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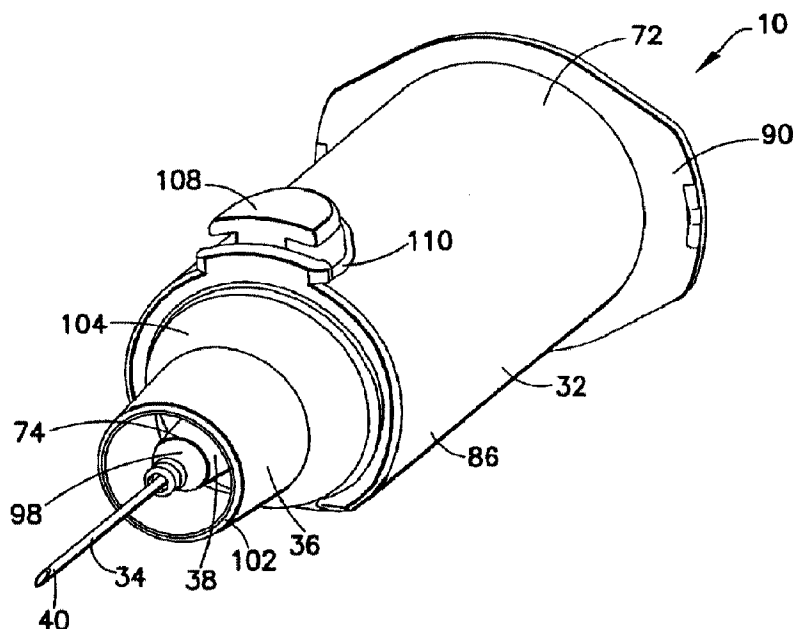
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(54) Titre : ASSEMBLAGE SECURISE DE COLLECTE DE SANG AVEC INDICATEUR

(54) Title: SAFETY BLOOD COLLECTION ASSEMBLY WITH INDICATOR



(57) Abrégé/Abstract:

A needle assembly, comprising: a housing having a flash chamber, and having a distal end and a proximal end engageable with a specimen collection container; a cannula, the patient end of the cannula projecting at least partially from the distal end of the

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housing, the cannula interior in fluid communication with the flash chamber; and a shield restrainably engaged with a portion of the housing and axially transitionable over the patient 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 shield. At least a portion of the flash chamber is visible through an observation window or a transparent or translucent portion of the shield when the shield is retracted.

ABSTRACT

A needle assembly, comprising: a housing having a flash chamber, and having a distal end and a proximal end engageable with a specimen collection container; a cannula, the patient end of the cannula projecting at least partially from the distal end of the housing, the cannula interior in fluid communication with the flash chamber; and a shield restrainably engaged with a portion of the housing and axially transitionable over the patient 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 shield. At least a portion of the flash chamber is visible through an observation window or a transparent or translucent portion of the shield when the shield is retracted.

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 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 application, a needle assembly includes a housing having a flash chamber, the housing having a distal end and a proximal end engageable with a specimen collection container. The needle assembly includes a cannula having a patient end, a non-patient end, and a sidewall extending therebetween defining a cannula interior. The patient end of the cannula projects at least partially from the distal end of the housing, and the cannula interior in fluid communication with the flash chamber. The needle assembly also includes a shield restrainably engaged with a portion of the housing. The shield is axially transitionable over the patient 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 shield. At least a portion of the flash chamber is visible in the retracted position.

[0011] The flash chamber may be visible through at least a portion of the shield in the retracted position. In one configuration, the portion of the shield through which the flash chamber is visible is transparent or translucent. In another configuration, the shield includes an observation window, and the flash chamber is visible through the observation window in the retracted position. The patient end of the cannula may include a bevel, and the position of the observation window within the shield may correspond to the orientation of the bevel.

[0012] In one configuration, the proximal end of the housing defines a specimen collection container receiving port. A removable seal may be disposed over a portion of the specimen

collection container receiving port. Alternatively, a rupturable seal may be disposed over a portion of the specimen collection container receiving port.

[0013] The shield may at least partially surround the patient end of the cannula in the extended position. Optionally, the shield is substantially circumferentially disposed about at least a portion of the cannula, and transition of the shield from the retracted position to the extended position telescopes the shield over the cannula. In certain embodiments, the sidewall of the cannula defines an opening extending between the cannula interior and the flash chamber. In other embodiments, the cannula includes at least two distinct needle portions, such as a patient needle in fluid communication with the flash chamber, and a non-patient needle in fluid communication with the flash chamber. The patient needle may project at least partially from the distal end of the housing, and the non-patient needle may extend in a substantially proximal direction from the patient cannula. In one embodiment, the specimen collection container engageable at the proximal end of the housing is a blood collection container.

[0014] The flash chamber may be integrally formed within a portion of the housing. In certain configurations, the housing includes a hub supporting at least a portion of the cannula, and the flash chamber is integrally formed with the hub. A porous vent may be disposed within the flash chamber such that the porous vent separates the flash chamber into a first chamber and a second chamber. The first chamber and the second chamber may be configured such that upon insertion of the patient end of the cannula into a patient, blood flows through the cannula and into the first chamber without sealing the porous vent. Upon application of an evacuated specimen collection container to the non-patient end of the cannula, blood may be drawn from the first chamber and air may be drawn from the second chamber, thereby establishing a negative pressure within the second chamber with respect to an external environment of the flash chamber. Alternatively, the flash chamber may include a vent mechanism in communication with an environment surrounding the needle assembly. The porous vent may include a plurality of pores for passage of blood therethrough from the first chamber to the second chamber. The vent mechanism may be a porous plug formed of a hydrophobic material, a one-way valve, or a porous plug formed of a hydrophilic material that swells on contact with blood.

[0015] The shielding portion of the shield may be restrainably engaged within an interior portion of the housing in the retracted position, and the shielding portion of the shield may extend from the interior portion of the housing in the extended position. The interior portion of the housing may be circumferentially disposed about a specimen collection container

receiving port defined within the housing, and the interior portion of the housing may be co-axial with the specimen collection container receiving port.

[0016] Optionally, the housing may include a first portion and a second portion, with the first portion distal to the second portion. The shield may be entirely disposed within an interior of the first portion in the retracted position, and a specimen collection container receiving port may be defined within the second portion. The first portion and the second portion of the housing may be co-formed. Alternatively, the first portion and the second portion of the housing may be separately formed and subsequently assembled. The first portion of the housing may define an observation window through which the shield is visible when in the retracted position.

[0017] In certain configurations, the shield may be biased against a portion of the housing by a spring when the shield is in the retracted position. The needle assembly may also include a release element transitionable from a first position to a second position, wherein the spring biases the shield to the extended position upon transition of the release element from the first position to the second position. The release element may be a push button. Optionally, the push button includes a member oriented in a substantially perpendicular orientation with respect to a transition axis of the shield. The member may also extend through at least a portion of the shield to maintain the shield against the bias of the spring in the first position. The member may also include a restraining portion and may define a passage region. The restraining portion may engage a shoulder of the shield in the restrained position, and the shoulder of the shield may pass through the passage region upon transition from the retracted position to the extended position. In one configuration, the passage region defines a substantially circular opening. Alternatively, the passage region defines a non-enclosed region. The needle assembly may also include a hub supporting at least a portion of the cannula, and the member of the push button may define an interior region at least partially surrounding a portion of the hub.

[0018] In another configuration, the needle assembly may also include a removable cannula guard engageable with a portion of the housing, and removable prior to transition of the shield from the retracted position to the extended position. A portion of the removable cannula guard may prevent transition of the release element from the first position to the second position. In another configuration, at least one of a distal portion of the housing and a proximal portion of the shield may include a barrier mechanism for preventing transition of the shield from the extended position to the retracted position. The barrier mechanism may include a tamper-resistant flange. The barrier mechanism may also include a locking tab

deflectable upon transition of the shield from the retracted position to the extended position, which substantially resists deflection once the shield is in the extended position. A portion of the housing may surround at least a portion of the locking tab. The portion of the housing surrounding the locking tab may substantially resist deflection of the locking tab.

[0019] The shield of the needle assembly may include a first portion for slideably engaging a portion of the housing along a longitudinal axis of the cannula, and a second portion at least partially surrounding a portion of the cannula in the extended position. The first portion of the shield may slideably engage an outer surface of the housing. In one configuration, the first portion of the shield includes a protrusion for slideably engaging a groove recessed within a portion of the outer surface of the housing. In another configuration, a glide mechanism includes a portion of the housing and portion of the first portion of the shield, wherein a portion of the safety shield is axially transitionable with respect to a portion of the housing.

[0020] The needle assembly may also include a hub disposed at least partially within a portion of the housing, such that the first portion of the shield slideably engages a portion of the hub along a longitudinal axis of the cannula. A first end of the first portion of the shield may slideably engage a portion of the hub, and a second end of the first portion may extend at least partially through a portion of an outer surface of the housing. The second end of the first portion may extend at least partially through a groove defined in the outer surface of the housing and extending along the longitudinal axis of the cannula. In another configuration, the second portion of the shield may surround at least a portion of the cannula.

[0021] The shield of the needle assembly may be transitioned from the retracted position to the extended position by force applied to the first portion of the shield in the direction along a longitudinal axis of the cannula. The second portion of the shield may also include restraining means for preventing transition of the shield from the extended position to the retracted position.

[0022] In one configuration, the second portion of the shield includes a depending arm transitionable from a first position in which the depending arm is substantially perpendicular to a longitudinal axis of the cannula, to a second position in which the depending arm is oriented substantially along the longitudinal axis of the cannula. The depending arm may include a first portion and a second portion, with the first portion and the second portion pivotally or hingedly connected to the first portion. The shield may include a depending arm, including a plurality of extendable segments, wherein the extendable segments are substantially laterally oriented in the retracted position and substantially longitudinally

oriented in the extended position. The plurality of extendable segments may be pivotally or hingedly connected therebetween. The depending arm may be oriented on a first side of the cannula, and a second depending arm may be oriented on a second side of the cannula, with the second side being substantially opposite the first side.

[0023] In another embodiment of the present invention, a blood collection assembly includes a housing including a flash chamber, the housing having a distal end and a proximal end, and a blood collection container holder adjacent the proximal end. The blood collection assembly includes a patient cannula having a cannula tip and defining a patient cannula interior. The patient cannula projecting at least partially from the distal end of the housing, and the patient cannula interior is in fluid communication with the flash chamber. The blood collection assembly also includes a non-patient cannula, defining a non-patient cannula interior, extending in a substantially proximal direction from the patient cannula within at least a portion of the blood collection container holder. The non-patient cannula interior is in fluid communication with the flash chamber. The blood collection assembly also includes a shield restrainably engaged with a portion of the housing. The shield is axially transitionable over the patient cannula from a retracted position in which the patient end is exposed, to an extended position in which the cannula tip is shielded by at least a portion of the shield. At least a portion of the flash chamber is visible in the retracted position.

[0024] The flash chamber may be visible through at least a portion of the shield in the retracted position. The blood collection assembly may further include a removable or rupturable seal disposed over at least a portion of the blood collection container holder. In one configuration, the shield may be biased against a portion of the housing by a spring in the retracted position. The blood collection assembly may further include a release element transitionable from a first position to a second position, wherein the spring transitions the shield to the extended position upon transition of the release element from the first position to the second position. The shield may also include a first portion for slideably engaging a portion of the housing along the longitudinal axis of the patient cannula, and a second portion at least partially surrounding a portion of the patient cannula in the extended position.

[0025] In yet another embodiment of the present invention, a needle assembly includes a housing having a flash chamber, the housing having a distal end, and a proximal end engageable with a specimen collection container. The needle assembly includes a cannula having a patient end, a non-patient end, and a sidewall extending therebetween defining a cannula interior. The patient end of the cannula projects at least partially from the distal end of the housing, and the cannula interior is in fluid communication with the flash chamber.

The needle assembly also includes a shield restrainably engaged with a portion of the housing. The shield is axially transitionable over the patient 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 shield. At least a portion of the flash chamber is visible in the retracted position. The needle assembly also includes a spring element biased between a portion of the housing and a portion of the shield in the retracted position. The needle assembly further includes a release element transitionable from a first position to a second position. The release element restrains the shield against the bias of the spring in the restrained position, and transition of the release element from the first position to the second position transitions the shield from the retracted position to the extended position.

[0026] The release element may be a push button. In certain configurations, at least a portion of the flash chamber is visible through a portion of the shield in the retracted position. In other configurations, the proximal end of the housing includes a blood collection container holder, and the non-patient end of the cannula extends at least partially within an interior of the blood collection container holder.

[0027] In another embodiment of the present invention, a blood collection assembly includes a housing having a flash chamber, the housing having a distal end and a proximal end, and a blood collection container holder adjacent the proximal end. The blood collection assembly includes a patient cannula having a cannula tip and defining a patient cannula interior. The patient cannula projects at least partially from the distal end of the housing, and the patient cannula interior is in fluid communication with the flash chamber. The blood collection assembly also includes a non-patient cannula, defining a non-patient cannula interior. The non-patient cannula extends in a substantially proximal direction from the patient cannula within at least a portion of the blood collection container holder. The non-patient cannula interior is in fluid communication with the flash chamber. The blood collection assembly also includes a shield restrainably engaged with a portion of the housing. The shield is axially transitionable over the patient cannula from a retracted position in which the cannula tip is exposed, to an extended position in which the cannula tip is shielded by at least a portion of the shield. At least a portion of the flash chamber is visible through the shield in the retracted position. The blood collection assembly also includes a spring element biased between a portion of the shield and a portion of the housing in the retracted position. The blood collection assembly further includes a push button engaged with a portion of the spring, and transitionable from a first position to a second position. The spring transitions the

shield to the extended position upon transition of the release element from the first position to the second position.

[0028] In yet another embodiment of the present invention, a blood collection assembly includes a housing having a flash chamber, the housing having a distal end, and a proximal end engageable with a specimen collection container. The blood collection assembly includes a cannula having a patient end, a non-patient end, and a sidewall extending therebetween defining a cannula interior. The patient end of the cannula projects at least partially from the distal end of the housing, and the cannula interior is in fluid communication with the flash chamber. The blood collection assembly also includes a shield, having an observation window, and engaged with a portion of the housing. The shield is transitionable from a first position to a second position with respect to the housing, wherein the shield is disposed over the patient end in the second position, and wherein at least a portion of the flash chamber is viewable through the observation window in the first position.

[0029] The shield may be axially transitionable over the cannula from a retracted position to an extended position. Alternatively, the shield may be pivotally transitionable over the patient cannula from a retracted position to an extended position.

[0030] In yet another embodiment of the present invention, a blood collection assembly include a housing having a flash chamber, the housing having a distal end, and a proximate end engageable with a specimen collection container. The blood collection assembly includes a cannula having a patient end, a non-patient end, and a sidewall extending therebetween defining a cannula interior. The patient end of the cannula projects at least partially from the distal end of the housing, and the cannula interior is in fluid communication with the flash chamber. The blood collection assembly also includes a shield engaged with a portion of the housing. The shield is transitionable from a first position to a second position with respect to the housing. The flash chamber is visible in the first position, and the shield is disposed over the patient end of the cannula in the second position. The locking structure engages at least a portion of the flash chamber in the second position. In one configuration, the locking structure of the shield engages a portion of the housing distal to the flash chamber.

[0031] In one embodiment, the housing of a needle assembly includes a base portion having a sidewall defining an opening, and a hub portion engageable with the base portion. A portion of the hub portion may be receivable through the opening. In another configuration, the sidewall of the base portion defines a first opening and a second opening aligned along a common axis. The hub portion may include a first portion and a second

portion aligned along a common axis. The first portion may be receivable through the first opening and the second portion is receivable through the second opening. In yet another configuration, the hub portion may be insertable within an interior of the base portion through a proximal end of the base portion. At least one of the first portion and the second portion may be deflectable against a portion of an interior wall of the base portion during insertion of the hub portion into the base portion.

[0032] In another embodiment, the housing of a needle assembly may include a forward hub portion and a rear hub portion connectable with the forward hub portion, and defining the flash chamber therebetween. The rear hub portion may be connectable with the forward hub portion through at least a portion of a specimen collection container holder. Alternatively, the rear hub portion may define a specimen collection container receiving port therein.

DESCRIPTION OF THE DRAWINGS

[0033] **FIG. 1** is a perspective view of a needle assembly having a safety shield in the retracted position in accordance with an embodiment of the present invention.

[0034] **FIG. 2** is a perspective view of the needle assembly of **FIG. 1** having a safety shield in the extended position.

[0035] **FIG. 3** is an enlarged perspective view of the push button element of a needle assembly in accordance with an embodiment of the invention.

[0036] **FIG. 4** is an enlarged perspective view taken from section 4 of **FIG. 2**, showing the channel of the safety shield in accordance with an embodiment of the invention.

[0037] **FIG. 5** is a side view of the needle assembly of **FIG. 1** having a safety shield in the retracted position.

[0038] **FIG. 6** is a side view of the needle assembly of **FIG. 2** having a safety shield in the extended position.

[0039] **FIG. 7** is a side cross-sectional view of the needle assembly of **FIG. 1** having a safety shield in the retracted position.

[0040] **FIG. 8** is a side cross-sectional view of the needle assembly of **FIG. 2** having a safety shield in the extended position.

[0041] **FIG. 9** is a top cross-sectional view of the needle assembly of **FIG. 1** having a safety shield in the retracted position and showing a locking mechanism in accordance with an embodiment of the present invention.

[0042] **FIG. 10** is a top cross-sectional view of the needle assembly of **FIG. 2** having a safety shield in the extended position and showing a locking mechanism.

[0043] **FIG. 11** is a perspective view of a needle assembly having a flash chamber in accordance with a further embodiment of the present invention.

[0044] **FIG. 12** is a rear perspective view of the needle assembly having a flash chamber of **FIG. 11**.

[0045] **FIG. 13** is an exploded view of the needle assembly having a flash chamber of **FIG. 11**.

[0046] **FIG. 14A** is a cross-sectional view of the needle assembly having a flash chamber of **FIG. 11**.

[0047] **FIG. 14B** is an enlarged cross-sectional view of a portion of the needle assembly of **FIG. 14A**.

[0048] **FIG. 15A** 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.

[0049] **FIG. 15B** is an enlarged sectional view of a portion of the needle assembly of **FIG. 15A**.

[0050] **FIG. 16** is a perspective view of a needle assembly having a safety shield in the retracted position and a needle cover in accordance with an embodiment of the present invention.

[0051] **FIG. 17** is a perspective view of the needle assembly of **FIG. 16** with the needle cover removed and having a safety shield in the extended position.

[0052] **FIG. 18** is a side view of the needle assembly of **FIG. 16** having a safety shield in the retracted position and with a needle cover.

[0053] **FIG. 19** is a side view of the needle assembly of **FIG. 17** with the needle cover removed and having a safety shield in the extended position.

[0054] **FIG. 20** is a side cross-sectional view of the needle assembly of **FIG. 16** having a safety shield in the retracted position and with a needle cover.

[0055] **FIG. 21** is a side cross-sectional view of the needle assembly of **FIG. 17** with the needle cover removed and having a safety shield in the extended position.

[0056] **FIG. 22** is a top cross-sectional view of the needle assembly of **FIG. 16** having a safety shield in the retracted position with a needle cover and showing a locking mechanism in accordance with an embodiment of the present invention.

[0057] **FIG. 23** is a top cross-sectional view of the needle assembly of **FIG. 17** with the needle cover removed and having a safety shield in the extended position and showing a locking mechanism.

[0058] **FIG. 24** is a perspective view of the needle assembly of the present invention, with the safety shield removed for illustration purposes and including a needle cover in accordance with an embodiment of the present invention.

[0059] **FIG. 25** is a cross-sectional view of the needle assembly of **FIG. 24**.

[0060] **FIG. 26** is a perspective view of the holder portion of the needle assembly of an embodiment of the present invention having the push button in the unengaged retracted position.

[0061] **FIG. 27** is a perspective view of the holder shown in **FIG. 26** having the push button in the engaged extended position.

[0062] **FIG. 28** is a perspective view of an embodiment of the push button in accordance with the present invention.

[0063] **FIG. 29** is a perspective view of a needle assembly having a safety shield in the retracted position in accordance with a further embodiment of the present invention.

[0064] **FIG. 30** is a perspective view of the needle assembly of **FIG. 29** having a safety shield in the extended position.

[0065] **FIG. 31** is a side view of the needle assembly of **FIG. 29** having a safety shield in the retracted position.

[0066] **FIG. 32** is a side view of the needle assembly of **FIG. 30** having a safety shield in the extended position.

[0067] **FIG. 33** is a top-down cross-sectional view of the needle assembly of **FIG. 29** having a safety shield in the retracted position.

[0068] **FIG. 34** is a top-down cross-sectional view of the needle assembly of **FIG. 30** having a safety shield in the extended position.

[0069] **FIG. 35** is a perspective view of **FIG. 29** showing the front-section of a portion of the needle holder.

[0070] **FIG. 36** is a perspective view of the push button of the needle assembly shown in **FIG. 29**.

[0071] **FIG. 37** is a perspective view of the needle assembly of **FIG. 29** having a needle shield in accordance with an embodiment of the present invention.

[0072] **FIG. 38** is a cross-sectional view of the needle assembly shown in **FIG. 29** having a removable cannula guard disposed thereon.

[0073] FIG. 39 is a perspective view of a needle assembly with a push button activator having a removable cannula guard covering a safety shield in the retracted position in accordance with an embodiment of the present invention.

[0074] FIG. 40 is a perspective view of the needle assembly of FIG. 39 having the removable cannula guard removed showing the safety shield in the extended position.

[0075] FIG. 41 is a side view of the needle assembly of FIG. 39.

[0076] FIG. 42 is a side view of the needle assembly of FIG. 40.

[0077] FIG. 43 is a cross-sectional view of the needle assembly of FIG. 39.

[0078] FIG. 44 is a cross-sectional view of the needle assembly of FIG. 40.

[0079] FIG. 45 is a top view of the needle assembly of FIG. 39.

[0080] FIG. 46 is a top view of the needle assembly of FIG. 40.

[0081] FIG. 47 is a cross-sectional view of the needle assembly of FIG. 39.

[0082] FIG. 48 is a cross-sectional view of the needle assembly of FIG. 40.

[0083] FIG. 49 is a close-up cross-section view of the needle assembly of FIG. 47.

[0084] FIG. 50 is an exploded perspective view of the needle assembly of FIG. 39.

[0085] FIG. 51 is a partial perspective side view of a locking tab in accordance with an embodiment of the present invention.

[0086] FIG. 52 is a partial perspective side view of the locking tab of FIG. 51 partially engaged with a housing in accordance with an embodiment of the present invention.

[0087] FIG. 53 is an exploded perspective view of a needle assembly in accordance with an embodiment of the present invention.

[0088] FIG. 54 is a partially assembled perspective view of the needle assembly of FIG. 53.

[0089] FIG. 55 is a partially assembled perspective view of the needle assembly of FIG. 53.

[0090] FIG. 56 is an alternative exploded perspective view of a needle assembly in accordance with an embodiment of the present invention

[0091] FIG. 57 is a partially assembled perspective view of the needle assembly of FIG. 56.

