(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 January 2014 (03.01.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/001918 A2

(51) International Patent Classification: Not classified

(21) International Application Number:
PCT/IB2013/002322

(22) International Filing Date:
21 June 2013 (21.06.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/663,400 22 June 2012 (22.06.2012) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

(54) Title: TENSIONING REEL

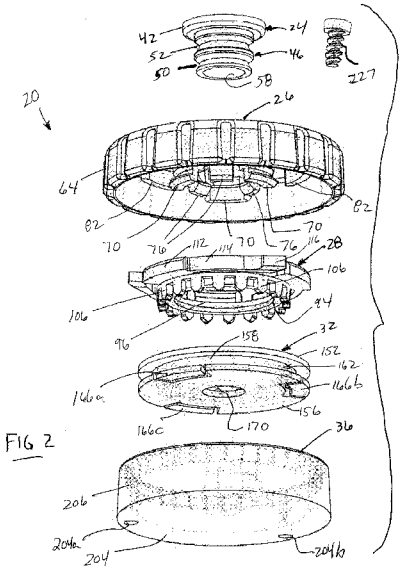

FIG 2

(57) Abstract: A cord tensioning device has three modes of operation: a tightening mode, a release to loosen and then hold mode, and a release mode for relieving all tension in the cord. In the tightening mode, the shape of ratchet pawls and ratchet teeth allow a cord winding spool to rotate in only a tightening direction. In the release to loosen and then hold mode, an actuator associated with the knob releases the ratchet pawl from the ratchet teeth in a reverse direction, but upon release of the knob, the pawl re-engages the ratchet teeth to prevent further loosening. In this manner, the tension can be incrementally loosened. In the release mode, the pawls are disengaged from the ratchet teeth, even after release of the knob, and the spool can continue to rotate within the base when an external tension is applied to the cord.

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TENSIONING REEL

Reference To Government Funding

This invention was made with Government support under Contract No. W911QY-11-C-0046, awarded by the U.S. Army Material Command, a division of the United States Department of Defense. The Government has certain rights in this invention.

FIELD OF THE INVENTION

Aspects of the invention relate to cord tensioning devices for use in tightening cords or laces used in lacing or strapping systems.

DISCUSSION OF THE RELATED ART

It is known to provide a reel for tightening laces to close closure flaps of shoes, such as disclosed in U.S. Pat. Nos. 5,042,177 or 7,584,528. A cord reel is known to provide a helmet with an adjustable safety strap, such as disclosed in U.S. Pat. No. 6,026,798.

In U.S. Pat. No. 6,026,798, a turn lock fastener is disclosed. This turn lock fastener includes a flat housing and a rotating knob disposed on top of the housing which can be rotated relative to the housing. Two pull cords pass out of the housing on opposite sides of the housing and are connected to helmet straps. A rotary actuator construction inside the housing allows the helmet strap to be tightened or released by turning a rotating knob. The rotary actuator is used to turn the cord wheel, on which ends of the cords are wound, in one direction or the other such that by turning the rotating knob the effective length of pull cords can be modified in opposite directions.

SUMMARY

An exemplary embodiment of the present application provides a cord tensioning reel having three modes of operation: a ratchet-to-tighten mode, a release-ratchet-to-loosen-and-then-hold mode, and a total release mode for relieving all tension in the cord. In the ratchet-to-tighten mode, the shape of at least one ratchet pawl and ratchet teeth allow a cord winding spool to rotate in a tightening direction upon the application of external torque. In the release-ratchet-to-loosen-and-then-hold mode, an actuator associated with the knob releases the ratchet pawl from the ratchet teeth upon an external torque to the knob in a reverse direction. Upon release of the torque on the knob in the reverse direction, the pawl re-

engages the ratchet teeth to prevent further loosening, e.g., the pawl holds the tension from further loosening. In this way the tension can be incrementally loosened. In the total release mode, the pawl is disengaged from the ratchet teeth, even after release of the knob, and the spool can freewheel within the base when an external tension is or is not applied to the cord.

According to this embodiment, the apparatus includes a knob having at least one downward extending actuator, a cord spool and a pawl ring that can engage with the spool for mutual rotation. The pawl ring is axially captured by the knob and rotationally engaged by the actuator to be forcibly rotated by the knob but with a loss in the degree of rotation between the knob and the pawl ring. The apparatus includes a base having ratchet teeth engaged by the pawl ring to allow relative rotation between a subassembly comprising the knob, pawl ring and spool with respect to the base when the knob rotates in a tightening direction and to prevent reverse rotation and cord loosening once tightened. The apparatus allows reverse rotation after the lost motion rotation is taken up, by allowing the subassembly of the knob, pawl ring and spool to rotate relative to one another in a reverse direction, a loosening direction, with respect to the base by torque applied to the knob.

The pawl engages the ratchet teeth and slips on the ratchet teeth when rotated in a cord tightening direction when a torque is applied to the knob~~,~~ by the actuator applying a tangential force to the pawl ring. When the knob is turned in a reverse, loosening direction, the actuator deflects the pawl from the ratchet teeth to allow rotation of the pawl ring and engaged spool with respect to the base in a loosening direction. Release of the applied loosening direction torque on the knob allows the pawl to snap back into engagement with the ratchet teeth and holds the selected tightening state of the spool with respect to the base.

The apparatus can also include a retainer that is secured to the base and which captures the knob onto the base. The retainer includes a body that has two grooves to provide a selectable axial position of the knob with respect to the base. In the first axial position, the apparatus is set to function in either the ratchet-to-tighten mode or the release-ratchet-to-loosen-and-then-hold mode as described herein. In a second axial position, the pawl ring is released from the ratchet teeth and/or the pawl ring is released from the spool, and the spool is free to turn within the base.

The reel of the present application is particularly useful for tension helmet straps, particularly for military helmets, wherein a user can tighten or loosen helmet straps with one hand.

Numerous other advantages and features will become readily apparent from the following detailed description of various embodiments and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an exploded upper perspective view of a cord tensioning reel according to one embodiment of the invention;

Figure 2 is an exploded lower perspective view of the cord tensioning reel of Figure 1;

Figure 3 is a sectional view of the apparatus of Figure 1 after assembly and in a first operating state;

Figure 4 is a sectional view of the apparatus of Figure 3 in a second operational state;

Figure 5 is a sectional view taken along line 5-5 of Figure 3 in the first operational state with the knob in a tightening mode;

Figure 6 is a sectional view taken along line 5-5 of Figure 3, in the first operational state with the knob in a loosening mode;

Figure 7 is a sectional view taken along line 7-7 of Figure 5 but only showing a base of the apparatus;

Figure 8 is a fragmentary sectional view taken along lines 8-8 of Figure 5;

Figure 9 is a sectional view showing the apparatus of one embodiment of the invention applied to a helmet retention system;

Figure 10 is a fragmentary rear view of the helmet retention system shown in Figure 9;

Figure 10A is a perspective view of a reel of the helmet retention system of Figure 9; and

Figure 10B is a front view of a contact strap and loop of the helmet retention system of Figure 9.

DETAILED DESCRIPTION

The present inventors have recognized a need for a cord tensioning reel that is compact, cost-effectively manufactured and assembled. The present inventors have recognized a need for a cord tensioning reel for military helmets or other helmets that can be used to adjust the fit and tension of a helmet strap. The present inventors have recognized a need for a cord tensioning reel that can be used in three modes of operation: a ratchet-to-tighten mode, a release-ratchet-to-loosen-and-then-hold mode, and a total release mode for relieving all tension in the cords.

There are shown in the drawing and will be described herein in detail specific embodiments thereof with the understanding that the present disclosure is to be considered as an exemplification and is not intended to limit the invention to the specific embodiments illustrated. Figures 1 and 2 illustrate a cord tensioning reel 20 comprising a retainer 24, a knob 26, a pawl ring 28, a spool 32 and a base 36.

