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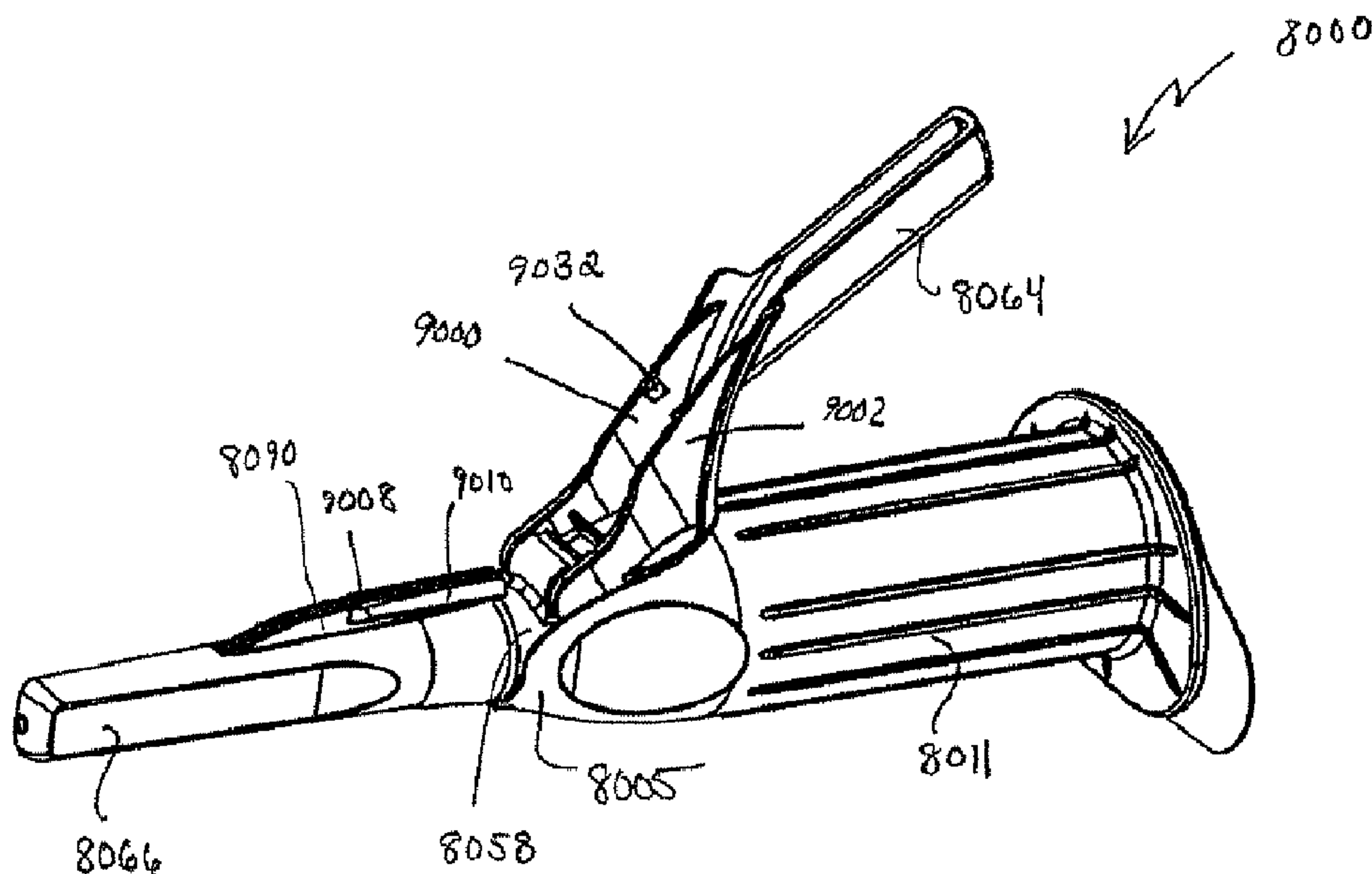
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(54) **Titre : ENSEMBLE COLLECTE DE SANG DE SECURITE AVEC INDICATEUR**

(54) **Title: SAFETY BLOOD COLLECTION ASSEMBLY WITH INDICATOR**



(57) **Abrégé/Abstract:**

A blood collection assembly includes a housing and a cannula extending distally from the housing including a patient end, and a cannula shield removably engaged with a portion of the housing. The cannula shield is capable of shielding at least the patient end



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(57) **Abrégé(suite)/Abstract(continued)**:

of the cannula, and includes a safety shield engagement. The assembly includes a pivoting safety shield engaged with a portion of the housing, which is transitionable from a retracted position in which the patient end of the cannula is exposed, to an extended position in which the patient end of the cannula is shielded by at least a portion of the safety shield. The safety shield includes at least one locking tab releasably engageable with the safety shield engagement, wherein the locking tab is fixedly engageable with a portion of the housing in the extended position.

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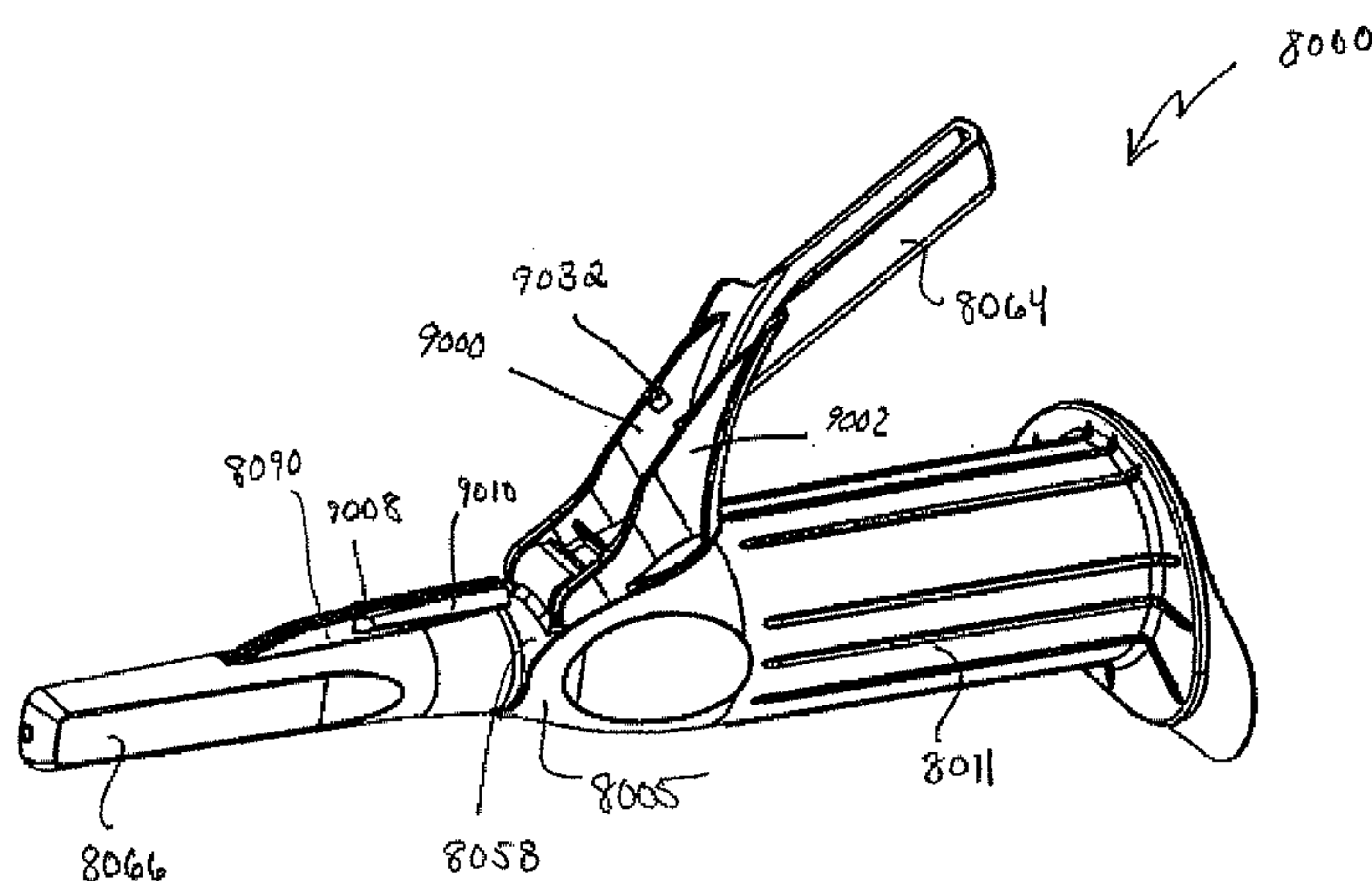


FIG. 48

(57) **Abstract:** A blood collection assembly includes a housing and a cannula extending distally from the housing including a patient end, and a cannula shield removably engaged with a portion of the housing. The cannula shield is capable of shielding at least the patient end of the cannula, and includes a safety shield engagement. The assembly includes a pivoting safety shield engaged with a portion of the housing, which is transitionable from a retracted position in which the patient end of the cannula is exposed, to an extended position in which the patient end of the cannula is shielded by at least a portion of the safety shield. The safety shield includes at least one locking tab releasably engageable with the safety shield engagement, wherein the locking tab is fixedly engageable with a portion of the housing in the extended position.

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SAFETY BLOOD COLLECTION ASSEMBLY WITH INDICATOR**BACKGROUND OF THE INVENTION****Field of the Invention**

[0001] The present invention relates generally to shieldable safety needle assemblies and, more particularly, to needle assemblies having a housing, a needle cannula, and a shield restrainably engaged with a portion of the housing.

Description of Related Art

[0002] Typical needle assemblies include a needle cannula having a proximal end, a pointed distal end with a puncture tip, and a lumen extending therebetween. A thermoplastic hub is often mounted securely to the needle cannula at a location spaced apart from the distal end. The hub is typically provided with external threads or other surface configurations for mounting the needle cannula to another structure. Some needle assemblies are used for drawing a specimen, such as a sample of blood or other bodily fluid, from a patient.

[0003] A needle assembly that is used to draw a sample of blood or other bodily fluid is typically used in association with a housing. Needle cannulae used in association with these assemblies typically have pointed proximal and distal ends, and the needle hub is mounted to a location between the opposed ends of the needle cannula. The housing typically includes a substantially tubular sidewall with a widely opened proximal end, and a partly closed distal end. The hub of the prior art needle assembly can be engaged with the partly closed distal end of the needle holder. Thus, the pointed proximal end of the needle cannula projects into the needle holder for engagement with an evacuated tube, while the pointed distal end of the needle cannula projects distally beyond the needle holder for puncturing the patient's skin.

[0004] The needle assembly is often used with a specimen collection tube for drawing a sample of blood or other bodily fluid from a patient. The specimen collection tube typically includes a closed end, an open end, and a sidewall extending therebetween. The tube is typically evacuated, and the open end is sealed by a septum that retains the vacuum within the tube. The evacuated tube is dimensioned to be slid into the open proximal end of the needle holder. Sufficient sliding of the evacuated tube into the needle holder causes the proximal point of the needle cannula to pierce the septum of the evacuated tube. Thus, the needle cannula can be placed in communication with the interior of the evacuated tube.

[0005] The combined needle assembly and evacuated tube is employed by initially urging the pointed distal end of the needle cannula into a blood vessel of a patient. Once the targeted blood vessel has been accessed, the evacuated tube is urged into the needle holder

such that the proximal point of the needle cannula pierces the septum of the tube. Low pressure conditions within the evacuated tube, as well as the patient's own vasculature pressure, generate a flow of blood from the patient through the needle cannula and into the evacuated tube. The evacuated tube may be removed from the needle holder after a sufficient quantity of blood has been collected. One or more additional evacuated tubes may similarly be urged into the open end of the needle holder for drawing one or more additional samples of blood to be analyzed. The needle cannula is then withdrawn from the patient after a sufficient volume of blood has been collected for the required analytical procedure. In order to reduce the risk of an accidental needle stick, or contact that could transmit pathogens from the patient to the medical practitioner, the needle cannula must be properly shielded after contact with the patient.

[0006] Many types of devices are available for shielding a used needle cannula. Example shielding devices include those disclosed in United States Patent Nos. 5,348,544; 5,242,417; 6,592,556; 6,635,032; and 7,001,363. Most shielded needle assemblies are effective at performing their primary function, *i.e.*, shielding a used needle cannula. However, many medical practitioners consider the available shieldable needle assemblies cumbersome. Additionally, in some cases, practitioners may be rushing and forget to operate the safety shield. Other situations arise where the patient moves suddenly or unexpectedly. Thus, the needle cannula may inadvertently be pulled out of the vein and exposed with no time for the phlebotomist to initiate safety shielding.

[0007] Another problem with many prior art blood collection devices relates to the time required to assure venous entry. In particular, blood will begin to flow through the cannula upon entry of the intravenous or distal end of the cannula into the vein. However, air present in the cannula, and in the multiple sample sleeve that covers the non-patient end of the cannula, will resist the flow of blood into and through the cannula. In response, the medical practitioner will typically urge an evacuated tube into the needle holder once the practitioner is reasonably sure that the vein has been entered. The rubber stopper at the end of the evacuated tube will deform the multiple sample sleeve over the non-patient end of the cannula and will permit the non-patient end of the cannula to enter the evacuated tube. The pressure differential between the evacuated tube and the cannula will cause the blood to flow into the evacuated tube. In conventional needle assemblies, this often provides the first visual assurance that the vein has been accessed properly.

[0008] However, there are many instances in which a medical practitioner will properly access a vein with the distal end of the needle cannula, but will mistakenly believe that the

vein has not been entered. Hence, the practitioner will make a second attempt to access the vein. This adds to the discomfort for the patient, extends the time required to carry out a blood collection procedure, and increases the risk for accidental contact between the medical practitioner and a cannula that has been exposed to the patient's blood. Additionally, in some instances a passive shielding mechanism will be activated when the cannula is withdrawn from the patient, thereby making the needle cannula unusable and requiring the medical practitioner to obtain a new needle assembly.

SUMMARY OF THE INVENTION

[0009] A need continues to exist for safety needle assemblies incorporating at least one or both a visual flash indicator and a safety shield that can be transitioned from a retracted position in which the tip of a needle cannula is exposed, to an extended position in which the tip of the needle cannula is shielded, which minimizes the risk of exposure to medical personnel, is convenient to use, and is cost-effective.

[0010] In one embodiment of the present invention, a needle assembly includes a housing having a distal end, and a proximal end engageable with a specimen collection container. The housing includes a cannula extending distally from the housing, with the cannula having a patient end. A cannula shield is removably engaged with a portion of the housing, and is capable of shielding at least the patient end of the cannula. The cannula shield includes a safety shield engagement. The needle assembly further includes a pivoting safety shield engaged with a portion of the housing and transitionable from a retracted position in which the patient end of the cannula is exposed, to an extended position in which the patient end of the cannula is shielded by at least a portion of the safety shield. The safety shield includes at least one locking tab releasably engageable with the safety shield engagement, with the locking tab fixedly engageable with a portion of the housing in the extended position.

[0011] In one configuration, the pivoting safety shield is transitionable from a restrained position in which the locking tab is engaged with the safety shield engagement, to the retracted position. Removal of the cannula shield from the housing allows for transition of the pivoting safety shield from the retracted position to the extended position. Optionally, the housing may further include a flash indicator, and the cannula interior may be provided in fluid communication with the flash indicator. The flash indicator may be visible in the retracted position, and the pivoting safety shield may be disposed over the patient end of the cannula and the locking tab may engage at least a portion of the flash indicator in the extended position. Alternatively, the housing may further include a flash indicator, with the

cannula interior in fluid communication with the flash indicator, with the flash indicator visible in the retracted position, and wherein the pivoting safety shield is disposed over the patient end of the cannula and the locking tab engages a portion of the housing distal to the flash indicator in the extended position.

[0012] In yet another configuration, the housing may include a forward hub portion and a rear hub portion connectable with the forward hub portion and defining a flash indicator therebetween. Optionally, the safety shield engagement is a ridge projecting dorsally from an outer surface of the cannula shield. The safety shield engagement may also extend substantially longitudinally along the cannula shield. The ridge may include a beveled edge and the locking tab may include an engagement surface corresponding to the beveled edge to provide a resistance interference therebetween. Alternatively, the locking tab may include a beveled edge and the ridge may include an engagement surface corresponding to the beveled edge to provide a resistance interference therebetween.

[0013] In yet a further configuration, at least a portion of the ridge is engageable with at least a portion of the locking tab in a detent arrangement to restrain the pivoting safety shield with the cannula shield. The detent arrangement may be adapted to resist disengagement until a force is imparted to the pivoting safety shield in a manner capable of moving the pivoting safety shield from the restrained position to the retracted position. The detent arrangement resists unintentional removal of the cannula shield from the housing. Release of the detent arrangement allows the pivoting safety shield to pivot from a restrained position to the retracted position.

[0014] In another embodiment of the present invention, a needle assembly includes a housing, having a distal end, and a proximal end, and a cannula extending distally from the housing. The cannula includes a patient end. The assembly also includes a pivoting safety shield fixedly engaged with a portion of the housing. The safety shield is transitionable over the cannula from a retracted position in which the patient end is exposed, to an extended position in which the patient end is shielded by at least a portion of the safety shield. The assembly also includes a cannula shield releasably engaged with a portion of the housing and shielding at least the patient end of the cannula. The cannula shield includes a safety shield engagement, and the pivoting safety shield is releasably engaged with the safety shield engagement, wherein removal of the cannula shield from the housing allows for transition of the safety shield from the retracted position to the extended position.

[0015] Optionally, the safety shield engagement is a ridge projecting dorsally from an outer surface of the cannula shield and extending along at least a portion of a longitudinal

axis of the cannula shield. The pivoting safety shield may further include at least one locking tab adapted to releasably engage the ridge. The ridge may include a beveled edge and the locking tab may include an engagement surface corresponding to the beveled edge to provide a resistance interference therebetween. At least a portion of the ridge is engageable with at least a portion of the locking tab in a detent arrangement to restrain the pivoting safety shield with the cannula shield. The detent arrangement may be adapted to resist disengagement until a force is imparted to the pivoting safety shield in a manner capable of moving the pivoting safety shield from the restrained position to the retracted position. The detent arrangement may prevent unintentional removal of the cannula shield from the housing, and disengagement of the detent arrangement enables removal of the cannula shield from the housing. Release of the detent arrangement allows the pivoting safety shield to pivot from a restrained position to the retracted position. In a further configuration, the housing includes a flash indicator, and the cannula interior is provided in fluid communication with the flash indicator.

[0016] In yet another embodiment of the present invention, a needle assembly includes a housing having a distal end and a proximal end, and a cannula extending distally from the housing. The cannula includes a patient end. The assembly also includes a cannula shield removably engaged with a portion of the housing, and including a locking tab receiving structure. The assembly also includes a pivoting safety shield engaged with a portion of the housing, transitionable from a retracted position in which the patient end of the cannula is exposed, to an extended position in which the patient end of the cannula is shielded by at least a portion of the safety shield. The safety shield includes at least one locking tab, wherein the locking tab receiving structure is adapted to receive the locking tab when the pivoting safety shield is in a restrained position.

[0017] The locking tab may extend from an internal wall of the pivoting safety shield. Optionally, the pivoting safety shield is pivotable about a hinge. When the cannula shield is removed from the needle assembly, the safety shield is capable of lockingly engaging at least one of the cannula or housing when the safety shield is in the extended position. In another configuration, when the pivoting safety shield is in the restrained position, the locking tab and locking tab receiving structure resist disengagement until a force is imparted to the pivoting safety shield in a manner capable of moving the safety shield from the restrained position to the retracted position.

[0018] In a further embodiment of the present invention, a blood collection assembly includes a first sub-assembly and a second sub-assembly, wherein the first sub-assembly

includes a first portion for press-fit engagement with the second sub-assembly, and the second sub-assembly includes a corresponding second portion for press-fit engagement with the first sub-assembly. The first sub-assembly includes a hub having a flash indicator, the hub having a distal end and a proximal end engageable with a specimen collection container. The first sub-assembly also includes a cannula extending between a patient end and a non-patient end, defining a cannula interior, with the patient end of the cannula projecting at least partially from the distal end of the hub. The cannula interior is in fluid communication with the flash indicator. The first sub-assembly also includes a cannula shield removably engaged with the distal end of the hub and shielding at least the patient end of the cannula. The first sub-assembly further includes a pivoting safety shield fixedly engaged with a portion of the hub, transitionable from a retracted position in which the patient end is exposed, to an extended position in which the patient end is shielded by at least a portion of the safety shield. The second sub-assembly includes a specimen collection container holder having an interior through which a specimen collection container may be engaged with the proximal end of the hub.

[0019] Optionally, the cannula shield includes a safety shield engagement, and the safety shield comprises at least one locking tab releasably engageable with the safety shield engagement. The safety shield engagement may be a ridge projecting upwardly from an outer surface of the cannula shield and extending along at least a portion of a longitudinal axis of the cannula shield. At least a portion of the ridge may be engageable with at least a portion of the locking tab in a detent arrangement to restrain the safety shield with the cannula shield. Release of the detent arrangement may allow the safety shield to pivot from a restrained position to the retracted position. Removal of the cannula shield from the housing may allow for transition of the safety shield from the retracted position to the extended position.

[0020] In another configuration, the locking tab is releasably engageable with the safety shield engagement in a restrained position and fixedly engageable with a portion of the housing in the extended position. Engagement of the first portion and the second portion may include deflection of at least one of the first portion and the second portion to provide an interference therebetween. In another configuration, the first portion and the second portion may include a two-stage press-fit engagement. Engagement of the first portion and the second portion may include a first deflection of at a portion of least one of the first portion and the second portion to provide an interference therebetween, and a second deflection of at least a portion of at least one of the first portion and the second portion to provide a second

interference therebetween. At least a portion of the first portion and at least a portion of the second portion may also include corresponding mating surfaces for threaded engagement therebetween. The press-fit engagement of the first portion of the first sub-assembly and the second portion of the second sub-assembly may prevent disengagement of the first sub-assembly from the second sub-assembly upon engagement of a specimen collection container with the proximal end of the hub.

DESCRIPTION OF THE DRAWINGS

[0021] FIG. 1 is a perspective view of a needle assembly having a hinged safety shield and a needle guard shield in accordance with an embodiment of the present invention.

[0022] FIG. 2 is a side view of the needle assembly of FIG. 1.

[0023] FIG. 3 is a top view of the needle assembly of FIG. 1.

[0024] FIG. 4 is a cross-sectional side view of the needle assembly of FIG. 1.

[0025] FIG. 5 is a perspective view of the needle assembly of FIG. 1 having the needle guard shield removed and in the retracted position.

[0026] FIG. 6 is a side view of the needle assembly of FIG. 5.

[0027] FIG. 7 is a top view of the needle assembly of FIG. 5.

[0028] FIG. 8 is a cross-sectional side view of the needle assembly of FIG. 5.

[0029] FIG. 9 is a perspective view of the needle assembly of FIG. 5 in the extended position.

[0030] FIG. 10 is a side view of the needle assembly of FIG. 9.

[0031] FIG. 11 is a cross-sectional view of the needle assembly of FIG. 9.

[0032] FIG. 12 is a perspective view of the engagement of the safety shield and the front hub portion in accordance with an embodiment of the present invention.

[0033] FIG. 13 is a close-up sectional perspective view of the engagement between the safety shield and the front hub portion in accordance with an embodiment of the present invention.

[0034] FIG. 14 is a perspective view of a needle assembly having a flash chamber in accordance with a further embodiment of the present invention.

[0035] FIG. 15 is a rear perspective view of the needle assembly having a flash chamber of FIG. 14.

[0036] FIG. 16 is an exploded view of the needle assembly having a flash chamber of FIG. 14.

- [0037] FIG. 17 is a cross-sectional view of the needle assembly having a flash chamber of FIG. 14.
- [0038] FIG. 18 is an enlarged cross-sectional view of a portion of the needle assembly of FIG. 17.
- [0039] FIG. 19 is a cross-sectional view of a needle assembly having a flash chamber used in connection with a blood collection assembly in yet a further embodiment.
- [0040] FIG. 20 is an enlarged sectional view of a portion of the needle assembly of FIG. 19.
- [0041] FIG. 21 is an exploded perspective view of a needle assembly having a hinged safety shield in accordance with an embodiment of the present invention.
- [0042] FIG. 22 is an assembled perspective view of the needle assembly of FIG. 21 in the retracted position.
- [0043] FIG. 23 is a side view of the needle assembly of FIG. 22.
- [0044] FIG. 24 is a top view of the needle assembly of FIG. 22.
- [0045] FIG. 25 is a cross-sectional side view of the needle assembly of FIG. 22.
- [0046] FIG. 26 is a front view of the needle assembly of FIG. 22.
- [0047] FIG. 27 is a rear view of the needle assembly of FIG. 22.
- [0048] FIG. 28 is a cross-sectional side view of the needle assembly of FIG. 22.
- [0049] FIG. 29 is an alternative exploded view of a needle assembly having a hinged safety shield in accordance with an embodiment of the present invention.
- [0050] FIG. 30 is a perspective view of the needle assembly of FIG. 22 in the extended position.
- [0051] FIG. 31 is a top view of the needle assembly of FIG. 30 in the extended position.
- [0052] FIG. 32 is a cross-sectional side view of the needle assembly of FIG. 30.
- [0053] FIG. 33 is a side view of the needle assembly of FIG. 30 in the extended position.
- [0054] FIG. 34 is a front view of the needle assembly of FIG. 30.
- [0055] FIG. 35 is a rear view of the needle assembly of FIG. 30.
- [0056] FIG. 36 is a sectional perspective view of an alternative hinged safety shield shown in the extended position in accordance with an embodiment of the present invention.
- [0057] FIG. 37 is an exploded perspective view of a needle assembly including a cannula shield and a pivoting safety shield in accordance with an embodiment of the present invention.
- [0058] FIG. 38 is an assembled perspective view of the needle assembly of FIG. 37 including the cannula shield and the safety shield in the restrained position.

- [0059] FIG. 39 is an alternative perspective view of the needle assembly of FIG. 38 including the safety shield in the restrained position.
- [0060] FIG. 40 is a side view of the needle assembly of FIG. 38.
- [0061] FIG. 41 is a top view of the needle assembly of FIG. 38.
- [0062] FIG. 42 is a bottom view of the needle assembly of FIG. 38.
- [0063] FIG. 43 is a front view of the needle assembly of FIG. 38.
- [0064] FIG. 44 is a rear view of the needle assembly of FIG. 38.
- [0065] FIG. 45 is a cross-sectional side view of the needle assembly of FIG. 40.
- [0066] FIG. 46 is a sectional side view of a needle assembly having a cannula shield and a pivoting safety shield in the restrained position in accordance with an embodiment of the present invention.
- [0067] FIG. 47 is a cross-sectional view of FIG. 46 taken along line CXLII-CXLII.
- [0068] FIG. 48 is a perspective view of the needle assembly of FIG. 38 including the cannula shield and the safety shield in the retracted position.
- [0069] FIG. 49 is a side view of the needle assembly of FIG. 48.
- [0070] FIG. 50 is a top view of the needle assembly of FIG. 48.
- [0071] FIG. 51 is a front view of the needle assembly of FIG. 48.
- [0072] FIG. 52 is a cross-sectional side view of the needle assembly of FIG. 48.
- [0073] FIG. 53 is a perspective view of the needle assembly of FIG. 48 having the cannula shield removed and showing the safety shield in the retracted position.
- [0074] FIG. 54 is an alternative perspective view of the needle assembly of FIG. 53 having the cannula shield removed and showing the safety shield in the retracted position.
- [0075] FIG. 55 is a side view of the needle assembly of FIG. 53.
- [0076] FIG. 56 is a top view of the needle assembly of FIG. 53.
- [0077] FIG. 57 is a cross-sectional side view of the needle assembly of FIG. 53.
- [0078] FIG. 58 is a cross-sectional side view of the needle assembly of FIG. 53 having a specimen collection container engaged therewith.
- [0079] FIG. 59 is a perspective view of the needle assembly of FIG. 53 showing the safety shield in the extended position.
- [0080] FIG. 60 is a side view of the needle assembly of FIG. 59.
- [0081] FIG. 61 is a top view of the needle assembly of FIG. 59.
- [0082] FIG. 62 is a bottom view of the needle assembly of FIG. 59.
- [0083] FIG. 63 is a cross-sectional side view of the needle assembly of FIG. 59.

- [0084] FIG. 64 is a cross-sectional side view of a needle assembly having a pivoting safety shield in the extended position in accordance with an embodiment of the present invention.
- [0085] FIG. 65 is a cross-sectional view of FIG. 64 taken along line CLXIX-CLXIX.
- [0086] FIG. 66 is a cross-sectional view of FIG. 64 taken along line CLXX-CLXX.
- [0087] FIG. 67 is a cross-sectional view of FIG. 64 taken along line CLXXI-CLXXI.
- [0088] FIG. 68 is a cross-sectional view of FIG. 64 taken along line CLXXII-CLXXII.
- [0089] FIG. 69 is a cross-sectional side view of a needle assembly having a non-patient cannula shield, including the safety shield in the restrained position in accordance with an embodiment of the present invention.
- [0090] FIG. 70 is a cross-sectional side view of the needle assembly of FIG. 69, showing the safety shield in the retracted position.
- [0091] FIG. 71 is a sectional perspective view of a first sub-assembly of a needle assembly in accordance with an embodiment of the present invention.
- [0092] FIG. 72 is a sectional perspective view of the first sub-assembly of FIG. 71 engaged with a second sub-assembly.
- [0093] FIG. 73 is a rear view of the first sub-assembly engaged with the second sub-assembly of FIG. 72.
- [0094] FIG. 74 is a sectional cross-sectional view of FIG. 73 taken along line CLXXVI-CLXXVI.
- [0095] FIG. 75 is a sectional cross-sectional view of FIG. 73 taken along line CLXXVII-CLXXVII.
- [0096] FIG. 76 is a sectional perspective view of a first sub-assembly of a needle assembly in accordance with an alternative embodiment of the present invention.
- [0097] FIG. 77 is a sectional perspective view of the first sub-assembly of FIG. 76 engaged with a second sub-assembly.
- [0098] FIG. 78 is a rear view of the first sub-assembly engaged with the second sub-assembly of FIG. 77.
- [0099] FIG. 79 is a sectional cross-sectional view of FIG. 78 taken along line CLXXXI-CLXXXI.
- [00100] FIG. 80 is a rear view of a first sub-assembly engaged with a second sub-assembly in accordance with an alternative embodiment of the present invention.
- [00101] FIG. 81 is a sectional cross-sectional view of FIG. 80 taken along line CLXXXIII-CLXXXIII.

[00102] FIG. 82 is a rear view of a first sub-assembly engaged with a second sub-assembly in accordance with an alternative embodiment of the present invention.

[00103] FIG. 83 is a sectional cross-sectional view of FIG. 82 taken along line CLXXXV-CLXXXV.

DETAILED DESCRIPTION

[00104] In general, the needle assembly of the present invention allows for access of a patient's vasculature by a needle cannula, visual indication of vasculature access, and subsequent safety shielding of the needle cannula to protect medical practitioners.

[00105] In one embodiment of the present invention, a needle assembly **30c1** is provided, as generally shown in **FIGS. 1-13**. The needle assembly **30c1** generally includes a housing having a flash chamber **60c1** integral therewith, a cannula **32c1** associated with the housing, and a safety shield **64c1** adapted to transition from a retracted position, shown in **FIGS. 5-8**, to an extended position, shown in **FIGS. 9-11**, for safety shielding of the cannula **32c1** during and/or after use of the needle assembly **30c1**. The needle assembly **30c1** is shown in the retracted position ready for use in a specimen collection procedure, such as a blood collection procedure, in **FIG. 5**, and after use in the extended position shielding the cannula in **FIG. 9**.

[00106] With particular reference to **FIGS. 1-13**, the needle assembly **30c1** includes a cannula **32c1** having a distal patient end **34c1** and a proximal non-patient end **36c1**. It will be noted that the term "distal" as used herein, refers generally to the forward end of the needle assembly **30c1** that is adapted to puncture the skin of a patient and access the patient's vasculature, while the term "proximal" refers generally to the rear end of the needle assembly **30c1** that is engageable with a specimen collection container **8003** (shown in **FIG. 58**). The cannula **32c1** includes a sidewall extending between the patient end **34c1** and the non-patient end **36c1** and defining a cannula interior **35c1**. In one embodiment, the cannula **32c1** may include at least two distinct needles, such as a distal patient needle **35c2** and a proximal non-patient needle **35c3**, both of which define a common central lumen within the cannula interior **35c1**. In a further embodiment, the distal patient needle **35c2** is aligned substantially along a common axis with the proximal non-patient needle **35c3** and separated from the proximal non-patient needle **35c3** by a break. The proximal non-patient end **36c1** of the cannula **32c1** is provided for puncturing a specimen collection container **8003** (shown in **FIG. 58**). In one embodiment, the proximal non-patient end **36c1** of the cannula **32c1** may be covered by a pierceable elastomeric multiple sample sleeve. The distal patient end **34c1** may have a bevel for allowing easier penetration of a patient's skin.

[00107] The cannula **32c1** of the needle assembly may be at least partially supported by a portion of the housing. In one embodiment, the housing may be a hub **58c1** for supporting a portion of the cannula **32c1**. For example, proximal non-patient needle **35c3** and distal patient needle **35c2** may be affixed or otherwise adhered within a central opening of the hub **58c1**, with a break present between proximal non-patient needle **35c3** and the distal patient needle **35c2**. In another configuration, the hub **58c1** may be formed of separate elements. For example, a proximal or rear hub portion **3028** may be connected with or affixed to a forward hub portion **3026**, thereby forming the hub **58c1** as a unitary structure, with the cannula **32c1** extending therethrough.

[00108] As shown in FIGS. 1-11, the housing may have a distal end **35c5** and a proximal end **35c4** engageable with a specimen collection container **8003** (shown in FIG. 58). As used herein, the phrase “engageable with a specimen collection container” means that a specimen collection container may be attached to or affixed with a portion of the proximal end **35c4** of the housing, or that a specimen collection container may be passed within or disposed over or about a portion of the proximal end **35c4** of the housing and secured to another portion of the housing. In one embodiment, the proximal end **35c4** of the needle assembly **30c1** may define a specimen collection container receiving port, adapted to receive a specimen collection container therewith.

[00109] In another embodiment, the needle assembly **30c1** is a specimen collection assembly, such as a blood collection assembly, in which the housing of the needle assembly **30c1** includes a specimen collection container holder **42c1** adjacent the proximal end **35c4** of the needle assembly **30c1**. At least a portion of the specimen collection container holder **42c1** may have a radially aligned flange **90** to facilitate manipulation of the needle assembly **30c1**. The flange **90** may be non-circular to prevent the needle assembly **30c1** from rolling, or for other purposes such as communicating to the user the intended orientation of the needle assembly **30c1**.

[00110] The specimen collection container holder **42c1** is adapted to accommodate at least a portion of the cannula **32c1** in a mating relationship. For example, the specimen collection container holder **42c1** may include an engagement portion to which a portion of the cannula **32c1**, such as the non-patient end **36c1** is mounted through a portion of the hub **58c1**. The hub **58c1** may be also adhesively affixed to the specimen collection container holder **42c1**. In another embodiment, the hub **58c1** may be press-fit, snapped, or threaded into the specimen collection container holder **42c1**. Alternatively, hub **58c1** may be integrally formed with the distal end **35c5** of the specimen collection container holder **42c1**, providing a mechanism for

direct attachment of the cannula **32c1** to the specimen collection container holder **42c1**. In certain embodiments, the cannula **32c1** is joined with a portion of the specimen collection container holder **42c1** by the manufacturer so that the device is ready for fast and convenient use by the medical practitioner.

[00111] In certain configurations, the patient end **34c1** of the cannula **32c1** projects at least partially from the distal end of the housing, and the non-patient end **36c1** extends in a substantially proximal direction from the patient end **34c1**. In another embodiment, the distal patient needle **35c2** projects at least partially from the distal end of the housing, and the proximal non-patient needle **35c3** extends in a substantially proximal direction from the patient needle.

[00112] At least a portion of the housing, including the hub **58c1**, the specimen collection container holder **42c1**, includes a flash chamber **60c1**. As used herein, the term “flash chamber” includes a cavity into which a specimen, such as blood, from a patient may pass, and through which the presence of the specimen within the cavity may be visibly detected by a medical practitioner. The flash chamber **60c1** may be integrally formed with a portion of the housing or, alternatively, may be separately formed and subsequently engaged with a portion of the housing. In one embodiment, the cannula interior **35c1** is in fluid communication with the flash chamber **60c1**. In a further embodiment, a sidewall of the cannula **32c1** may define an opening extending between the cannula interior **35c1** and the flash chamber **60c1** to permit the flow of a specimen, such as blood, from the cannula **32c1** to the flash chamber **60c1**. In another embodiment, the cannula **32c1** includes a distal patient needle **35c2** in fluid communication with the flash chamber **60c1**, and a proximal non-patient needle **35c3** in fluid communication with the flash chamber **60c1**. Accordingly, when the distal patient needle **35c2** is provided access with a patient’s vasculature, blood may flow from the patient through the distal patient needle **35c2** and into the flash chamber **60c1**. When the proximal non-patient needle **35c3** is engaged with an evacuated specimen collection container **8003**, shown in **FIG.58**, blood may flow from the flash chamber **60c1** and through the proximal non-patient needle.

[00113] In one embodiment, the hub **58c1** may include an interior between a portion of the rear hub portion **3028** and a portion of the forward hub portion **3026**. A flash chamber **60c1** may be formed within at least a portion of the interior of the hub **58c1**. In one configuration, the hub **58c1**, or at least a portion of the hub **58c1**, such as the forward hub portion **3026**, may be constructed from a transparent or translucent material, such as a polymeric material or

resin. Alternatively, a flash chamber **60c1** may be integrally formed within another portion of the housing, such as integrally formed with the specimen collection container holder **42c1**.

[00114] In use, blood flow from a patient through the cannula **32c1** will enter the flash chamber **60c1** through an opening in the cannula **32c1**, thereby partially filling the flash chamber **60c1** with blood. The flash chamber **60c1** provides a visual mechanism for recognition of venous access to a medical practitioner. Example flashback indicators are described, for example, in United States Patent Publication No. 2005/0004524.

[00115] As shown in **FIGS. 14-20**, an alternative flash chamber, may include a vent mechanism in communication with an external environment surrounding the needle assembly, it is also contemplated herein that a needle assembly may include a flash chamber having a vent plug which seals upon flow of blood into the flashback chamber, thereby inhibiting any pressurized air that may build up within the chamber, from moving in a reverse direction toward the inlet of the cannula. As shown in **FIGS. 14-20**, it is also contemplated herein that a similar vent plug may be positioned within the housing at a location such that the vent plug divides the housing into two chambers having sizes and dimensions to establish predetermined volumes thereto. Moreover, the porous vent remains porous to blood and does not seal upon contact with blood. Desirably, the blood does not contact the vent plug at the initial flash indication, but such sealing occurs at a later point during use of the assembly, as will be described in more detail herein.

[00116] For example, as shown in **FIGS. 14-17**, a porous vent is positioned within the housing at a location such that the vent divides the housing into two chambers having sizes and dimensions to establish predetermined volumes thereto, so that the blood does not contact the porous vent for at the initial flash indication, but such contact occurs at a later point during use of the assembly, as will be described in more detail herein.

[00117] As shown in **FIGS. 14-17**, needle assembly **410** includes a housing **412** having a fluid inlet end or first end **414** and a fluid outlet end or second end **416**. Needle assembly **410** includes exterior wall **418** defining the housing interior. Exterior wall **418** extends generally longitudinally at the first end **414** forming an elongate longitudinal first portion **419** having a first diameter. At second end **416**, exterior wall **418** forms a second portion **421** that has a second diameter that is generally larger than the first diameter of the first portion **419**. Accordingly, housing **412** may form a structure having a generally T-shaped cross-section. The exterior wall **418** at second end **416** may be a separate element **428** that is attachable to main body portion **430** forming housing **412**, thereby assisting in manufacture and assembly of needle assembly **410**. First portion **419** and second portion **421** may be arranged relative

to each other in a variety of arrangements, so long as they are capable of functioning for transport of air therebetween as discussed herein.

[00118] Needle assembly **410** further includes a fluid inlet cannula **436** extending from first end **414** of housing **412**. Fluid inlet cannula **436** includes an exterior end **439** that defines a sharpened bevel at patient puncture tip **438**, and extends within first end **414** of housing **412**, and may be fixedly mounted therein. Fluid inlet cannula **436** is characterized further by a substantially cylindrical lumen extending between the ends and communicating with the interior of housing **412**.

[00119] Needle assembly **410** also includes a non-patient puncture tip extending from second end **414** of housing **412**. As seen in **FIG. 16**, this may be accomplished by providing needle assembly **410** with a second cannula in the form of fluid outlet cannula **452**. In particular, the end of fluid outlet cannula **452** may define a sharpened bevel forming non-patient puncture tip **462**. Fluid outlet cannula **452** extends within second end **416** of housing **412**, and may be fixedly mounted therein. Fluid outlet cannula **452** is characterized further by a substantially cylindrical lumen communicating with the interior of housing **412**. Fluid outlet cannula **452** is mounted within housing **412** so that an interior end **464** passes substantially coaxially therein such that fluid outlet cannula **452** substantially aligns axially with the interior end of inlet cannula **436**. Desirably, this is achieved by mounting fluid outlet cannula **452** at a location adjacent second end **416** of housing **412**, such that the interior end **464** of fluid outlet cannula **452** extends within housing **412** to a location adjacent the interior end **439** of inlet cannula **436**. Additionally, the interior end **464** of fluid outlet cannula **452** is spaced only a small distance from the interior end **439** of inlet cannula **436**, thereby forming an axial gap therebetween for flow of blood into flash chamber **426** about fluid outlet cannula **452**. The distance between the interior end **464** of fluid outlet cannula **452** and the interior end **439** of inlet cannula **436** forming the axial gap is sufficient to provide for flow of blood into the flash chamber **426** based upon the patient's blood pressure after venipuncture. In certain embodiments, an axial gap that is less than 0.5mm may result in a flashback that is inconsistent.

[00120] As seen in **FIG. 18**, fluid inlet cannula **436** and fluid outlet cannula **452** are positioned and dimensioned within housing **412** so as to achieve both desirable flow of blood through assembly **410** and to achieve effective flashback indication. In particular, wall **418** of housing **412** is dimensioned to provide a radial gap around fluid outlet cannula **452** of about 0.2mm at an area surrounding the internal end **464** thereof. This gap achieves a substantially laminar blood flow within flashback chamber **426** and prevents blood

hemolysis. Additionally, the small radial gap between the inner surface of wall 418 and fluid outlet cannula 452 at the area surrounding the internal end 464 enables a drop of blood to be spread thinly across the radial gap in flashback chamber 426 to provide a magnified flashback indication with a very small volume of blood. Thus, an easily visualized flashback indication is achieved quickly at the first appearance of blood within flashback chamber 426. It is contemplated herein that internal end 464 of outlet cannula 452 may be partially supported within housing 412, so long as blood flow into flashback chamber 426 is achieved about the internal end 464.

[00121] In an alternate arrangement, a single cannula is provided. Such an arrangement is depicted in the embodiment of FIGS. 19-20 (shown in connection with a blood collection assembly as will be described in more detail herein). In such an arrangement, the fluid inlet cannula and the fluid outlet cannula represent one single cannula 470, having a patient puncture tip 438 a non-patient puncture tip 462, and a lumen 442 extending therethrough, and with the body of the cannula 470 being fixedly attached to a portion of the housing 412 and passing entirely through housing 412. A portion of cannula 470 extending through housing 412 includes one or more openings such as slot or aperture 444 to provide communication between lumen 442 and flashback chamber 436 within housing 412. In the embodiment shown in FIGS. 19-20, two separate apertures 444 are shown on opposing sides of cannula 470, although it is contemplated that any number of openings or apertures 444 can be included to provide for blood flow into the flash chamber 436.

[00122] Returning to the embodiment of FIGS. 14-17, needle assembly 410 further includes a sealable sleeve 461 mounted to fluid outlet end 416 of housing 412. This may be accomplished by providing a mounting protrusion 429 at second end 416 of housing 412, such as on element 428, with sealable sleeve 461 representing an elastomeric element that can be frictionally fit or otherwise affixed over protrusion 429. Sealable sleeve 461 covers non-patient puncture tip 462 at the exterior end of fluid outlet cannula 452 when sealable sleeve 461 is in an unbiased condition. However, sealable sleeve 461 can be collapsed in response to pressure exerted by the stopper of an evacuated tube for urging exterior end 460 of fluid outlet cannula 452 through both sealable sleeve 461 and the stopper of an evacuated tube, as known in the art.

[00123] The embodiment of FIGS. 14-17 further includes a porous vent 402 positioned within the interior of housing 412. Porous vent 402 is positioned within housing 412 to divide housing 412 into two distinct chambers, namely a first chamber represented by flashback chamber 426 and a second chamber represented by secondary chamber 427.

Porous vent **402** may be constructed of a suitable material as described above with respect to vent plug **900**, albeit without the hydrophilic material that swells on contact. In this manner, porous vent **402** is adapted to vent air therethrough, and represents a porous structure including a plurality of pores that allow for passage of blood therethrough. As discussed in more detail herein, during use of needle assembly **410**, the internal pores within porous vent **402** at least partially fill with blood due to the negative pressure established within secondary chamber **427**. Such filled pores in combination with the negative pressure within secondary chamber **427** prevent air flow between the secondary chamber **427** and the flashback chamber **426**, and provide for fluid resistance of the blood through porous vent **402**, as will be described in further detail.

[00124] Desirably, porous vent **402** is positioned within the interior of housing **412** between first portion **419** and second portion **421**. In this manner, first portion **419** of housing **412** essentially defines the flashback chamber **426**, and second portion **421** of housing **412** essentially defines the secondary chamber **427**. Alternatively, porous vent **402** may be positioned within the interior of housing **412** at a location spanning the transition between the first diameter of first portion **419** and the second diameter of second portion **421**, as shown in the embodiment of **FIGS. 19-20**. In any event, porous vent **402** is generally a cylindrically shaped member with a central opening therein axially encircling a portion of the cannula, particularly fluid outlet cannula **452**.

[00125] The interior volume of housing **412** is defined by the sum of the volumes of flashback chamber **426** and secondary chamber **427** as well as the volume represented by the pores of porous vent **402**. Such interior volume is configured so as to provide for certain attributes to the needle assembly **410**, in particular with respect to the ability of the secondary chamber **427** to be at least partially evacuated of a portion of air therein to establish a negative pressure therein upon application of an evacuated tube to needle assembly **410** during use thereof. Such negative pressure within secondary chamber **427** draws blood through the pores of porous vent **402** based on when blood contacts porous vent **402** and partially fills the pores thereof. In a particular embodiment of the invention, the overall interior volume of housing **412** may be from about 300 mm^3 to about 400 mm^3 . Such a volume is particularly useful for the intended use of needle assembly **410** for conventional venipuncture for drawing a blood sample from a patient using a needle cannula having a conventional gauge for venipuncture as is known in the art. With such an internal volume, porous vent **402** is desirably positioned within housing interior so as to define flashback chamber **426** as having a volume that represents from about 5 percent to about 20 percent of

the total overall volume of housing 412, desirably from about 7 percent to about 12 percent of the total overall volume of housing 412, including the volume of secondary chamber 427 and the volume of the pores within porous vent 402. Such a ratio of the flashback chamber 426 to the total overall volume of the housing 412 assures that flashback chamber 426 has sufficient volume to properly visualize the initial flash, and desirably while preventing blood from fully contacting the porous vent 402 at initial venipuncture, based on the initial build-up of pressure within secondary chamber 427 caused by venous pressure forcing the blood into flashback chamber 426. Such volume ratios are effective for the intended use as described in further detail herein, wherein blood flowing into flashback chamber 426 upon initial venipuncture does not contact porous vent 402, and wherein at least a portion of the air is drawn out from secondary chamber 427 based upon application of an evacuated blood collection tube to the needle assembly 410. In this manner, secondary chamber 427 can effectively draw blood from within flashback chamber 426 and from within fluid inlet cannula 436 toward secondary chamber 427, such as into and through porous vent 402, when patient puncture tip 438 is removed from the patient and is exposed to the external environment. In one particular embodiment, the total interior volume of the housing 412 is about 380 mm³, with the flashback chamber 426 having a volume of about 30 mm³, the secondary chamber 427 having a volume of about 300 mm³, and the pores of the porous vent 402 representing a volume of about 50 mm³.