[0092] FIG. 58 is a partially assembled perspective view of the needle assembly of FIG. 56.

[0093] FIG. 59 is a perspective view of a needle assembly having a distal needle shield, and proximal needle shield in accordance with an embodiment of the present invention.

[0094] **FIG. 60** is a top view of the hub assembly, distal needle shield, and proximal needle shield of **FIG. 59**.

[0095] **FIG. 61** is a cross-sectional top view of the needle assembly of **FIG. 60**.

[0096] **FIG. 62** is a side view of the needle assembly of **FIG. 59**.

[0097] **FIG. 63** is a cross-sectional view of the side view of **FIG. 62**.

[0098] **FIG. 64** is a perspective view of the needle assembly of **FIG. 59** engaged with a specimen collection container holder in accordance with an embodiment of the present invention.

[0099] **FIG. 65** is a cross-sectional side view of a needle assembly in the retracted position having an alternative locking mechanism in accordance with an embodiment of the present invention.

[00100] **FIG. 66** is a cross-sectional side view of the needle assembly of **FIG. 65** in the extended position.

[00101] **FIG. 67** is a perspective view of a needle assembly having a safety shield in the retracted position and including a glide mechanism in accordance with an embodiment of the present invention.

[00102] **FIG. 68** is a perspective view of the needle assembly of **FIG. 67** having a safety shield in the extended position.

[00103] **FIG. 69** is a side view of the needle assembly of **FIG. 67** having a safety shield in the retracted position.

[00104] **FIG. 70** is a side view of the needle assembly of **FIG. 68** having a safety shield in the extended position.

[00105] **FIG. 71** is a cross-sectional view of the needle assembly of **FIG. 69** having a safety shield in the retracted position.

[00106] **FIG. 72** is a cross-sectional view of the needle assembly of **FIG. 70** having a safety shield in the extended position.

[00107] **FIG. 73** is an exploded perspective view of a needle assembly with a glideable safety shield in accordance with an embodiment of the present invention.

[00108] **FIG. 74** is an exploded perspective view of the needle assembly of **FIG. 73**.

[00109] **FIG. 75** is a top view of the needle assembly of **FIG. 73** in the assembled and retracted position.

[00110] **FIG. 76** is a cross-sectional top view of the needle assembly of **FIG. 75** in the retracted position.

[00111] **FIG. 77** is a cross-sectional side view of the needle assembly of **FIG. 73** in the assembled and retracted position.

[00112] **FIG. 78** is a side view of the needle assembly of **FIG. 77** in the retracted position.

[00113] **FIG. 79** is a bottom view of the needle assembly of **FIG. 73** in the assembled and retracted position.

[00114] **FIG. 80** is a front view of the assembled needle assembly of **FIG. 73**.

[00115] **FIG. 81** is a rear view of the needle assembly of **FIG. 80**.

[00116] **FIG. 82** is a cross-sectional top view of the needle assembly of **FIG. 76** in the extended position.

[00117] **FIG. 83** is a top view of the needle assembly of **FIG. 82** in the extended position.

[00118] **FIG. 84** is a cross-sectional side view of the needle assembly of **FIG. 77** in the extended position.

[00119] **FIG. 85** is a side view of the needle assembly of **FIG. 78** in the extended position.

[00120] **FIG. 86** is a bottom view of the needle assembly of **FIG. 79** in the extended position.

[00121] **FIG. 87** is a perspective view of a needle assembly having an articulating hinge safety shield in the retracted position in accordance with an embodiment of the present invention.

[00122] **FIGS. 88-90** are perspective views of the needle assembly of **FIG. 87** having an articulating hinge safety shield shown in various stages of partial extension.

[00123] **FIG. 91** is a perspective view of the needle assembly of **FIG. 87** having an articulating hinge safety shield in the fully extended position.

[00124] **FIG. 92** is a perspective view of a needle assembly having a butterfly hinged safety shield in the retracted position in accordance with an embodiment of the present invention.

[00125] **FIG. 93** is a perspective view of the needle assembly of **FIG. 92** having a butterfly hinged safety shield shown in the extended position.

[00126] **FIG. 94** 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.

[00127] **FIG. 95** is a side view of the needle assembly of **FIG. 94**.

[00128] **FIG. 96** is a top view of the needle assembly of **FIG. 94**.

[00129] **FIG. 97** is a cross-sectional side view of the needle assembly of **FIG. 94**.

[00130] **FIG. 98** is a perspective view of the needle assembly of **FIG. 94** having the needle guard shield removed and in the retracted position.

[00131] FIG. 99 is a side view of the needle assembly of FIG. 98.

[00132] FIG. 100 is a top view of the needle assembly of FIG. 98.

[00133] FIG. 101 is a cross-sectional side view of the needle assembly of FIG. 98.

[00134] FIG. 102 is a perspective view of the needle assembly of FIG. 98 in the extended position.

[00135] FIG. 103 is a side view of the needle assembly of FIG. 102.

[00136] FIG. 104 is a cross-sectional view of the needle assembly of FIG. 102.

[00137] FIG. 105 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.

[00138] FIG. 106 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.

[00139] FIG. 107 is an exploded perspective view of a needle assembly having a hinged safety shield in accordance with an embodiment of the present invention.

[00140] FIG. 108 is an assembled perspective view of the needle assembly of FIG. 107 in the retracted position.

[00141] FIG. 109 is a side view of the needle assembly of FIG. 108.

[00142] FIG. 110 is a top view of the needle assembly of FIG. 108.

[00143] FIG. 111 is a cross-sectional side view of the needle assembly of FIG. 108.

[00144] FIG. 112 is a front view of the needle assembly of FIG. 108.

[00145] FIG. 113 is a rear view of the needle assembly of FIG. 108.

[00146] FIG. 114 is a cross-sectional side view of the needle assembly of FIG. 108.

[00147] FIG. 115 is an alternative exploded view of a needle assembly having a hinged safety shield in accordance with an embodiment of the present invention.

[00148] FIG. 116 is a perspective view of the needle assembly of FIG. 108 in the extended position.

[00149] FIG. 117 is a top view of the needle assembly of FIG. 116 in the extended position.

[00150] FIG. 118 is a cross-sectional side view of the needle assembly of FIG. 116.

[00151] FIG. 119 is a side view of the needle assembly of FIG. 116 in the extended position.

[00152] FIG. 120 is a front view of the needle assembly of FIG. 116.

[00153] FIG. 121 is a rear view of the needle assembly of FIG. 116.

[00154] FIG. 122 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.

[00155] FIG. 123 is a perspective view of a needle assembly having a pierceable seal prior to use with a sample container in accordance with an embodiment of the present invention.

[00156] FIG. 124 is a perspective view of the needle assembly of FIG. 123 in use.

[00157] FIG. 125 is a perspective view of the needle assembly of FIG. 124 having the container removed from the pierceable seal after use.

[00158] FIG. 126 is a perspective view of a base portion of the housing of a needle assembly in accordance with an embodiment of the present invention.

[00159] FIG. 127 is a side view of the base portion of FIG. 126.

[00160] FIG. 128 is a perspective view of a hub portion of the housing of a needle assembly in accordance with an embodiment of the present invention.

[00161] FIG. 129 is a side view of the hub portion of FIG. 128.

[00162] FIG. 130 is a perspective view of an assembled housing of a needle assembly including the base portion of FIG. 126 and the hub portion of FIG. 128.

[00163] FIG. 131 is a side view of the assembled housing of FIG. 130.

DETAILED DESCRIPTION

[00164] 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.

[00165] In one embodiment of the present invention, a needle assembly 30 is provided, as generally shown in FIGS. 1-10. The needle assembly 30 generally includes a housing 32 having a flash chamber 38 integral therewith, a cannula 34 associated with the housing 32, and a safety shield 36 adapted to transition from a retracted position, shown in FIG. 1, to an extended position, shown in FIG. 2, for safety shielding of the cannula 34 during and/or after use of the needle assembly 30. The needle assembly 30 is shown in the retracted position ready for use in a specimen collection procedure, such as a blood collection procedure, in FIG. 1, and after use in the extended position shielding the cannula in FIG. 2.

[00166] With particular reference to FIGS. 7-10, the needle assembly 30 includes a cannula 34 having a distal patient end 40 and a proximal non-patient end 42. It will be noted that the term "distal" as used herein, refers generally to the forward end of the needle assembly 30 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

30 that is engageable with a specimen collection container (shown in **FIG. 123**). The cannula **34** includes a sidewall **48** extending between the patient end **40** and the non-patient end **42** and defining a cannula interior **50**. In one embodiment, the cannula **34** may include at least two distinct needles, such as a distal patient needle **52** and a proximal non-patient needle **54**, both of which define a common central lumen within the cannula interior **50**. In a further embodiment, the distal patient needle **52** is aligned substantially along a common axis with the proximal non-patient needle **54** and separated from the proximal non-patient needle **54** by a break **56**. The proximal non-patient end **42** of the cannula **34** is provided for puncturing a specimen collection container (shown in **FIG. 123**). In one embodiment, the proximal non-patient end **42** of the cannula **34** may be covered by a pierceable elastomeric multiple sample sleeve **60**. The distal patient end **40** may have a bevel for allowing easier penetration of a patient's skin.

[00167] The cannula **34** of the needle assembly may be at least partially supported by a portion of the housing **32**. In one embodiment, the housing **32** may be a hub **64** for supporting a portion of the cannula **34**. For example, proximal non-patient needle **54** and distal patient needle **52** may be affixed or otherwise adhered within a central opening **66** of the hub **64**, with a break **56** present between proximal non-patient needle **54** and the distal patient needle **52**. In another configuration, the hub **64** may be formed of separate elements. For example, a proximal or rear hub portion **68** may be connected with or affixed to a forward hub portion **70**, thereby forming the hub **64** as a unitary structure, with the cannula **34** extending therethrough.

[00168] As shown in **FIGS. 1-2** and **5-10**, the housing **32** may have a distal end **74** and a proximal end **72** engageable with a specimen collection container (shown in **FIG. 123**). 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 **72** of the housing **32**, or that a specimen collection container may be passed within or disposed over or about a portion of the proximal end **72** of the housing **32** and secured to another portion of the housing **32**. In one embodiment, the proximal end **72** of the needle assembly **30** may define a specimen collection container receiving port **76**, adapted to receive a specimen collection container (shown in **FIG. 123**) therewith.

[00169] In another embodiment, the needle assembly **30** is a specimen collection assembly, such as a blood collection assembly, in which the housing **32** of the needle assembly **30** includes a specimen collection container holder **78** adjacent the proximal end **72** of the needle assembly **30**. The specimen collection container holder **78** includes a proximal end **80**, a

distal end 82, and a tubular sidewall 84 extending therebetween. In one embodiment, the specimen collection container holder 78 may include a second tubular sidewall 86 circumferentially disposed about the tubular sidewall 84. The proximal end 80 of the specimen collection container holder 78 may be substantially open at opening 88 and may be adapted to receive a specimen collection container (shown in FIG. 123) therein. The proximal end 80 may also have a radially aligned flange 90 to facilitate manipulation of the needle assembly 30. The flange 90 may be non-circular to prevent the needle assembly 30 from rolling, or for other purposes such as communicating to the user the intended orientation of the needle assembly 30.

[00170] The specimen collection container holder 78 is adapted to accommodate at least a portion of the cannula 34 in a mating relationship. For example, the distal end 82 of the specimen collection container holder 78 may include an engagement portion 92 to which a portion of the cannula 34, such as the non-patient end 42 is mounted through a portion of the hub 64. In particular, the distal end 82 of the specimen collection container holder 78 may include an engagement portion 92 having a mating structure, such as a threaded engagement, adapted to receive the rear hub portion 68 of the hub 64. In one embodiment, the engagement portion 92 can include threads 94 for engagement with corresponding threads 96 of the rear hub portion 68 of hub 64. Other mating relationships are also contemplated herein, such as mating male and female luer assembly components. The hub 64 may be also adhesively affixed to the engagement portion 92 of the specimen collection container holder 78. In another embodiment, the hub 64 may be press-fit or snapped into the specimen collection container holder 78. Alternatively, hub 64 may be integrally formed with the distal end 82 of the specimen collection container holder 78, providing a mechanism for direct attachment of the cannula 34 to the specimen collection container holder 78. In certain embodiments, the cannula 34 is joined with a portion of the specimen collection container holder 78 by the manufacturer so that the device is ready for fast and convenient use by the medical practitioner.

[00171] In certain configurations, the patient end 40 of the cannula 34 projects at least partially from the distal end 74 of the housing 32, and the non-patient end 42 extends in a substantially proximal direction from the patient end 40. In another embodiment, the distal patient needle 52 projects at least partially from the distal end 74 of the housing 32, and the proximal non-patient needle 54 extends in a substantially proximal direction from the patient needle.

[00172] At least a portion of the housing **32**, including the hub **64**, the specimen collection container holder **78**, and the second tubular sidewall **86**, includes a flash chamber **98**. 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 **98** may be integrally formed with a portion of the housing **32** or, alternatively, may be separately formed and subsequently engaged with a portion of the housing **32**. In one embodiment, the cannula interior **50** is in fluid communication with the flash chamber **98**. In a further embodiment, the sidewall **48** of the cannula may define an opening extending between the cannula interior **50** and the flash chamber **98** to permit the flow of a specimen, such as blood, from the cannula **34** to the flash chamber **98**. In another embodiment, the cannula **34** includes a distal patient needle **52** in fluid communication with the flash chamber **98**, and a proximal non-patient needle **54** in fluid communication with the flash chamber **98**. Accordingly, when the distal patient needle **52** is provided access with a patient’s vasculature, blood may flow from the patient through the distal patient needle **52** and into the flash chamber **98**. When the proximal non-patient needle **54** is engaged with an evacuated specimen collection container (not shown), blood may flow from the flash chamber **98** and through the proximal non-patient needle.

[00173] In one embodiment, the hub **64** may include an interior **100** between a portion of the rear hub portion **68** and a portion of the forward hub portion **70**. A flash chamber **98** may be formed within at least a portion of the interior **100** of the hub **64**. In one configuration, the hub **64**, or at least a portion of the hub **64**, such as the forward hub portion **70**, may be constructed from a transparent or translucent material, such as a polymeric material or resin. Alternatively, a flash chamber **98** may be integrally formed within another portion of the housing **32**, such as integrally formed with the specimen collection container holder **78**, or within a portion of a secondary tubular sidewall **86**.

[00174] In use, blood flow from a patient through the cannula **34** will enter the flash chamber **98** through the opening **88** in the cannula **34**, thereby partially filling the flash chamber **98** with blood. The flash chamber **98** 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.

[00175] The needle assembly **30** further includes a safety shield **36**, which provides a mechanism to shield the cannula **34**, and in particular the puncture tip at the patient end **40**, after use thereof. At least a portion of the safety shield **36** is restrainably engaged with a

portion of the housing **32** and transitionable from a retracted position, as shown in **FIGS. 1, 5, 7, and 9**, to an extended position, as shown in **FIGS. 2, 6, 8, and 10**. The safety shield **36** may be transitionable from the retracted position to the extended position over a portion of the cannula **34**. In one embodiment, the safety shield **36** is axially transitionable over the cannula **34**. In a further embodiment, the safety shield **36** is axially transitionable over the cannula **34** from a retracted position, in which at least the puncture tip of the patient end **40** of the cannula **34** is exposed, such as for accessing a patient, to an extended position, in which at least the puncture tip of the patient end **40** of the cannula **34** is shielded by at least a portion of the safety shield **36**. As used herein, the phrase “shielded by at least a portion of the safety shield” means that accidental contact with the puncture tip at the patient end **40** of the cannula **34** is prevented by the position of at least a portion of the safety shield in shielding orientation with respect to the patient end **40** of the cannula **34**. In one embodiment, the safety shield **36** at least partially surrounds or encompasses the patient end **40** of the cannula **34** in the extended position.

[00176] In one embodiment, as shown specifically in **FIGS. 5-10**, the shield **36** may be disposed within an interior portion **106** of the housing **32**, such as between the sidewall **84** and the second sidewall **86** of the housing **32**, in the retracted position. For example, the safety shield **36** may be disposed between a sidewall **84** forming a portion of the specimen collection container holder **78** and a second sidewall **86** disposed about the sidewall **84**. The safety shield **36** may have any suitable dimensions and configuration such that it is adapted to shield the puncture tip of the patient end **40** of the cannula **34** when the safety shield **36** is actuated to extend to the extended position, as shown in **FIG. 2**. In one embodiment, transition of the safety shield **36** from the retracted position to the extended position may be initiated once the puncture tip of the patient end **40** of the cannula **34** has been removed from the patient. In another embodiment, transition of the safety shield **36** from the retracted position to the extended position, may be initiated while the cannula **34** is in communication with the body of a patient, such as while the patient end **40** of the cannula **34** is in fluid communication with the vasculature of a patient. Accordingly, the safety shield **36** may be deployed over the cannula **34** while the cannula **34** is accessing the interior of the patient's blood vessel (not shown), or after the cannula **34** has been removed from the patient. If the transition of the safety shield **36** from the retracted position to the extended position occurs while the cannula **34** is accessing the interior of a patient's blood vessel, the distal portion **102** of the safety shield **36** will contact the patient's skin.

[00177] In one embodiment, the shield **36** includes a shielding portion **104** which is axially moveable in the direction of the longitudinal axis **A** of the cannula **34**, shown in **FIG. 5**, from the retracted position to the extended position. The shielding portion **104** may be restrainably engaged within the interior portion **106** of the housing **32** in the retracted position, and the shielding portion **104** may extend from the interior portion **106** of the housing **32** in the extended position. In one embodiment, axial transition of the shield **36** from the retracted position to the extended position transitions the shielding portion **104** from within the interior portion **106** of the housing **32** to a location at least partially exterior to the housing **32** substantially along the longitudinal axis **A** of the cannula **34**. In another embodiment, the interior portion **106** of the housing **32** may be circumferentially disposed about the specimen collection container holder **78** or specimen collection container receiving port **76**. In yet another embodiment, the interior portion **106** of the housing **32** is co-axial with the specimen collection container holder **78** or specimen collection container receiving port **76**. As used herein, the term “co-axial” includes orientations in which the interior portion **106** and the specimen collection container holder **78** or specimen collection container receiving port **76** are each disposed about the longitudinal axis **A** of the cannula **34**. In a further embodiment, the safety shield **36** is disposed about at least a portion of the cannula **34**, and transition of the safety shield **36** from the retracted position to the extended position telescopes the safety shield **36** over a portion of the cannula **34**. Optionally, the safety shield **36** may be substantially circumferentially disposed about at least a portion of the cannula **34**. It is also contemplated herein that the safety shield **36** may include a single telescoping portion, such as shielding portion **104**, or may include multiple circumferentially disposed nesting segments that are each transitionable over the cannula **34**.

[00178] The safety shield **36** may be deployed by a release member **108**, such as a push button, transitionable from a first position to a second position. The release member **108** may be deployable through an exterior surface **110** of the safety shield **36** and housing **32**. In one embodiment, the release member **108** may actuate the transition of the safety shield **36** from the retracted position to the extended position. In another embodiment, the release member **108** may initiate an activator to transition the safety shield **36** from the retracted position to the extended position. In the embodiment depicted in **FIGS. 1-10**, the release member **108** includes a member **112**, such as an arm, oriented in a substantially perpendicular orientation with respect to the transition axis **T** of the safety shield **36**, shown in **FIG. 6**. As used herein, the phrase “transition axis” includes the orientation of the shield during transition from the retracted position to the extended position. In certain embodiments, the transition axis is

aligned with the longitudinal axis **A** of the cannula **34**. The member **112** may be connected to a restraining portion **114**, such as an enlarged body, creating a passage region **116**, such as a narrowed neck, as shown in **FIG. 3**. In one embodiment, the passage region **116** defines a non-enclosed region, such as an indentation or a cut-away portion. The restraining portion **114** of the release member **112** further includes a shoulder **118** adjacent the passage region **116**. Further, as shown in **FIG. 3**, safety shield **36** includes an elongated channel **120** extending through the shield **36**, with an enlarged opening adjacent the forward or distal end thereof, creating a stop surface shoulder **122** adjacent the forward edge of the channel **120**. In one embodiment, the elongated channel **120** extends longitudinally through the shield **36** along a top surface thereof.

[00179] With the safety shield **36** in the retracted position as shown in **FIG. 1**, the release member **108** is in a first position, with the restraining portion **114** extending into the shield **36**, and with the stop surface shoulder **122** in an abutting engagement with the shoulder **118** of the release member **108**, thereby preventing movement of the safety shield **36** in a forward or distal direction. When release member **108**, such as a push button, is transitioned from the first position, such as depressed in the direction of arrow **A** in **FIG. 3**, the restraining portion **114** moves in a substantially downward orientation with respect to safety shield **36**, thereby releasing the abutting engagement between stop surface shoulder **122** and the shoulder **118**. As such, the sidewall **124** of the safety shield **36** adjacent elongated channel **120** can guide through the passage region **116** of the release member **108** unobstructed, thereby permitting safety shield **36** to transition from the retracted position shown in **FIG. 1** to the extended position shown in **FIG. 2**. Accordingly, the restraining portion **114** of the release member **108** engages a stop surface shoulder **122** of the shield **36** in the restrained position, and the stop surface shoulder **122** of the shield **36** passes through the passage region **116** of the release member **108** upon transition of the release member from a first position to a second position and transition of the shield **36** from the restrained position to the extended position.

[00180] In one embodiment, the safety shield **36** may be biased toward the extended position by a spring **126** disposed between a portion of the safety shield **36** and a portion of the housing **32**. The safety shield **36** may be biased toward the extended position by the spring **126** when the shield **36** is in the retracted position. In one embodiment, the spring **126** may be disposed between a proximal portion **128** of the safety shield **36** and a proximal end **72** of the housing **32**. In another embodiment, as shown in **FIGS. 7-10**, the spring **126** may be disposed between the sidewall **84** of the housing **32** and the second sidewall **86**. Upon transition of the release member **108** from the first position to the second position, the

abutting engagement between the stop surface shoulder **122** and the shoulder **118**, shown in **FIG. 3**, is released and the spring **126** biases the safety shield **32** to the extended position thereby safely shielding the cannula **32**.

[00181] As shown in **FIGS. 9-10**, the safety shield **36** may further be provided with a barrier mechanism **130** structured to prevent the safety shield **36** from transitioning from the extended position to the retracted position once the safety shield **36** has been transitioned from the retracted position to the extended position. Accordingly, the barrier mechanism **130** prevents re-entry of the shield **36** into the housing **32** and exposure of cannula **34** after it has been shielded. In the embodiment, at least one of the distal end **74** of the housing **32** and the proximal portion **128** of the shield **36** include a barrier mechanism **130**. In another embodiment, both the distal end **74** of the housing **32** and the proximal portion **128** of the shield **36** include a barrier mechanism **130**.

