containing a plurality of deck teeth thereon, said deck teeth positioned for interacting relationship with said detent teeth, wherein when said deck teeth mesh with said detent teeth, said articulation body is in one of said locked positions, and when said deck teeth do not mesh with said detent teeth, said articulation body is in one of said unlocked positions; and

b) a drive member coupled to said deck, said drive member descending into said bore of said nozzle body, said drive member having first and second elongated transmission members attached thereto and extending through said bore into said shaft;

iii) a lever secured to said articulation body for rotating said articulation body within said detent housing of said nozzle, said lever including a cap thereon fitted on said detent housing, said cap containing a slot therein for receiving said first and second detents of said deck halves for attachment of said deck halves to said cap, wherein when a rotating force is applied to said lever, said cap slot urges said first and second detents toward each other so as to withdraw said deck teeth from said detent teeth for facilitating rotation of said articulation body within said detent housing from said locked positions to said unlocked positions.

2. The instrument of Claim 1 wherein said articulation body has a base therein from which said drive member extends, and said base supports said deck halves.

3. The instrument of Claim 2 wherein each of said deck halves is connected to said base of said articulation body by an outer flexible beam and an inner flexible beam.

- 19 -

4. The instrument of Claim 3 wherein said drive member of said articulation body is a drive gear.

5. The instrument of Claim 4 wherein said detent housing of said nozzle has a floor adjacent said nozzle body, and said base of said articulation body sits on said floor.

6. The instrument of Claim 5 wherein said base of said articulation body has a pair of rotation stops thereon, and said floor of said detent housing has a pair of ledges thereon, wherein when said rotation stops are in abutment with said ledges after said articulation body has been rotated in a first rotation direction, said articulation body is thereafter prevented from rotating in said first direction.

7. An articulating surgical instrument comprising an articulation transmission assembly for remotely articulating an end effector of said instrument, said articulation transmission assembly including:

a) a detent housing mounted on said instrument, said detent housing having a plurality of detent teeth thereon;

b) a compressible deck with a plurality of ratchet deck teeth thereon, said deck teeth matingly coupled with said detent teeth when said articulation transmission assembly is in a first locked position;

c) an actuator fitted on said detent housing for applying a rotational force on said deck, wherein when said rotational force is applied, said deck compresses so as to decouple said deck teeth from said detent teeth for facilitating ratcheting rotation of said deck from said first locked position to a second locked position; and

- 20 -

d) a drive member in communication with said deck for translating rotational movement of said deck into axial movement of an elongated transmission member attached to said drive member.

5 8. The instrument of Claim 7 wherein said deck has a pair of first and second spaced-apart deck halves, and said deck is compressed when said deck halves are urged towards each other.

10 9. The instrument of Claim 8 wherein said first deck half has a first compression detent and said second deck half has a second compression detent in mutual opposition to said first detent, and said deck halves are urged toward each other when said compression detents are urged toward each other.

15 10. The instrument of Claim 9 wherein said actuator has a slot therein for receiving said compression detents of said deck halves, and said slot urges said compression detents toward each other when said actuator is rotated.

20 11. The instrument of Claim 10 wherein said deck halves are supported on a base from which said drive member extends, and inner and outer flexible beams connect each of said deck halves to said base.

12. An articulating surgical stapler adapted for endoscopic surgery, said stapler comprising:

25 a) a frame including a hand grip for gripping and manipulating said stapler at a first end of said stapler;

b) an elongated endoscopic shaft extending from said frame, said shaft having a longitudinal axis;

- 21 -

c) a surgical fastening assembly in communication with said shaft at an opposite end of said stapler for clamping tissue and firing staples into the clamped tissue, said surgical fastening assembly carrying an elongated anvil facing an elongated channel for receiving a staple cartridge therein, said surgical fastening assembly being movable to provide articulation of said surgical fastening assembly from a first position generally parallel to said shaft longitudinal axis to a second position angled from said shaft longitudinal axis; and

d) an articulation transmission assembly adjacent said frame for remotely articulating said surgical fastening assembly from said first position to said second position, said articulation transmission assembly including:

i) a nozzle coupled to said shaft and secured to said frame, said nozzle having a nozzle body with a bore extending therethrough generally parallel to said shaft longitudinal axis, and a detent housing extending from said nozzle body, said detent housing containing a plurality of detent teeth therein;

ii) an articulation body rotatably mounted within said detent housing of said nozzle body for rotational movement from a plurality of locked positions spaced between a plurality of unlocked positions, said articulation body including:

a) a deck therein, said deck including first and second spaced-apart deck halves, said first deck half having a first detent attached thereto and said second deck half having a second detent attached thereto in mutual opposition to said first detent, said first and second deck halves separated by said mutually-opposed first and second detents, each of said deck halves containing a plurality of deck teeth thereon, said deck teeth positioned for interacting relationship with said detent teeth, wherein when said deck teeth mesh with said detent teeth, said

- 22 -

articulation body is in one of said locked positions, and when said deck teeth do not mesh with said detent teeth, said articulation body is in one of said unlocked positions; and

5 b) a drive member coupled to said deck, said drive member descending into said bore of said nozzle body, said drive member having first and second elongated transmission members attached thereto and extending through said bore into said shaft;

10 iii) a lever secured to said articulation body for rotating said articulation body within said detent housing of said nozzle, said lever including a cap thereon fitted on said detent housing, said cap containing a slot therein for receiving said first and second detents of said
15 deck halves for attachment of said deck halves to said cap, wherein when a rotating force is applied to said lever, said cap slot urges said first and second detents toward each other so as to withdraw said deck teeth from said detent teeth for facilitating rotation of said articulation body
20 within said detent housing from said locked positions to said unlocked positions.

13. The stapler of Claim 12 wherein said articulation body has a base therein from which said drive member extends, and said base supports said deck halves.

25 14. The stapler of Claim 13 wherein each of said deck halves is connected to said base of said articulation body by an outer flexible beam and an inner flexible beam.

15. The stapler of Claim 14 wherein said drive member is a drive gear, and said drive gear has a flared opening
30 therethrough for receiving a staple firing rod.

- 23 -

16. The stapler of Claim 15 wherein said detent housing of said nozzle has a floor adjacent said nozzle body, and said base of said articulation body sits on said floor.

5 17. The stapler of Claim 16 wherein said base of said articulation body has a pair of rotation stops thereon, and said floor of said detent housing has a pair of ledges thereon, wherein when said rotation stops are in abutment with said ledges after said articulation body has been
10 rotated in a first rotation direction, said articulation body is thereafter prevented from rotating in said first direction.