[00126] Needle assembly 410 may be assembled as follows. Fluid inlet cannula 436 is positioned through first end 414 of housing 412 such that the open interior end 439 is positioned within an interior portion of housing 412 at first portion 419 and patient puncture tip 438 extends externally of first end 414. Fluid outlet cannula 452 is positioned within housing 412 through the opposite end, such that open internal end 464 is positioned within an interior portion of housing 412 at first portion 419 adjacent interior end 439 of fluid inlet cannula 436, with a slight gap therebetween, and with non-patient puncture tip extending externally of second end 416. Fluid inlet cannula 436 and fluid outlet cannula 452 may be affixed therein in any known manner, desirably through a medical grade adhesive.

[00127] In alternate embodiments including only a single cannula 470, such cannula 470 is affixed within housing 412 such that opening 472 is positioned within the interior of housing 412 at first portion 419, with patient puncture tip 438 extending externally of first end 414 and non-patient puncture tip 462 extending externally of second end 416.

[00128] Porous vent 402 is then inserted within housing 412 and positioned over fluid outlet cannula 452 (or over the single cannula 470), and element 428 is thereafter affixed to

the second end **416**, enclosing the interior of housing **412**. Sealable sleeve **461** is then affixed over protrusion **429**. As such, the interior of housing **412** is closed from the external environment, with the sole path for fluid communication between the interior of housing **412** and the external environment being provided through the patient puncture tip **438**.

[00129] Needle assembly **410** assembled as such can be used in connection with a blood collection tube holder **403**, as depicted in the embodiment shown in **FIGS. 19-20**.

[00130] In use, needle assembly **410** may be provided with collection tube holder **403** attached thereto. Patient puncture tip **438** is inserted through the skin of a patient and into the patient's vasculature, desirably into a vein. Upon venipuncture, a closed environment is achieved within housing **412**, since housing **412** is an entirely closed structure, and since sealable sleeve **461** closes off the only outlet of housing **412** (*i.e.*, fluid outlet cannula **452**). The patient's blood pressure causes blood to flow through patient puncture tip **438**, into fluid inlet cannula **436**, and out interior end **439** (or through opening **472** in the embodiment of **FIGS. 19-20**), into flashback chamber **426** surrounding interior end **464** of fluid outlet cannula **452**. The transparent or translucent nature of housing **412** permits visualization of the blood within flashback chamber **426**, providing an indication that venipuncture is achieved.

[00131] Since the interior of housing **412** is a closed environment, the flow of blood into flashback chamber **426** causes air to be trapped within the housing interior, including within flashback chamber **426**, porous vent **402** and secondary chamber **427**, as well as within fluid outlet cannula **452**, causing such trapped air to be slightly pressurized therein. Flashback chamber **426** and secondary chamber **427** are configured through their size and dimensions such that the volumes thereof permit blood to flow into flashback chamber **426** at this initial venipuncture, but the build up of air pressure within the pores of porous vent **402** and within secondary chamber **427** prevents blood from fully contacting porous vent **402**, and desirably prevents blood from even partially contacting porous vent **402** at the initial venipuncture.

[00132] After such initial venipuncture and flash visualization, a sample collection container having a negative pressure therein, such as an evacuated blood collection tube (not shown) as is commonly known in the art, is inserted within the tube holder **403**. The stopper (not shown) of such evacuated container contacts and displaces sealable sleeve **461**, causing non-patient puncture tip **462** to puncture through sealable sleeve **461** and through the stopper of the evacuated container. At this point, fluid communication is established between the non-patient puncture tip **462** and the interior of the evacuated collection container. The negative pressure within the evacuated collection container draws the blood that has collected

within flashback chamber 426 into fluid outlet cannula 452 and into the evacuated collection container. Along with the blood within flashback chamber 426, the negative pressure within the evacuated collection container will also draw at least a portion of the air out of the flashback chamber 426 and out of the secondary chamber 427 through the pores of the porous vent 402, toward and into the evacuated collection container. In addition, the close proximity and alignment of fluid outlet cannula 452 and fluid inlet cannula 426 causes blood to be drawn from fluid inlet cannula 436 and from the patient, simultaneously with such air being drawn from the flashback chamber 426 and secondary chamber 427.

[00133] Such drawing of air reduces the pressure within the flashback chamber 426 and the secondary chamber 427, establishing a negative pressure therein with respect to the patient's blood stream and with respect to the external environment. This negative pressure that has been established within the interior of housing 412, and specifically within flashback chamber 426 and secondary chamber 427, draws additional blood from within fluid inlet cannula 436 and from the patient into flashback chamber 426, with the blood contacting porous vent 402. With such blood filling flashback chamber 426, the blood fully contacts the surface of porous vent 402 that extends within flashback chamber 426, and begins to fill the pores of porous vent 402. Such filling of the pores of porous vent 402 that are directly at the interface of porous vent 402 and flashback chamber 426 closes off the porous vent 402 from airflow therethrough but does not fully act as a seal, in that the blood does not cause the material of the porous vent 402 to swell or close off to air flow, but instead merely physically fills the voids within the porous vent 402. Moreover, since a portion of the air within secondary chamber 427 has been drawn out from secondary chamber 427, the secondary chamber 427 represents a closed chamber with a negative pressure therein relative to the external environment. Secondary chamber 427 will therefore continue to have a drawing effect on the blood within the pores of porous vent 402 and within flashback chamber 426 through the pores of porous vent 402 toward secondary chamber 427, without releasing any air from the secondary chamber 427 in the opposite direction due to the pores of porous vent 402 at the interface of the flashback chamber 426 being filled with blood, thereby effectively preventing air flow through porous vent 402 due to the filled pores. The draw created by negative pressure within secondary chamber 427 has a fluid resistance based on the blood filling the pores of porous vent 402 and based on the tortuous path created by the pores of the porous vent 402, and therefore is a gradual draw with reduced fluid movement.

[00134] At this point, the evacuated collection container and the secondary chamber 427 are both at a negative pressure with respect to the external environment (and with respect to

the patient's bloodstream), and therefore both effect a draw from the fluid inlet cannula 436. This effect may essentially establish an equilibrium within the flashback chamber 426, such that the blood contained within the flashback chamber 426 is not drawn toward or into either the secondary chamber 427 through the pores of porous vent 402 or into the evacuated collection container (through the fluid inlet cannula 436), but instead essentially remains within flashback chamber 426 in a steady state. The negative pressure of the evacuated collection container draws blood directly from the patient through fluid inlet cannula 436, due to the close proximity and alignment of fluid outlet cannula 452 and fluid inlet cannula 436, as well as due to the equilibrium established within flashback chamber 426 (based on the opposite draw forces between the evacuated collection container and the evacuated secondary chamber 427). The continual draw of blood into the evacuated collection container gradually causes the pressure within the collection container to increase.

[00135] Once the evacuated collection container is filled with the desired amount of blood, the container is removed from the non-patient puncture tip 462, thereby releasing the fluid communication between the non-patient puncture tip 462 and the evacuated collection container, with sealable sleeve 461 then covering and closing off non-patient puncture tip 462. Absent such draw from the negative pressure of the evacuated collection tube, the negative pressure within the secondary chamber 427 effects a slight draw on the blood within flashback chamber 426 through the pores of porous vent 402. Such draw, however, is very slow and gradual, due to the tortuous path of blood flow through the pores of porous vent 402.

[00136] Additional evacuated collection containers can thereafter be inserted into tube holder 403 and used for sample collection through non-patient puncture tip 462 as described above, by placing a second evacuated collection container within the holder 403 and establishing fluid communication between the non-patient puncture tip 462 and the interior of the evacuated collection container by puncturing the stopper, as discussed. In such further sampling, the evacuated collection container and the secondary chamber 427 are both at a negative pressure, and therefore both effect a draw from the fluid inlet cannula 436. As above, this effect essentially establishes an equilibrium within the flashback chamber 426, thereby preventing the blood contained within the flashback chamber 426 from being drawn toward or into the secondary chamber 427 (through the porous vent 402). The negative pressure of the evacuated collection container draws blood directly from the patient through fluid inlet cannula 436 as discussed above, due to the close proximity and alignment of fluid outlet cannula 452 and fluid inlet cannula 426. Once any such additional evacuated

collection containers are filled with the desired amount of blood, the container is removed from the non-patient puncture tip **462**, thereby releasing the fluid communication between the non-patient puncture tip **462** and the evacuated collection container, with sealable sleeve **461** then covering and closing off non-patient puncture tip **462**.

[00137] Once all of the desired blood samples have been drawn in this manner, patient puncture tip **438** is removed from the vasculature of the patient, thereby exposing the opening of patient puncture tip **438** to the external environment. Since the sole communication path between the housing interior and the external environment is through patient puncture tip **438**, the negative pressure established within secondary chamber **427** relative to the external environment will affect a gradual draw on the blood contained within flash chamber **426** and within fluid inlet cannula **436** toward and through porous vent **402**. Such drawing effect will move any blood contained within fluid inlet cannula **436** away from patient puncture tip **438**, thereby preventing any blood from leaking from patient puncture tip **438** out of fluid inlet cannula **436**. Such negative pressure within secondary chamber **427** may continue to have a gradual drawing effect through the porous vent **402** for a prolonged period of time after removal of patient puncture tip **438** from the patient, and may draw all of the remaining blood contained within fluid inlet cannula **436** and flashback chamber **426** through porous vent **402** and/or into secondary chamber **427**. Needle assembly **410** can then be properly disposed of in a known manner. It is anticipated herein, that the flash chamber **426** described with reference to **FIGS. 14-20** may be employed within any of the embodiments described elsewhere in the present application.

[00138] Referring again to the embodiment, shown in **FIGS. 1-13**, a needle assembly **30c1** having a hinged safety shield **64c1** is shown. Needle assembly **30c1** generally includes needle structure **32c1** associated with needle holder **42c1**, and a safety shield **64c1** adapted for safety shielding of the needle structure **32c1** after use of the device. Needle assembly **30c1** further includes a hub **58c1** for supporting the needle structure **32c1** and a flashback indicator **60c1** defined therein, as previously described.

[00139] In the embodiment shown in **FIGS. 1-13**, the safety shield **64c1** may include a first depending arm **3000** and a second depending arm **3002** substantially parallel to the first depending arm **3000**. The first depending arm **3000** and the second depending arm **3002** are connected together by a connection surface **3004** that is substantially perpendicular to the first depending arm **3000** and the second depending arm **3002**. The safety shield **64c1** has a proximal end **3006** adjacent the needle holder **42c1** and a distal end **3008** opposed from the proximal end **3006**. At least a portion of the proximal end **3006** of the safety shield **64c1** is

pivotally connected to the needle holder **42c1**. Preferably, the proximal end **3006** of the safety shield **64c1** is connected to the needle holder **42c1** by two opposing pivots **3010**. In a further embodiment, the safety shield **64c1** is pivotally connected to the front cone **3012** of the needle holder **42c1** by pivots **3010** extending through opposing attachment arms **3014** connected to the front cone **3012** and oriented along the longitudinal axis of the needle holder **42c1**.

[00140] The pivot(s) **3010** allow the safety shield **64c1** to transitionally pivot in a rotational manner with respect to the needle holder **42c1** from a retracted position, as shown in FIGS. 5-8 to an extended position, as shown in FIGS. 9-11. In one embodiment, the safety shield **64c1** may also include a shield engaging area **3016** within the connection surface **3004** adjacent the proximal end **3006** having a contour substantially corresponding to the contour of the exterior surface **3018** of the needle holder **42c1** and/or the exterior surface **3018** of the front cone **3012**. In this configuration, the shield engaging area **3016** may rest against a portion of the needle holder **42c1** in the retracted position.

[00141] As shown in FIG. 4, the hub **58c1** may include a front hub portion **3026** and a rear hub portion **3028** joined to the first hub portion **3026**. The front hub portion **3026** may have a substantially conical shape disposed about the flashback indicator **60c1**. In one embodiment, at least a portion of the front hub portion **3026** extends distally beyond the front cone **3012** of the needle holder **42c1**. In another embodiment, at least a portion of the front hub portion **3026** has a contour that corresponds to a contour of the front cone **3012** of the needle holder **42c1**. The rear hub portion **3028** of the hub **58c1** may include a disk structure dimensioned to contact an interior perimeter of the needle holder **42c1** to prevent advancement of an evacuated blood collection tube (not shown) therebeyond. At least a portion of the needle structure **32c1** may extend through the front hub portion **3026** and the rear hub portion **3028** of the hub **58c1**. Although the hub **58c1** may be provided within the collection assembly as an integral element, in an alternative configuration, the hub **58c1**, including the front hub portion **3026** and the rear hub portion **3028**, as well as the needle structure **32c1** may be separately formed and subsequently assembled within the collection assembly **30c1**.

[00142] In one embodiment, the needle assembly **30c1** may be provided with a removable IV needle shield **3020** covering at least a portion of the needle structure **32c1**, such as covering at least a portion of the distal needle portion **34c1**. In one embodiment, as shown in FIG. 4, the needle shield **3020** can be sized to extend over at least a portion of the front hub portion **3026** of the hub **58c1**, the front cone **3012** of the needle holder **42c1**, the flashback

indicator **60c1**, and/or the hub **58c1**. The needle shield **3020** can be removed from the needle assembly **30c1** prior to use by typical manual applied pressure.

[00143] Referring again to **FIG. 4**, in another embodiment the needle shield **3020** can be provided with a raised protrusion **3022** disposed on the exterior surface **3024** of the needle shield **3020**. In one embodiment, the raised protrusion **3022** is circumferentially disposed about the needle shield **3020**. In another embodiment, the raised protrusion **3022** corresponds to a notch **3030** within the safety shield **64c1** such that the needle shield **3020** cannot be accidentally released from the needle assembly **30c1** until the safety shield **64c1** is positioned in the retracted position, as shown in **FIGS. 5-8**.

[00144] The safety shield **64c1** can be sized to have any dimensions suitable to allow the safety shield **64c1** to be pivoted away from the needle structure **32c1** in the retracted position, as shown in **FIGS. 5-8**, to allow a medical practitioner to engage the needle structure **32c1** with a patient, and to pivot toward and shield the needle structure **32c1**, specifically the tip of the distal needle portion **34c1** in the extended position, as shown in **FIGS. 9-11**. In one embodiment, the safety shield **64c1** may be pivoted away from the axis of the needle structure **32c1** to a sufficient angle to allow a medical practitioner to view the flashback indicator **60c1** and/or hub **58c1** in the retracted position. In another embodiment, the safety shield **64c1** is made of a transparent and/or translucent material to allow a medical practitioner to view the flashback indicator **60c1** and/or hub **58c1** therethrough.

[00145] Once the distal needle portion **34c1** has been removed from the patient, the needle assembly **30c1** may be transitioned from the retracted position to the extended position. In one embodiment, the first depending arm **3000** and the second depending arm **3002** of the safety shield **64c1** may be constructed to form a press-fit lock with at least a portion of the front hub portion **3026**, the front cone **3012** and/or the needle holder **42c1**. This prevents the safety shield **64c1** from re-transitioning to the retracted position once the initial transition from the retracted position to the extended position has occurred. As shown in **FIGS. 12-13**, the first depending arm **3000** and the second depending arm **3002** may each include an inwardly angled restraint **3032** disposed adjacent the pivot **3010** at the proximal end **3006** of the safety shield **64c1**. The angled restraint **3032** includes a sloped surface **3036** and a restraining surface **3038**. The front hub portion **3026** may also include a plurality of ledges **3034** for engaging the angled restraints **3032**. In one embodiment, when the safety shield **64c1** of the needle assembly **30c1** is transitioned from the retracted position to the extended position, the angled restraint **3032** of the safety shield **64c1** engages the ledge(s) **3034** of the front hub portion **3026**. Specifically, the restraining surface **3038** engages the ledge(s) **3034**

and prevents subsequent movement of the safety shield **64c1**. In one embodiment, the ledge(s) **3034** are positioned on the distal end **3050** of the hub **58c1**. In another embodiment, the angled restraint(s) **3032** are positioned on the safety shield **64c1** at a location distal from the pivot(s) **3010** for correspondingly engaging the ledge(s) **3034** on the distal end **3050** of the hub **58c1**. Alternatively, the front cone **3012** may also include a plurality of ledges **3034a** for engaging the angled restraint **3032** of the safety shield **64c1**. In yet another embodiment, the angled restraint(s) **3032** are positioned on the superior side **3052** of the safety shield **64c1** and may extend in a direction proximal from the pivot(s) **3010**. Accordingly, the engagement of the safety shield **64c1** and the hub **58c1** may occur at the superior side **3052** (bottom side), of the needle assembly **30c1**. Transition of the angled restraint **3032** over the ledge(s) **3034** can be effectuated with typical manual pressure. As shown in **FIG. 13**, the safety shield **64c1** may optionally include a biasing element **3040** for further securing the front hub portion **3026** within the safety shield **64c1**. Thus, the locking structure of the safety shield **64c1** engages at least a portion of the flash chamber, defined within the hub **58c1**. In one embodiment, the locking structure of the safety shield **64c1** engages at least a portion of the housing, such as the hub **58c1**, at a location distal to the flash chamber.

[00146] **FIGS. 21-35** depict another alternative hinged assembly embodiment of the present invention. A needle assembly **5000**, as shown in **FIGS. 21-27**, generally includes a needle structure **32c2**, associated with a hub **58c2**, and a safety shield **64c2** connected to the hub **58c2** and adapted for safety shielding of the needle structure **32c2** after use of the device. In one embodiment, the needle assembly **5000** may incorporate features of other known needle assemblies having hinged safety shields, such as those disclosed in United States Patent Publication No. 2005/0187493.

[00147] The needle structure **32bc2** may include a distal needle portion **5002** and a proximal needle portion **5004**. Distal needle portion **5002** and proximal needle portion **5004** may be separate needles, both of which represent needle cannulae defining central lumen **5006** extending therethrough. The proximal needle portion **5004** represents a non-patient end of the needle structure **32bc2**, which is provided for puncturing of an evacuated blood collection tube (not shown). The proximal needle portion **5004** may be covered by an elastomeric multiple sample sleeve **5008** that can be pierced by a pointed end of proximal needle portion **5004** of the needle structure **32c2**. Distal needle portion **5002** represents a patient end of the needle structure **32c2**, and may be beveled to define a puncture tip for puncturing the skin of a patient and accessing the vasculature of the patient.

[00148] The hub **58c2** may include a front hub portion **5010** and a rear hub portion **5012** and is capable of supporting the needle structure **32c2** therethrough. In one embodiment, the distal needle portion **5002** may be integral with the front hub portion **5010** and the proximal needle portion **5004** may be integral with the rear hub portion **5012**. The front hub portion **5010** and the rear hub portion **5012** are structured to matingly engage. The front hub portion **5010** may include a protrusion **5014**, such as a raised annular ring, for engaging a corresponding recess **5016** integral to the rear hub portion **5012**. In another embodiment, the front hub portion **5010** and the rear hub portion **5012** may be joined together via an adhesive or weld. Once assembled, the hub **58c2** defines a flashback indicator **60c2** therein, as previously described.

[00149] The hub **58c2** may further include a collar **5018** for surrounding at least a portion of the safety shield **64c2**, such as a pivot **5020** of the safety shield **64c2**, as previously described herein. In one embodiment, the front hub portion **5010** includes a first collar portion **5022** and the rear hub portion **5012** includes a second collar portion **5024**. The first collar portion **5022** may include a generally c-shaped region **5028** for accommodating an attachment bearing **5026** of the safety shield **64c2**, shown in **FIGS. 26** and **28**, therein. The attachment bearing **5026** may be integral with the safety shield **64c2**. The attachment bearing **5026** may also be integral with a portion of the hub **58c2**, such as the first collar portion **5022** and/or the second collar portion **5024**. Alternatively, the attachment bearing **5026** may be separately provided and subsequently assembled with the safety shield **64c2** and/or the hub **58c2**. The attachment bearing **5026** can extend between a first depending arm **5044** and a second depending arm **5046** of the safety shield **64c2**, as shown in **FIG. 29**. The second collar portion **5024** may include a cap region **5030** having an interior surface **5032** substantially corresponding to the attachment bearing **5026** of the safety shield **64c2**. The first collar portion **5022** may include a protrusion **5034** for engaging a corresponding recess **5036** integral to the second collar portion **5024**. Accordingly, in one embodiment, the engagement of the front hub portion **5010** with the rear hub portion **5012** also engages the first collar portion **5022** with the second collar portion **5024**. In another embodiment, the collar **5018** is positioned substantially on a top surface of the hub **58c2** to allow the safety shield **64c2** to likewise be connected to the top surface of the hub **58c2**.

[00150] Referring again to **FIGS. 21-27**, a proximal IV needle shield **5038** and a distal IV needle shield **5040** can be respectively provided over the proximal needle portion **5004** and the distal needle portion **5002** prior to use, as described herein.

[00151] During use, the proximal IV needle shield **5038** can be removed from the proximal needle portion **5004** and the needle holder **42c2**, shown in **FIGS. 29-35**, can be inserted over the proximal needle portion **5004** and engaged with at least a portion of the hub **58c2**. In one embodiment, the needle holder **42c2** is engaged with a portion of the rear hub portion **5012**.

[00152] In another embodiment, shown in **FIG. 28**, the attachment bearing **5026** of the safety shield **64c2** may include a notch **5042** for retaining the safety shield **64c2** within a specified location. For example, the notch **5042** may frictionally retain the safety shield **64c2** within the collar **5018** at a specified angle in the retracted position. This allows a medical practitioner to position the safety shield **64c2** at a desired angle during a medical procedure without attending to accidental closure or slippage of the safety shield **64c2**.

[00153] As shown in **FIGS. 29-35**, the needle assembly **30c2** can be transitioned from the retracted position, shown in **FIG. 28**, in which the distal needle portion **5002** is unshielded for the purpose of accessing a patient, to the extended position, in which the distal needle portion **5002** is safety shielded from exposure, as described herein. With reference to **FIGS. 21-35**, in another embodiment, the safety shield **64c2** may include a thumb press-region **64c2a** for enabling a medical practitioner to pivot the safety shield **64c2** to engage a portion of the proximal IV shield **5038** prior to puncturing the skin of a patient. In one embodiment, the thumb press-region **64c2a** extends at least partially beyond the safety shield **64c2** to enable the medical practitioner to easily contact the thumb-press region **64c2a** with a single finger or thumb.

[00154] In an alternative embodiment, as shown in **FIG. 36**, a collection assembly **130w**, may include a safety shield **64w** may include a first end **138w** having a first depending arm **132w** and a second depending arm **134w** substantially parallel to the first depending arm **132w**. The first depending arm **132w** and the second depending arm **134w** may be connected together. The first depending arm **132w** and the second depending arm **134w** may have substantially the same area. The safety shield **64w** has an end **140w** that is connected to the needle holder **42w** by at least one pivot **142w**. Preferably, the end **140w** of the safety shield **64w** is connected to the needle holder **42w** by two pivots **142w**. Example pivoting mechanisms are described in United States Patent Publication No. 2005/187,493.

[00155] In one embodiment, the pivot **142w** may include a protrusion integrally formed with the second end **140w** of the safety shield **64w** and a corresponding recess defined in the distal end of the needle holder **42w**. In another embodiment, the pivot **142w** may include a recess defined within the second end **140w** of the safety shield **64w** and a corresponding recess defined within the distal end of the needle holder **42w**. In yet another embodiment, a

first pivot **142w** can be disposed on a first side of the distal end of the needle holder **42w** and a second pivot **142w** can be disposed on a second side of the distal end of the needle holder **42w**, the first and second sides of the needle holder **42w** being substantially opposite each other. The pivot(s) **142w** allow the safety shield **64w** to pivot in a rotational manner with respect to the needle holder **42w** from a retracted position, as shown in **FIG. 36** to an extended position, as previously described.

[00156] **FIGS. 37-44** depict yet another embodiment of the present invention, in which a needle assembly **8000**, such as a blood collection assembly, having a pivoting safety shield **8064** and a removable cannula shield **8066** engaged with a housing **8005** is generally shown in the restricted position. As shown specifically in **FIG. 37**, needle assembly **8000** generally includes a cannula structure **8032**, associated with a hub **8058** with the pivoting safety shield **8064** connected to the hub **8058** and adapted for safety shielding of the cannula structure **8032** after use of the device. The cannula structure **8032** may include a distal needle portion **8002** and a proximal needle portion **8004**. Distal needle portion **8002** and proximal needle portion **8004** may be separate needles, both of which represent needle cannula defining a cannula interior and central lumen extending therethrough. Alternatively, distal needle portion **8002** and proximal needle portion **8004** may be one needle with or without an opening between the ends. The proximal needle portion **8004** represents a non-patient end of the cannula structure **8032**, which is provided for puncturing of an evacuated specimen collection container **8003**, such as shown in **FIG. 58**. The proximal needle portion **8004** may be covered by an elastomeric multiple sample sleeve **8008** that can be pierced by a pointed end of proximal needle portion **8004** of the cannula structure **8032**. Distal needle portion **8002** represents a patient end of the cannula structure **8032**, and may be beveled to define a puncture tip for puncturing the skin of a patient and accessing the vasculature of the patient. The patient end of the distal needle portion **8002** projects at least partially from the distal end **8001** of the housing **8005** opposite the proximal end **8007** of the housing **8005** which is engageable with a specimen collection container **8003**.

[00157] In one embodiment, the housing **8005** includes a hub **8058** which includes a distal front hub portion **8010** and a proximal rear hub portion **8012** and is capable of supporting the cannula structure **8032** therethrough. In one embodiment, the distal needle portion **8002** may be integral with the front hub portion **8010** and the proximal needle portion **8004** may be integral with the rear hub portion **8012**. The front hub portion **8010** and the rear hub portion **8012** are structured to matingly engage. At least one of the front hub portion **8010** and the rear hub portion **8012** may include a protrusion, such as a raised annular ring for engaging a

corresponding recess integral to the other of the front hub portion **8010** and the rear hub portion **8012**. In another embodiment, the front hub portion **8010** and the rear hub portion **8012** may be joined together via an adhesive or weld. Once assembled, the hub **8058** defines a flashback indicator **8060** therein, as previously described. The hub **8058** may also include a porous vent **8061** as also previously described.

[00158] The hub **8058** may further include a collar **8018** for surrounding at least a portion of the safety shield **8064**, such as an attachment bearing **8020** of the safety shield **8064**, as previously described herein. In one embodiment, the front hub portion **8010** includes a first collar portion **8022** and the rear hub portion **8012** includes a second collar portion **8024**. The first collar portion **8022** may include a generally c-shaped region for accommodating the attachment bearing **8020** of the safety shield **8064** therein. In one embodiment, the first collar portion **8022** may include a chamfered portion adjacent the c-shaped region for further restraining the attachment bearing **8020** therein. The attachment bearing **8020** may be integral with the safety shield **8064**. The attachment bearing **8020** may also be integral with a portion of the hub **8058**, such as the first collar portion **8022** and/or the second collar portion **8024**. Alternatively, the attachment bearing **8020** may be separately provided and subsequently assembled with the safety shield **8064** and/or the hub **8058**. The second collar portion **8024** may include an interior surface substantially corresponding to the attachment bearing **8020** of the safety shield **8064**, such that when the first collar portion **8022** and the second collar portion **8024** are joined, the safety shield **8064** is fixedly engaged with the housing **8005** and capable of pivoting with respect to the housing **8005**. In one embodiment, the safety shield **8064** is capable of pivoting substantially along the longitudinal axis L_{Pivot} of the housing **8005**, as shown in FIG. 38.

[00159] Referring again to FIG. 37, it is contemplated herein that the needle assembly **8000** may include an integrated specimen collection container holder **8011**. The specimen collection container holder **8011** may define an interior **8013** through which a specimen collection container **8003**, shown in FIG. 62, may be engaged with the proximal end of the rear hub portion **8012**. Optionally, the proximal end of the specimen collection container holder **8011** may be provided with a cover **8017** for maintaining sterility within the interior **8013** of the specimen collection container holder **8011** prior to use, as previously described. Alternatively, although the needle assembly **8000** is depicted as engaged with a specimen collection container holder **8011**, it is anticipated herein that the proximal end of the needle assembly **8000** may be provided without a specimen collection container holder **8011** engaged therewith. Specifically, the proximal needle portion **8004** of the cannula structure

8032 may be covered with a proximal needle cover, such as shown and described herein with reference to **FIGS. 21-27**.

[00160] Referring again to **FIG. 37**, prior to use of the needle assembly **8000**, the distal needle portion **8002** of the cannula structure **8032** is covered with a cannula shield **8066**. The cannula shield **8066** is adapted to removably engage a portion of the housing **8005**, such as the hub **8058**, and to shield at least the patient end of the distal needle portion **8002** of the cannula structure **8032**. In one embodiment, a proximal portion **8072** of the cannula shield **8066** is adapted to engage the distal front hub portion **8010**. The proximal portion **8072** of the cannula shield **8066** may include an attachment protrusion **8074**, having a plurality of attachment ridges **8076** extending outwardly from the attachment protrusion **8074**, adapted to engage a receiving recess **8080** of the distal front hub portion **8010** to secure the cannula shield **8066** to the hub **8058**. In this configuration, a frictional interference fit is created between the attachment protrusion **8074** and the receiving recess **8080**. In a further configuration, the attachment ridges **8076** may be adapted to slightly deform against the inner surface **8081** of the receiving recess **8080** to increase the frictional interference between the cannula shield **8066** and the hub **8058**.

[00161] Referring yet again to **FIG. 37**, the cannula shield **8066** further includes a safety shield engagement **8090**, such as a locking tab receiving structure. The safety shield engagement **8090** is adapted for releasably engaging at least a portion of the safety shield **8064** in the restrained position, as shown in **FIGS. 38-47**, prior to use of the needle assembly **8000**. In this embodiment, a portion of the cannula shield **8066** and a portion of the safety shield **8064** are engaged to releasably lock the cannula shield **8066** to the needle assembly **8000** to prevent accidental removal of the cannula shield **8066** from the needle assembly **8000** prior to use. Accordingly, in addition to the frictional interference between the cannula shield **8066** and the hub **8058**, the releasable engagement between the cannula shield **8066** and the safety shield **8064** provides an additional locking mechanism to prevent accidental removal of the cannula shield **8066** from the needle assembly **8000**. In prior needle assemblies, changes in temperature and other environmental factors could weaken the frictional resistance between protective cover structures and the base assembly causing unintentional release of a protective cover. In the present invention, the releasable engagement between the cannula shield **8066** and the safety shield **8064** provides additional mechanical locking mechanism for further restraining the cannula shield **8066** with the needle assembly **8000** prior to use.

[00162] As shown in FIGS. 38-47, when the needle assembly 8000 is in the restrained position, the cannula shield 8066 is engaged with the safety shield 8064. In this configuration, environmental factors such as changes in temperature or typically manually applied axial force F_{Axial} , as shown in FIG. 38, on the cannula shield 8066 will not disengage the cannula shield 8066 from the needle assembly 8000.

[00163] As shown in FIG. 42, an optional sterility label 9007 can be applied between a portion of the cannula shield 8066 and the housing 8005 to evidence that the cannula shield 8066 has not been removed from the needle assembly 8000 prior to use.

[00164] As shown specifically in FIGS. 45-47, the safety shield engagement 8090 may be a ridge projecting dorsally from an outer surface 8091 of the cannula shield 8066, such as in a generally upwardly direction. The safety shield engagement 8090 may extend along at least a portion of a longitudinal axis of the cannula shield $L_{\text{CannulaShield}}$, as shown in FIG. 45. As shown in FIG. 47, the ridge may include a first ridge portion 9008 and a second ridge portion 9010 separated by a divided region 9006. In a further configuration, the first ridge portion 9008 and the second ridge portion 9010 may include corresponding beveled edge portions 9012, 9014 disposed to opposingly face the outer surface 8091 and separated from the outer surface 8091 by a neck region 9018.

[00165] Referring again to FIGS. 45-47, the safety shield 8064 may be provided with a first depending arm 9000 and a second depending arm 9002, constructed to form a press-fit lock with at least a portion of the cannula shield 8066. In one configuration, the first depending arm 9000 includes a first locking tab 9032, and the second depending arm 9002 includes a second locking tab 9034, with each of the first locking tab 9032 and the second locking tab 9034 adapted to releasably engage the safety shield engagement 8090. In a further configuration, the first locking tab 9032 releasably engages the first ridge portion 9008 and the second locking tab 9034 releasably engages the second ridge portion 9010. Each of the first locking tab 9032 and the second locking tab 9034 may have an engagement surface 9040, 9041 corresponding to the beveled edge portions 9012, 9014 to provide a resistance interference therebetween. In a further configuration, the engagement surface 9040, 9041 may have an upwardly angled slope and/or an opposingly corresponding beveled edge to increase the interference resistance when engaged with the first ridge portion 9008 and the second ridge portion 9010.

[00166] The engagement of the safety shield engagement 8090 of the cannula shield 8066 and the locking tab 9032, 9034 of the safety shield 8064 are provided in a detent arrangement to releasably restrain the safety shield 8064 with the cannula shield 8066. The detent

arrangement prevents unintentional removal of the cannula shield **8066** from the housing **8005** of the needle assembly **8000**. The detent arrangement is adapted to resist disengagement until an intentionally upwardly directed force is imparted to the safety shield **8064** in a direction opposite the cannula shield **8066**, as shown in **FIG. 46** by the arrow F_{Applied} . The intentionally upwardly directed force may be imparted by typically manually pressure applied by a medical practitioner. As such a force is applied, the first locking tab **9032** and the second locking tab **9034** of the safety shield **8064** are deflected laterally in opposing directions, as shown by arrows $F_{\text{Deflection}}$ in **FIG. 47**. Once the first locking tab **9032** and the second locking tab **9034** are deflected laterally, the engagement of the first locking tab **9032** with the first ridge portion **9008** and the engagement of the second locking tab **9034** with the second ridge portion **9010** are released and detent arrangement of the cannula shield **8066** with the safety shield **8064** is disengaged.

[00167] Once the safety shield **8064** is transitioned from the restrained position, shown in **FIGS. 38-47**, to the retracted position, shown in **FIGS. 48-52**, the detent arrangement between the safety shield **8064** and the cannula shield **8066** has been disengaged. Disengagement of the detent arrangement allows a medical practitioner to subsequently remove the cannula shield **8066** from the needle assembly **8000** by applying manual force along the longitudinal axis of the cannula shield $L_{\text{Cannula Shield}}$, as shown in **FIG. 45**. Removal of the cannula shield **8066** from the needle assembly **8000** causes the sterility label **9007**, shown in **FIG. 42**, to break, thereby evidencing exposure of the distal needle portion **8002** of the cannula structure **8032**, shown in **FIG. 52**.

[00168] Once the needle assembly **8000** is transitioned to the retracted position and the cannula shield **8066**, shown engaged with the needle assembly **8000** in **FIGS. 48-52**, is removed, the distal needle portion **8002** of the needle assembly **8000** is exposed and ready for use by a medical practitioner to contact the vasculature of a patient, as shown in **FIGS. 53-57**. As used herein, the term “retracted position” means the position in which the safety shield **8064** is pivoted away from the patient end of the distal needle portion **8002** of the cannula structure **8032**. Once the safety shield **8064** is transitioned to the retracted position and the cannula shield **8066**, shown in **FIGS. 37-47**, is removed, the flashback indicator **8060** defined within the hub **8058** may be visible to a medical practitioner, as previously described herein, for providing visual evidence of contact between the distal needle portion **8002** of the cannula structure **8032** and the patient’s vasculature. As shown in **FIG. 58**, a specimen collection container **8003** may be inserted into the interior **8013** of the specimen collection container holder **8011** of the needle assembly **8000** during use of the needle assembly in a

vasculature access medical procedure. As also shown in **FIG. 58**, the exterior profile **9050** of the safety shield **8064** and the exterior profile **9052** of the housing **8005** may have a substantially corresponding profile to provide enhanced user stability.

[00169] Once the needle assembly **8000**, in particular the distal needle portion **8002** of the cannula structure **8032** has been removed from contact with the patient, the safety shield **8064** may be transitioned to the extended position, as shown in **FIGS. 59-68**. The safety shield **8064** is transitionable over the distal needle portion **8002** of the cannula structure **8032** from a retracted position in which the patient directed distal needle portion **8002** is exposed, to an extended position in which the patient directed distal needle portion **8002** is shielded by at least a portion of the safety shield **8064**. It is noted that transition of the safety shield **8064** from the retracted position to the extended position is possible only after the cannula shield **8066**, shown in **FIGS. 37-53**, has been removed from the needle assembly **8000**. Accordingly, removal of the cannula shield **8066** from the housing **8005** allows for transition of the safety shield **8064** from the retracted position, shown in **FIGS. 48-58**, to the extended position, shown in **FIGS. 59-68**. It is further noted that transition from the extended position to the retracted position does not automatically occur once the cannula shield **8066** is removed from the needle assembly **8000**, but rather a medical practitioner must apply a downwardly directed force on a portion of the safety shield **8064**, such as the thumb-press region **9063**, to transition to safety shield **8064** from the retracted position to the extended position, as previously described.

[00170] As shown specifically in **FIGS. 63-64**, once the safety shield **8064** is transitioned to the extended position, the first locking tab **9032** of the first depending arm **9000** and the second locking tab **9034** of the second depending arm **9002** engage with and lock to at least a portion of the housing **8005**, such as the front hub portion **8010**, as previously described. Specifically, the engagement surface **9040** of the first locking tab **9032**, and the engagement surface **9041** of the second locking tab **9034**, may each engage a portion of the housing **8005** to fixedly and substantially non-removably secure the safety shield **8064** over the distal needle portion **8002**.

[00171] As shown in **FIG. 65**, the engagement surface **9040** of the first locking tab **9032** of the first depending arm **9000** of the safety shield **8064** engages a first ledge **9073** of the front hub portion **8010** at least partially supporting the cannula structure **8032**, as previously described herein with reference to **FIG. 13**. Also shown in **FIG. 65**, engagement surface **9041** of the second locking tab **9034** of the second depending arm **9002** of the safety shield **8064** engages a second ledge **9075** of the front hub portion **8010** at least partially supporting

the cannula structure **8032**, as also previously described herein with reference to **FIG. 13**. It is anticipated herein that the engagement surface **9040** of the first locking tab **9032** and the engagement surface **9041** of the second locking tab **9034** may engage the flashback indicator **8060**. It is also anticipated herein that the engagement surface **9040** of the first locking tab **9032** and the engagement surface **9041** of the second locking tab **9034** may engage a portion of the housing **8005**, such as the hub **8058** at a location that is distal to the flashback indicator **8060**. The engagement surfaces **9040**, **9041** of the safety shield **8064** are adapted to fixedly engage the housing **8005** to prevent disengagement thereof absent malicious force. Accordingly, the first locking tab **9032** and the second locking tab **9034** releasably engage a portion of the cannula shield **8066** in the restrained position, shown in **FIGS. 37-53**, and fixedly engage a portion of the housing **8005**, such as the front hub portion **8010**, in the extended position, shown in **FIGS. 59-68**.

[00172] As shown in **FIG. 66**, the safety shield **8064** may also include a deformable needle restraint **9077** for deflecting over cannula structure **8032** as the safety shield **8064** is transitioned to the extended position by applying force in the direction of arrow F_{Extended} , as shown in **FIG. 66**. Once the deformable needle restraint **9077** is engaged over the cannula structure **8032**, the deformable needle restraint **9077** resists deflection upon application of a reversing force applied to the safety shield **8064** in the direction of arrow F_{Reverse} , as also shown in **FIG. 66**.

[00173] As previously described, it is anticipated herein that the housing **8005** of the needle assembly **8000** may or may not include a specimen collection container holder **8011**, as shown in **FIGS. 37-44**. Alternatively, as shown in **FIGS. 69-70**, a needle assembly **9080** may include a non-patient cannula shield **9081** disposed over the proximal needle portion **8004** in place of a specimen collection container holder. This configuration is similarly described herein with reference to **FIGS. 21-27**, with the exception that, as shown in **FIGS. 69-70**, the needle assembly **9080** includes a cannula shield **8066A** having a safety shield engagement **8090A**, such as a ridge. As previously described, the safety shield engagement **8090A** is releasably engageable with the safety shield **8064A** in the restrained position. The safety shield **8064A** is transitionable from the restrained position to the retracted position and is subsequently transitionable from the retracted position to the extended position, as also previously described. The safety shield **8064A** is releasably engaged with the cannula shield **8066A** in the restrained position, and is fixedly engaged with a portion of the housing **8005A** in the extended position, once the cannula shield **8066A** has been removed from engagement with the housing **8005A**.

[00174] As shown in **FIGS. 71-75**, assembly of a needle assembly as described herein may be accomplished by assembling a first sub-assembly **9090** and subsequently joining the first sub-assembly **9090** with a second sub-assembly **9091** by press-fit engagement. The first sub-assembly **9090** may include elements previously described herein with reference to **FIGS. 37-68** including a hub **8058**, a distal hub portion **8010**, a flashback indicator **8060**, a cannula structure **8032**, a cannula shield **8066** removably engaged with the hub **8058**, and a pivoting safety shield **8064** fixedly engaged with a portion of the hub **8058**. The safety shield **8064** being transitionable from a restricted position to a retracted position, and subsequently transitionable from a retracted position to an extended position. The safety shield **8064** and the cannula shield **8066** being releasably engaged therewith in the restricted position. The safety shield **8064** fixedly engaged with a portion of the flashback indicator **8060** and/or the distal hub portion **8010** in the extended position. The second sub-assembly **9091** includes a specimen collection container holder **8011** having an interior **8013**, as previously described herein with reference to **FIGS. 37-44**, through which a specimen collection container **8003**, shown in **FIG. 58**, may be engaged with the proximal end of the hub **8058** or proximal rear hub portion **8012**.

[00175] As shown in **FIGS. 74-75**, the first sub-assembly **9090** includes a first portion **9092** for press-fit engagement with the second sub-assembly **9091**. The second sub-assembly **9091** includes a second portion **9093** for press-fit engagement with the first sub-assembly **9090**. The first portion **9092** may include a first abutment surface **9094** for engaging a first restraining surface **9095** of the second portion **9093**. The engagement of first abutment surface **9094** and first restraining surface **9095** substantially prevents movement between the first sub-assembly **9090** and the second sub-assembly **9091** in the proximal or rightwardly direction along the longitudinal axis $L_{\text{Sub-Assembly}}$ as shown in **FIG. 74**.

[00176] Also shown in **FIGS. 74-75**, the first sub-assembly **9090** includes a second restraining surface **9096** for restraining a second abutment surface **9097** of the second sub-assembly **9091**. The engagement of second abutment surface **9097** and second restraining surface **9096** substantially prevents movement between the first sub-assembly **9090** and the second sub-assembly **9091** in the distal or leftwardly direction along the longitudinal axis $L_{\text{Sub-Assembly}}$ as shown in **FIG. 74**. Additionally, the second sub-assembly **9091** may include a restraining portion **9099** adapted for receipt within a neck portion **9098** of the first sub-assembly **9090** to further secure the first sub-assembly **9090** with the second sub-assembly **9091**. The restraining portion **9099** may include an engagement surface **10001** for engaging a restraining tab **10002**. In one configuration, engagement of the first sub-assembly **9090** and

the second sub-assembly **9091** requires a deflection of at least one of first portion **9092** and the second portion **9093** to provide an interference therebetween. During engagement, an axial force is applied along the longitudinal axis $L_{\text{Sub-Assembly}}$ as shown in **FIG. 74** to deflect at least one of the first portion **9092** and the second portion **9093** against the other of the first portion **9092** and the second portion **9093**. In a further embodiment, the engagement of the first sub-assembly **9090** and the second sub-assembly **9091** includes a two-stage press-fit engagement. In the first stage, during applied axial force a first portion of at least one of the first portion **9092** and the second portion **9093** against the other of the first portion **9092** and the second portion **9093** occurs. In the second stage, still during applied axial force, a second portion of at least one of the first portion **9092** and the second portion **9093** against the other of the first portion **9092** and the second portion **9093** occurs. For example, the restraining portion **9099** may first deflect against the first abutment surface **9094**, and subsequently deflect against the second restraining surface **9096**.

[00177] Alternatively, as shown in **FIGS. 76-79**, engagement of a first sub-assembly **9090B** and a second sub-assembly **9091B** may include a portion of the first portion **9092B** including locking teeth **10004** for engagement with a corresponding section **10006** of the second portion **9093B**. In this configuration, the first sub-assembly **9090B** and the second sub-assembly **9091B** are engaged in press-fit configuration, and the further engagement of the locking teeth **10004** and the corresponding section **10006** further secure the first sub-assembly **9090B** and the second sub-assembly **9091B** against proximally or distally applied forces along the longitudinal axis $L_{\text{Sub-Assembly}}$ as shown in **FIG. 74**.

[00178] In yet another configuration, as shown in **FIGS. 80-83**, the first sub-assembly **9090C** and the second sub-assembly **9091C** may be secured by the above-described press-fit engagement of the first portion **9092C** and the second portion **9093C**, and by corresponding threaded engagement therebetween. In one configuration, at least a portion of the first portion **9092C** and at least a portion of the second portion **9093C** include corresponding mating surfaces for threaded engagement therebetween. As shown in **FIG. 83**, the first portion **9092C** includes a plurality of threads **9194** for engagement with a plurality of corresponding recesses **9195** defined within the second portion **9093C**. As also shown in **FIG. 83**, the first sub-assembly **9090C** and the second sub-assembly **9091C** may be press-fit engaged by interaction between a series of raised annular ridges and corresponding recesses. In one embodiment, the second sub-assembly **9091C** may include at least one raised annular ridge **9100** extending outwardly within an interior **9113** of the second sub-assembly **9091C**. The first sub-assembly **9090C** may include at least one corresponding recess **9115** defined

within a portion of the first portion **9092C** and adapted to receive the raised annular ridge **9100** therein.

[00179] In each of the above-described press-fit engagements between the first sub-assembly **9090** and the second sub-assembly **9091**, the press-fit engagement prevents disengagement of the first sub-assembly **9090** from the second sub-assembly **9091** upon engagement of a specimen collection container, such as shown as item **8003** in **FIG. 58**, with the proximal end of the hub **8058** and/or proximal rear hub portion **8012**, each shown for example in **FIG. 37**. The above-described press-fit engagement mechanisms provide improved stability over sub-assemblies that are affixed together through adhesives, as they are temperature independent and resist additional environmental changes. The above-described press-fit engagement mechanisms also provide improved stability over sub-assemblies that are joined together through threaded engagement alone, as the press-fit mechanisms cannot become engaged through unintentionally applied rotational forces.

CLAIMS

1. A needle assembly, comprising:
 - a housing having a distal end, and a proximal end engageable with a specimen collection container;
 - a cannula extending distally from the housing, the cannula comprising a patient end;
 - a cannula shield removably engaged with a portion of the housing and capable of shielding at least the patient end of the cannula, the cannula shield comprising a safety shield engagement; and
 - a safety shield pivotably engaged with the housing and comprising at least one locking tab, the safety shield transitionable from a first position in which the locking tab is releasably engaged with the safety shield engagement of the cannula shield, to a second position in which the locking tab is disengaged from the safety shield engagement and the patient end of the cannula is exposed, to a third position in which the patient end of the cannula is shielded by at least a portion of the safety shield and the locking tab is fixedly locked with a portion of the housing,wherein at least one of the locking tab and/or the safety shield engagement are configured such that engagement therebetween resists application of axial force to the cannula shield.
2. The needle assembly of claim 1, wherein removal of the cannula shield from the housing allows for transition of the safety shield from the second position to the third position.
3. The needle assembly of claim 1, wherein the housing further comprises a flash indicator, and a cannula interior is provided in fluid communication with the flash indicator, the flash indicator visible in the second position and wherein the safety shield is disposed over the patient end of the cannula and the locking tab engages at least a portion of the flash indicator in the third position.

4. The needle assembly of claim 1, wherein the housing further comprises a flash indicator, and a cannula interior is provided in fluid communication with the flash indicator, the flash indicator visible in the second position and wherein the safety shield is disposed over the patient end of the cannula and the locking tab engages a portion of the housing distal to the flash indicator in the third position.

5. The needle assembly of claim 1, wherein the housing comprises a forward hub portion and a rear hub portion connectable with the forward hub portion and defining a flash indicator therebetween.

6. The needle assembly of claim 1, wherein the safety shield engagement is a ridge projecting dorsally from an outer surface of the cannula shield.