The retainer 24 includes a disk-shaped retainer flange 42 and a retainer body 46 extending downward from the flange. The retainer body 46 is substantially hollow and cylindrical and has a lower annular groove 50 and an upper annular groove 52 on an outside of the retainer body 46. The grooves 50, 52 can have a V.-shaped cross-section. A mounting hole 56 extends centrally through the flange 42. The body includes a cylindrical cavity 58 that is open to the mounting hole 56.

Knob 26 includes a disc-shaped top wall 63 and a slotted or knurled cylindrical side wall 64 extending downward from the top wall 63. The top wall 63 includes a central opening 66. An annular bottom lip 67 extends radially inward from an end of the sidewall 64.

Extending downward from the top wall 63 around the opening 66 are lifting arms 70 and detent arms 76. Also extending downward from the top wall 63 are bosses or actuators 82. The bosses 82 are arranged radially spaced from the opening 66 and the lifting arms 70 and the-detent arms 76. The members 70, 76, 82 all have a circular curvature about the center of the opening 66.

The pawl ring 28 includes a base ring 94 having a central opening 96. A plurality of spaced-apart teeth 106 extend downward from the base ring 94. Teeth 106 are spaced apart evenly around the circumference of the base ring 94. On top of the base ring 94 are three pawl members 110a, 110b, 110c.

Each pawl member 110a, 110b, 110c includes a pawl base 112, a flexible pawl arm 114 extending from the pawl base 112 and a pawl head 116 extending from the flexible pawl arm 114. The three pawl members 110a, 110b, 110c curl from pawl base 112 to pawl head 116 concentrically around a center of the opening 96 in a common rotary direction.

The spool 32 includes an annular top wall 152 and a substantially circular bottom wall 156. An annular wall 158 connects the walls 152, 156 and forms a cord winding groove 162 on outside of the annular wall 158. The bottom wall 156 includes slotted portions 166a, 166b, 166c that allow for anchoring the cords 205a, 205b (Figure 3) wound on the spool 32. The bottom wall 156 includes a central opening 170. Within the annular walls 152, 158 a plurality of teeth 180 extend upward from the bottom wall 156. The teeth 180 are evenly spaced around a circumference of the annular wall 158. The teeth 180 are configured and spaced to mesh with the teeth 106 of the pawl ring when the pawl ring 28 is positioned against the spool 32.

Base 36 includes a bottom circular wall 204 and a surrounding cylindrical sidewall 206 that extends upward from the bottom wall 204. The bottom wall 204 includes cylindrical bores 204a, 204b for cords 205a, 205b to enter/exit the base 36 and to be wrapped around the spool 32.

The cords 205a, 205b are wound in a same rotary direction on the spool such that clockwise turning of the spool draws both cords 205a, 205b into the base 36 and counterclockwise rotation of the spool dispenses the cords 205a, 205b out of the base 36. A plurality of ratchet teeth 210 extend radially inward from an inside surface of the sidewall 206. The teeth 210 are evenly spaced around the circumference of the sidewall 206. A cylindrical attachment boss 220 extends upward from the bottom wall 204. Boss 220 includes a central bore 226 that can accept a screw 227 to hold together the entire assembled reel 20.

Figures 3-5 illustrate the reel 20 in an assembled state. Spool 32 having the cords 205a, 205b wound thereon is placed over the boss 220 and inside the base 36 with the attachment boss 220 extending through the spool opening 170. The cords 205a, 205b are threaded through two holes 204a, 204b in the base bottom wall 204. The spool 32 is now freely rotatable on the attachment boss 220. Then, the pawl ring 28 is placed over and onto the spool 32 and the pawl ring teeth 106 mesh with the spool teeth 180 and pawl heads 116 mesh with the base ratchet teeth 210.

A subassembly comprising the retainer 24 and knob 26 are pressed down onto the pawl ring 28 and the base 36. The attachment boss 220 fits into the cavity 58 of the retainer 24. The screw 227 attaches the retainer 24 to the base 36. As the knob 26 is pressed onto the base 36, the lift arms 70 deflect radially inward due to sliding between the opposing tapered surfaces 70a, 94a on, respectively, the lift arms 70 and pawl base ring 94. When the lift arms 70 have deflected sufficiently inward as the knob 26 is pressed down onto the pawl ring, lift arm heads 70b clear the pawl base ring 94 and snap back radially outward to underlie the pawl ring 94. Each boss or actuator 82 fits between a flexible arm 114 of a respective pawl 110a, 110b, 110c and the ratchet teeth 210.

As illustrated in Figure 3, each detent arm 76 includes a rounded head 76a that snaps into a selectable one of the grooves 50, 52. The opening 66 through the top wall of the knob is large enough and deep enough that the flange 42 can move in relative axial motion through the opening between the two positions shown in Figure 3 and Figure 4 as the knob 26 is raised and lowered with respect to the base 36.

In the position shown in Figure 3, the detent head 76a snaps into the lower groove 50. In the position shown in Figure 4, the knob 26 has been pulled up with respect to the base 36 and the detent head 76a has snapped into the upper groove 52. In the position shown in Figure 3, the pawl heads 116 are engaged to the ratchet teeth 210 and the pawl ring teeth 106 mesh with the spool teeth 180. In the position shown in Figure 4, the pawl heads 116 are pulled up to non-engagement with the ratchet teeth 210 and the pawl ring teeth 106 are pulled up to non-engagement with the spool teeth 180. The pawl ring 28 is pulled up by the lift arms 70 via the lift arm heads 70b. The detent heads 76a snap into the groove 52 and a stop 70c provided on the inside of each lift arm 70 abuts an underside 42a of the retainer flange 42 to prevent further upward travel of, and separation of, the knob 26 from the base 36.

As understood from Figure 5, for clockwise turning of the knob 26 with respect to the base 36, the pawl flexible arms 114 deflect radially inwardly as the pawl heads 116 slip over the ratchet teeth 210. Each pawl head 116 has a sloping surface 116a that slides over a sloping surface 210a of the ratchet teeth.

Figure 5 illustrates the knob ready to turn further in a tightening direction, clockwise. The bosses 82 abut a shoulder 112a of each respective base 112. Further rotation of the knob 26 presses the bosses 82 against the shoulders 112a and forces rotation of the pawl ring 28

and the spool 32, by the engagement of the teeth 106, 180, in a clockwise direction as the pawl heads 116 slip over the teeth 210.

Figure 6 illustrates the knob 26 rotated counterclockwise a short rotational angle from the positions shown in Figure 5, to a position where the steep surfaces 116b of the pawl head 116 is clear from a steep surface 210b of the ratchet teeth 210 to allow counterclockwise rotation of the pawl ring and spool with respect to the base. The bosses 82 press against a sloping backside 114a of the flexible arms 114 to deflect the pawl heads 116 out of engagement with the ratchet teeth 210.

In operation, with the knob 26 pressed down into the configuration of Figure 3, clockwise turning of the knob 26 with respect to the base 36 causes the pawl ring 28 and spool 32 to rotate clockwise and the cords are drawn into the base 36 as the cords are wound on the spool 32. Once the cords are tightened a desired amount, the steep opposing surfaces 116a, 210a of the pawl heads and the ratchet teeth respectively, prevent reverse rotation of the pawl ring and loosening of cords when the knob is released by the user.

With the apparatus still in the orientation of Figure 3, a counterclockwise rotation of the knob 26 with respect to the base 36, after passing a small angle of lost motion, will rotate the pawl ring 28 and spool 32 to loosen the cord. Release of torque on the knob allows the pawl heads 116 to snap back into engagement with the ratchet teeth 210 and prevents further loosening of the cord.

A third operational mode occurs when the knob 26 is pulled up with respect to the base 36 into the orientation of Figure 4. In this orientation, the spool is effectively disengaged from the base and/or from the pawl ring and is freely rotatable on the attachment boss. Thus, tension is released and the cords can be manually pulled out of the base, rotating the spool within the base.