18. An articulating surgical instrument comprising:

15 a) a frame including a hand grip for gripping and manipulating said instrument at a first end of said instrument;

b) a shaft extending from said frame, said shaft having a longitudinal axis;

20 c) an end effector at an opposite end of said instrument for manipulating tissue to carry out a desired surgical function, said end effector being movable to provide articulation of said end effector from a first position generally parallel to said shaft longitudinal axis to a second position angled from said shaft longitudinal
25 axis; and

d) a flexible neck assembly coupled to a proximal end of said end effector for articulating said end effector from said first position to said second position, said flexible neck assembly including:

30 i) first and second flexible neck portions separated by a central longitudinal rib therebetween, each of said flexible neck portions having a plurality of neck ribs extending from said longitudinal rib and a plurality of

- 24 -

kerfs separating each of said neck ribs from an adjacent neck rib, and each of said neck ribs having a side slot therethrough; and

5 ii) first and second transmission band assemblies received within each said side slot of said neck ribs of said first and second flexible neck portions for reciprocating movement therein, each of said transmission band assemblies having an interior articulation band and an exterior reinforcement band attached thereto;

10 wherein when said first and second transmission band assemblies are reciprocated in opposite directions within each said side slot of said neck ribs of said first and second flexible neck portions of said flexible neck assembly, said end effector is articulated
15 from said first position to said second position.

19. The instrument of Claim 18 further comprising an articulation transmission assembly spaced from said flexible neck assembly and coupled to said first and second transmission band assemblies for effecting reciprocating
20 movement of said transmission band assemblies.

20. The instrument of Claim 19 wherein each of said neck ribs is configured as a semi-circular disk.

21. The instrument of Claim 20 wherein each said disk includes an interior plate extending generally
25 perpendicularly from said central longitudinal rib and parallel to an adjacent interior plate, and a concave exterior dish extending from said interior plate.

22. The instrument of Claim 21 wherein said flexible neck assembly has first and second spaced-apart supporting
30 guide surfaces extending proximally from said first and second flexible neck portions, and said first and second

- 25 -

flexible band assemblies slide on said first and second support guide surfaces for supporting thereon.

23. The instrument of Claim 22 wherein said central longitudinal rib has a central slot therethrough.

5 24. The instrument of Claim 23 wherein said shaft is an elongated shaft, and said instrument is adapted for endoscopic surgery.

25. The instrument of Claim 24 wherein said end effector is a surgical fastening assembly.

10 26. An articulating surgical instrument comprising:

a) a frame including a hand grip for gripping and manipulating said instrument at a first end of said instrument;

15 b) a shaft extending from said frame, said shaft having a longitudinal axis;

20 c) an end effector at an opposite end of said instrument for manipulating tissue to carry out a desired surgical function, said end effector being movable to provide articulation of said end effector from a first position generally parallel to said shaft longitudinal axis to a second position angled from said shaft longitudinal axis;

25 d) a flexible neck assembly coupled to a proximal end of said end effector for articulating said end effector from said first position to said second position, said flexible neck assembly including:

30 i) first and second flexible neck portions separated by a central longitudinal rib therebetween, each of said flexible neck portions having a plurality of neck ribs configured as semi-circular disks extending from said central longitudinal rib and a plurality of kerfs separating

- 26 -

each of said neck ribs from an adjacent neck rib, each of said neck ribs having a side slot therethrough, and each of said semi-circular disks of said neck ribs having an interior plate extending generally perpendicularly from said
5 central longitudinal rib and parallel to an adjacent interior plate, and a concave exterior dish extending from said interior plate; and

ii) first and second transmission bands received within each said side slots of said neck ribs of
10 said first and second flexible neck portions for reciprocating movement therein;

wherein when said first and second transmission bands are reciprocated in opposite directions within each said side slot of said neck ribs of said first
15 and second flexible neck portions of said flexible neck assembly, said end effector is articulated from said first position to said second position.

27. The instrument of Claim 26 further comprising an articulation transmission assembly spaced from said flexible
20 neck assembly and coupled to said first and second transmission bands for effecting reciprocating movement of said transmission bands.

28. The instrument of Claim 27 wherein said central longitudinal rib has a central slot therethrough.

25 29. The instrument of Claim 28 wherein said shaft is an elongated shaft, and said instrument is adapted for endoscopic surgery.