7. The needle assembly of claim 6, wherein the safety shield engagement extends substantially longitudinally along the cannula shield.

8. The needle assembly of claim 6, wherein the ridge comprises a beveled edge and the locking tab comprises an engagement surface corresponding to the beveled edge to provide a resistance interference therebetween.

9. The needle assembly of claim 6, wherein the locking tab comprises a beveled edge and the ridge comprises an engagement surface corresponding to the beveled edge to provide a resistance interference therebetween.

10. The needle assembly of claim 6, wherein at least a portion of the ridge is engageable with at least a portion of the locking tab in a detent arrangement to restrain the safety shield with the cannula shield.

11. The needle assembly of claim 10, wherein the detent arrangement is adapted to resist disengagement until a force is imparted to the safety shield in a manner capable of moving the safety shield from the first position to the second position.

12. The needle assembly of claim 10, wherein the detent arrangement resists unintentional removal of the cannula shield from the housing.

13. The needle assembly of claim 10, wherein release of the detent arrangement allows the safety shield to pivot from the first position to the second position.

14. The needle assembly of claim 1, wherein the at least one locking tab is engaged with the safety shield engagement in a detent arrangement that resists unintentional disengagement of the cannula shield from the housing.

15. A needle assembly, comprising:
a housing, having a distal end, and a proximal end;
a cannula extending distally from the housing, the cannula comprising a patient end;
a safety shield pivotably engaged with the housing and having a locking tab, the safety shield transitionable over the cannula from a retracted position in which the patient end is exposed, to an extended position in which the patient end is shielded by at least a portion of the safety shield and the locking tab fixedly locks with a portion of the housing; and
a cannula shield releaseably engaged with the housing and shielding at least the patient end of the cannula, wherein the cannula shield comprises a safety shield engagement, the safety shield releaseably engaged with the safety shield engagement to form a lock,
wherein the lock is configured to resist application of axial force to the cannula shield.

16. The needle assembly of claim 15, wherein the safety shield engagement is a ridge projecting dorsally from an outer surface of the cannula shield and extending along at least a portion of a longitudinal axis of the cannula shield.

17. The needle assembly of claim 16, wherein the safety shield further comprises at least one locking tab adapted to releaseably engage the ridge.

18. The needle assembly of claim 17, wherein the ridge comprises a beveled edge and the locking tab comprises an engagement surface corresponding to the beveled edge to provide a resistance interference therebetween.

19. The needle assembly of claim 17, wherein at least a portion of the ridge is engageable with at least a portion of the locking tab in a detent arrangement to restrain the safety shield with the cannula shield.

20. The needle assembly of claim 19, wherein the detent arrangement is adapted to resist disengagement until a force is imparted to the safety shield in a manner capable of moving the safety shield from a restrained position to the retracted position.

21. The needle assembly of claim 19, wherein the detent arrangement prevents unintentional removal of the cannula shield from the housing.

22. The needle assembly of claim 19, wherein disengagement of the detent arrangement enables removal of the cannula shield from the housing.

23. The needle assembly of claim 19, wherein release of the detent arrangement allows the safety shield to pivot from a first position to a second position.

24. The needle assembly of claim 15, wherein the housing further comprises a flash indicator, and a cannula interior is provided in fluid communication with the flash indicator.

25. The needle assembly of claim 15, wherein the lock forms a detent arrangement that resists unintentional disengagement of the cannula shield from the housing.

26. A blood collection assembly, comprising:
a first sub-assembly comprising,
a hub comprising, a flash indicator, having a distal end and a proximal end

engageable with a specimen collection container,

a cannula extending between a patient end and a non-patient end, defining a cannula interior, the patient end of the cannula projecting at least partially from the distal end of the hub, the cannula interior in fluid communication with the flash indicator,

a cannula shield removably engaged with the distal end of the hub and shielding at least the patient end of the cannula, the cannula shield comprising a safety shield engagement, and

a safety shield pivotably engaged with the hub comprising at least one locking tab, the safety shield transitionable from a first position in which the locking tab is releasably engaged with the safety shield engagement of the cannula shield, to a second position, in which the locking tab is disengaged from the safety shield engagement and the patient end is exposed, to a third position in which the patient end is shielded by at least a portion of the safety shield and the locking tab is fixedly locked with a portion of the hub,

wherein at least one of the locking tab and/or the safety shield engagement are configured such that engagement therebetween resists application of axial force to the cannula shield; and

a second sub-assembly comprising a specimen collection container holder having an interior through which a specimen collection container may be engaged with the proximal end of the hub,

wherein the first sub-assembly further comprises a first portion for press-fit engagement with the second sub-assembly, and the second sub-assembly comprises a corresponding second portion for press-fit engagement with the first sub-assembly.

27. The blood collection assembly of claim 26, wherein the safety shield engagement is a ridge projecting upwardly from an outer surface of the cannula shield and extending along at least a portion of a longitudinal axis of the cannula shield, and at least a portion of the ridge is engageable with at least a portion of the locking tab in a detent arrangement to restrain the safety shield with the cannula shield.

28. The blood collection assembly of claim 27, wherein release of the detent arrangement allows the safety shield to pivot from the first position to the second position.

29. The blood collection assembly of claim 27, wherein removal of the cannula shield from the hub allows for transition of the safety shield from the second position to the third position.

30. The blood collection assembly of claim 27, wherein the locking tab is releasably engagable with the safety shield engagement in the first position and fixedly engagable with a portion of the hub in the third position.

31. The blood collection assembly of claim 26, wherein engagement of the first portion and the second portion comprises deflection of at least one of the first portion and the second portion to provide an interference therebetween.

32. The blood collection assembly of claim 26, wherein the first portion and the second portion comprise a two-stage press-fit engagement, wherein engagement of the first portion and the second portion comprises a first deflection of at least a part of at least one of the first portion and the second portion to provide an interference therebetween, and a second deflection of at least a part of at least one of the first portion and the second portion to provide a second interference therebetween.

33. The blood collection assembly of claim 26, wherein at least a part of the first portion and at least a part of the second portion comprise corresponding mating surfaces for threaded engagement therebetween.

34. The blood collection assembly of claim 26, wherein the press-fit engagement of the first portion of the first sub-assembly and the second portion of the second sub-assembly prevents disengagement of the first sub-assembly from the second sub-assembly upon engagement of the specimen collection container with the proximal end of the hub.

35. The blood collection assembly of claim 26, wherein the at least one locking tab is engaged with the safety shield engagement in a detent arrangement that resists unintentional disengagement of the cannula shield from the hub.

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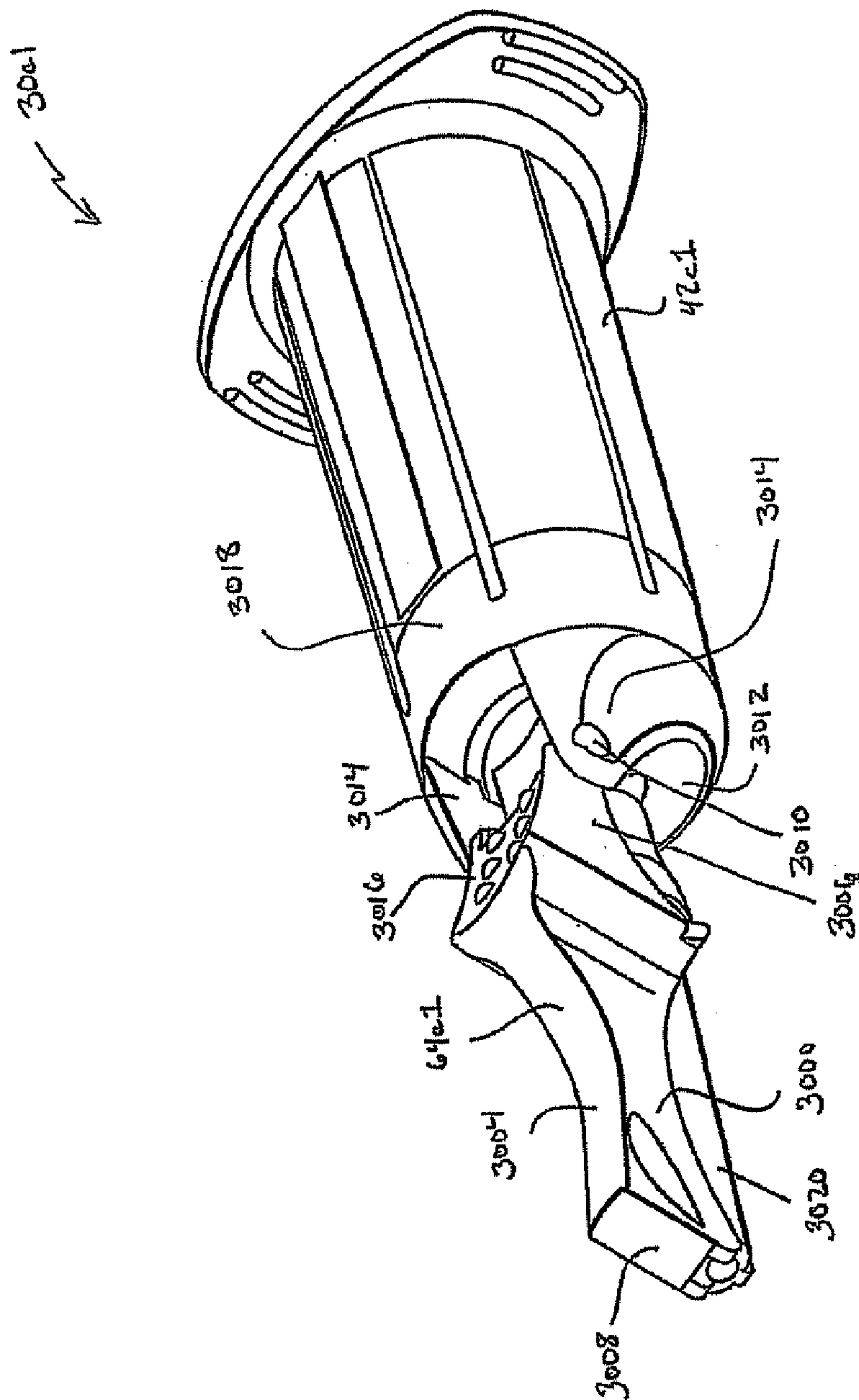


FIG. 1

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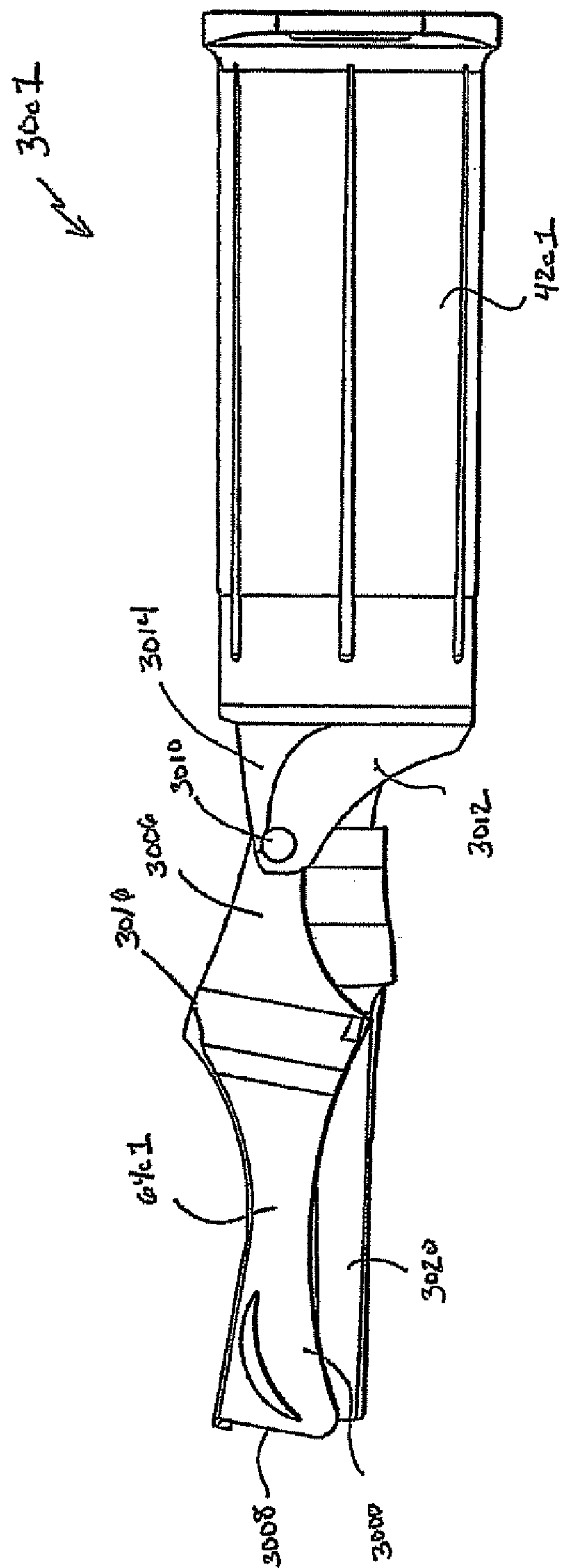
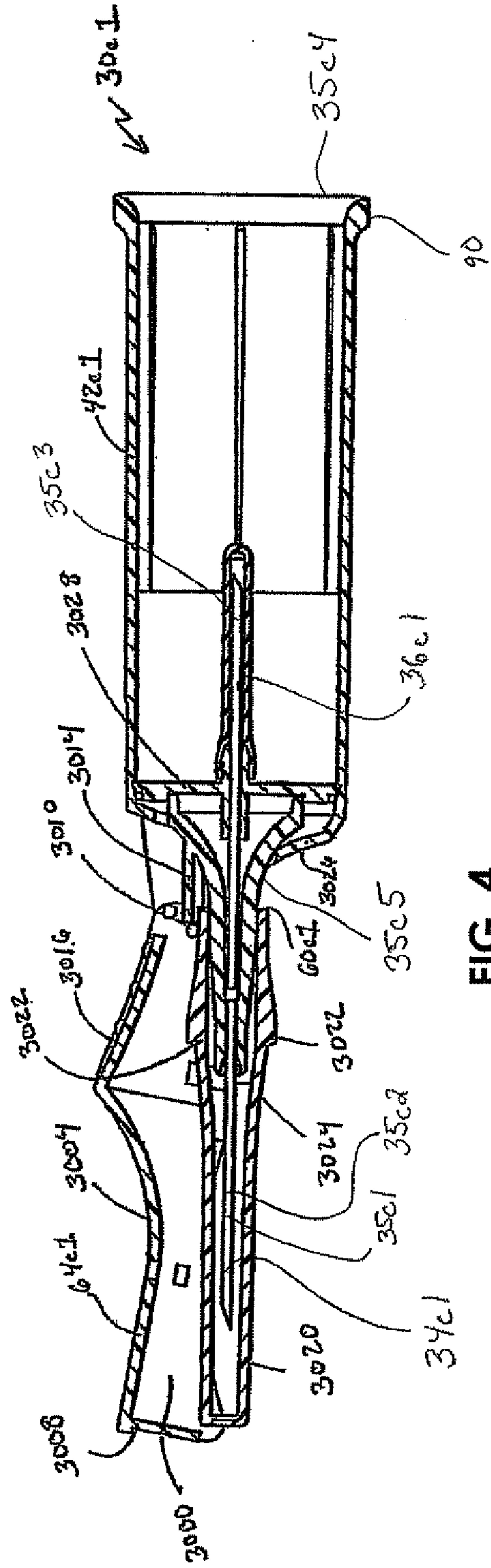
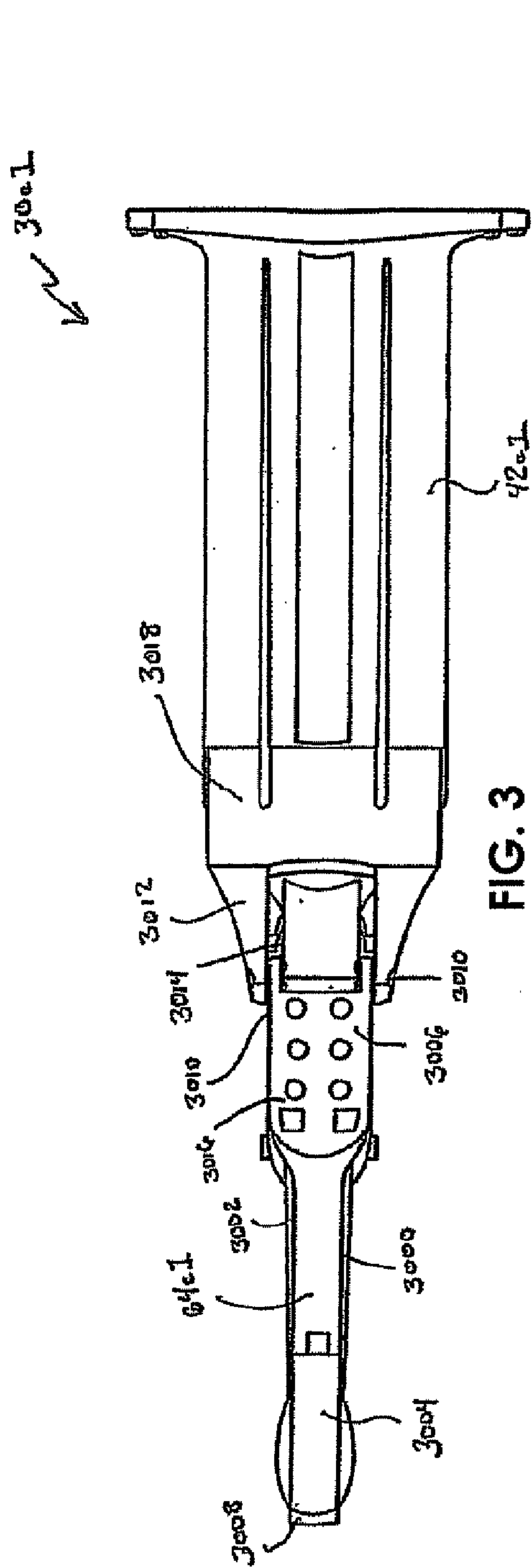


FIG. 2

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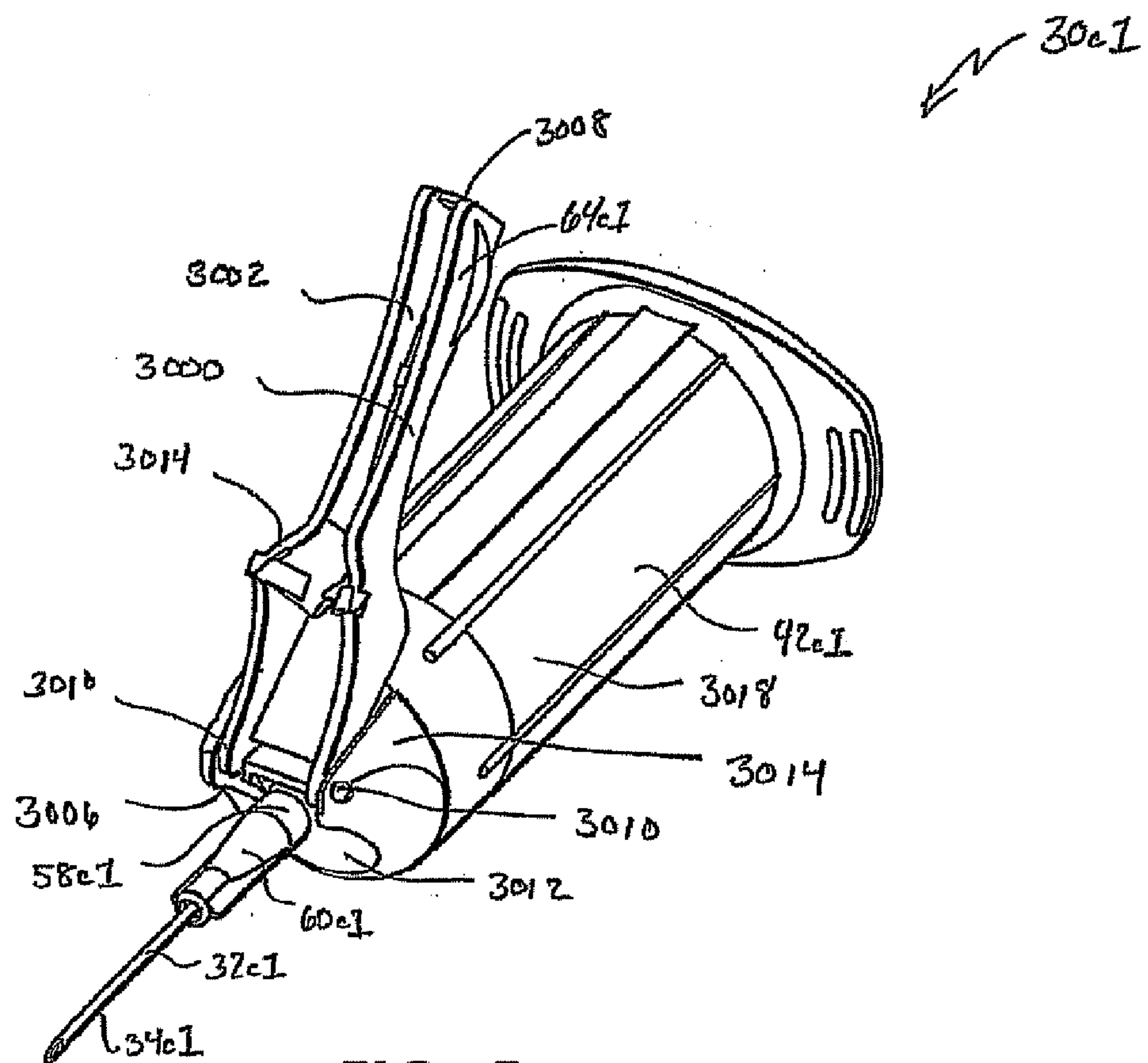
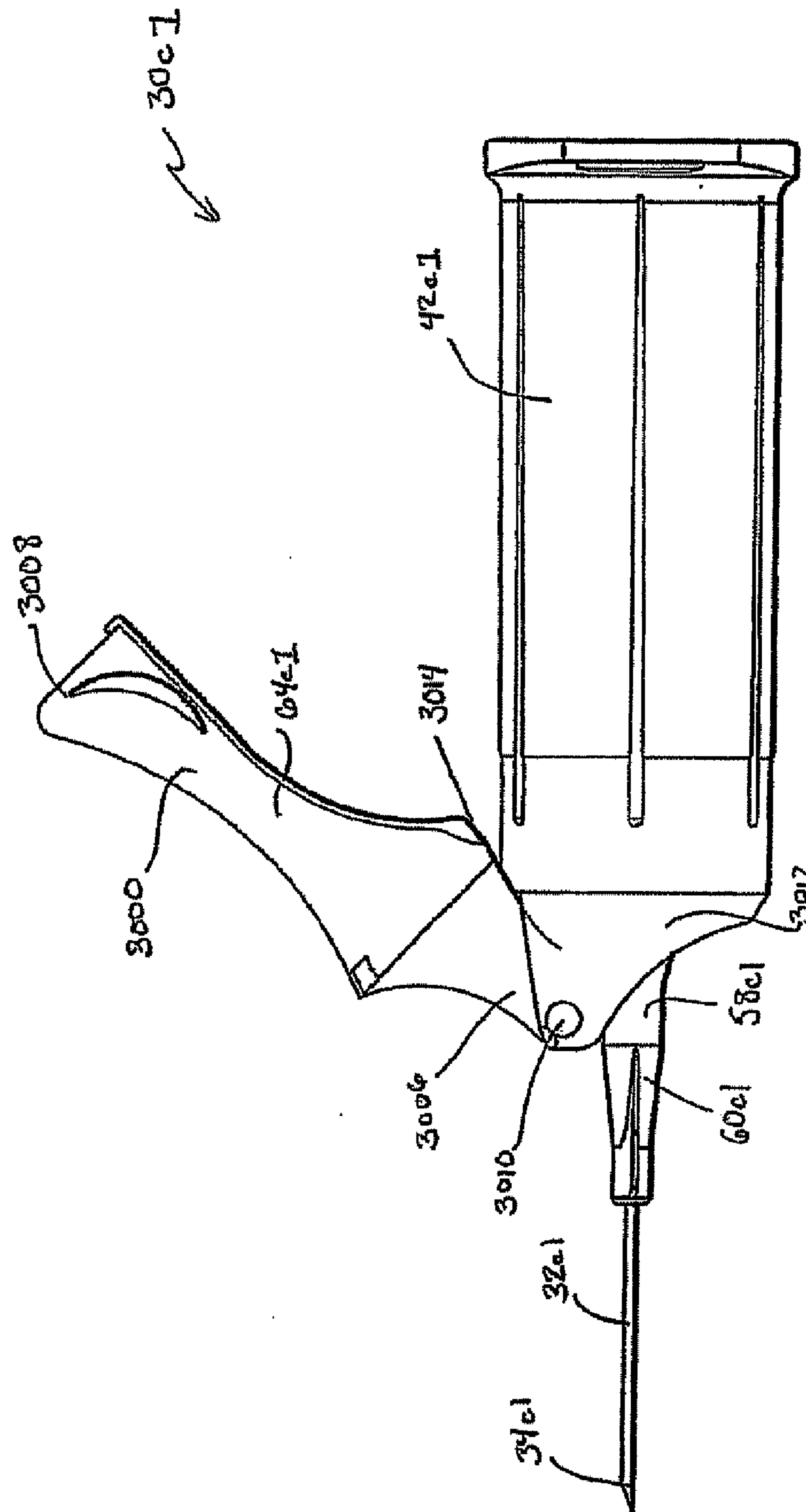


FIG. 5



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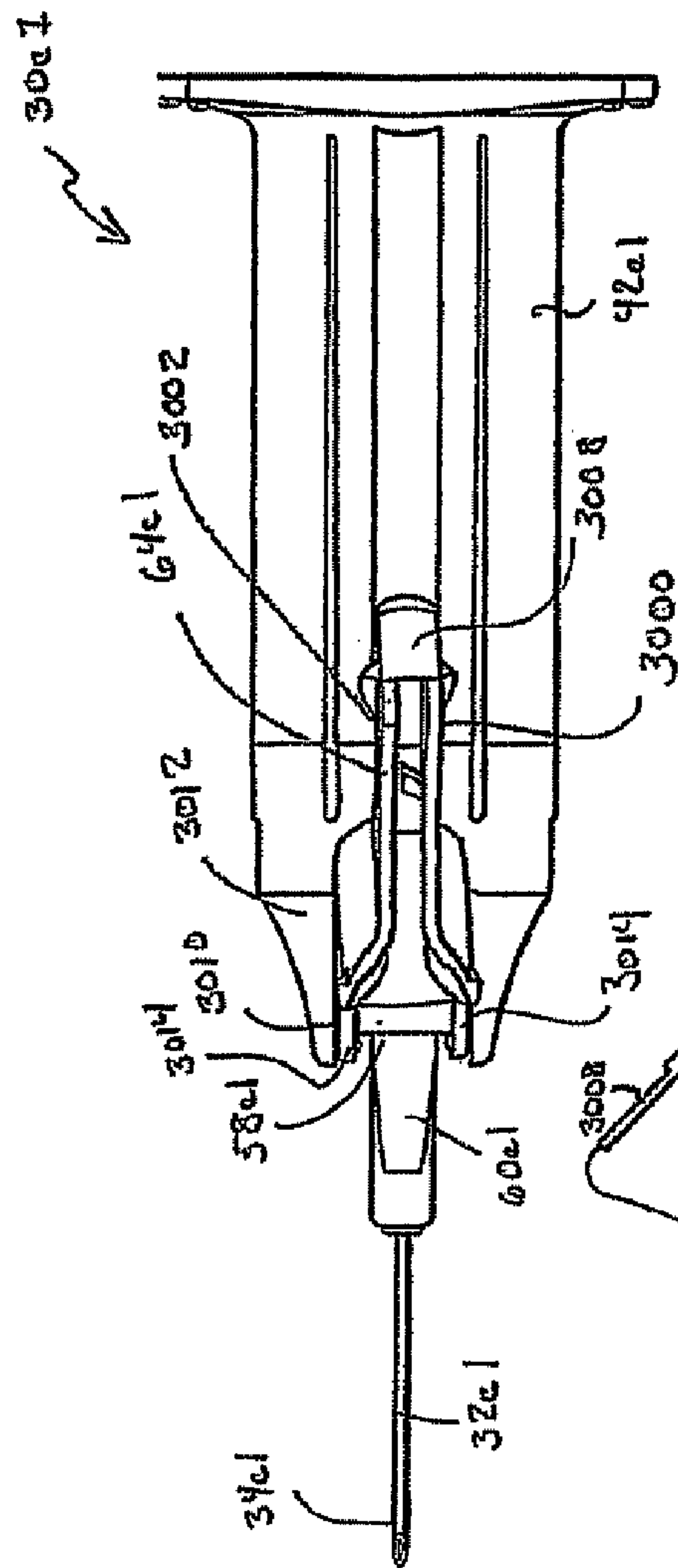


FIG. 7

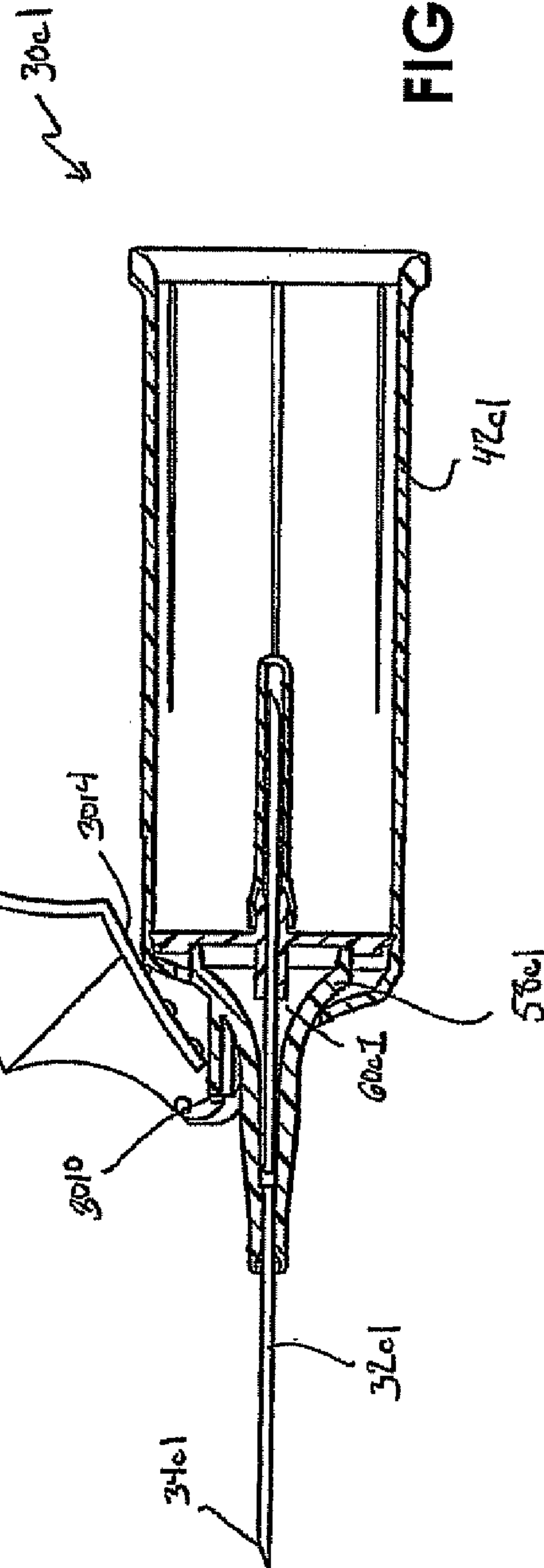
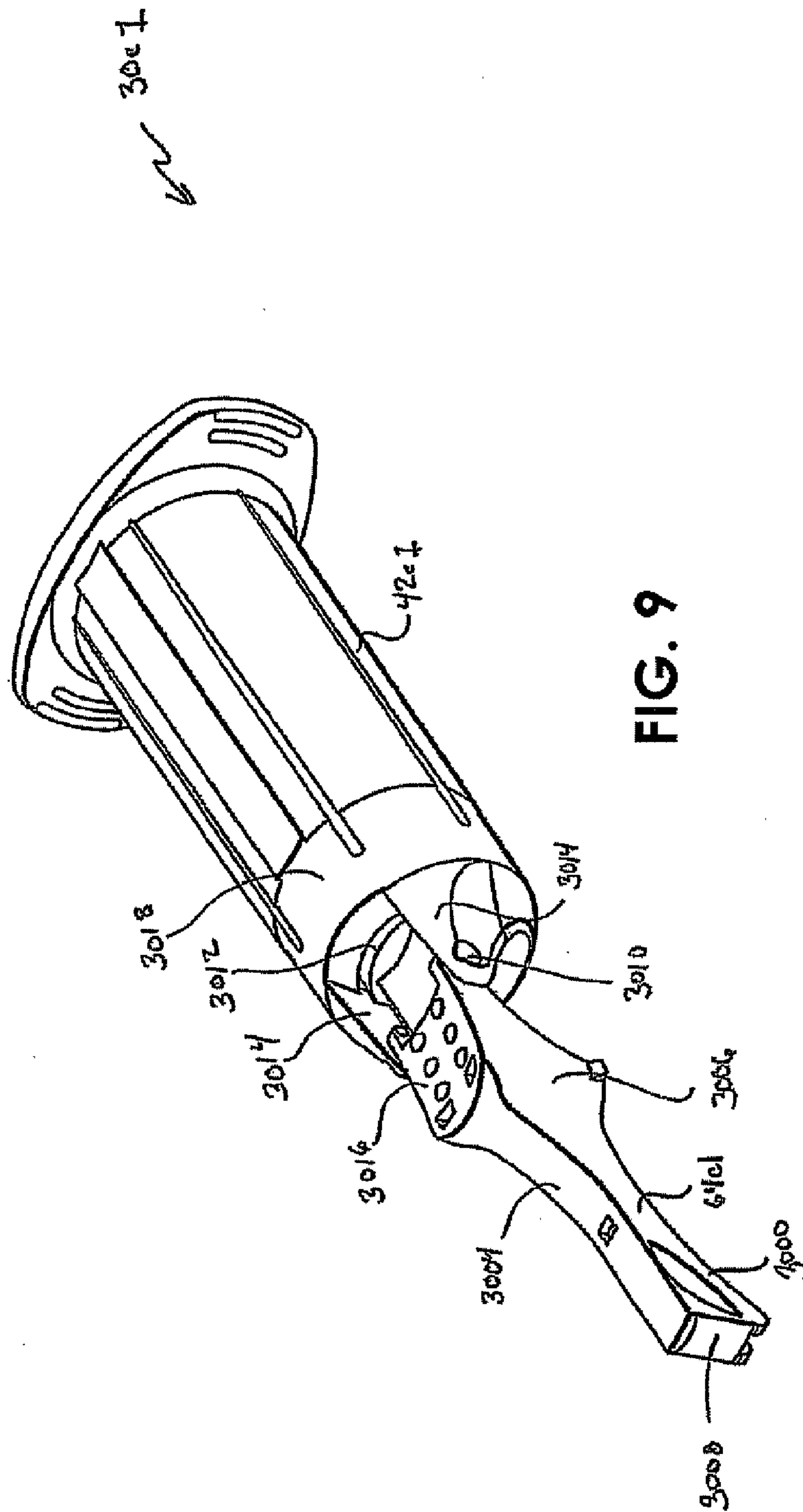


FIG. 8

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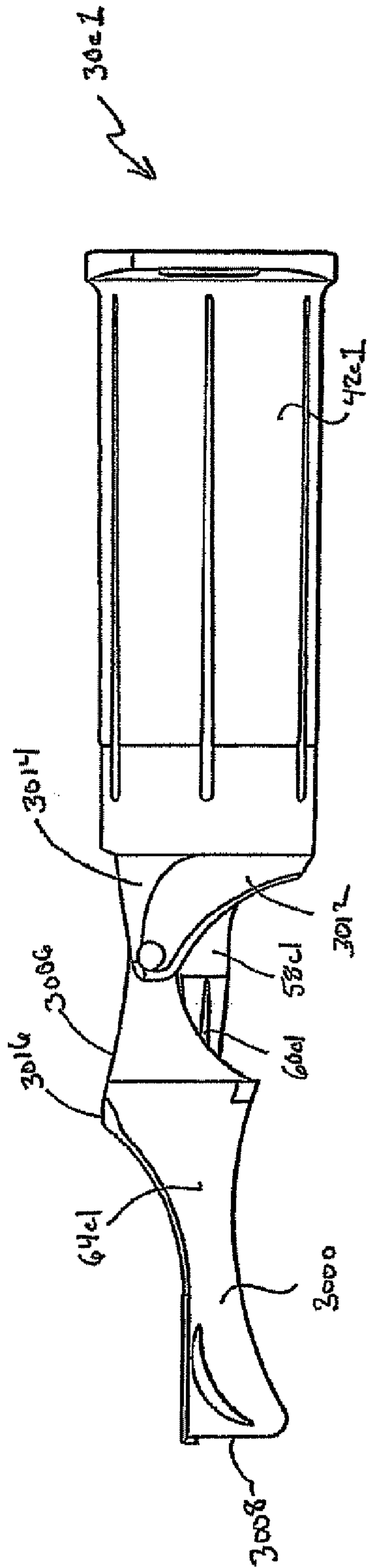


FIG. 10

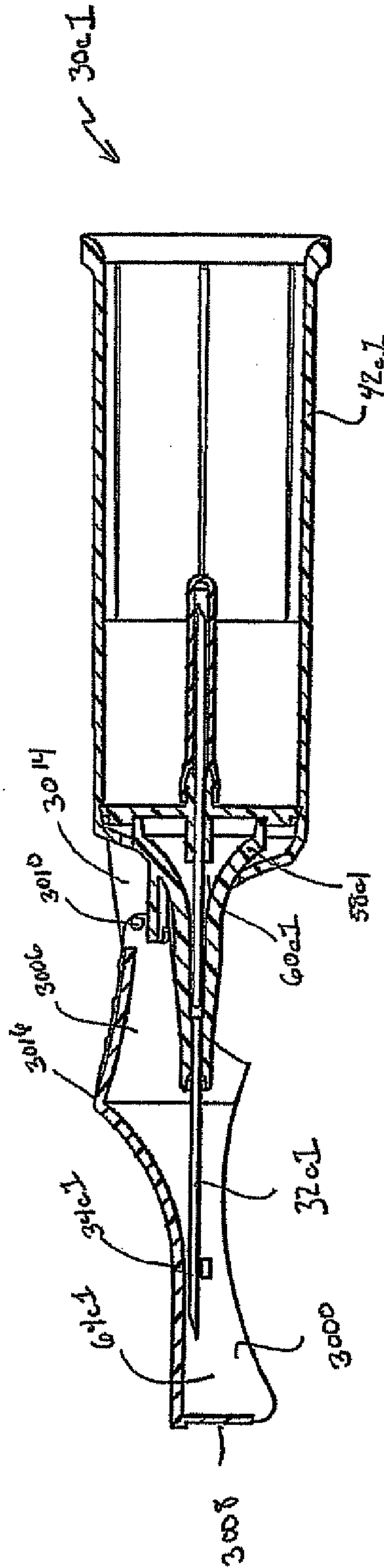
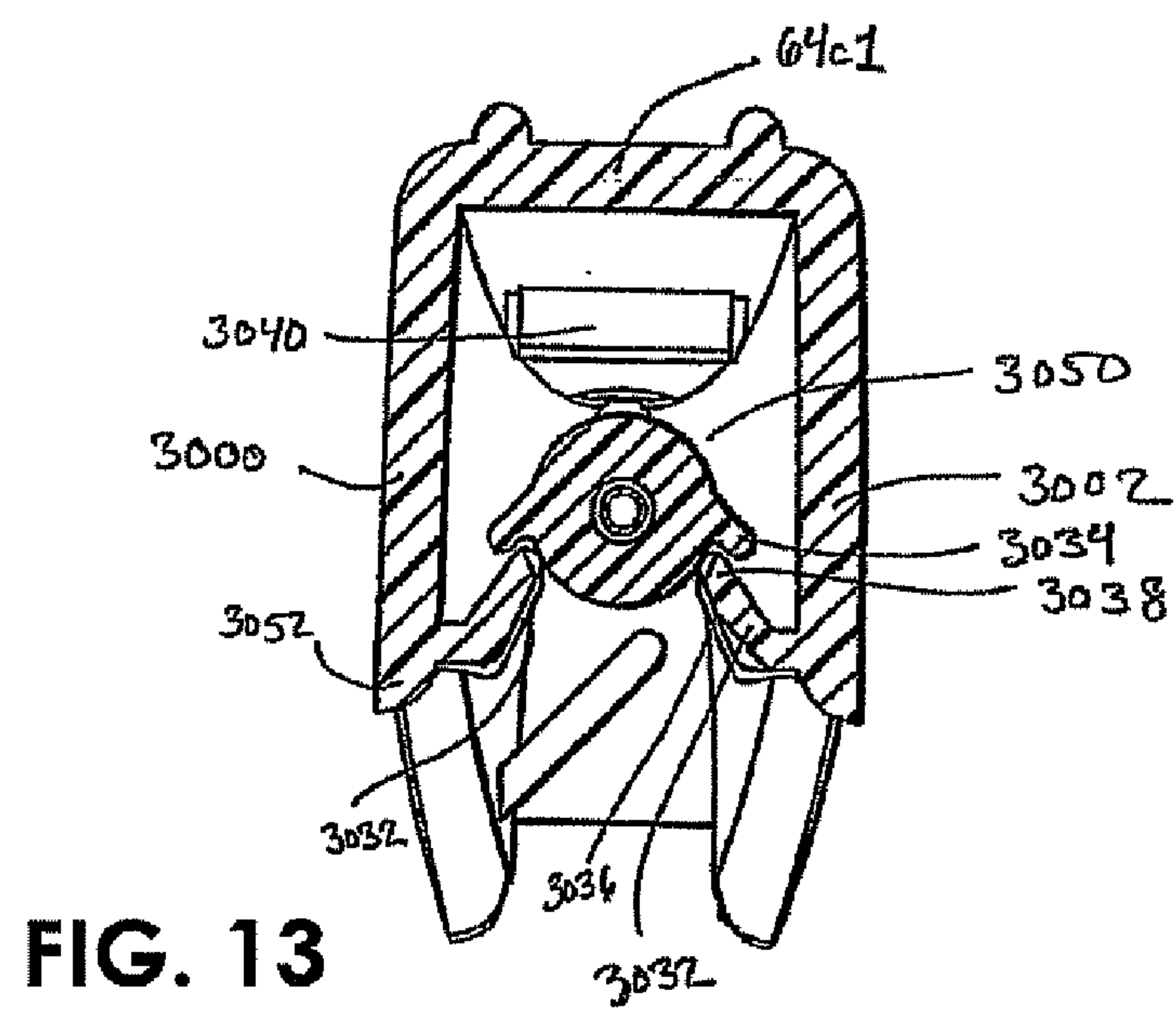
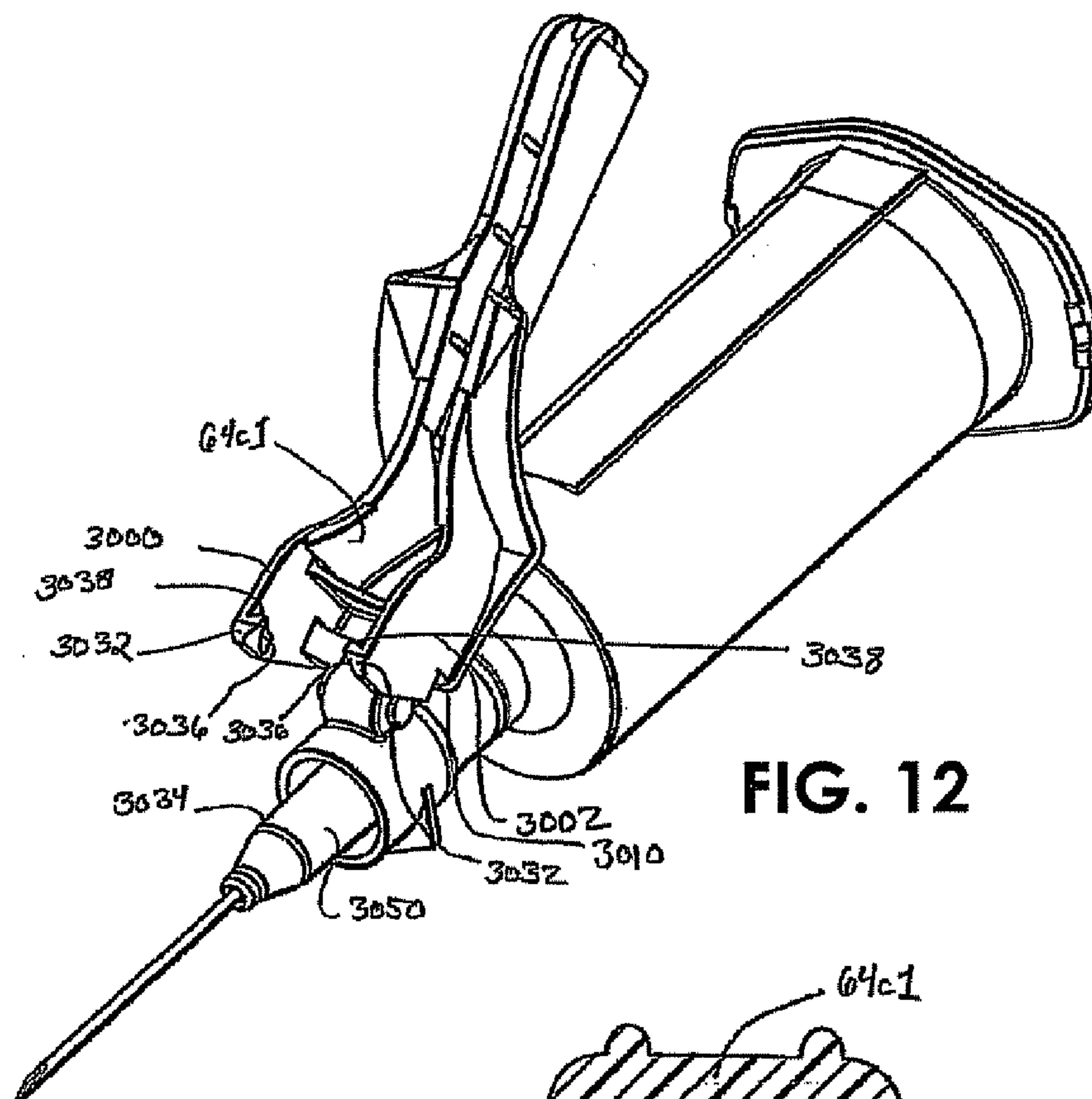