[00182] The barrier mechanism **130** may include a restraint **132** and a break **134**. The break **134** may include a slanted distal portion **136** and a proximal portion **138** having a plane substantially perpendicular to a portion of the safety shield **36**. The break **134** is sized to allow passage beyond the restraint **132** included within the distal end **74** of the housing **32** when the safety shield **36** is transitioned from the restrained position to the extended position. The proximal portion **138** of the break **134** is also dimensioned to restrain the safety shield **36** against the restraint **132** to resist passage of the safety shield **36** past the restraint **132** once the shield **36** is transitioned from the retracted position to the extended position. In another embodiment, the release member **108** may be at least partially restrained by a portion of the shield **36**, such that the shield **36** cannot be reset after transitioning from the retracted position to the extended position.

[00183] As shown in **FIGS. 1, 5, 7, and 10**, the flash chamber **98** is at least partially visible to a medical practitioner when the safety shield **36** is in the retracted position. In one embodiment, at least a portion of the flash chamber **98** extends beyond the distal portion **102** of the safety shield **32** in the retracted position. In another embodiment, at least a portion of the flash chamber **98** is visible through at least a portion of the shield **36** in the retracted position. In another embodiment, at least a portion of the shield **36** through which the flash chamber **98** is visible made of a translucent or transparent material.

[00184] As shown in **FIGS. 11-15B**, an alternative flash chamber, such as described in United States Publication No. 2006/0036219 and United States Application Publication No. 2009/0227953, may be employed within the present invention.

[00185] In addition to conventional flash chambers which 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. 11-15B**, 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.

[00186] For example, as shown in **FIGS. 11-14**, 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.

[00187] As shown in **FIGS. 11-14**, 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.

[00188] 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.

[00189] Needle assembly 410 also includes a non-patient puncture tip extending from second end 414 of housing 412. As seen in FIG. 13, 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.

[00190] As seen in FIG. 14B, 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**.

[00191] In an alternate arrangement, a single cannula is provided. Such an arrangement is depicted in the embodiment of **FIGS. 15A-15B** (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. 15A-15B**, 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**.

[00192] Returning to the embodiment of **FIGS. 11-14**, 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.

[00193] The embodiment of **FIGS. 11-14** 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.

[00194] 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. 15A and 15B. 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.

[00195] 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 mm³ to about 400 mm³. 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.

[00196] 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.

[00197] 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.

[00198] 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.

[00199] 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. 15A-15B**.

[00200] 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. 15A-15B), 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.

[00201] 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.

[00202] 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**.

[00203] 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.

[00204] 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.

[00205] 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.

[00206] 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.

[00207] 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. 11-15B** may be employed within any of the embodiments described elsewhere in the present application.

[00208] In yet another embodiment, **FIGS. 16-28** depict an alternative configuration of a needle assembly **230** in accordance with the present invention. As shown, needle assembly **230** is similarly constructed to the needle assembly **30**, described above with reference to **FIGS. 1-10**. Needle assembly **230** includes an alternate release member **208** and an optional removable cannula guard **216**. Needle assembly **230** generally includes a cannula **234** associated with a housing **232**, and a safety shield **236** adapted for safety shielding the cannula **234** during and/or after use of the device. As previously described, the housing **232** may include a hub **264**, a specimen collection container receiving port **276** and/or a specimen collection container holder **278**, and a second sidewall **286** at least partially surrounding a sidewall **284** of the specimen collection container holder **278**. The hub **264** may be adapted for at least partially supporting the cannula **34**, which includes a patient end **240** and a non-patient end **242**, as previously described. The cannula **34** may also include a distal patient needle **252** and a separate proximal non-patient needle **254**, as also previously described. The needle assembly **230** further includes a flash chamber **298** defined therein, as previously described.

[00209] As shown in **FIGS. 16, 18, 20, and 21-25**, the needle assembly **230** is shown in the retracted position with a removable cannula guard **216** associated with a portion of the housing **232** and generally shielding the cannula **234**. The removable cannula guard **216** is engageable with a portion of the housing **232** and is removable prior to use of the needle

assembly **230**. The removable cannula guard **216** is provided to shield the cannula **234**, in particular, the puncture tip of the patient end **240** of the cannula **234**, prior to use in a specimen collection procedure. In one embodiment, the cannula guard **216** is configured to circumferentially surround the cannula **234**. The cannula guard **216** has a proximal end **246** having an interior portion **248** sized to extend at least partially over a portion of the housing **232**, such as an exterior surface **253** of the hub **264**. In another embodiment, the removable cannula guard **216** has a proximal end **246** having an interior portion **248** sized to extend at least partially over the exterior surface **253** of the hub **264** and to extend within at least a portion of the interior **258** of the distal end **260** of the housing **232**.

[00210] The removable cannula guard **216** may be removably mated to a portion of the hub **264** and/or the specimen collection container holder **278**, such as by a frictional engagement or press-fit mechanism. Alternately, removable cannula guard **216** may be mated by a threaded engagement (not shown), in which threads (not shown) may be disposed on a portion of the hub **264**, or specimen collection container holder **278**, and/or removable cannula guard **216**. In one embodiment, the proximal end **246** of the removable cannula guard **216** may have an area of increased thickness **266**, as compared to the thickness of the remainder of the removable cannula shield **216**, to provide additional support for mating engagement with the housing **232**. In a further embodiment, the area of increased thickness **266** if provided is to provide additional support for mating engagement with the hub **264**.

[00211] The removable cannula guard **216** may have any suitable dimensions and may be made of any suitable materials to allow the puncture tip of the patient end **240** of the cannula **234** to remain shielded prior to use and/or during transport. In one embodiment, the removable cannula guard **216** has sufficient strength to allow the needle assembly **230** to be packaged as a “hardpack” packaging configuration, as is conventionally known, without damage to the cannula **234** or needle assembly **230**. An example removable cannula guard and an example hardpack packaging structures are disclosed, for example, in United States Patent Nos. 6,997,913 and 6,984,223.

[00212] Prior to use, the removable cannula guard **216** is removed from the needle assembly **230**, such as by applying force to disengage the frictional engagement or press-fit mechanism and/or unscrew the threaded engagement. Once the removable cannula guard **216** has been removed from the needle assembly **230**, a medical practitioner can use the needle assembly **230** as previously described herein.

[00213] Further, as shown specifically in **FIGS. 26-28**, the needle assembly **230** may include an alternative release member **208**, such as an alternative push button. In one

embodiment, the release member **208** may actuate the transition of the safety shield **236** from the retracted position to the extended position. In another embodiment, the release member **208** may initiate an activator to transition the safety shield **236** from the retracted position to the extended position. In the embodiment depicted in **FIGS. 26-28**, the release member **208** includes a member **210** having a restraining portion **212** and a passage region **214**, as previously described. The restraining portion **212** may also define an interior recess **218** defined at least in part by two depending arms **220**. The interior recess **218** is dimensioned to accommodate at least a portion of the housing **232**, such as a portion of the hub **264**, therethrough. **FIGS. 26-27** are partial perspective views of the needle assembly **230** having the shield and cannula removed therefrom to illustrate the mechanism of the release member **208**. When the release member **208** is in a first position, as shown in **FIG. 26**, the rim **222** may be provided such that it does not engage a portion of the hub **264**. When the release member **208** is transitioned to the second position, as shown in **FIG. 27**, both depending arms **220** are lowered and the rim **222** contacts a portion of the hub **264**.

[00214] As shown in **FIG. 26**, when the release member **208** is in a first position, corresponding to the retracted position of the shield (shown in **FIG. 16**), the rim **222** of the interior recess **218** is separated from the hub **264** and restraining portions **224** of the depending arms **220** may contact at least a portion of the hub **264**. The safety shield is prevented from transitioning from the restrained position to the extended position by the restraining portion **212**, as similarly discussed herein in greater detail with reference to **FIGS. 3-4**. As shown in **FIG. 27**, when the release member **208** is deployed to the second position, corresponding to the extended position of the shield (shown in **FIG. 17**), the rim **222** engages at least a portion of the hub **264**. The restraining portions **212** are advanced beyond the hub **264**. Once the restraining portions **212** have advanced beyond the hub **264**, the hub **264** prevents the release member **208** from being returned to its original state prior to activation, such as through a locking engagement with hub **264**. Also shown in **FIG. 17**, the needle assembly **230** may include a plurality of ribs **238** to prevent rotation of the safety shield **236** with respect to the housing **232**, such as with respect to the specimen collection container holder **278**.

[00215] As shown in **FIGS. 24-25**, the removable cannula guard **216** may further include a portion in abutment with a portion of release member **208**, thereby physically preventing deployment of the release member **208** until the removable cannula guard **216** is removed from the needle assembly **230**. In one embodiment, the removable cannula guard **216** includes a tab **274** that extends at least partially within the interior recess **218** (shown in **FIG.**

28) of the release member 208, thereby preventing transition of the release member 208 from a first position, as shown in FIG. 16, to a second position, as shown in FIG. 17. Accordingly, accidental transition of the safety shield 236 from a retracted position to the extended position is prevented during transport or standard pre-use handling.

[00216] Moreover, as shown in FIGS. 22-23, a tamper-resistant flange 278 may be provided adjacent the distal end 260 of the housing 232, such as adjacent the distal end 282 of the second sidewall 286 to prevent the forced re-entry of the safety shield 236 into the housing 232 once the safety shield 236 has been transitioned from the retracted position to the extended position. In one embodiment, the flange 278 is attached to, or integral with, an exterior surface 284 of the second sidewall 286 at the distal end 282 and oriented to extend beyond the distal end 282 of the housing 232 in the distal direction. As shown in FIG. 23, when the needle assembly 230 is in the extended position, the flange 278 may shield a barrier mechanism 292, similar to the barrier mechanism previously described herein with reference to FIGS. 9-10. The barrier mechanism 292 is structured to prevent the re-entry of the safety shield 236 into the housing 232 once the safety shield 236 has been transitioned from the retracted position to the extended position. However, in certain configurations, it may be possible to insert a pry tool (not shown) between the safety shield 236 and a portion of the housing 232 thereby flexing the needle assembly 230 to a sufficient degree that abutting portions of the barrier mechanism 292 can become disengaged, thereby allowing re-entry of the safety shield 236 into the housing 232. In order to prevent insertion of such a pry tool, flange 278 may be provided to shield the distal end 260 of the housing 232 from tampering.

[00217] FIGS. 29-38 depict another embodiment of the present invention, in which a needle assembly 330 is similarly constructed as described above, with the exception of the configuration of the housing 332. Needle assembly 330 generally includes a cannula 334 associated with the housing 332, and a safety shield 336 adapted for safety shielding of the cannula 334 during and/or after use of the device. Needle assembly 330 further includes a hub 364 for supporting at least a portion of the cannula 334 and a flash chamber 398 as previously described.

[00218] In the embodiment shown in FIGS. 29-38, the housing 332 may include a first portion 344, with a second portion 346 connected to the first portion 344. The first portion 344 may be distal to the second portion 346 along the transition axis T (shown in FIG. 32) of the shield 336. In one embodiment, the first portion 344 and the second portion 346 are co-formed. In another embodiment, the first portion 344 and the second portion 346 are separately formed and subsequently assembled. In yet another embodiment, the first portion

344 and the secondary portion **346** may be secured together in a bayonet fashion. Alternatively, the first portion **344** and the secondary portion **346** may be adhered together through the use of conventional adhesives.

[00219] As shown in **FIGS. 33-34**, the cannula **334** may be positioned in part within the interior **350** of the secondary portion **346** and in part within the interior **352** of the first portion **344**. In another embodiment, the non-patient end **342** of the cannula **334** may be positioned within the interior **350** of the secondary portion **346**, and at least the puncture tip of the patient end **340** of the cannula **334** extending beyond the first portion **344**. The hub **364** may be positioned within the interior **352** of the first portion **344**, although in certain embodiments it may be desirable to position the hub **364** in part within the interior **350** of the secondary portion **346** and in part within the interior **352** of the first portion **344**. In another embodiment, the secondary portion **346** may include a conventional specimen collection container holder **378**. In yet another embodiment, a specimen collection container receiving port **380**, engageable with a specimen collection container (shown in **FIG. 123**), is defined within the secondary portion **346**.

[00220] The flash chamber **398** is visible to a medical practitioner when the safety shield **336** is in the retracted position, as shown in **FIG. 29**. Referring again to **FIGS. 29-34**, the housing **332**, such as the first portion **344**, may include a sidewall **358** having an observation window **360**, shown in **FIGS. 29-32**, defined therein. In one embodiment, the observation window **360** includes an opening surrounded entirely by a sidewall **358**. In another embodiment, the observation window **360** includes a cut-away portion of the housing **332**. In another embodiment, the observation window **360** includes a translucent and/or transparent material within the opening. In yet another embodiment, the observation window **360** includes a cut-away portion that is at least partially open, i.e., the observation window **360** is not entirely surrounded by a sidewall **358** of the housing **332**.

[00221] In accordance with an embodiment of the present invention, at least a portion of the flash chamber **398** is visible through the observation window **360** when the shield **336** is in the retracted position. In another embodiment, at least a portion of the first portion **344** of the housing **332** defines an observation window **360** and the flash chamber **398** is visible through the observation window **360** of the first portion **344** of the housing **332** when the shield is in the retracted position. In another embodiment, the safety shield **336** may be formed of a translucent and/or transparent material such that the flash chamber **398** is visible through both the observation window **360** and a portion of the safety shield **336**. In another embodiment, both the safety shield **336** and the first portion **344** of the housing **332** are made

of a transparent material or translucent material, such that the flash chamber 398 is visible through both structures. The first portion 344 and the safety shield 336 can be made of the same or different translucent and/or transparent materials. In another embodiment, the patient end 340 of the cannula 334 may include a bevel 338 and the position of the observation window 360 within the housing 332 corresponds to the orientation of the bevel 338, i.e., the orientation of the angled surface of the bevel 338. This may assist medical practitioners in properly orienting the cannula 334 within the patient without visually observing the patient end 340 of the cannula 334.

[00222] As shown in FIG. 33, the safety shield 336 may be disposed entirely within the first portion 344 of the housing 332 in the retracted position. In one embodiment, the safety shield 336 is adapted to at least partially surround, such as circumferentially surround, at least a portion of the cannula 334. In one embodiment, the safety shield 336 may be made of a substantially rigid material. In another embodiment, the safety shield 336 may be made of any substantially resilient deformable material having an elasticity sufficient that the safety shield 336 may be compressed and expanded without substantial damage thereof, such that it may be configured to fold against itself in an accordion folding arrangement.

[00223] As shown in FIGS. 33-34, a spring 368 may be biased between a portion of the safety shield 336 and a portion of first portion 344 of the housing 332. In one embodiment, the spring 368 is biased between a proximal portion 372 of the shield 336 and an inner surface 384 of the interior 352 of the first portion 344. In another embodiment, the spring 368 is biased between a proximal portion 372 of the shield 336 and a distal end 376 of the secondary portion 346. In yet another embodiment, the spring 368 is biased between a biasing portion 388 of the safety shield 336 and either of an inner surface 384 of the interior 352 of the first portion 344 and a distal end 376 of the secondary portion 346.

[00224] As shown in FIGS. 29-38, the safety shield 336 may be transitioned from the retracted position, shown in FIG. 29, to the extended position, shown in FIG. 30, by spring 368. During transition of the safety shield 336 from the retracted position to the extended position, spring 368 advances the safety shield 336 from a position within the first portion 344 of the housing 332 to a location distal from the distal portion 392 of the first portion 344. In this embodiment, the safety shield 336 is adapted to move between the retracted position, in which at least the puncture tip of the patient end 340 of the cannula 334 is exposed for accessing the patient, and the extended position in which the puncture tip of the patient end 340 is encompassed or otherwise safely shielded from exposure. The safety shield 336 may be at least partially deployed over the cannula 334 while the cannula 334 is accessing the

interior of the patient's blood vessel (not shown), or after the cannula **334** has been removed from the patient. If the transition of the safety shield **336** from the retracted position to the extended position occurs while the cannula **334** is accessing the interior of a patient's blood vessel, the distal portion **394** of the safety shield **336** will contact the patient's skin.

[00225] In yet another embodiment, the needle assembly **330** may further include a barrier mechanism **396**, similar to the barrier mechanisms previously described, to prevent the safety shield **336** from re-entering the housing **332** once the safety shield **336** has been transitioned from the retracted position to the extended position. Alternatively, as shown in **FIGS. 33-34**, the restraint **390** and break **386** are shown in opposite arrangement, such that the break **386** is incorporated within the housing **332**, specifically the distal end **392** of the first portion **344**, and the restraint **390** is incorporated within the safety shield **336** adjacent a proximal portion **372** of the shield **336**.

[00226] As shown in **FIGS. 29-36**, a release member **308**, such as a push button, may actuate the transition of the safety shield **336** from the retracted position to the extended position. In another embodiment, the release member **308** may initiate an activator to transition the safety shield **336** from the retracted position to the extended position. In the embodiment depicted in **FIGS. 29-34**, the release member **308** may operate in a substantially similar fashion to the release members previously described, however, the passage region **310** may define at least one substantially circular opening. As shown in **FIG. 36**, the restraining portion **312** of the release member **308** may also define a partially circular opening. **FIG. 35** shows a cut away view of the needle assembly **330** with the release member **308** in the first position, corresponding to the shield **336** in the retracted position. As shown in **FIG. 35**, the restraining portion **312** is engaged with at least a portion of the safety shield **336**, such that a shoulder **314** of the release member **308** prevents the safety shield **336** from transitioning to the extended position by the bias of the spring **368**. In this configuration, the restraining portion **312** and the passage region **310** define continuous partially circular openings having different diameters. In one embodiment, the passage region **310** has a diameter **D₁** and the restraining portion **312** has a diameter **D₂**, wherein **D₂** is smaller than **D₁**. When the release member **308** is in the first position, the safety shield **336** is at least partially aligned with and restrained by the diameter of the opening of the restraining portion **312**, thereby holding the safety shield **336** in the retracted position. When the release member **308** is transitioned to the second position, the restraining portion **312** is advanced below the safety shield **336** and the passage region **310**, having an opening of increased diameter is aligned with the safety shield **336**, thereby allowing the safety shield **336** to transition therethrough.

[00227] In one embodiment, the restraining portion 312 may be sized to circumferentially surround a portion of the housing 332, such as the hub 364. Optionally, the release member 308 may include a stabilizing feature for stabilizing the release member 308 in the first position and engaging a corresponding shoulder 318 of the housing 332, such as shown in FIGS. 29 and 35. In one embodiment, the stabilizing feature may include a detent protrusion 316, such as two detent protrusions 316, for engaging a corresponding shoulder 318 of the housing 332 and stabilizing the release member 308 in the first position. When the release member 308 is depressed in the direction shown by arrow R in FIGS. 29 and 36, the safety shield 336 is transitioned to the extended position, shown in FIG. 30. As the release member 308 is advanced in the direction shown by arrow R, the detent protrusions 316 are advanced in a downward direction and are received within a recess 320, shown in FIG. 35, within the housing 332. Due to the increased diameter of the passage region 310, as compared to the diameter of the restraining portion 312, and the presence of the detent protrusion 316 within the recess 320, the safety shield 336 is advanced through the passage region 310, thereby transitioning the safety shield 336 from the retracted position to the extended position.

[00228] Further, as shown in FIGS. 37-38, the needle assembly 330 may include a removable cannula guard 324 for surrounding the cannula 334, particularly the puncture tip of the patient end 340, prior to use. As previously described herein, the removable cannula guard 324 may include a tab portion 326 structured to prevent transition of the release member 308 from a first position to a second position. In this embodiment, the tab portion 326 includes an upper surface 354 structured to face a lower surface 356 of the release member 308 to provide an abutment or interference therebetween. Once a medical practitioner removes the removable cannula guard 324 from the needle assembly 330, the release member 308 may be deployed as described herein.

[00229] As shown in FIGS. 37-38, the removable cannula guard 324 may include a tapered portion 328 having a contour for allowing a medical practitioner to more easily grip the removable cannula guard 324 for removal from the needle assembly 330. In another embodiment, the removable cannula guard 324 may have a reinforcing tube 348 disposed within the interior of the removable cannula guard 324 and structured to at least partially surround the cannula 334. The reinforcing tube 348 may also include fastening means 362 for removeably securing the removable cannula guard 324 to the hub 364 of the needle assembly 330. In one embodiment, the fastening means 362 can include corresponding friction-fit or press-fit structures. In another embodiment, the fastening means 362 can include corresponding threaded structures for mating engagement allowing a medical

practitioner to remove the removable cannula guard **324** from the needle assembly **330** by rotational movement of the removable cannula guard **324** with respect to the housing **332**.

[00230] **FIGS. 39-58** illustrate yet another embodiment of a needle assembly **530** of the present invention. **FIGS. 39, 41, 43, 45, and 47** each illustrate the needle assembly **530** with a removable cannula guard **512** which must be removed prior to use of the needle assembly **530**, as previously described. The removable cannula guard **512** may include a tab portion **512a** structured to prevent depression of the release member **508**. In this embodiment, the tab portion **512a** is designed to provide an abutment or interference between the release member **508** and the safety shield **536**, as previously described.

[00231] The needle assembly **530** generally includes a cannula **534** associated with a portion of the housing **532**, such as a hub **564** for supporting at least a portion of the cannula **534**, and/or a specimen collection container holder **578**. The needle assembly also generally includes a safety shield **536** adapted for safety shielding the cannula **534** during and/or after use of the needle assembly **530**. The needle assembly **530** further includes a flash chamber **598** within at least a part of the housing **532**, as previously described.

[00232] In one embodiment, the needle assembly **530** includes a first portion **538**, with a secondary portion **540** connected to the first portion **538**. The secondary portion **540** defines an interior **542** structured to receive the specimen collection container, such as an evacuated blood collection tube (not shown) therein. In one embodiment, the secondary portion **540** is a specimen collection container holder **578**. In another embodiment, the secondary portion **540** is a blood collection container holder **578** and the needle assembly **530** is a blood collection assembly **530**.

[00233] In one embodiment, the secondary portion **540** includes an arcuate proximal end **544**. As shown specifically in **FIGS. 41-42**, the side portions of the arcuate proximal end **544** each define a generally concave proximal region **546** and, as shown specifically in **FIGS. 43-44**, the top and bottom portions of the arcuate proximal end **544** each define a generally convex proximal region **548** separated by the generally concave proximal regions **546** of the side portions. Optionally, the exterior surface **550** of the secondary portion **540** may include opposing ridged areas **552** for allowing a medical practitioner to easily grasp the secondary portion **540**. In one embodiment, the opposing ridged areas **552** may be made of a tacky elastomeric material.

[00234] The distal end **554** of the secondary portion **540** may also include an engagement mechanism **556** for engaging the first portion **538**. In one embodiment, the distal end **554** of the secondary portion **540** includes at least one recess **558**, shown in **FIGS. 47-48**, for mating

engagement with a protrusion **560** integral with the proximal end **562** of the first portion **538**. The first portion **538** and the secondary portion **540** may be secured together by a press-fit locking mechanism, a threaded screw mechanism, a bayonet mechanism, or may be adhered together through the use of conventional adhesives. Optionally, the exterior surface **566** of the first portion **538** may also include opposing ridged areas **568** for allowing a medical practitioner to easily grasp the first portion **538**. The cannula **534** may be positioned in part within the interior **42** of the secondary portion **540** and in part within the interior **570** of the first portion **538**, as previously described.