30. The instrument of Claim 29 wherein said end effector is a surgical fastening assembly.

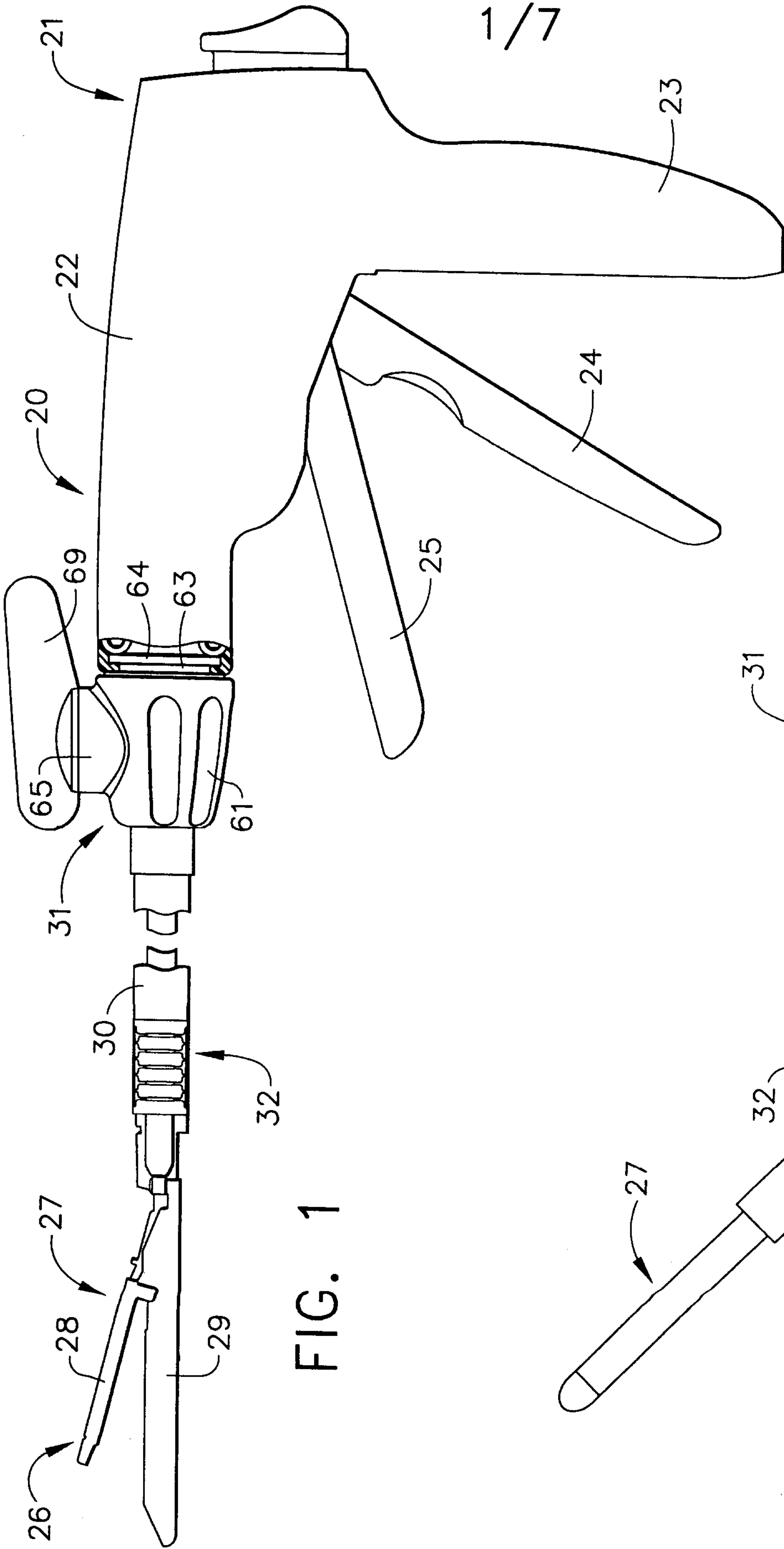