FIG. 11

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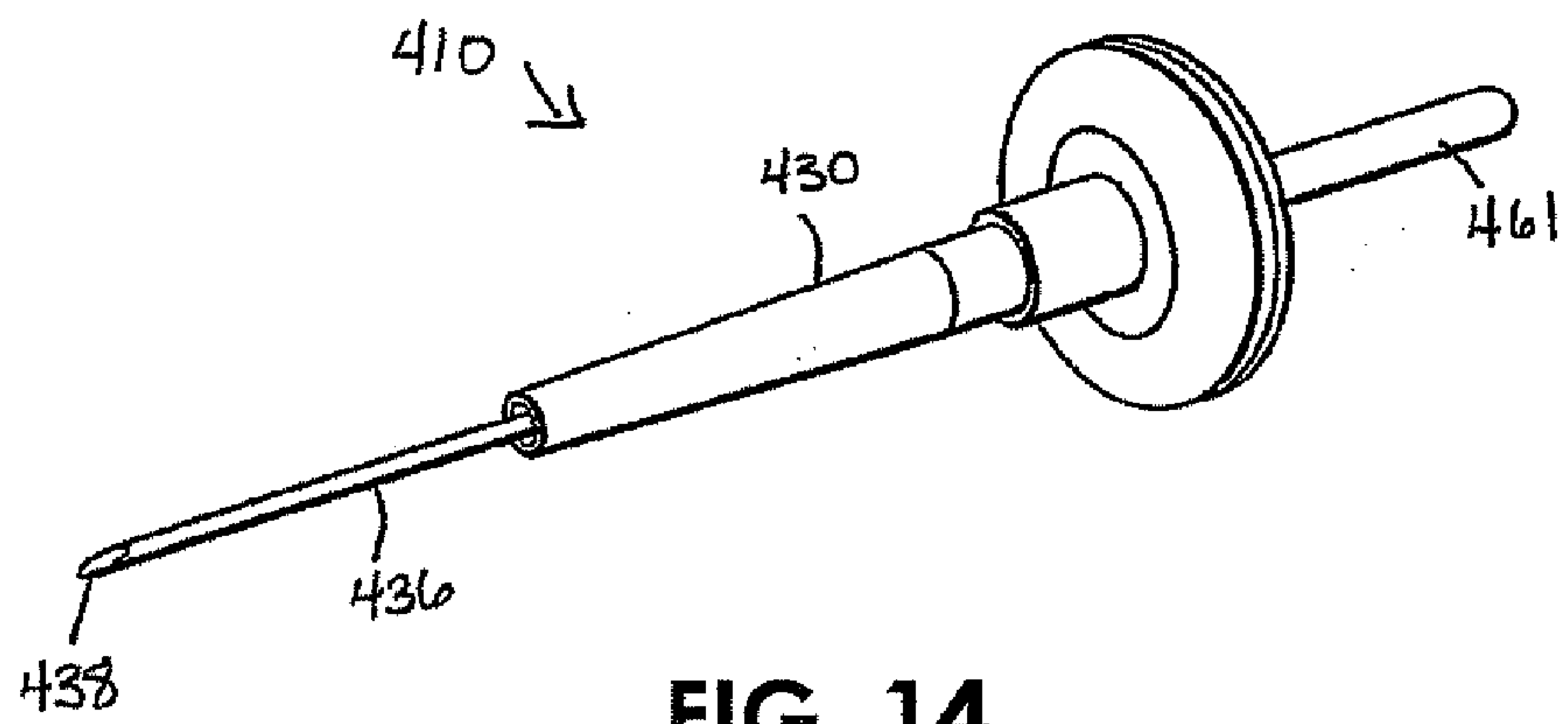


FIG. 14

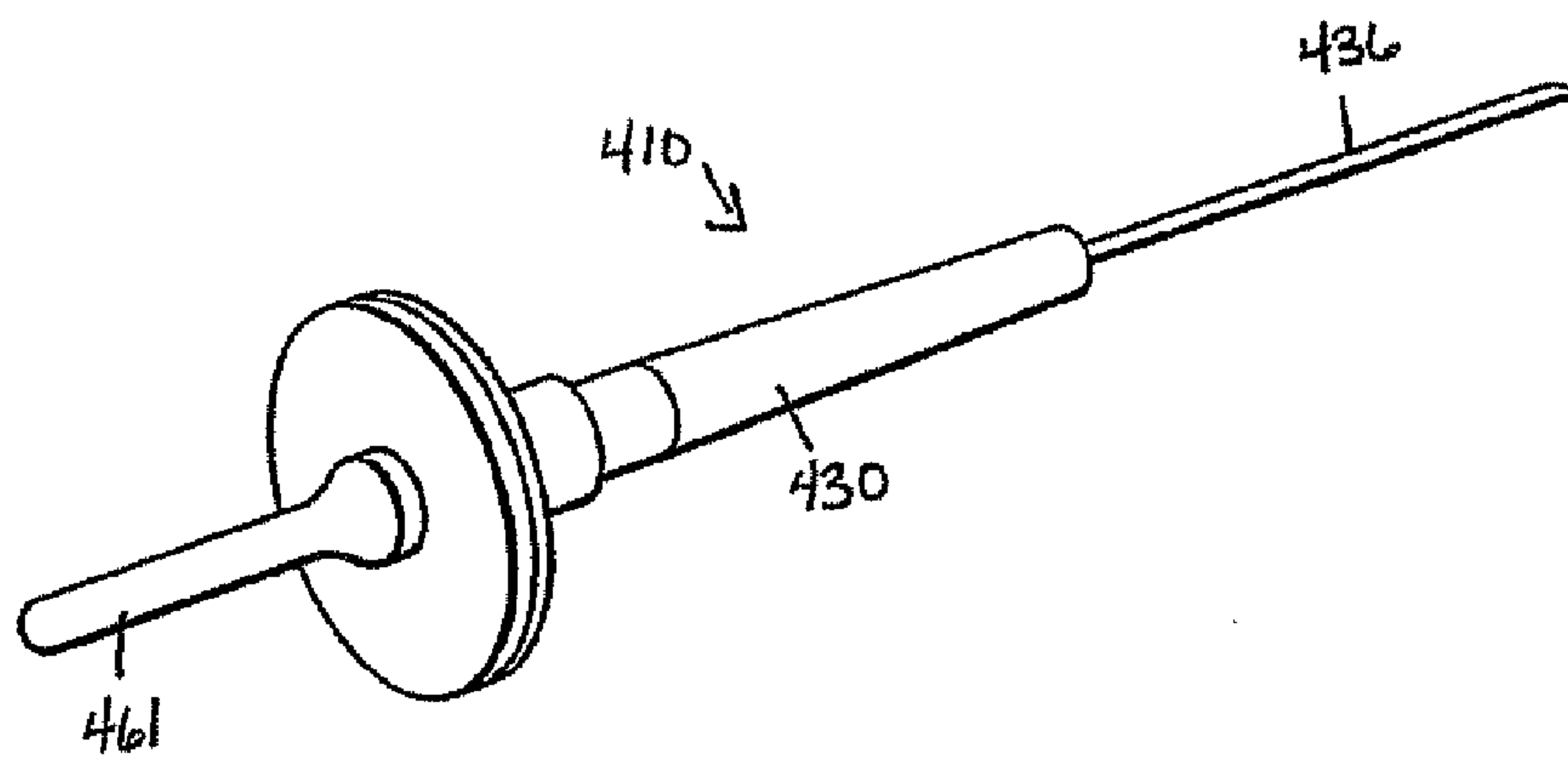
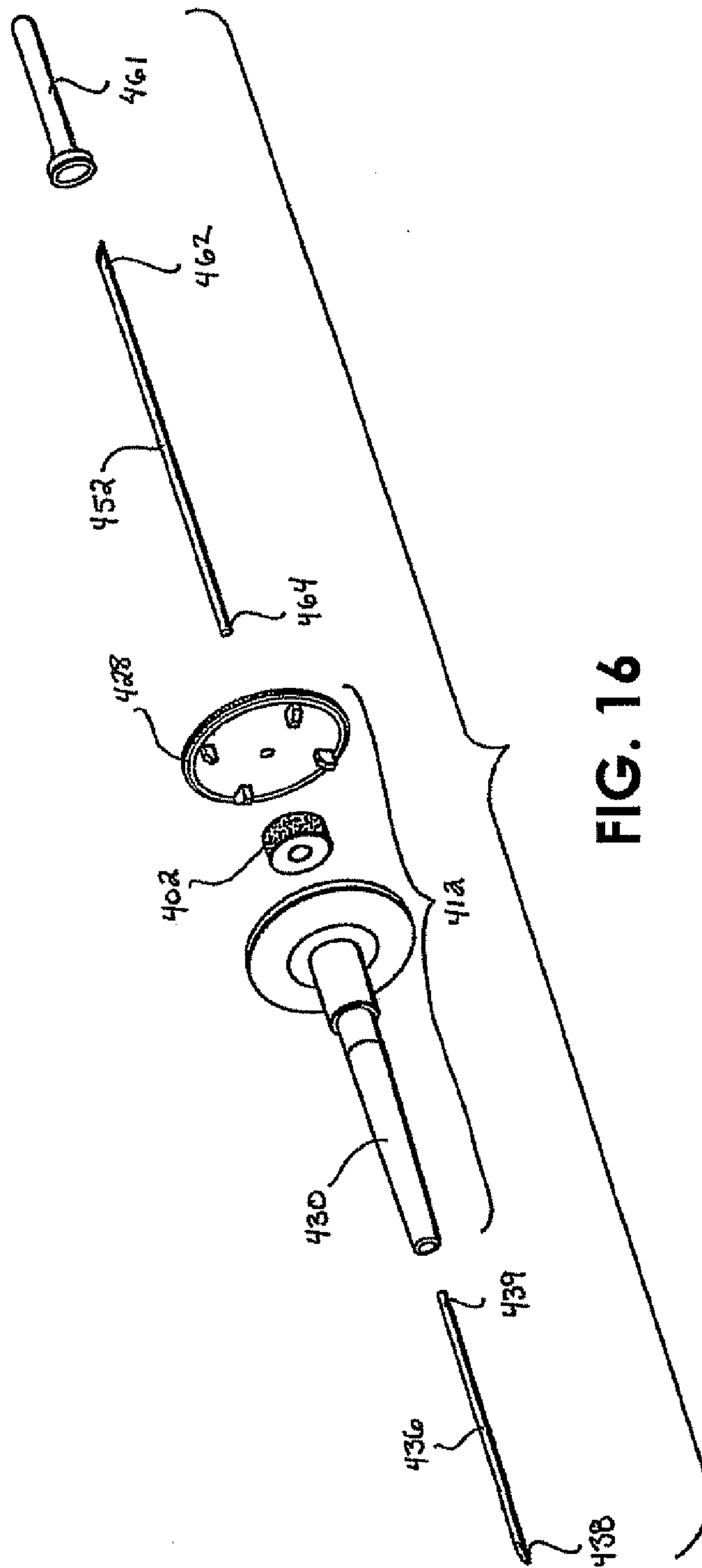
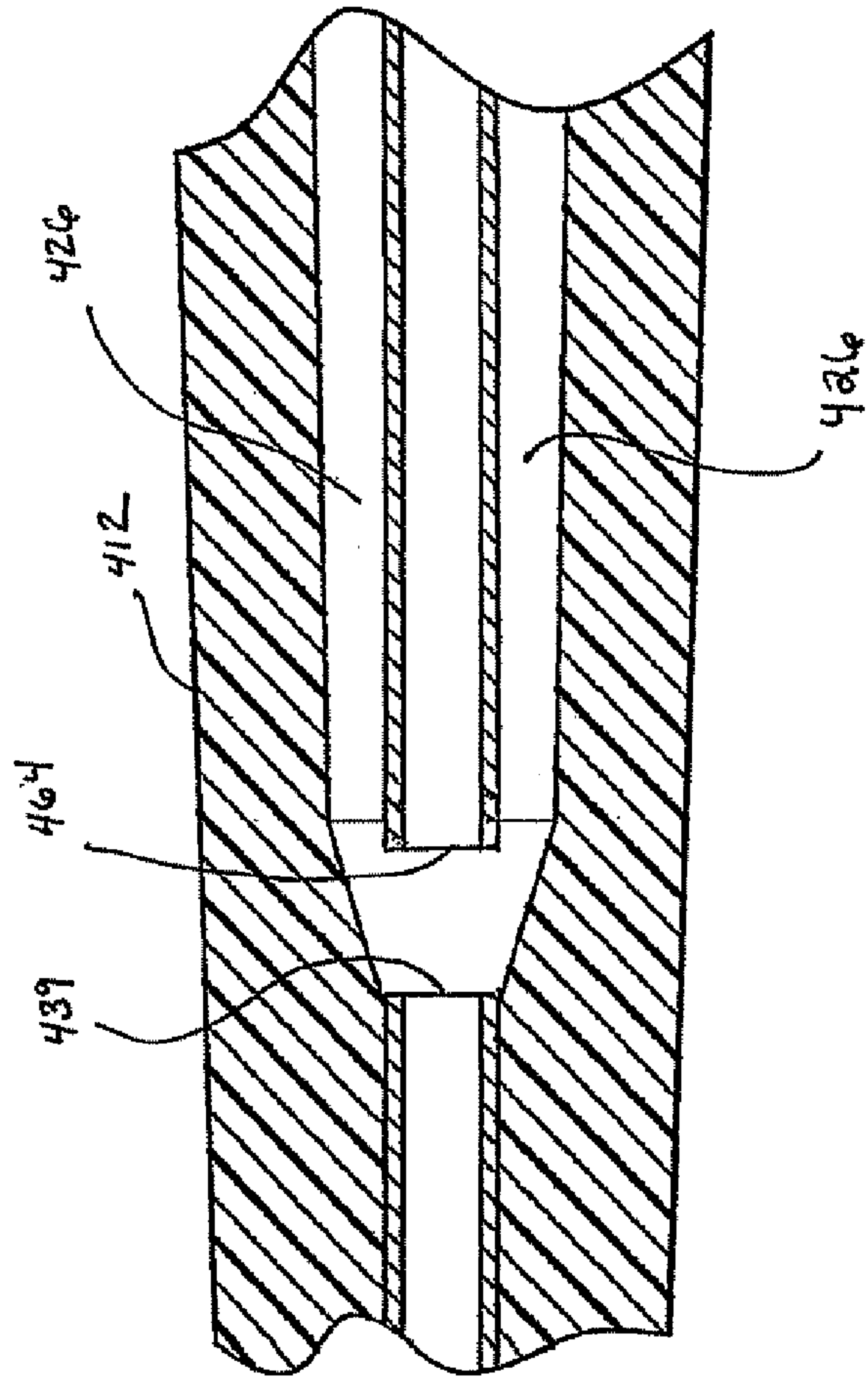
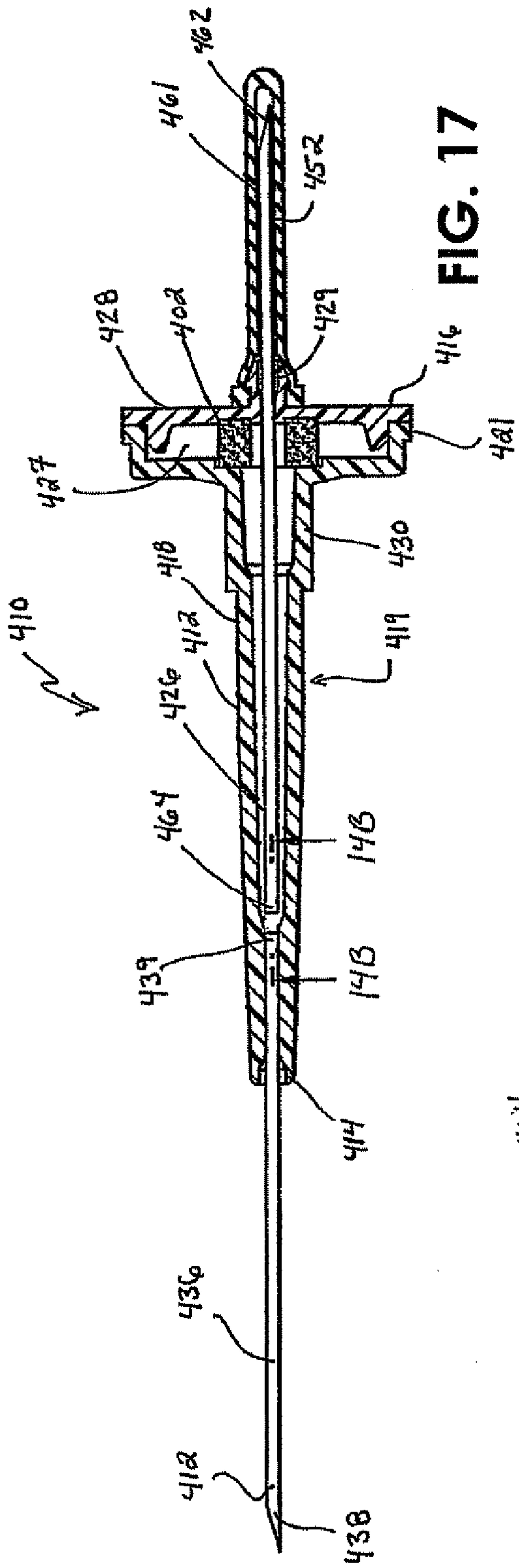


FIG. 15

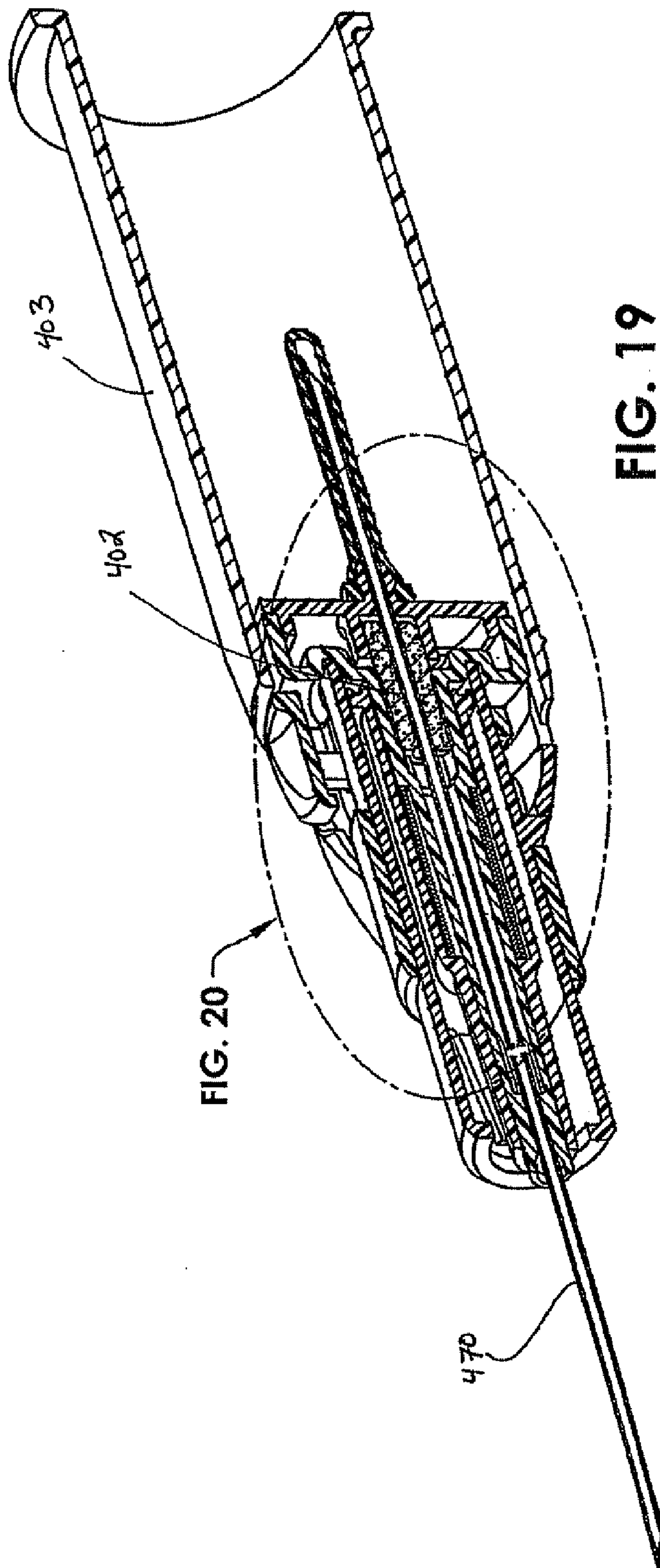
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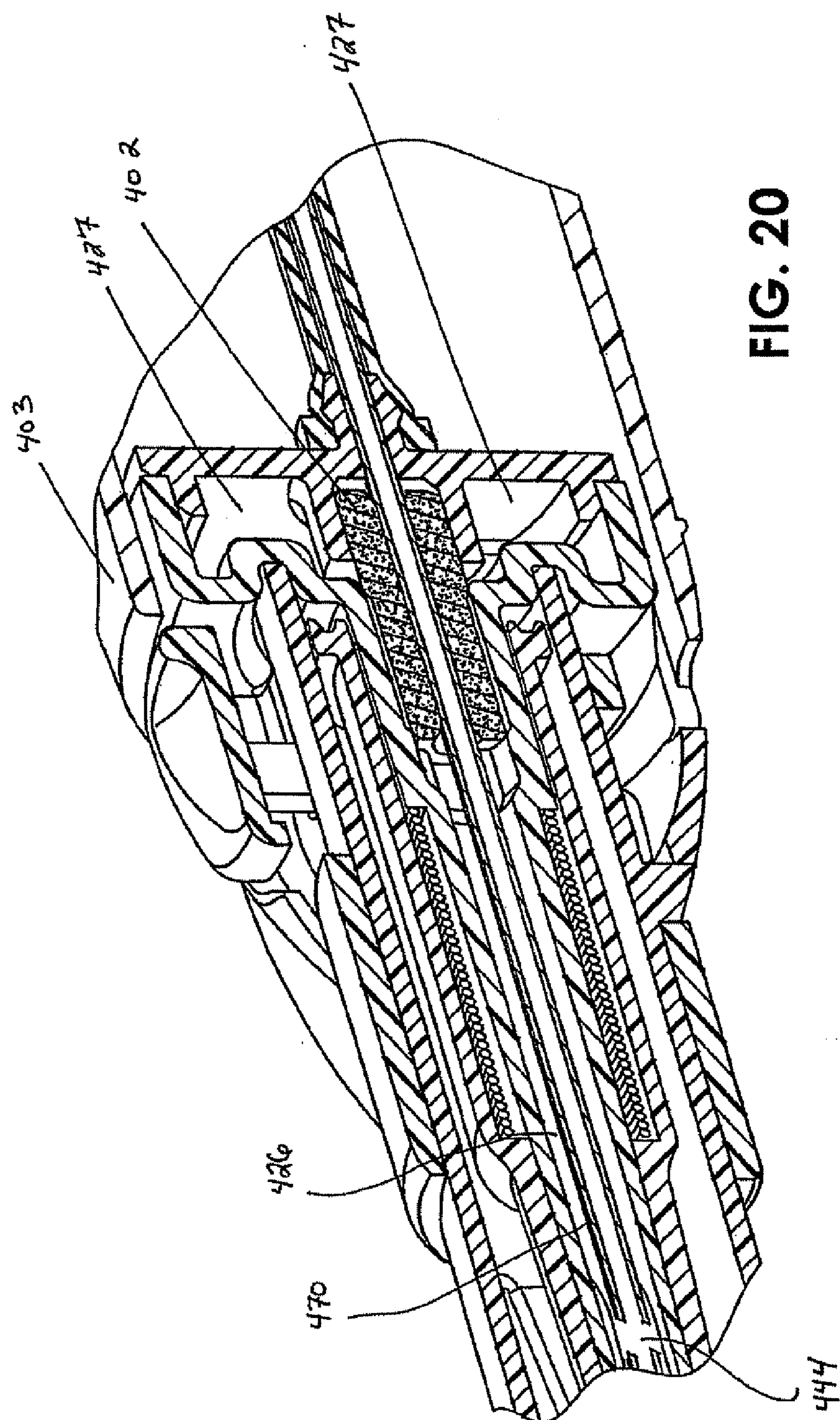
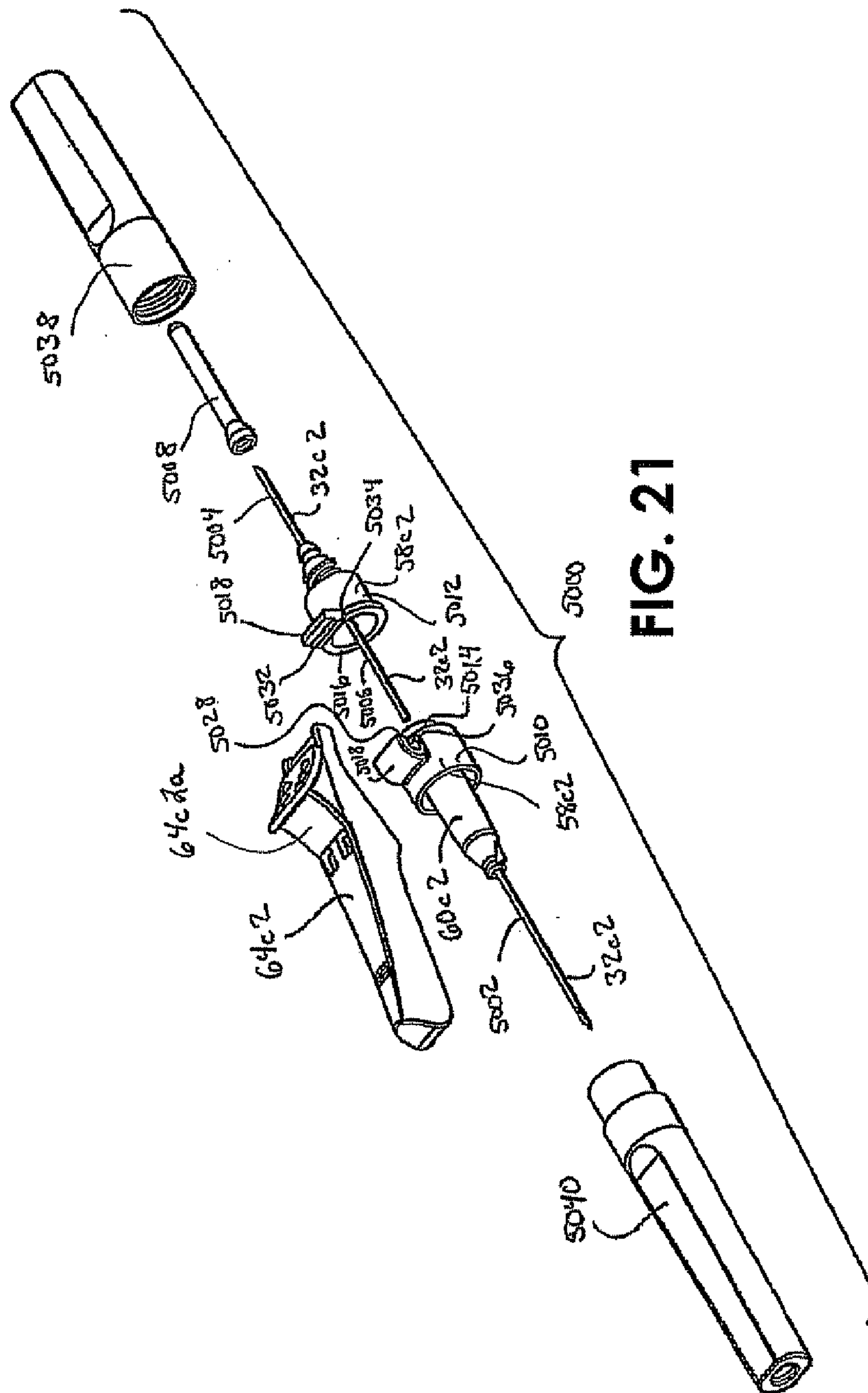
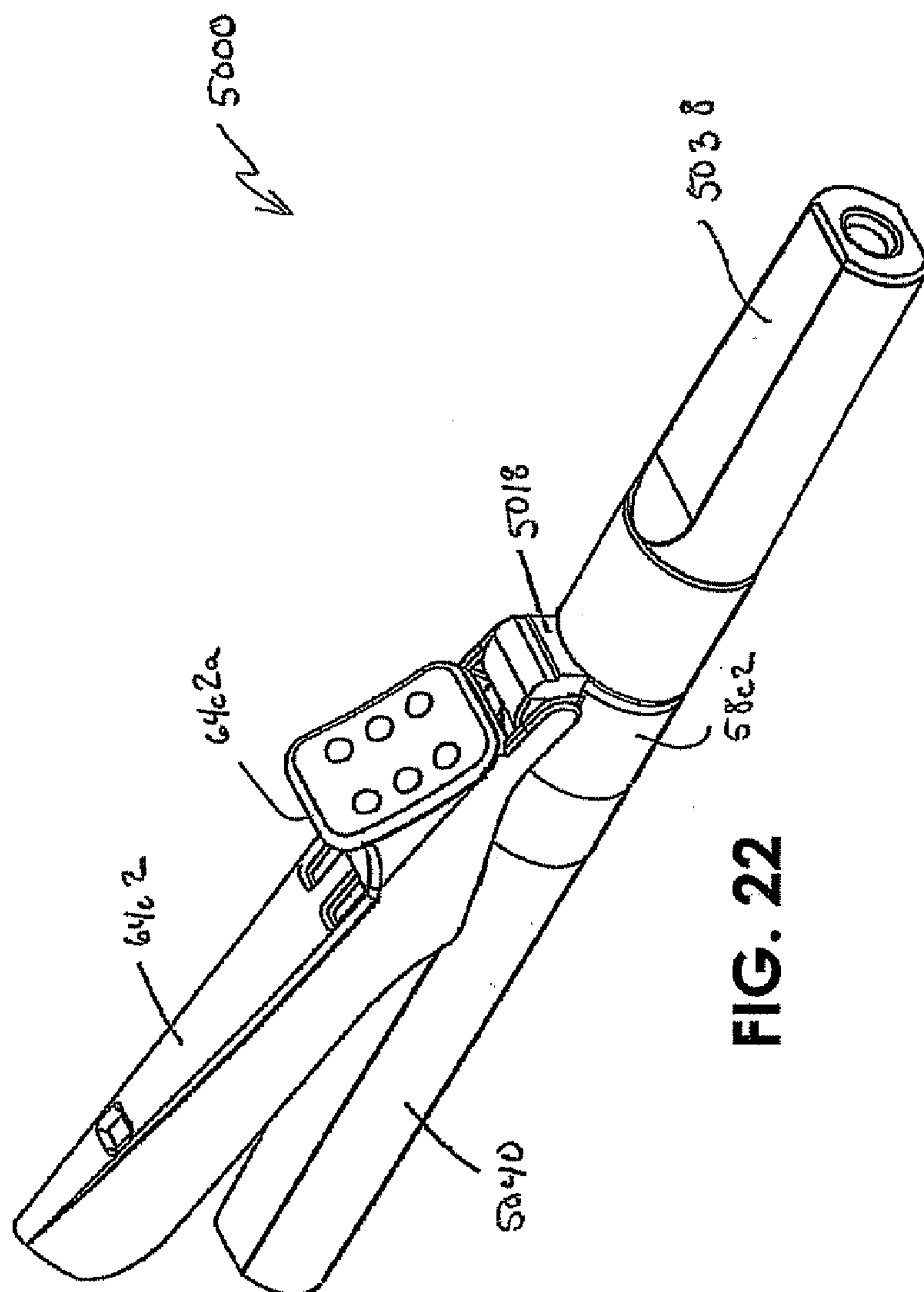


FIG. 20

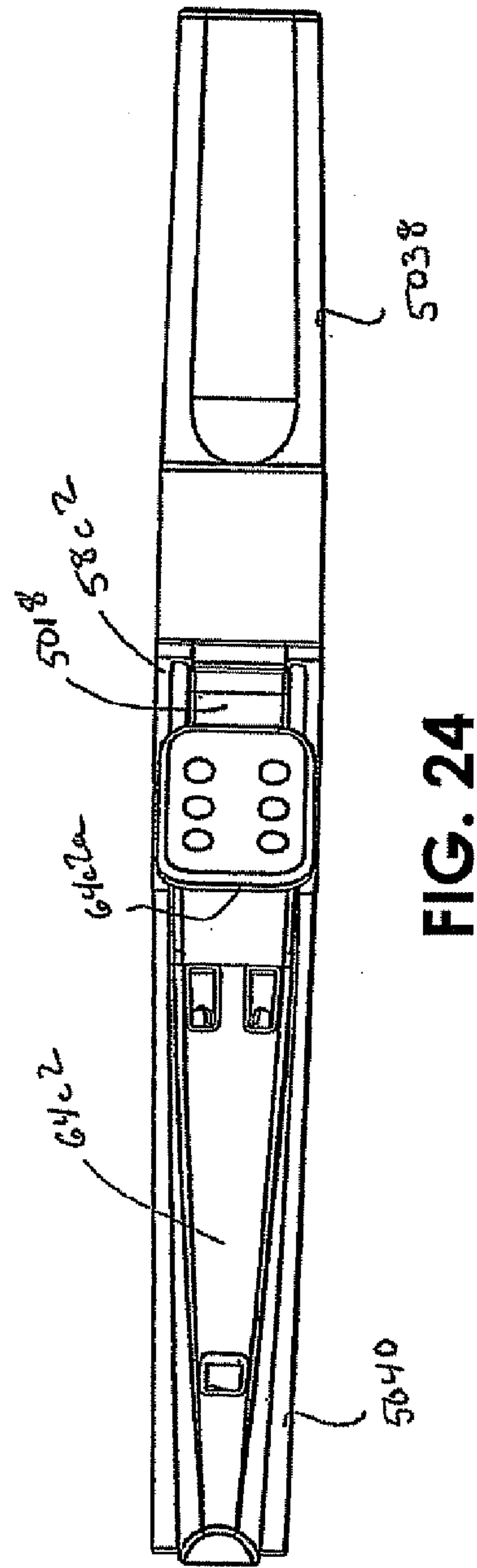
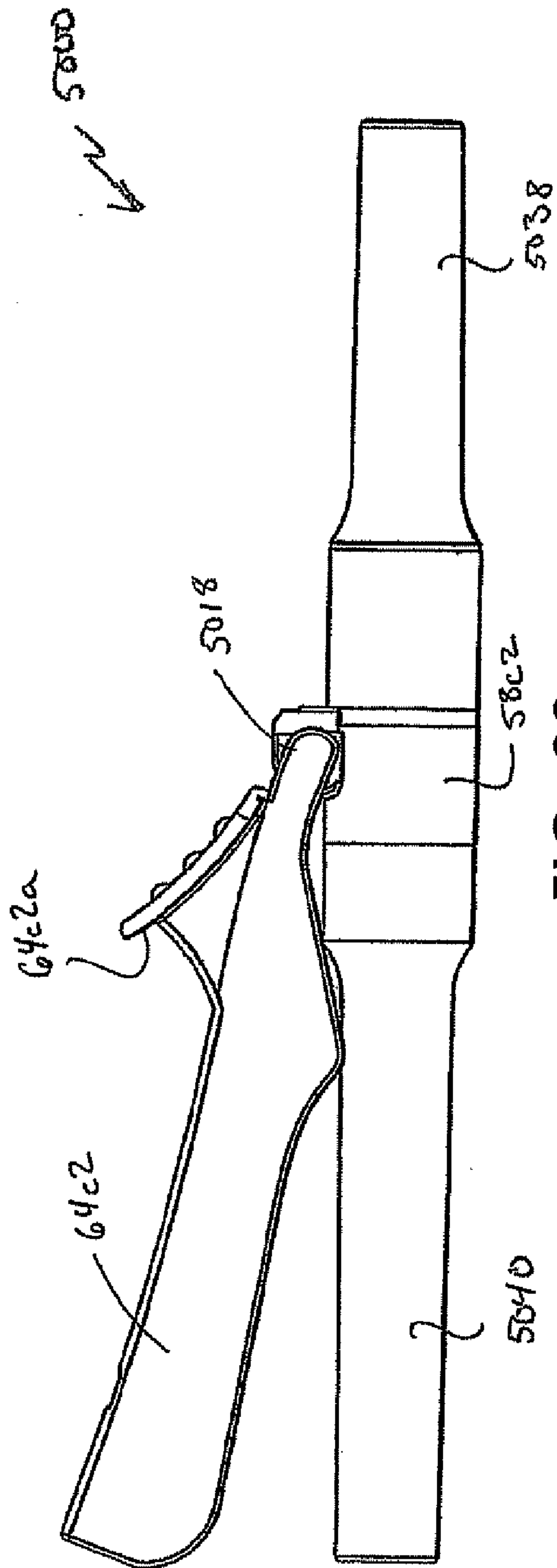
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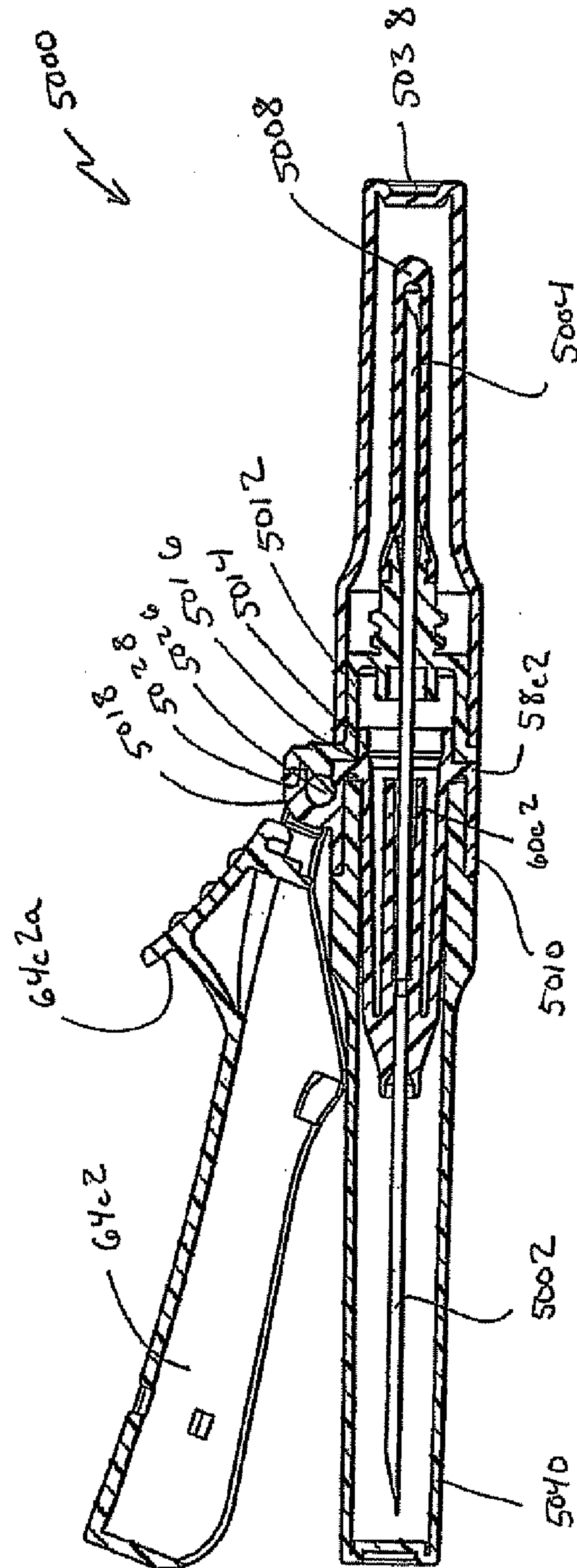
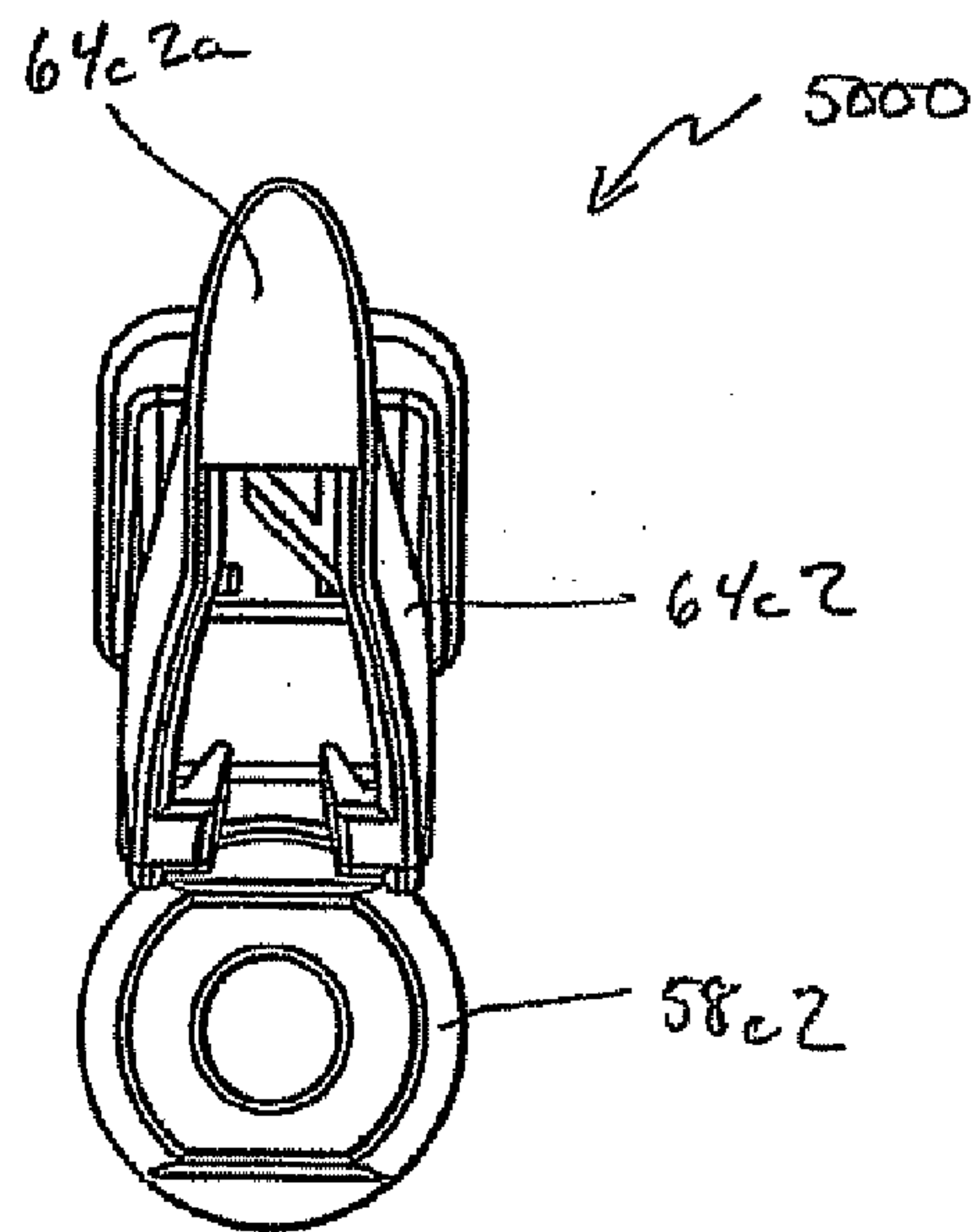
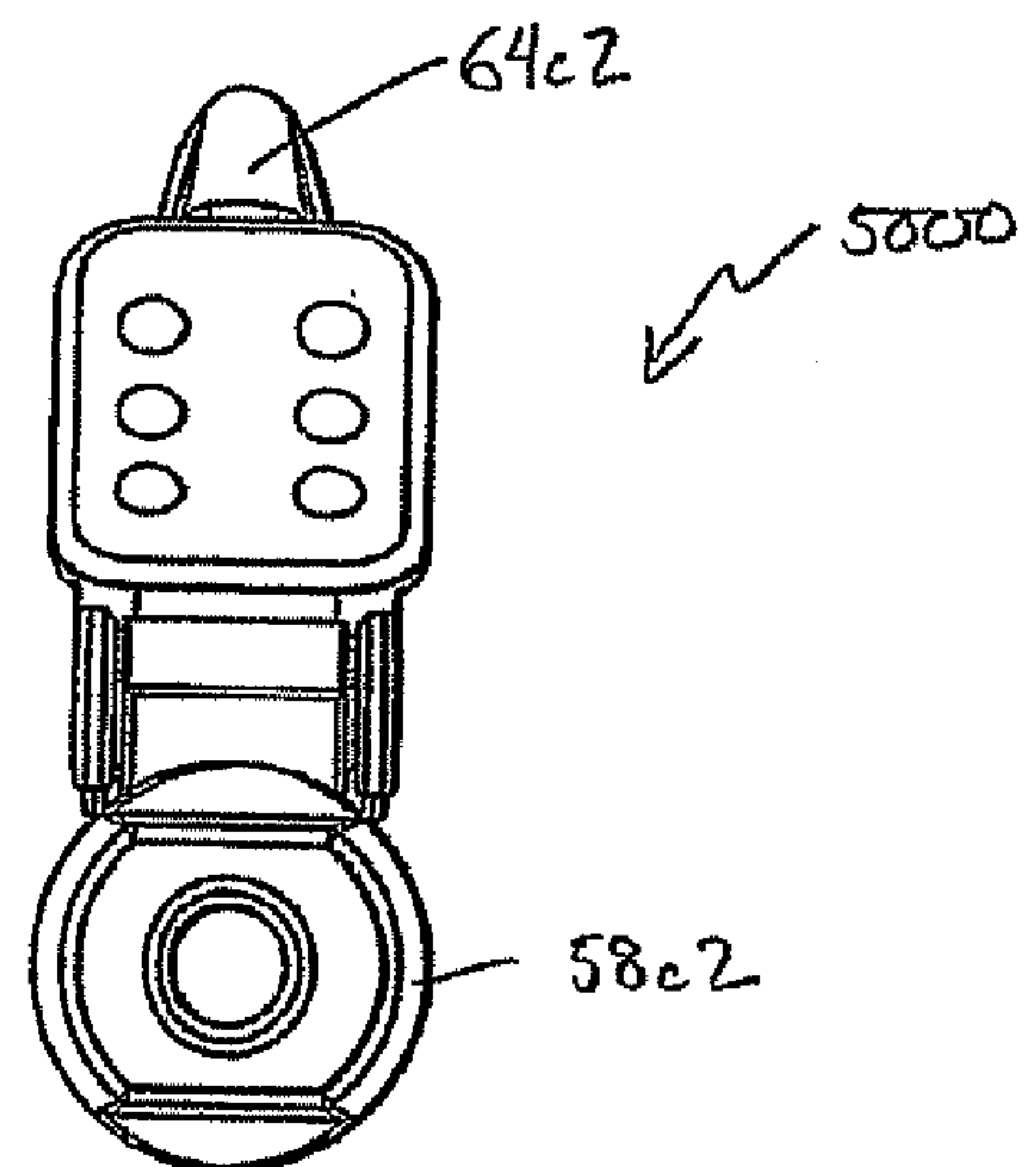
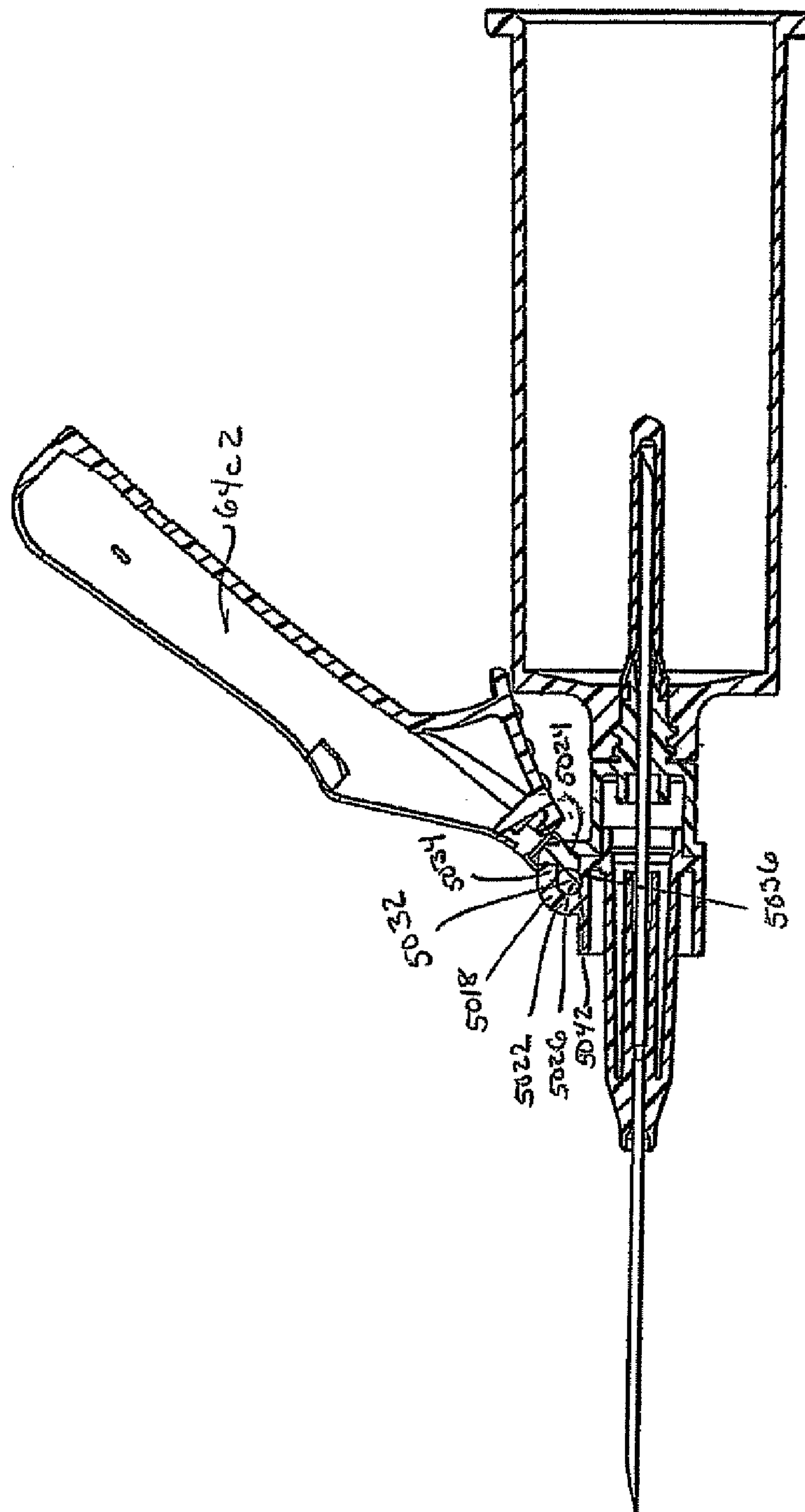