Figures 7 and 8 illustrate how the cords 205a, 205b enter/exit the base 36 and are wound on the spool 32. The bottom wall 205 of the base 36 includes the cylindrical bores 204a, 204b. The bores 204a, 204b are located radially outside the circumference of the spool 32. The bores 204a, 204b are open to a curved cord feed channel 204c, 204d which respectively guide the two cords 205a, 205b. The feed channels 204c, 204d are each open to a respective window 204e, 204f into an interior portion of the base 36 and exposed to the spool to be wound thereon. The bore/feed channel/window combinations 204a, 204c, 204e and

204b, 204d, 204f each guide a respective cord 205a, 205b into/out of the base 36 to be wound on the spool and each allow a right angle turn of the cord from its entry into the bottom wall to its approach and winding on the spool.

The present embodiment of a tension reel is particularly effective for setting tension in a strap system for a helmet.

A helmet retention system 600 may be used with helmet 90 shown in Figures 9, 10, 10A and 10B. The helmet retention system is substantially a mirror image across the center, vertical mid-plane of the helmet. The helmet retention system 600 comprises a front strap system 610 and a lower strap system 620. The front strap system 610 has a first reeling cord 616, a first contact strap 612, and a first reel 631. The lower strap system 620 has a second reeling cord 626, a second contact strap 622, and a second reel 632. The first and second reels can be housed in a reel housing 630. The reel housing 630 is enclosed in a soft armor neck pad for contacting the rear of a user's neck and/or head.

The first and second reels 631, 632 may be configured similarly to the reel 20 described in Figures 1-8.

Referring to the front strap system 610, the first reeling cord 616 is anchored to the helmet at a forward location adjacent a user's temple by a front anchor 643. The front anchor may be located between a user's eye and a user's ear, such as shown in Figure 9. A downward extending portion 616a extends downward and is fed through a loop 614 attached to a first contact strap 612. After the loop 614 an upward extending portion 616b extends upward from the loop adjacent to, and in some versions substantially parallel to, the downward extending portion 616a until the first reeling cord reaches a first front system block 641. The first reeling cord slides over the first block 641 and thereafter the first reeling cord extends rearward along a rearward extending portion 616c toward the rear of the helmet on a slightly declining angle to second front system block 642. The reeling cord slides over the second block 642 and downward and forward to a third block 645 then rearward to the reel housing 630 and then into the first reel 631 with portion 616d.

The reels 631,632 are substantially the same and an exemplary reel 631, 632 is shown in Figure 10A. The reel 631 is circular and has a channel 635 defined by the outer disk walls 637, 638. The channel is for reeling, holding, and releasing the reeling straps 616, 626. The reel 631 comprises a center hub 636 about which a knob 26 (Figure 2) of the reel can be

turned. The reel 631 may also include an anchor where a reel cord is held at someplace along a length of the reel cord that is not an end of the reel cord. In one embodiment, the reel cord is anchored at a midpoint along its length. Turning the knob 26 of the reel 631 in a first direction draws both ends of the reel cord closer to the reel and thereby increase the tension on the reel cord and the associated contact strap. Turning the reel knob in a second direction, opposite of the first direction, will spool out the reel cord in both direction and thereby release tension on the reel cord and the corresponding contact strap.

As the reel cord enters the reel 631 at cord portion 616d, it is anchored as just described, and then may be wound around the reel a number of times depending on the position of the reel, and a reel cord 616e will extend out of the reel along to the opposite side of the helmet as shown in Figure 10A. On the opposite side of the helmet, the reeling cord 616 continues in a configuration which is a mirror image to that shown in Figure 9 and the reel cord end is anchored in place in a mirror image location opposite that shown in Figure 9, in some embodiments. Opposite ends of the reel cord may be anchored to the helmet in opposite front temple areas of the helmet. Likewise, the first contact strap continues under a user's chin as shown in Figure 9 to engage the first reel cord on the opposite side.

The front strap system 610 is configured to increase or decrease the downward tension in a forward area between a helmet 10 and the user's head. Turning the first reel knob moves the reel cord and the position of the loop 614 to move up or down in the direction *H* shown in Figure 9 depending on the direction that the first reel knob is turned.

The lower strap system 620 operates similarly to that of the front strap system 610 but the lower strap system 620 may be positioned differently than the front strap system. The second reel cord 626 may be anchored at a rear position of the helmet by a rear anchor 644. The anchor 644 may be positioned on the helmet behind the rear of a user's head when viewed from the side as shown in Figure 9. The second reel cord 626 extends from the anchor 644 downward along a downward extending portion 626a and forward to a first lower system block 646. The first block may be positioned on the helmet or on the reel housing. The second reel cord then extends forward toward a user's ear, on a forward portion 626b to a loop 624 of the second contact strap 622. The second reel cord 626 loops back around loop 624 and extends rearward along a rearward portion 626c, 626d to enter the second reel 632 (not shown). The rearward portion 626c travels adjacent, and some configurations, substantially parallel to the forward portion 626b.

As the second reel cord enters the reel 632 at reel portion 626d it may be wound around the reel a number of times depending on the position of the reel, and reel cord 626e will extend out of the reel along to the opposite side of the helmet as shown in Figure 10A. On the opposite side of the helmet, the reeling cord 626 continues in a configuration which is a mirror image to that shown in Figure 9 and the reel cord end is anchored in place in a mirror image location opposite that shown in Figure 9, according to some embodiments. Opposite ends of the reel cord may be anchored to the helmet in opposite rear areas of the helmet. Likewise the second contact strap is configured to continue over the front of a user's chin as shown in figure 9 to engage the second reel cord on the opposite side. The open area chin cup 621 configuration provide by the first contact strap 612 and the second contact strap 622 and the gap there-between below the contact or cross point 611 secures the contact with the user's chin while leaving an open area of the users chin for a more comfortable fit.

The lower strap system 620 is configured to increase or decrease the downward tension in a rear area between a helmet 90 and the user's head. Turning the second reel knob moves the second reel cord and causes the position of the loop 624 to move substantially forward or backward in the direction *I* shown in Figure 9 depending on the direction that the second reel knob is turned.

Each of the front strap system 610 and the lower strap system 620 are adjustable by turning the knobs of the corresponding reels 631, 632. Therefore, in some embodiments, the helmet retention system 600 may be adjusted by a user using only one hand.

The cords 616d, 626d and 616e, 626e can be guided laterally across the back side of the helmet (not shown) to enter the respective cylindrical bores 204a, 204b (see Figure 2) on the back side of the reels 631, 632.

From the foregoing, it will be observed that numerous variations and modifications may be effected without departing from the spirit and scope of the invention. It is to be understood that no limitation with respect to the specific apparatus illustrated herein is intended or should be inferred.

CLAIMS

1. A cord tension device comprising:

a base having ratchet teeth positioned along at least a portion of an inside circumference of the base;

a spool positioned within the base, wherein the spool is rotatable relative to the base to gather and release a cord;

a pawl ring having a flexible pawl arm configured to engage the ratchet teeth of the base; and

a knob having a first actuator configured such that when the knob is rotated in a first direction, the first actuator rotates the pawl ring;

wherein the knob further includes a second actuator configured such that when the knob is rotated in a second direction, opposite to the first direction, the second actuator deflects the pawl arm to move the pawl arm out of engagement with the ratchet teeth.

2. The cord tension device of claim 1, wherein:

the spool has a first engagement portion; and

the pawl ring has a second engagement portion which is releasably engageable with the first engagement formation of the spool

3. The cord tension device of claim 2, comprising a retainer that is mounted to the base and captures the knob onto the base, the knob axially capturing the pawl ring, wherein:

the retainer provides for first and second axial positions of the knob with respect to the base;

in the first axial position, the first and second engagement formations are engaged such that the pawl ring can rotate the spool and the spool can rotate the pawl; and

in the second axial position, the first and second engagement formations are not engaged such that relative rotation between the pawl ring and the spool is permitted.

4. The cord tension device of claim 3, wherein the first engagement formation comprises first axially extending teeth, and the second engagement formation comprises second axially extending teeth that are configured to mesh with the first axially extending teeth when the

knob is in the first axial position, and to de-mesh when the knob is in the second axial position.

