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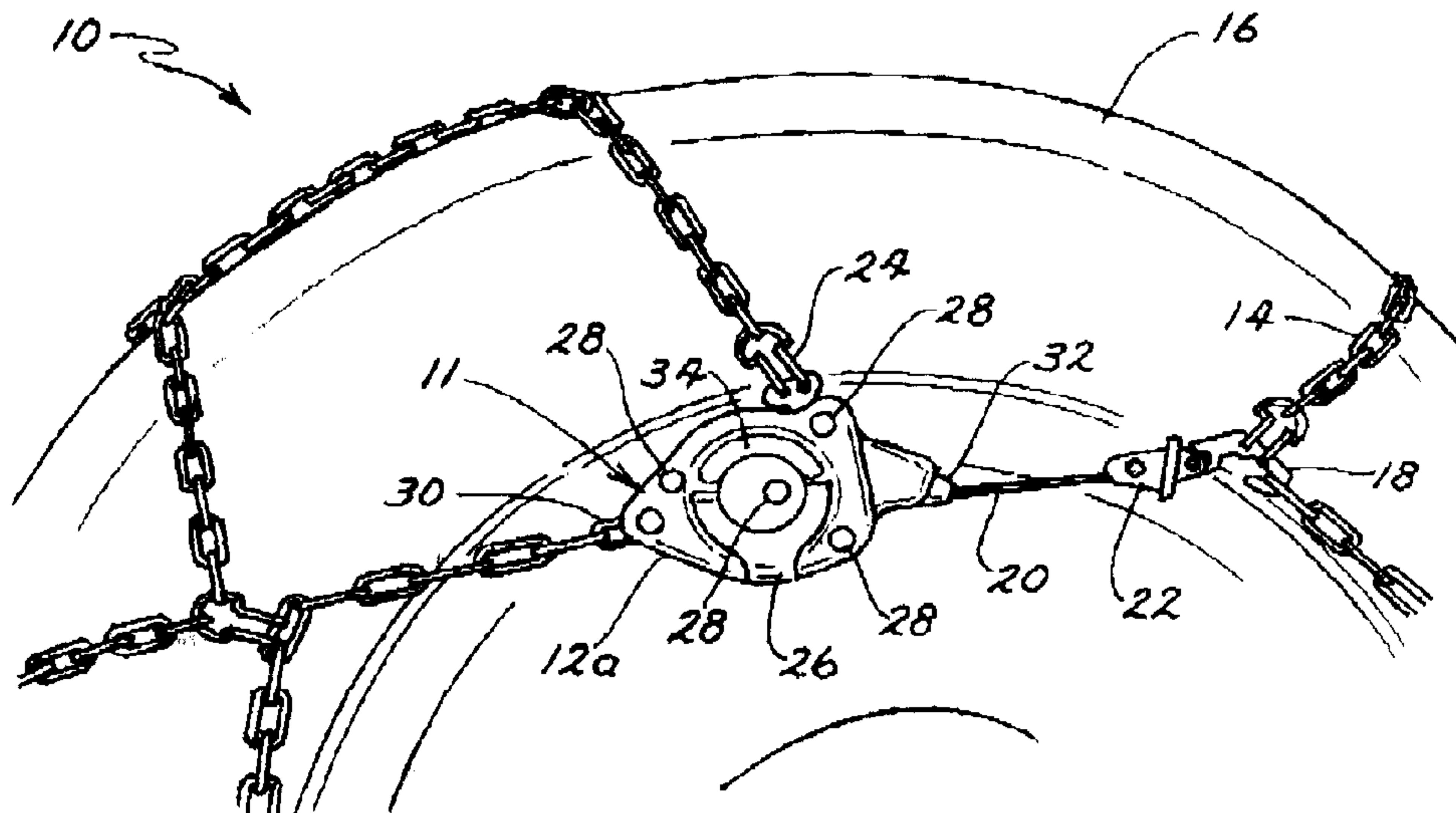
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(54) **Titre : CHAINES ANTI-DERAPANTES A SERRAGE AUTOMATIQUE ET PROCEDES D'UTILISATION**
(54) **Title: SELF-TIGHTENING SNOW CHAIN AND METHODS OF USE**



(57) **Abrégé/Abstract:**

Self-tightening snow chain for attachment to a vehicle wheel to provide traction. The preferred self-tightening snow chain includes a traction cable and a tensioning device including a housing having a top including a set of housing teeth, a bottom and at least one aperture; a lever interconnected to the housing; a ratchet spool within the housing having a set of ratchet teeth that mate with the housing teeth and a channel between upper and under surfaces to receive a cord that is interconnected with the ratchet spool; a tension spring that places a bias on the ratchet spool toward a wind-up direction; and a wave spring. A preferred tensioning device includes a cord sub-unit having two knobs, one on each end, and a grommet encircling the cord. A method of assembling the tensioning device is also disclosed.

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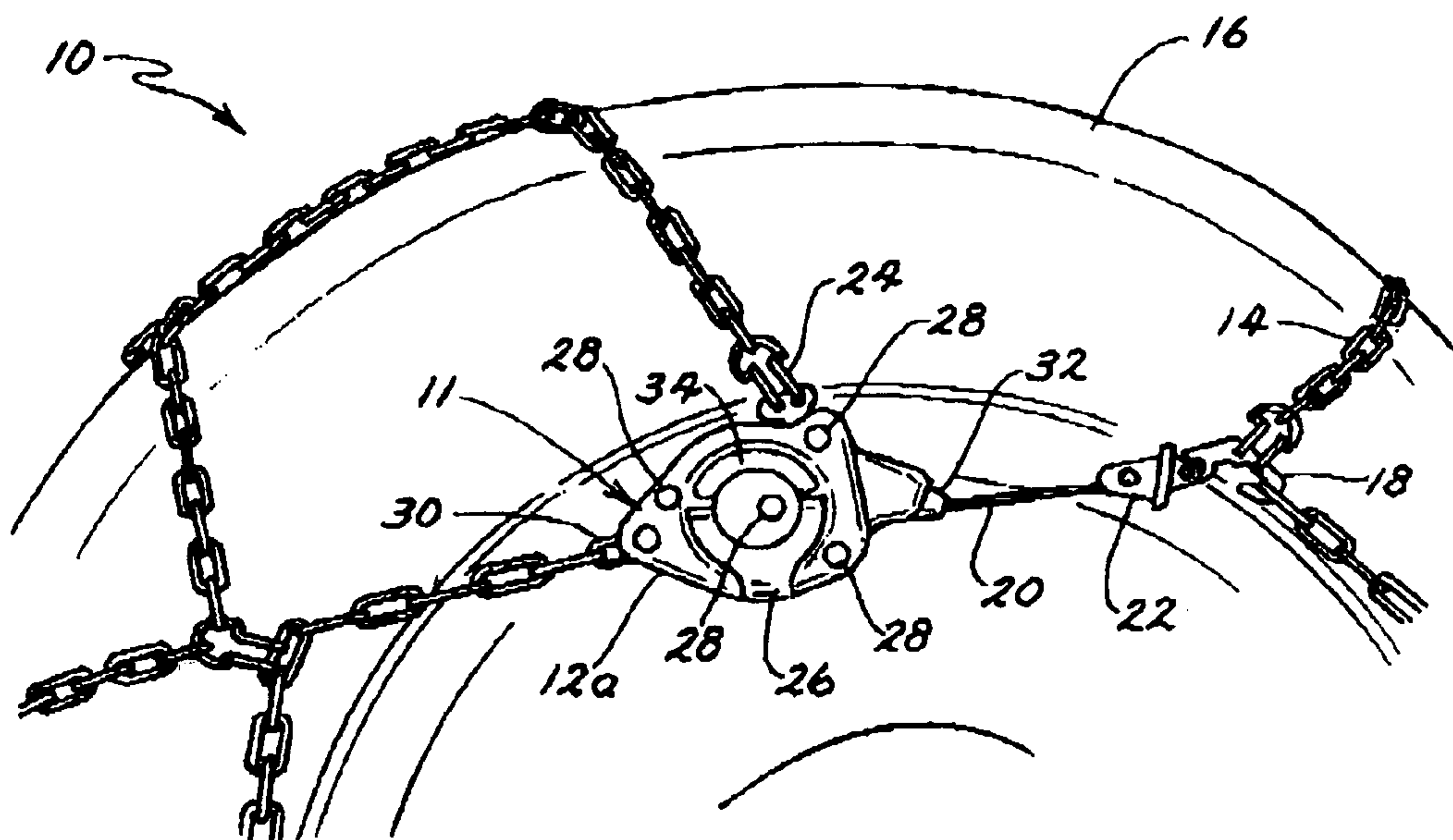
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Self-Tightening Snow Chain and Methods of Use

FIELD OF THE INVENTION

[0001] The present invention relates generally to snow chains, particularly, snow chains that self-tighten to ensure proper fit. More particularly, the present invention relates to self-tightening snow chains having a tensioning device including a winding device and a tensioning cord, the snow chains having a tensioned mode when secured for use on a wheel of a land vehicle and a separate extended mode, wherein the tensioning cord, interconnected with the winding device is released to extend away from the winding device to permit the snow chain to be easily engaged with the wheel of the land vehicle prior to securing the snow chain to the wheel. In alternate embodiments, the present invention relates to self-tightening snow chains that self-tighten when a plurality of cords are tensioned by a single winding device. In further embodiments, the present invention relates to a tensioning device for a snow chain that places a spring bias upon a tensioning cord or a plurality of tensioning cords and/or is resistant to infiltration of dirt, debris and moisture. Methods of providing and using these inventions are also disclosed.

BACKGROUND OF THE DISCLOSURE

[0002] Self-tightening snow chains have been used to provide vehicles with improved traction when driving on irregular surfaces where poorer traction is anticipated (i.e. ice or snow covered surfaces, off-road or backcountry terrains). Numerous states require the use of snow chain under certain weather conditions to

mitigate potential hazards. Most models of snow chains require retightening after initial chain installation, where all of the wheel chains need to be retightened after the vehicle has been slowly driven forward or backward. It is essential that snow chains fit properly to obtain proper performance and increase durability. Having to retighten the cables is burdensome for the user and has costly consequences if forgotten or neglected.

[0003] Because proper fit of the snow chains is so essential, self-tightening snow chains have been developed. One of these devices is disclosed in U.S. Patent No. 6,213,421 to Franklin. The Franklin patent discloses a clamping lock for a traction device. The lock has a single clamping rope connected to a winding device within a housing. The winding device is pre-tensioned in the wind-up direction. Toothing is provided laterally around the winding device. There is an actuating lever attached to the housing that has three positions: a first catch position, which allows the clamping rope to move in or out of the housing; a second wind-up position, which unlocks the rope so it may move into the housing, thereby tightening the clamping rope; and a third locked position wherein the clamping rope is locked in its current position. The lever controls a pawl. Whether or not the clamping rope may be pulled in or out of the housing depends on whether the pawl is engaged with the teeth on the winding device.

[0004] Self-tightening snow chains having tensioning devices of this kind are difficult to secure to a wheel of a vehicle with two hands. A user may need to let go of the cord in order to better grip the tensioning device or grab the corresponding hook on the snow chain. In order to prevent the cord from being pulled back into the

housing, the user must lock the cord in both directions to keep the cord in the extended position. Then, the cord would need to be unlocked to extend further, again requiring releasing either the cord or the corresponding hook. Additionally, self-tightening snow chain tensioning devices that can only tighten one cord are less cost effective because numerous self-tightening tensioning devices are required on each snow chain to tighten each cord.

[0005] Of further concern, self-tightening snow chain tensioning devices of this kind are made by simply screwing two flat-edged housing pieces together. Dirt, debris and moisture may easily penetrate this type of joint and cause damage to the mechanisms inside the housing. Additionally, the use of actuating levers creates an easy path for dirt, debris and moisture to enter and damage the device. It is also noted that the tensioning cord is generally equipped with crimped on or cast on ends and that one of these ends is then passed through a grommet and that the grommet and the cord are then incorporated into the tensioning device during assembly. In order to accept the crimped or cast on end, the opening in the grommet is required to be quite a bit larger than the diameter of the cord and the difference in size provides another area where an easy path is provided for dirt, debris and moisture to enter and damage the device.

SUMMARY OF THE INVENTION

[0006] The present invention provides a self-tensioning snow chain for attachment to a wheel of a vehicle, the self-tensioning snow chain includes a snow chain; and a tensioning device. The tensioning device includes (1) a housing having

a top including a set of housing teeth, a bottom and at least one aperture defined by the top and the bottom when joined together; (2) a lever interconnected to the housing; (3) a cord; (4) a ratchet spool having a set of ratchet teeth on an upper surface, the ratchet teeth constructed and arranged to mate with the housing teeth, an under surface and a channel between the upper surface and the under surface in which sufficient space is provided to receive the cord, wherein the cord is interconnected with the ratchet spool; (5) a tension spring interconnected with the ratchet spool and constructed and arranged to place a bias on the ratchet spool toward a wind-up direction; and (6) a wave spring positioned between a top surface of the bottom of the housing and the under surface of the ratchet spool to bias the ratchet spool in the direction of the housing teeth; wherein the snow chain is interconnected with the tensioning device and the cord can be connected with the snow chain so that the tensioning device can secure the snow chain to the wheel. The snow chain can also be a traction cable or the like that is made out of rope, wire, wire rope, chains and the like.

[0007] It is an object of the present invention to provide a self-tightening snow chain that more effectively tightens and is easier to install. It is another object of the present invention to provide a self-tightening snow chain that may tighten a plurality of cords with one winding device, preferably a ratchet spool. It is yet another object of the present invention to provide a self-tightening snow chain having a tensioning device that is resistant to an infiltration of dirt, debris and moisture into the housing.

[0008] The present invention achieves these and other objectives by providing a self-tightening snow chain having two modes of operation. First, is an extended or

extending mode that allows the user to extend the cord from the housing and release their grip on the cord without having the cord wind-up into the housing. The ability to only allow movement in a wind-out direction is created when the ratchet spool is in down position, where the spool, although biased in a wind-up direction, is blocked from turning in a wind-up direction. To get the ratchet spool in the down position, the user raises the actuating lever until it is perpendicular to the housing. This action forces a cam-lever to push the ratchet spool down. When the ratchet spool is in the down position, the ratchet teeth are disengaged from the housing teeth thereby allowing movement of the ratchet spool in either direction. However, movement in the wind-up direction is prevented by catches on the under surface of a ratchet spool that are pushed into a zone of a stop or stopper where they will be blocked by the stopper, thereby stopping the ratchet spool from turning in a wind-up direction more than a full turn, a half turn or preferably a quarter turn. When the user wants to continue extending the cord, the cord simply needs to be pulled further outward.

[0009] Second, is a self-tightening mode wherein the cord may only move in the wind-up direction. This mode is for when the cord is engaged and in use and the user wants to maintain constant tension on the snow chain without the possibility of the cord extending out. To operate in this mode, the user lowers the actuating lever until it snaps back into a position adjacent to the housing. When the actuating lever is down, the ratchet spool is up. Therefore, the housing teeth and the ratchet teeth are engaged to only allow movement in the wind-up direction. When the ratchet spool is in the up position, the catches cannot be blocked by the stopper, which

would otherwise prevent more than a small movement of the ratchet spool in the wind-up direction.

[0010] In an alternate embodiments of the present invention, the ratchet and housing teeth may be overcut or undercut. In preferred embodiments, the respective teeth will be undercut at an angle ranging from about 3 to about 30 degrees, preferably about 5 to about 25 degrees more than the 90 degree angle to a horizontal plane b perpendicular to a vertical axis c of the ratchet spool and the housing. In the most preferred embodiment, the respective teeth will be undercut about 20 degrees more than the 90 degree angle to a horizontal plane b perpendicular to a vertical axis c of the ratchet spool and the housing. Therefore, when the teeth are undercut, and the device is in a wind-up mode and the cord is tugged outwardly, the harder the cord is tugged, the more the ratchet teeth will become engaged and resist the cord being moved in the wind-out direction. This is particularly important during normal conditions, when a significant amount of vibration results from interaction between the tire and the road surface.

[0011] In another embodiment of the tensioning device of the present invention, a plurality of cords, all interconnected with the same winding device or ratchet spool, may extend from different apertures or openings of the housing. Although it is possible to have more than three cords extend from a single tensioning device, such a device may be difficult to optimize because of the limited room on the ratchet spool, unequal forces that could be placed on each cord when in use and also the potential need for a tension spring that can generate greater winding force on the spool that may be needed to wind a greater number of cords.

[0012] Additionally, a lip-groove configuration may be utilized to aid in sealing the housing from dirt, debris and moisture. For example, a lip may trace along the opening of the housing top and a groove may trace along the opening of the housing bottom. When the two housing components are joined together, the lip and groove will mate to form a more secure seal than if two flat surfaces are pressed together. Alternatively, the lip may trace along the opening of the housing bottom and the groove may trace along the opening of the housing top.