FIG. 25

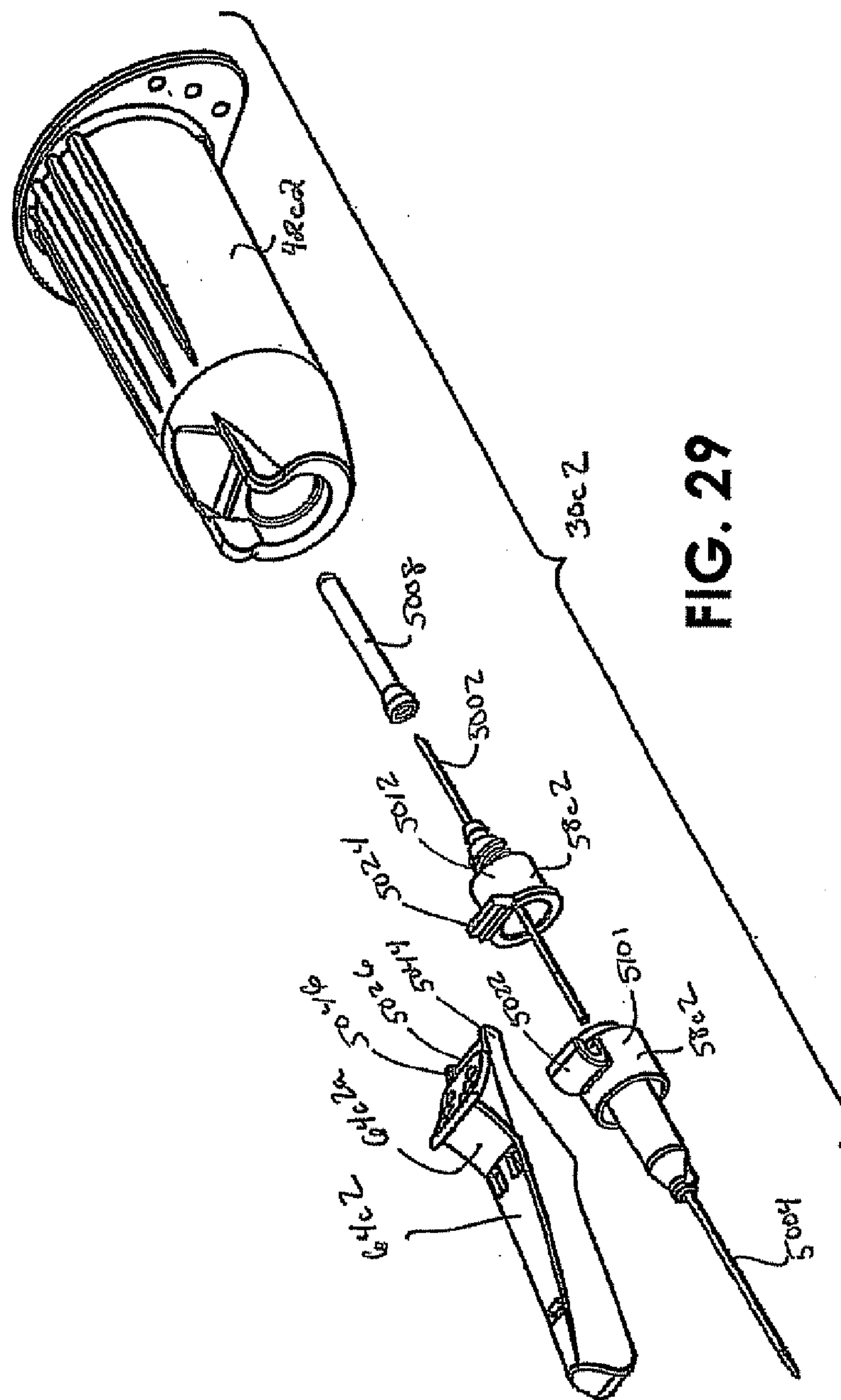
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**FIG. 26****FIG. 27**

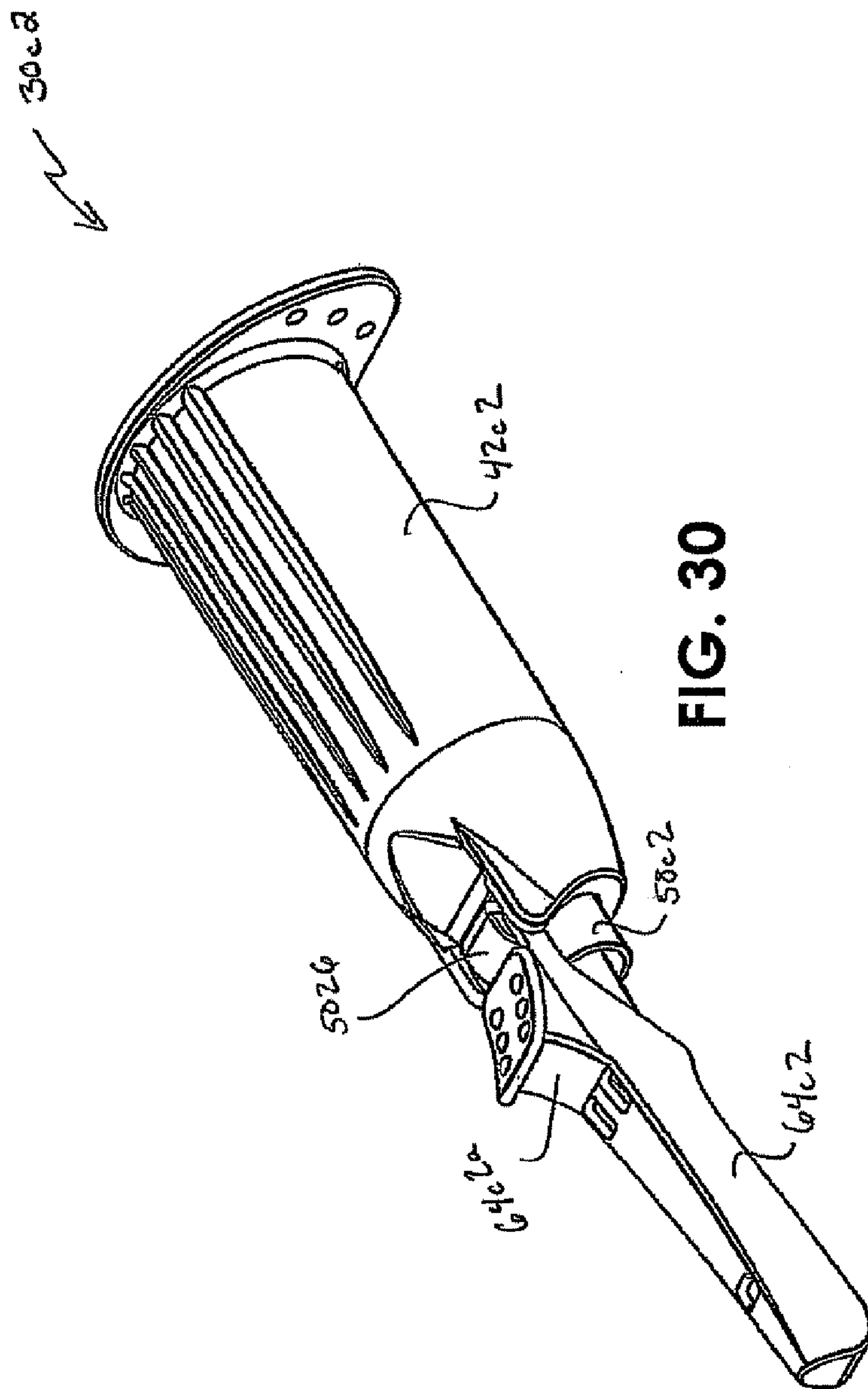
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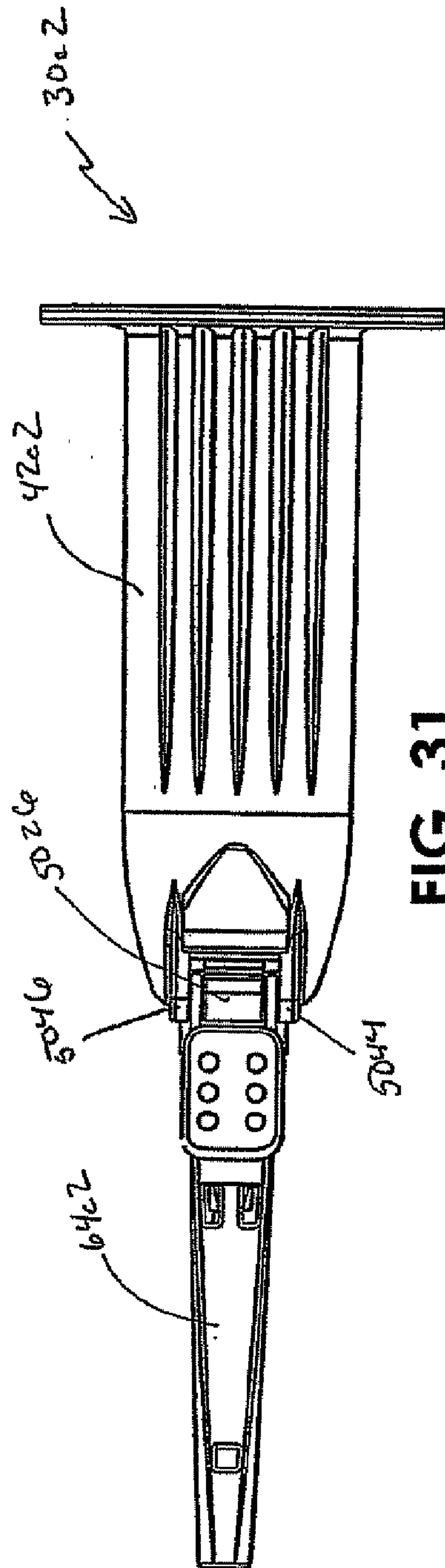


FIG. 31

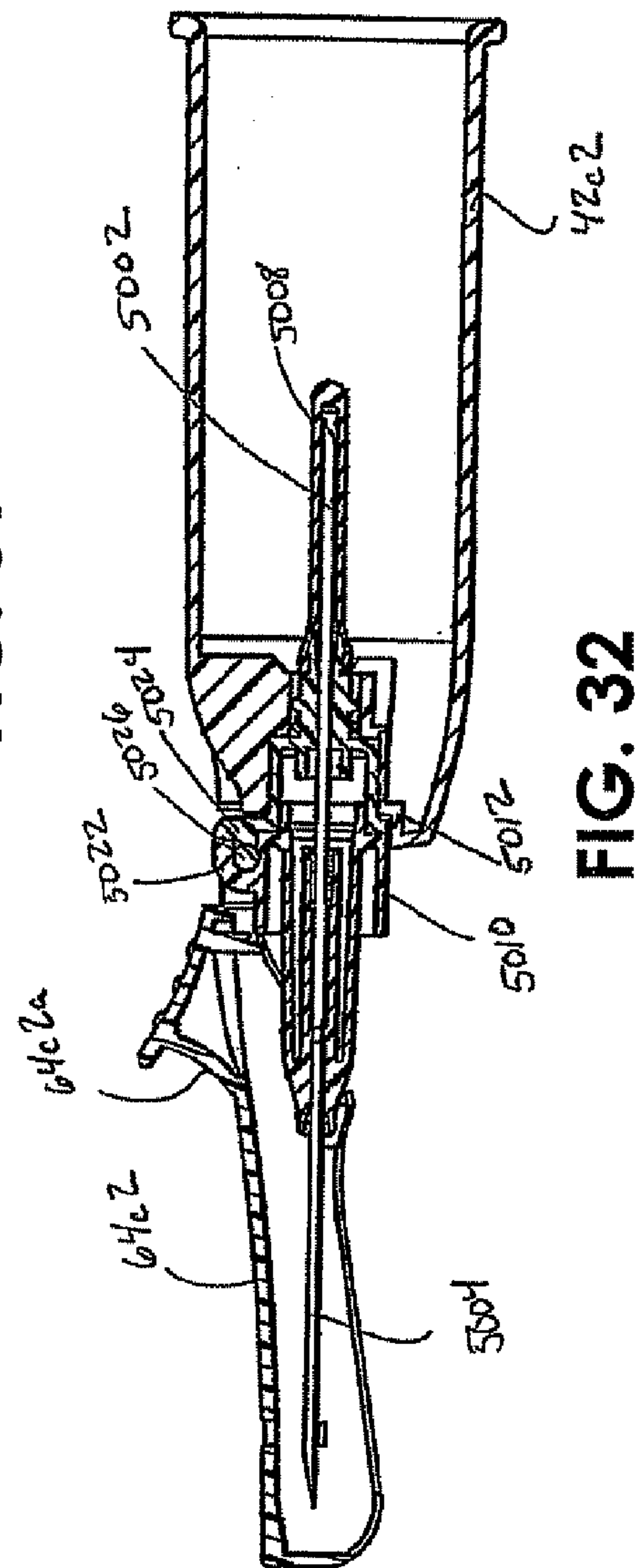
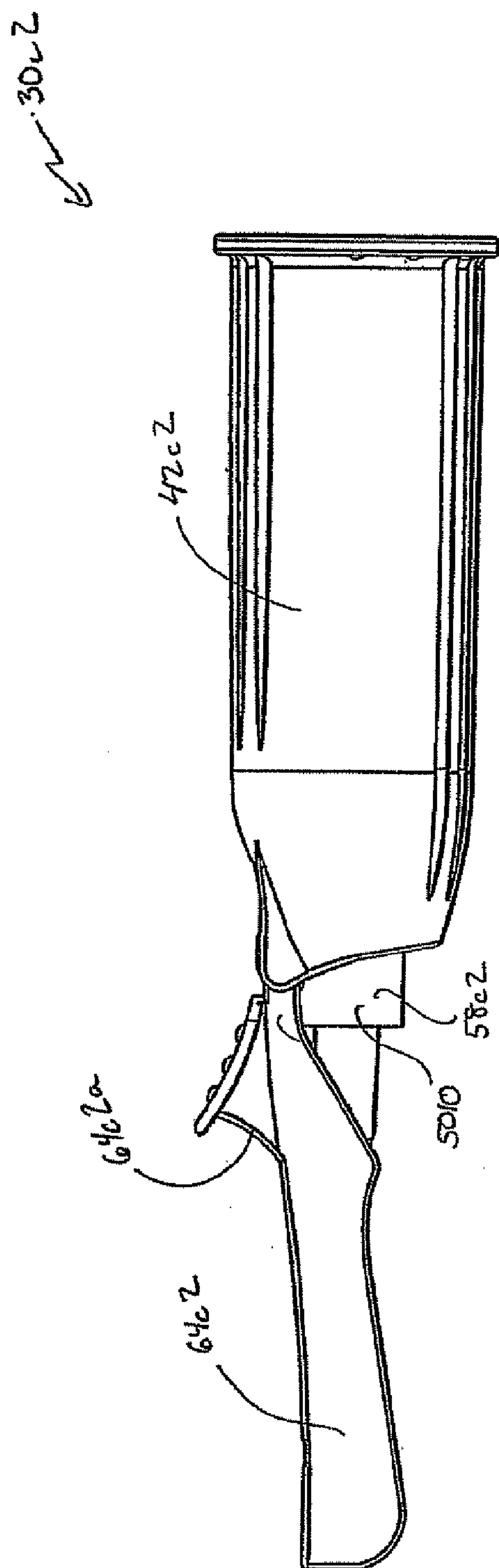


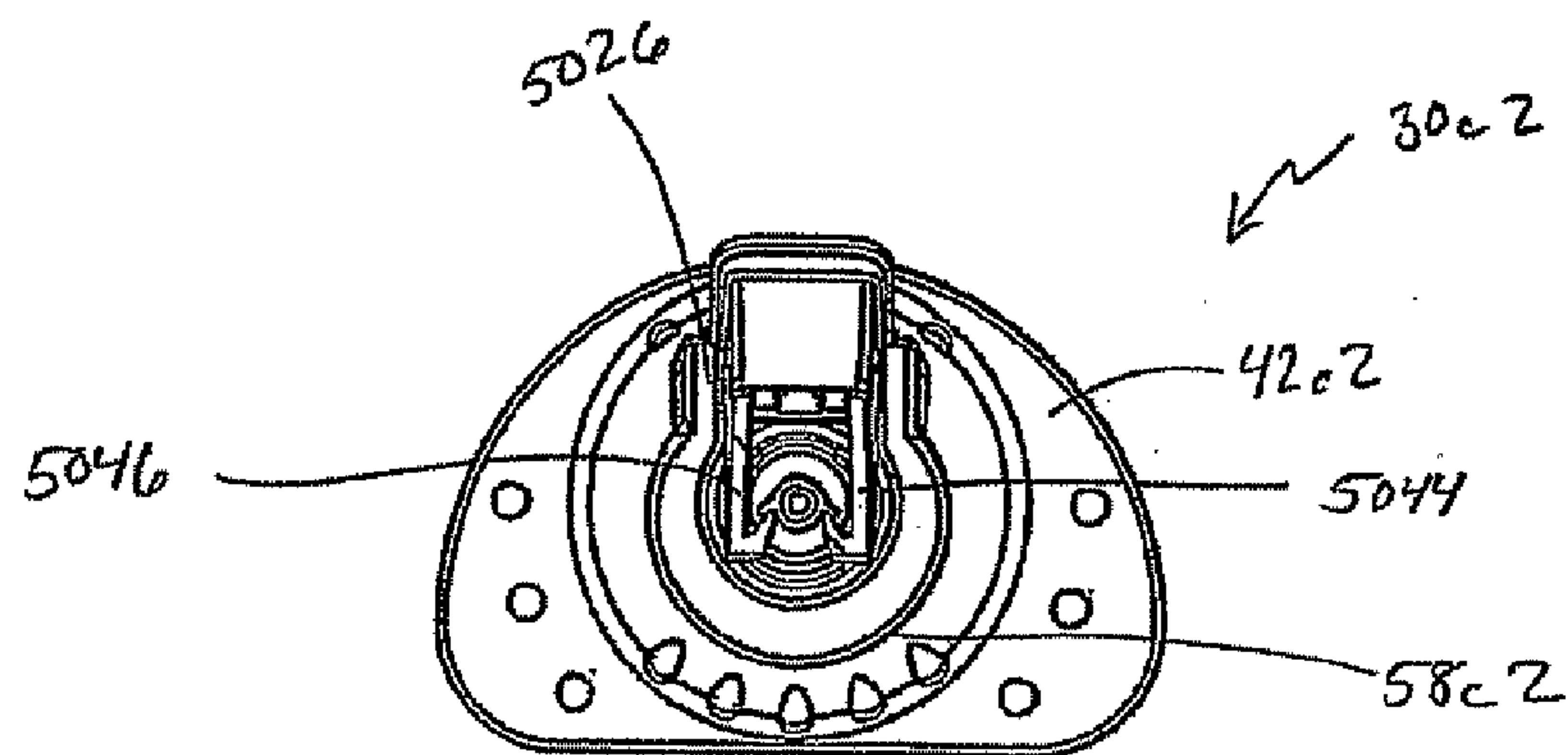
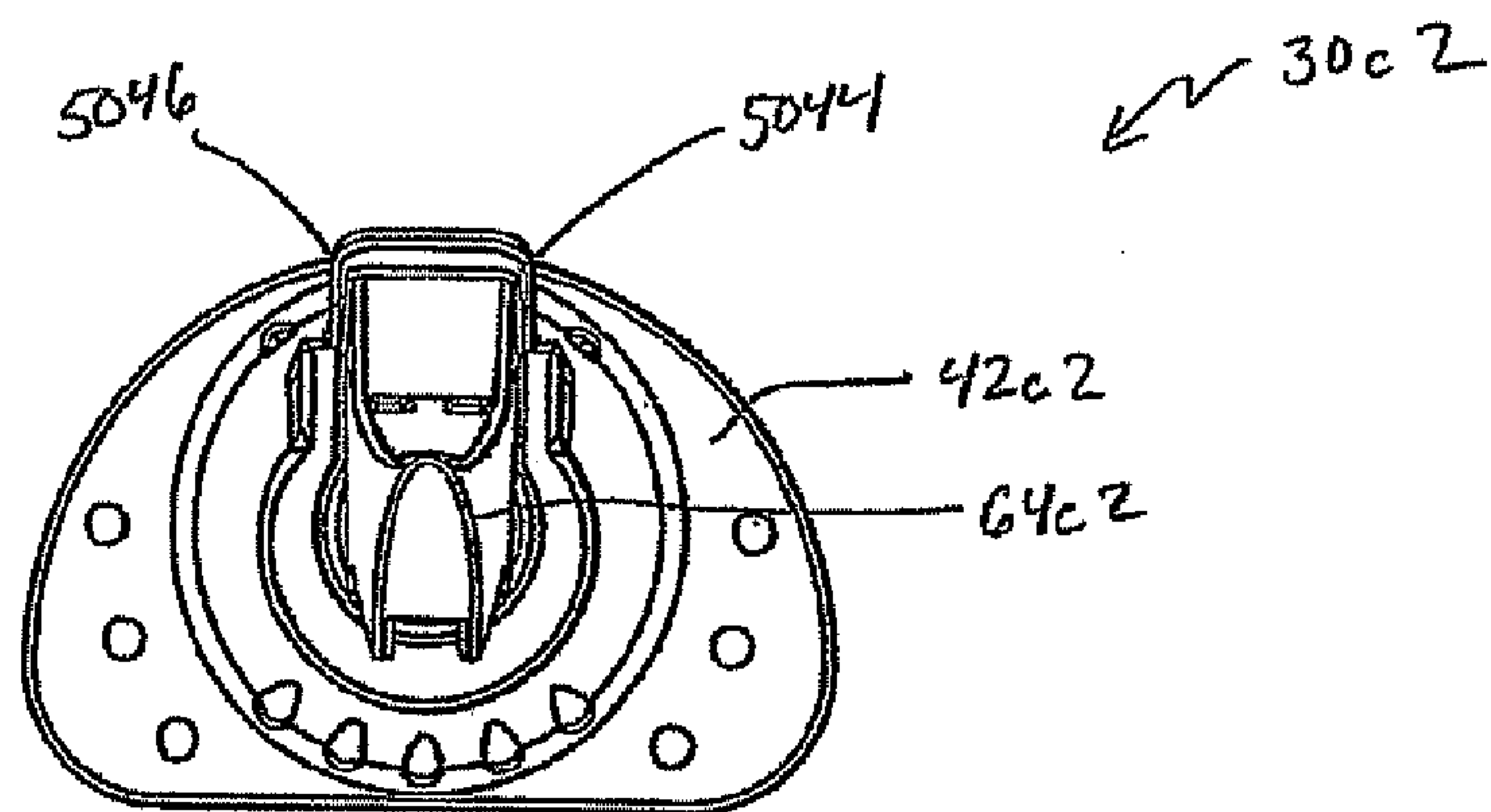
FIG. 32

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FLG. 33

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**FIG. 34****FIG. 35**

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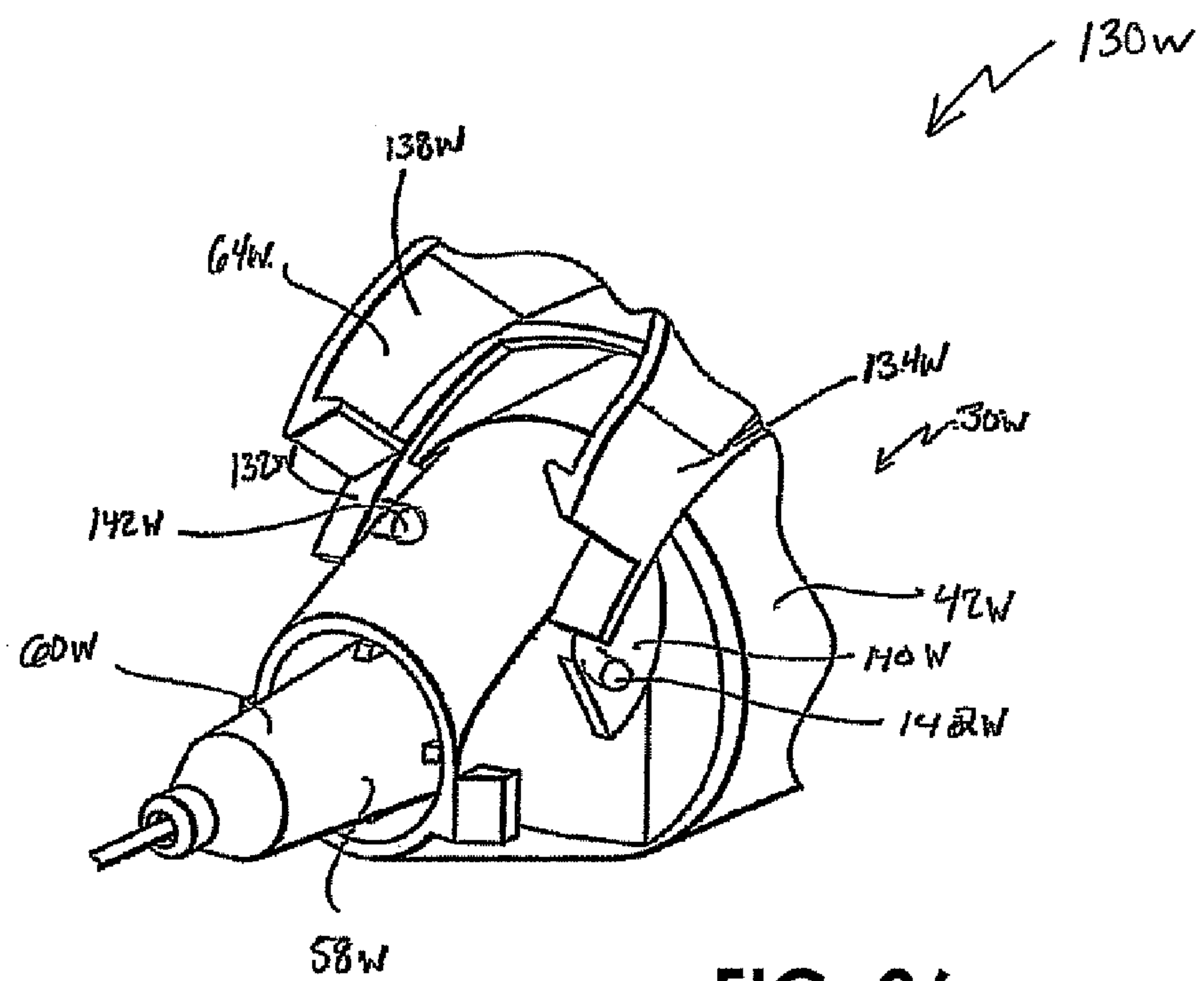


FIG. 36

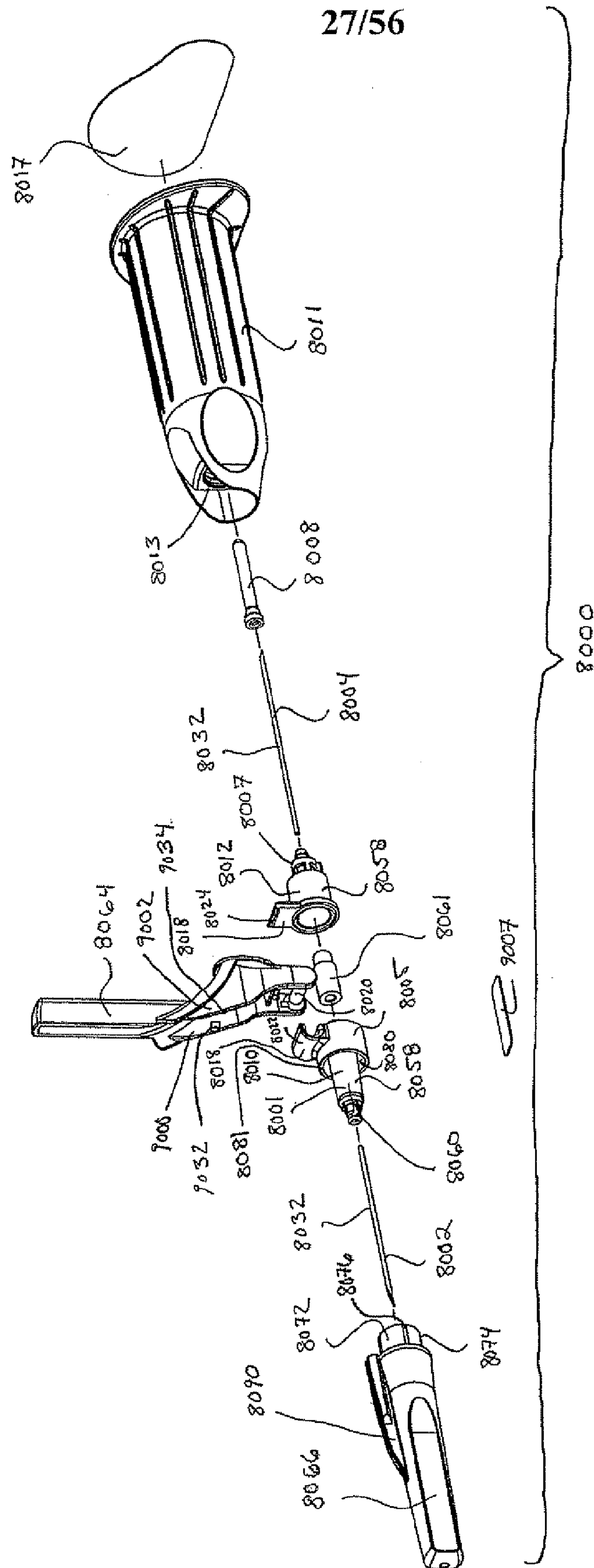


FIG. 37

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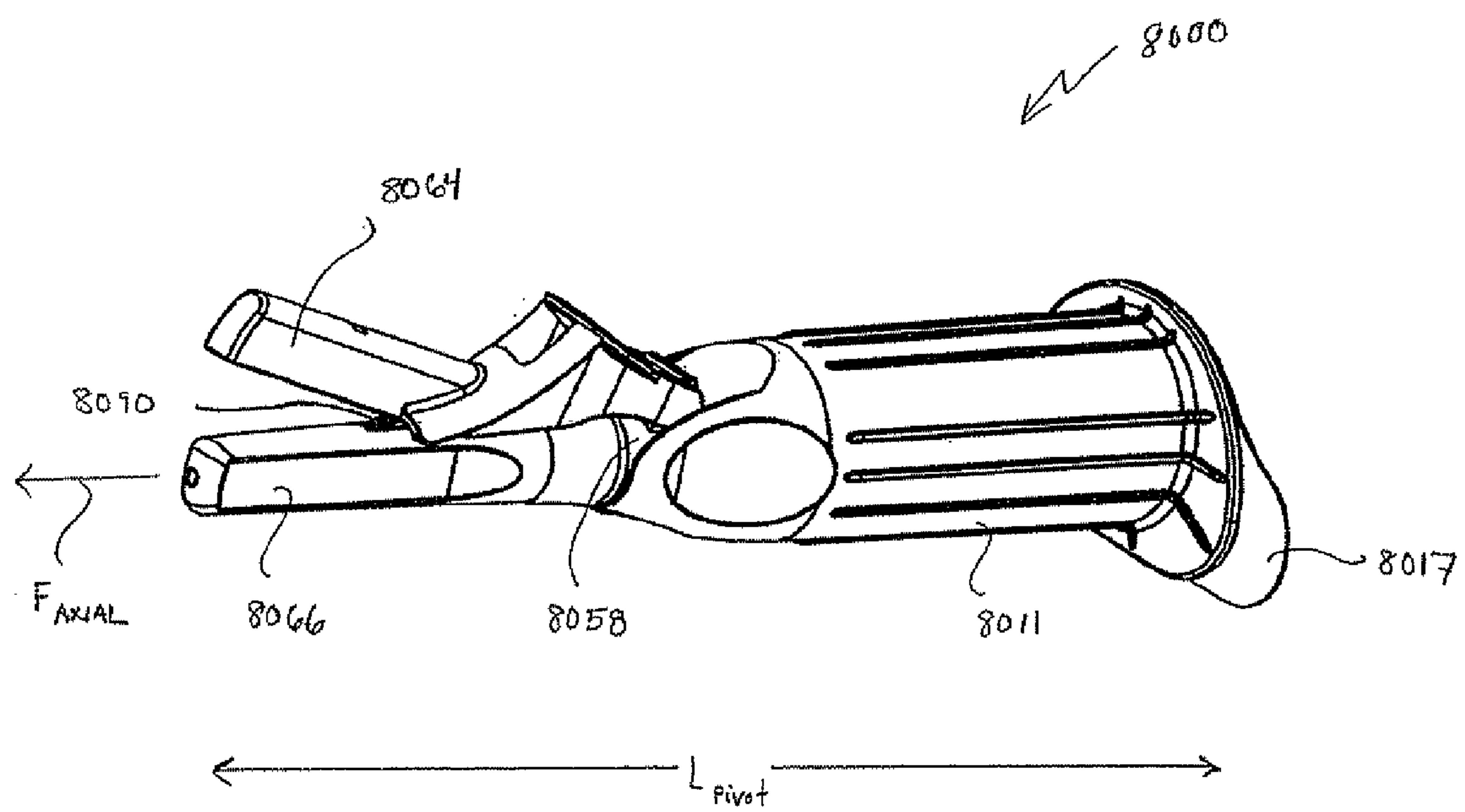


FIG. 38

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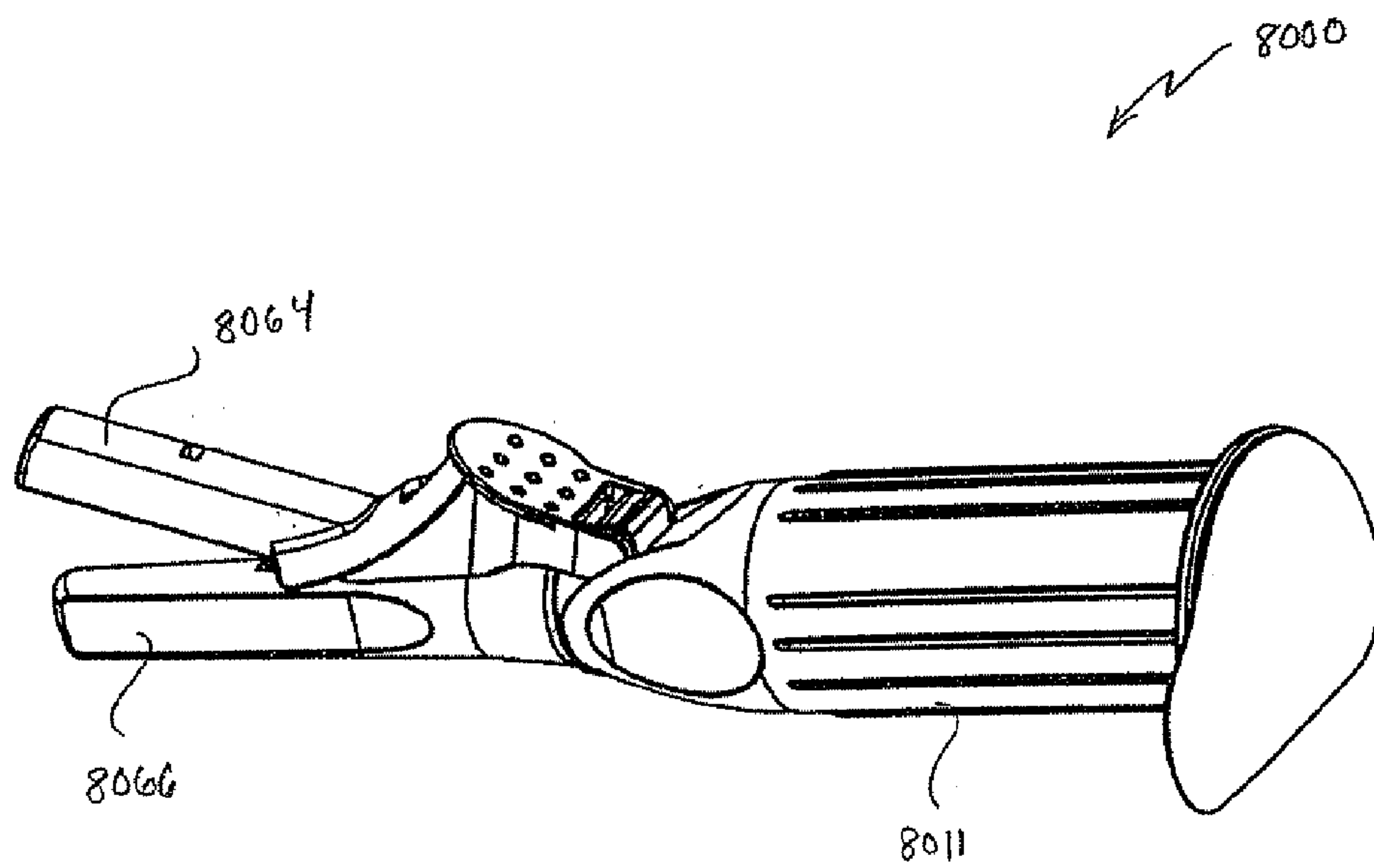


FIG. 39

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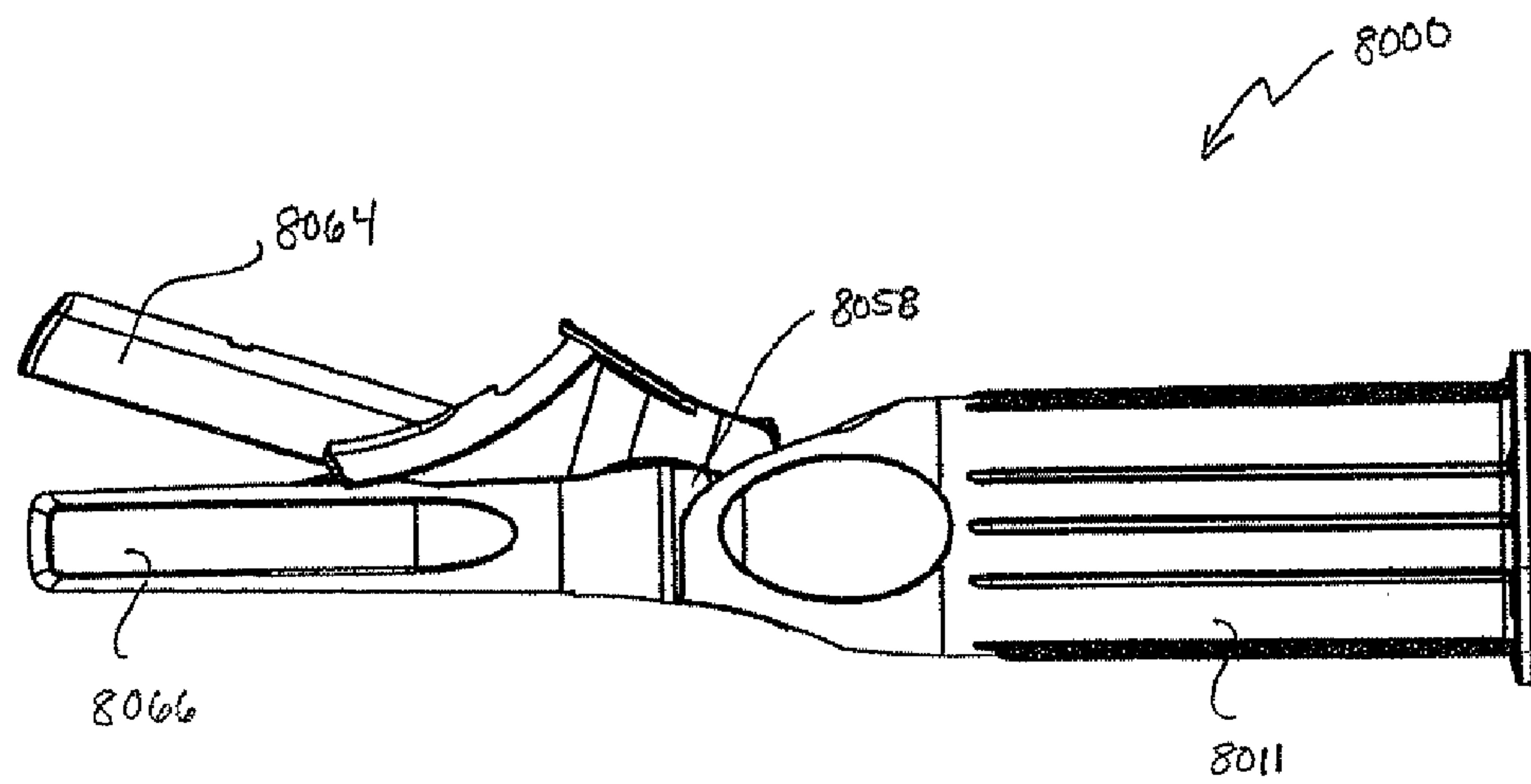


FIG. 40

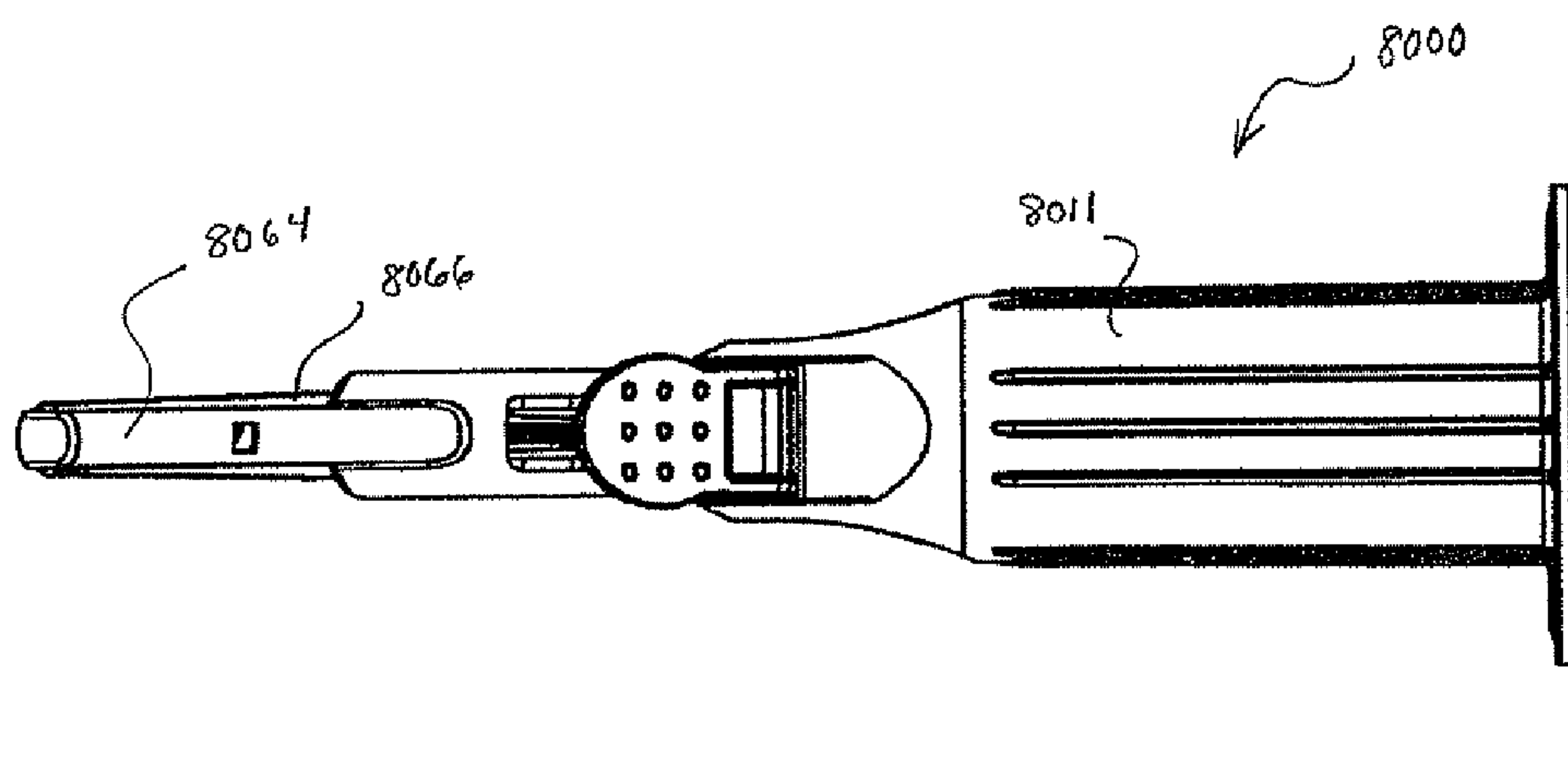


FIG. 41

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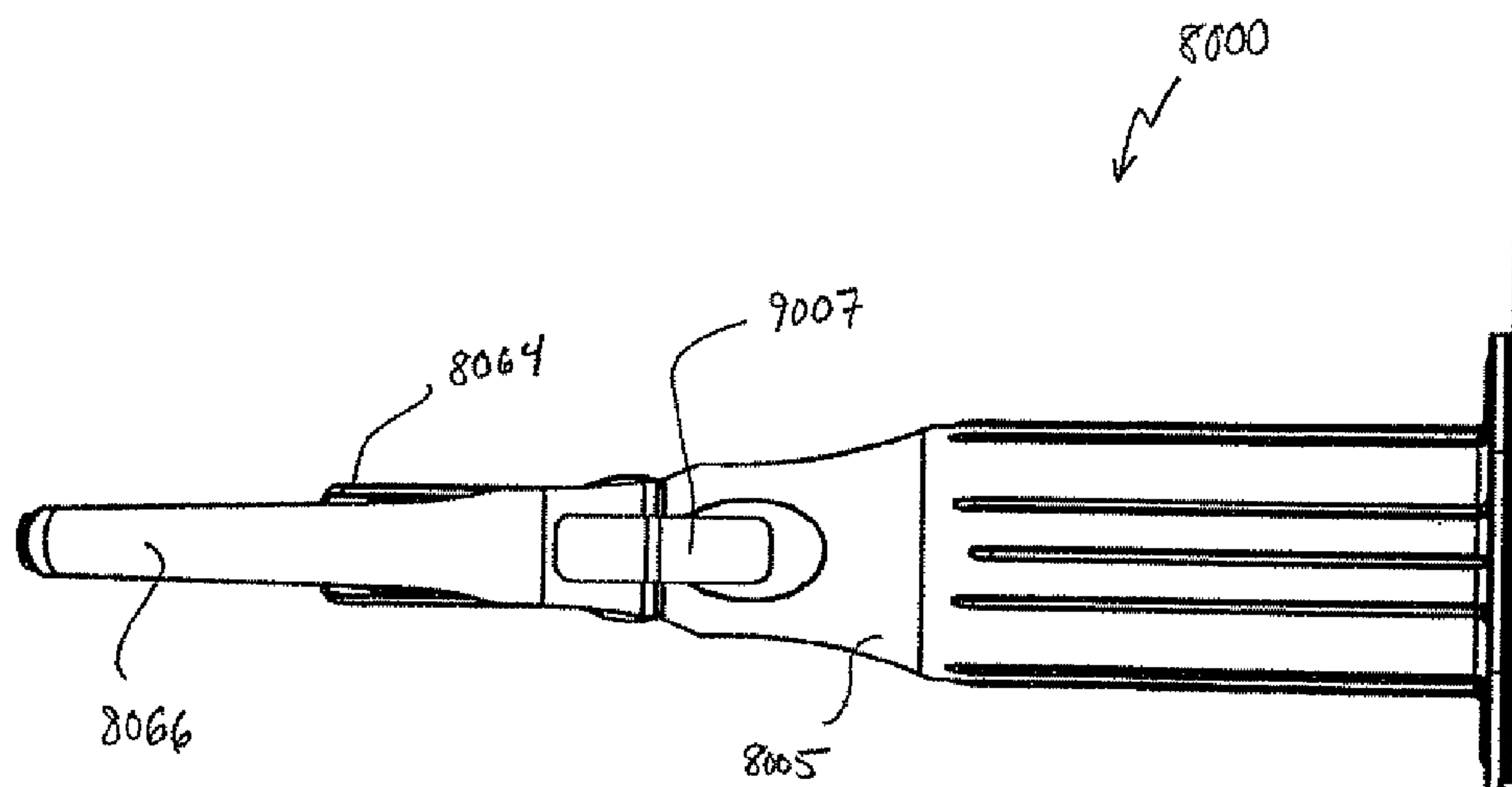