[00235] Optionally, the secondary portion **540** of the present embodiment can include at least one tube preload indicator **572** for indicating to a medical practitioner the appropriate depth to which a specimen collection container, such as an evacuated blood tube, can be inserted without accessing the interior of the evacuated blood tube, such as by penetration of the cannula **534**. Optionally, a portion of the cannula **534** may be protected by a pierceable sleeve **582** disposed about the proximal end of the cannula **534**. In one embodiment, the preload indicator **572** may be a raised or recessed band disposed within the interior or exterior surface of the secondary portion **540**, such as within an interior or exterior surface of the sidewall of the secondary portion **540**. Alternatively, the preload indicator **572** can be a colored or textured band within the interior or exterior of the secondary portion **540**. In another embodiment, the preload indicator **572** can be a continuous or segmented band. In this manner, an evacuated blood collection tube can be “pre-loaded” into the needle assembly **530** prior to use.

[00236] In one embodiment, the hub **564** at least partially supports the cannula **534**, as previously described. The hub **564**, including rear hub portion **574** and forward hub portion **576**, is desirably molded from a transparent or translucent polymeric material or resin. As such, the hub **564**, and in particular forward hub portion **576**, defines a flash chamber **598**. In one embodiment, the rear hub portion **574** engages the forward hub portion **576** through a portion of the secondary portion **540** of the housing **532** to form a sealed flash chamber **598**. In this configuration, the flash chamber **598** can be formed by introduction of the rear hub portion **574** through the interior **542** of the secondary portion **540** for engagement with a portion of the forward hub portion **576** disposed within the interior **570** of the first portion **538**. The housing **532** may include a forward hub portion **576** and a rear hub portion **574** connectable with the forward hub portion **576** and defining the flash chamber therebetween. In one embodiment, a protrusion **580** of the rear hub portion **574** extends through the secondary portion **540** of the housing **532** and matingly engages a corresponding recess

within the forward hub portion **576**. Accordingly, in one configuration, the rear hub portion **574** is connectable with the forward hub portion **576** through at least a portion of a specimen collection container holder **578**, shown in **FIG. 39**. In another configuration, the rear hub portion **576** defines a specimen collection container receiving port **504** therein, shown in **FIG. 55**.

[00237] As shown in **FIG. 49**, in one embodiment at least a portion of the rear hub portion **574** is restrained within the interior **542** of the secondary portion **540**, such that a portion of the flash chamber **598** may be formed within the secondary portion **540**, such as within a blood collection tube holder. In another embodiment, the flash chamber **598** can be formed at least partially within the forward hub portion **576** and at least partially within rear hub portion **574**. In this configuration, a slim profile of the needle assembly **530** can be maintained while increasing the volume of the interior of the flash chamber **598** visible to a medical practitioner when the safety shield **536** is in the retracted position.

[00238] As shown in **FIG. 49**, in one embodiment, the void **598a** formed between the forward hub portion **538** and the rear hub portion **540** may allow for the compression of air therein, thereby creating sufficient pressure to force fluid, such as blood, entering the cannula **534** to be forced into the flash chamber **598**. In one embodiment, the void **598a** is sized to accommodate a sufficient volume of compressed air to force blood entering the cannula **534** into the flash chamber **598**.

[00239] Transition of the safety shield from the retracted position, shown in **FIG. 39** with the removable cannula guard **512** in place, to the extended position, shown in **FIG. 40**, may be effected as previously described. In one embodiment, a spring **584** disposed between a portion of the safety shield **536** and a portion of the housing **532** biases the safety shield **536** toward the extended position. In another embodiment, a release member **508**, such as a push button, may actuate the transition of the safety shield **536** from the retracted position to the extended position, as previously described. Alternatively, the release member **508** may initiate an activator to transition the safety shield **536** from the retracted position to the extended position, also as previously described.

[00240] During transition of the safety shield **536** from the retracted position to the extended position, the spring **584** advances the safety shield **536** from a position at least partially within the first portion **538** of the housing **532** to a location distal from the distal region **586** of the first portion **538**, as shown in **FIGS. 43-44**. In this embodiment, the safety shield **536** is adapted to move between the retracted position, in which at least the puncture tip of the patient end **588** of the cannula **534** is exposed for accessing the patient, and the

extended position in which the puncture tip of the patient end 588 of the cannula 534 is encompassed or otherwise safely shielded from exposure. It is noted that although FIGS. 39, 41, 43, 45, and 47 each show the removable cannula guard 512 disposed over the cannula 534 in the retracted position, the removable cannula guard 512 is removed prior to use of the needle assembly 530, in which the cannula 534 is exposed.

[00241] As shown in FIG 44, in the extended position, the safety shield 536 is retained within the distal region 586 of the first portion 538 by the engagement of proximal rim 590 of the safety shield 536 against distal restraint 592 of the first portion 538. As shown in FIG. 48, also in the extended position, the safety shield 536 is prevented from re-entering the first portion 538 of the housing 532, beyond the engagement at the distal region 586, by the engagement of the proximal rim 590 of the safety shield 536 and the barrier mechanism 594 of the first portion 538 of the housing 532.

[00242] As shown in FIGS. 48, the barrier mechanism 594 may include a locking tab 596 that is deflectable upon transition of the safety shield 536 from the retracted to the extended position, but substantially resists deflection once the safety shield 536 is in the extended position. The locking tab 596 may include a tapered surface 528 which allows the safety shield 536 to advance thereover due to the applied force of spring 584 during transition from the retracted position to the extended position. The locking tab 596 may also include a stopped surface 526 to prevent the safety shield 536 from passing over the locking tab 596 once transition from the retracted position to the extended position has occurred. Therefore, the safety shield 536 of the needle assembly 530 remains locked in place over the cannula 534 once the safety shield 536 has been transitioned from the retracted position to the extended position.

[00243] As shown in FIGS. 51-52, an alternative locking tab 596a may be included within the needle assembly 530. The locking tab 596a includes a similar geometry as described above, permitting transition of the safety shield 536 thereover by deflection when the shield 536 is transitioned from the retracted position to the extended position, and substantially resisting axial deflection once the shield 536 has been transitioned to the extended position. As shown in FIG. 52, a portion of the housing 532 may be disposed about the locking tab 596a to substantially resist deflection in the radial direction as shown by the arrow B in FIG. 52.

[00244] As shown in FIGS. 53-55, during assembly of the present embodiment, the cannula 534 may be joined with the forward hub portion 576 and the rear hub portion 574 to form hub 564 having a flash chamber 598 therein, with the cannula 534 in fluid

communication with the interior of the flash chamber **598**. A spring **584** may be disposed between the forward hub portion **576** and a portion of the safety shield **536**. The safety shield **536** may be inserted within an interior of a second housing portion **532a** through a portion of the release member **508**. As shown in **FIG. 53**, a portion of the housing **536** may include a joining mechanism **522** for engaging a corresponding tab **524** on the hub **564** to engage the hub **564** with a second housing portion **532a**. As shown, locking tabs **596a** may be provided within a distal end of the second housing portion **532a**. When the hub **564** and the second housing portion **532a** are joined, the shield **536** is biased toward the extended position by the spring **584**. However, the release element **508** restrains the bias of the spring in the first position by engaging a shoulder **514** of the safety shield **536** and the restraining portion **520** of the release member **508**. As shown in **FIGS. 53-55**, assembly of the release member **508** may be accomplished for a proximal or rearward direction, however, it is also contemplated herein that assembly may be directed from an upwardly direction, as shown in **FIGS. 65-66**, or from a distally or frontward direction.

[00245] As shown in **FIG. 56**, the hub **564** may be formed by engaging the forward hub portion **576** with the rear hub portion **574**. The cannula **534** may be engaged with and partially supported by at least one of the forward hub portion **576** and the rear hub portion **574**. A porous plug **510** may be disposed between the forward hub portion **576** and the rear hub portion **574** within the flash chamber **598** defined therebetween and in fluid communication with the cannula **534**.

[00246] As shown in **FIGS. 57-58**, a needle assembly **530** may include a non-patient needle **516** (or the non-patient end of the cannula) having a pierceable sleeve **582** disposed thereover and may be aligned with the patient needle **518** through the flash chamber **598** defined within the hub **564**. A spring **584** may be disposed between the forward hub portion **576** and a portion of the safety shield **536**. The safety shield **536** may be inserted within an interior of a second housing portion **532a** through a portion of the release member **508**. The combined safety shield **536**, second housing portion **532a**, hub **564**, and cannula **534** may be inserted within a third housing portion **532b**, such as a specimen collection container holder or a blood collection tube holder.

[00247] It is anticipated herein that the hub **564**, cannula **534**, safety shield **536**, and second housing portion **532a** may be integrally provided within a third housing portion **532b**, such as a blood collection tube holder. Alternatively, hub **564**, cannula **534**, safety shield **536**, and second housing portion **532a** may be provided as a non-integral arrangement in

which the hub **564** may include a specimen collection container receiving port **504**, shown in **FIG. 55**, adapted for later engagement with a specimen collection container.

[00248] As shown in **FIGS. 59-63**, the non-integrated needle assembly **630** is similarly structured to the embodiments described above. In one embodiment, the forward hub portion **674** and the rear hub portion **676** are joined, such as permanently joined, via a weld adjacent the outer circumference **678** of the hub **664**. The flash chamber **698** may be formed between the forward hub portion **674** and the rear hub portion **676**. In another embodiment, at least one of the forward hub portion **674** and the rear hub portion **676** are formed, such as molded, from a transparent or translucent polymeric material or resin. Accordingly, the flash chamber **698** may be visible to a medical practitioner through the hub **664**.

[00249] A first housing portion **632a** may be disposed about at least a portion of the forward hub portion **674** and the safety shield **636** and removable cannula guard **612** may be disposed about the patient end **640** of the cannula **634** and engaged with the first housing portion **632a**, as previously described. A distal cannula guard **646** may be provided for at least partially surrounding the non-patient end **642** of the cannula **634**, prior to use. The distal cannula guard **646** may engage at least a portion of the first housing portion **632a** and can be removed therefrom upon application of typical manual pressure. Both the distal cannula guard **646** and the removable cannula guard **612** are provided to shield the non-patient end **642** of the cannula **634** (or non-patient needle) and the patient end **640** of the cannula **634** (or patient needle) from accidental contact with medical practitioners prior to initiation of a medical procedure.

[00250] The rear hub portion **676** further includes a specimen collection container engagement port **656**, shown in **FIGS. 61** and **63**, which is engageable with a specimen collection container holder **652** (as shown in **FIG. 64**), such as a blood collection tube holder. In another embodiment, the specimen collection container engagement port **656** is directly engageable with a specimen collection container, such as an evacuated blood collection tube. It is further contemplated herein, that a flash chamber similar to the configuration shown in **FIG. 49** with reference to **598**, may be employed within the present design.

[00251] As shown in **FIGS. 65-66**, an additional mechanism **668** of the needle assembly **630** is shown. In this embodiment, the release member **608** is adapted to transition from a first position to a second position, as previously described. Release member **608** further includes a projection **610** which deforms at least a portion of the housing **632**, such as tab portion **638** adjacent the release member **608**, when the release member is transitioned from the first position to the second position. Deformation of the tab portion **638** of the housing

632 restrains the release member **608** in the second position, thereby preventing the release member **608** from returning to the first position.

[00252] **FIGS. 67-72** depict another embodiment of the present invention, in which collection assembly **730**, is similarly constructed to the above-described embodiments, with the exception of the configuration of safety shield **736** and the attachment of safety shield **736** to the housing **732**. Needle assembly **730** generally includes a cannula **734**, associated with the housing **732**, such as supported by a hub **764**, as previously described. A flash chamber **798** is associated with a portion of the housing **732**, such as defined within the hub **764**.

[00253] In the embodiment shown in **FIGS. 67-72**, the safety shield **736** may include a first portion **710**, such as an arm portion, and a second portion **712**, such as a shield portion, with the second portion **712** connected to the first portion **710**. The first portion **710** is configured to slideably engage a portion of the housing **732** along the longitudinal axis **L**, shown in **FIG. 71**, of the cannula **734** when a medical practitioner applies typical manual force to the safety shield **736** substantially in the direction shown by arrow **C**. In one embodiment, the first portion **710** is configured to slideably engage, such as glide along, a glide mechanism **714** integral with the housing **732**. In another embodiment, a portion of the housing **732** and a portion of the safety shield **736** define an engaging glide mechanism **714**, wherein a portion of the safety shield **736** is axially transitionable with respect to a portion of the housing **732**.

[00254] In one embodiment, the first portion **710** includes a protrusion **718** for slideably engaging a groove **720** recessed into a portion of the exterior surface **716** of the housing **732**, thereby establishing a glide mechanism **714**. In another embodiment, the first portion **710** includes a recess for slideably engaging a protrusion extending above the exterior surface **716** of the housing **732**. The first portion **710** may include a grip region **722** for receiving the finger of a medical practitioner to aid in the advancement of the safety shield **736** from the retracted position, shown in **FIG. 67**, to the extended position, shown in **FIG. 68** along the glide mechanism **714**.

[00255] The second portion **712** of the safety shield **736** is adapted to at least partially surround, such as circumferentially surround, a portion of the hub **764** disposed at least partially within the housing **732** when the shield **736** is in the retracted position, such that the flash chamber **798** defined therein, is at least partially visible to a medical practitioner when the safety shield **736** is in the retracted position. In one embodiment, at least a portion of the flash chamber **798** is visible to a medical practitioner through an observation window **724** or cutaway portion within the second portion **712** of the safety shield **736**. In another

embodiment, the second portion 712 of the safety shield 736 may be constructed of a transparent material and/or translucent material, such that the flash chamber 798 may be visible therethrough.

[00256] In this embodiment, the safety shield 736 is adapted to move between a retracted position, as shown in FIG. 67, in which at least the puncture tip of the patient end 740 of the cannula 734 is exposed for accessing the patient, and an extended position, shown in FIG. 68, in which the puncture tip of the cannula 734 is encompassed or otherwise safely shielded from exposure. The second portion 712 of the safety shield 736 is adapted to at least partially surround, such as circumferentially surround, at least a portion of the cannula 734 in the extended position. In another embodiment, the patient end 740 of the cannula 734 is at least partially surrounded by the second portion 712 of the safety shield in the extended position.

[00257] The safety shield 736 may be deployed over the cannula 734 while the cannula 734 is accessing the interior of the patient's blood vessel (not shown), or after the cannula 734 has been removed from the patient. If the transition of the safety shield 736 from the retracted position to the extended position occurs while the cannula 734 is accessing the interior of a patient's blood vessel, the distal portion 744 of the safety shield 736, such as of the second portion 712 of the safety shield 736, will contact the patient's skin. In one embodiment, the safety shield 736 includes a detent mechanism to temporarily restrain the safety shield 736 in a retracted position and a locking mechanism 750 adapted to maintain the safety shield 736 in the extended position after it is moved thereto. As shown in FIG. 71, the first portion 710 of the safety shield 736 may include a locking mechanism 750 which is deflected or otherwise radially biased against a portion of the housing 732, such as by a portion of the first portion 710, when the safety shield 736 is in the retracted position. As shown in FIG. 72, once the safety shield 736 is transitioned to the extended position, the locking mechanism 750 is advanced, such as longitudinally advanced along the longitudinal axis L of the cannula 734 until contact with the housing 732 is disrupted. At this point, the radially biasing forces maintaining the locking mechanism 750 in a substantially parallel orientation with respect to the cannula 734 are released, and the locking mechanism swings toward the cannula 734, as shown by arrow D, to engage a distal end of the housing 732. Once the locking mechanism 750 is engaged with the distal end of the housing 732, retraction of the safety shield 736 from the extended position to the retracted position is prevented.

[00258] An alternative needle assembly 830 having a glideable safety shield 836 is shown and described with reference to FIGS. 73-86. In this configuration, the needle assembly 830 generally includes a cannula 834 associated with a portion of the housing 832, and a safety

shield **836** adapted for safety shielding of the cannula **834** during and/or after use of the device. A proximal portion **838** of the interior of housing **832** may be configured to receive an evacuated blood collection tube (not shown) therein and may include an interior ridge **840**, as shown in **FIG. 76**, for limiting the advancement of the evacuated blood collection tube through the proximal portion **838** of the housing **832**.

[00259] The cannula **834**, may include a distal patient needle **44** (or a patient end of a single cannula) and a proximal non-patient needle **46** (or a non-patient end of a single cannula). The proximal non-patient needle **46** may be provided for puncturing of an evacuated blood collection tube (not shown). Distal patient needle **44** may be beveled to define a puncture tip for puncturing the skin of a patient and accessing the patient's vasculature. The cannula **834** is supported by at least a portion of the housing **832**, such as a hub portion **864**. A flash chamber **898** may be defined within the hub **864** as previously described. In one embodiment, the hub **864** and the cannula **834** can be integrally formed with the remainder of the housing **832**. Alternatively, the hub **864** and/or the cannula **834** can be separately formed and subsequently assembled.

[00260] In the embodiment shown in **FIGS. 73-86**, the safety shield **836** may include a first portion **810**, such as an arm portion, and a second portion **812**, such as a shield portion. The first portion **810** and the second portion **812** are connected. The first portion **810** may include a grip portion **814** for receiving the finger of a medical practitioner to aid in the advancement of the safety shield **836** from the retracted position in which the patient end **44** is exposed, shown in **FIGS. 75-79**, to the extended position in which the patient end **44** is shielded, shown in **FIGS. 82-86**.

[00261] The safety shield **836** is configured to slideably engage a portion of the hub **864** along a glide mechanism **816** established by the interface of an upper surface **820** of the hub **864** and a lower surface **818** of the safety shield **836**, such as a lower surface of the second portion **812** of the safety shield **836**. The interface of the upper surface **820** and the lower surface **818** may be provided as a frictional slide between the two surfaces. Alternatively, the upper surface **820** may be provided with a protrusion (not shown), as previously described, for receipt within a corresponding groove (not shown), as previously discussed, within a portion of the lower surface **818**. Alternatively, the upper surface **820** may be provided with a groove (not shown) for receipt of a protrusion (not shown) extending from a portion of the lower surface **818**.

[00262] In one embodiment, the first portion **810** of the shield **836** may slideably engage a portion of the hub **864** along the longitudinal axis **T** (shown in **FIG. 75**) of the cannula **834**.

As shown in **FIG. 77**, the first portion **810** of the shield **836** may have a first end **850** which slideably engages a portion of the hub **864**, such that the lower surface **818** of the shield **836** slideably engaged the upper surface **820** of the hub **864**. The first portion **810** of the shield **836** may also have a second end **852**, shown in **FIGS. 77-78**, extending at least partially through a portion of the housing **832**. In another embodiment, the second end **852** of the first portion **810** may extend at least partially through a portion of the outer surface **856** of the housing **832**. In yet another embodiment, as shown in **FIG. 75**, the second end **852** of the first portion **810** extends at least partially through a groove **858** defined in the outer surface **856** of the housing **832**. The groove **858** may extend within the housing **832** substantially along the longitudinal axis **T** of the cannula **834**. The first portion **810** of the shield **836** may slide within the groove **858** as the shield **836** is transitioned from the retracted position to the extended position. In another embodiment, as shown in **FIG. 74**, the first portion **810** may have a contoured surface **868** that substantially corresponds to a distal contoured surface **870** of the housing **832**.

[00263] The second portion **812** of the safety shield **836** is adapted to at least partially surround, such as circumferentially surround, at least a portion of the hub **864** in the retracted position. In one embodiment, the second portion **812** is disposed about a portion of the cannula **834** and axially aligned with a portion of the first portion **810** to transition about the cannula **834** from the retracted position to the extended position.

[00264] The safety shield **836** may also be prevented from unintentional advancement from the housing **832**, prior to initiation by a medical practitioner, by the resistance engagement of a portion of the shield **836** with a portion of the housing **832** and/or hub **864**. Upon application of force by a medical practitioner to the grip portion **814** in the direction shown by arrow **R** in **FIG. 77**, the safety shield **836** is advanced in a distal direction along the longitudinal axis **T**, shown in **FIG. 75**, from the housing **832**.

[00265] With reference to **FIGS. 79** and **86**, the safety shield **836** may include restraining means **874** for preventing transition of the shield **836** from the extended position to the retracted position, once the shield **836** has been transitioned from the retracted position to the extended position. During transition of the safety shield **836** from the retracted position to the extended position, a proximal protrusion **876** of the safety shield **836** is advanced through a restraint notch **878** within the housing **832** and/or hub **864**, such as within the glide mechanism **816**.

[00266] The restraint notch **878** may include a triangular portion **880** structured to allow the proximal protrusion **876** of the safety shield **836** to easily pass therethrough, and a

restraining surface **882** structured to prevent re-entry of the proximal protrusion **876** of the safety shield **836** once the transition of the safety shield **836** from the retracted position to the extended position has occurred. In this manner, once the safety shield **836** has shielded the patient end **844** of the cannula **834**, the safety shield **836** may not re-enter the housing **832**.

[00267] In one embodiment, the flash chamber **898** is at least partially visible to a medical practitioner when the safety shield **836** is in the retracted position. Accordingly, a portion of the shield **836**, such as the second portion **812**, may be constructed of a transparent material and/or translucent material, such that the flash chamber **898** may be visible therethrough.

[00268] FIGS. **87-91** depict another embodiment of the present invention, in which collection assembly **930** is constructed as similarly described above, with the exception of the configuration of safety shield **936** and the attachment of safety shield **936** to the housing **932**. Needle assembly **930** generally includes cannula **934** associated with the housing **932**, and a safety shield **936** adapted for safety shielding of the cannula **934** during and/or after use of the device. Needle assembly **930** further includes a hub **964** for supporting the cannula **934** and defining a flash chamber **998**, as previously described, therein.

[00269] In the embodiment shown in FIGS. **87-91**, a safety shield **936** includes a depending arm **940** attached to the exterior surface **942** of the housing **932**. The depending arm **940** may include a plurality of extendable segments **948**, such as first extendable segment **944** connected to second extendable segment **950**. In one embodiment, the first extendable segment **940** may be pivotally or hingedly connected, such as by a pivot **956**, to the base portion **952** of the depending arm **940**, allowing the first extendable segment **944** to articulate with respect to the base portion **952**. In another embodiment, the second extendable segment **950** may be pivotally or hingedly connected, such as by a pivot **956**, to the first extendable segment **944**, allowing the second extendable segment **950** to articulate with respect to the first extendable segment **944**.

[00270] In one embodiment, the depending arm **940** of the shield **936** is oriented on a first side of the cannula **934**. In another embodiment, the shield **936** includes a second depending arm **970**, as similarly described, oriented on a second side of the cannula **934**, with the second side being substantially opposite the first side. In a further embodiment, the depending arm **940** and the second depending arm **970** may be connected, such as by a union **972**. In another embodiment, the depending arm **940** and the second depending arm **970** may be connected by at least one pivot **956**. In a further embodiment, a pivot **956** may provide for an articulation of less than 180 degrees.