[0013] To further protect the internal components, a grommet having an opening only slightly larger than the diameter of the cord may be utilized. If the grommet is secured around the cord prior to securing knobs at both ends of the cord, the grommet opening can be smaller than the diameter of the knobs, thereby reducing the size of the passageway in the grommet where dirt, debris and moisture can breach the housing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] In the drawings, in which corresponding reference numerals and letters indicate corresponding parts of the various embodiments throughout the several views, and in which the various embodiments generally differ only in the manner described and/or shown, but otherwise include corresponding parts;

[0015] FIGURE 1 is a perspective view of one embodiment of a self-tightening snow chain of the present invention having a tensioning device, wherein the self-tightening snow chain is in use attached to a wheel (partially shown);

[0016] FIGURE 2 is a perspective view of one embodiment a housing of a tensioning device of the present invention showing the exterior of the device shown in Figure 1;

[0017] FIGURE 3 is an exploded perspective view of the one embodiment of a tensioning device of the present invention showing the internal and external components shown in Figure 1;

[0018] FIGURE 4 is an exploded partial schematic view of certain components of the tensioning device of one embodiment of the tensioning device of the present invention showing the location of the ratchet spool, the compression spring and the stopper shown in Figures 1 and 3;

[0019] FIGURE 5 is a partial perspective view of a stopper and compression spring fitted in a housing bottom, of the tensioning device of the present invention shown in Figure 4;

[0020] FIGURE 6 is a partial perspective view of a portion of the housing of the tensioning device of the present invention showing a housing lip-groove configuration joint shown in Figures 1 and 3;

[0021] FIGURE 7A is a perspective view of a tensioning cord sub-unit of the tensioning device of the present invention shown in Figures 1 and 3;

[0022] FIGURE 7B is a perspective view of the tensioning cord sub-unit shown in Figure 7A before it is completely assembled;

[0023] FIGURE 8A is a partial, schematic view of the tensioning device of Figure 1 showing the internal components when the lever is in a down position and the

ratchet spool is in an up position within the housing, which is shown in phantom, but without showing the wave spring to permit clarity;

[0024] FIGURE 8B is a partial, schematic view of the tensioning device shown in Figure 1, similar to that shown in Figure 8A, but showing the internal components when the lever is in an up position and the ratchet spool is in a down position;

[0025] FIGURE 9A is an enlarged, partial, schematic view of a portion of tensioning device shown in area 9a-9a of Figure 8B illustrating enlarged ratchet teeth and housing teeth cut at an angle of about 90 degrees to a horizontal plane perpendicular to a vertical axis of the ratchet spool and the housing;

[0026] FIGURE 9B is an enlarged, partial, schematic view similar to that shown in Figure 9A but illustrating a preferred embodiment, wherein the ratchet and housing teeth are undercut about 20 degrees more than a 90 degree angle to a horizontal plane b perpendicular to a vertical axis c of the ratchet spool and the housing;

[0027] FIGURE 10A is a diagrammatic view of one embodiment of the tensioning device of the present invention showing a preferred positioning on a wheel of two, single-cord tensioning devices similar to that shown in Figure 1;

[0028] FIGURE 10B is a diagrammatic view of one embodiment of an alternate tensioning device of the present invention showing a preferred positioning of a single, dual cord tensioning device that tightens two tensioning cords with respect to a snow cable (not shown) on a wheel;

[0029] FIGURE 10C is a diagrammatic view of one embodiment of an alternate tensioning device of the present invention showing a preferred positioning of a

single, multiple cord tensioning device that tightens three tensioning cords with respect to a snow cable (not shown) on a wheel;

[0030] FIGURE 11A is a plan view of a dual cord tensioning device, similar to the tensioning device shown in Figure 1, but where two cords are tensioned in a single tensioning device;

[0031] FIGURE 11B is a plan view of a triple cord tensioning device, similar to the tensioning device shown in Figure 1, but where three cords are tensioned in a single tensioning device;

[0032] FIGURE 12A is a perspective view of one embodiment, a ratchet spool, similar to that shown in Figure 3, for a dual cord tensioning device of the present invention wherein two tensioning cords are wrapped around a single ratchet spool; when the cords are fully wound in;

[0033] FIGURE 12B is a perspective view of one embodiment, a ratchet spool for a triple cord tensioning device of the present invention wherein three tensioning cords are wrapped around a single ratchet spool when the cords are fully wound in;

[0034] FIGURE 13 is a perspective view of an alternate embodiment of a tensioning device of the present invention wherein buttons are used to change device modes;

[0035] FIGURE 14 is an exploded view of the alternate tensioning device shown in Figure 13;

[0036] FIGURE 15 is a diagrammatic view of one embodiment of the alternate tensioning device of the present invention shown in Figures 13 and 14 showing the pivot and contact points of the pawls and top button;

[0037] FIGURE 16A is a sectional view, similar to that shown in Figure 8A, but showing the alternate tensioning device of the present invention shown in Figure 13, showing the internal components when the top button is in the down position and the ratchet spool is in the up position (wave spring not shown for clarity); and

[0038] FIGURE 16B is a sectional view, similar to that shown in Figure 8B, but showing the alternate tensioning device of the present invention shown in Figure 13, showing the internal components when the top button is in the down position and the ratchet spool is in the down position (wave spring not shown for clarity).

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0039] Preferred embodiments of the present invention are illustrated in Figs. 1-16B. Figure 1 is a perspective view of a self-tightening snow chain **10** of the present invention in use on a wheel **16** (partially shown). The self-tightening snow chain **10** comprises of a snow chain **14** and a tensioning device **11**. Referring now also to Figures 2 and 3, the self-tightening snow chain **10** has a housing **12** including a housing top **12a**, an actuating lever **26**, a grommet **32**, and a cord **20** extending through grommet **32** and connected to a hook **18** with a first connection member **22**.

The hook **18** connects to the chain **14** of the self-tightening snow chain **10**, to supply tension to the chain **14**. In this embodiment, there is a second connection point **24** and third connection point **30** where parts of the snow chain **14** are secured to the housing **12**. Rivets **28** are placed through rivet receiving openings or recesses **29** to secure the housing top **12a** to the housing bottom **12b**, although any other fasteners such as threaded screws, bolts and nuts, adhesives, double backed tape and the like

could be used. The housing top **12a** has a recess **34** to prevent distortion during injection molding, which may additionally be used as a place for company identifiers and the like, if desired.

[0040] Figure 2 is a perspective view of the housing **12** of the tensioning device **11** shown in Figure 1. The housing top **12a** can be secured to the housing bottom **12b** by rivets or threaded screws (not shown) that may be inserted through the holes **29**. The housing top **12a** and the housing bottom **12b** define an aperture **38** for receiving the grommet **32** that provides a passageway for the tensioning cord **20**. Additionally, an actuating lever **26** including a cam **126** is pivotally connected to the housing top **12a**.

[0041] In Figure 3, there is illustrated an exploded view of one embodiment of the tensioning device **11** of the present invention. A wave spring **112** sits on the inside of the housing bottom **12b**. The wave spring **112** is positioned in a way to apply pressure to the ratchet spool **100**. The tension spring **110** also rests inside the ratchet spool **100** and has a crimp **122** that mates with a notch **120** in the ratchet spool **100** to secure the tension spring **110** to the ratchet spool **100**. The ratchet spool **100** has a center channel **124** running circumferentially around its exterior and is sufficiently wide and deep enough for a cord **20** to be wound within the channel **124** around the ratchet spool **100**. In this embodiment, the under surface **132** of the ratchet spool **100** has four catches **104**. It is not essential that there be four catches **104** as two to six catches **104** will result in similar function. More than six catches **104** is possible but not recommended. As better shown in Figs. 8A-8B, the catches

104 prevent the ratchet spool **100** from rotating in the wind-up direction when they are blocked by the stopper **108**. The catches **104** can only be blocked by the stopper **108** when the ratchet spool **100** is in the down position (when the cam **126** is in the down position/the actuating lever **26** is in the up position). On the top of the ratchet spool **100** are ratchet teeth **102**. As seen in Figs. 8A and 8B, the ratchet teeth **102** can engage with the housing teeth **118** located in the housing top **12a** when the actuating lever **26** is oriented in the down position. When the actuating lever **26** is in the down position, a cam **126**, which extends from the actuating lever **26**, is parallel to the plane of rotation of the ratchet spool **100**. Therefore, there is no added pressure on the wave spring **112**, which allows the wave spring **112** to push the ratchet spool **100** to its up position, engaging the ratchet spool **100** with the housing teeth **118**. When the actuating lever **26** is in the up position/the cam **126** is in a down position and pushes the top base **114** down against the ratchet teeth **102**, which are subsequently pushed down thereby disengaging the ratchet teeth **102** from the housing teeth **118**. The top **116** has slots **117** for the cam levers **26** to rotate. The housing teeth **118** are molded into the housing top **12a**.

[0042] Referring now also to Figures 4 and 5, showing the arrangement of the catches **104**, the compression spring **106** and stopper **108**. The compression spring **106** is attached to the stopper **108** and they both are placed in the housing bottom **12b** such that the compression spring **106** applies force to the housing bottom **12b**. The compression spring **106** places a bias on the stopper **108** such that the stopper

108 will block a catch **104** should the ratchet spool **100** be in the down position and rotating in the wind-up direction.

[0043] Now also referring to Figure 6 showing the lip **40** and groove **42** configuration near the aperture **38** defined by the housing **12**. The lip **40** and groove **42** mate to form a housing joint **44** resistant to dirt, debris and moisture.

[0044] Now also referring to Figures 7A and 7B showing an assembled tensioning cord sub-unit **134**. A cord **20** is threaded through a grommet **32** and has a first knob **128a** and a second knob **128b**. The knobs **128** may be fitted to the cord **20** by crimping, melting, casting and the like. The cord **20** is threaded through the grommet **32** before both of the knobs **128** are fitted to the cord **20**, which permits the diameter of the grommet **32** to be smaller than the diameter of the knobs **128**, so that the grommet **32** may more closely fit the cord **20**, allowing the grommet to be more appropriately sized to limit the infiltration of dirt, debris and moisture into the housing **12**. The cord **20** is attached to the first connection member **22** that is connected to a hook **18** (shown in phantom) used for securing the tensioning device **11** to parts of the snow chain **14**. Figure 7B shows how the second knob **128b** fits into a recess **46** (partially shown) formed by a first piece **22a** and second piece **22b** of the first connection member **22**. The first and second pieces **22a** and **22b** are secured together around the second knob **128b** that is tightly secured to the cord **20**. Rivets **23** are placed through rivet receiving openings **25** to secure first and second pieces **22a** and **22b** together, although any other fasteners such as threaded screws, bolts and nuts, adhesives, double backed tape and the like could be used.

[0045] Referring now also to Figures 8A and 8B, Figure 8A is a sectional view showing the internal components when the actuating lever **26** is in the down position thereby allowing the ratchet spool **100** to be in the up position. When the ratchet spool **100** is in the up position, the catches **104** are clear of the stopper **108** thereby allowing the ratchet spool **100** to freely wind-up and tighten the cord **20**. In this mode, the ratchet spool **100** may only rotate in the wind-up direction, because the ratchet teeth **102** can fully engaged with the housing teeth **118** to limit rotation if an extending or wind-out force is applied to the cord **20**.

[0046] Figure 8B is a sectional view showing the internal components when the actuating lever **26** is in the up position thereby forcing the ratchet spool **100** to be in the down position. While the ratchet spool **100** is in the down position, the ratchet teeth **102** are disengaged from the housing teeth **118**. This allows the ratchet spool **100** to rotate freely in either direction. The catches **104** stop the ratchet spool **100** from fully rotating in the wind-up direction. As the ratchet spool **100** begins to rotate in the wind-up direction, the stopper **108** will block the next catch **104** it encounters, thereby preventing the ratchet spool **100** from further winding-up.

[0047] In the embodiment shown in Figures 8A through 9A, the ratchet teeth **102** and the housing teeth **118** are cut at an angle "a" of about 90 degrees to a horizontal plane perpendicular to a vertical axis of the ratchet spool and the housing. In alternate embodiments of the present invention, the ratchet teeth **102** and housing teeth **118** may be overcut or undercut. The teeth **102**, **118** may be undercut at an angle ranging from about 3 to about 30 degrees, preferably from about 10 to about

25 degrees more than a 90 degree angle to a horizontal plane b perpendicular to a vertical axis c of the ratchet spool and the housing, so that when the tensioning device **11** is in a wind-up mode and the cord is tugged outwardly, the more the ratchet teeth **118** will become engaged and resist the cord **20** being moved in the wind-out direction. In the most preferred embodiments, the teeth **102, 118** are undercut at an angle a' of about 20 degrees more than a 90 degree angle to a horizontal plane b perpendicular to a vertical axis c of the ratchet spool and the housing, as illustrated in Figure 9B.

[0048] Now referring also to Figure 10A, Figure 10A is a diagrammatic view of one embodiment of the present invention showing the preferred positioning of two, single tensioning devices **11** attached to a wheel **16**. In this embodiment, the tensioning devices **11** are approximately 180 degrees from each other and their respective cords **20** and hooks **18** extend in opposite directions.

[0049] Referring now also to Figure 10B and 10C, Figure 10B is a diagrammatic view of one embodiment of the present invention showing the preferred positioning of a single, tensioning device **11'** attached to a first cord **20** and a second cord **20a** that each have their respective hooks **18**. In this embodiment, the tensioning device **11'** is centered with the exterior of the wheel **16** to provide equal tension on the first cord **20a** and the second cord **20b** which extend parallel to each other.

[0050] Figure 10C is a diagrammatic view of one embodiment of the present invention showing the preferred positioning of a single, tensioning device **11''** attached to a first cord **20**, a second cord **20b**, and a third cord **20c** that each have

their respective hooks **18**. The tensioning device **11''** is centered with the exterior of the wheel **16** to provide equal tension on the first cord **20a**, the second cord **20b**, and the third cord **20c**, which extend approximately 120 degrees from each other.

[0051] Now referring also to Figure 11A that shows another embodiment of the tensioning device of the present invention wherein the tensioning device **11'** tensions a first cord **20a** and a second cord **20b**. Referring now also to Figure 11B, which shows another embodiment of the tensioning device **11'** of the present invention, wherein the tensioning device **11''** applies tension to a first cord **20a**, a second cord **20b** and a third cord **20c**.

[0052] Now referring also to Figure 12A, Figure 12A is a perspective view of one embodiment an alternate ratchet spool **100'** of the present invention showing the ratchet spool **100'** configuration of having a first cord **20a** and a second cord **20b** that are attached to the ratchet spool **100'** and wound in the channel **124**. In this embodiment, only two catches **104** are on the under surface **132** of the ratchet spool **100'**, because less space is available. The first cord **20a** and second cord **20b** have a first knob **128a** fitted to their respective ends sized to fit snugly into the ratchet spool recess **130** to prevent the first cord **20a** and the second cord **20b** from being pulled off of the ratchet spool **100'**.

[0053] Referring now also to Figure 12B, Figure 12B shows a perspective view of an embodiment of the present invention showing a further alternate ratchet spool **100''** configuration having a first cord **20a**, a second cord **20b**, and a third cord **20c**.

[0054] Referring now to Figure's 13-16B, there is illustrated an alternate tensioning device **11'''** having a housing **12'''** having a housing top **12a'''** and a housing bottom **12b'''**. There are holes **29** where rivets (not shown) will be inserted to attach the housing top **12a'''** and the housing bottom **12b'''** as in the other embodiments of the tensioning device. Located on the housing top **12a'''** is a top button **138**. Additionally, on the side of the housing **12'''** are a first side button **136a** and a second mirroring side button **136b** (not shown). Protruding from the housing **12'''** is a grommet **32** from which a cord **20** (not shown) may pass.

[0055] Figure 14 shows an exploded view of the tensioning device **11'''** shown in Figure 13. A wave spring **112** sits on the inside of the housing bottom **12b'''** and is positioned in a way to apply pressure to the ratchet spool **100'''**. A washer **156** is placed in between the wave spring **112** and the ratchet spool **100'''**. The tension spring **110** also rests inside the ratchet spool **100'''** and has a crimp **122** that may be inserted into a notch **120** (not shown) in the ratchet spool **100'''** to secure the tension spring **110** to the ratchet spool **100'''**. The ratchet spool **100'''** has a channel **124** running around the outside of the ratchet spool **100'''** in the center and is sufficiently wide and deep enough for a cord **20** (not shown) to be wound around it. On the top of the ratchet spool **100'''** are ratchet teeth **102**. The ratchet teeth **102** engage with the housing teeth **118** (not shown). In addition, there is a pawl **152** connected to each of the side buttons **136** with a pivot point **150**. The side buttons **136** are spring loaded with a pawl spring **154**. As seen in Fig. 16A and 16B, the ratchet teeth **102** engage with the housing teeth **118** (not shown) located in the housing top **12a'''**

when the top button **138** is in the up position. When the top button **138** is in the up position, the ratchet spool **100'''** may only move in the wind-in direction to tighten the cord **20** (not shown). In this mode, the side buttons **136** are pushed into the housing **12'''**. When the top button **138** is in the down position, the ratchet spool **100'''** may move in either the wind-in or the wind-out direction. In this mode, the side buttons **136** are pushed out of the housing **12'''** by the force of the spring **154**.