FIG. 42

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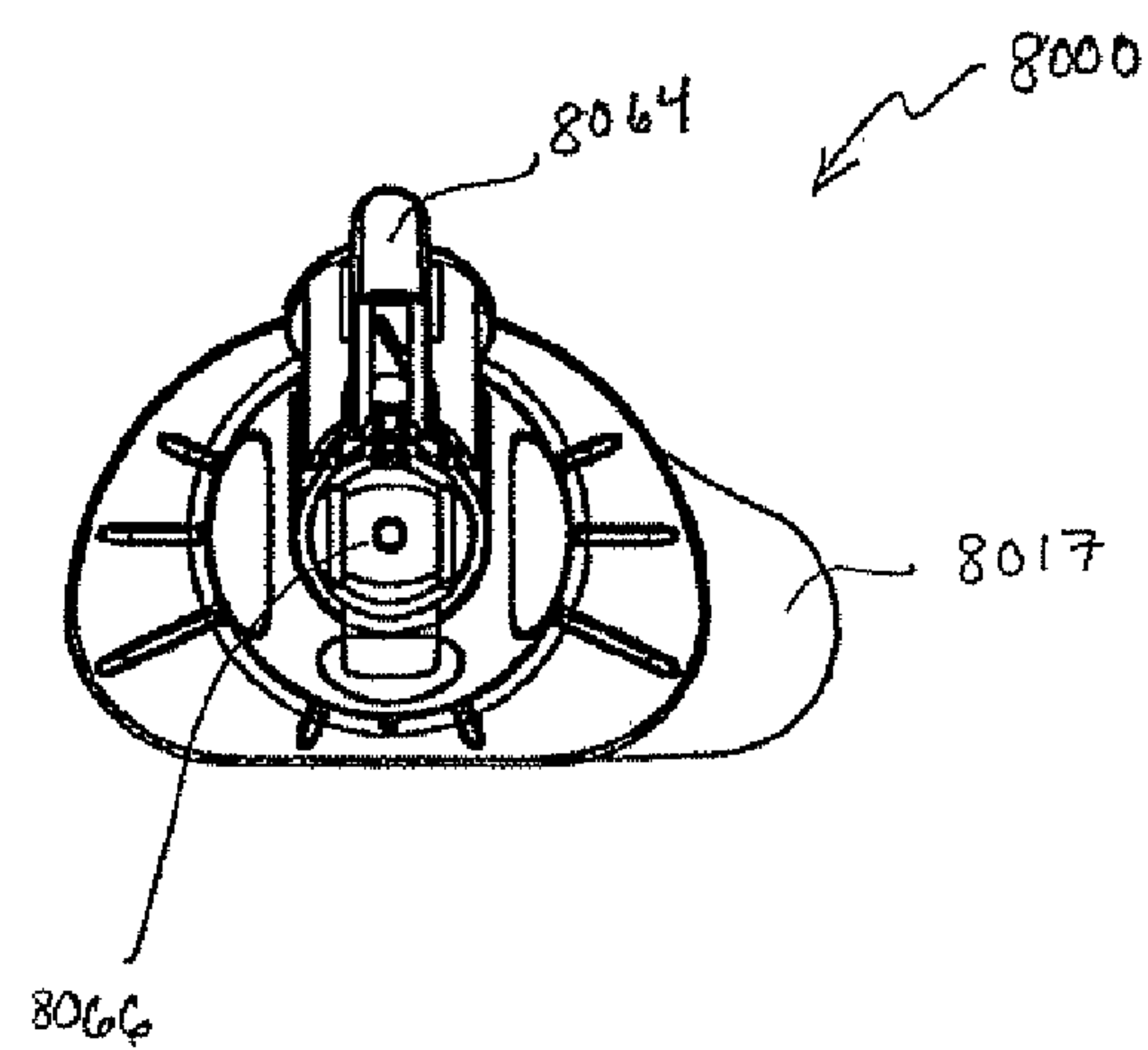


FIG. 43

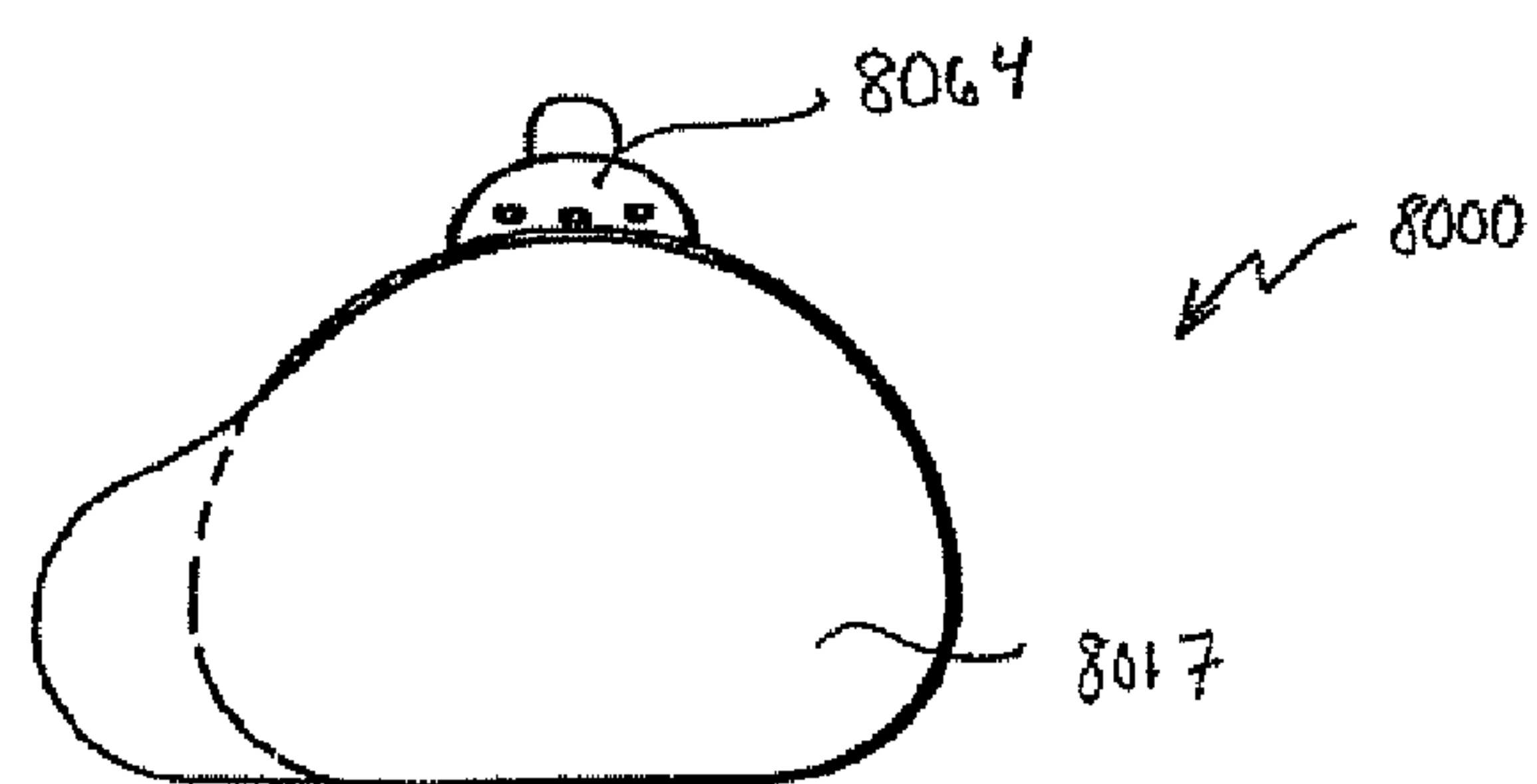


FIG. 44

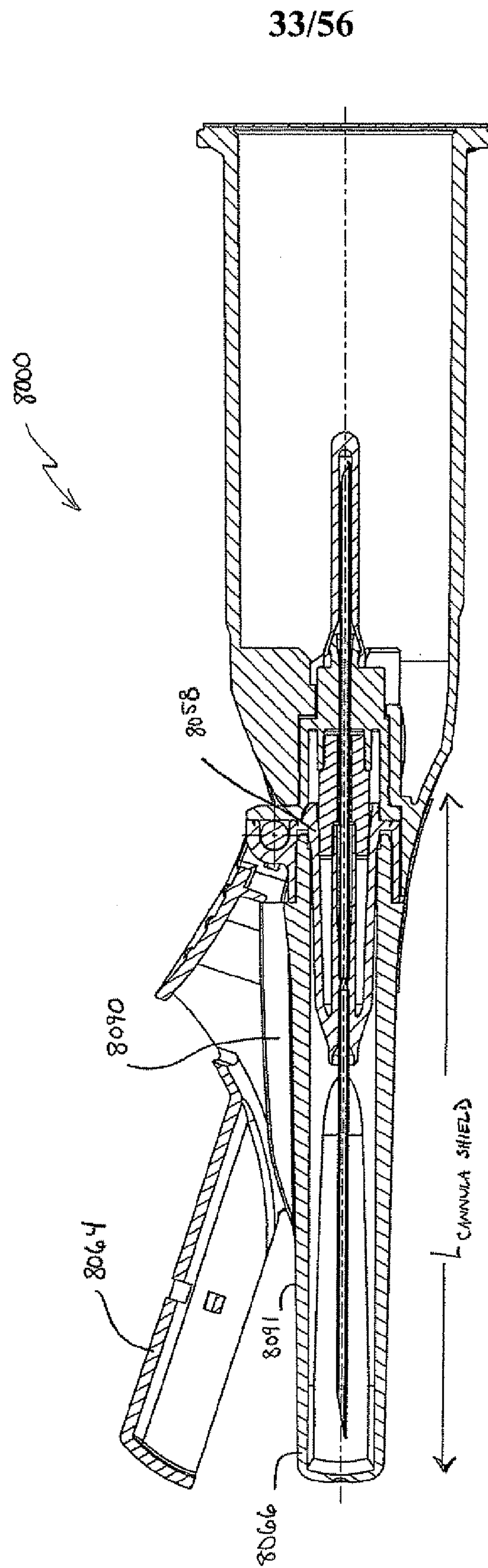


FIG. 45

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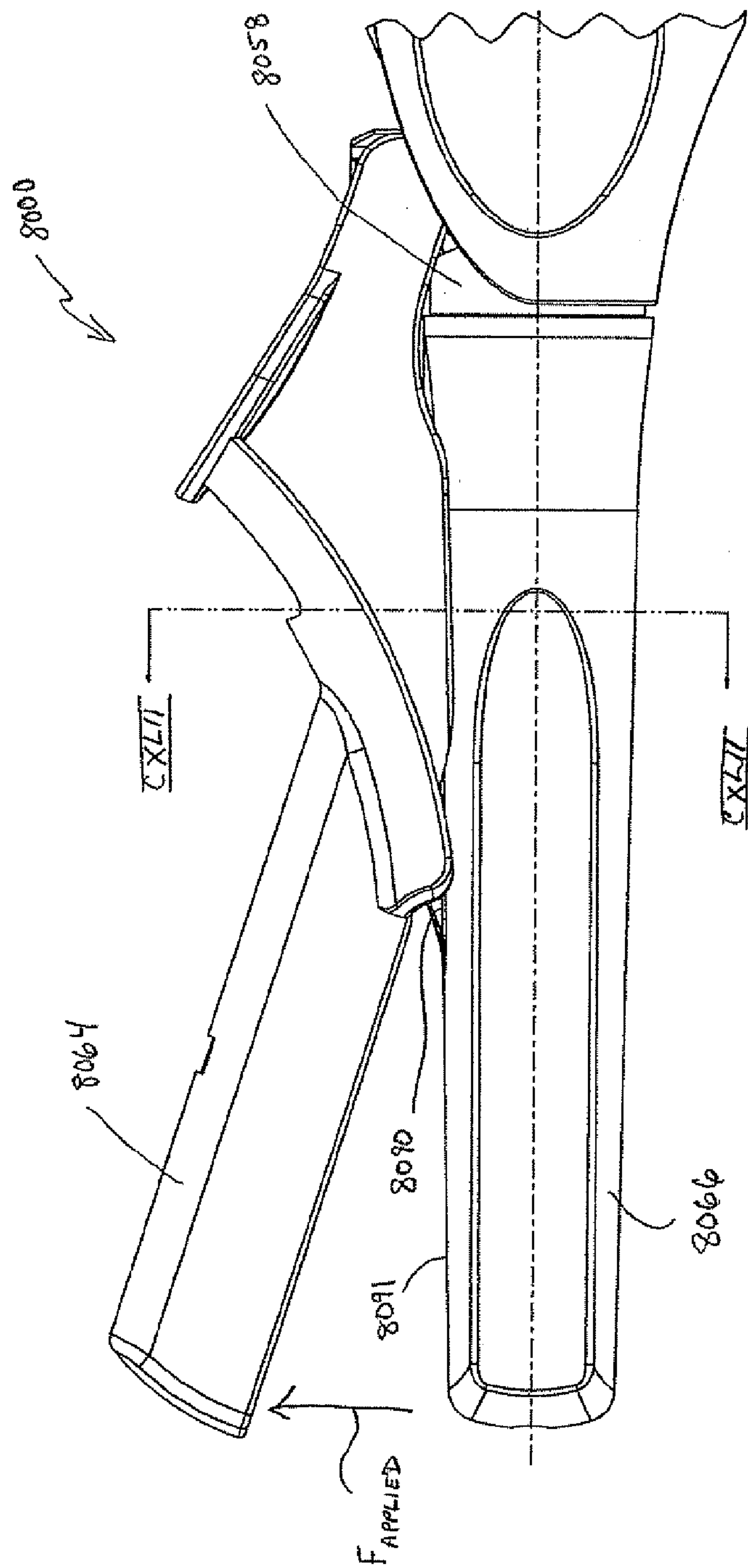


FIG. 46

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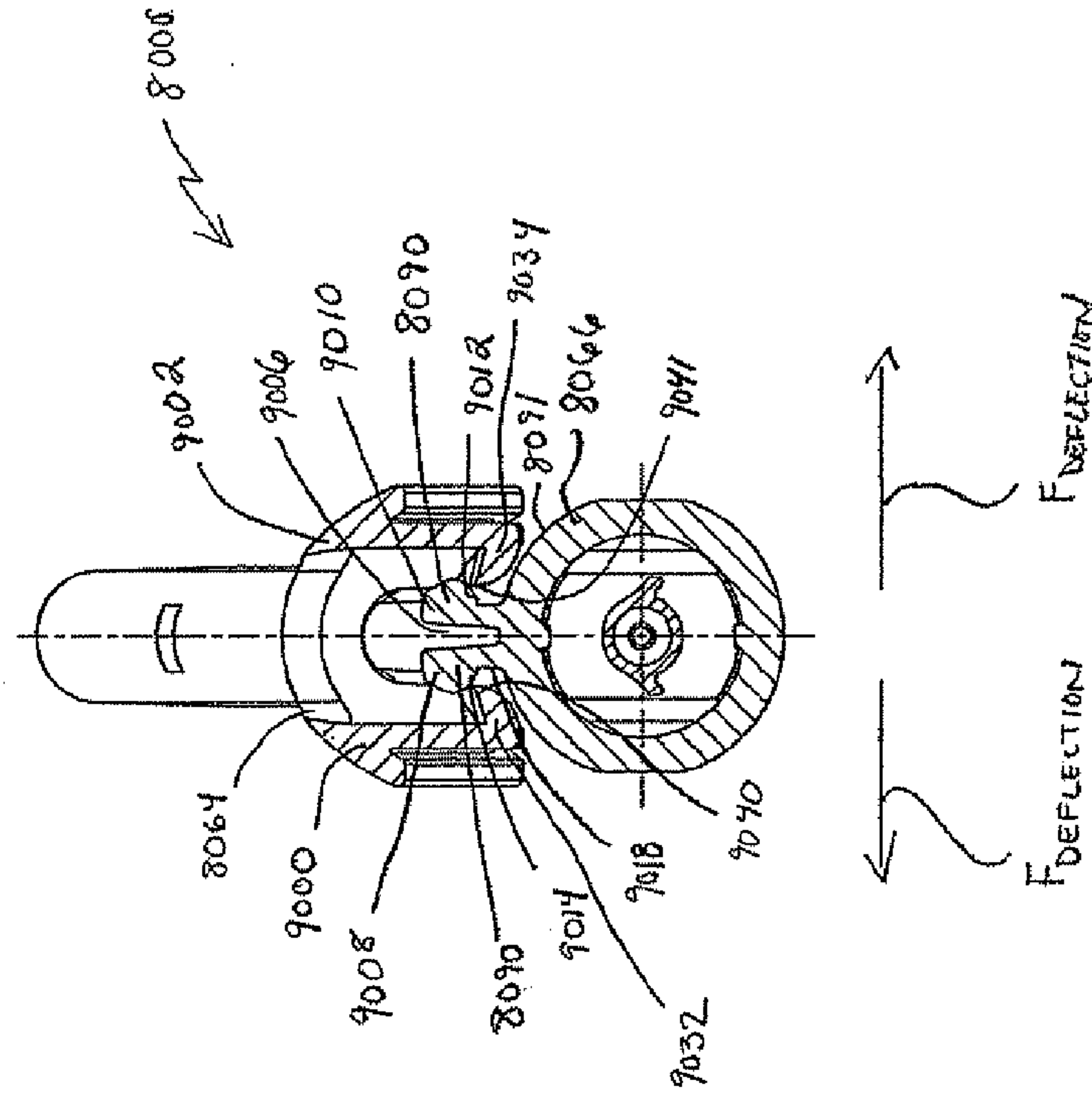


FIG. 47

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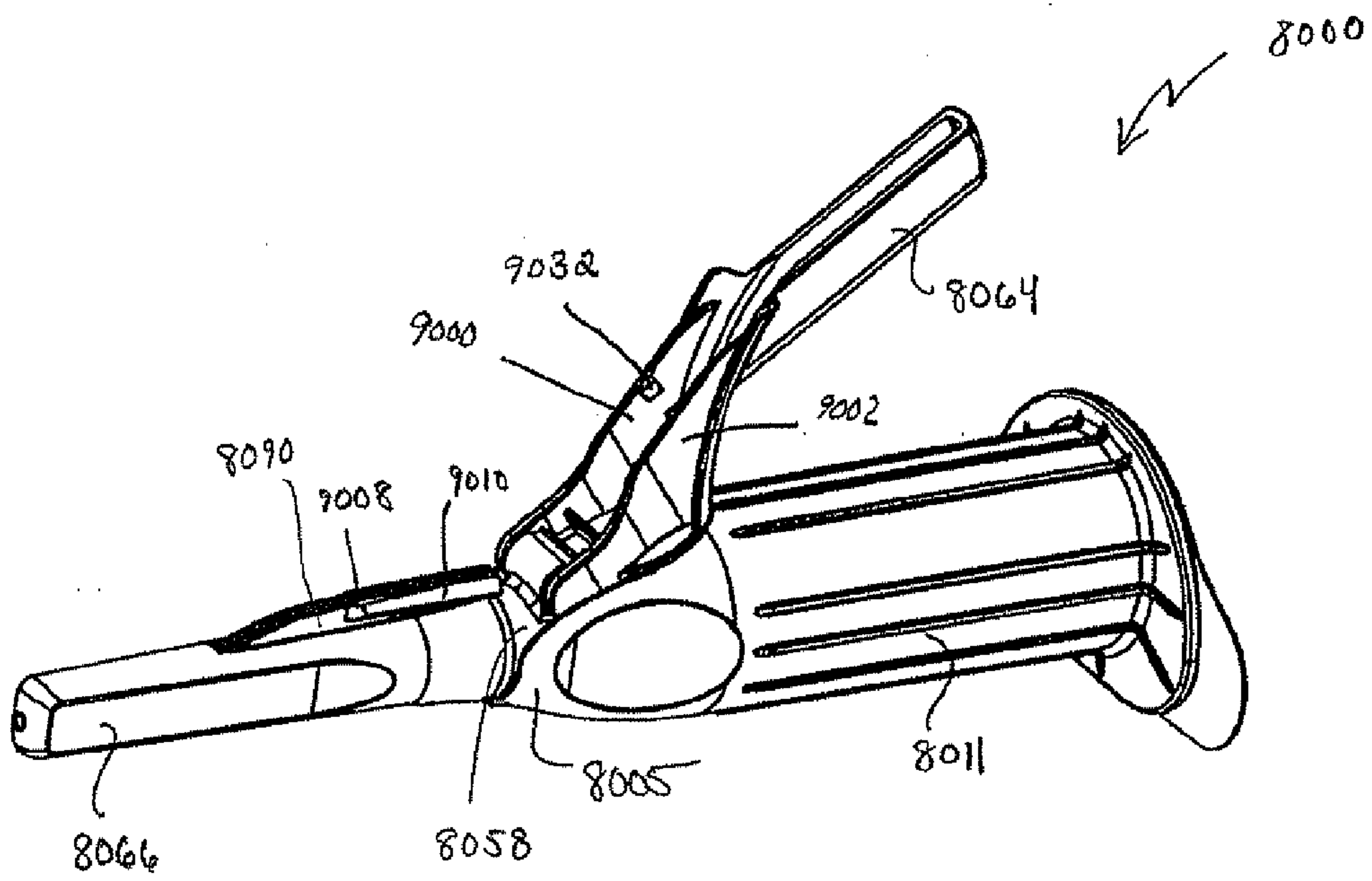


FIG. 48

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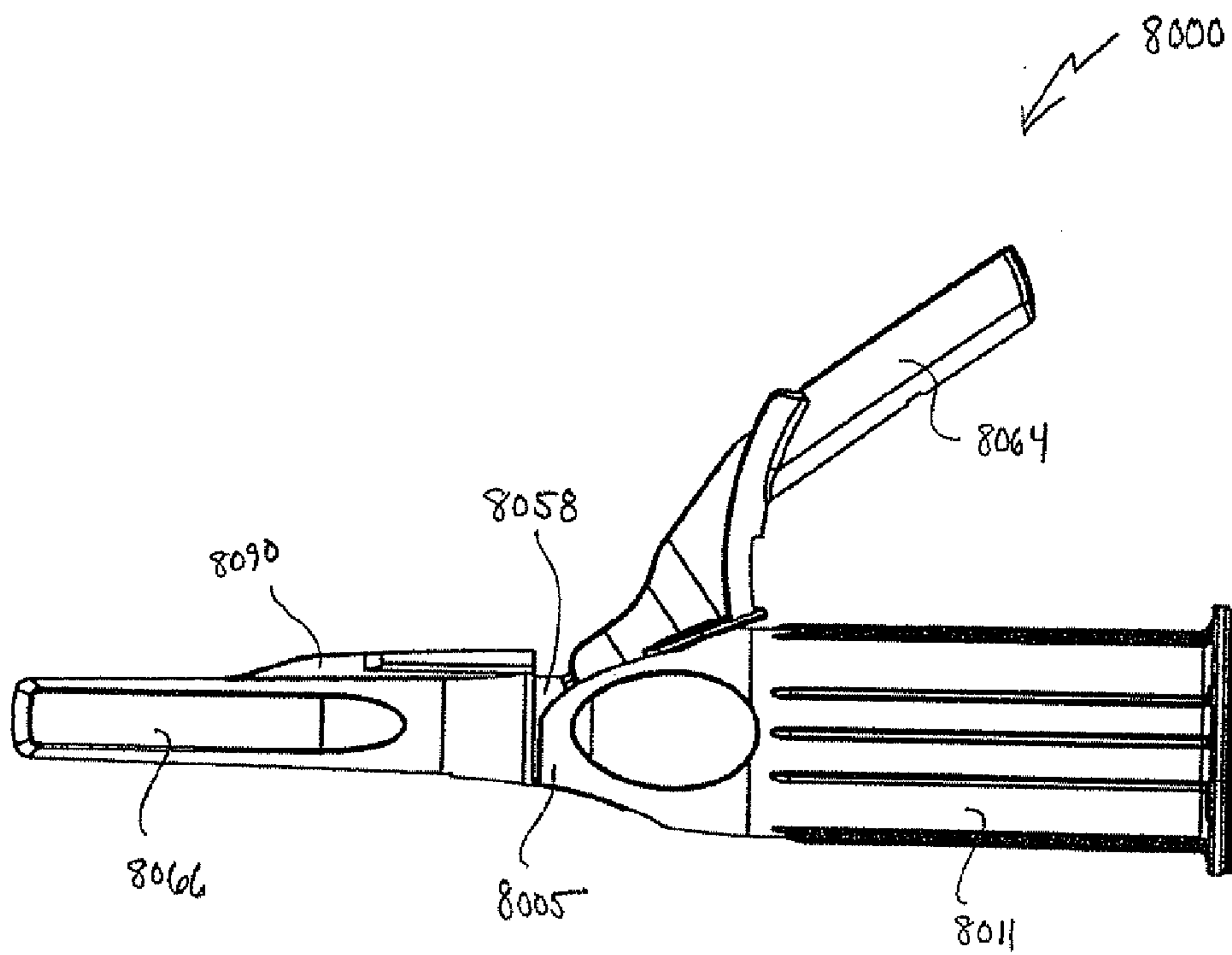


FIG. 49

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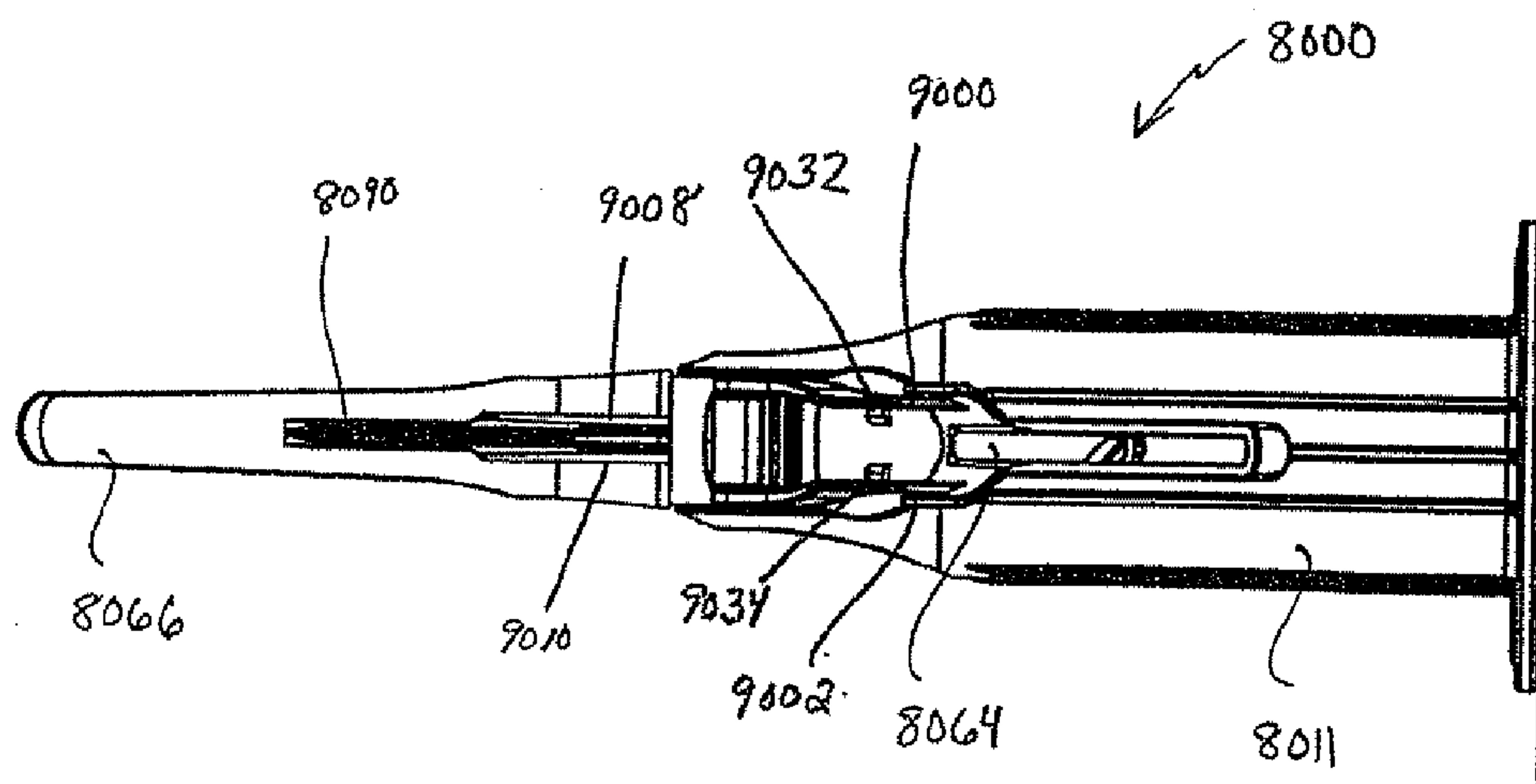


FIG. 50

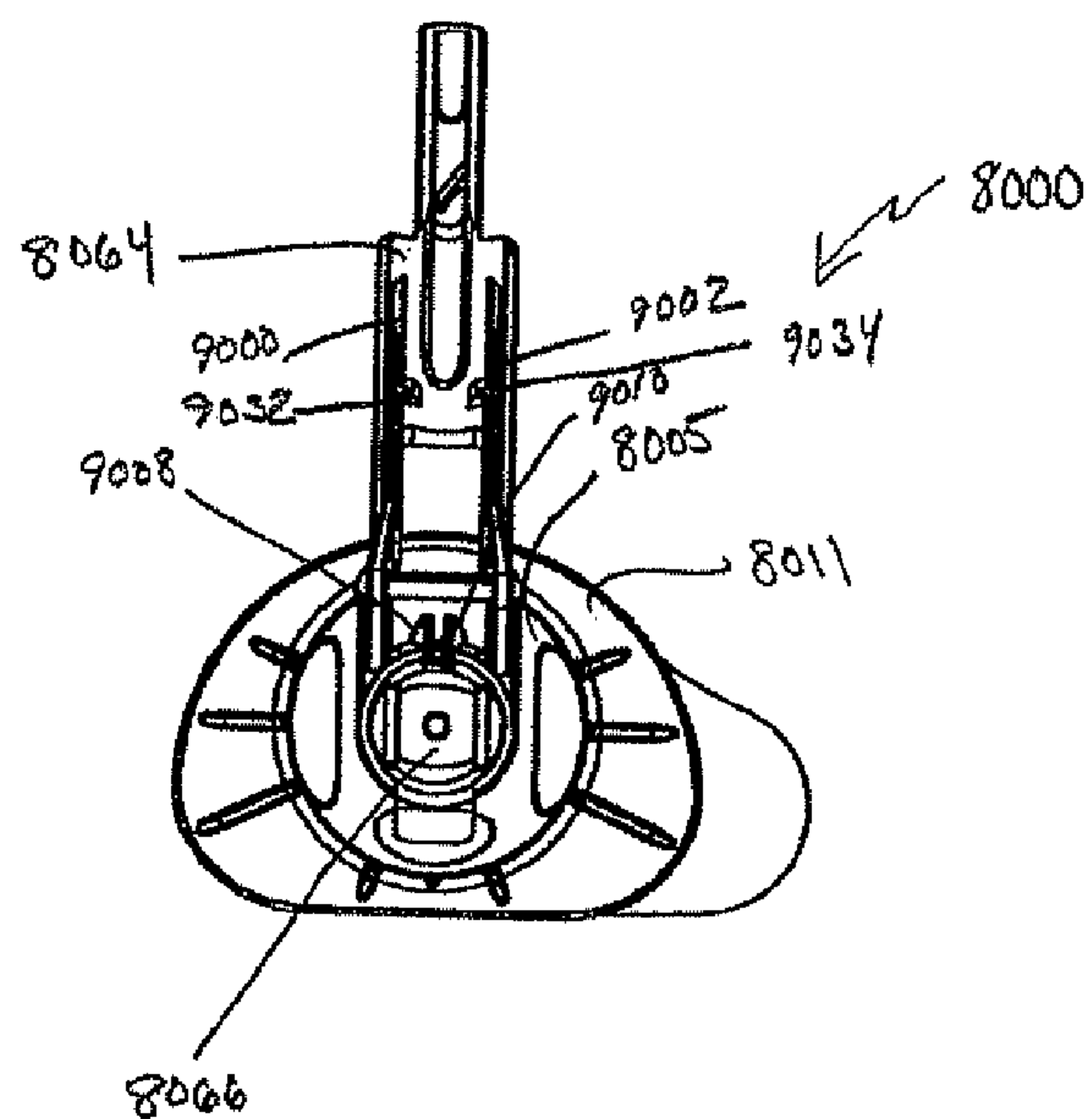


FIG. 51

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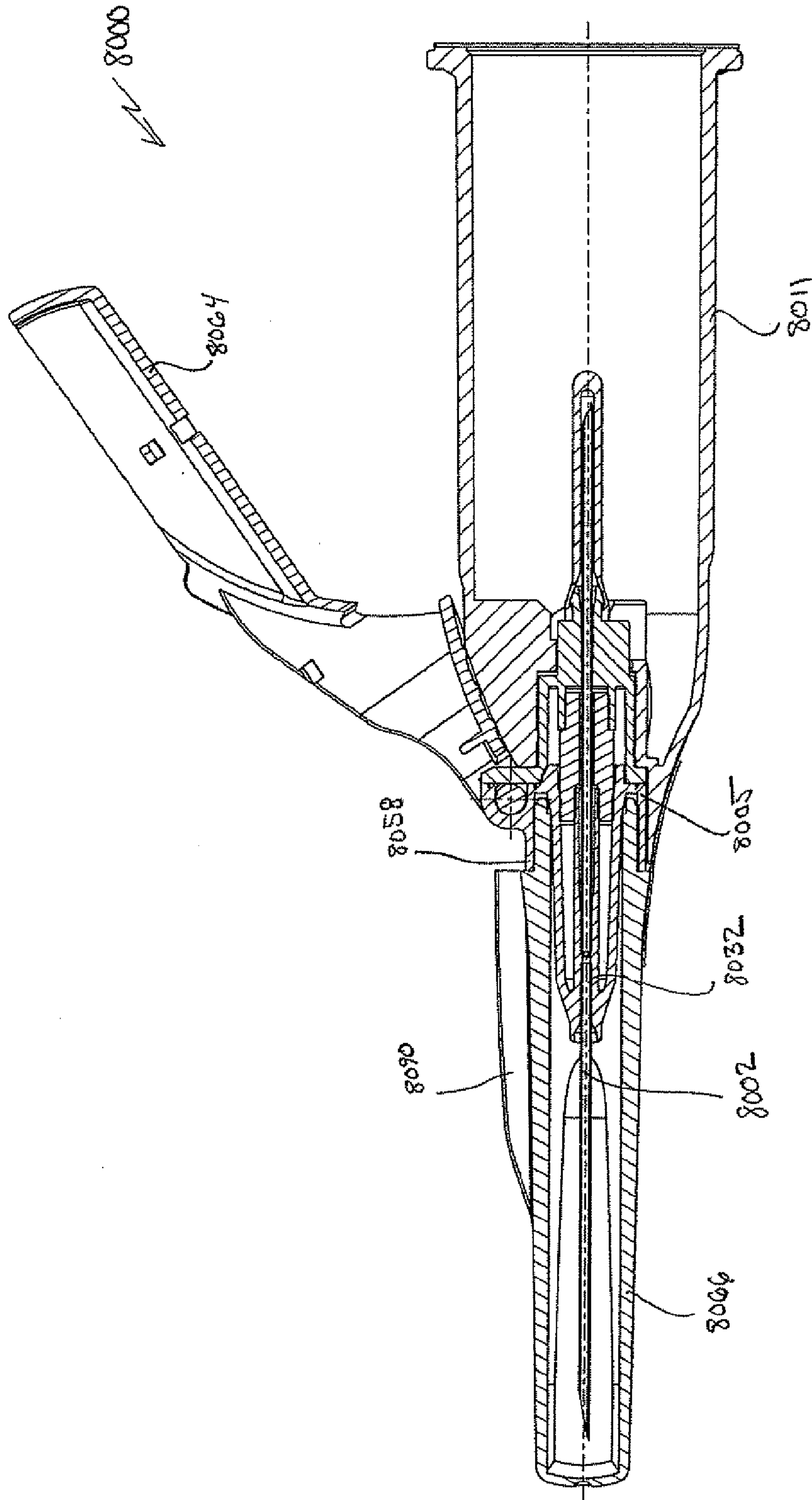


FIG. 52

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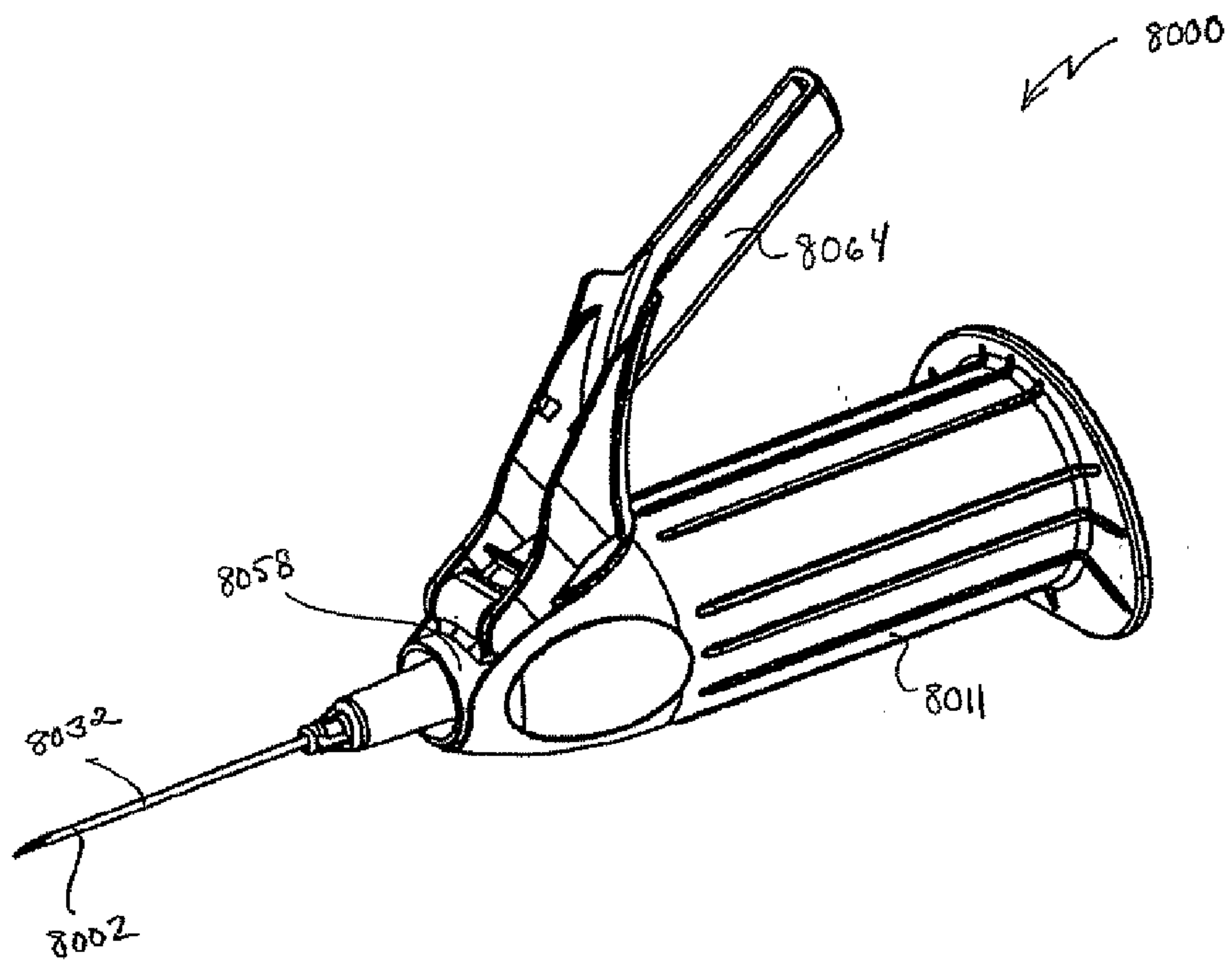


FIG. 53

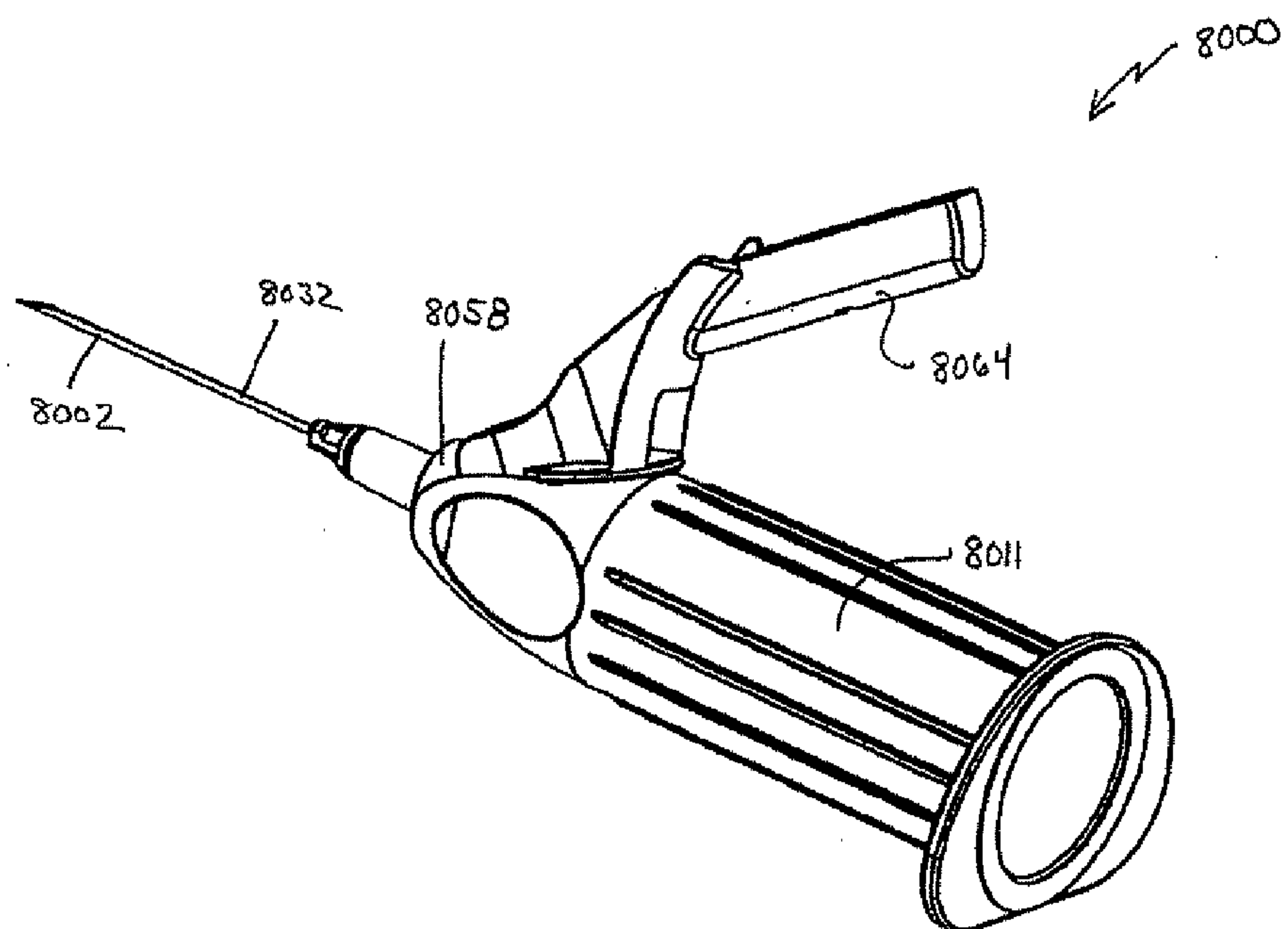


FIG. 54

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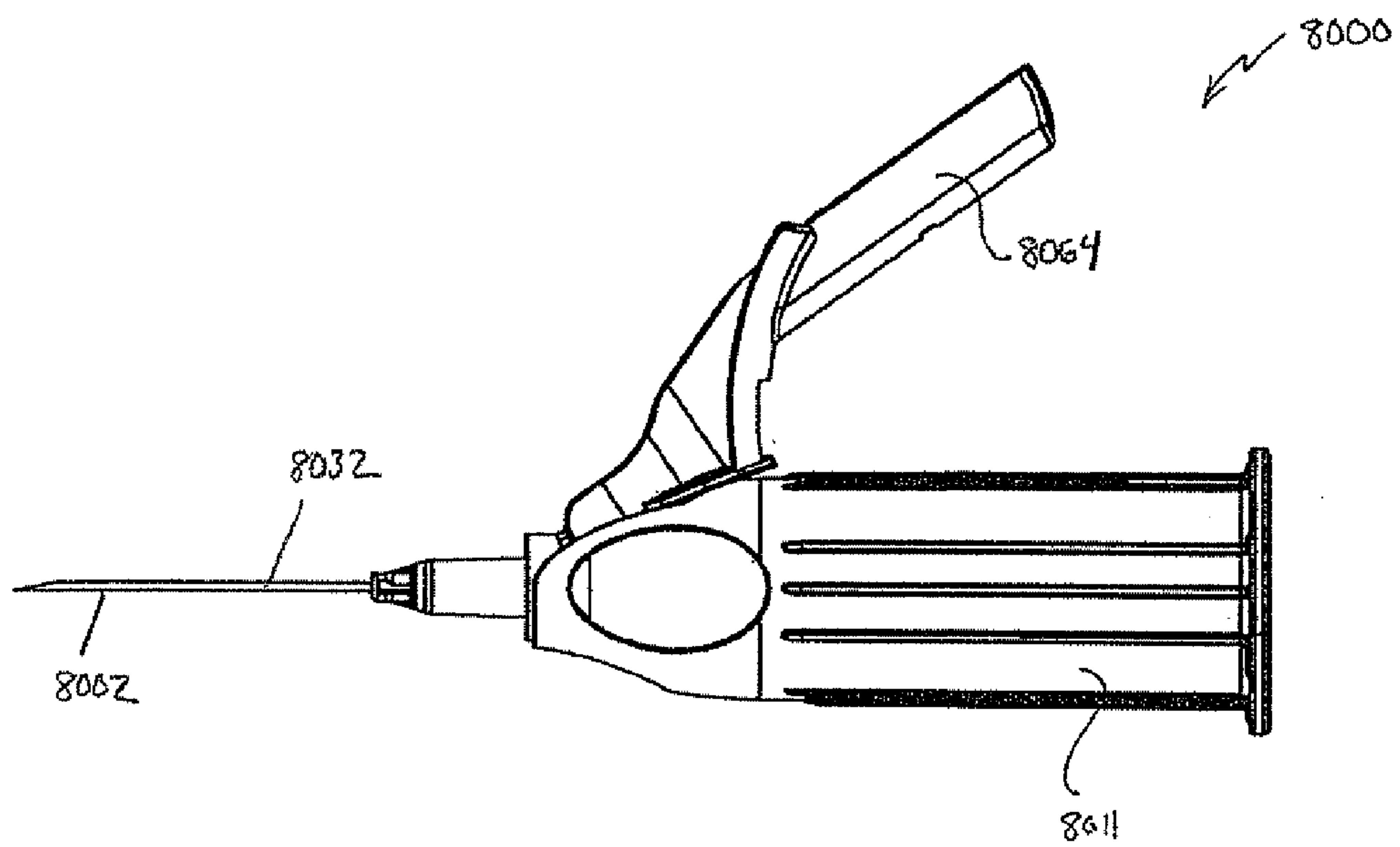