5. The cord tension device of claim 4, wherein when the knob is moved to the second axial position, the pawl head is axially displaced from the ratchet teeth to a non-engagement position.

6. The cord tension device of claim 5, wherein the retainer comprises a disc-shaped flange and a cylindrical body depending from said flange, and the base comprises a cylindrical attachment boss that fits inside the cylindrical body, and the flange is fastened to the cylindrical attachment boss.

7. The cord tension device of claim 6, wherein the retainer includes two grooves to define the first and second axial positions.

8. The cord tension device of claim 6, wherein the knob comprises an opening which permits axial movement on the retainer, wherein the flange can move axially through the opening.

9. The cord tension device of claim 6, wherein:

the knob comprises a top wall, a depending surrounding side wall, and lift arms and detent arms depending from the top wall, wherein the lift arms axially capture the pawl ring such that axial movement of knob axially moves the pawl ring;

the retainer includes two grooves defining first and second axial positions of the knob with respect to the base; and

the detent arms include detent heads that are configured to snap into one of the two grooves based on the axial position of the knob.

10. The cord tension device of claim 2, wherein the knob comprises a top wall having a lift arm depending from the top wall to axially capture the pawl ring.

11. The cord tension device of claim 3, wherein the base has an attachment boss and the retainer is fastened to the attachment boss.

12. The cord tension device of claim 2, in combination with a strap for retaining a helmet on a user's head, the strap operatively connected to a cord and positionable to engage a user's chin, wherein turning the knob of the cord tension device in a first direction tensions the cord and tightens the strap on the user's chin, and turning the knob of the reel in a second direction relaxes the cord and loosens the strap on the user's chin.

13. The cord tension device of claim 1, further comprising a retainer that is mounted to the base and captures the knob onto the base, wherein:

the retainer provides for first and second axial positions of the knob with respect to the base;

in the first axial position, the pawl head is engaged to the ratchet teeth; and

in the second axial position, the pawl head is displaced from the ratchet teeth to a non-engagement position.

14. The cord tension device of claim 1, wherein the retainer comprises a disc-shaped flange and a cylindrical body depending from said flange, and the base comprises a cylindrical attachment boss that fits inside the cylindrical body, and the flange is fastened to the cylindrical attachment boss.

15. The cord tension device of claim 14, wherein the retainer includes two grooves to define the first and second axial positions.

16. The cord tension device of claim 1, wherein the knob comprises a top wall having a lift arm depending from the top wall to axially capture the pawl head and pawl arm.

17. The cord tension device of claim 1, wherein the base has an attachment boss and the retainer is fastened to the attachment boss.

18. The cord tension device of claim 1, further comprising a cord and a helmet strap system, wherein the spool coils a cord to tension the strap system.

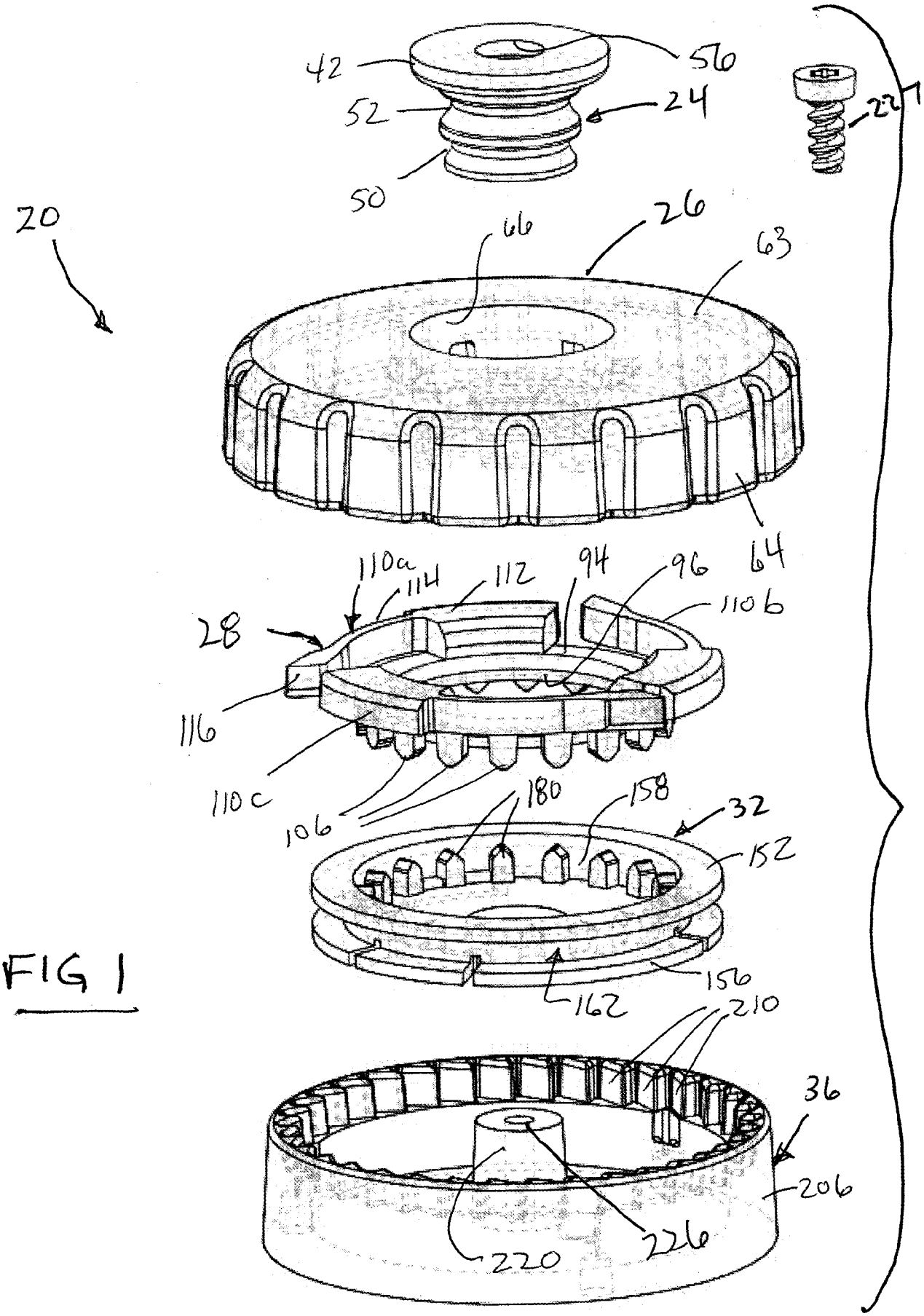
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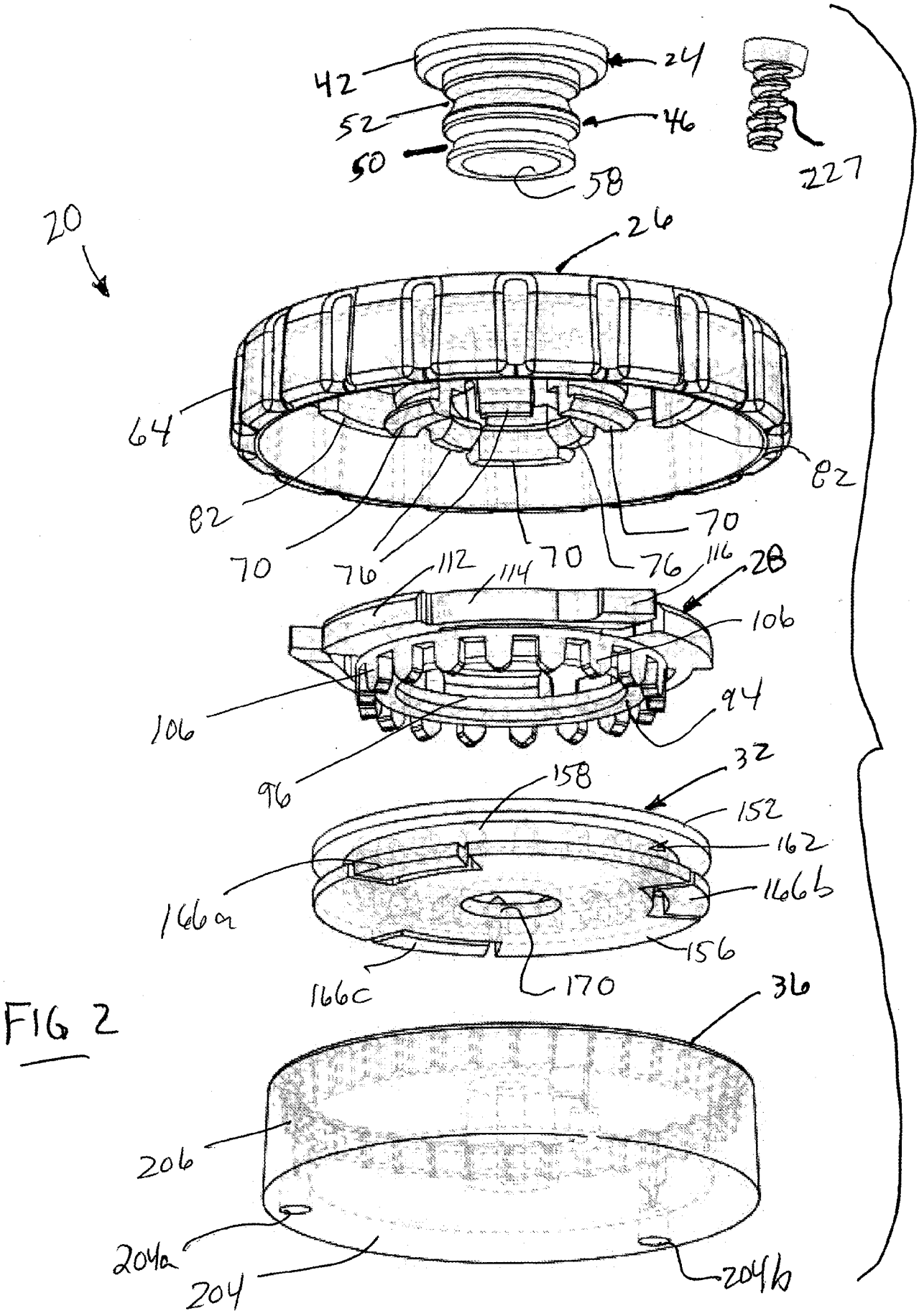
FIG 1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46
50
58
227
20
26
64
82
82
70
70
76
70
76
112
114
116
28
106
106
94
96
32
158
152
162
166a
166b
156
166c
170
36
206
204a
204
204b