[0056] Referring now also to Figure 15, showing the positioning of the top button **138** and the side buttons **136** when the top button **138** is in the up position. Here, the side buttons **136** are pushed into the housing **12'''**. Two button springs **154** rest against the interior of the housing top **12a'''** and apply pressure to move the side buttons **136** out of the housing **12'''**. However, the side buttons **136** do not move out of the housing because the pawls **152** are stopped by the top button **138**. When the top button bottom **138** is pushed down, the pawls **152** are no longer blocked and the side buttons **136** will pop out of the housing **12'''**. When housing teeth **118** are not in contact with the ratchet teeth **102** (not shown), the ratchet spool **100'''** (not shown) may rotate freely.

[0057] Referring now also to Figures 16A and 16B, Figure 16A, shows the arrangement of the side buttons **136**, the top button **138**, the ratchet teeth **102**, and the housing teeth **118** when the top button **138** is in the up position. When the top button **152** is in the up position, the pawls **152** engage with the ratchet teeth **102** and the ratchet spool **100'''** may only move in the wind-up direction. In this view, for clarity, the wave spring **112** is not shown.

[0058] Referring now also to Figure 16B, illustrating the arrangement of the top button 152, the ratchet teeth 102, and the housing teeth 118 when the top button 152 is in the down position. As the top button 152 gets pushed into to the down position, the force created by the button springs 154 (not shown) snaps the pawls 152 away from the ratchet teeth 118 so that the ratchet spool 100" may move in the wind-in or wind-out direction. To switch modes and prevent the ratchet spool 100" from rotating in the wind-out direction, the user presses the side buttons 136 back into the housing 12" to force the top button 138 back up and allow the pawls 152 to again come into contact with the ratchet teeth 118. In this view, for clarity, the wave spring 112 is not shown.

[0059] Although the preferred embodiments of the present invention have been described herein, the above description is merely illustrative. The scope of the claims should not be limited by the preferred embodiments set forth in the examples, but should be given the broadest interpretation consistent with the description as a whole.

What is Claimed is:

1. A tensioning device for placing tension on a snow chain for attachment to a wheel of a vehicle to provide traction, the tensioning device comprising:
 - a housing including:
 - at least one aperture;
 - a top having a set of housing teeth; and
 - a bottom having an inside and the inside having a top surface;
 - an actuating lever pivotally interconnected to the housing;
 - a cord;
 - a ratchet spool including:
 - an upper surface and an under surface;
 - a set of ratchet teeth on the upper surface, the ratchet teeth constructed and arranged to mate with the housing teeth; and
 - a channel in which sufficient space is provided to receive the cord between the upper surface and the under surface; the cord being interconnected with the ratchet spool;
 - a tension spring interconnected with the ratchet spool, the tension spring constructed and arranged to place a bias on the ratchet spool in a wind-up direction; and
 - a wave spring positioned between the top surface of the inside of the housing bottom and the under surface of the ratchet spool to bias the ratchet spool in the direction of the housing teeth; wherein the tensioning device can be interconnected with the snow chain so that the tensioning device can secure the snow chain to the wheel; wherein the actuating lever has an up position and a down position, the actuating lever having a cam that extends away from the point at which the actuating lever pivots with respect to the housing, wherein the cam holds the ratchet spool in a down position when the actuating lever is in an up position and the ratchet spool is in an up position when the pivotal actuating lever is in a down position.

2. The tensioning device of Claim 1, wherein the aperture is defined by the top and the bottom of the housing.
3. The tensioning device of Claim 1, wherein the ratchet teeth and the housing teeth are undercut at an angle of more than 90 degrees to a horizontal plane perpendicular to a vertical axis of the ratchet spool and the housing.
4. The tensioning device of Claim 1, wherein the ratchet spool has an up position and a down position; wherein the ratchet teeth engage the housing teeth when the ratchet spool is in the up position and the ratchet teeth do not engage the housing teeth when the ratchet spool is in the down position.
5. The tensioning device of Claim 1, wherein the ratchet spool further includes a catch on the bottom surface of the ratchet spool and the tensioning device further includes a stopper having an up position and a down position, the stopper being biased toward the up position in which the stopper will block the catch when the ratchet spool is in the down position so that the ratchet spool will not rotate more than 360 degrees in the wind-up direction when the ratchet spool is in a down position.
6. The tensioning device of Claim 1, further comprising a crimp at an exterior end of the tension spring and notch in an interior surface of the ratchet spool proximate a circumferential recess thereof, sufficiently sized to receive and hold the crimp.
7. The tensioning device of Claim 1, wherein the ratchet teeth and the housing teeth are undercut at an angle of from about 3 to about 30 degrees more than a 90 degree angle to a horizontal plane perpendicular to a vertical axis of the ratchet spool and the housing.

8. The tensioning device of Claim 1, further comprising a plurality of connection members for attaching the snow chain to the housing.
9. The tensioning device of Claim 1, wherein a joint between the top and the bottom is constructed and arranged to include a lip and groove that mate with one another.
10. The tensioning device of Claim 1, wherein a plurality of cords are interconnected to the ratchet spool.
11. The tensioning device of Claim 1, wherein the housing includes a plurality of apertures defined by the top and the bottom; wherein each of the respective plurality of cords extends through one of the respective plurality of apertures.
12. The tensioning device of Claim 1, wherein the cord is a portion of a cord sub-unit; the cord having first and second ends and the cord sub-unit further includes:
 - a first knob at the first end of the cord;
 - a second knob at the second end of the cord; and
 - a grommet encircling the cord; wherein the grommet has an opening through which the cord passes and the opening has a diameter that is constructed and arranged to prevent the passage of the first or second knob through the opening.
13. the tensioning device of Claim 12, wherein the grommet is engaged with the housing between the top and the bottom proximate the aperture.

14. A self-tensioning snow chain for attachment to a wheel of a vehicle, the self-tensioning snow chain comprising:

a snow chain for securing around the wheel; and

a tensioning device connected to the snow chain, the tensioning device including:

a housing including a top having a set of housing teeth; and a bottom; the housing defining at least one aperture;

an actuating lever pivotally interconnected to the housing;

a ratchet spool including: upper and under surfaces; a set of ratchet teeth on the upper surface, the ratchet teeth constructed and arranged to mate with the housing teeth;

a cord; the cord being attached to the ratchet spool;

a tension spring interconnected with the ratchet spool, the tension spring constructed and arranged to place a bias on the ratchet spool toward a wind-up direction; and

a spring positioned between a top surface of the housing bottom and the under surface of the ratchet spool so as to bias the ratchet spool in the direction of the housing teeth; wherein the snow chain is interconnected with the tensioning device and the cord can be connected with the snow chain so that the tensioning device can secure the snow chain to the wheel;

wherein the ratchet spool can be pushed in the direction away from the housing teeth with the actuating lever;

wherein the actuating lever has an up position and a down position, the actuating lever having a cam that extends away from the point at which the actuating lever pivots with respect to the housing, wherein the cam holds the ratchet spool in a down position in which the ratchet teeth are disengaged from the housing teeth when the actuating lever is in an up position, and the ratchet spool is in an up position when the pivotal actuating lever is in a down position.

15. The self-tightening snow chain of Claim 14, wherein the ratchet teeth and the housing teeth are undercut at an angle of more than 90 degrees to a horizontal plane perpendicular to a vertical axis of the ratchet spool and the housing.

16. The self-tightening snow chain of Claim 15, wherein the angle is from about 3 to about 30 degrees more than a 90 degree angle to a horizontal plane perpendicular to a vertical axis of the ratchet spool and the housing.

17. The self-tightening snow chain of Claim 14, further comprising a crimp at an exterior end of the tension spring and notch in an interior surface of the ratchet spool proximate a circumferential recess thereof, sufficiently sized to receive and hold the crimp.

18. The self-tightening snow chain of Claim 14, wherein a joint between the top and bottom of the housing is constructed and arranged to include a lip and a groove that mate with one another.

19. The self-tightening snow chain of Claim 14, wherein the cord is a portion of a cord sub-unit; the cord having first and second ends and the cord sub-unit further includes:

- a first knob at the first end of the cord;

- a second knob at the second end of the cord; and

- a grommet encircling the cord; wherein the grommet has an opening through which the cord passes and the opening has a diameter that is constructed and arranged to prevent the passage of the first or second knob through the opening.

20. The self-tightening snow chain of Claim 19, wherein the grommet is engaged with the housing between the top and the bottom within the aperture.

21. The self-tightening snow chain of Claim 19, wherein the tensioning device includes a plurality of cord sub-units and each of the cords is interconnected to the ratchet spool.

22. The self-tensioning snow chain of Claim 21, wherein the tensioning device includes a plurality of apertures and each of the plurality of grommets which encircle each of the respective cords is engaged within an aperture.

23. A tensioning device comprising:

- a housing including a top having a set of housing teeth; and a bottom; the housing defining at least one aperture;

- an actuating lever pivotally interconnected to the housing;

- a ratchet spool including: upper and under surfaces; a set of ratchet teeth on the upper surface, the ratchet teeth constructed and arranged to mate with the housing teeth;

- a cord; the cord being attached to the ratchet spool;

- a tension spring interconnected with the ratchet spool, the tension spring constructed and arranged to place a bias on the ratchet spool toward a wind-up direction; and

- a spring positioned between a top surface of the housing bottom and the under surface of the ratchet spool so as to bias the ratchet spool in the direction of the housing teeth; wherein the snow chain is interconnected with the tensioning device and the cord can be connected with the snow chain so that the tensioning device can secure the snow chain to the wheel; wherein the ratchet spool can be pushed in the direction away from the housing teeth with the actuating lever; wherein the actuating lever has an up position and a down position, the actuating lever having a cam that extends away from the point at which the actuating lever pivots with respect to the housing, wherein the cam holds the ratchet spool in a down position in which the ratchet teeth are

disengaged from the housing teeth when the actuating lever is in an up position, and the ratchet spool is in an up position when the pivotal actuating lever is in a down position.

24. The tensioning device of Claim 23, wherein the ratchet teeth and the housing teeth are undercut at an angle of more than 90 degrees to a horizontal plane perpendicular to a vertical axis of the ratchet spool and the housing.

25. The tensioning device of Claim 24, wherein the angle is from about 3 to about 30 degrees more than a 90 degree angle to a horizontal plane perpendicular to a vertical axis of the ratchet spool and the housing.

26. The tensioning device of Claim 23, further comprising a crimp at an exterior end of the tension spring and notch in an interior surface of the ratchet spool proximate a circumferential recess thereof, sufficiently sized to receive and hold the crimp.

27. The tensioning device of Claim 23, wherein a joint between the top and bottom of the housing is constructed and arranged to include a lip and a groove that mate with one another.

28. The tensioning device of Claim 23, wherein the cord is a portion of a cord sub-unit; the cord having first and second ends and the cord sub-unit further includes:

- a first knob at the first end of the cord;

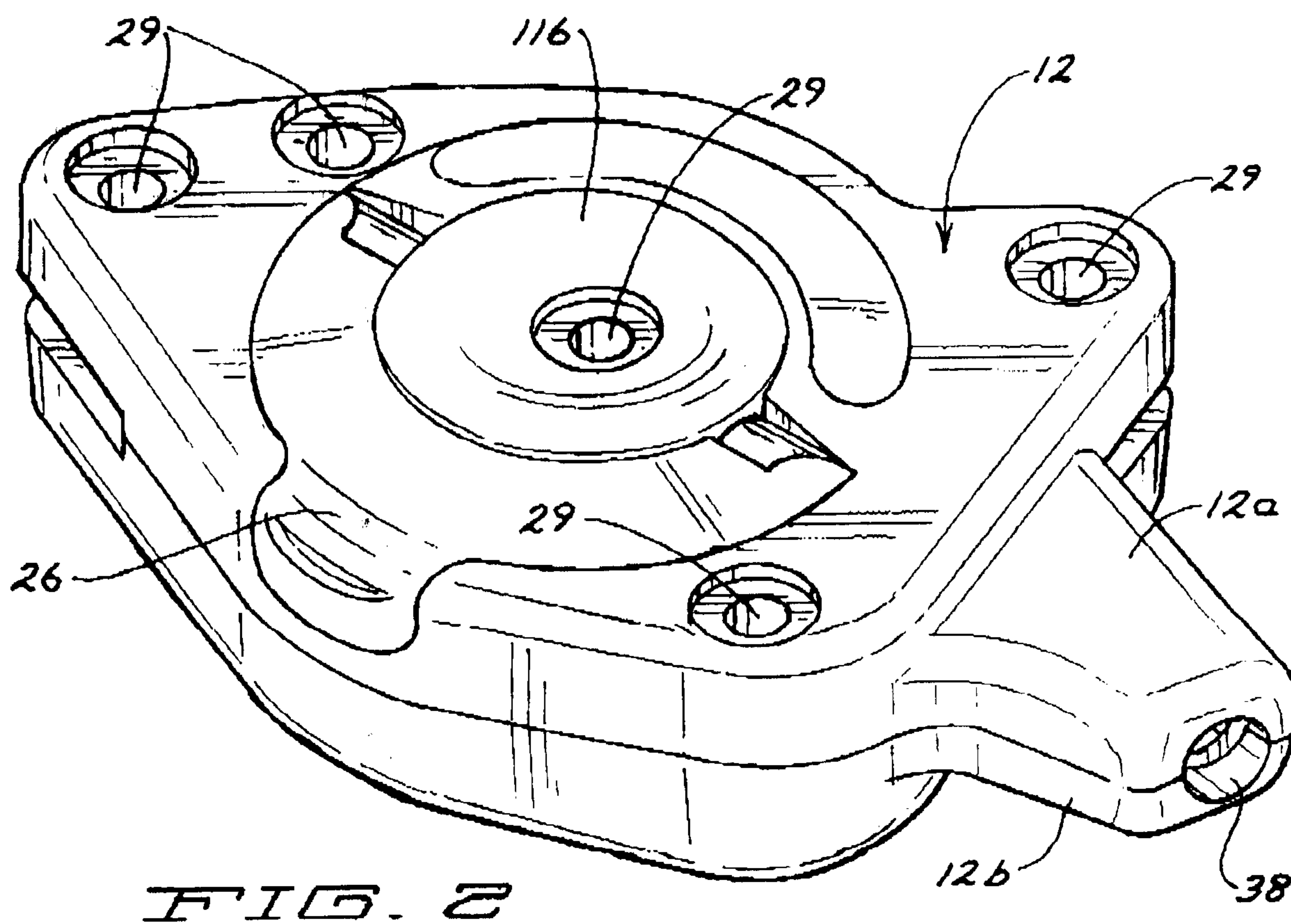
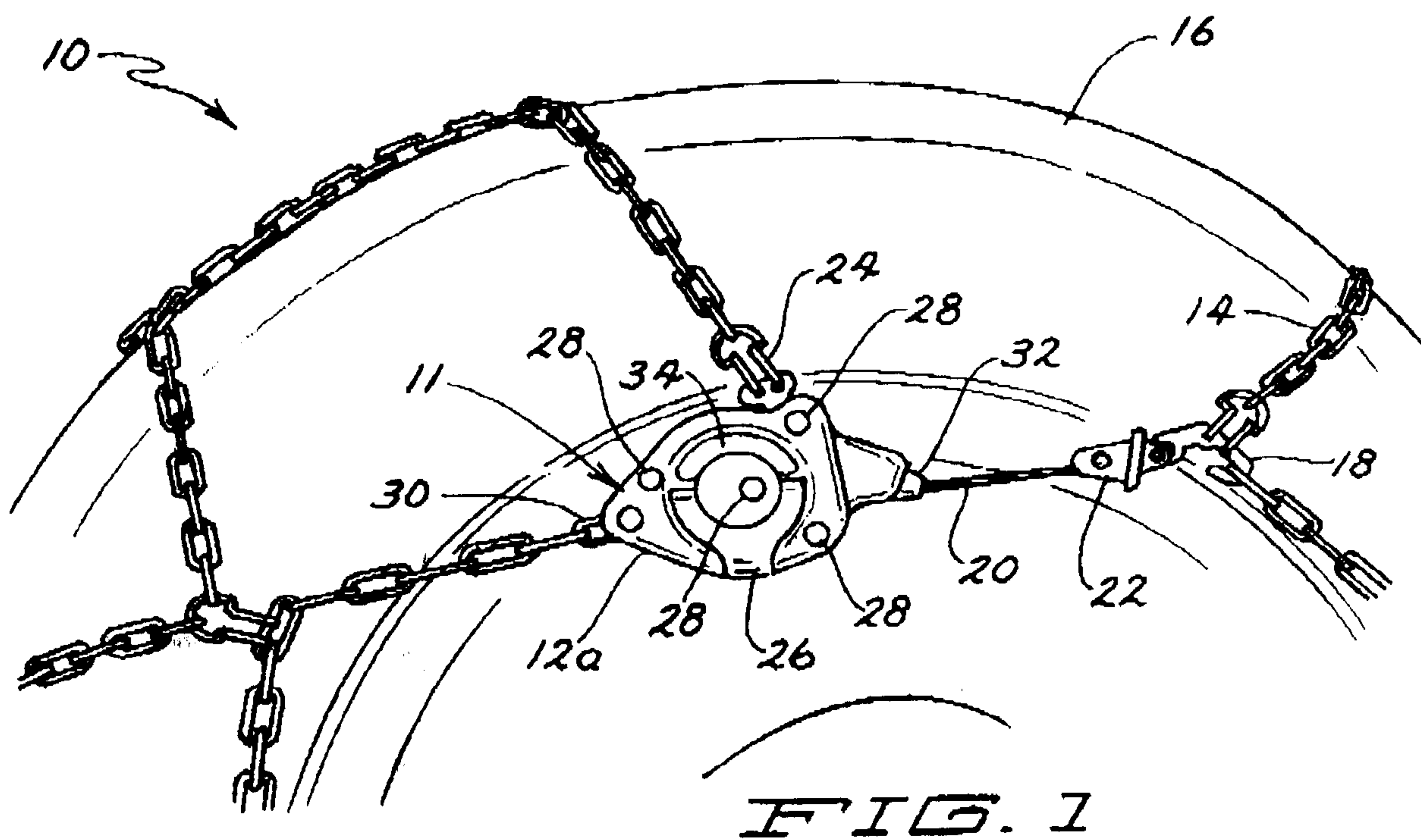
- a second knob at the second end of the cord; and