FIG. 1

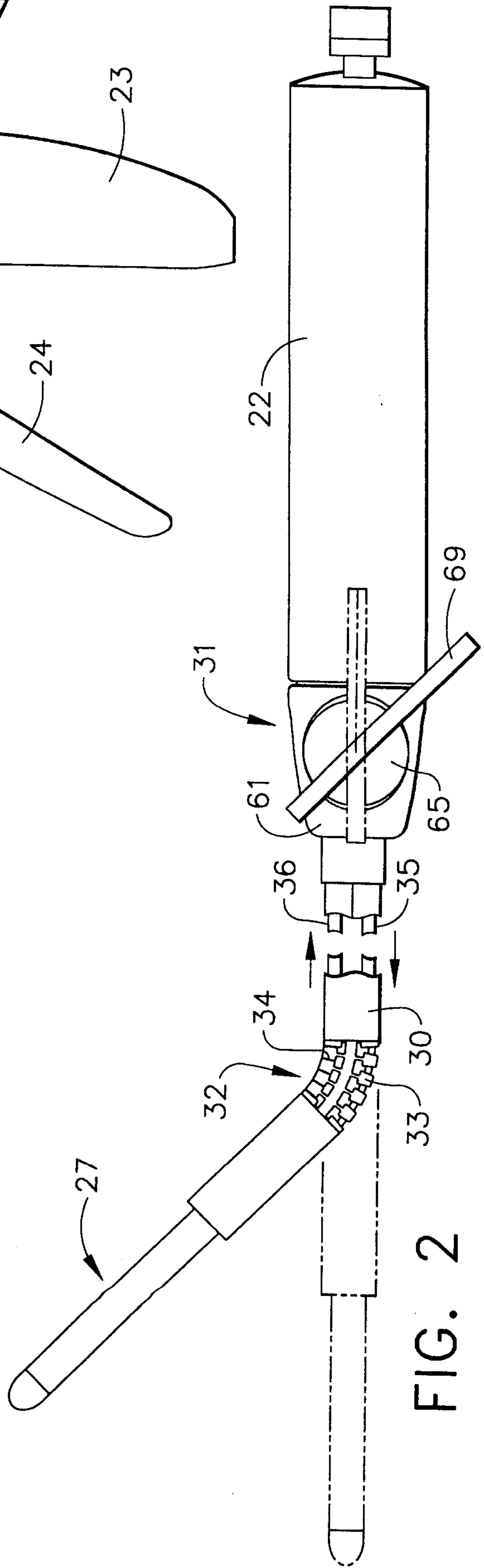


FIG. 2

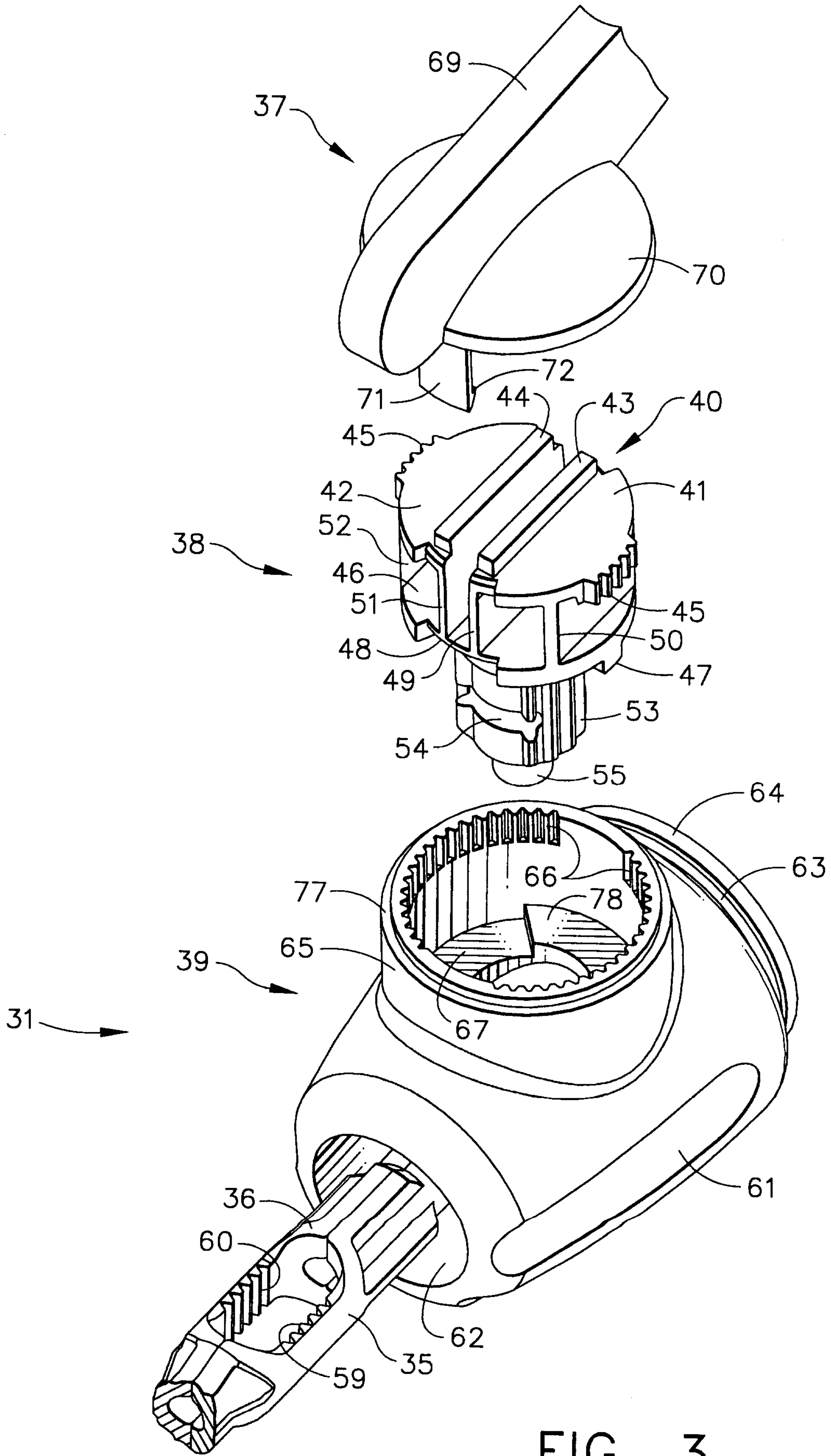