[00271] In one embodiment, the orientation of the depending arm 940 and the second depending arm 970 provides for the flash chamber 998 to be easily viewed when the shield is in the retracted position. In the retracted position, as shown in FIG. 87, the extendable segments 948 are oriented in a substantially lateral orientation, such that a distal alignment end 976 of the first extendable segment 944 is spaced apart from a proximal alignment end 978 of the second extendable segment 950. In one embodiment, the distal alignment end 976 of the first extendable segment 944 is offset or positioned within a distinct longitudinal plane from the proximal alignment end 978 of the second extendable segment 950 in the lateral orientation. In a further embodiment, at least one of the distal alignment end 976 of the first extendable segment 944 and the proximal alignment end 978 of the second extendable segment 950 are offset from the transition axis W of the shield 936 in the lateral orientation.

[00272] The safety shield 936 may be transitioned from the retracted position to the extended position by the application of manually applied force to the release member 982 in the direction as shown by arrow H, shown in FIG. 87. In the partially extended position, as shown in FIG. 88, the forward urging of the base portion 952 initiates the first extendable segment 944 to articulate about the pivot 956 until a proximal end 960 reaches the apex position (shown in FIG. 88). As shown in FIG. 89, movement of the first extendable segment 944 advances the second extendable segment 950 through pivot 956. Such movement may be accomplished by continued forward movement of release member 982 in the direction of arrow H, shown in FIG. 87, which causes movement of the base portion 952, which in turn articulates the first extendable segment 944. Alternatively, the extendable segments 948 may be constructed of a material having resiliency, so as to effect automatic movement once the first extendable segment 944 reaches an apex, thereby creating a mechanism for automatic continued movement. In order to accommodate this motion, the free end 986 of the second extendable segment 950 is advanced along the transition axis W, shown in FIG. 87.

[00273] In the fully extended position, as shown in FIG. 91, the first extendable segment 944 and the second extendable segment 950 are oriented in a substantially parallel orientation with respect to each other along substantially the same longitudinal plane as the cannula 934 in shielding orientation of the cannula 934. In the fully extended position the extendable segments 948 are substantially longitudinally oriented, such that a distal alignment end 976 of the first extendable segment 944 is substantially adjacent the proximal alignment end 978 of the second extendable segment 950. In one embodiment, the distal alignment end 976 of the

first extendable segment **944** contacts the proximal alignment end **978** of the second extendable segment **950** along the same longitudinal plane **W**, as shown in **FIG. 91**.

[00274] The safety shield **936**, specifically the first extendable segment **944** and the second extendable segment **950**, may have any suitable dimensions and configuration such that they are adapted to shield the cannula **934**, and in particular the puncture tip thereof, when the safety shield **936** is in the extended position. The safety shield **936** may be deployed over the cannula **934** while the cannula **934** is accessing the interior of the patient's blood vessel (not shown), or after the cannula **934** has been removed from the patient. A locking mechanism, as similarly described herein, may further be employed to prevent transition of the shield **936** from the extended position to the retracted position once the shield **936** has been transitioned from the retracted position to the extended position.

[00275] In one embodiment, the flash chamber **998** may be visible to medical practitioners in both the retracted position and the extended position, as well as in the partly extended position. In another embodiment, transition of the safety shield **936** from the retracted position to the extended position is accomplished without obstructing the view of the flash chamber **998**. In this configuration, articulation of the safety shield **936** occurs remotely from the viewpath of the flash chamber **998**. For example, the pivots **956** may be positioned on the bottom portion of needle assembly **930**, so as not to obstruct a direct top-line view of the flash chamber **998** by a medical practitioner.

[00276] **FIGS. 92-93** depict another embodiment of the present invention, in which needle assembly **1030** is similarly as described above, with the exception of the configuration of safety shield **1036** and the attachment of safety shield **1036** to the housing **1032**. Needle assembly **1030** generally includes a cannula **1034** associated with the housing **1032**, and a safety shield **1036** adapted for safety shielding of the cannula **1034** during and/or after use of the device. Needle assembly **1030** further includes a hub **1064** for supporting the cannula **1034** and defining a flash chamber **1098** therein, as previously described. At least a portion of the hub **1064** and the flash chamber **1098** are visible through a portion of the safety shield **1036** in the retracted position.

[00277] In one embodiment, the shield **1036** includes a depending arm **1006** transitionable from a first position, shown in **FIG. 92**, in which the depending arm **1006** is substantially perpendicular to the longitudinal axis **S** of the cannula **1034** (shown in **FIG. 92**), to a second position, shown in **FIG. 93**, in which the depending arm is substantially oriented along the longitudinal axis **S** of the cannula **1034**. In one embodiment, the depending arm **1006** may

include a first portion **1008** and a second portion **1010** pivotally or hingedly connected therebetween.

[00278] A portion of the shield **1036** is adapted to at least partially surround, such as circumferentially surround, at least a portion of the tip of the cannula **1034** in the extended position shown in **FIG. 93**. In one embodiment, the flash chamber **1098** is at least partially visible to a medical practitioner when the safety shield **1036** is in the retracted position. In the retracted position, the first portion **1008** and the second portion **1010** are oriented in a substantially perpendicular orientation with respect to the axis of the cannula **1034**, and substantially parallel to each other in the extended position. The shield may further include a circular portion **1088** disposed circumferentially about a portion of the cannula **1034**. In one embodiment, once the first portion **1008** and the second portion **1010** are aligned in substantially parallel orientation, the circular portion **1088** may be advanced over the depending arm **1006**, such as over the hinge **1090** connecting the first portion **1008** and the second portion **1010**, thereby locking the hinge **1090** in place.

[00279] In another embodiment, shown in **FIGS. 94-106**, another alternative hinged assembly embodiment of the present invention 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.

[00280] In the embodiment shown in **FIGS. 94-106**, 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**.

[00281] 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. 98-101** to an extended position, as shown in **FIGS. 102-104**. 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.

[00282] As shown in **FIG. 97**, 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**.

[00283] 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. 97**, 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.

[00284] Referring again to **FIG. 97**, 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. 98-101**.

[00285] 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. 98-101**, 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. 102-104**. 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.

[00286] 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. 105-106**, 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. 106**, 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.

[00287] **FIGS. 107-121** depict yet another alternative hinged assembly embodiment of the present invention. A needle assembly **5000**, as shown in **FIGS. 107-113**, 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.

[00288] 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.

[00289] 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.

[00290] 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. 112** and **114**, 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. 115**. 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**.

[00291] Referring again to **FIGS. 107-113**, 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.

[00292] 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. 115-121**, 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**.

[00293] In another embodiment, shown in **FIG. 114**, 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**.

[00294] As shown in **FIGS. 115-121**, the needle assembly **30c2** can be transitioned from the retracted position, shown in **FIG 114**, 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. 107-121**, 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.

[00295] In an alternative embodiment, as shown in **FIG. 122**, 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.

[00296] 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. 122** to an extended position, as previously described.

[00297] In yet another embodiment of the invention, shown in **FIGS. 123-125**, the needle assembly **1130** includes a specimen collection container holder **1101** having a pierceable or

punctureable shield **1102** disposed over the proximal end **1103** of the specimen collection container holder **1101** to provide a sterile environment within the interior of the specimen collection container holder **1101** prior to use. In one embodiment, the pierceable or punctureable shield **1102** is made of a paper, polymeric, and/or thin metal film having perforated sections therein which may be pierced by standard manually applied pressure. In use, a medical practitioner may insert any conventionally known specimen collection container **1105**, such as a blood collection tube, into the proximal end **1103** of the specimen collection container holder **1101** through the pierceable or punctureable shield **1102**.

[00298] The needle assembly **1130** may then be used in any manner as previously described herein to perform a medical procedure and/or shield a cannula **1134** after use. After use, the pierceable or punctureable shield **1102** may remain attached to the specimen collection container holder **1101** to provide a clear indication of use of the needle assembly **1130**. Accordingly, a needle assembly **1130** including a pierceable or punctureable shield **1102** provides a clear tamper and/or use indicator to a medical practitioner. The pierceable or punctureable shield **1102** described herein is suitable for use with any of the above-described collection assemblies. It is further contemplated that a separate, removable liner (not shown) may be affixed, such as through a removable adhesive, over the outer surface of shield **1102**. Such a removable liner provides further sterility and barrier protection prior to the use. In addition, the pierceable or punctureable shield **1102** may be applied to the proximal end **1103** of the specimen collection container holder **1101** as a prepackaged device with the need for additional external packaging.

[00299] **FIGS. 126-131** illustrate yet a further embodiment of the present invention in which the housing **7000** of a needle assembly, shown in **FIGS. 130-131**, as previously described herein, includes a base portion **7002**, shown in **FIGS. 126-127**, and a hub portion **7004**, shown in **FIGS. 128-129**, engageable with the base portion **7002**. Referring to **FIGS. 126-127**, the base portion **7002** has a distal end **7006** and a proximal end **7008** with a sidewall **7010** extending therebetween. In one embodiment, the sidewall **7010** defines at least one opening **7012** through which a first portion **7016** of the hub **7004**, shown in **FIG. 128**, may be received. In another embodiment, the opening **7012** is adapted to allow a first portion **7016** of the hub **7004**, to pass from an interior **7022** of the base portion **7002** through the sidewall **7010** to a position external to the interior **7022** of the base portion **7002**. In another embodiment, the sidewall **7010** defines a second opening **7014** through which a second portion **7018** of the hub **7004**, shown in **FIG. 128**, may be received. In yet another embodiment, the first opening **7012** of the base portion **7002** may be aligned in a

substantially opposed orientation with respect to the second opening **7014**, such that the first opening **7012** and the second opening **7014** are aligned along a common through-axis **Z**, as shown in **FIG. 126**. In a further embodiment, the sidewall **7010** of the base portion **7002** may include a release member opening **7020** through which a release member **7040**, shown in **FIGS. 130-131** and as previously described, may be received.

[00300] As shown in **FIGS. 128-129**, the hub **7004** may include a first portion **7016** extending in a substantially radial orientation from a body portion **7024** of the hub **7004**. In another embodiment, the hub **7004** may include a second portion **7018** extending in a substantially radial orientation from the body portion **7024** of the hub **7004** and aligned in a substantially opposed orientation with respect to the first portion **7016**, such that the first portion **7016** and the second portion **7018** are aligned at least partially along a common axis **Y**, as shown in **FIG. 128**. In another embodiment, the common axis **Y** of the hub portion **7004** may be alignable with the through-axis **Z** of the base portion **7002**, shown in **FIG. 126**.

[00301] As shown in **FIGS. 130-131**, the hub portion **7004** may be at least partially insertable within the base portion **7002** such that the first portion **7016** of the hub **7004** extends at least partially through the opening **7012** defined within the sidewall **7010** of the base portion **7002**. In another embodiment, the hub portion **7004** may be at least partially insertable within the base portion **7002** such that the first portion **7016** of the hub portion **7004** extends at least partially through the opening **7012** defined within the sidewall **7010** of the base portion **7002**, and the second portion **7018** of the hub extends at least partially through the second opening **7014** defined within the sidewall **7010** of the base portion **7002**. In yet another embodiment, the hub portion **7004** may be insertable into the interior **7022** of the base portion **7002** through the proximal end **7008**. In yet another embodiment, at least one of the first portion **7016** and the second portion **7018** are deflectable against an interior wall **7026** of the interior **7022** of the base portion, such as adjacent the proximal end **7008** during insertion of the hub portion **7004** into the base portion **7002**. In yet a further embodiment, at least one of the first portion **7016** and the second portion **7018** include a gripable region **7030** enabling a user to easily contact the housing **7000** when the hub portion **7004** is disposed within the base portion **7002**. In one embodiment, the gripable region **7030** includes a plurality of ribs **7032**.

CLAIMS

1. A needle assembly, comprising:

a housing having a proximal end, a distal end, and sidewall extending therebetween, the housing comprising a flash chamber and a specimen collection container holder, the specimen collection container holder adjacent the proximal end of the housing, a sidewall of the specimen collection container holder spaced a distance apart from the sidewall of the housing;

a cannula having a patient end, a non-patient end, and a sidewall extending therebetween defining a cannula interior, the patient end of the cannula projecting at least partially from the distal end of the housing, the cannula interior in fluid communication with the flash chamber; and

a shield, at least a portion of which is restrainably engaged between the sidewall of the housing and the sidewall of the specimen collection holder, the shield axially transitionable over the patient end of the cannula between a retracted position in which the patient end is exposed and an extended position in which the patient end is shielded by at least a portion of the shield, wherein at least a portion of the flash chamber is visible in the retracted position,

wherein at least one of the distal end of the housing and a proximal end of the shield comprises a barrier mechanism engageable with the other of the distal end of the housing and the proximal end of the shield wherein at least a portion of the barrier mechanism is associated with the shield and is located external to the housing when the shield is in the extended position for cooperating with a portion of the housing to prevent transition of the shield from the extended position to the retracted position and wherein the barrier mechanism associated with the shield comprises a pair of locking members and the barrier mechanism further includes an inwardly directed restraint associated with the distal end of the housing and wherein the restraint is disposed between the pair of locking members when the shield is in the extended position for preventing transition of the shield from the extended position to the retracted position.

2. The needle assembly of claim 1, wherein the axially transitionable shield is telescoped over the patient cannula from the retracted position to the extended position.

3. The needle assembly of claim 1, wherein the flash chamber is visible through at least a portion of the shield in the retracted position.

4. The needle assembly of claim 3, wherein the portion of the shield, through which the flash chamber is visible, is transparent or translucent.

5. The needle assembly of claim 1, wherein the shield at least partially surrounds the patient end of the cannula in the extended position.

6. The needle assembly of claim 1, wherein the sidewall of the cannula defines an opening extending between the cannula interior and the flash chamber.

7. The needle assembly of claim 1, wherein the cannula comprises at least two distinct needle portions.

8. The needle assembly of claim 7, wherein the cannula comprises a patient needle in fluid communication with the flash chamber and a non-patient needle in fluid communication with the flash chamber.

9. The needle assembly of claim 8, wherein the patient needle projects at least partially from the distal end of the housing, and wherein the non-patient needle extends in a substantially proximal direction from the patient needle.

10. The needle assembly of claim 1, wherein the flash chamber is integrally formed within a portion of the housing.

11. The needle assembly of claim 1, wherein the housing further comprises a hub supporting at least a portion of the cannula.

12. The needle assembly of claim 11, wherein the flash chamber is integrally formed with the hub.

13. The needle assembly of claim 1, wherein at least a shielding portion of the shield is restrainably engaged within an interior portion of the housing in the retracted position, and the shielding portion of the shield extends from the interior portion of the housing in the extended position.

14. The needle assembly of claim 13, wherein the interior portion of the housing is circumferentially disposed about a specimen collection container receiving port defined within the housing.

15. The needle assembly of claim 14, wherein the interior portion of the housing is co-axial with the specimen collection container receiving port.

16. A blood collection assembly, comprising:

a housing, comprising a flash chamber, having a distal end and a proximal end, and a blood collection container holder adjacent the proximal end;

a patient cannula having a cannula tip and defining a patient cannula interior, projecting at least partially from the distal end of the housing, the patient cannula interior in fluid communication with the flash chamber;

a non-patient cannula, defining a non-patient cannula interior, extending in a substantially proximal direction from the patient cannula within at least a portion of the blood collection container holder, the non-patient cannula interior in fluid communication with the flash chamber;

a shield restrainably engaged within a portion of the housing and axially transitionable over the patient cannula between a retracted position, in which the patient cannula is exposed and an extended position, in which the cannula tip is shielded by at least a portion of the shield, wherein at least a portion of the flash chamber is visible in the retracted position, and

a release element transitionable from a first position to a second position, wherein the shield moves to the extended position upon transition of the release element from the first position to the second position,

wherein at least one of the distal end of the housing and a proximal end of the shield comprises a barrier mechanism engageable with the other of the distal end of the housing and the proximal end of the shield wherein at least a portion of the barrier mechanism is associated with the shield and is located external to the housing when the shield is in the extended position for cooperating with a portion of the housing and wherein the release element is at least partially restrained by a portion of the shield to prevent transition of the shield from the extended position to the retracted position.

17. The blood collection assembly of claim 16, further comprising a spring, wherein the shield is biased against a portion of the housing by the spring when the shield is in the retracted position.

18. The blood collection assembly of claim 17, wherein the spring biases the shield to the extended position upon transition of the release element from the first position to the second position.

19. The blood collection assembly of claim 18, wherein the release element is a push button.

20. A blood collection assembly, comprising:

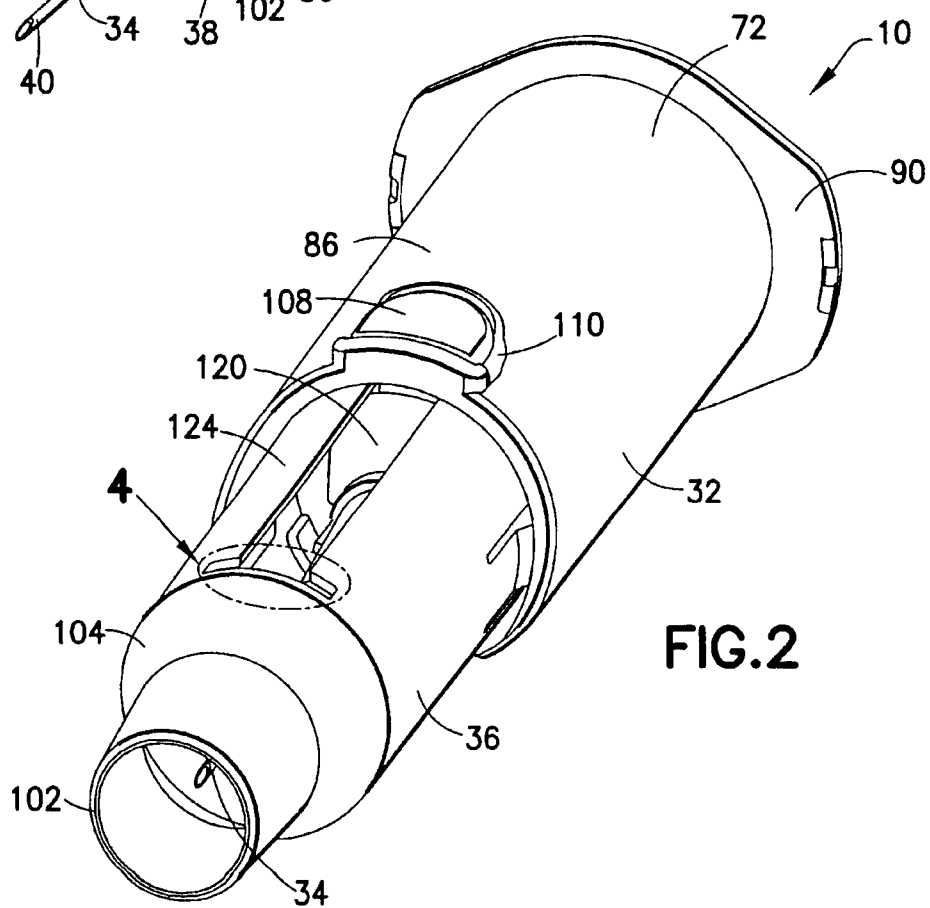
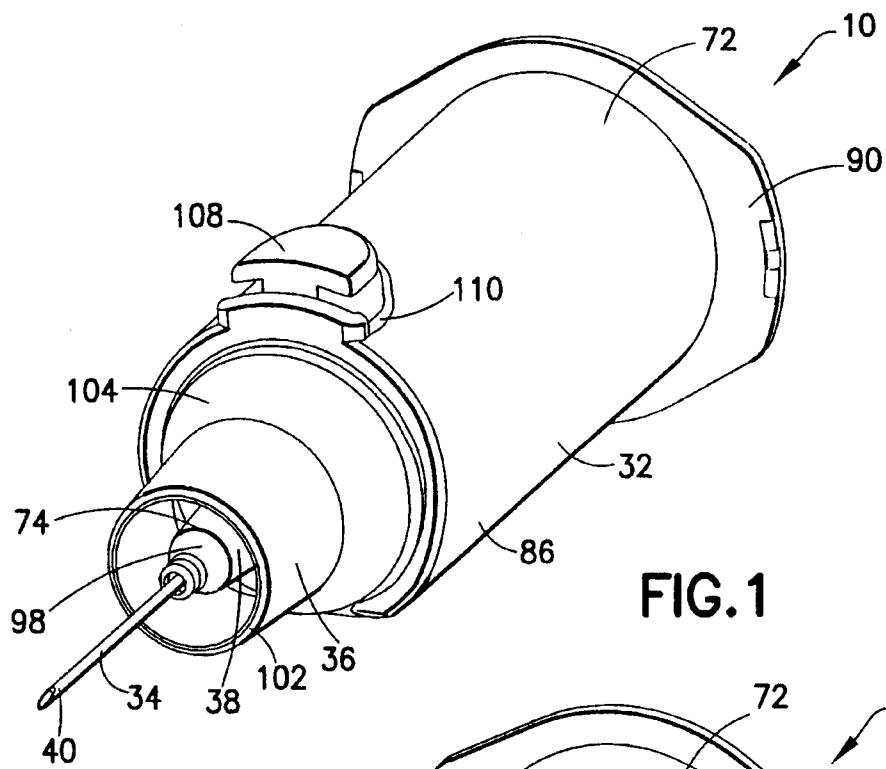
a housing having a proximal end, a distal end, and a sidewall extending therebetween, the housing comprising a flash chamber and a blood collection container holder, the blood collection container holder adjacent the proximal end of the housing, a sidewall of the blood collection holder spaced a distance apart from the sidewall of the housing;

a patient cannula having a cannula tip and defining a patient cannula interior, projecting at least partially from the distal end of the housing, the patient cannula interior in fluid communication with the flash chamber;

a non-patient cannula, defining a non-patient cannula interior, extending in a substantially proximal direction from the patient cannula within at least a portion of the blood collection container holder, the non-patient cannula interior in fluid communication with the flash chamber; and

a shield, at least a portion of which is restrainably engaged between the sidewall of the housing and the sidewall of the blood collection holder, the shield axially transitionable over the patient end of the cannula from a retracted position in which the patient end is exposed and at least a portion of the flash chamber is visible, to an extended position in which the patient end is shielded by at least a portion of the shield.