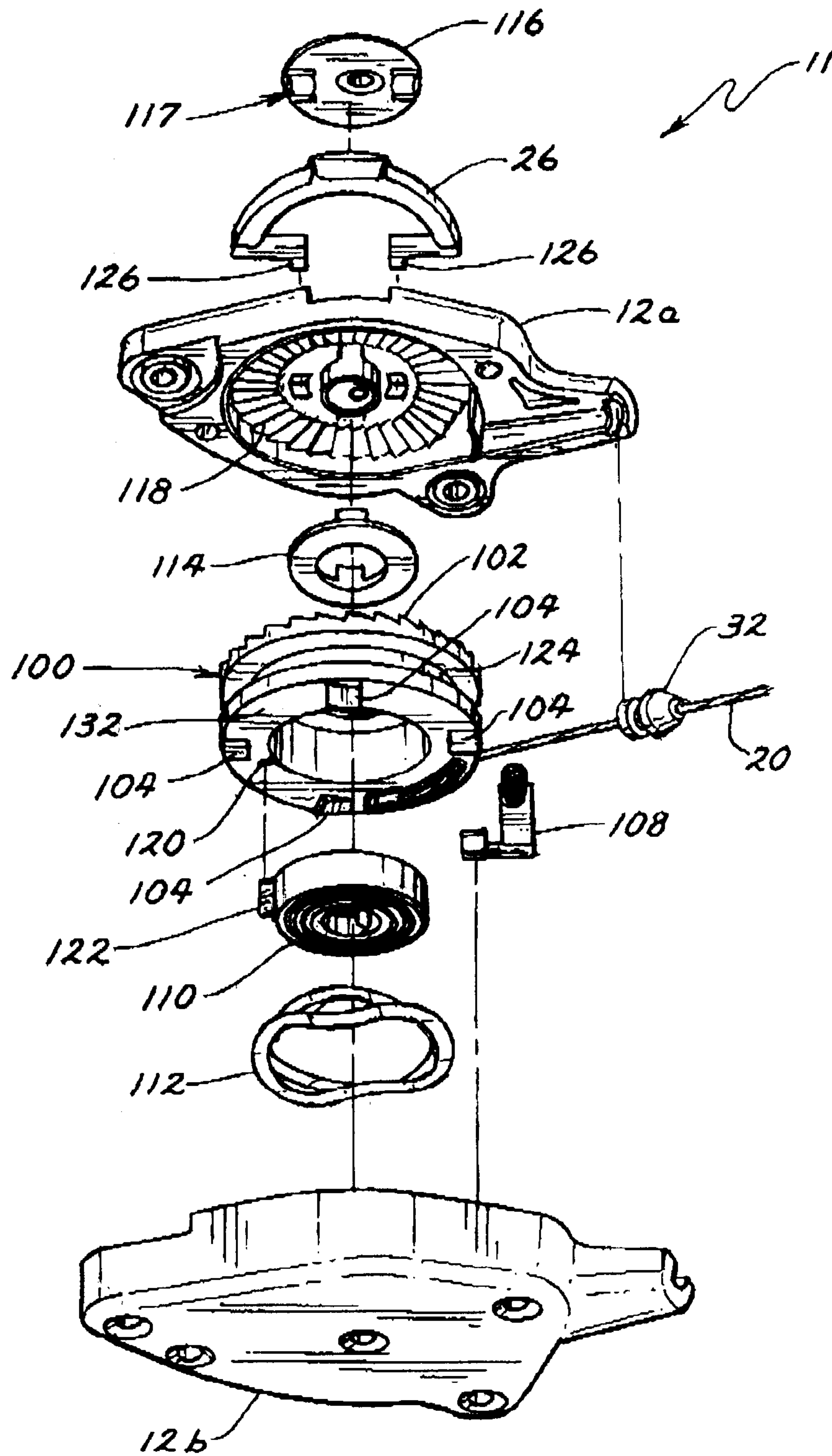
- a grommet encircling the cord; wherein the grommet has an opening through which the cord passes and the opening has a diameter that is constructed and arranged to prevent the passage of the first or second knob through the opening.

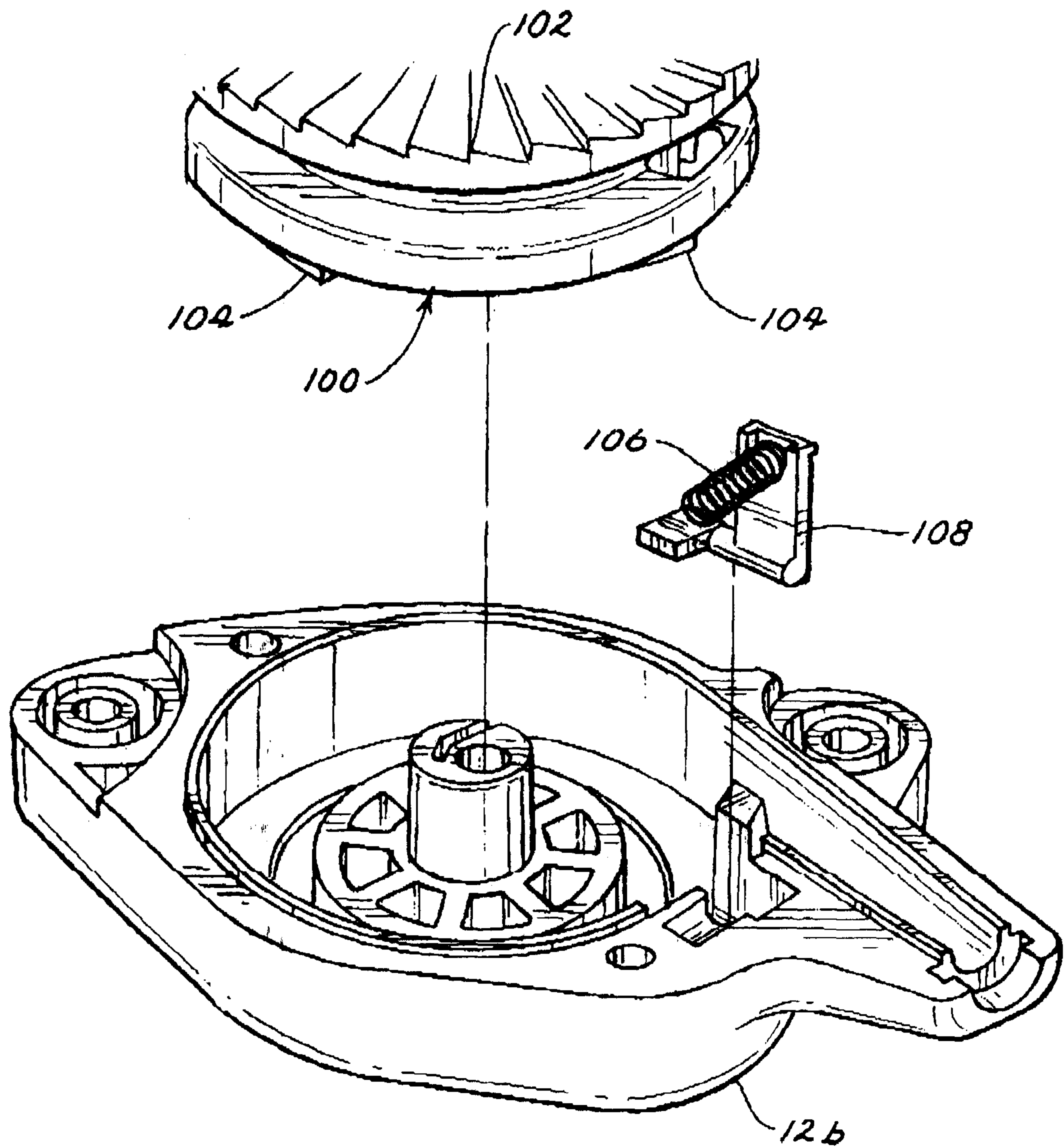
29. The tensioning device of Claim 28, wherein the grommet is engaged with the housing between the top and the bottom within the aperture.

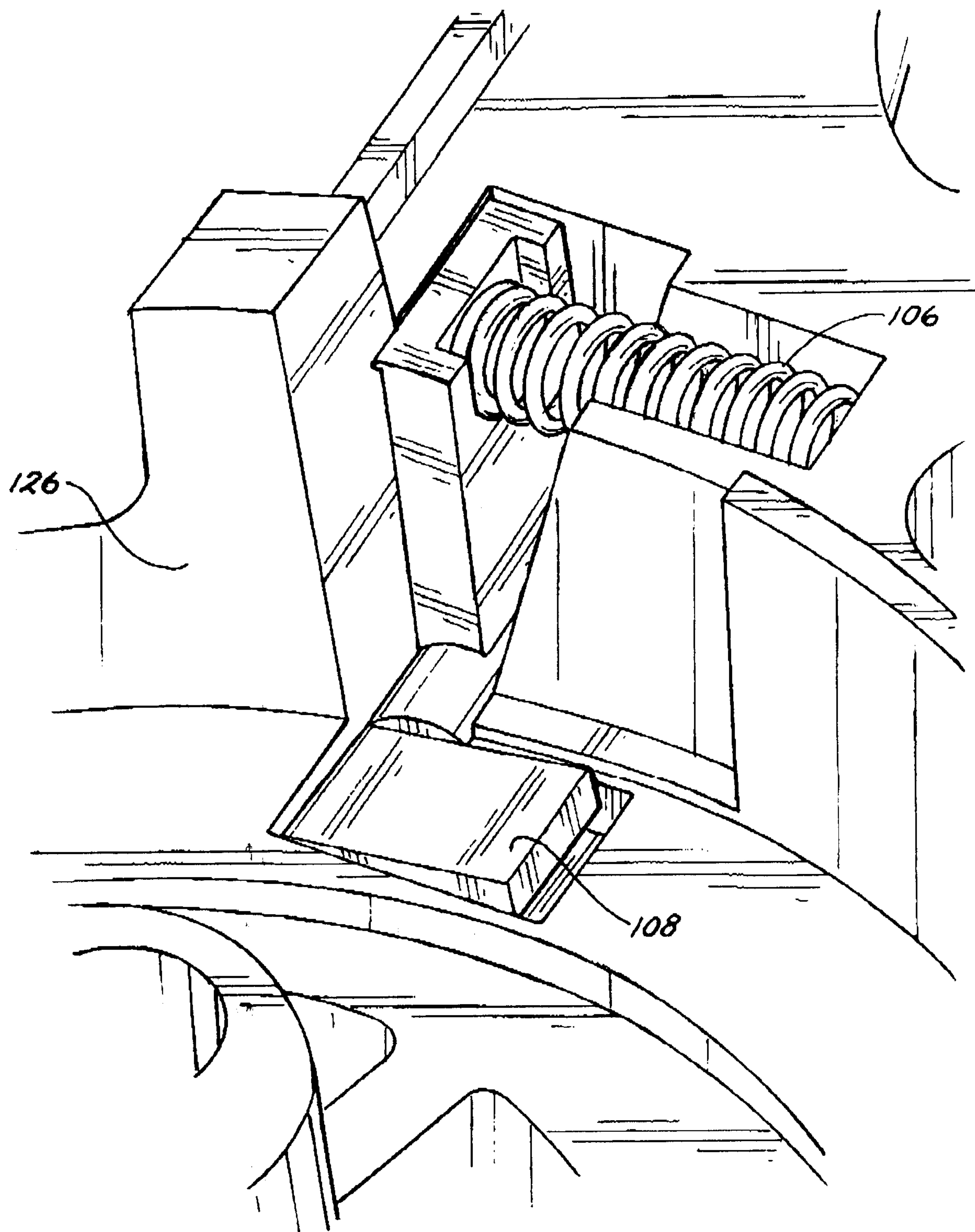
30. The tensioning device of Claim 28, wherein the tensioning device includes a plurality of cord sub-units and each of the cords is interconnected to the ratchet spool.

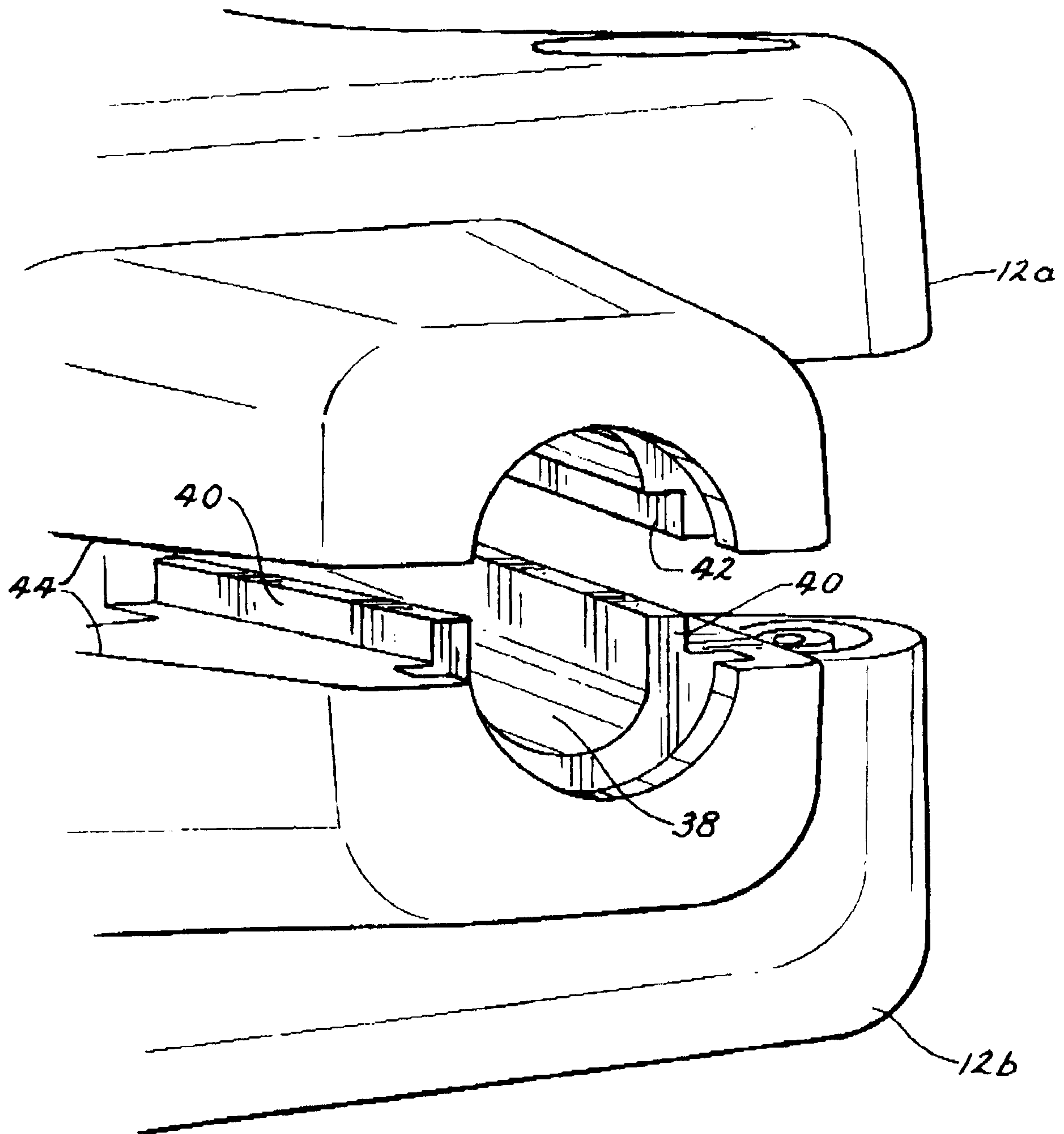
31. The tensioning device of Claim 30, wherein the tensioning device includes a plurality of apertures and each of the plurality of grommets which encircle each of the respective cords is engaged within an aperture.