FIG 2

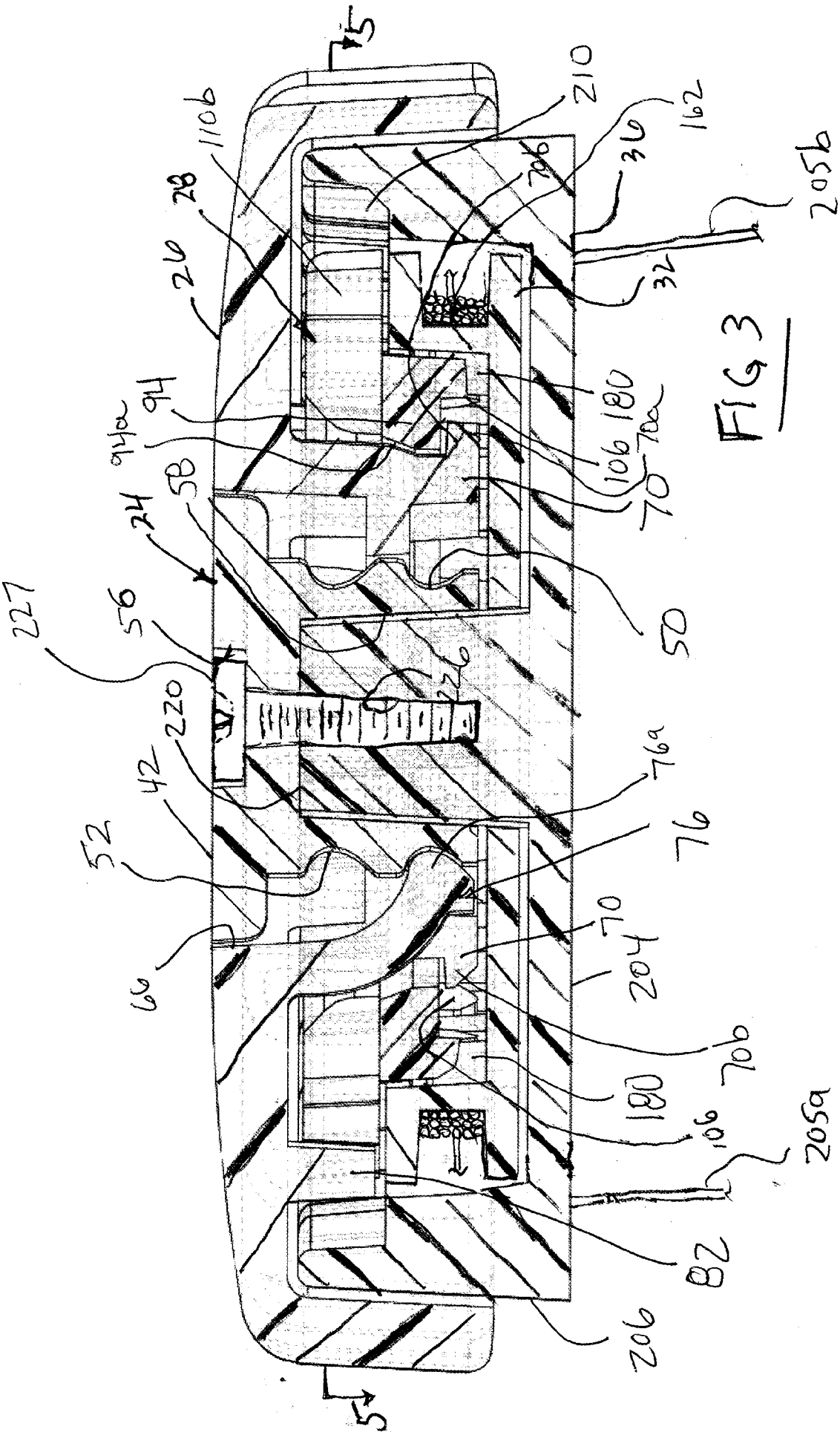

5
210
110b
28
26
206
36
162
205b
32
94a
94
58
24
106 180
70a
70
227
56
50
220
42
52
76a
76
66
204
70
180
70b
106
205a
82
206
5