FIG. 3

3/7

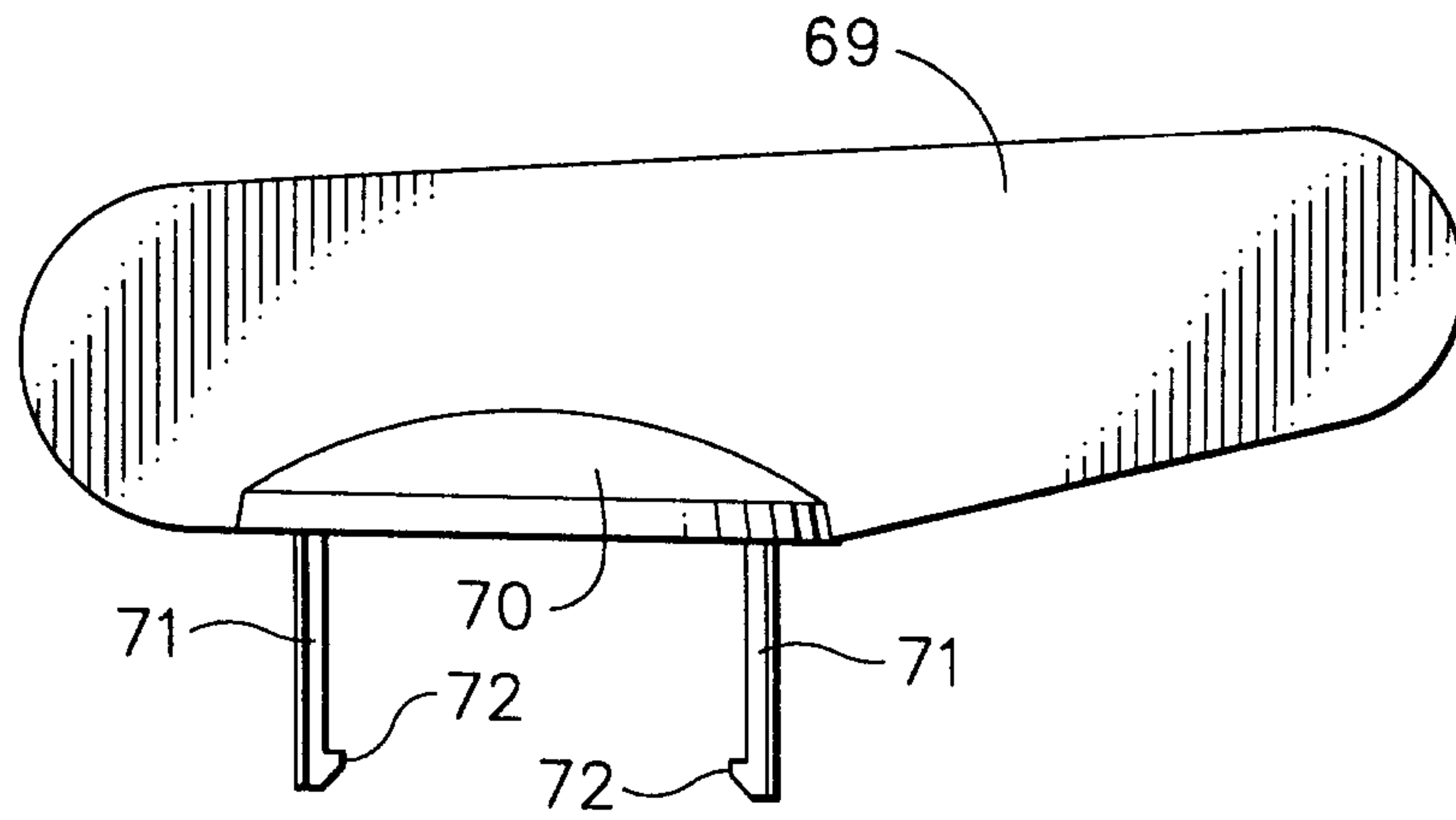


FIG. 4

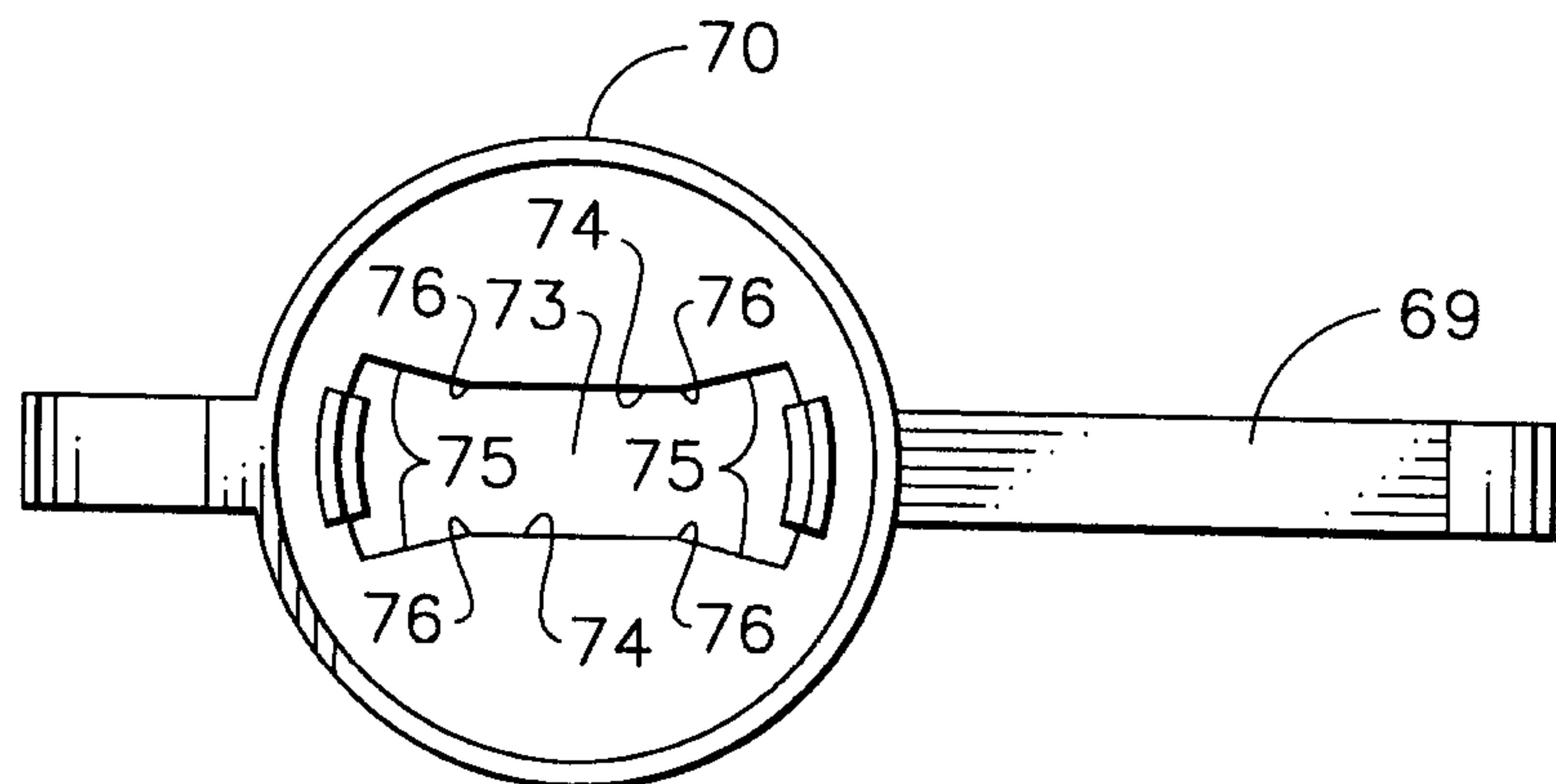


FIG. 5