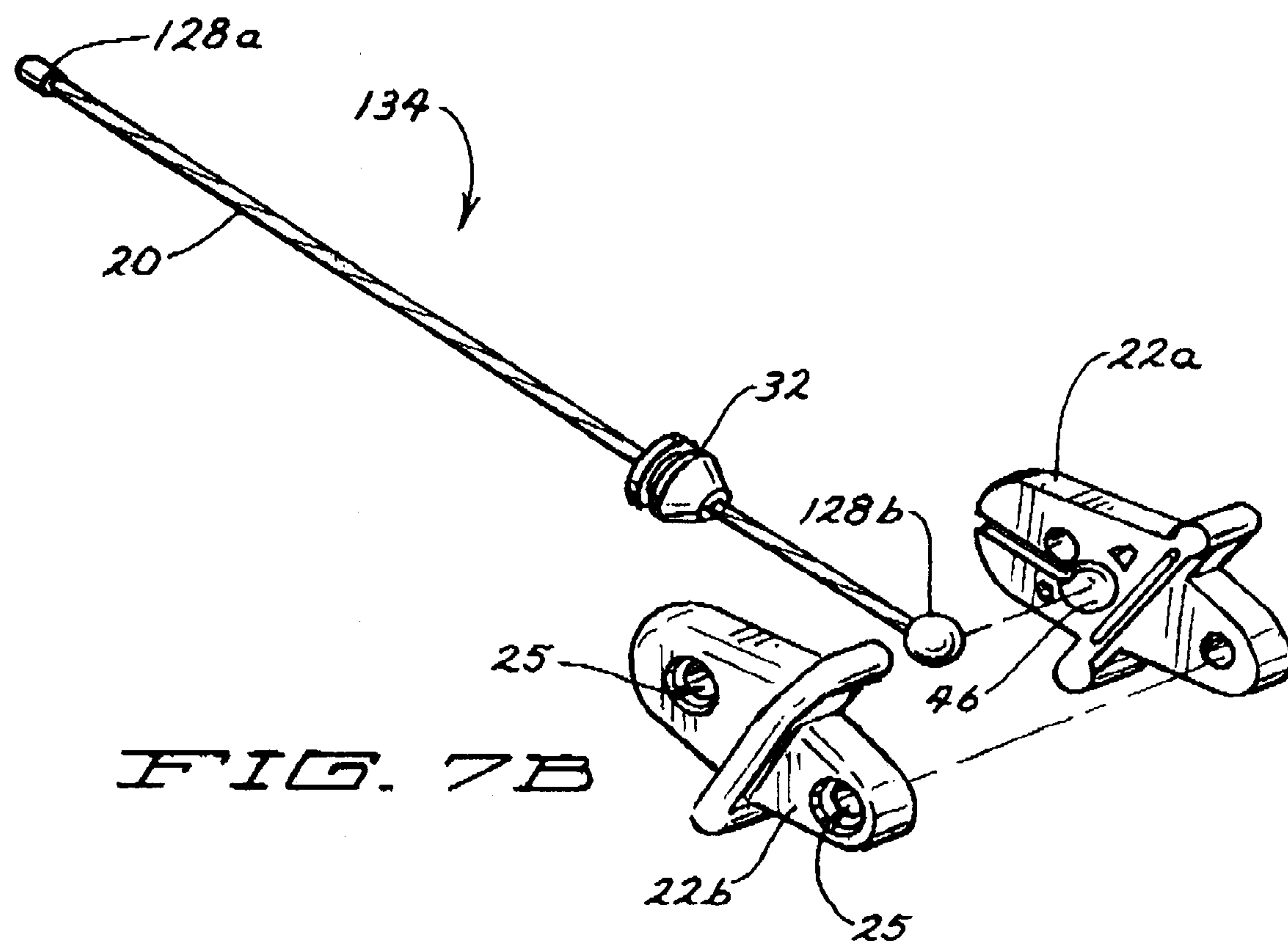
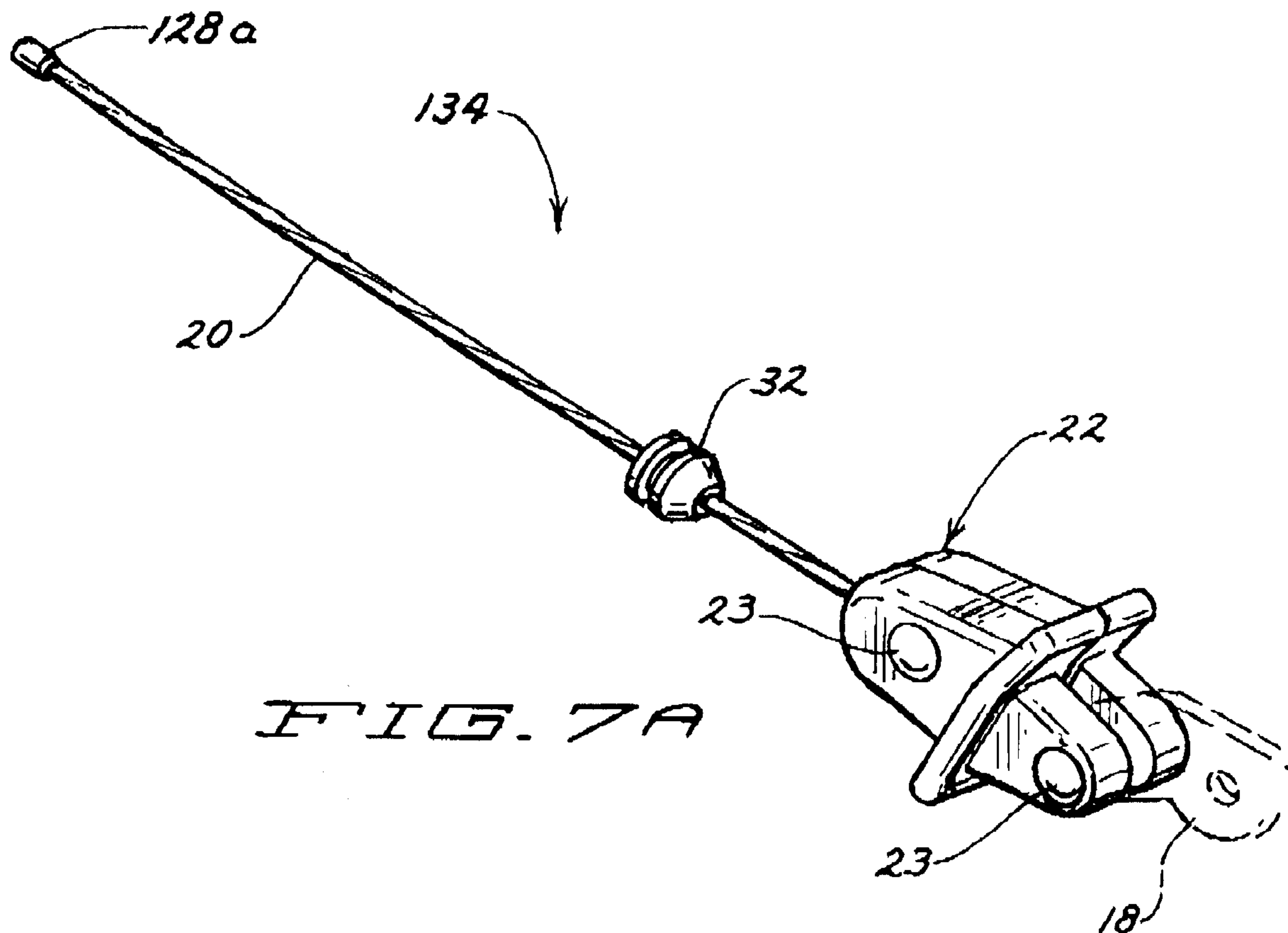


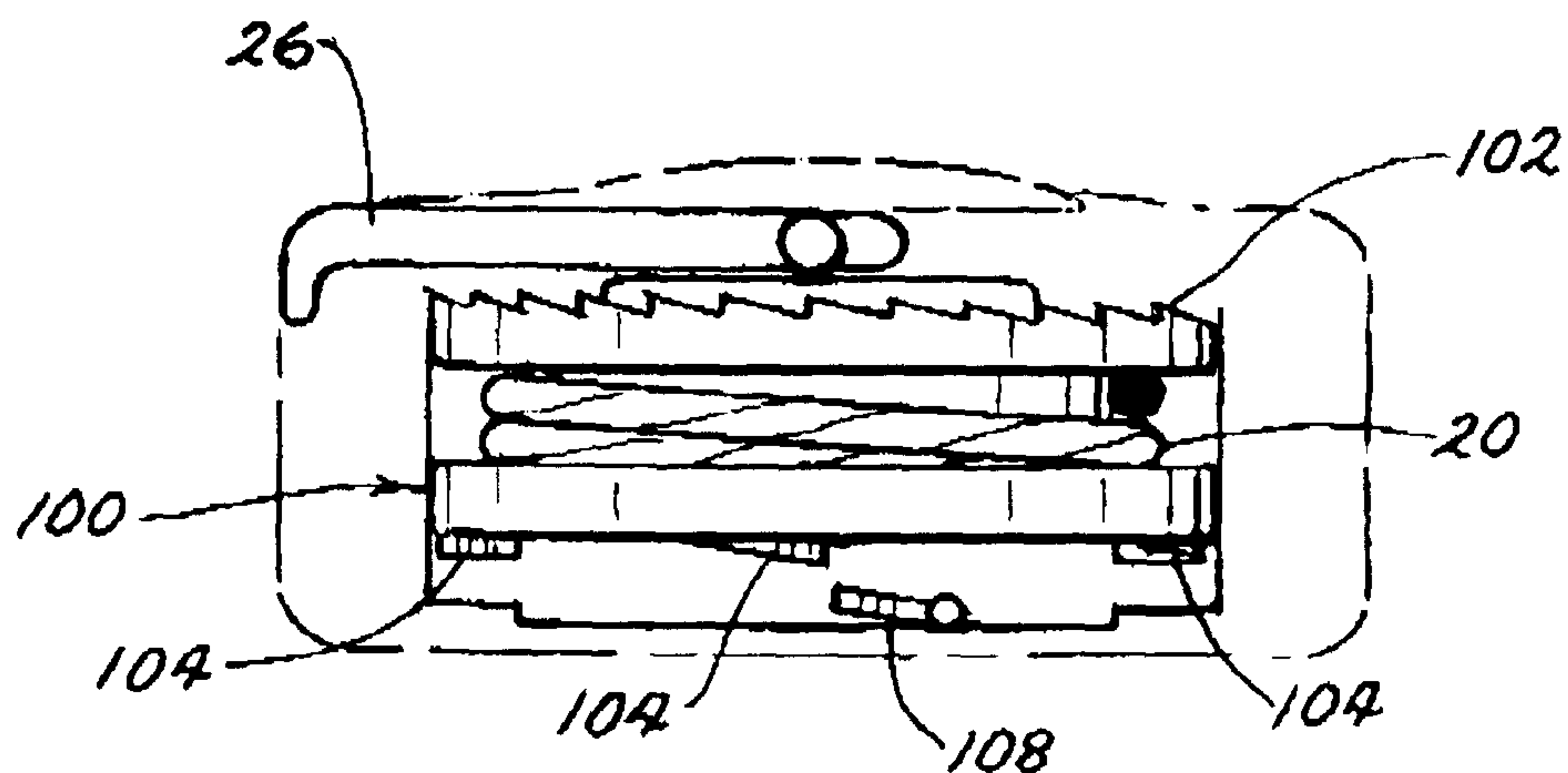
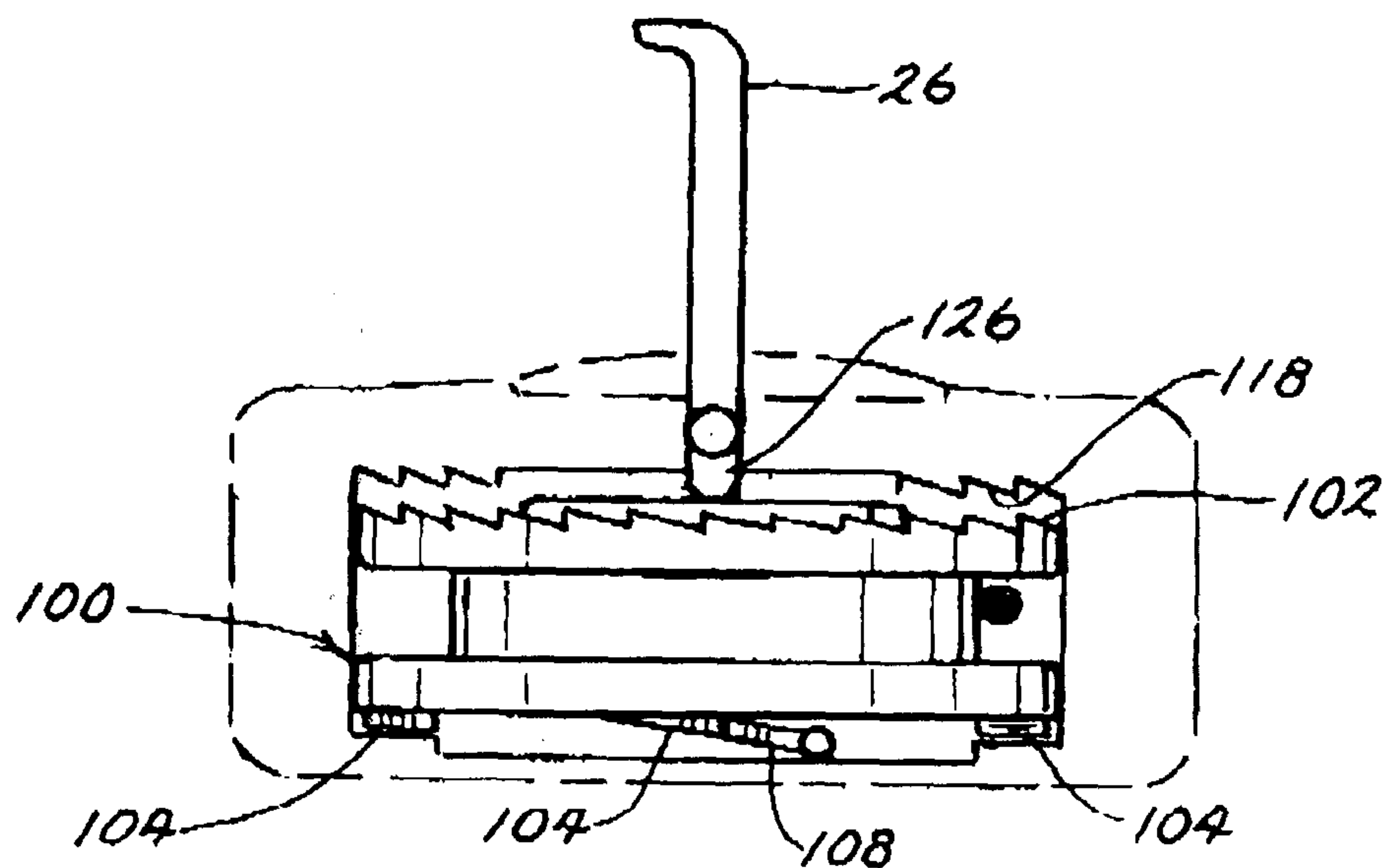
**FIG. 3**