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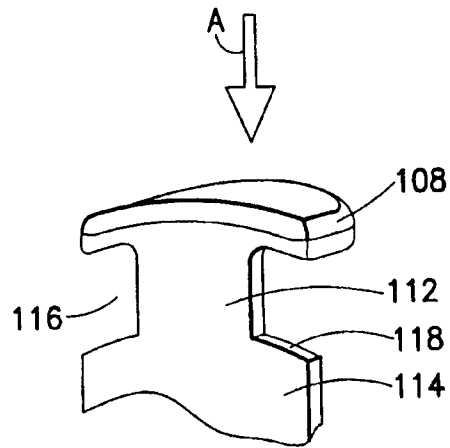


FIG. 3

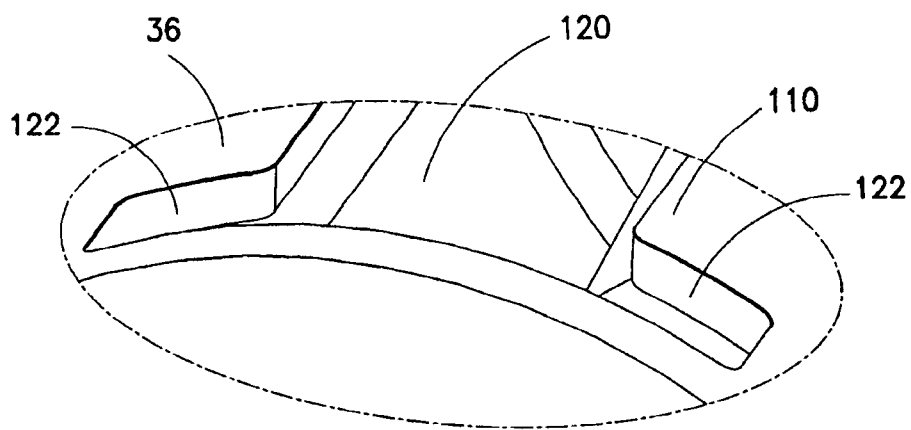
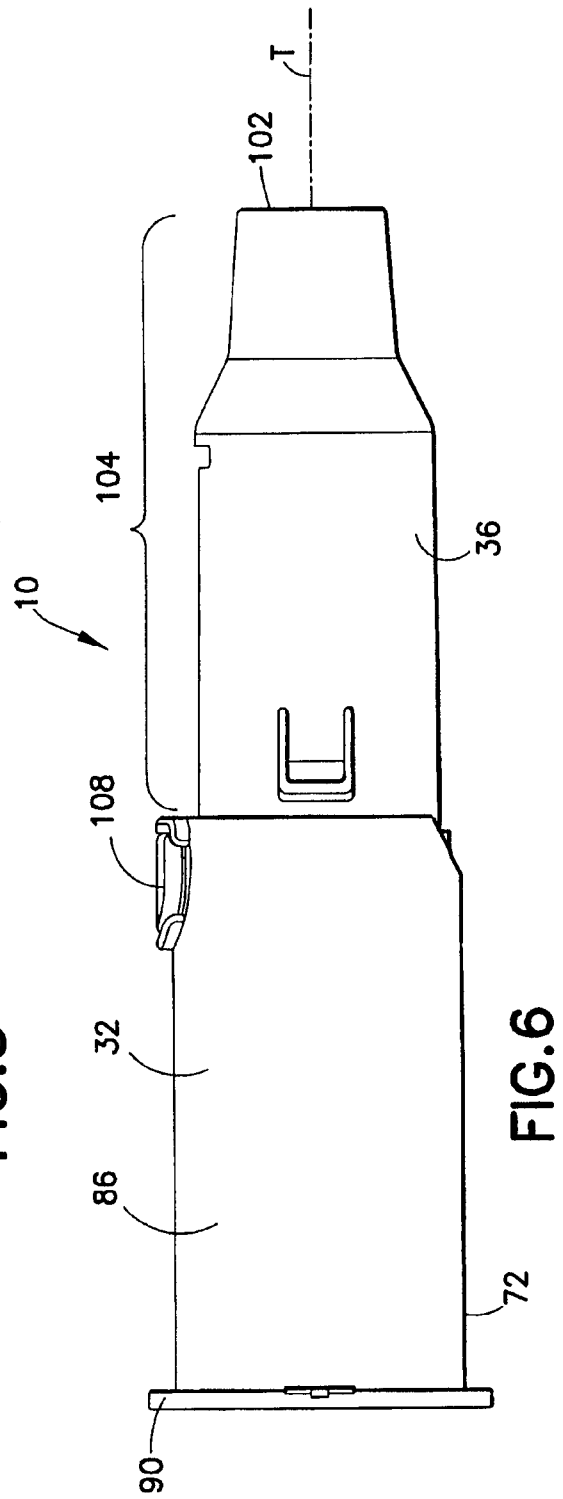
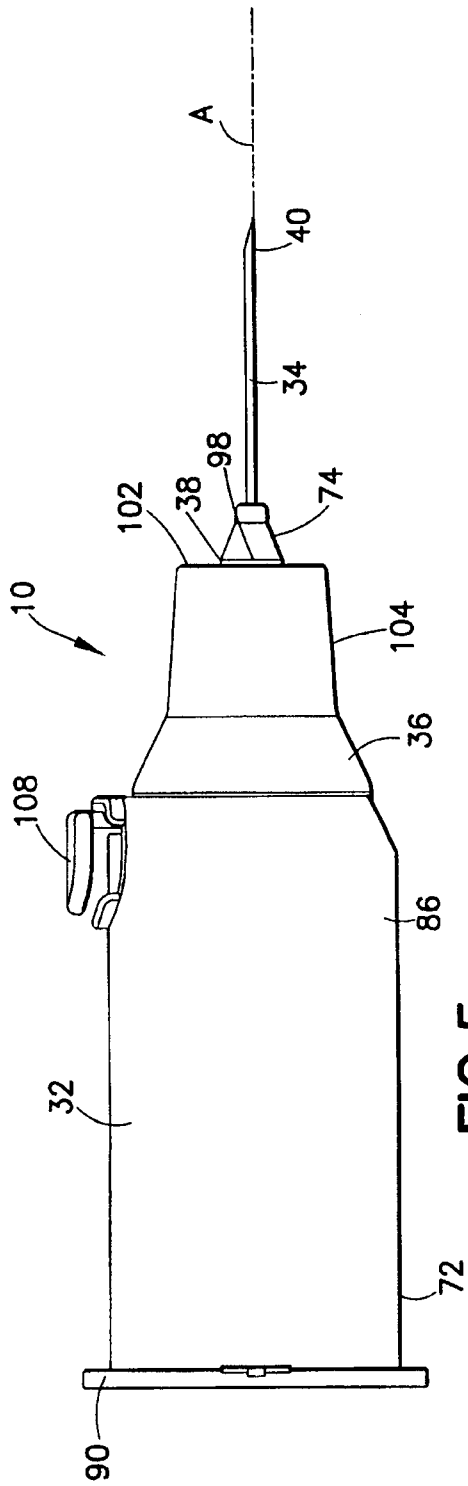


FIG. 4



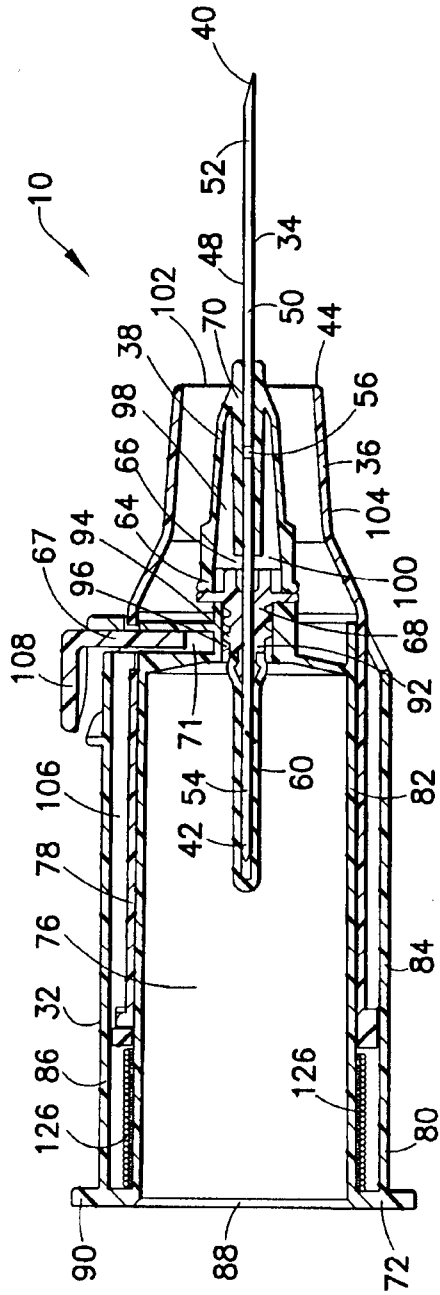


FIG. 7

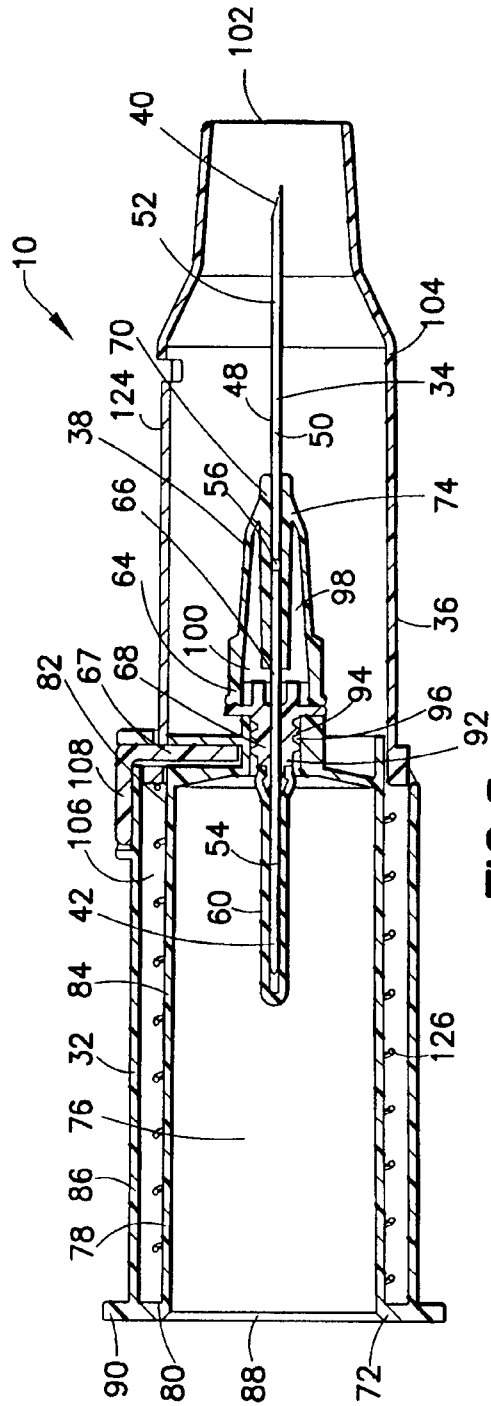


FIG. 8

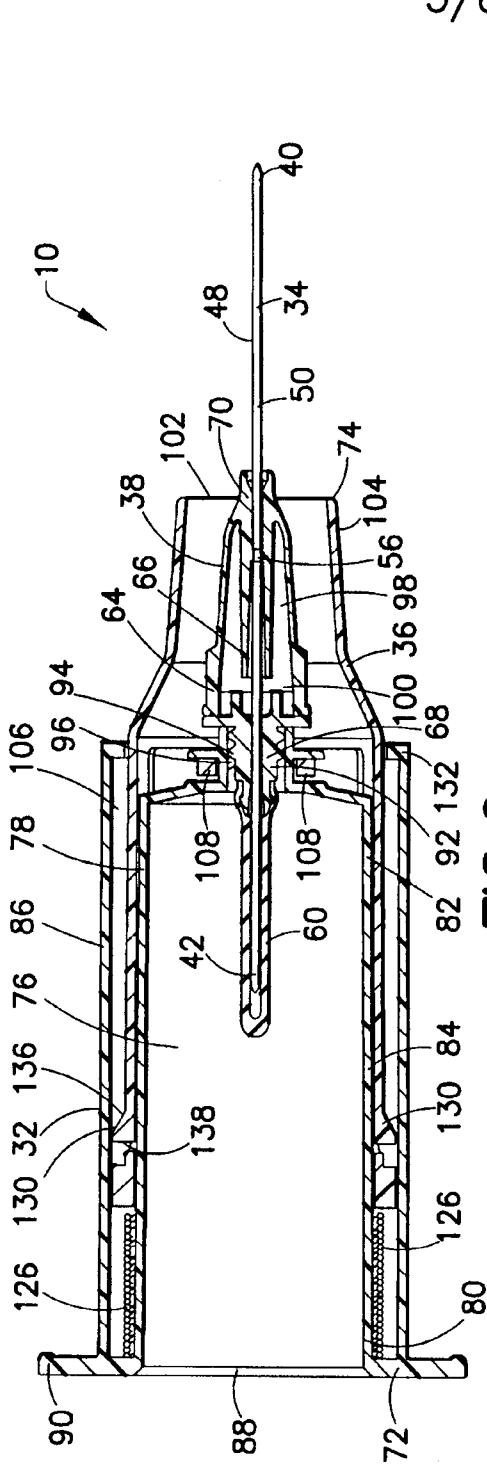


FIG. 9

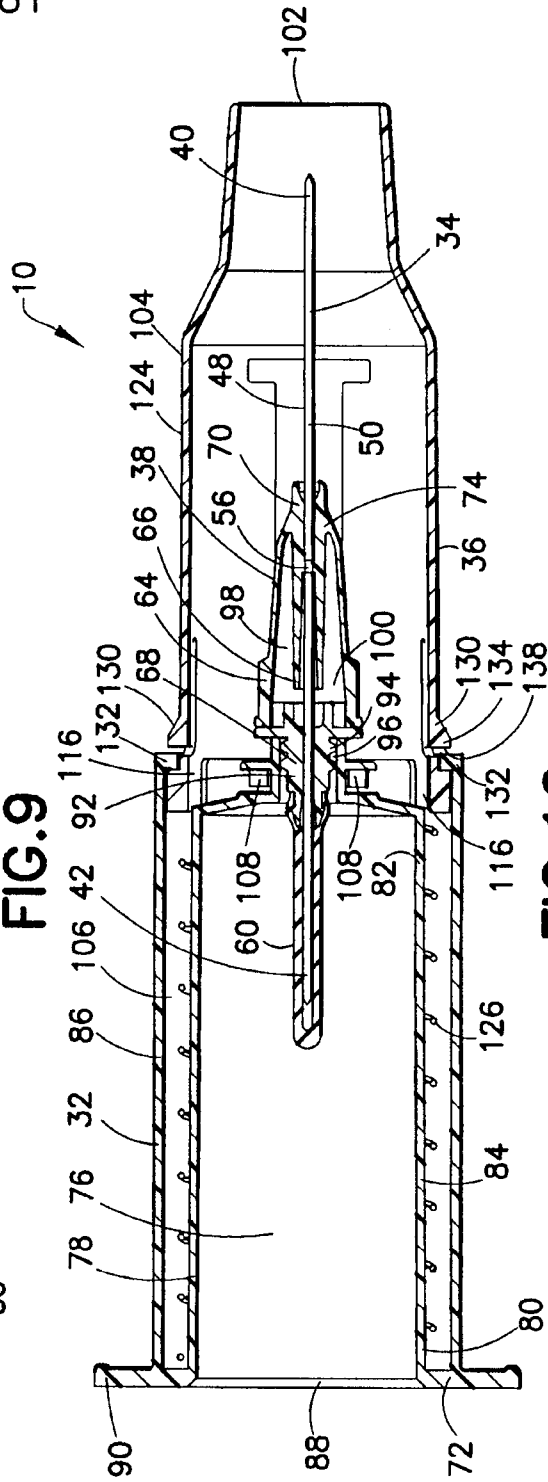


FIG. 10

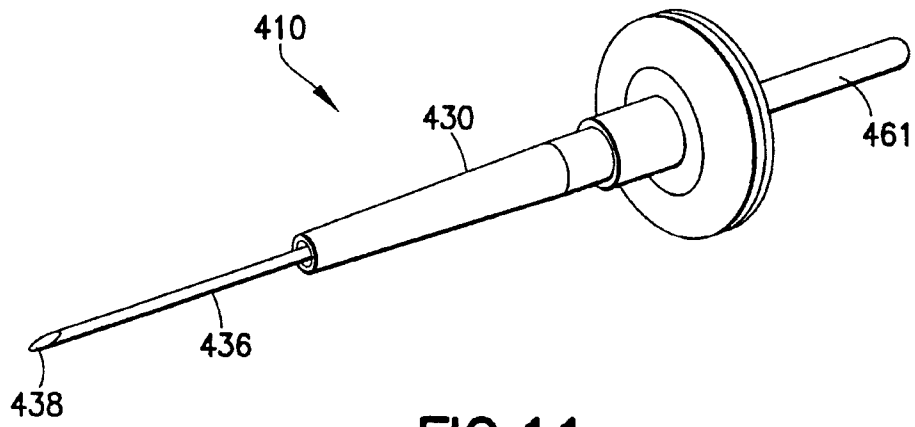


FIG. 11

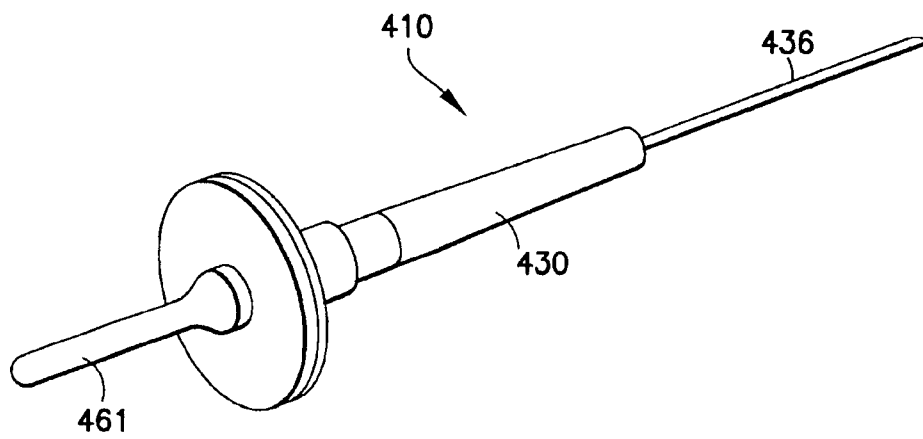


FIG. 12

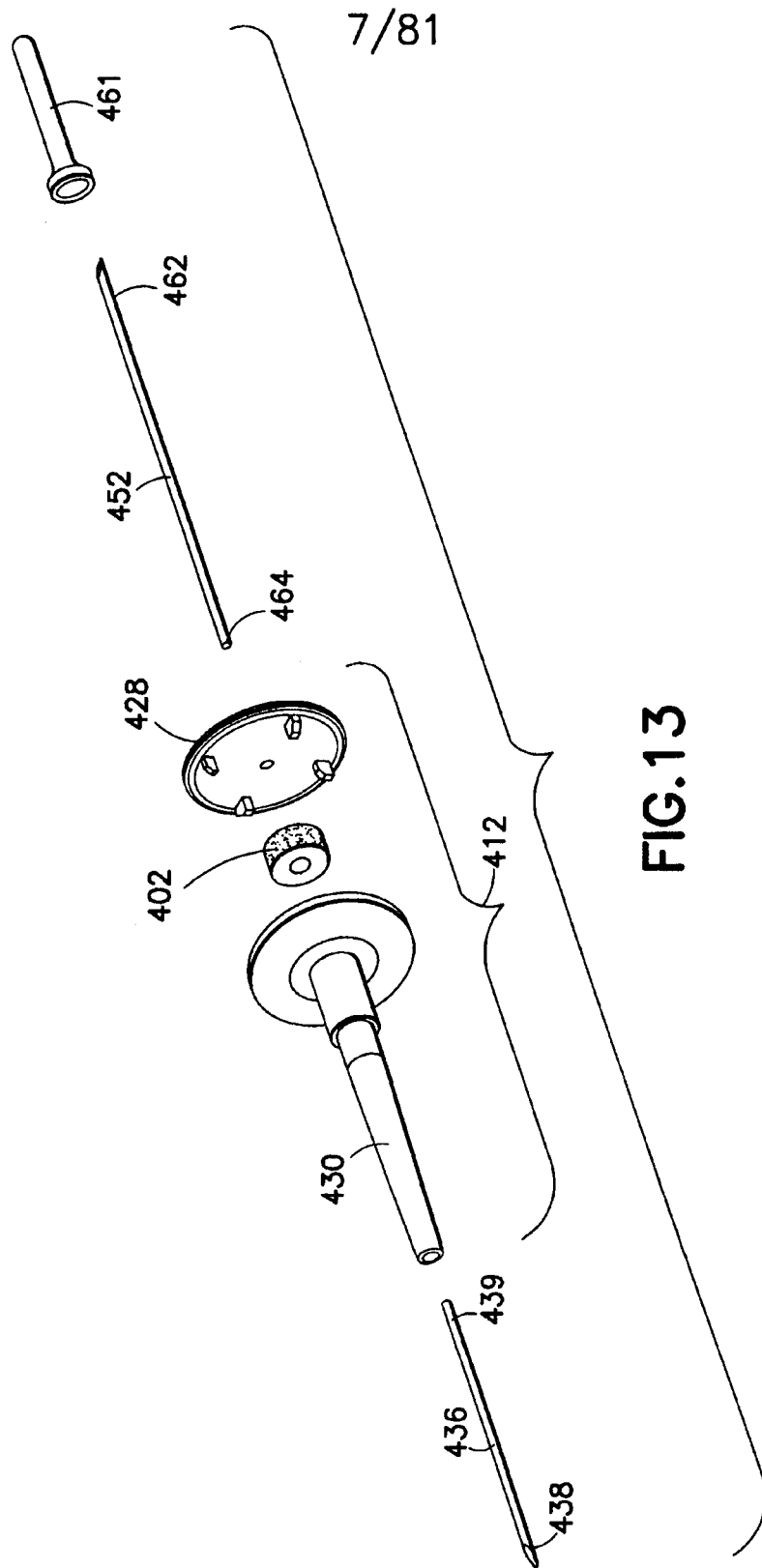
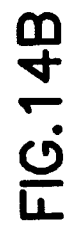
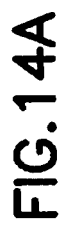