FIG 3

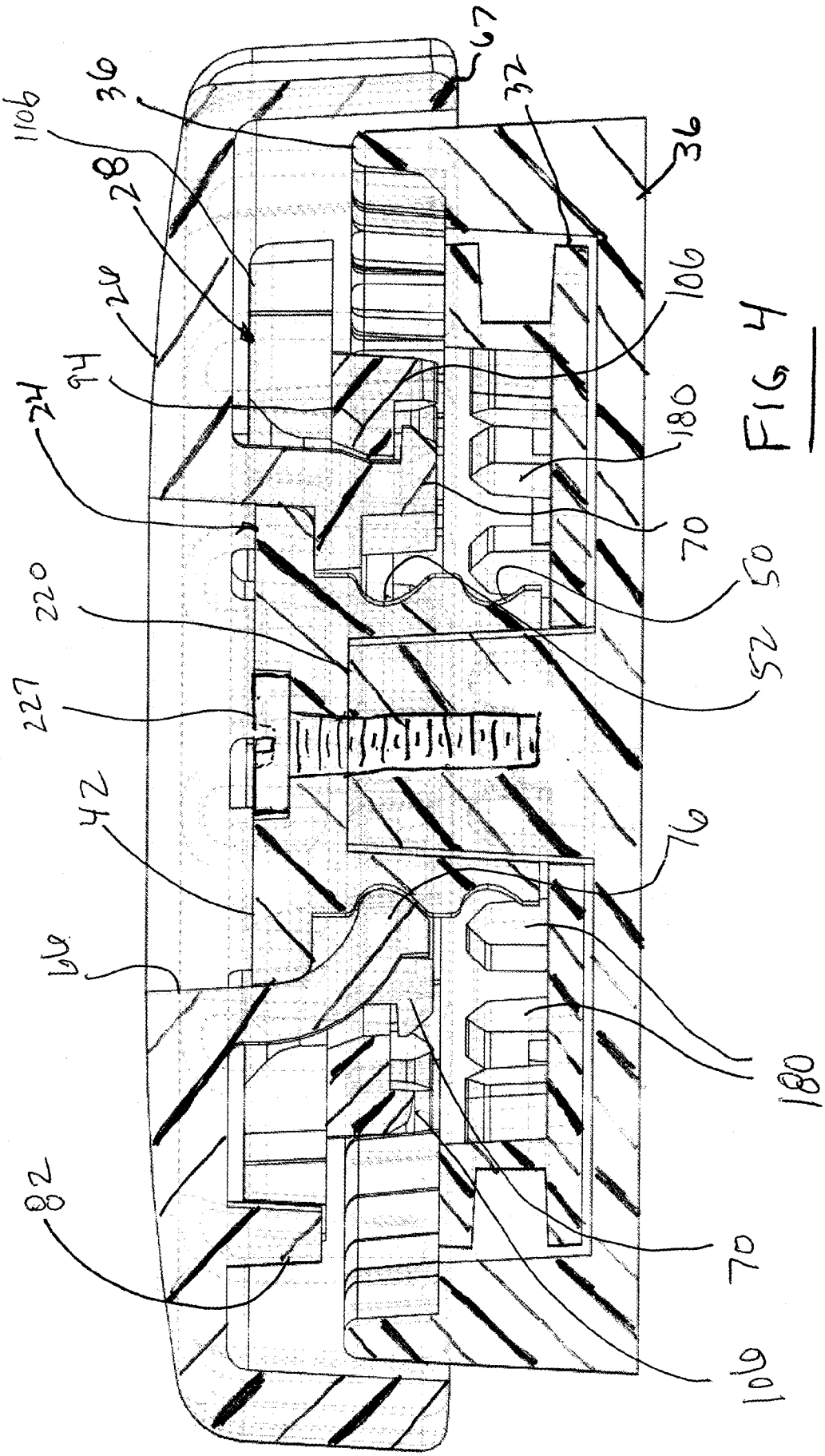

67
36
32
36
110b
28
106
24
94
180
24
70
50
220
52
227
42
76
109
180
82
70
109

FIG 4

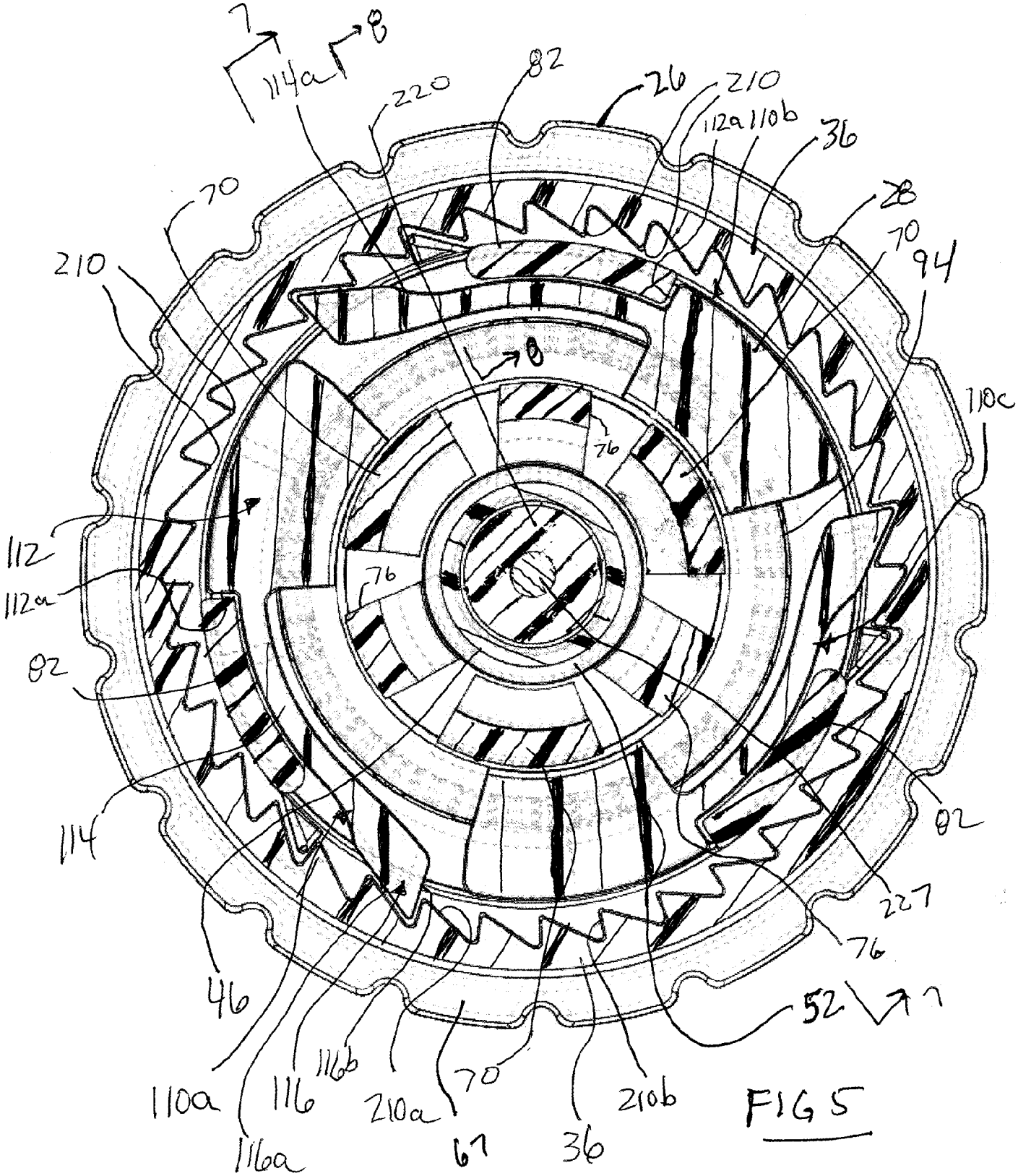

7
8
114a
220
82
26
210
112a
110b
36
28
70
94
210
110c
112
112a
82
114
46
110a
116
116b
210a
70
210b
227
76
52
67
116a