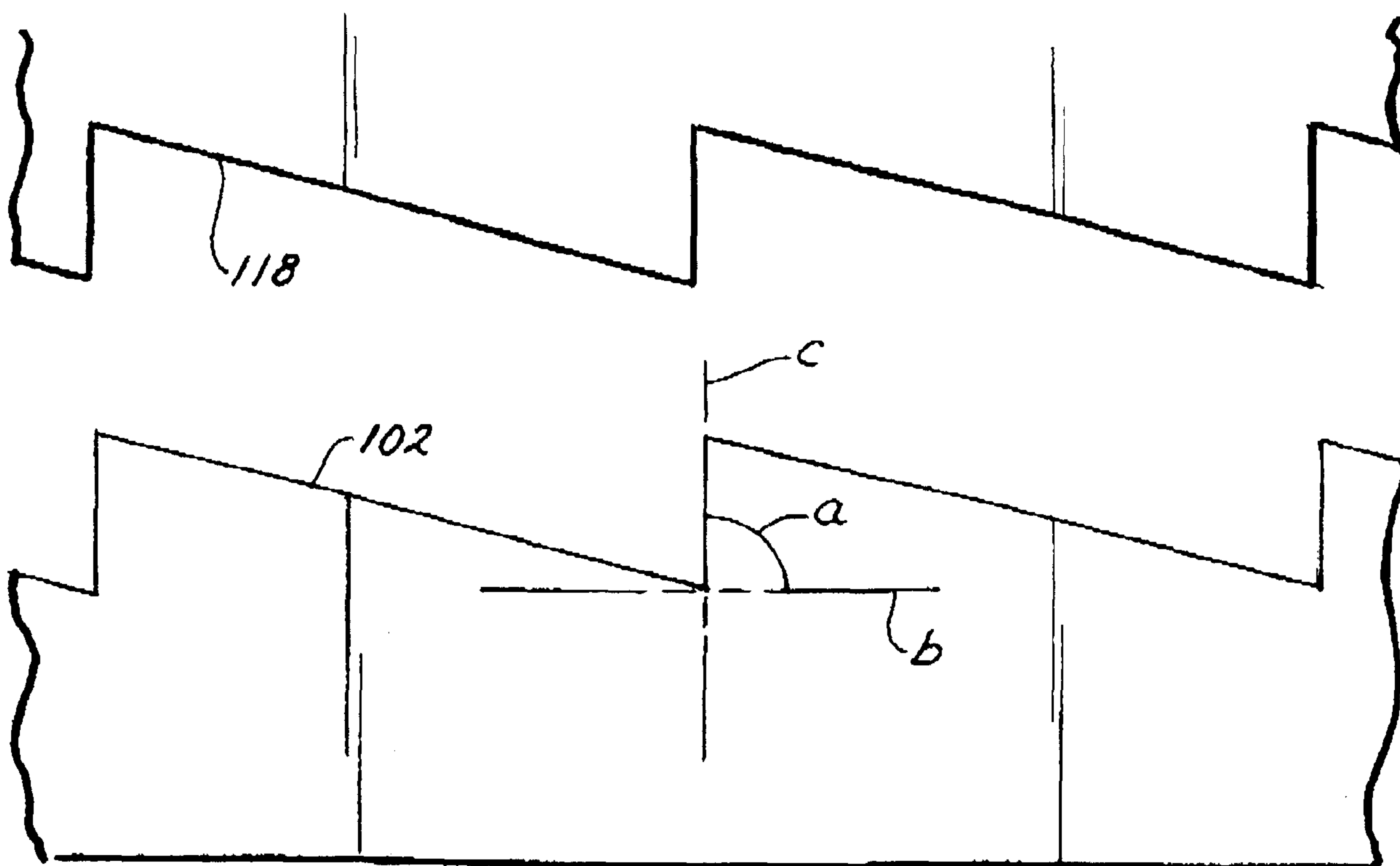
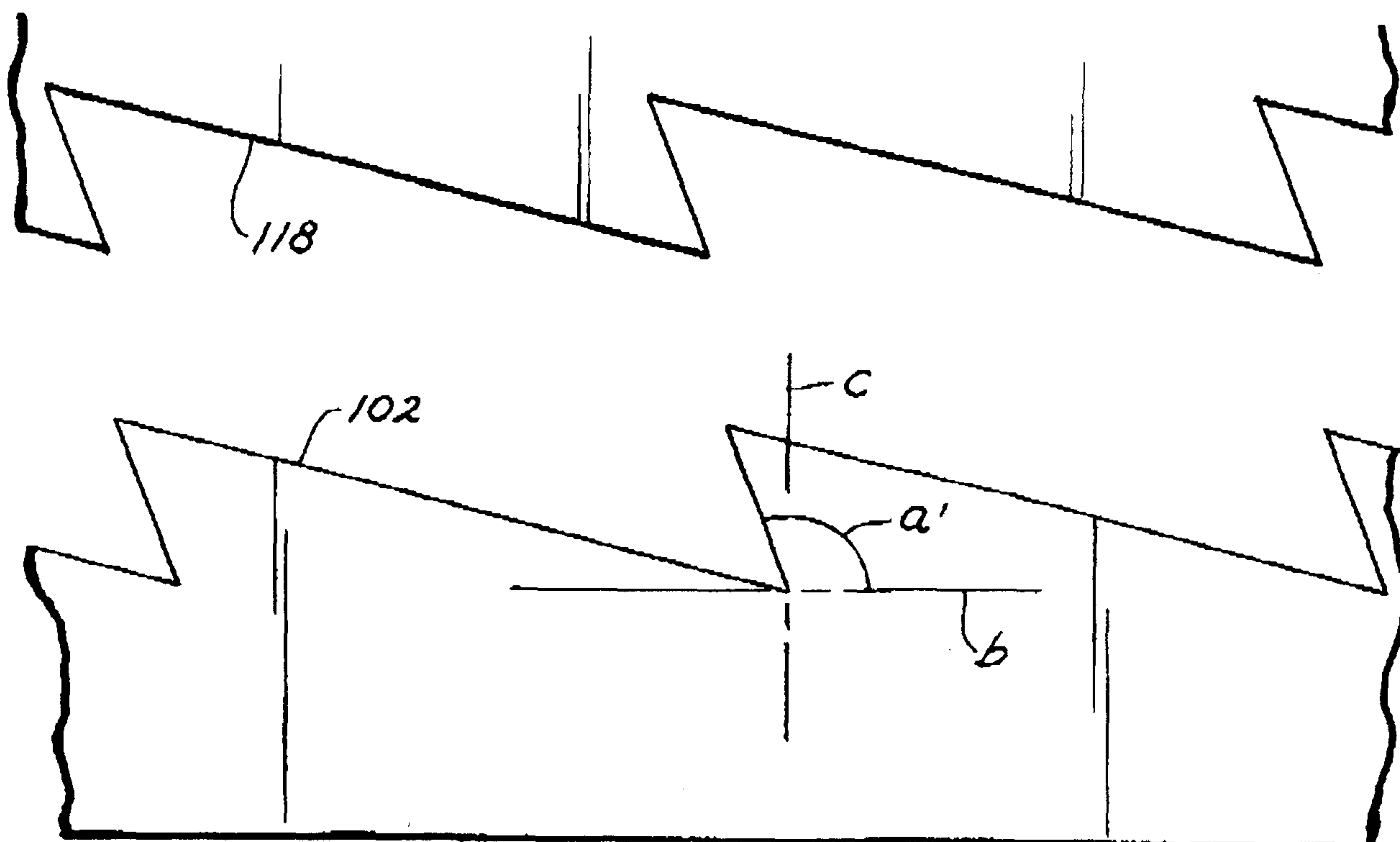
*FIG. 4*

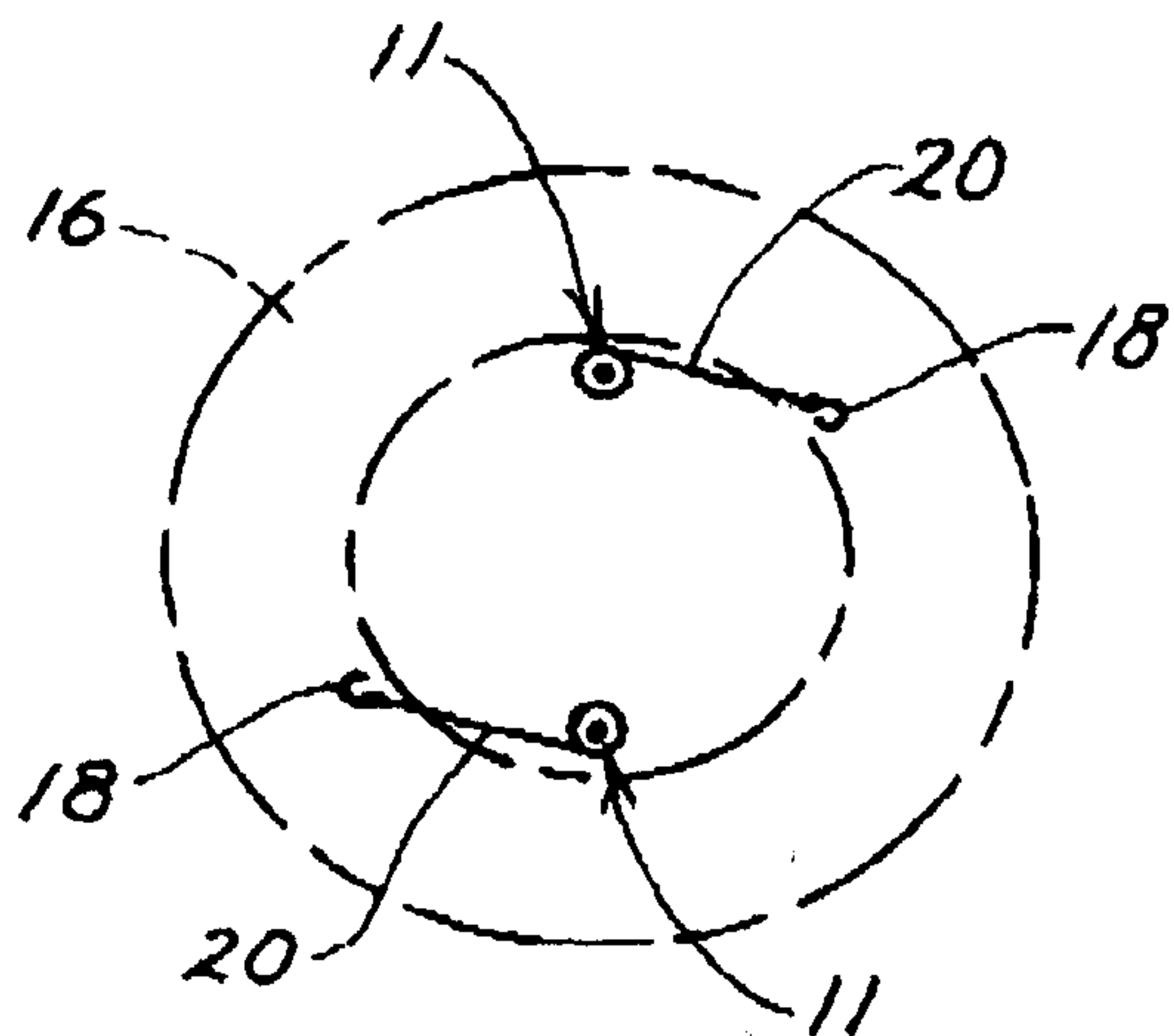
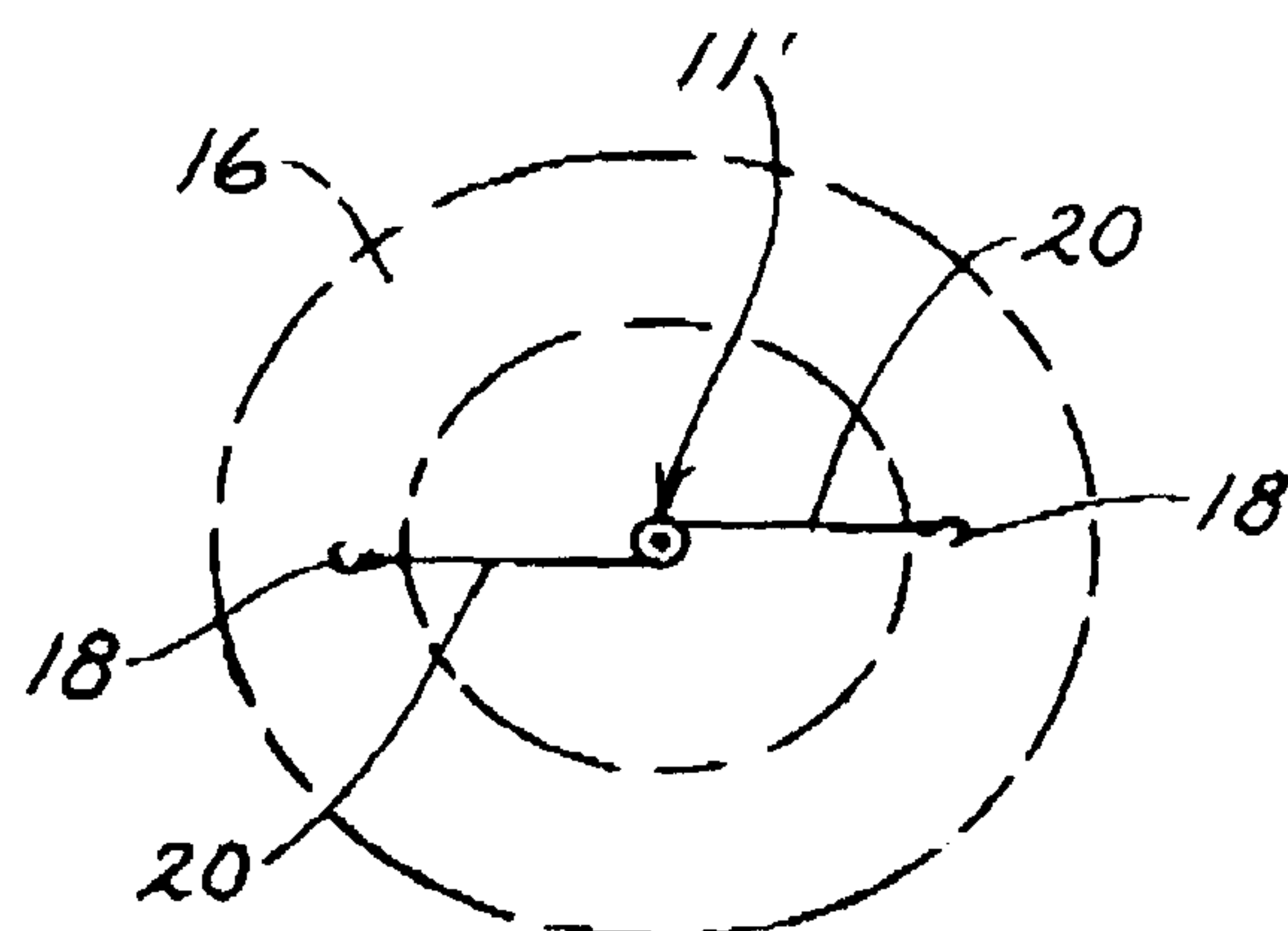
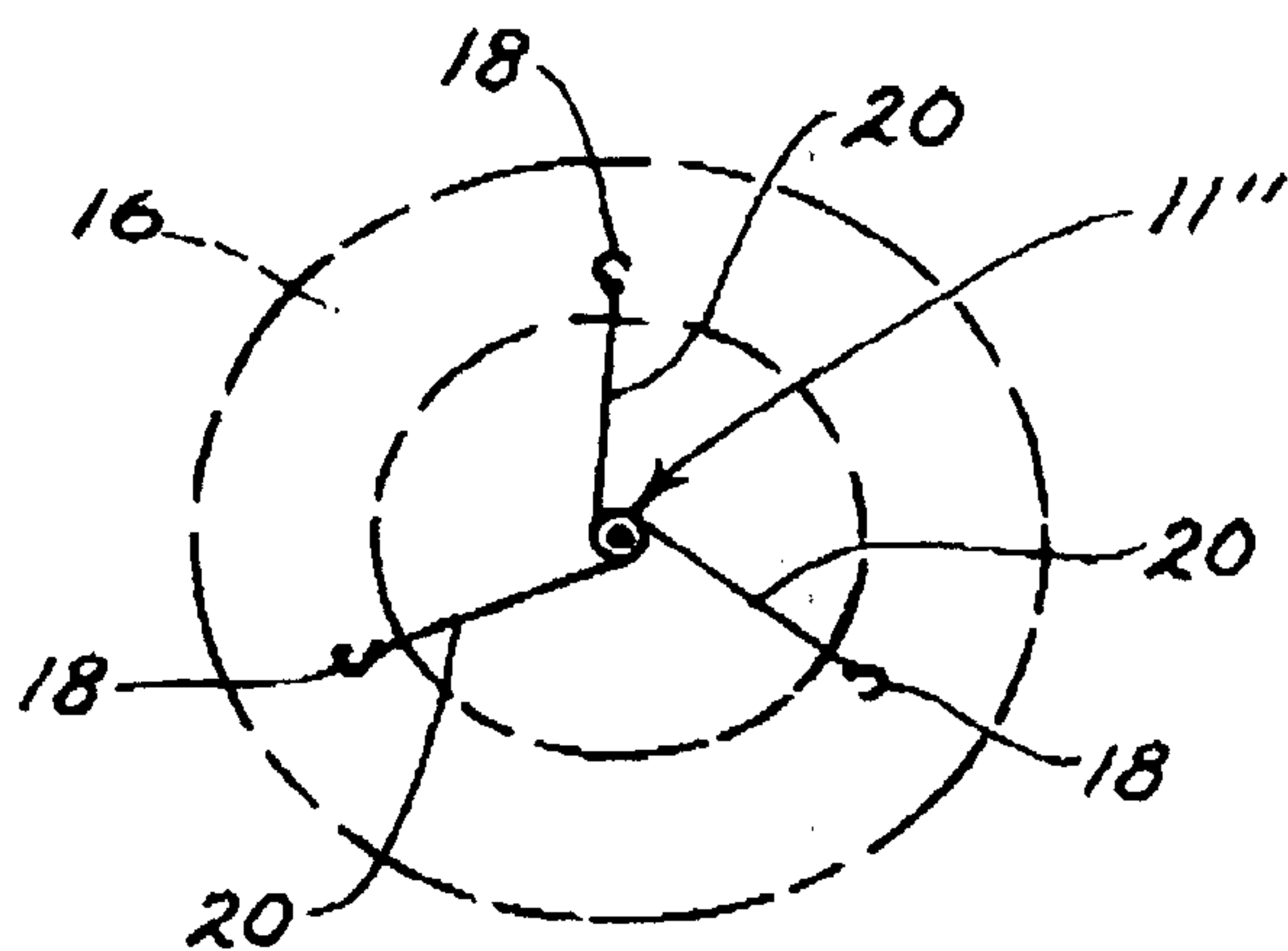
*FIG. 5*