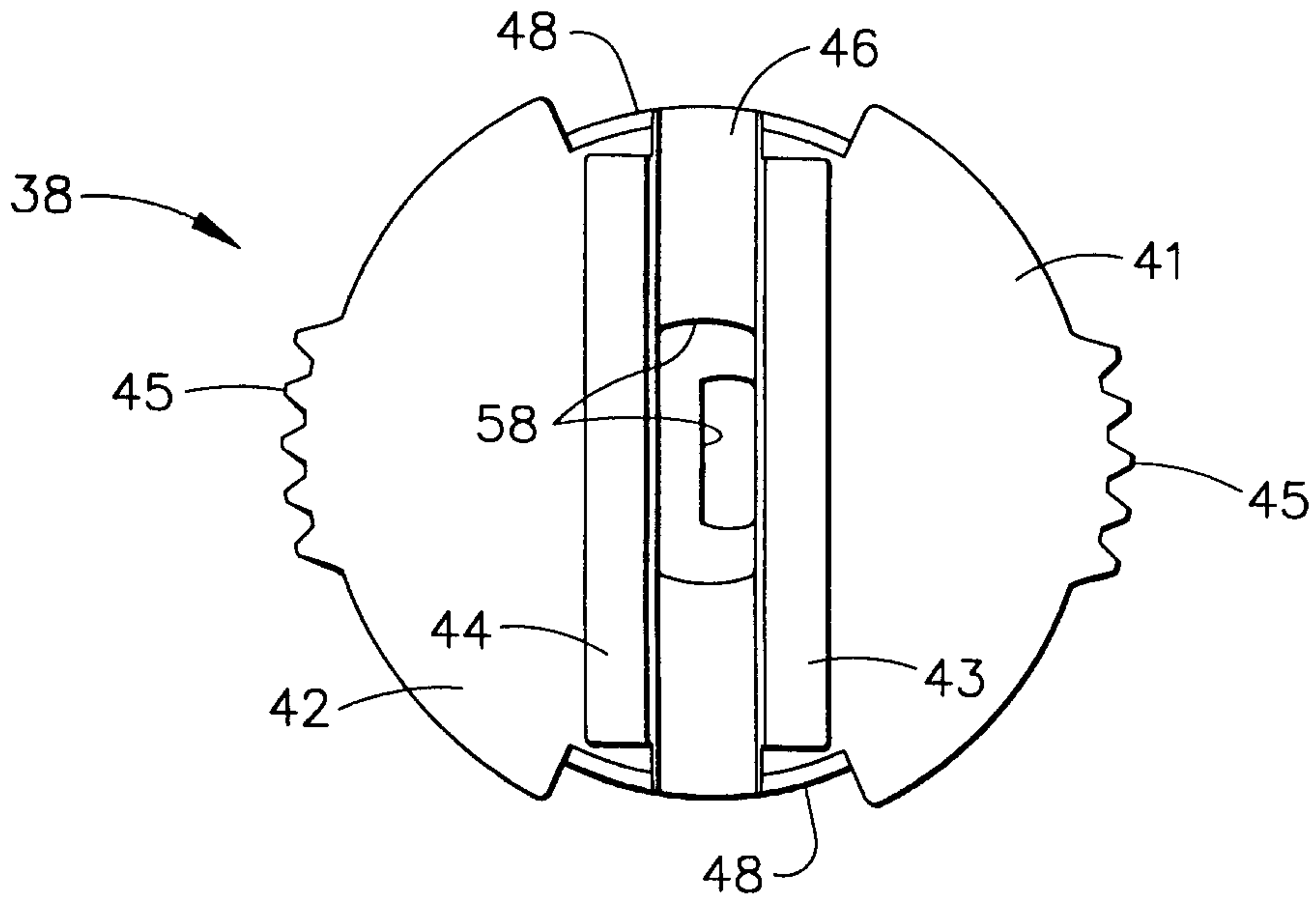


FIG. 6

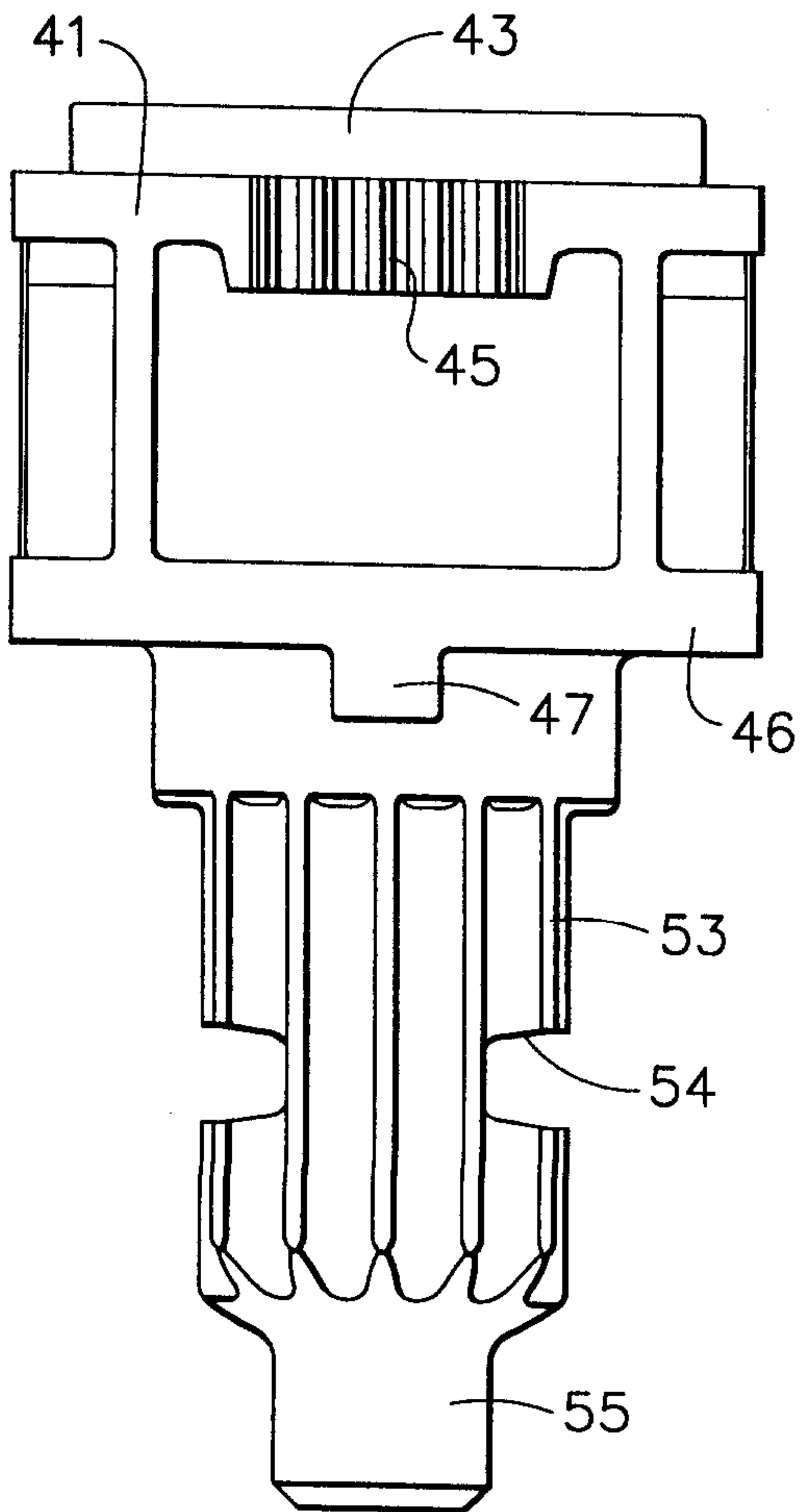


FIG. 7

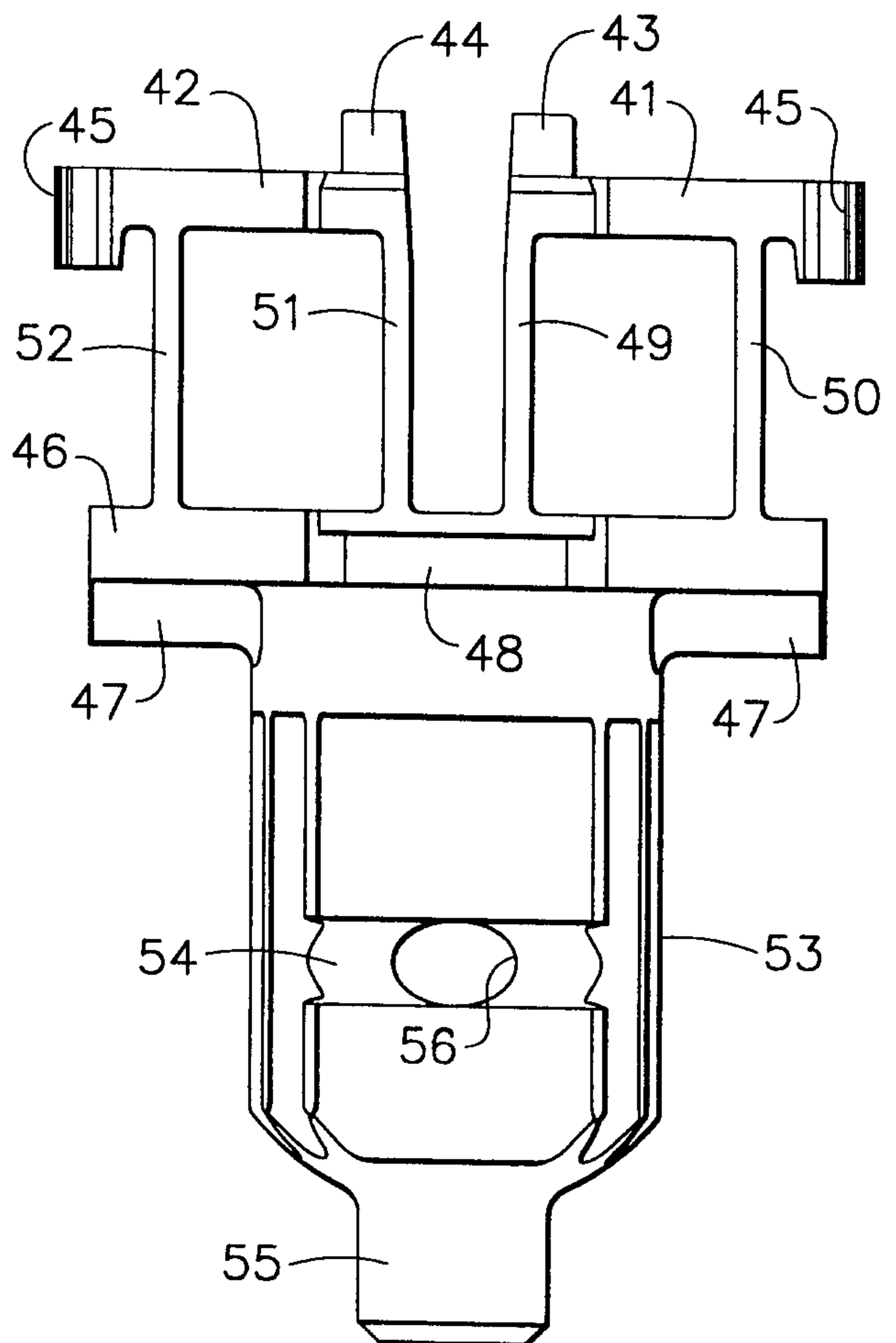