FIG. 55

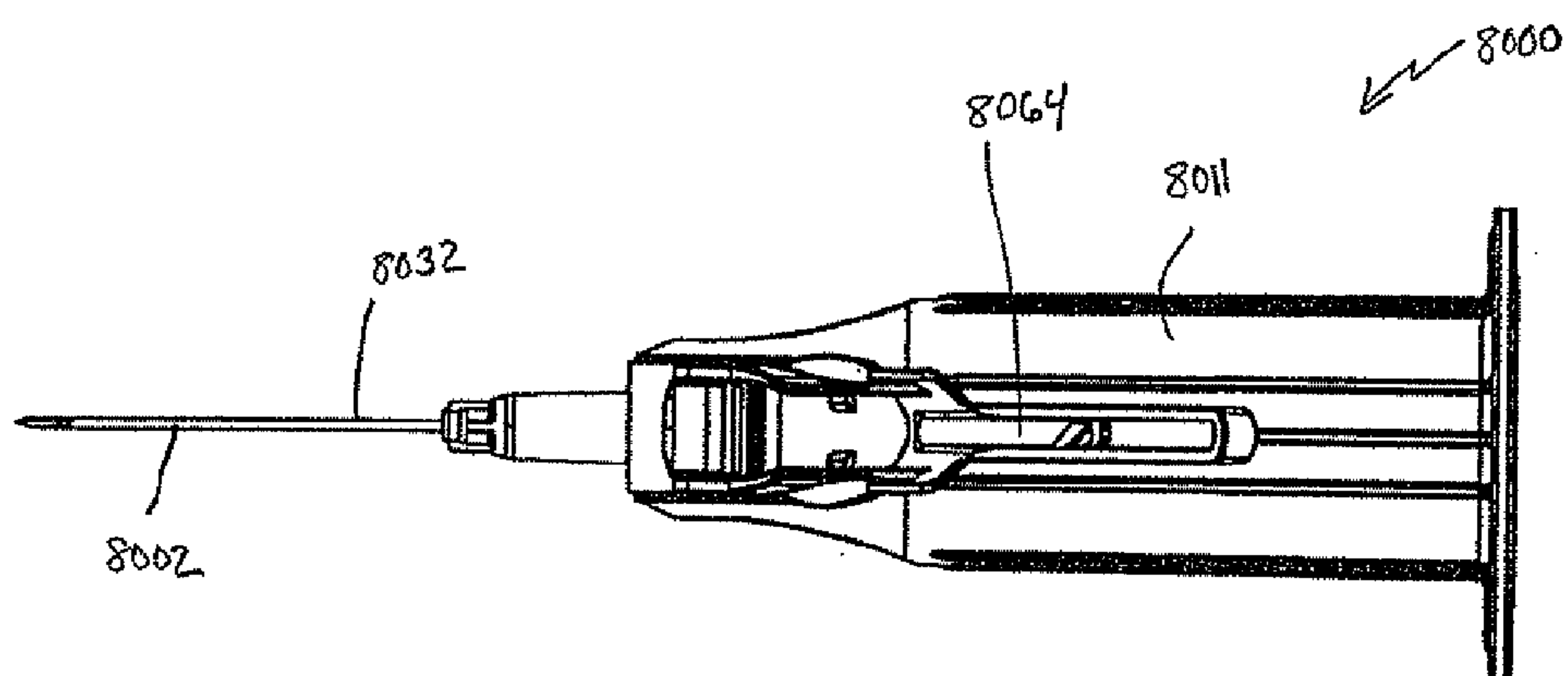


FIG. 56

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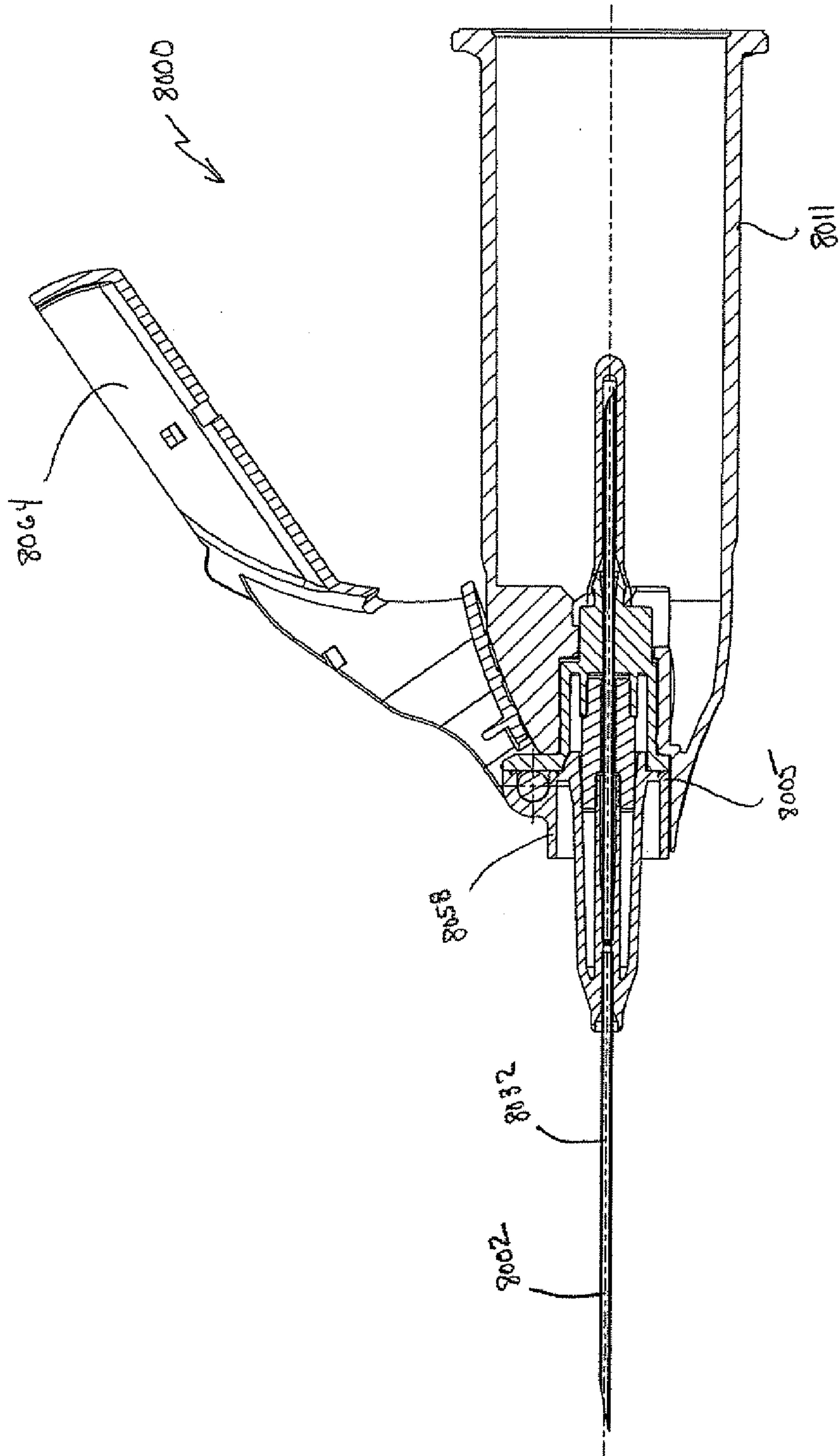


FIG. 57

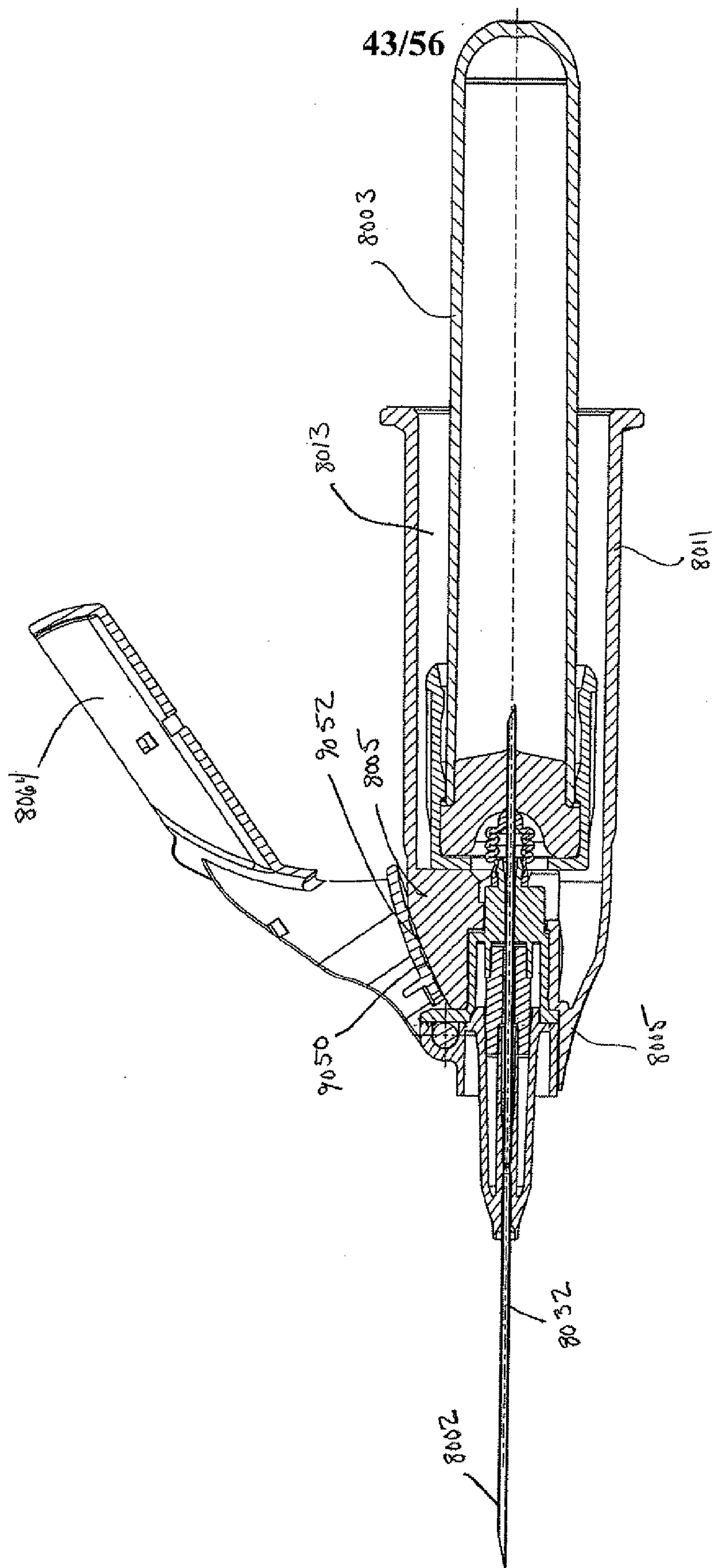


FIG. 58

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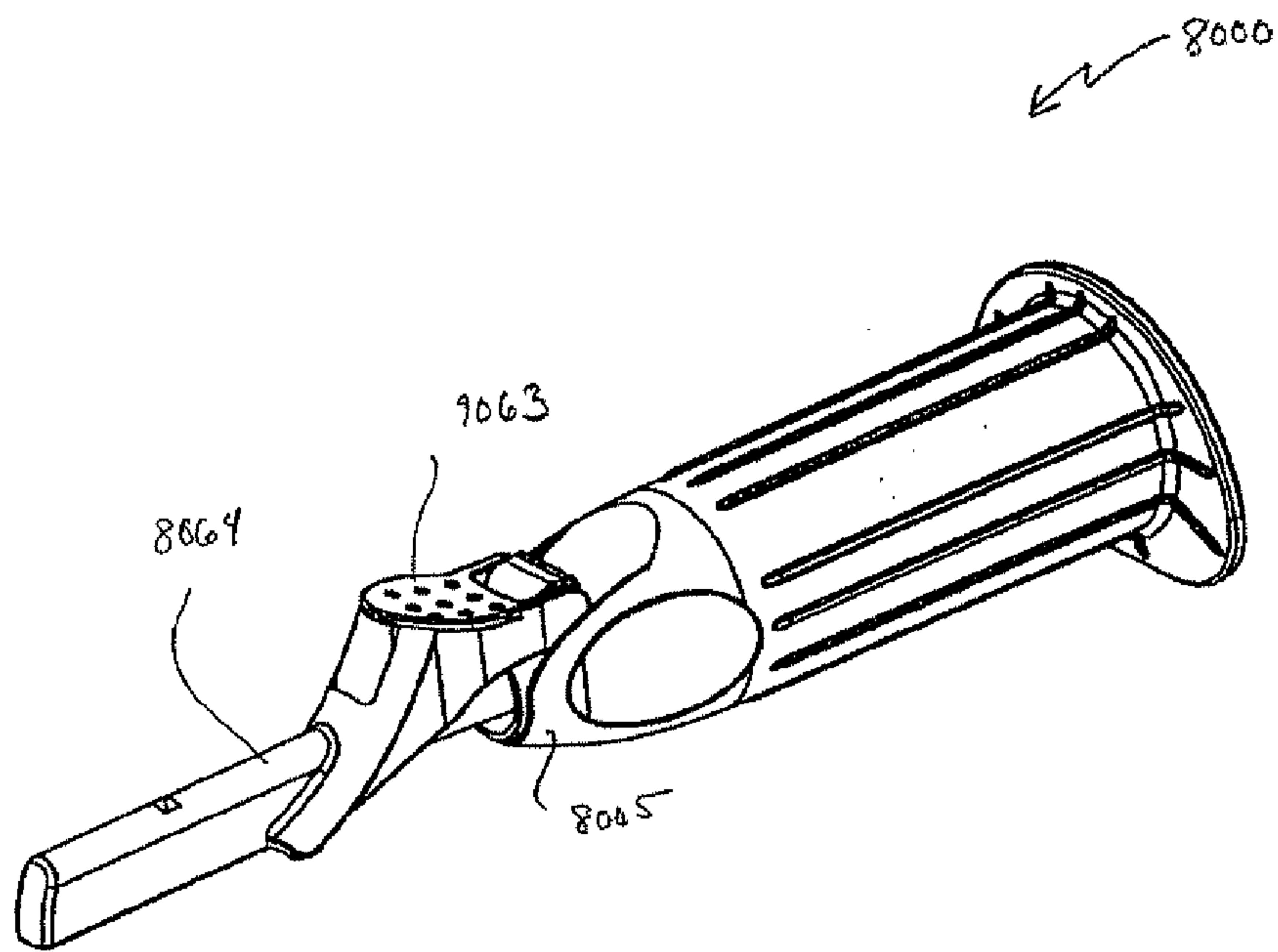


FIG. 59

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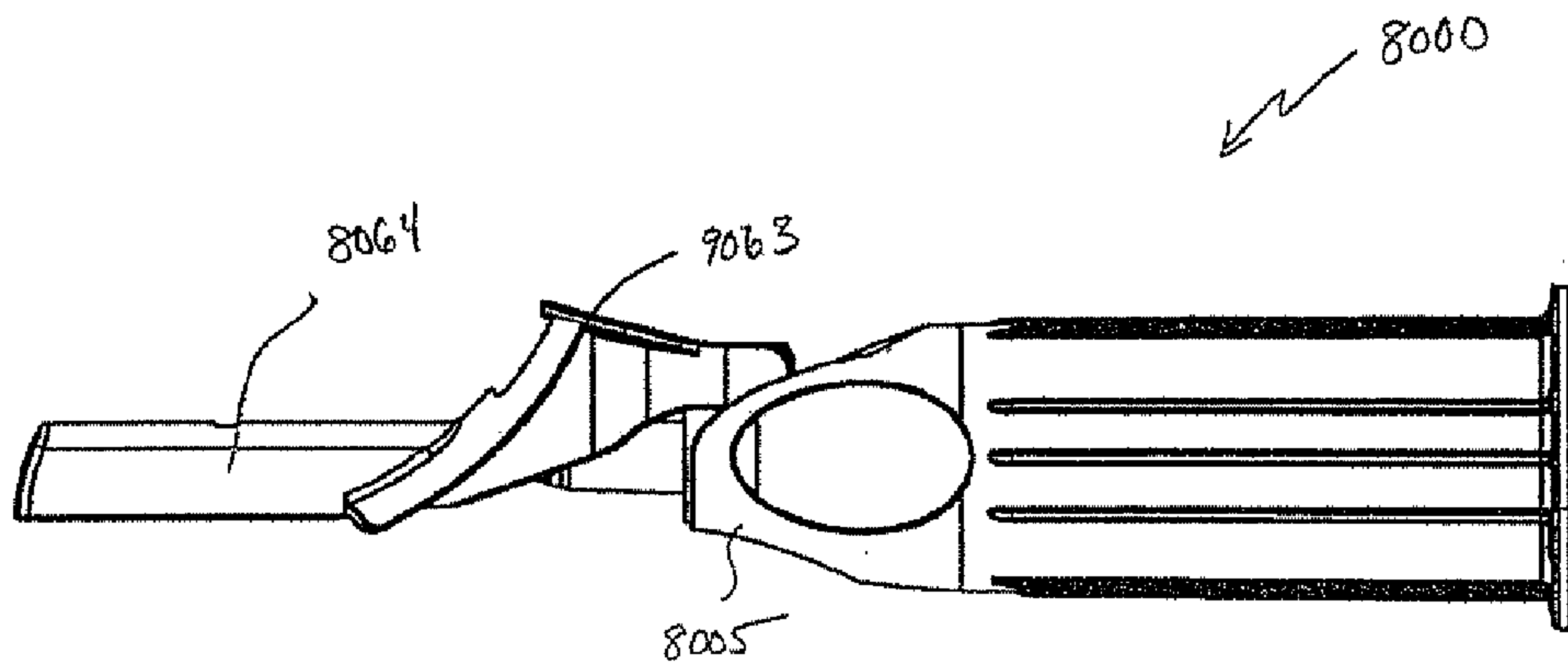


FIG. 60

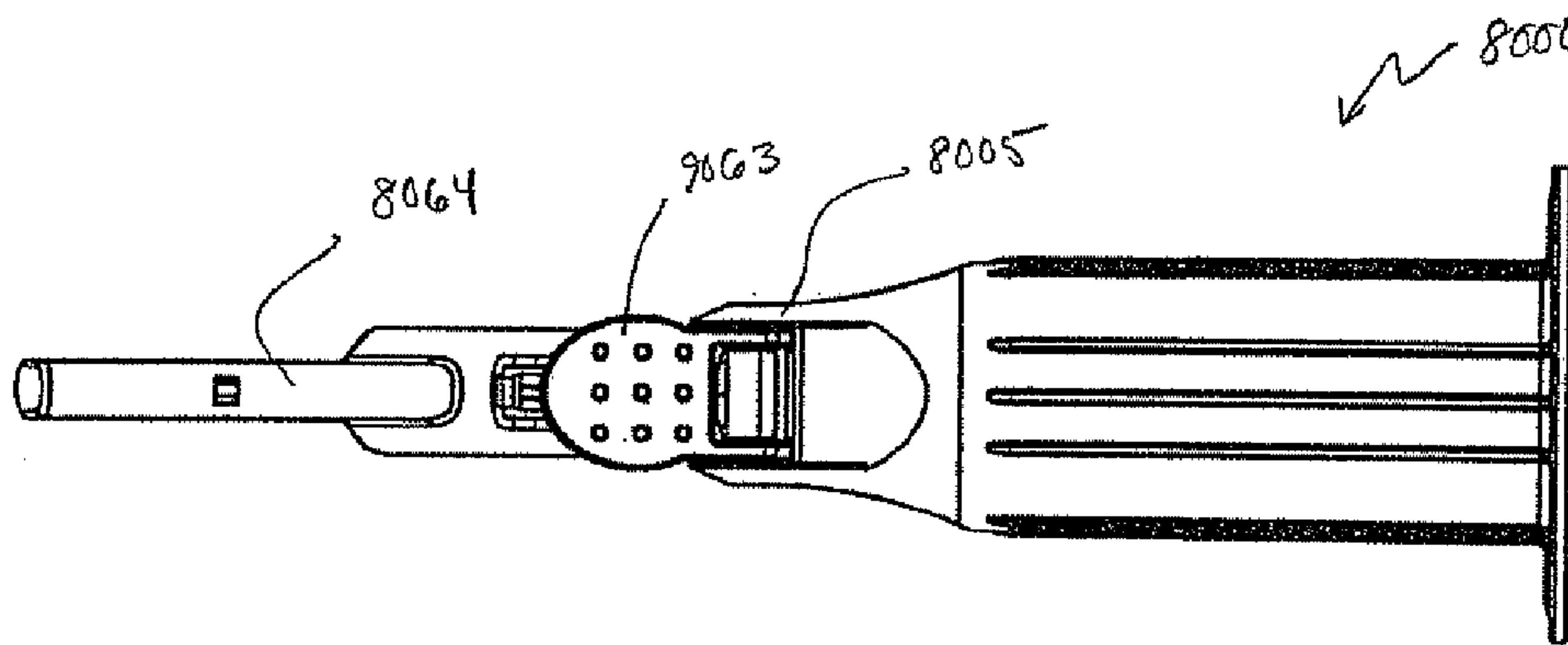


FIG. 61

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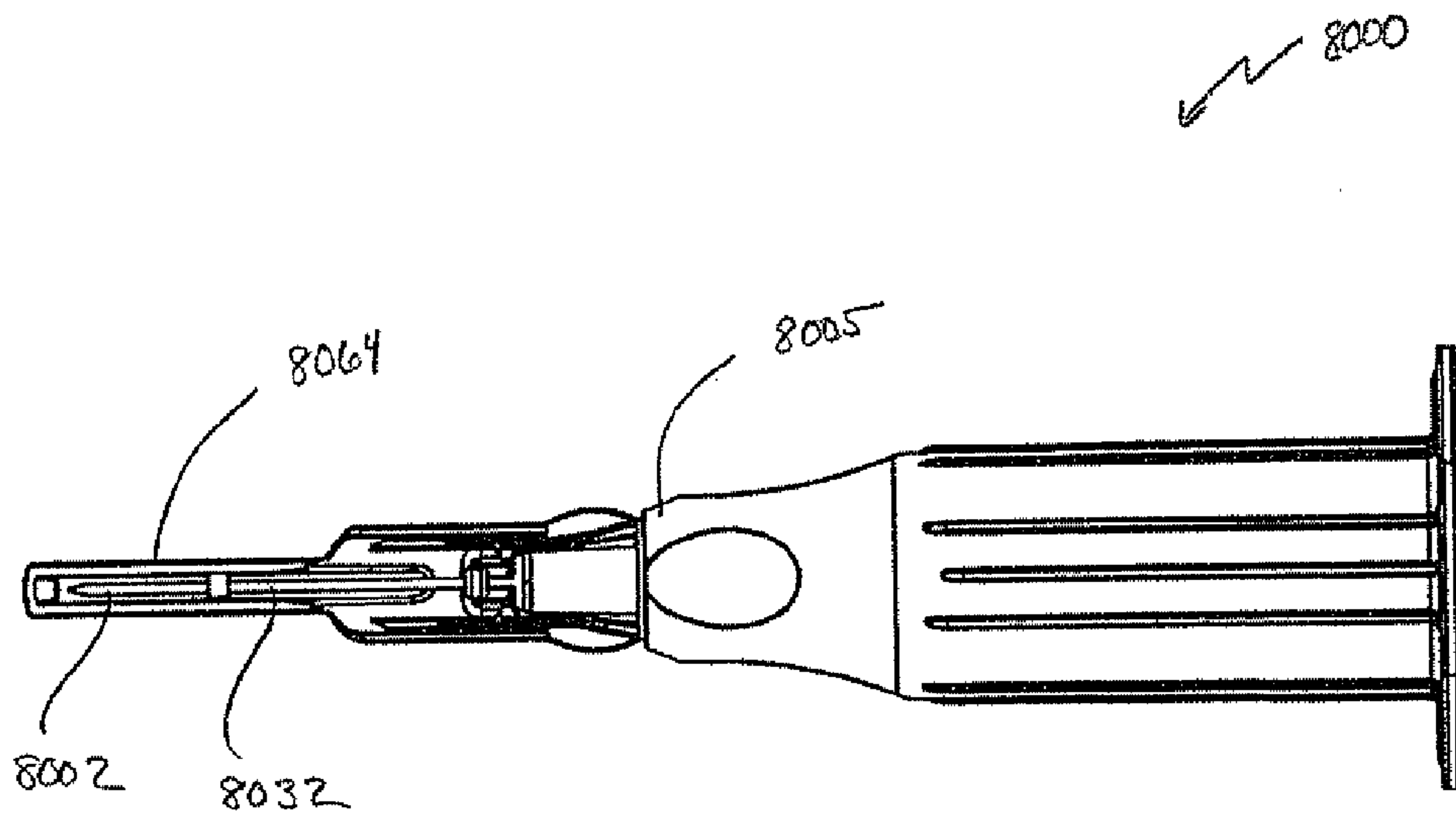


FIG. 62

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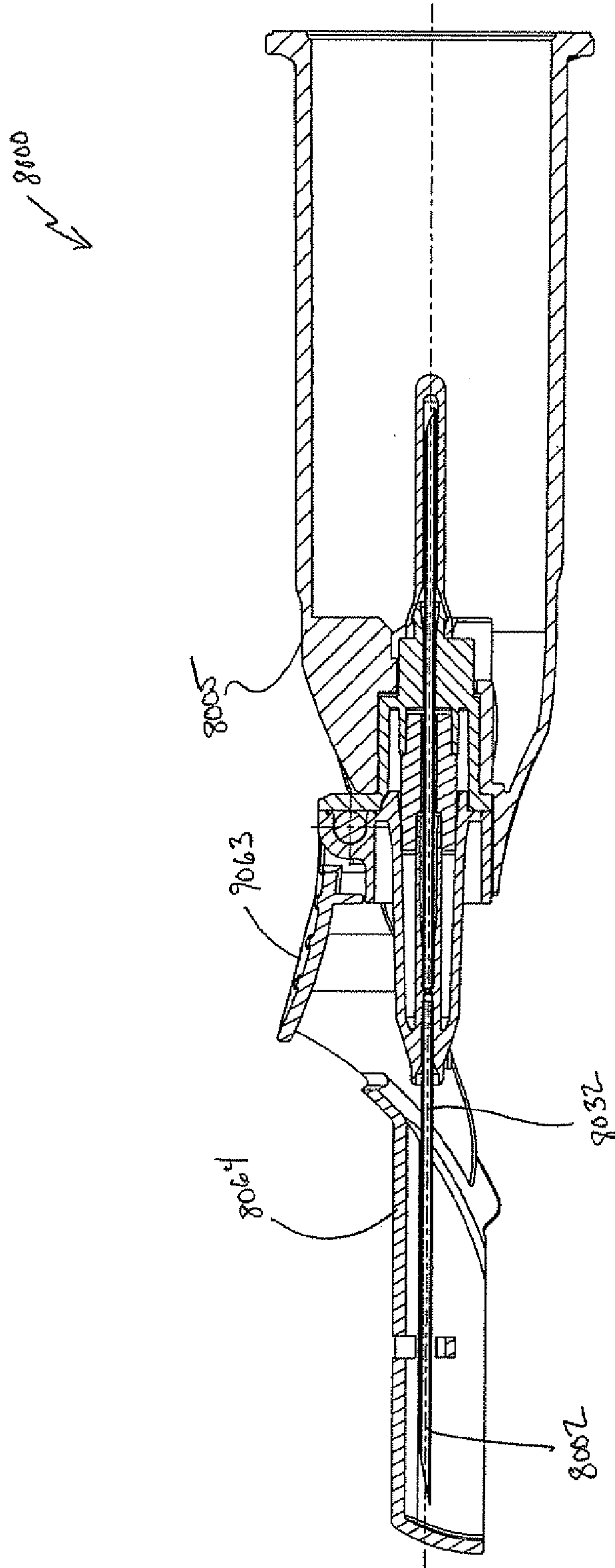


FIG. 63

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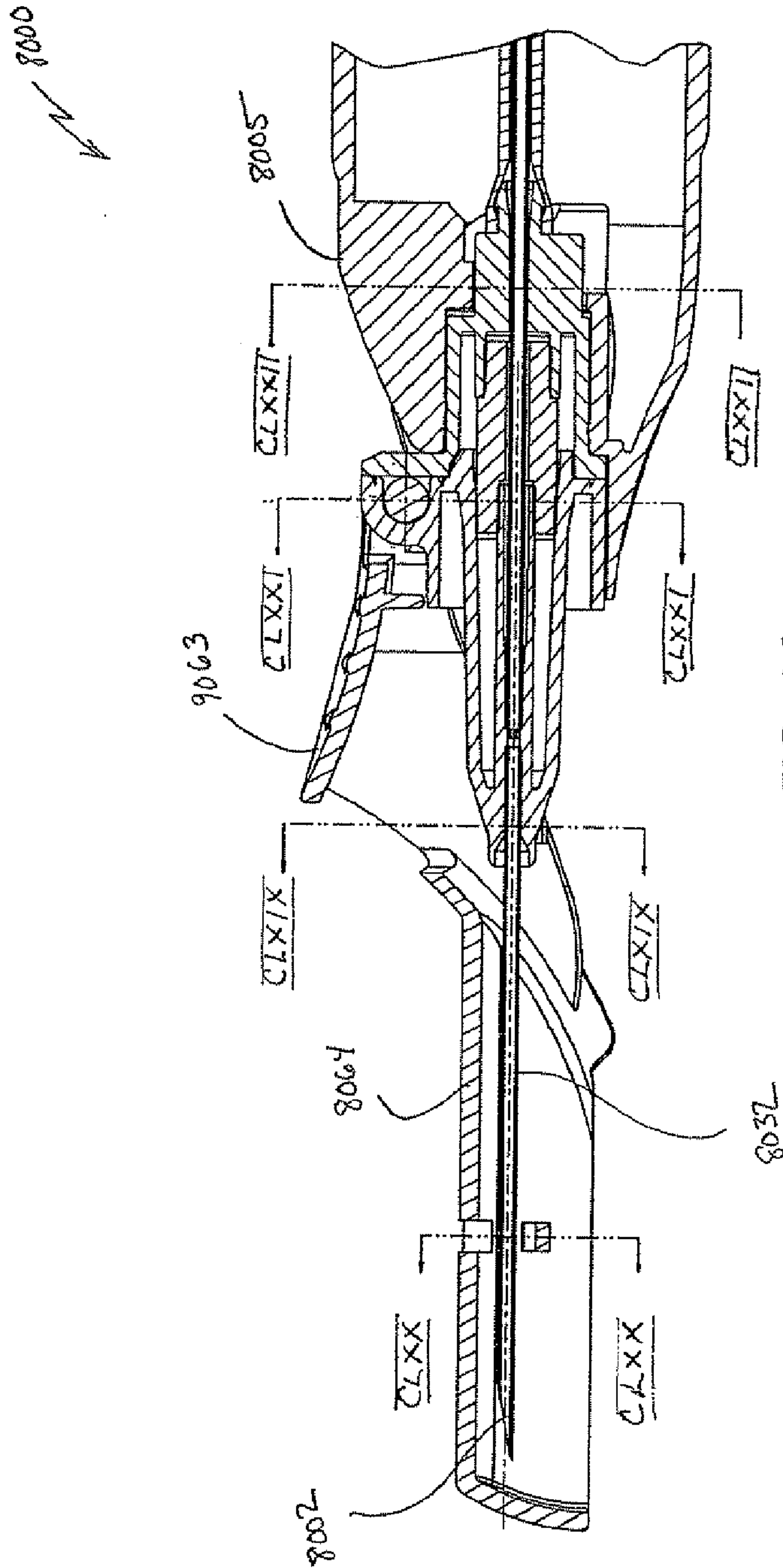


FIG. 64

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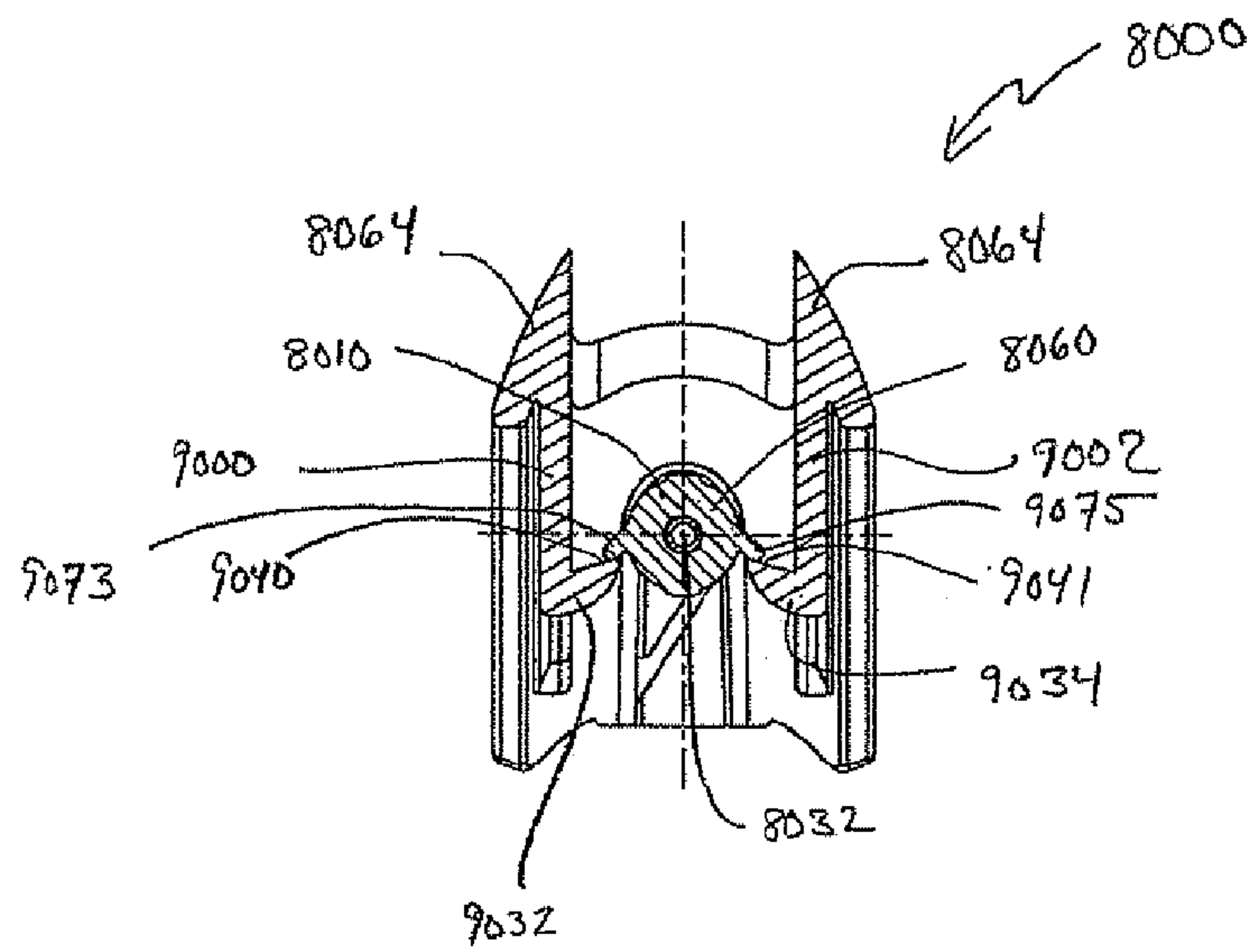


FIG. 65

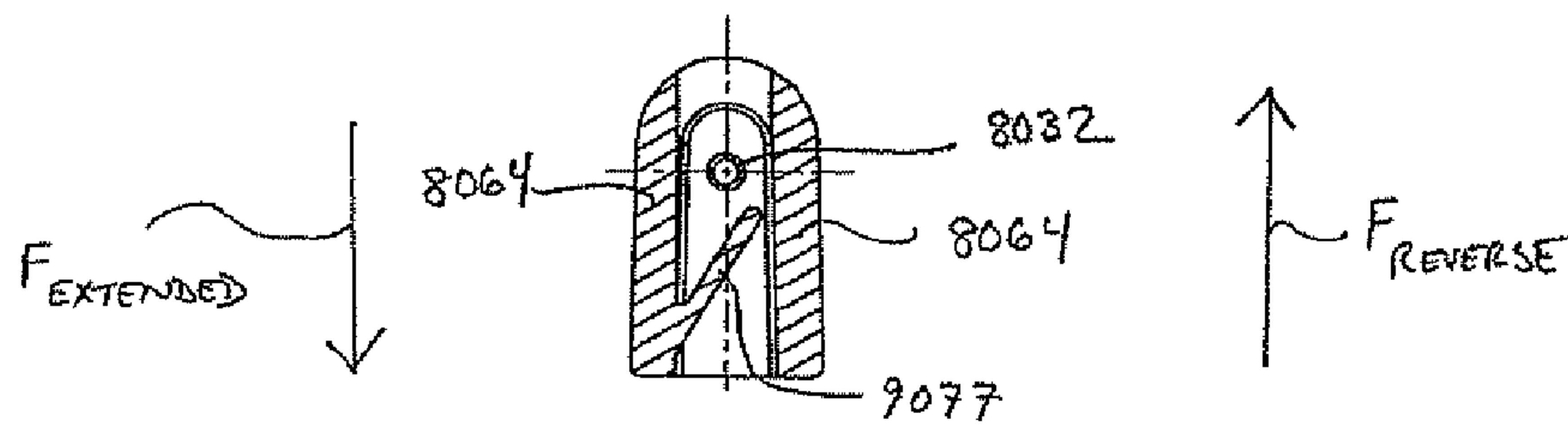


FIG. 66

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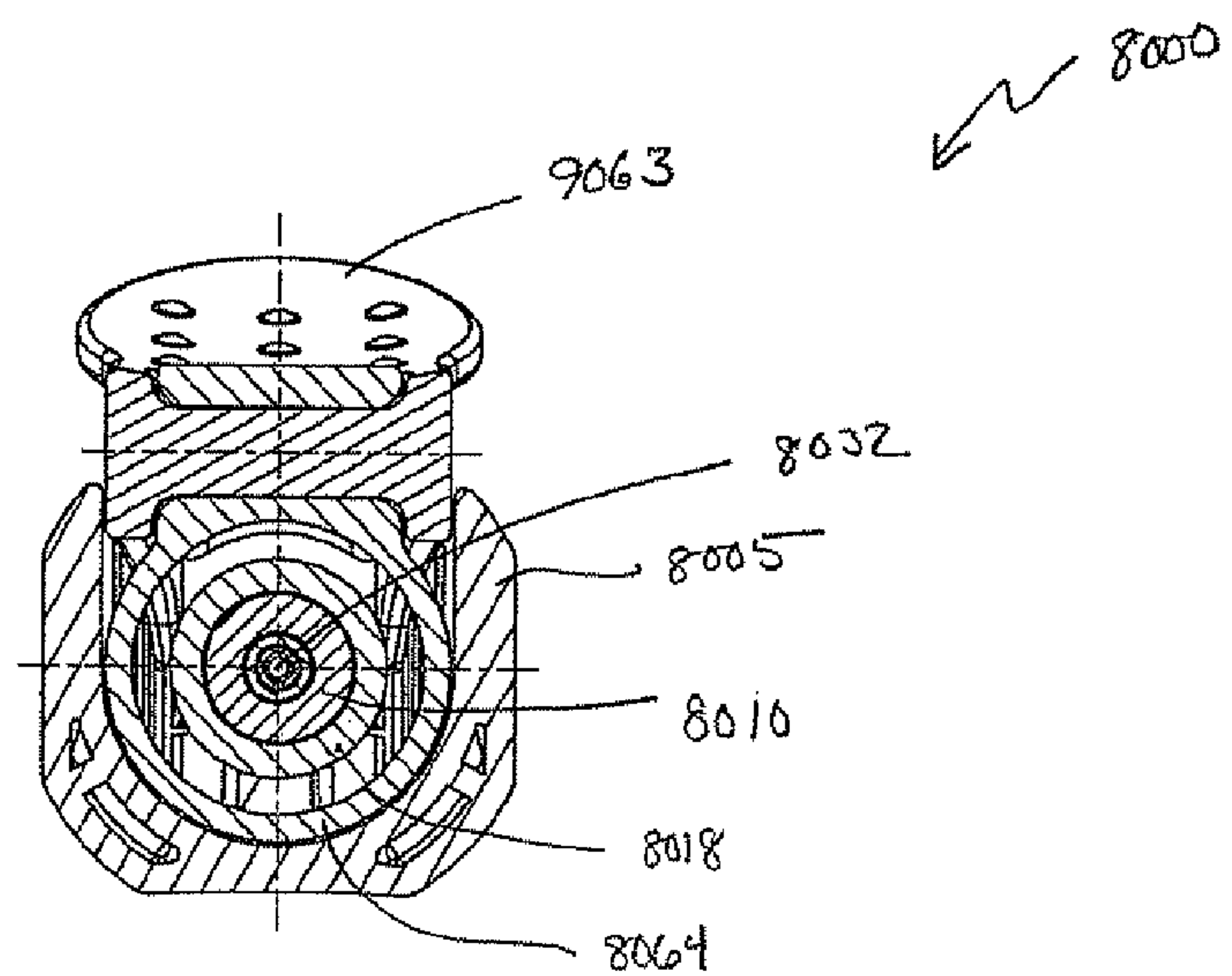


FIG. 67

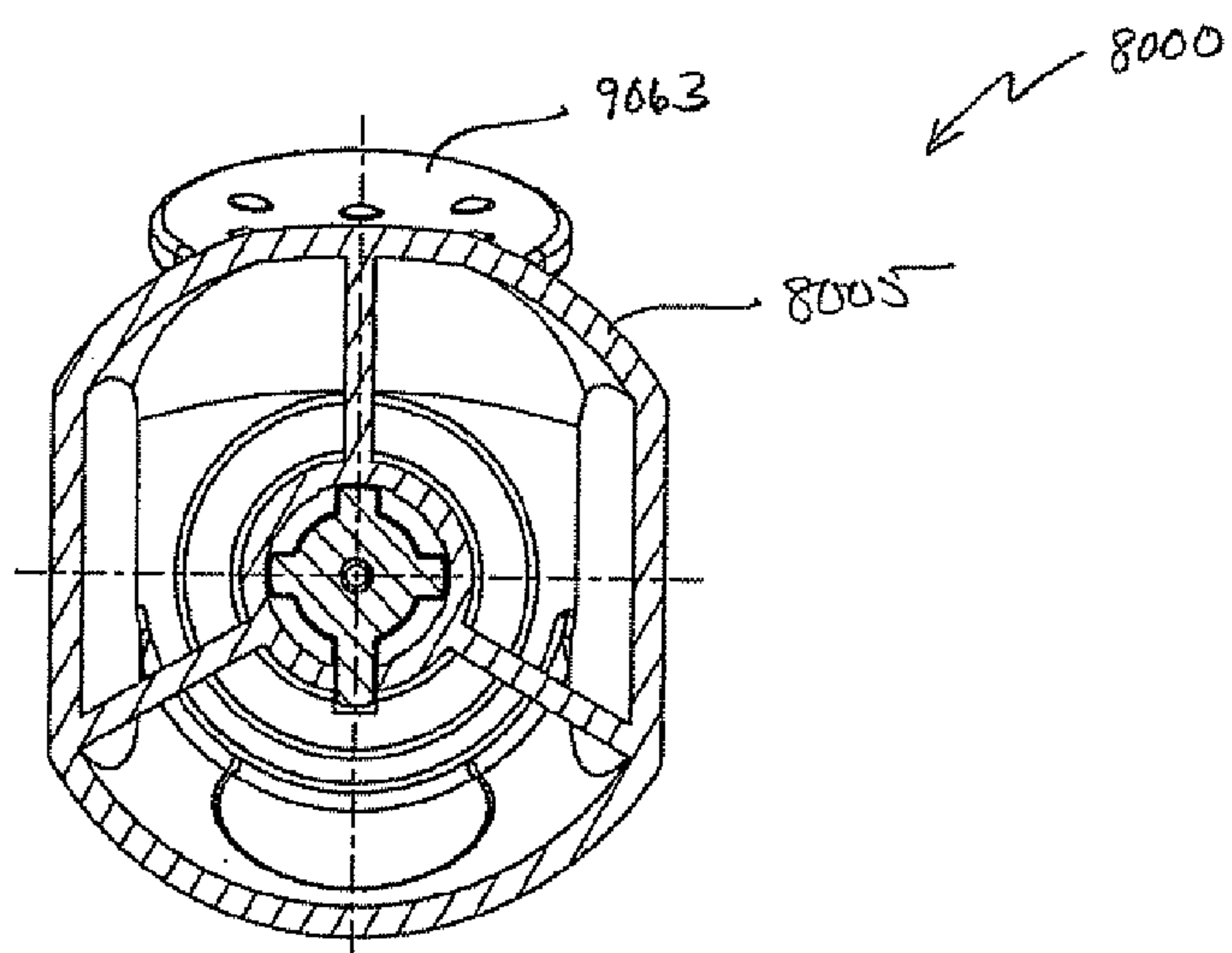


FIG. 68

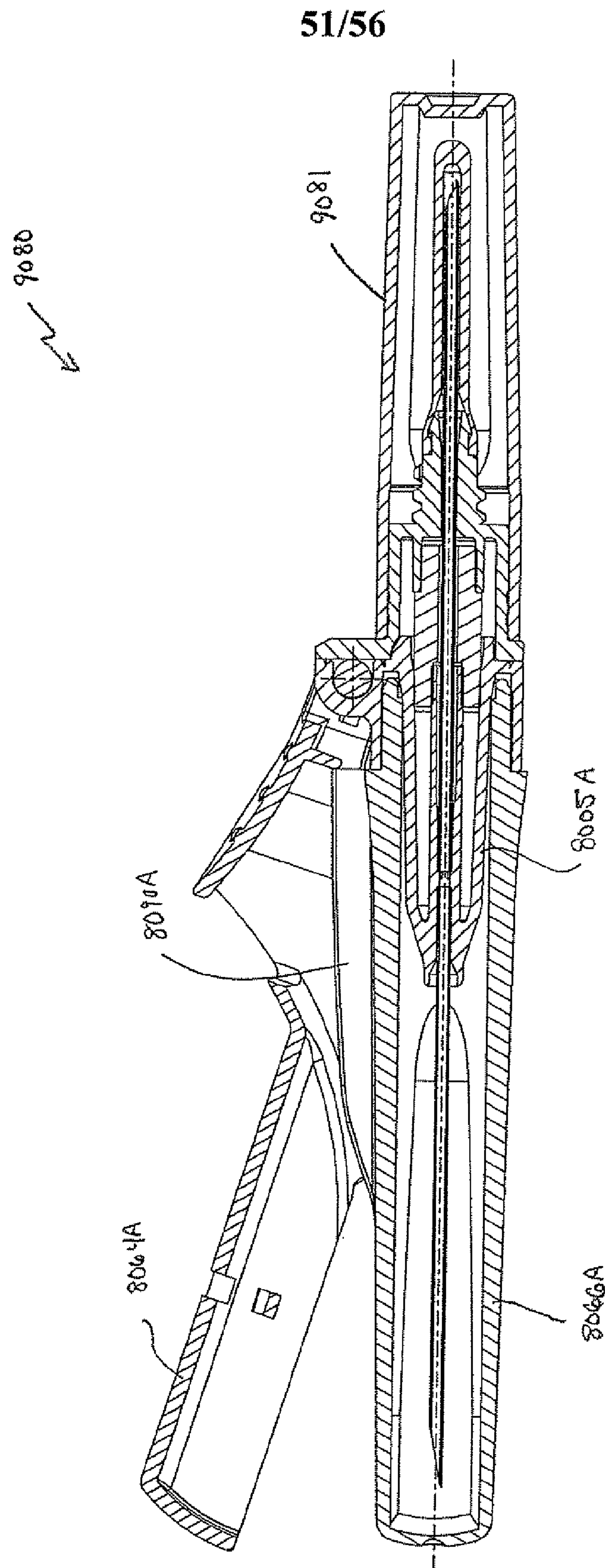
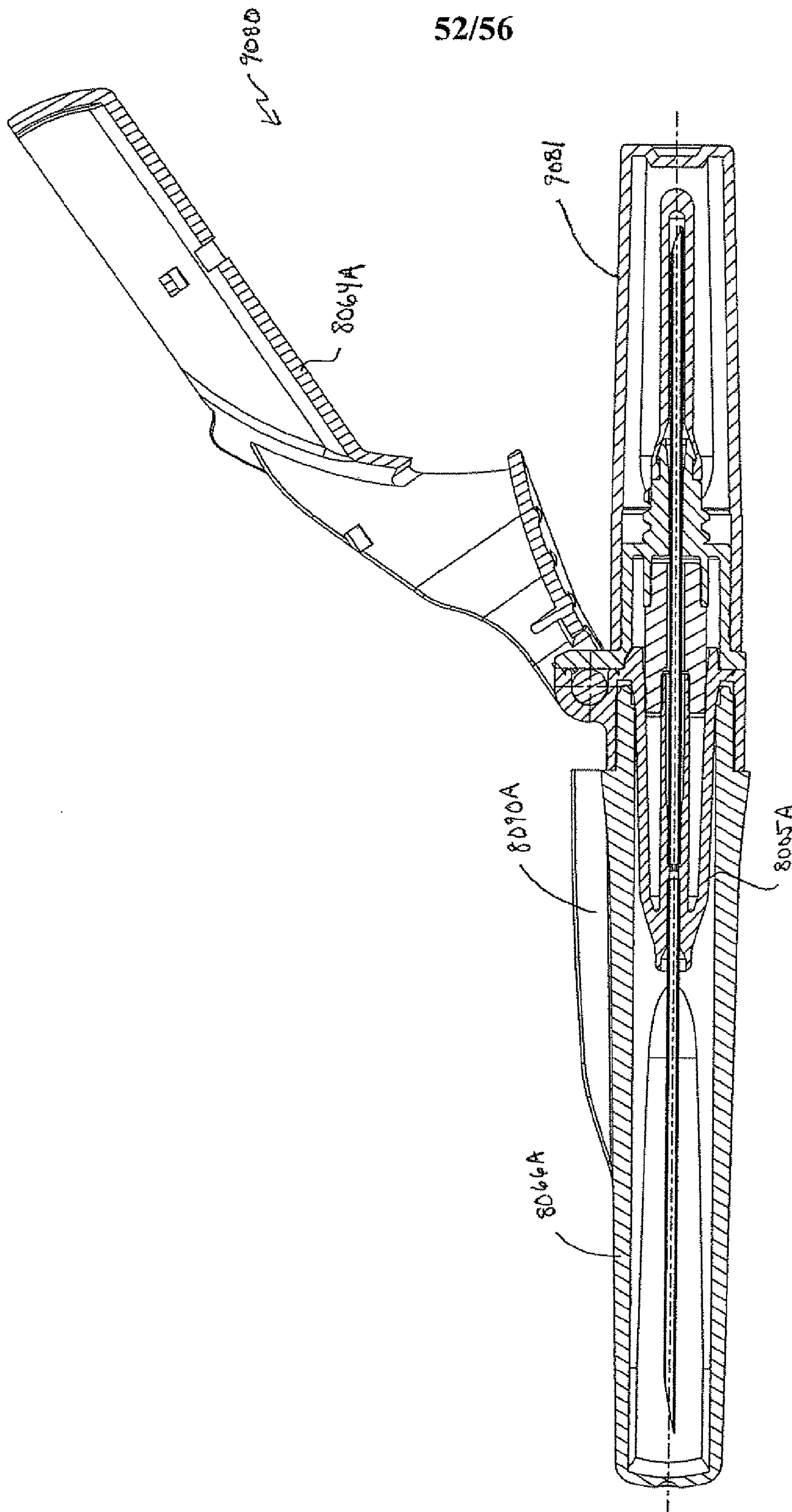