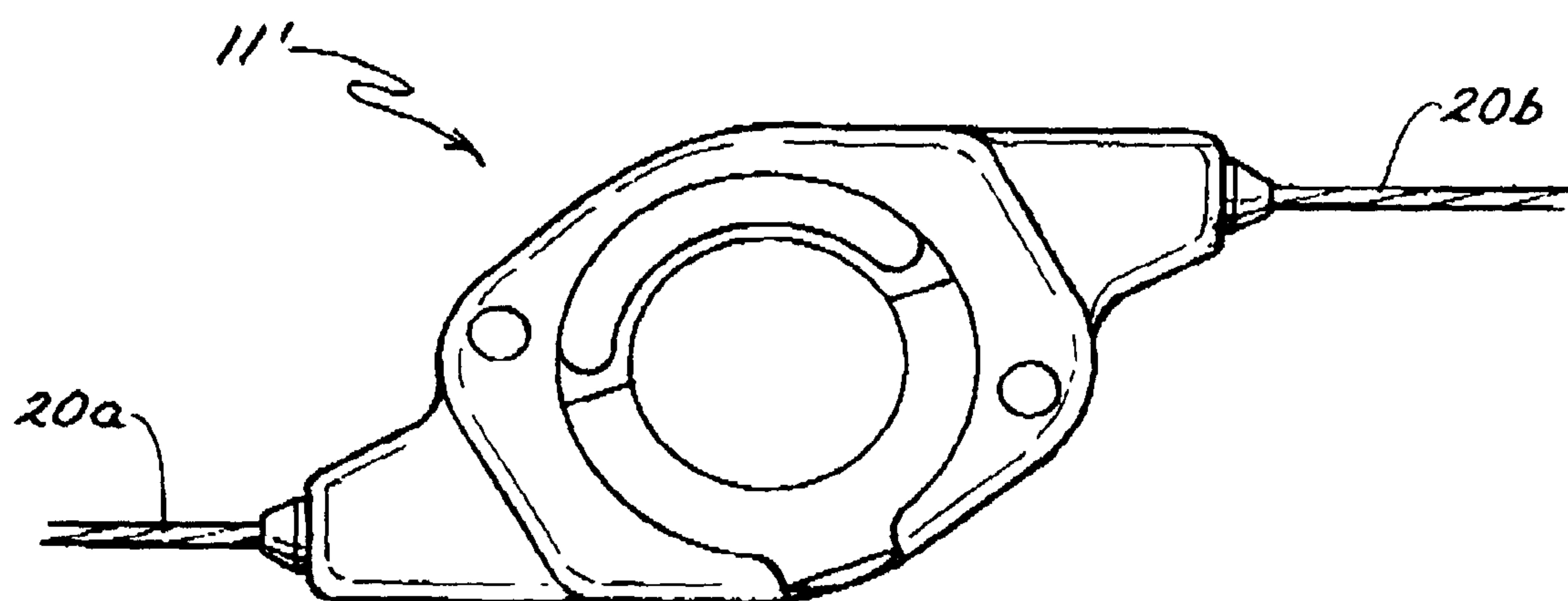
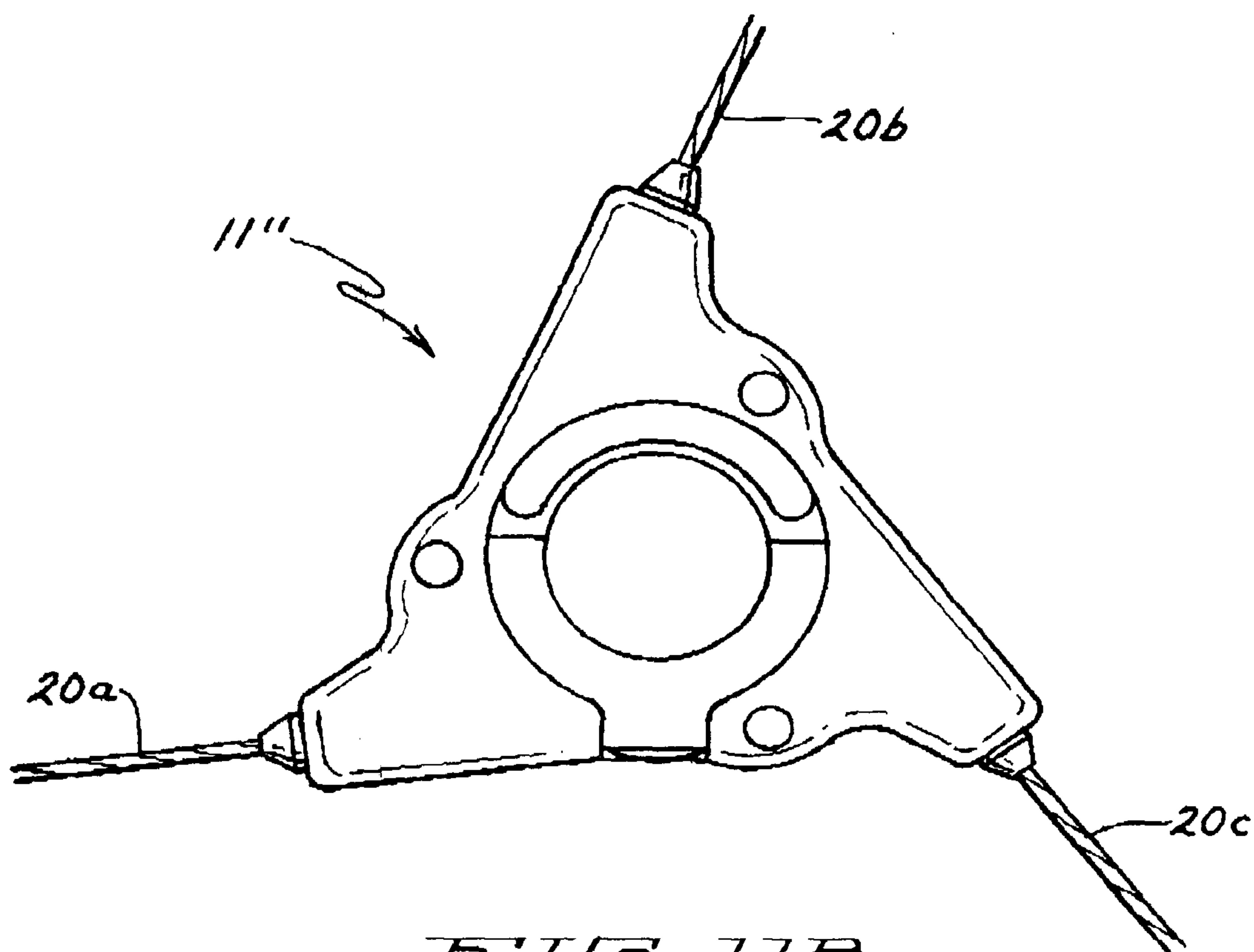
*FIG. 6*

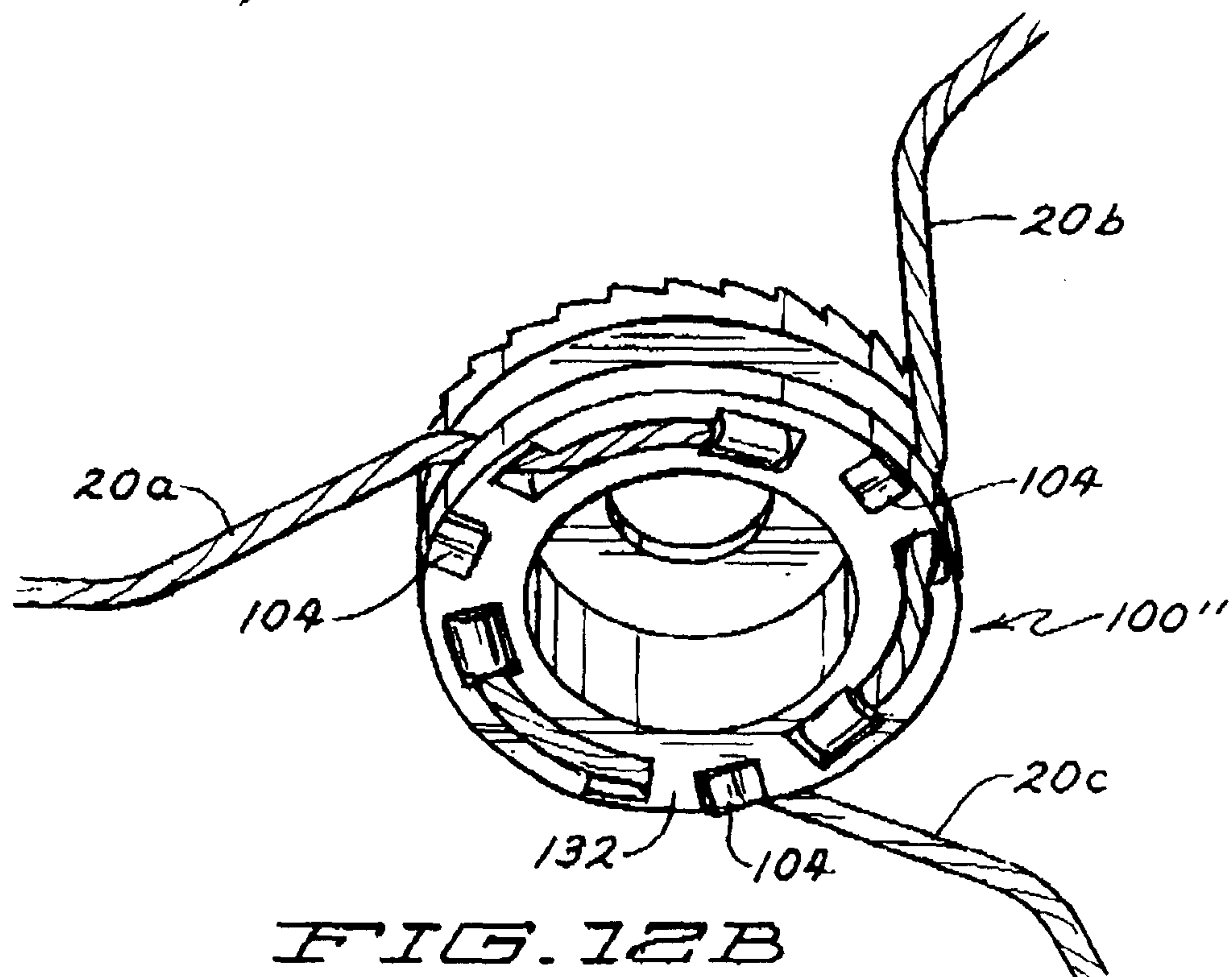
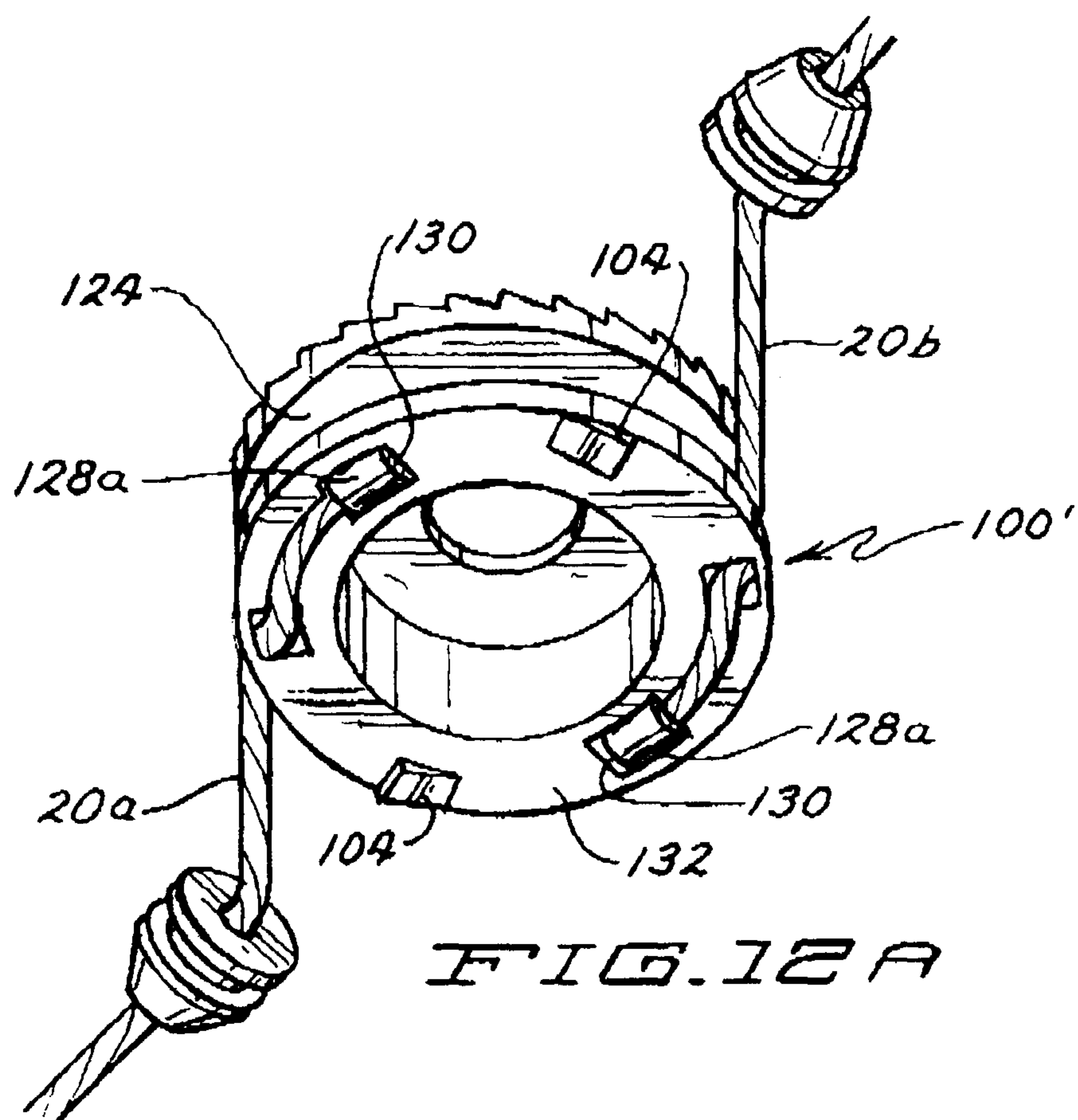