FIG.13



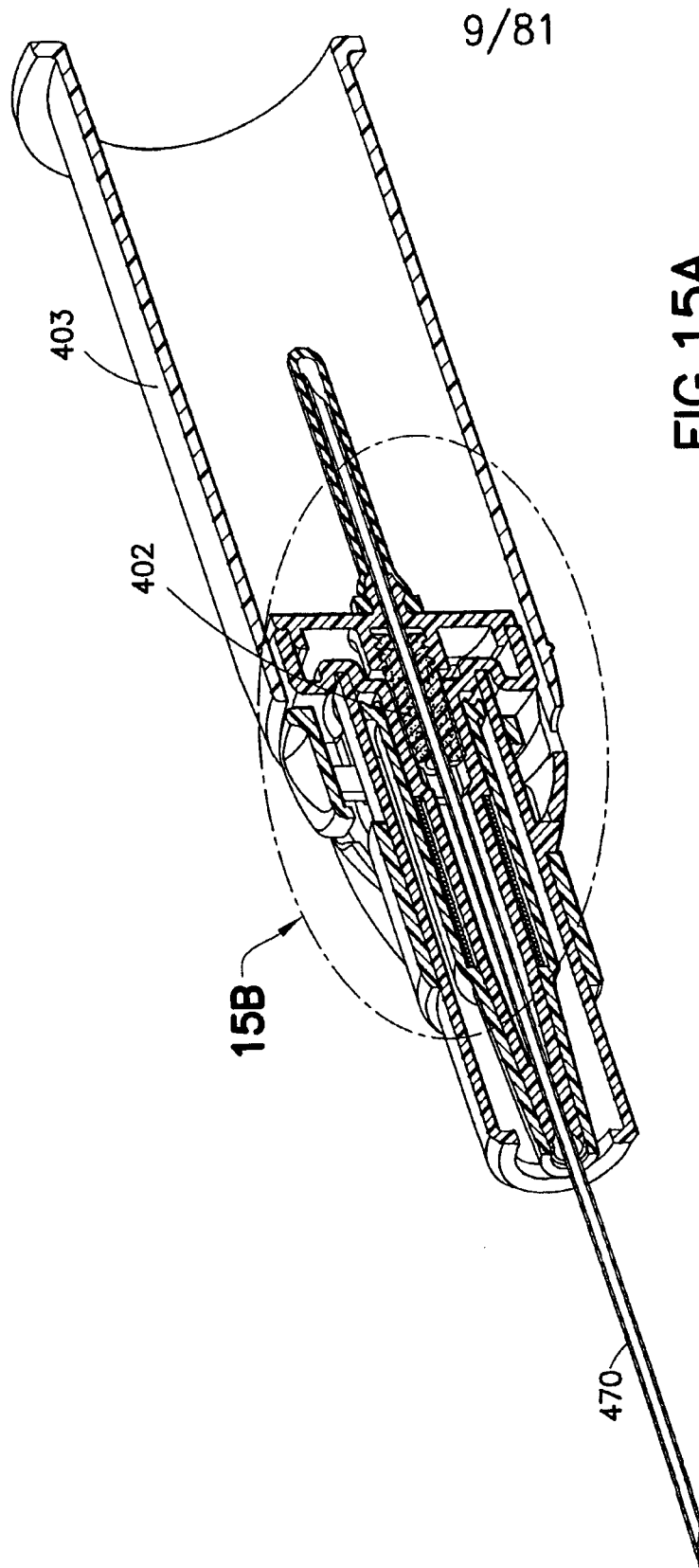


FIG. 15A

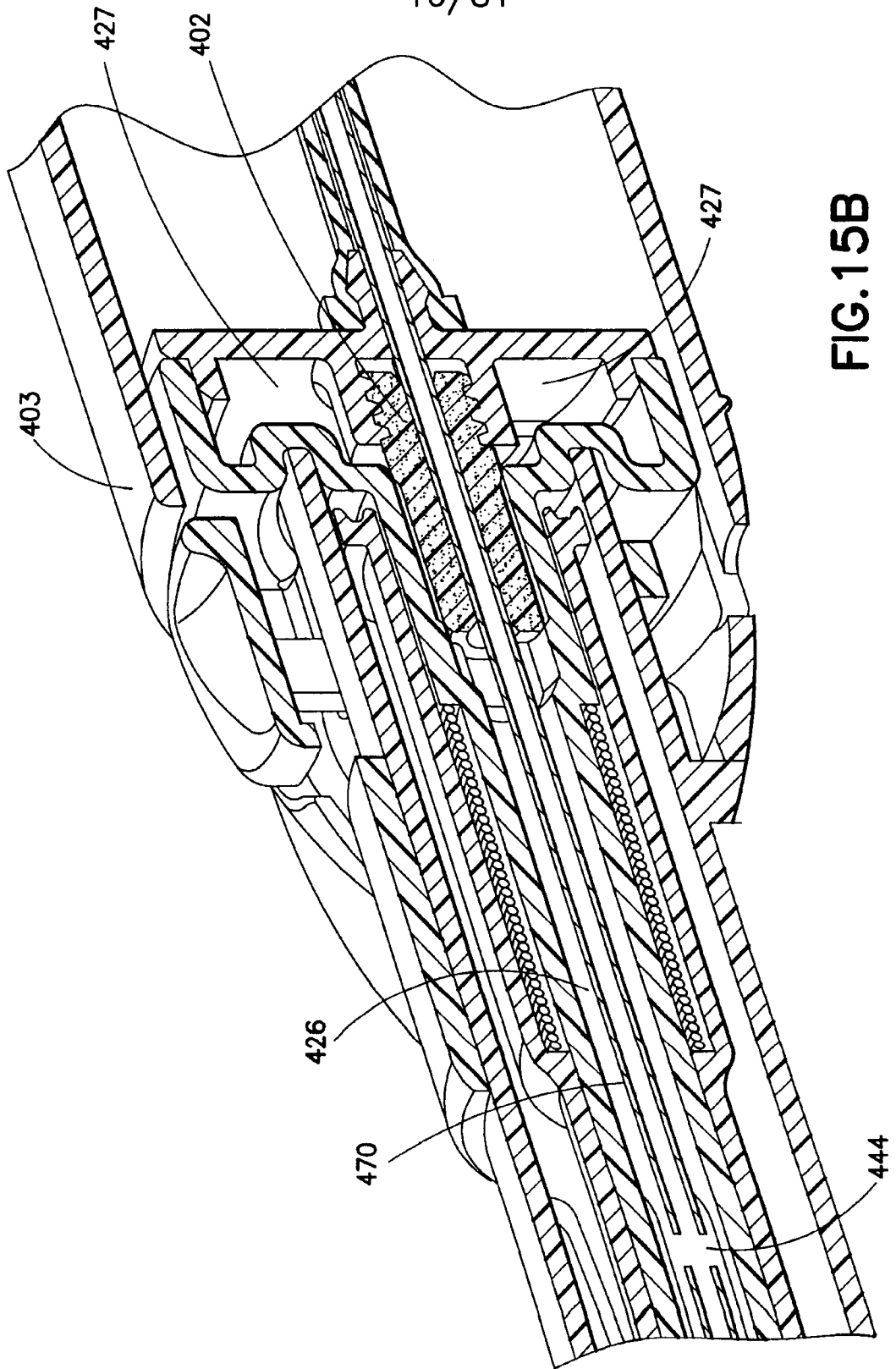
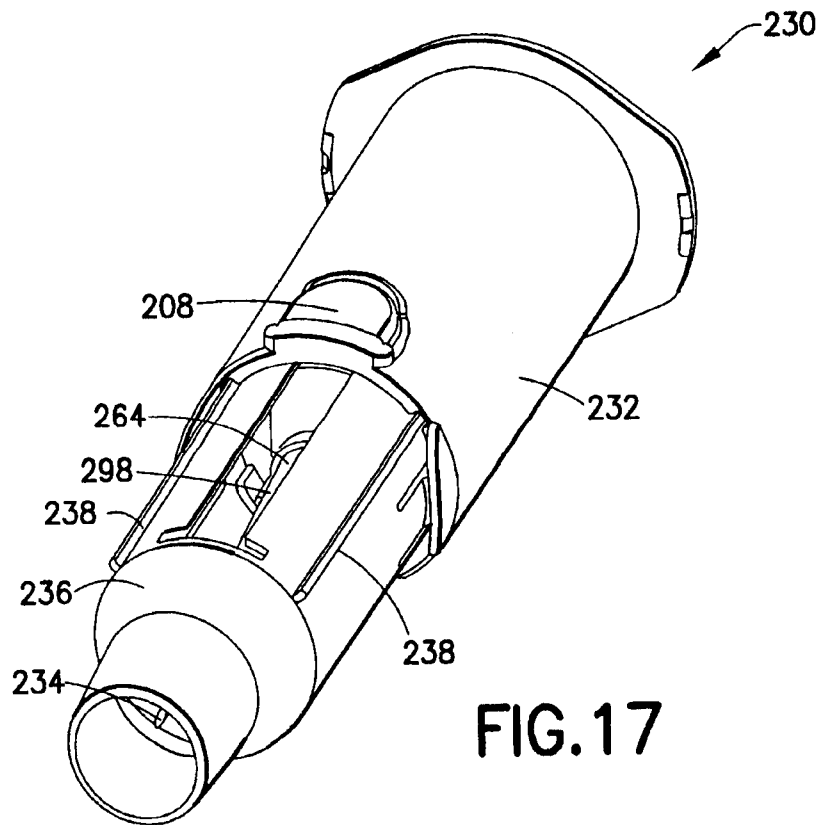
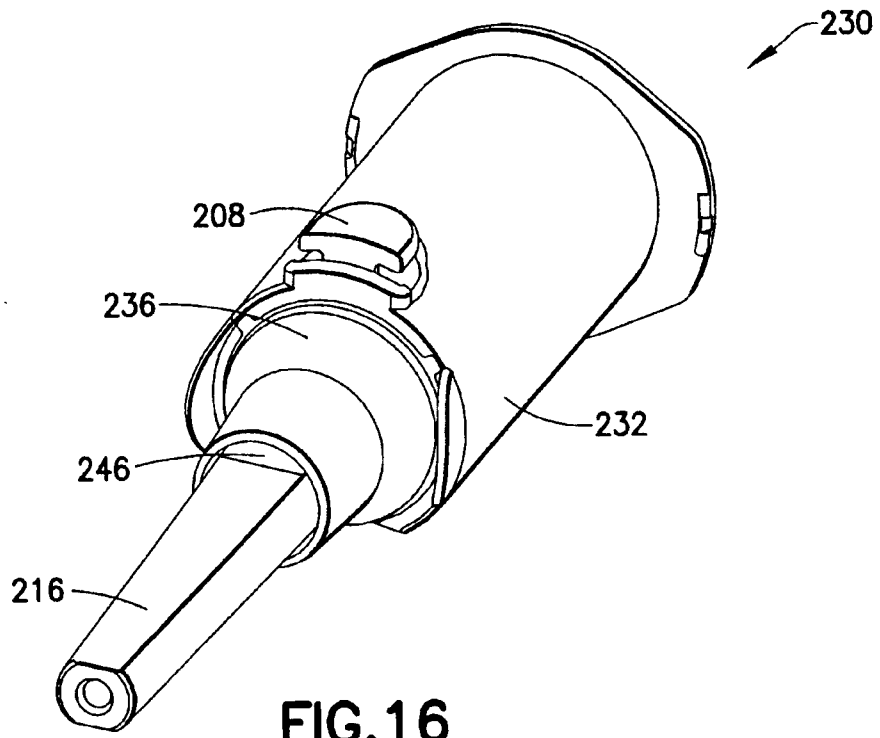


FIG. 15B



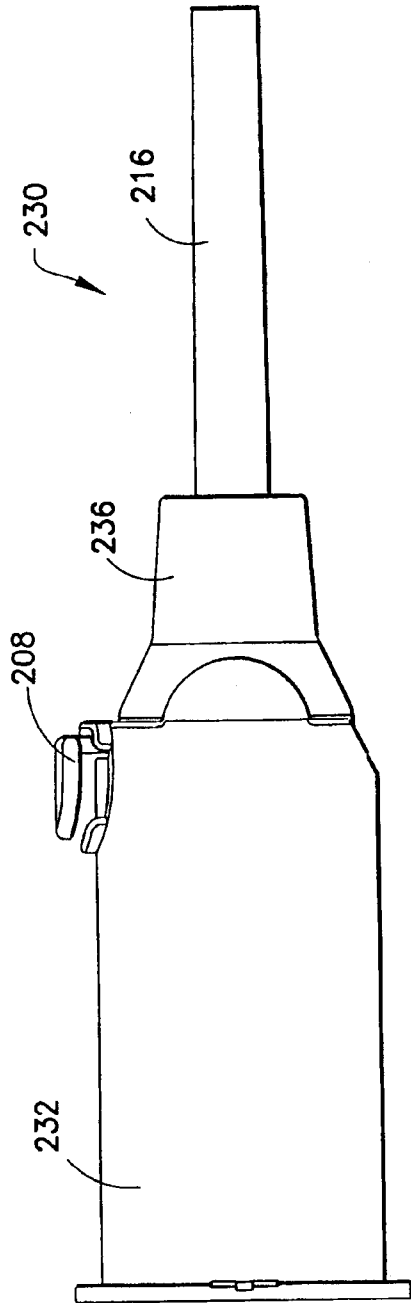


FIG. 18

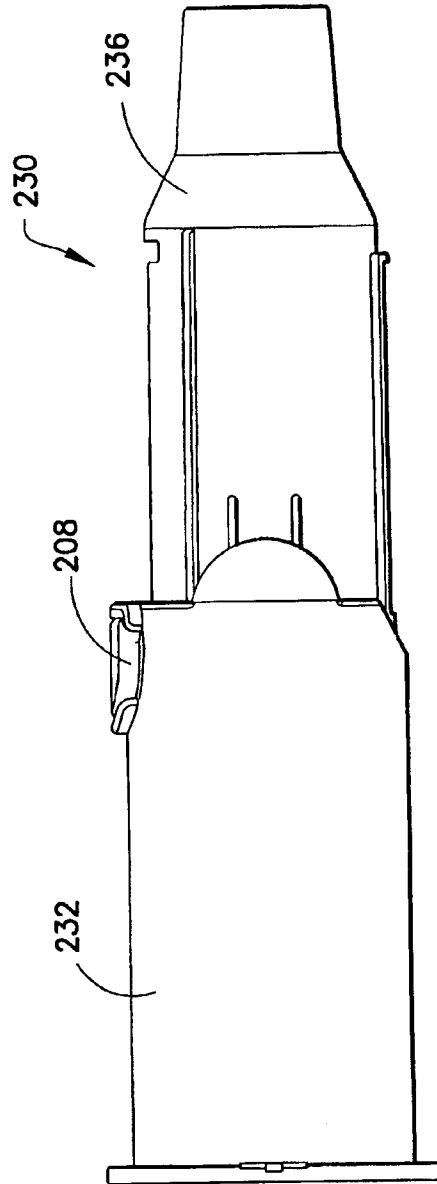


FIG. 19

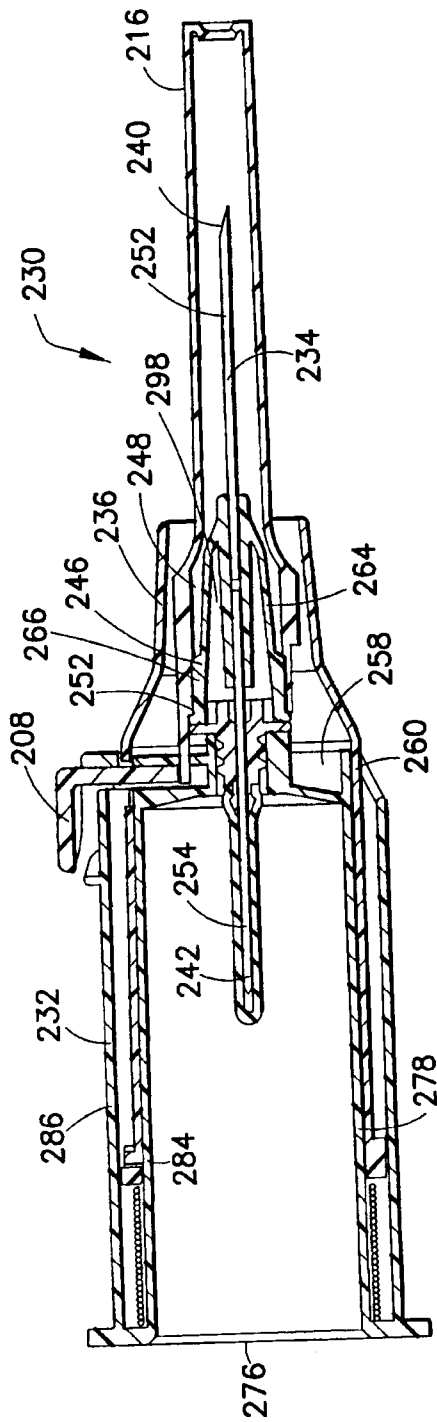


FIG. 20

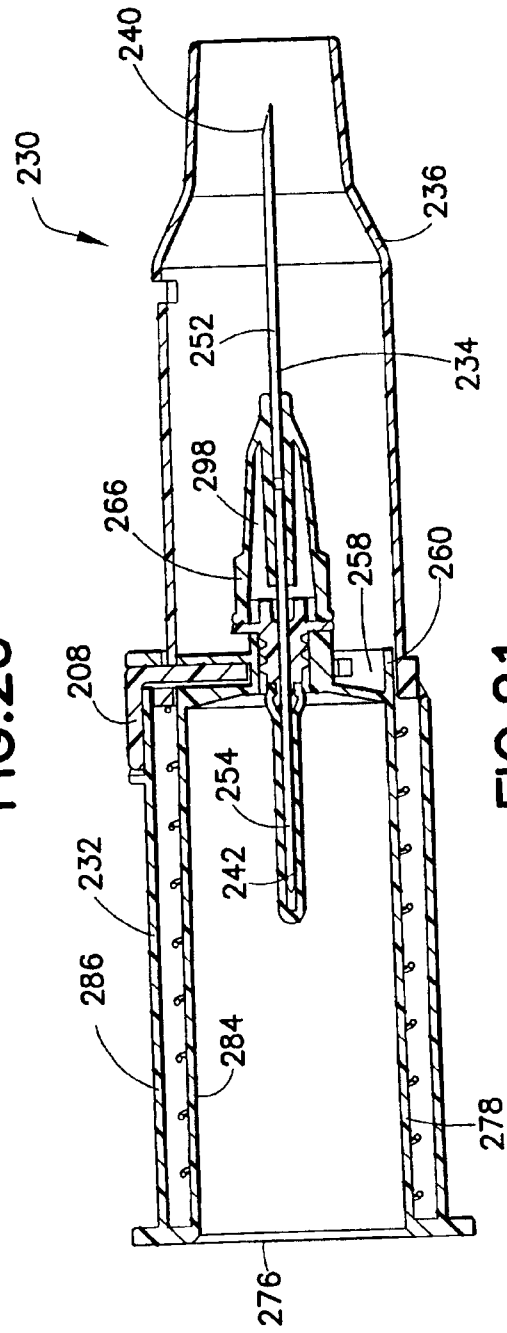
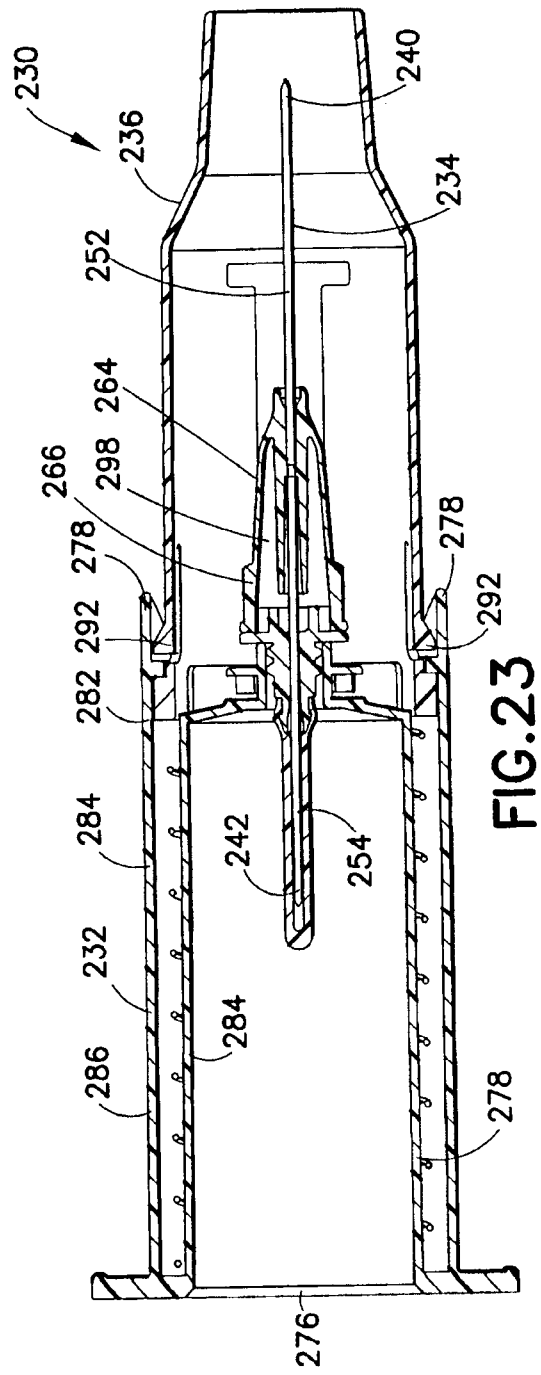
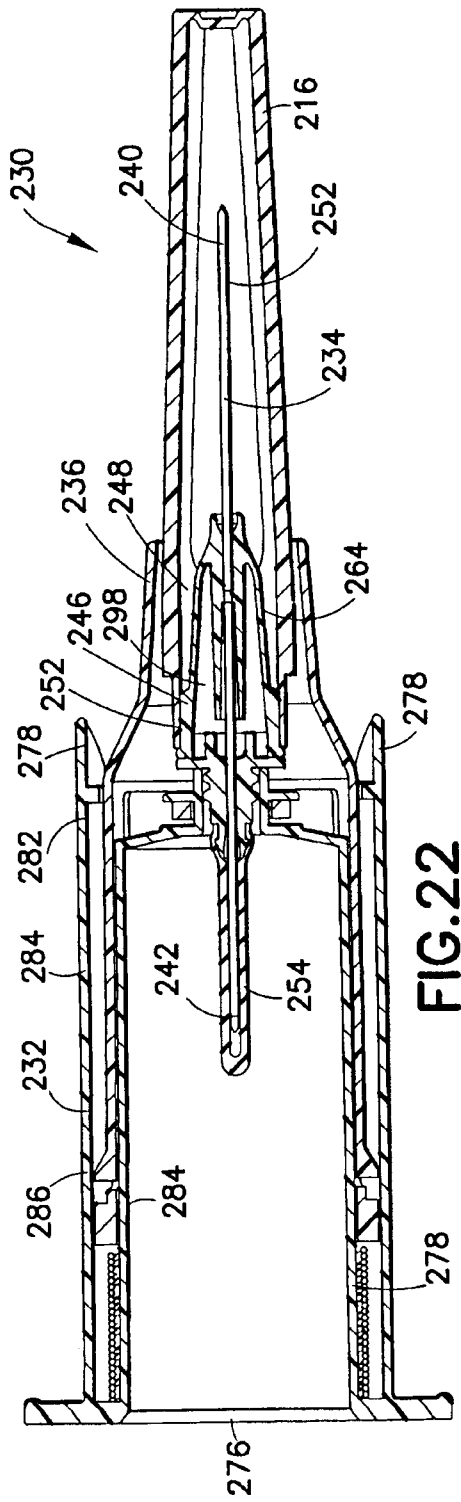