FIG. 69



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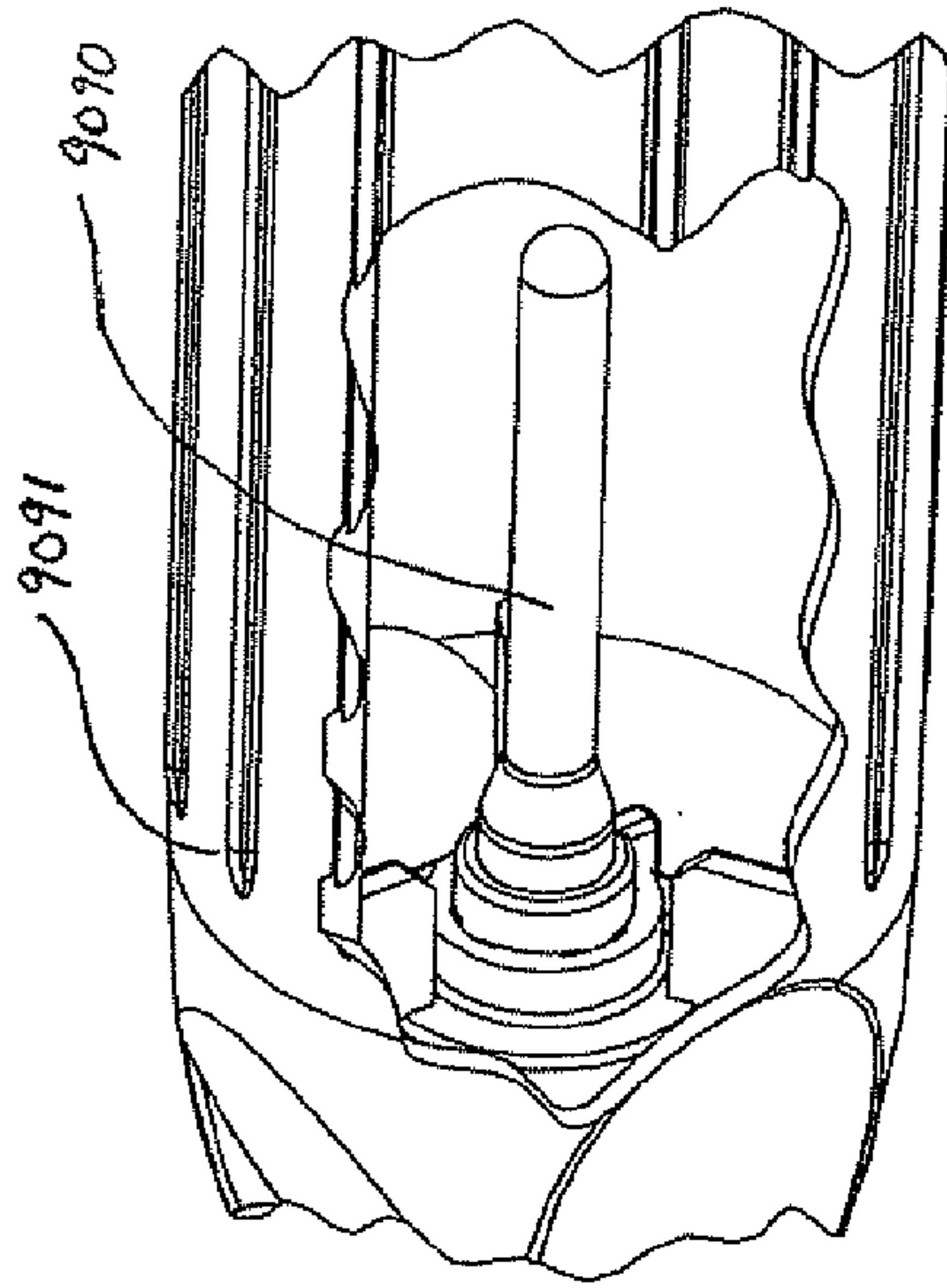


FIG. 72

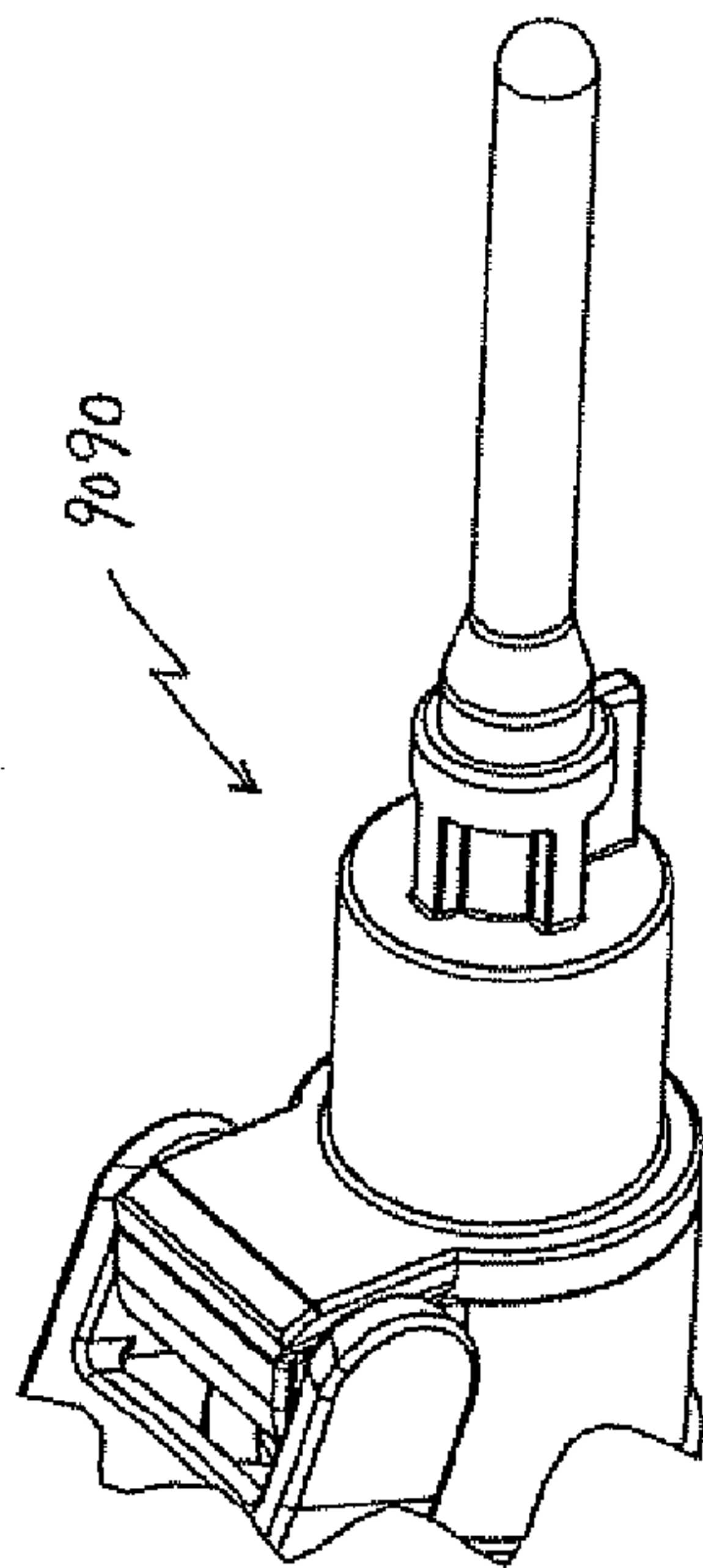


FIG. 71

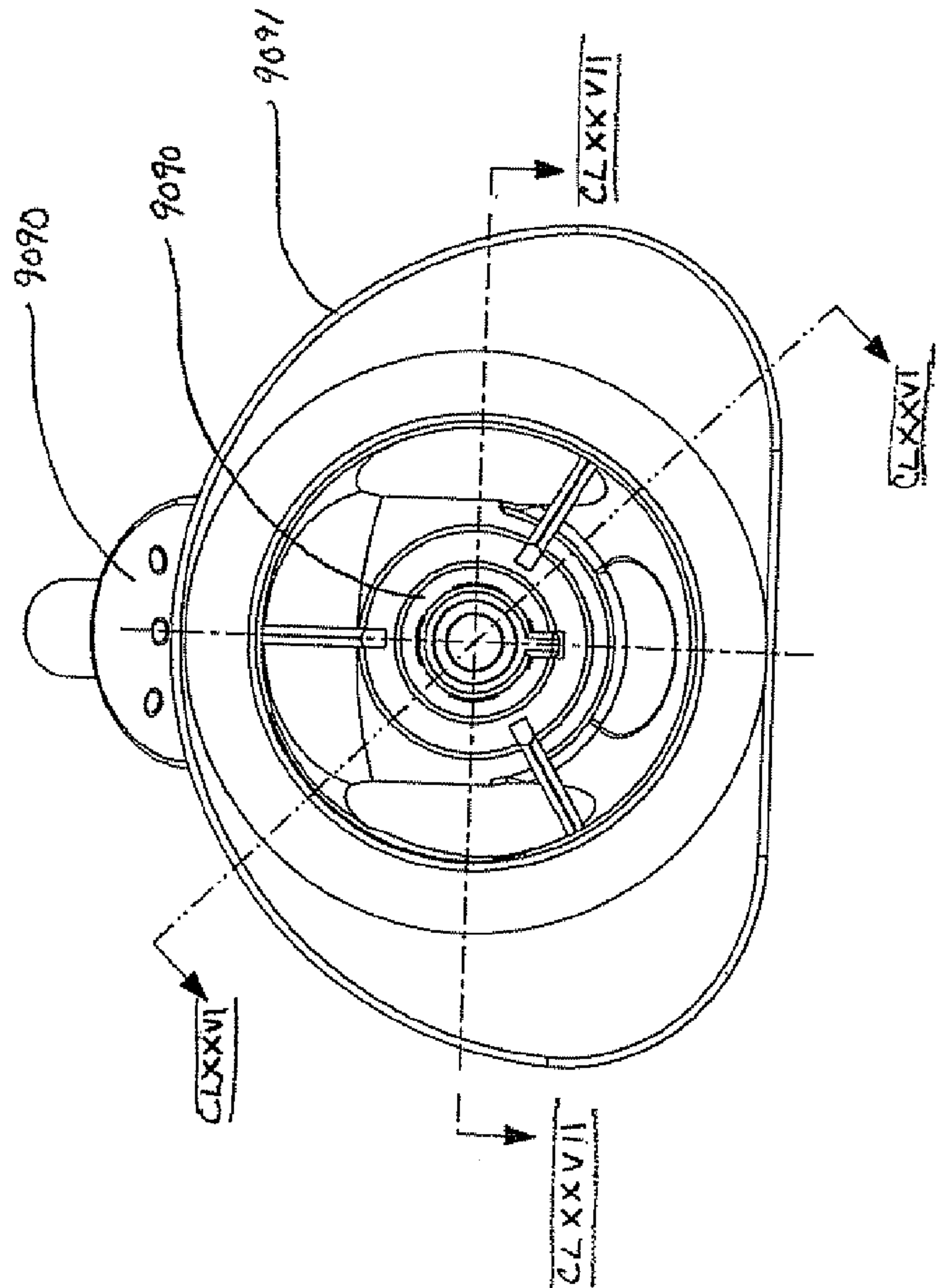


FIG. 73

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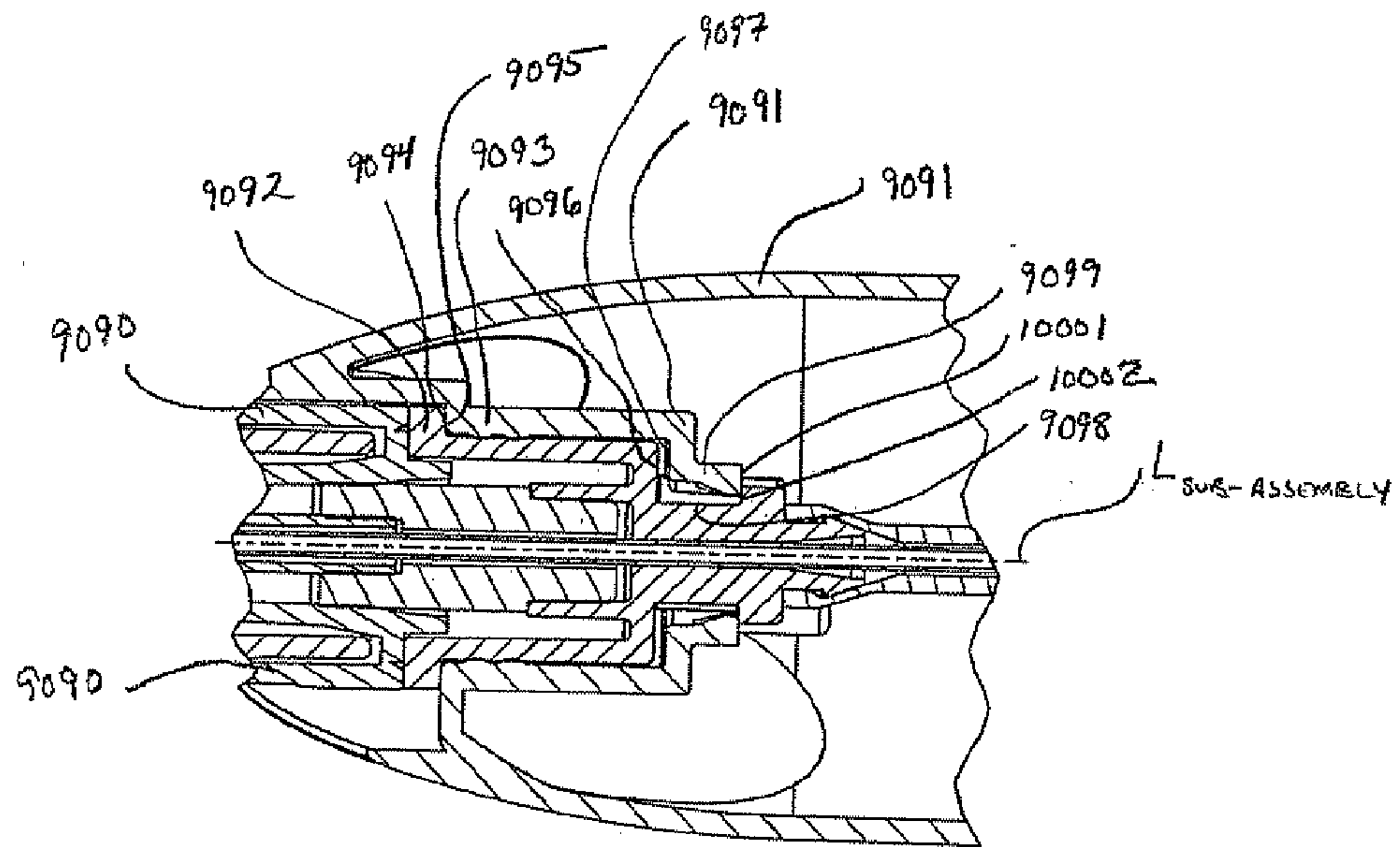


FIG. 74

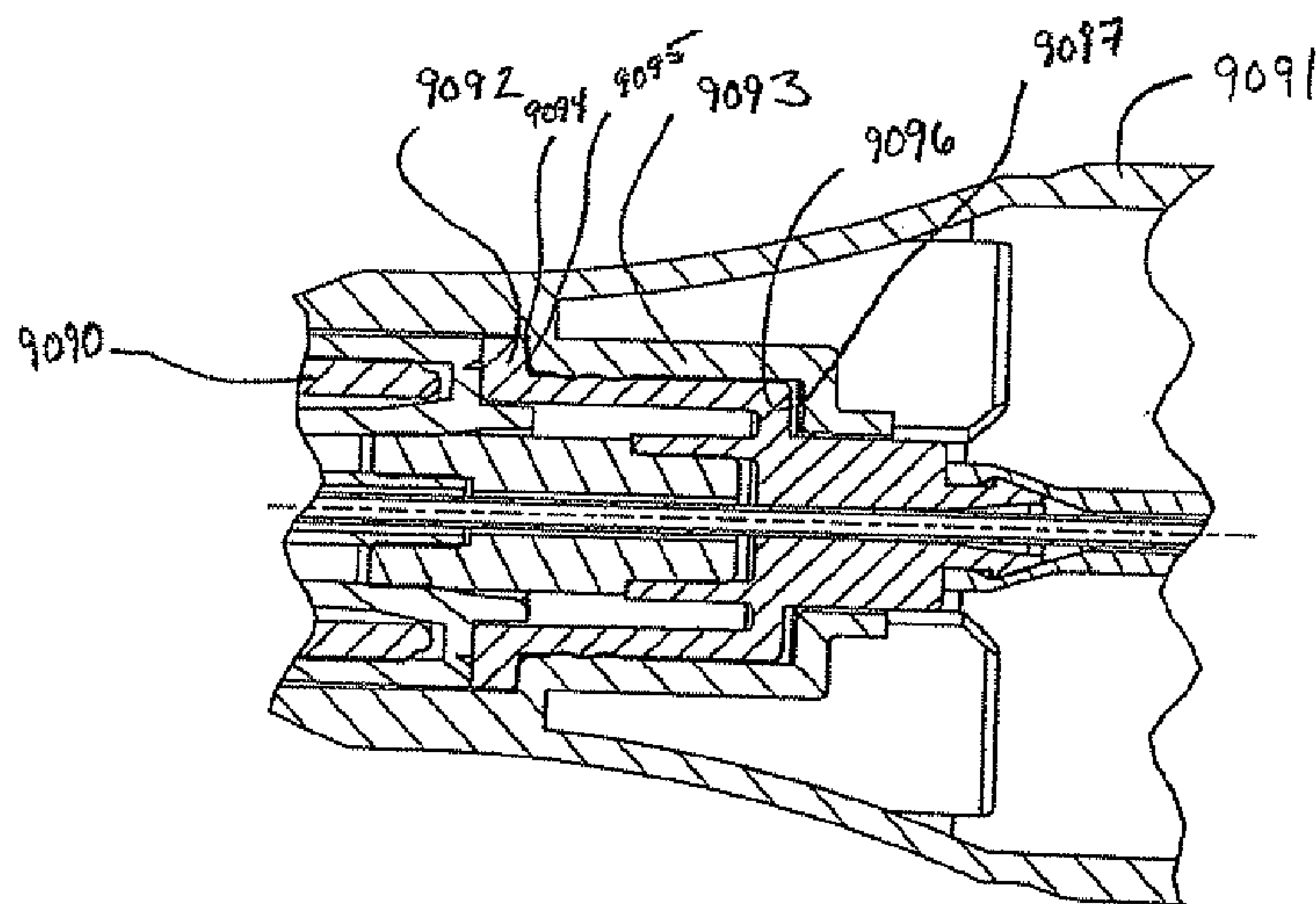


FIG. 75

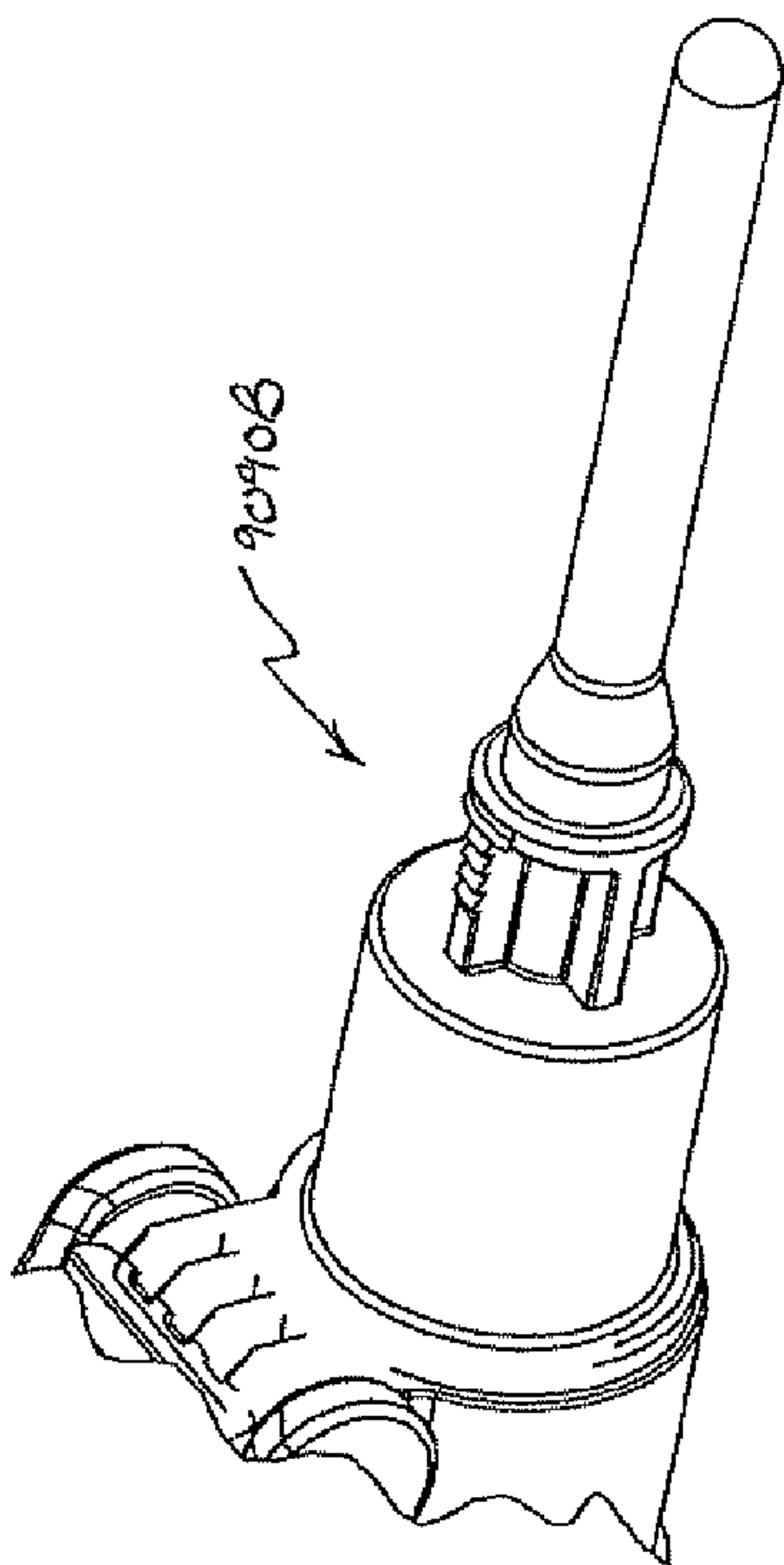


FIG. 76

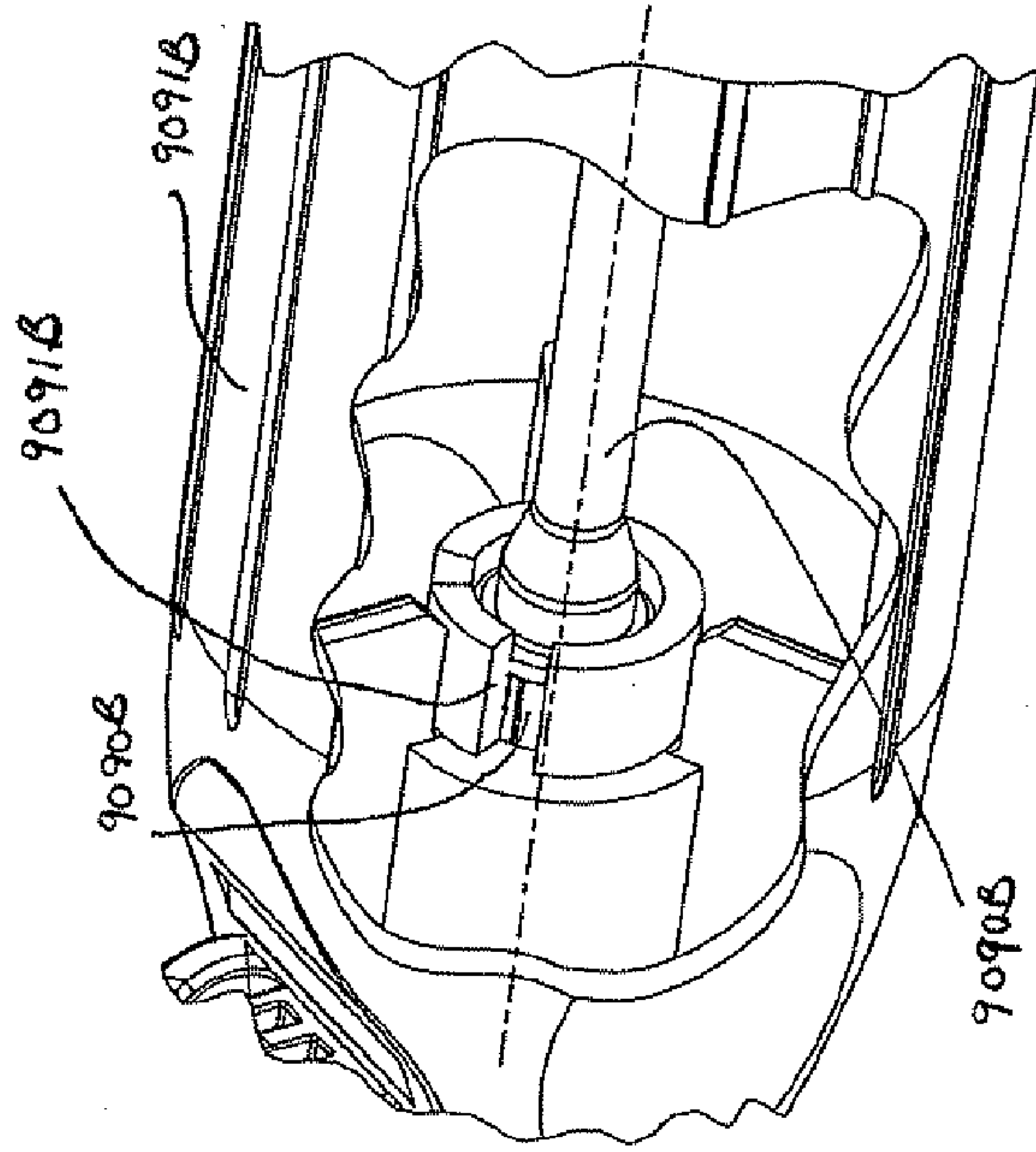


FIG. 77

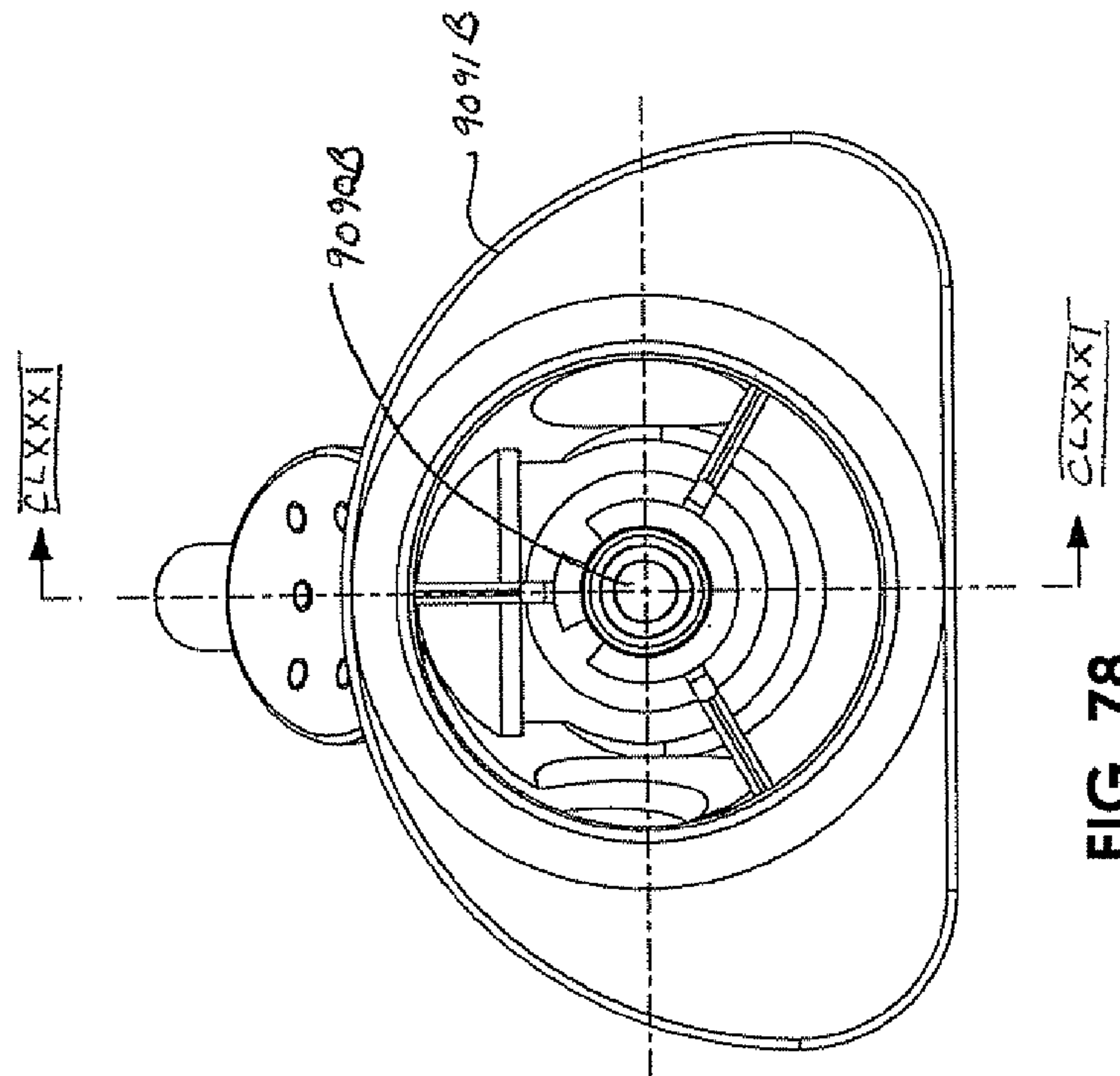


FIG. 78

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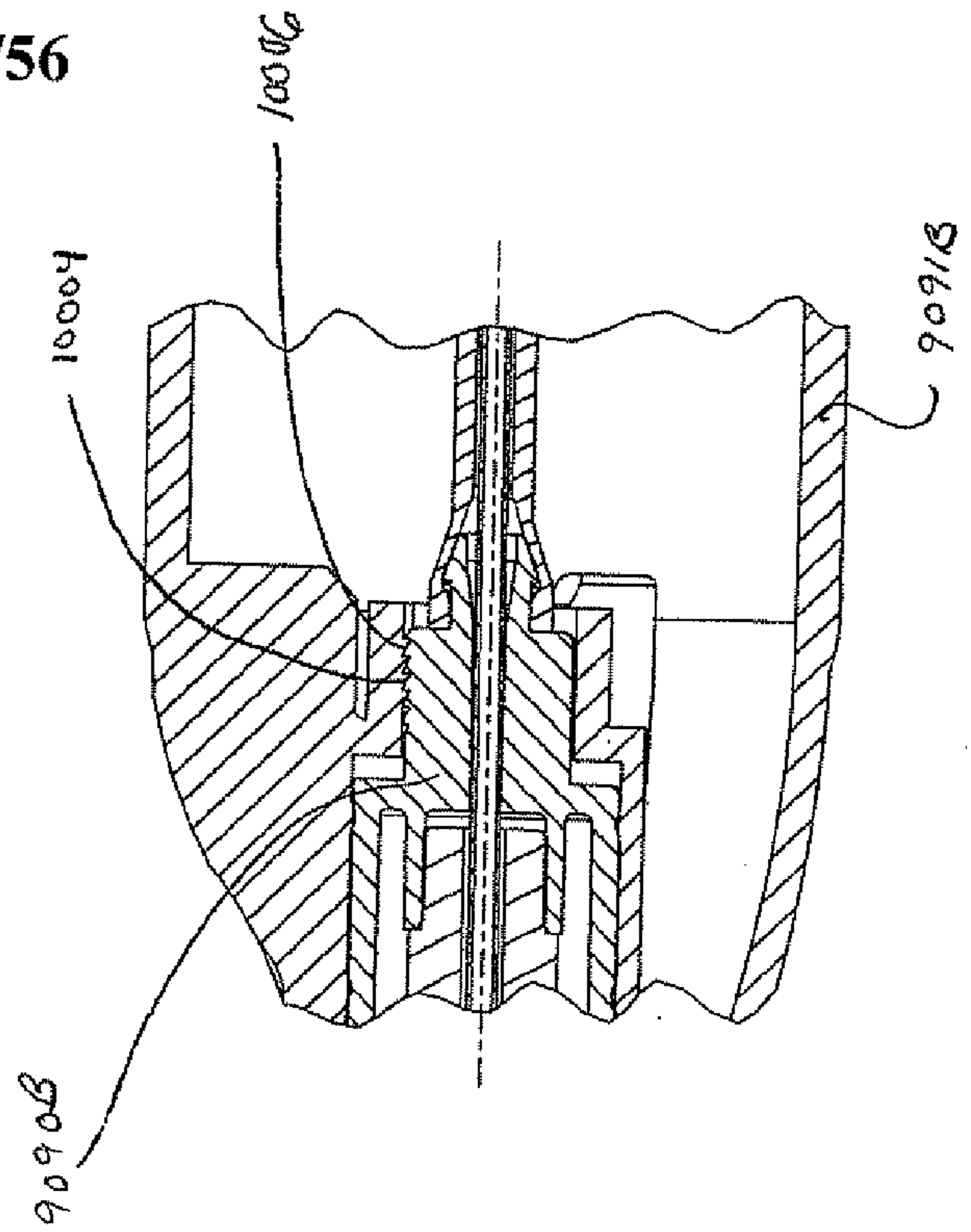


FIG. 79

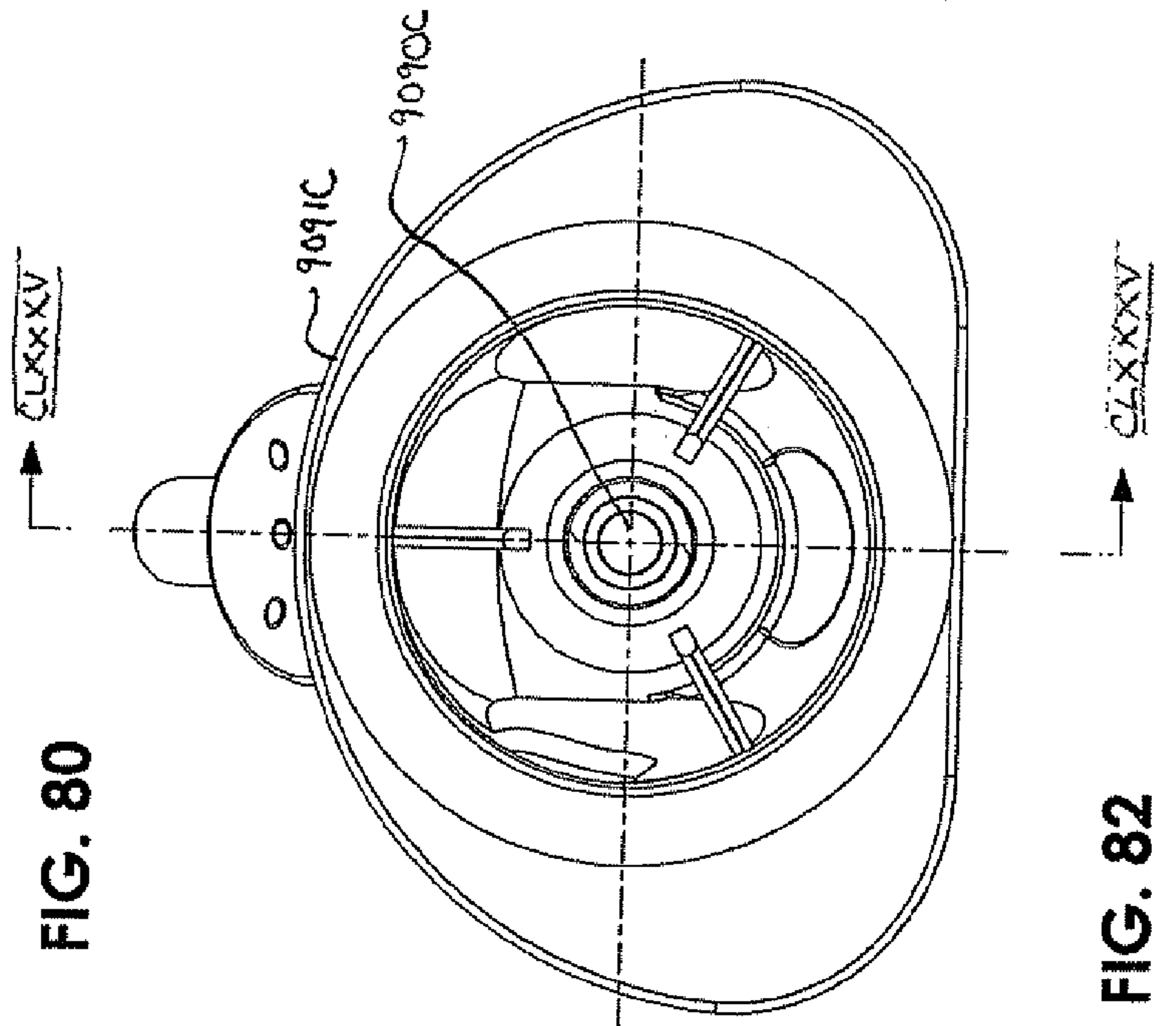
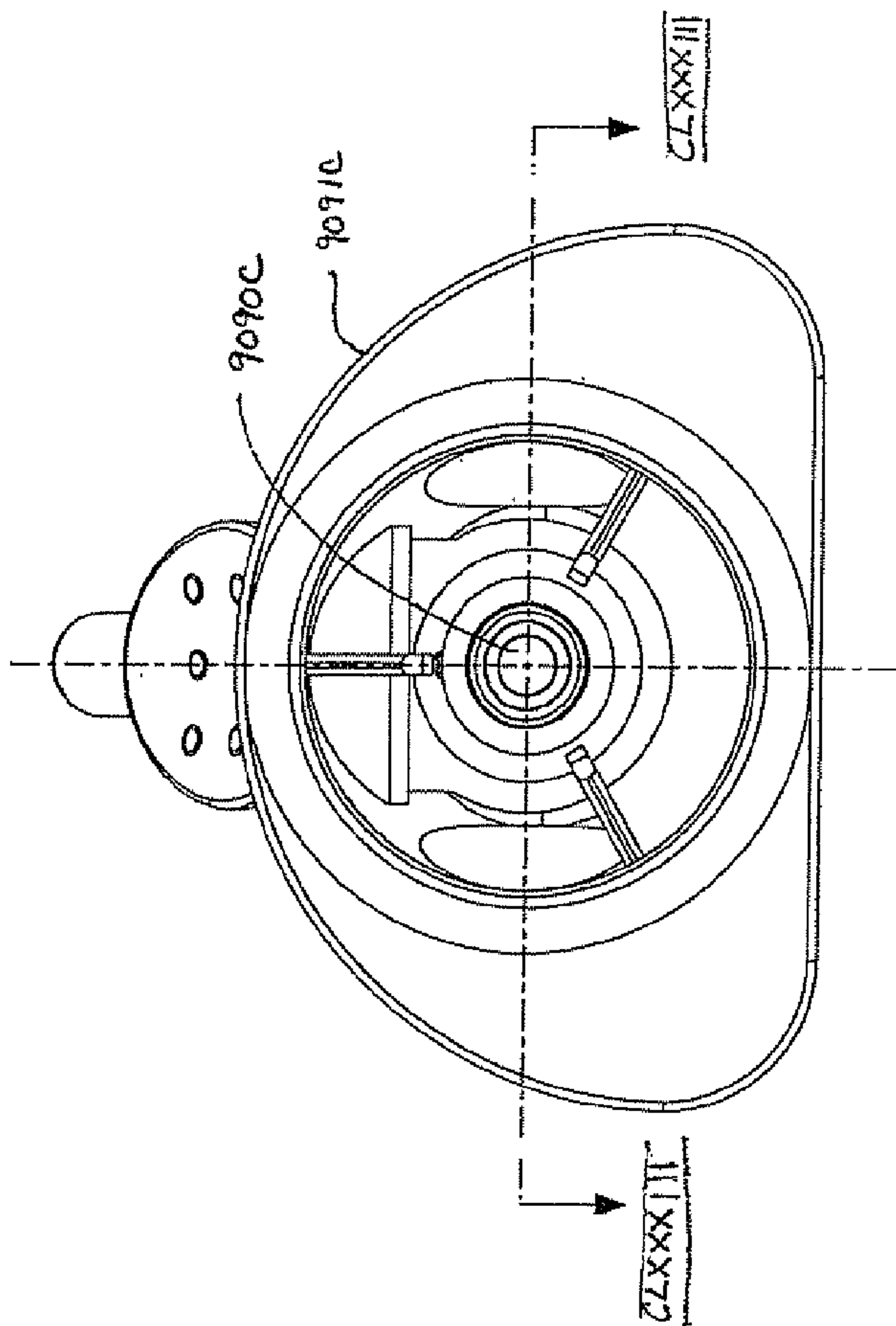


FIG. 82

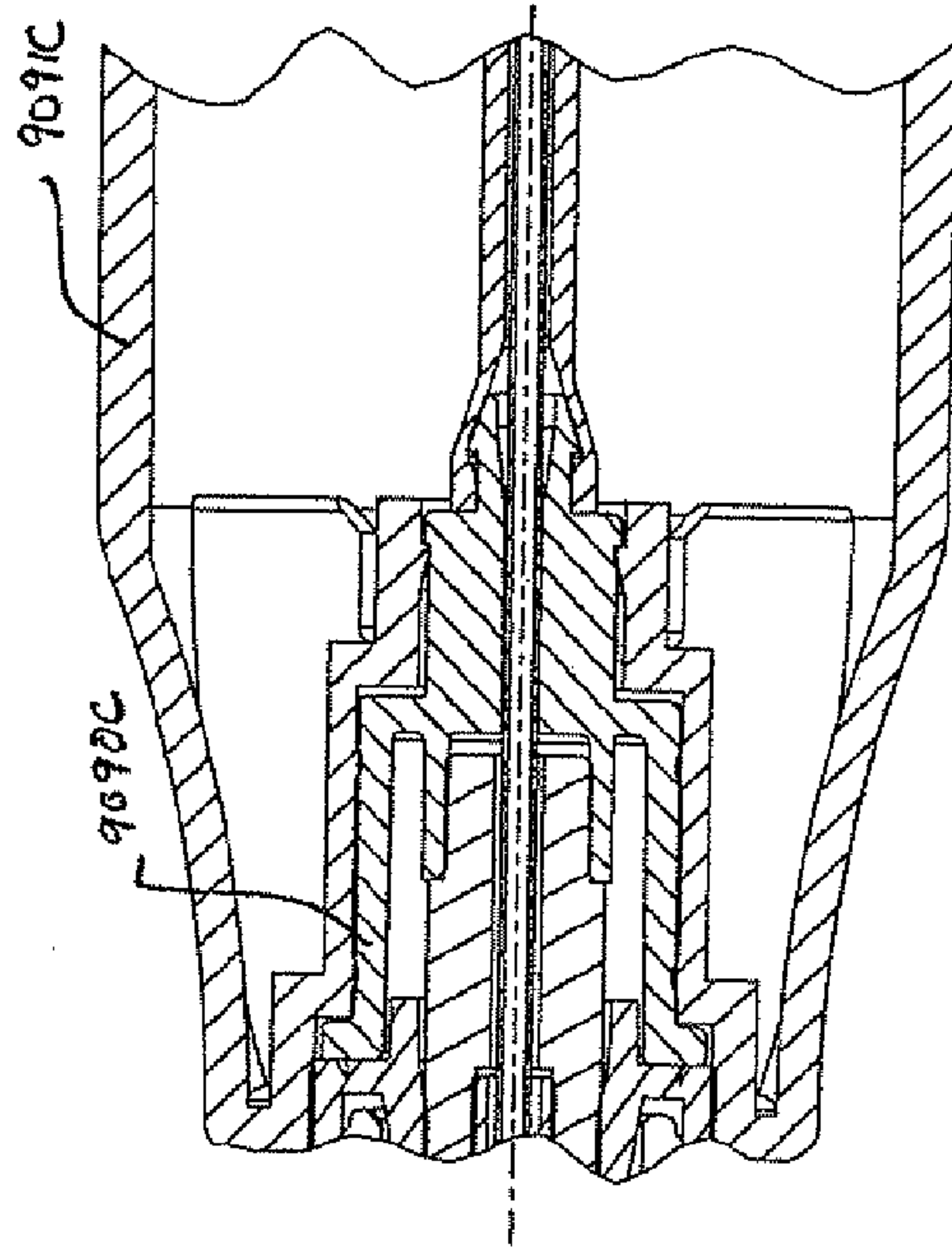


Fig. 18

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