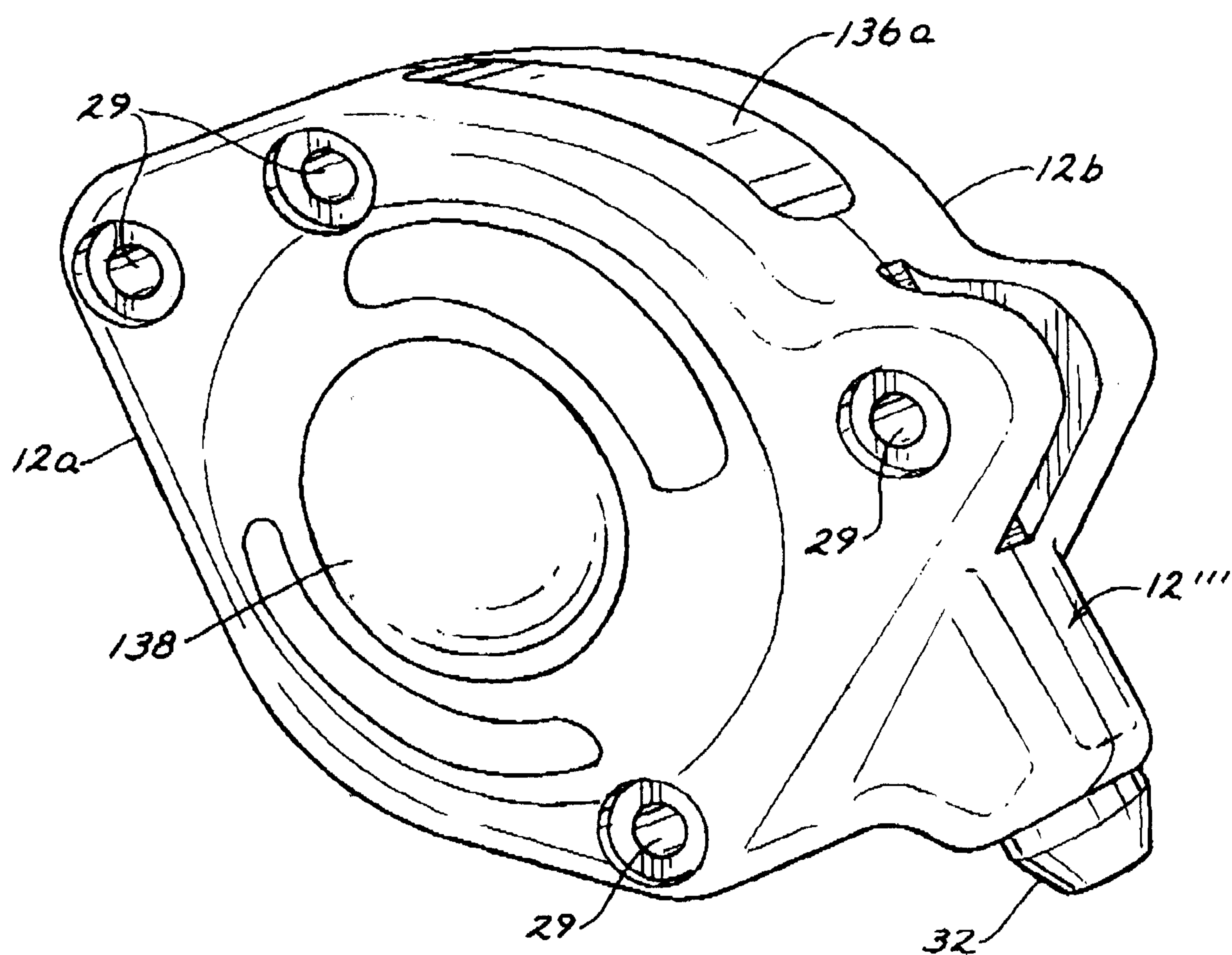
*FIG. 8A**FIG. 8B*

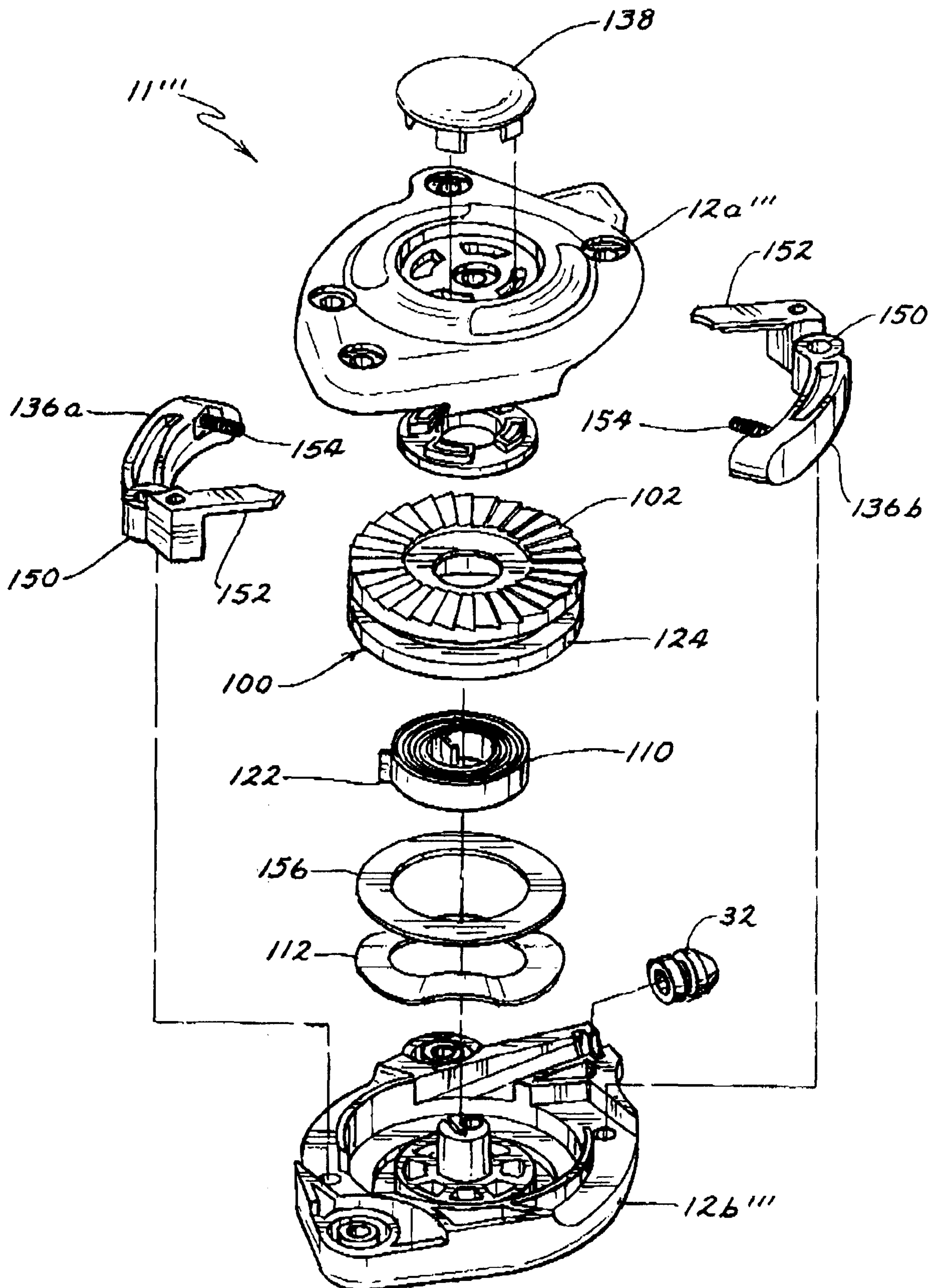
*FIG. 9A**FIG. 9B*

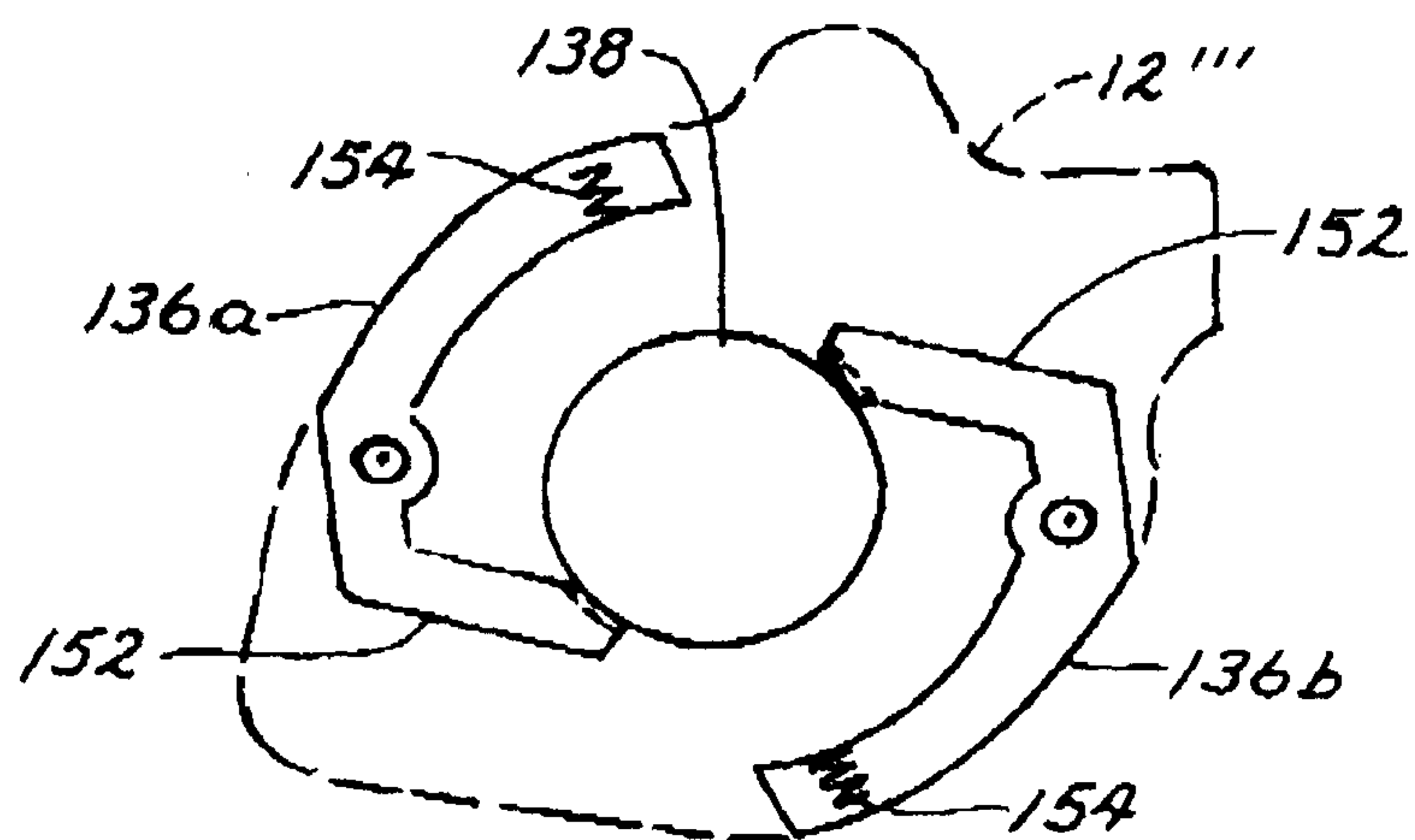
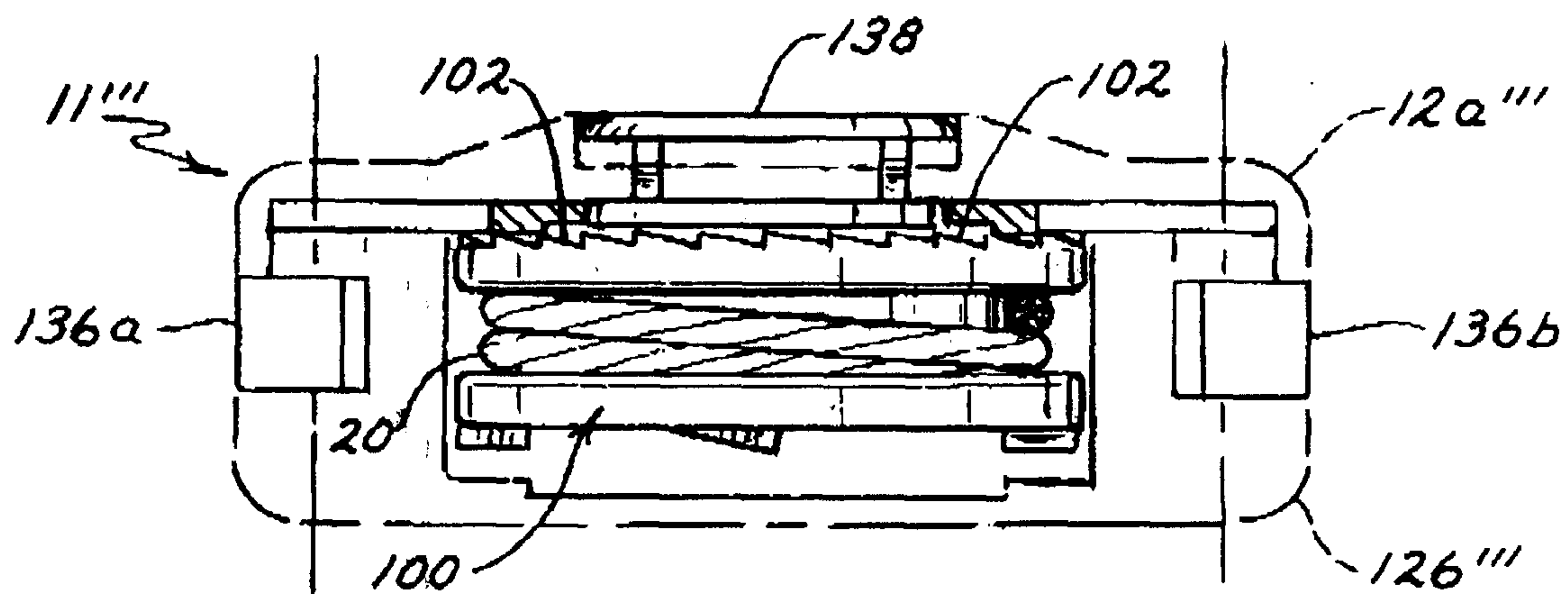
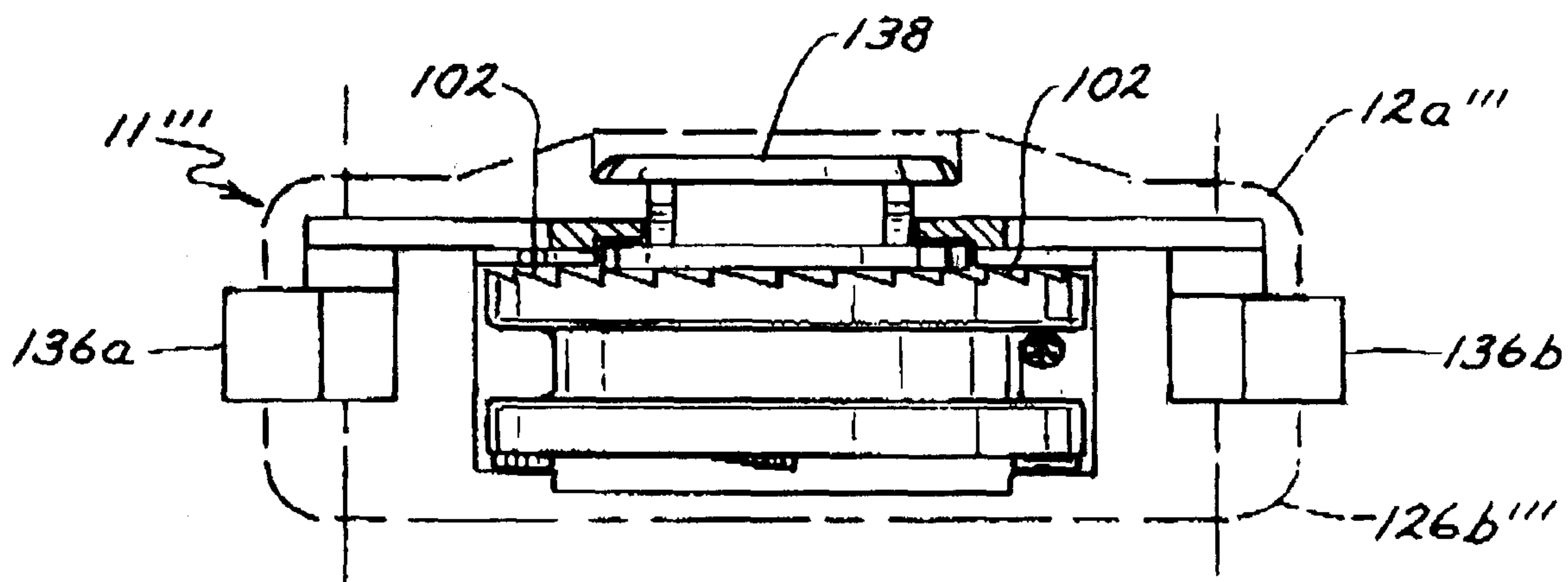
*FIG. 10A**FIG. 10B**FIG. 10C*

*FIG. 11A**FIG. 11B*



**FIG. 13**

**FIG. 14**

*FIG. 15**FIG. 16A**FIG. 16B*