FIG 5

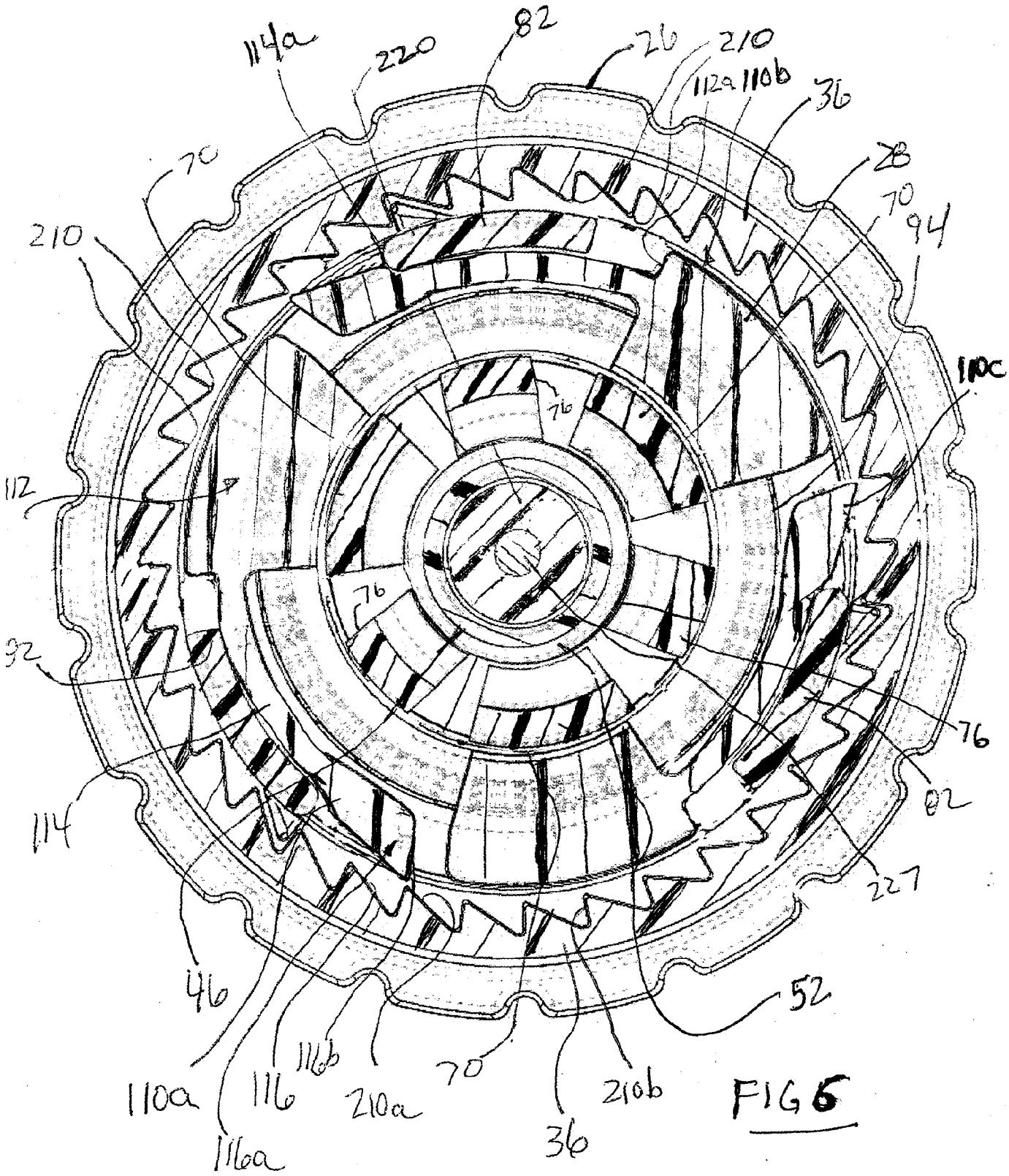

114a
220
82
26
210
112a
110b
36
28
70
94
210
70
110c
76
112
76
92
76
114
82
227
46
52
116b
70
110a
116
210a
210b
116a
36