FIG. 8

5/7

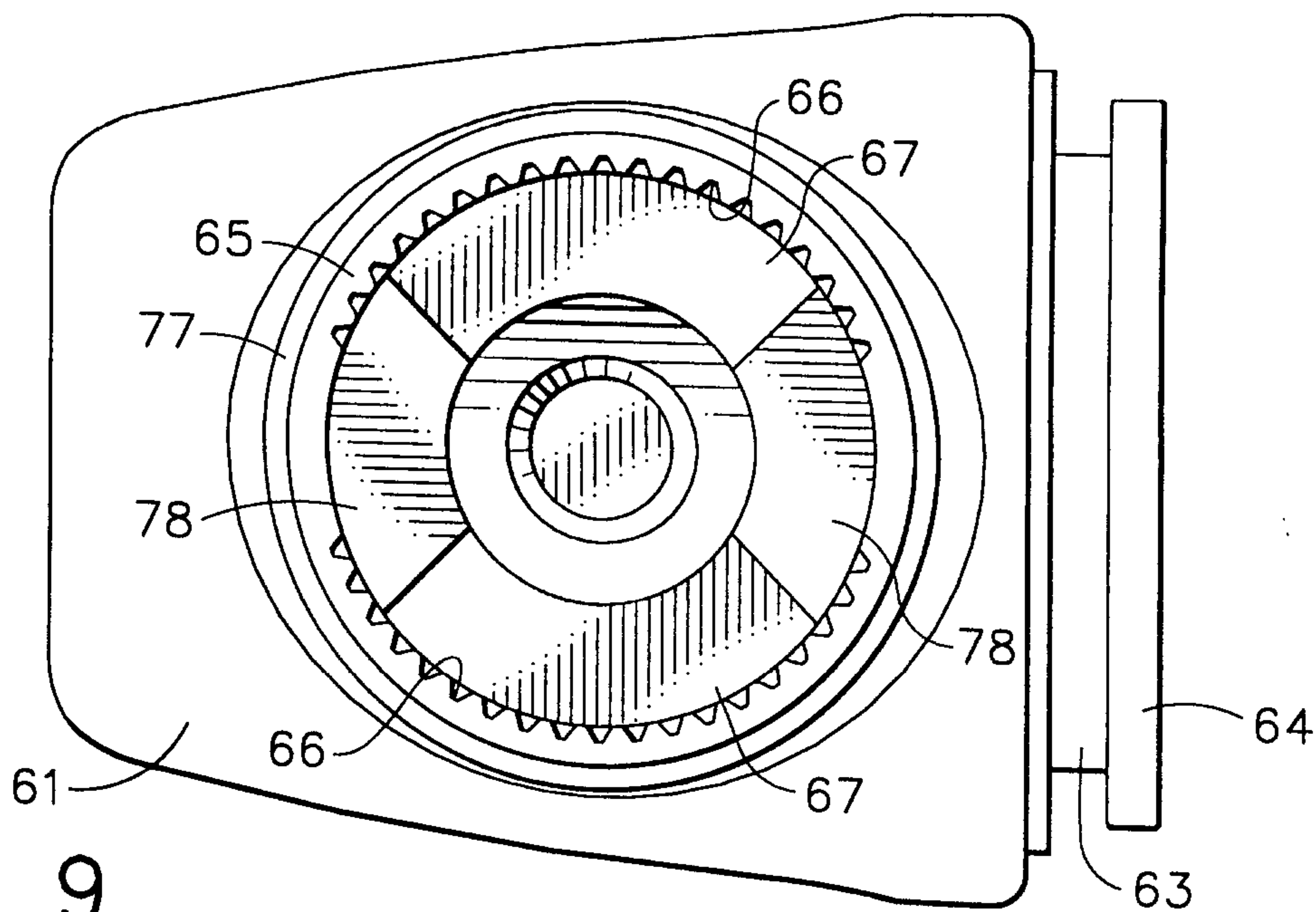


FIG. 9

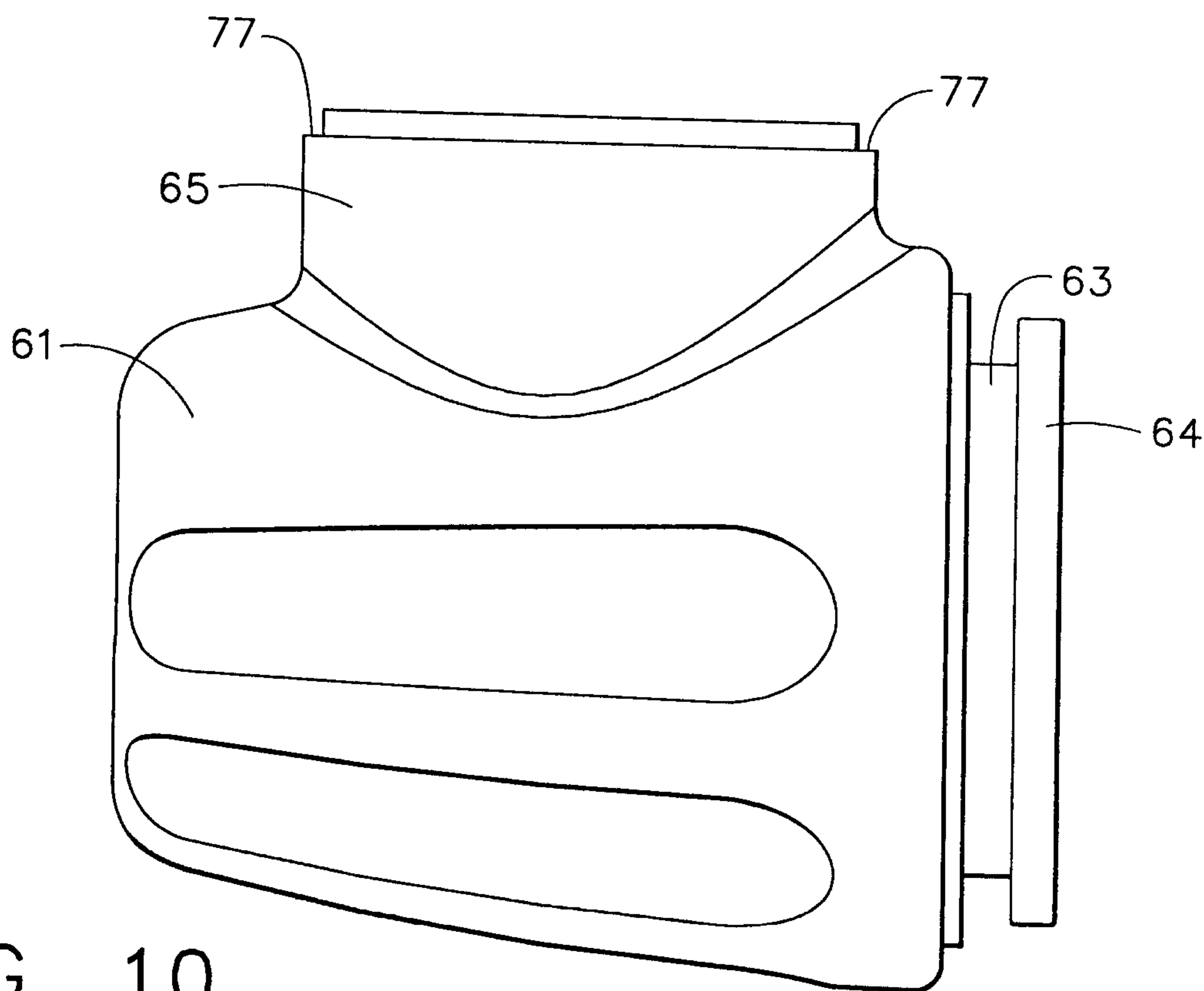


FIG. 10

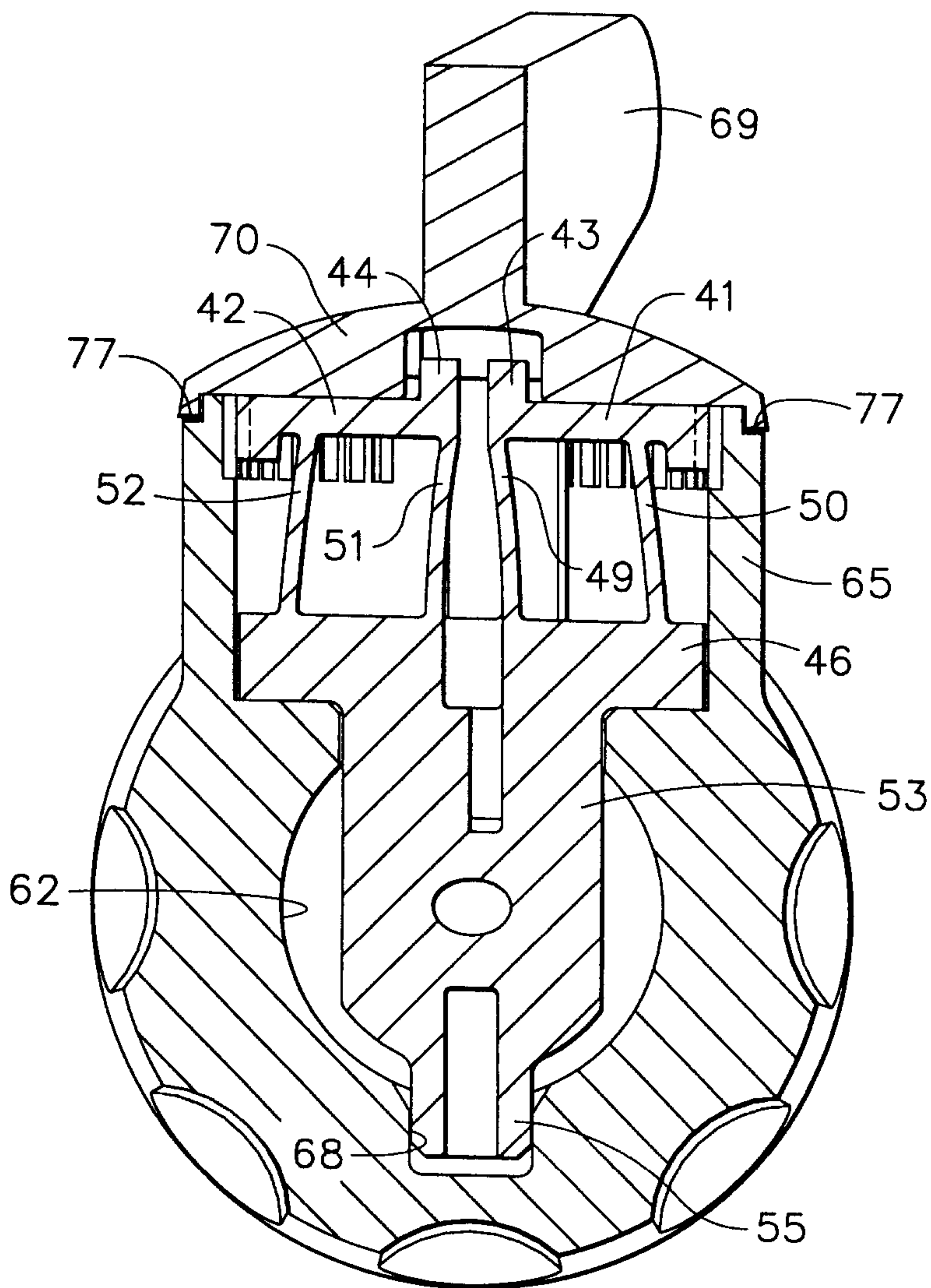


FIG. 13

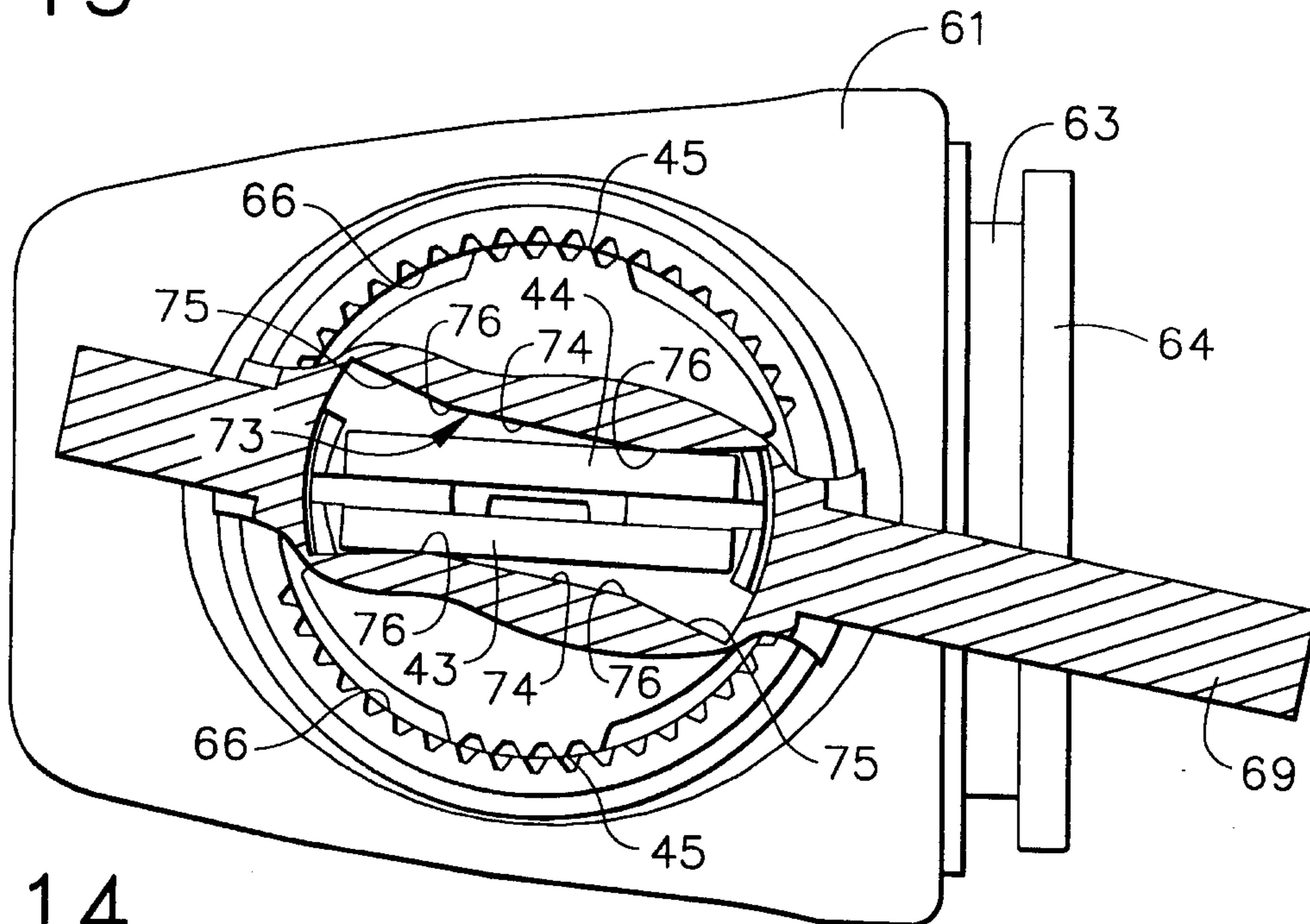


FIG. 14