FIG 6

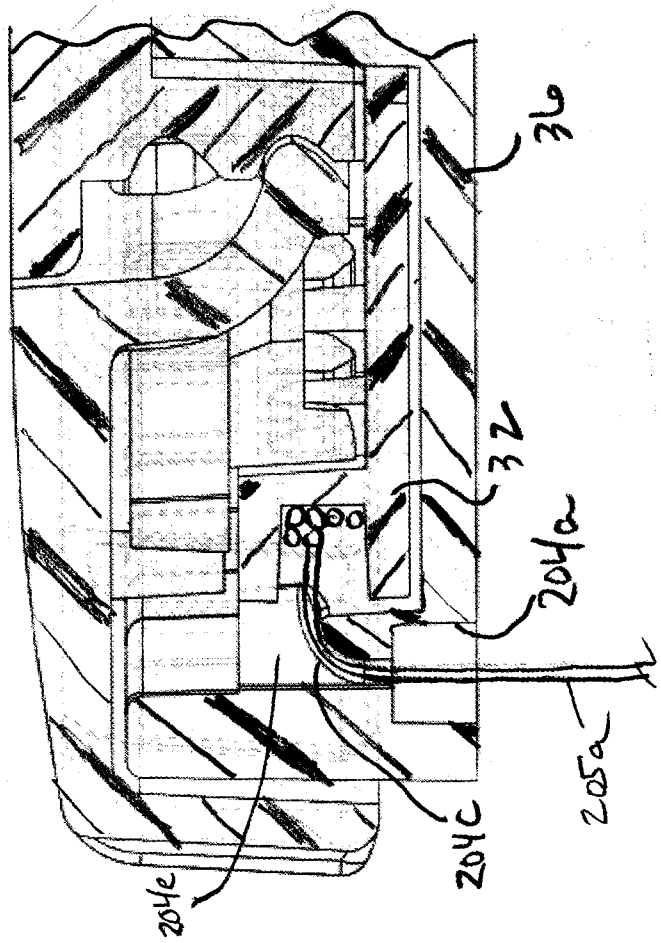

36
32
204a
205a
204c
204e

FIG. 8

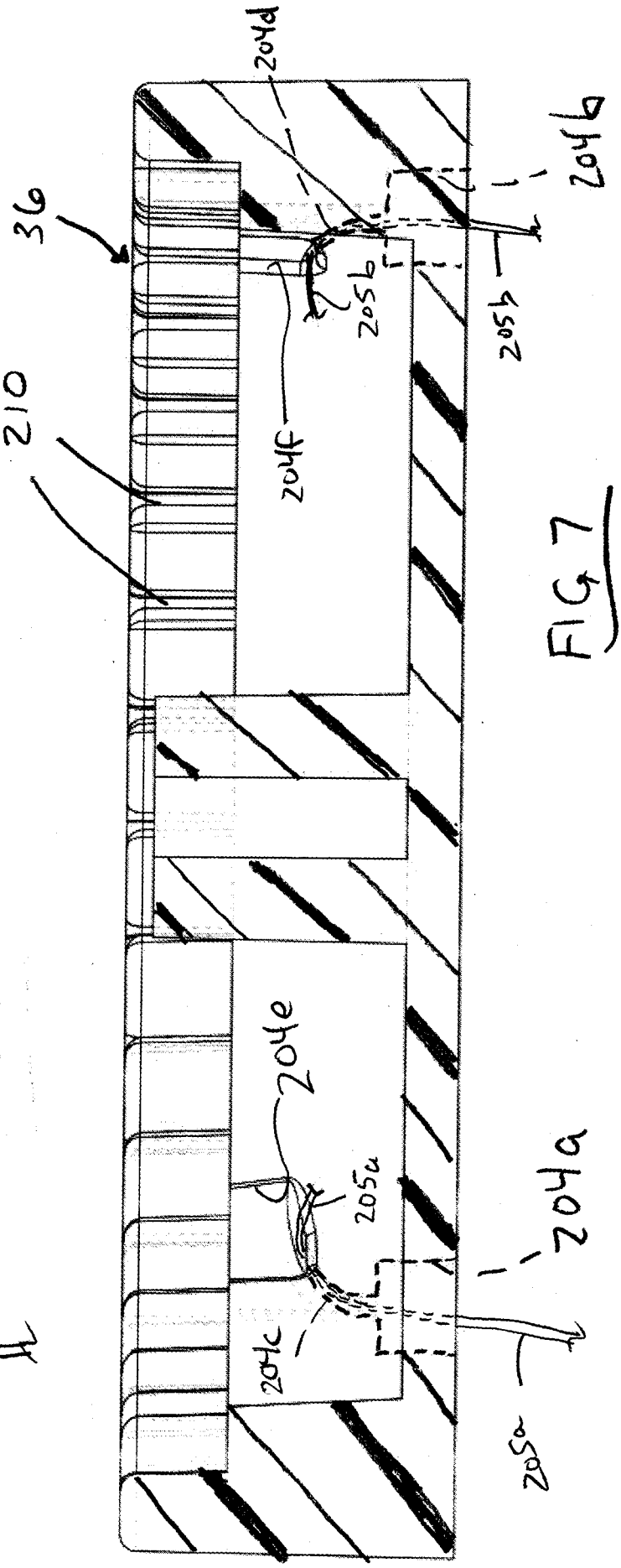

204d
36
204b
205b
205b
210
204f
204e
205a
204c
204a
205a

FIG 7

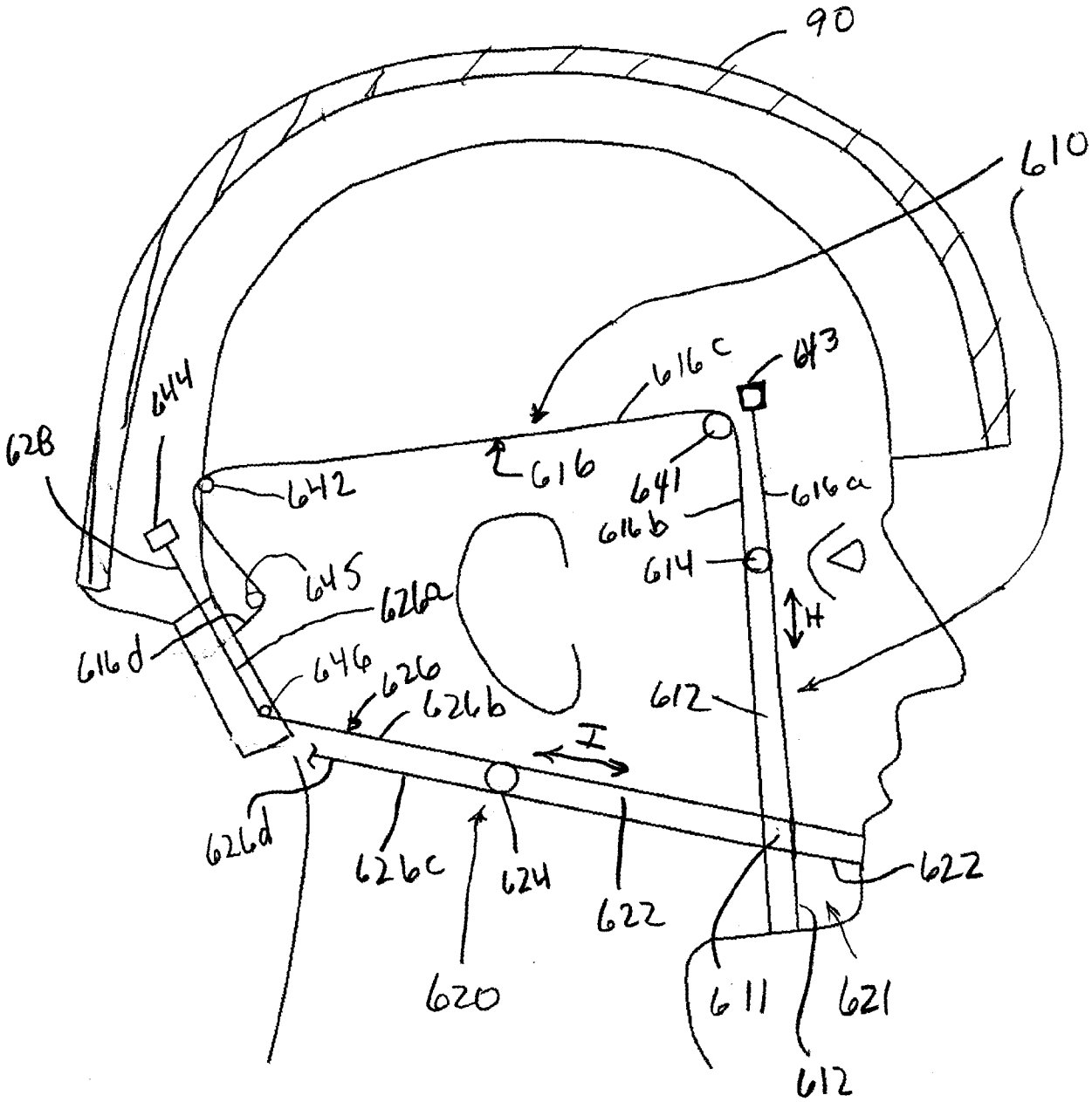
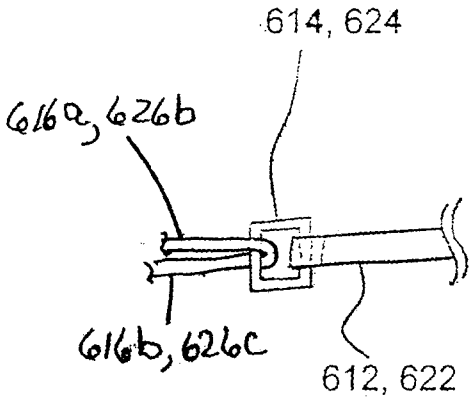

90
610
644
628
642
616c
643
616
641
616a
616b
645
626a
614
H
616d
646
626
626b
612
I
626d
626c
624
622
620
611
621
612

FIG. 9



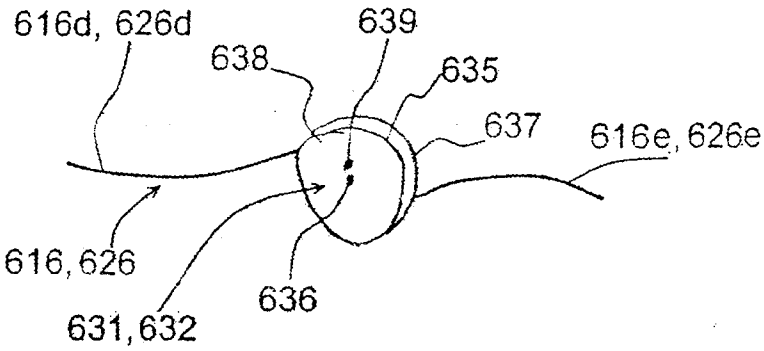


Fig 10B

Fig 10A

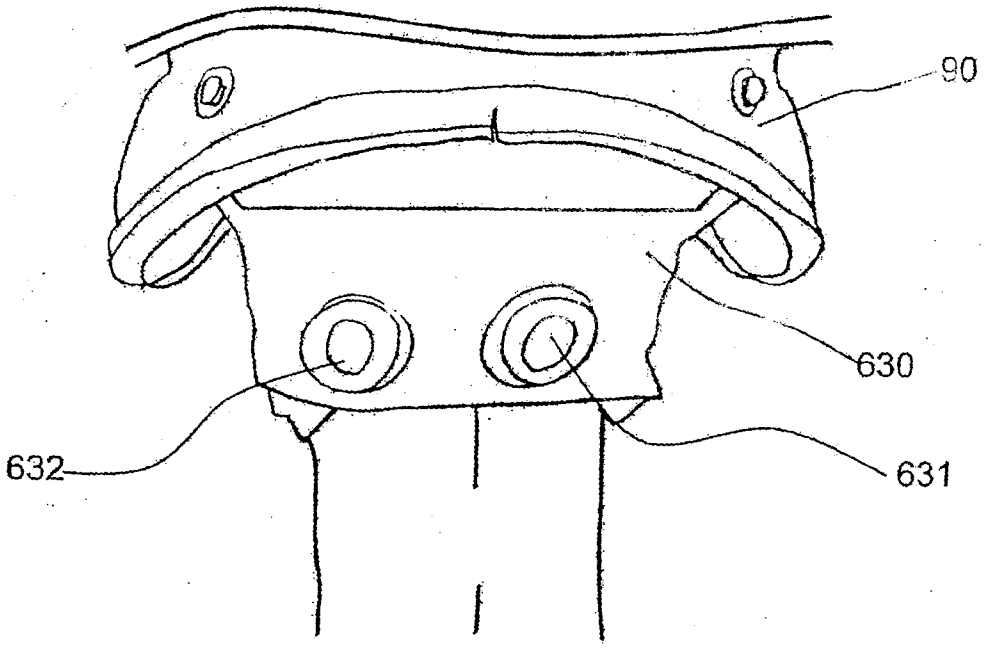


Fig 10