FIG. 21



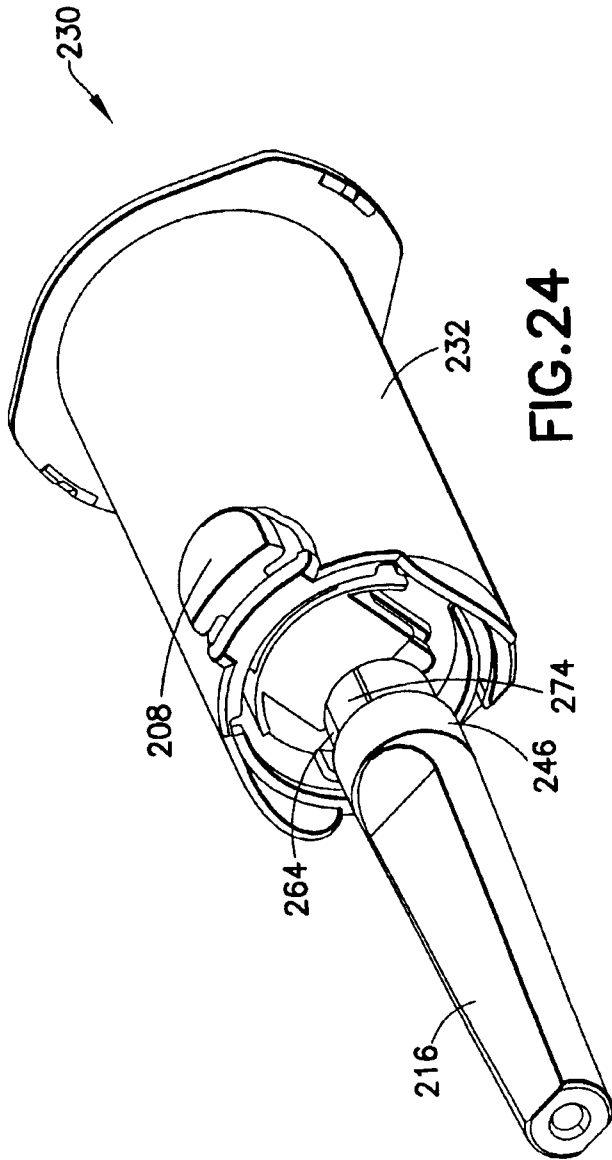


FIG. 24

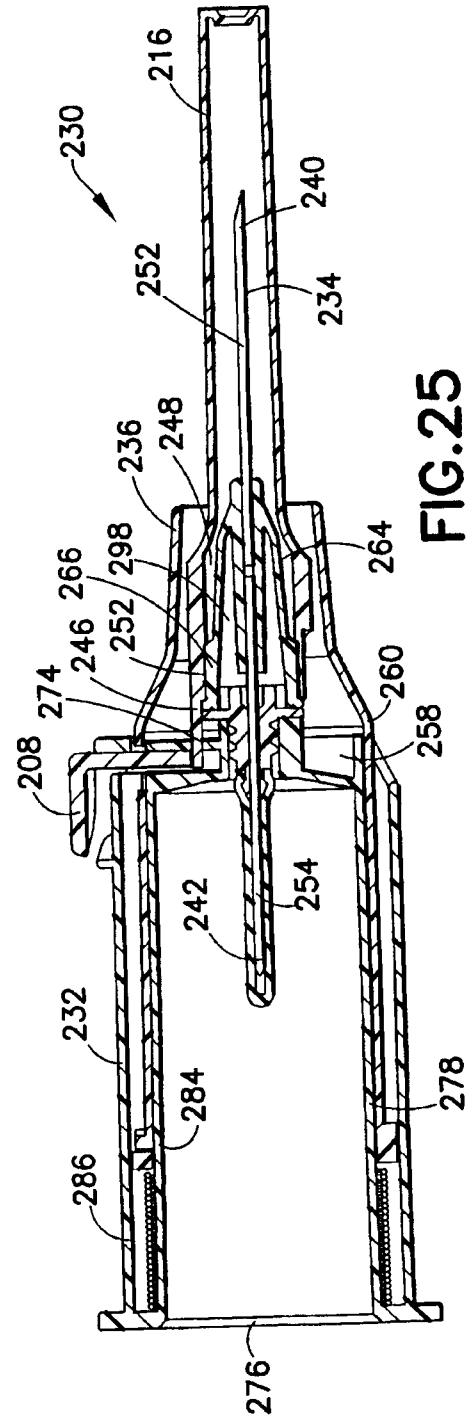


FIG. 25

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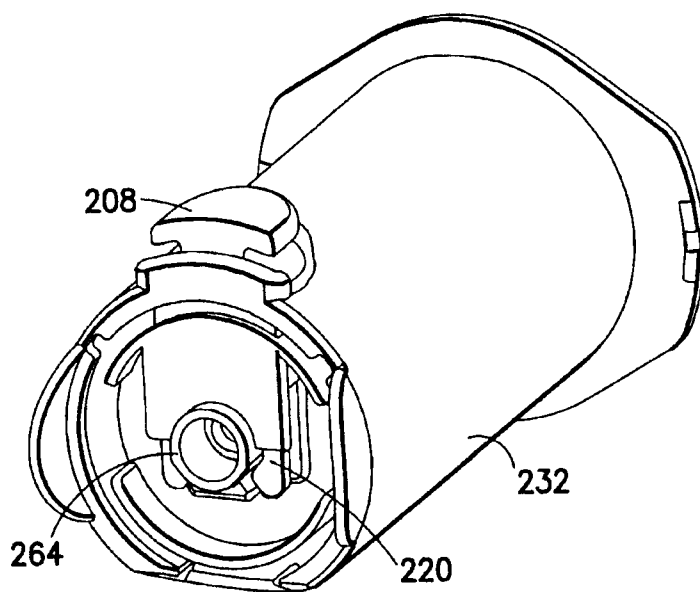


FIG. 26

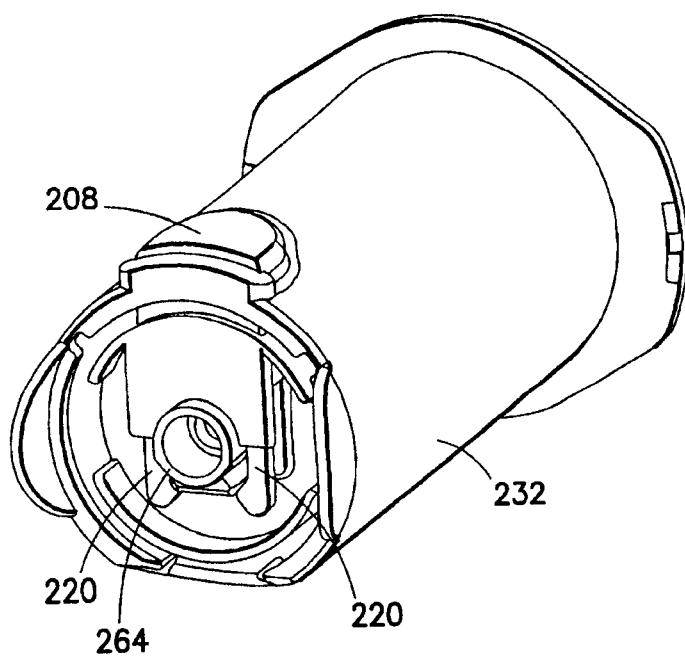


FIG. 27

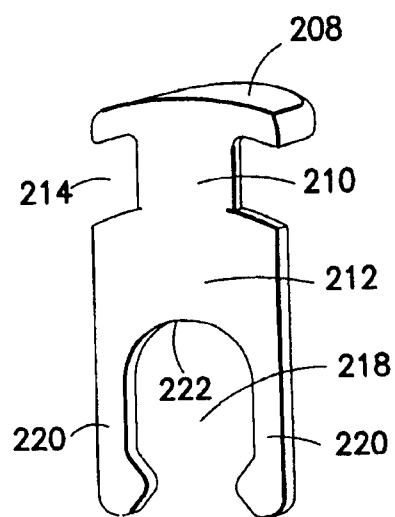


FIG. 28

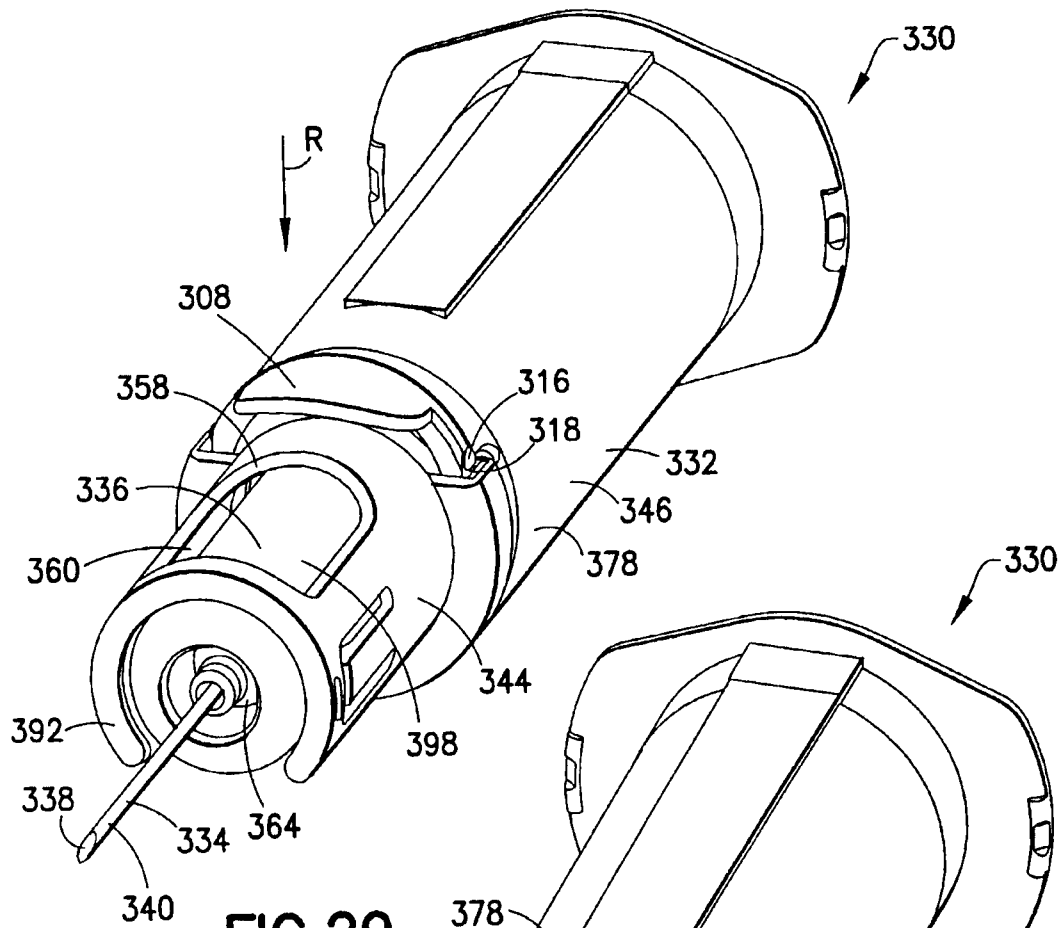


FIG. 29

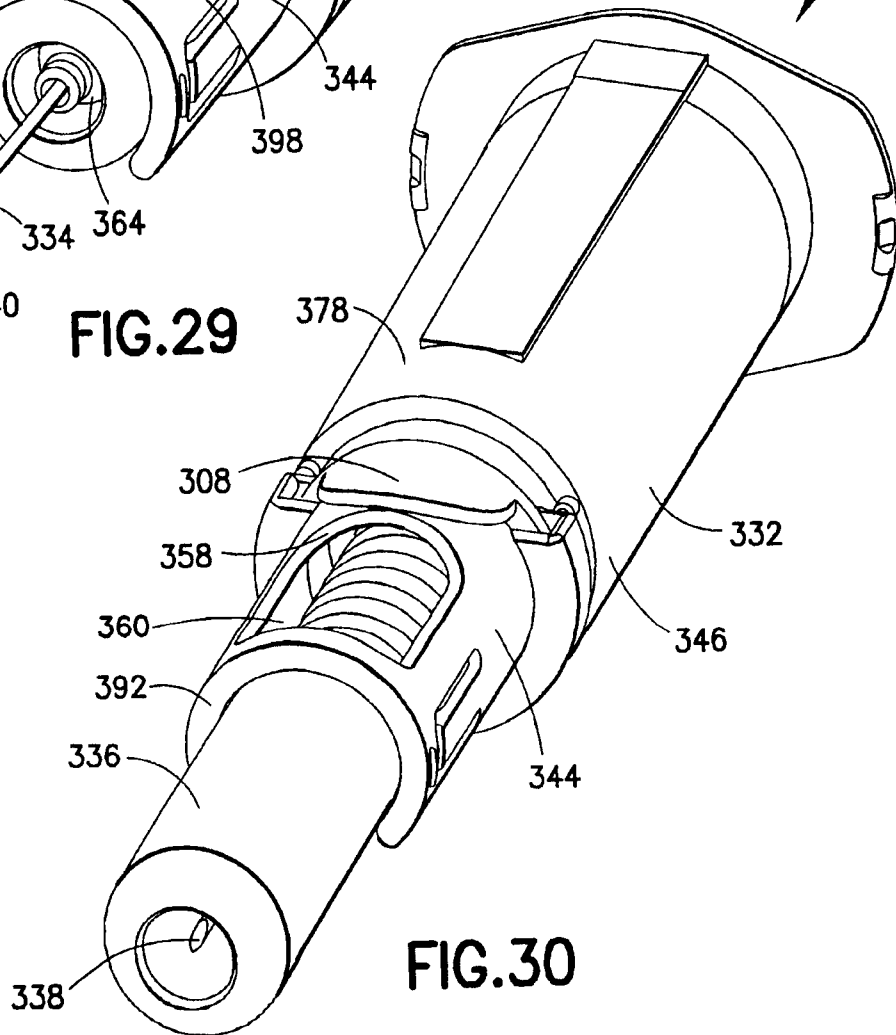


FIG. 30

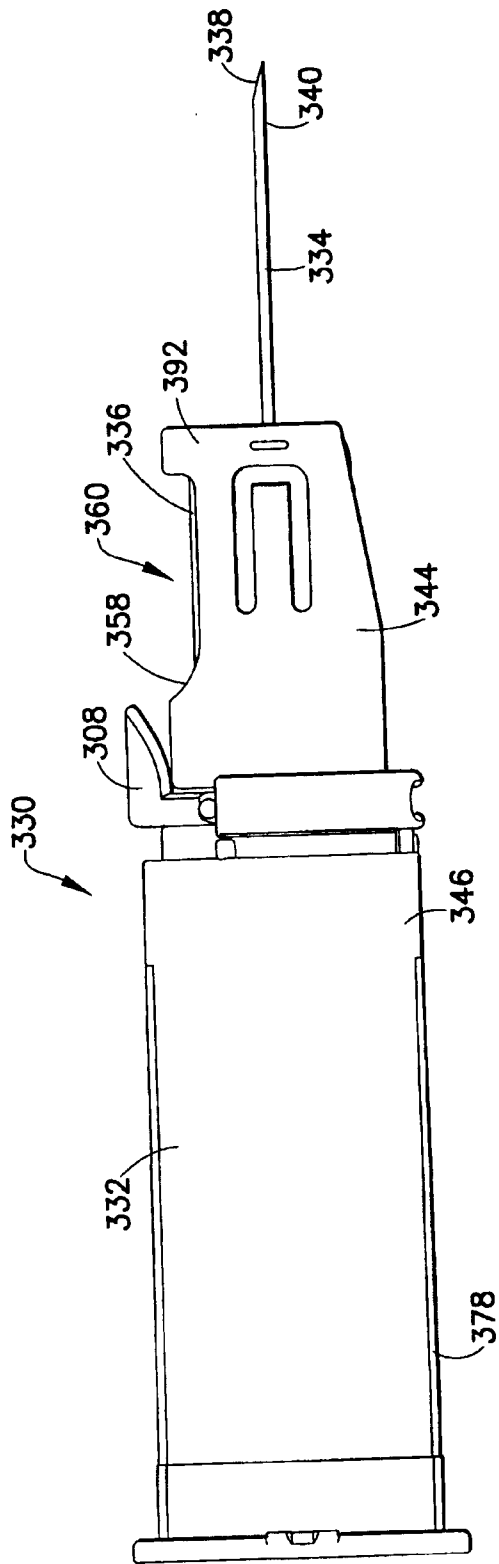


FIG. 31

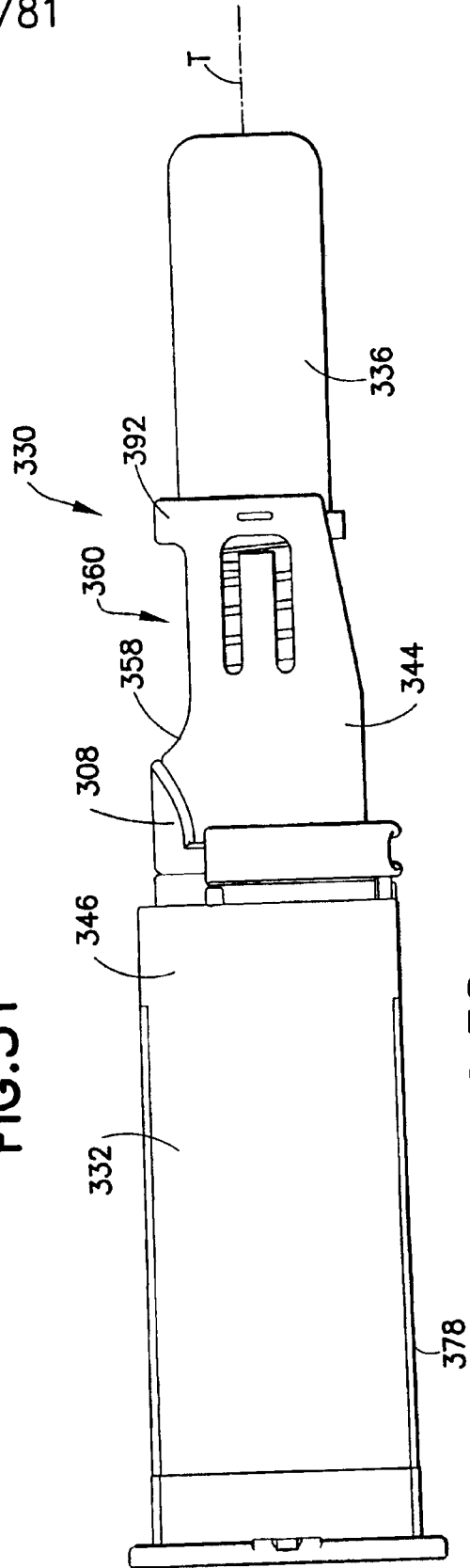


FIG. 32

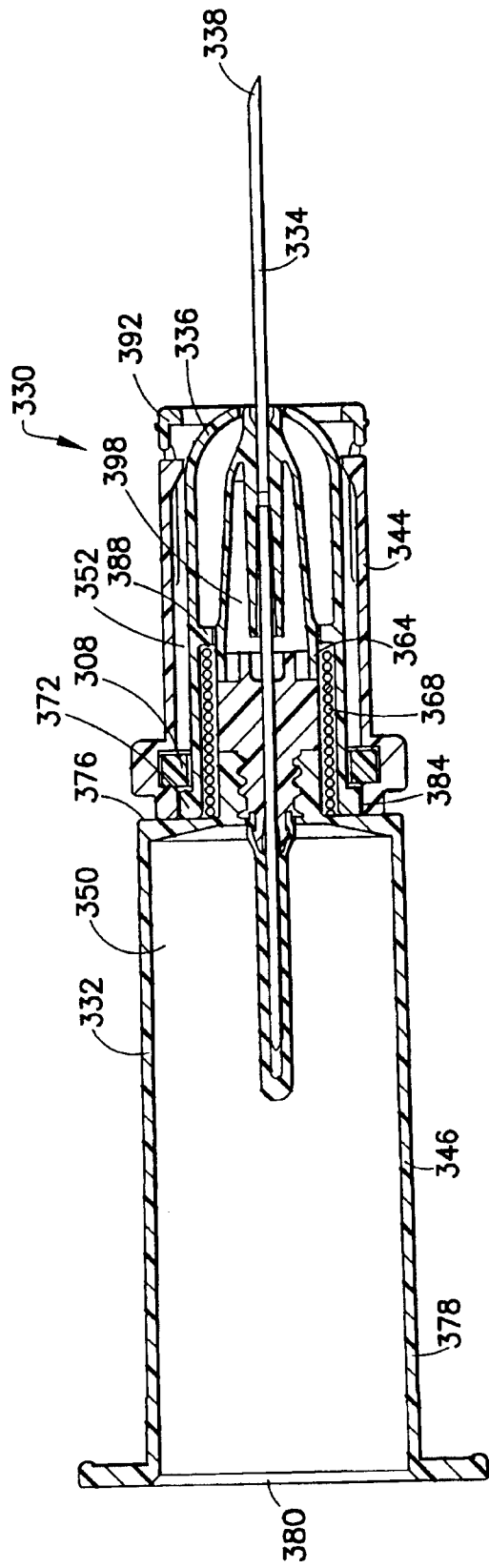


FIG. 33

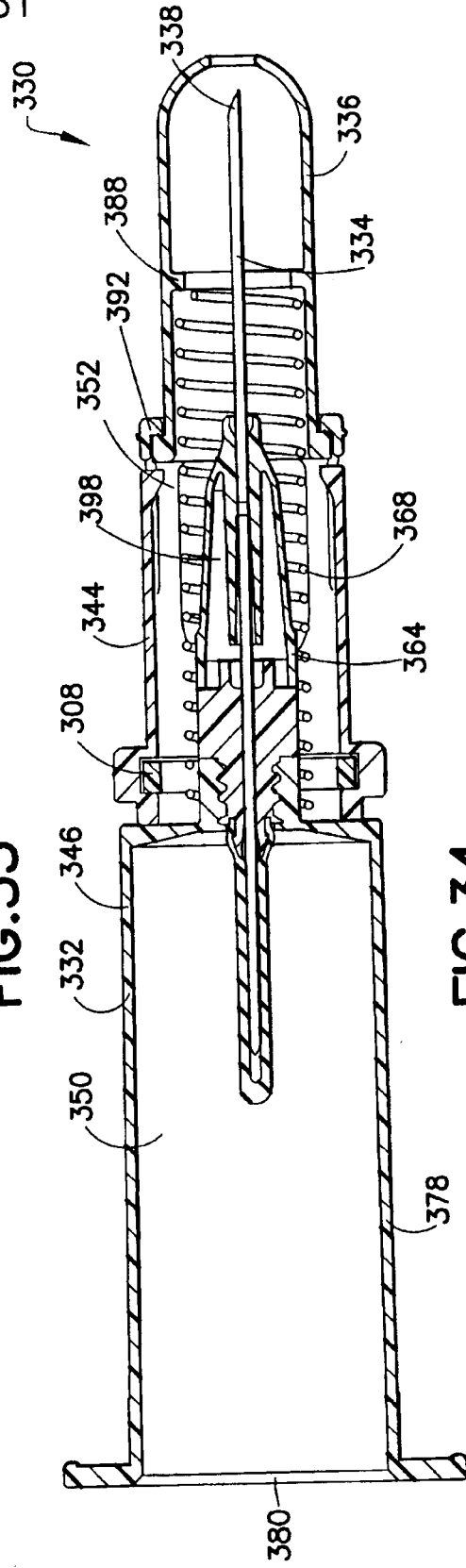


FIG. 34

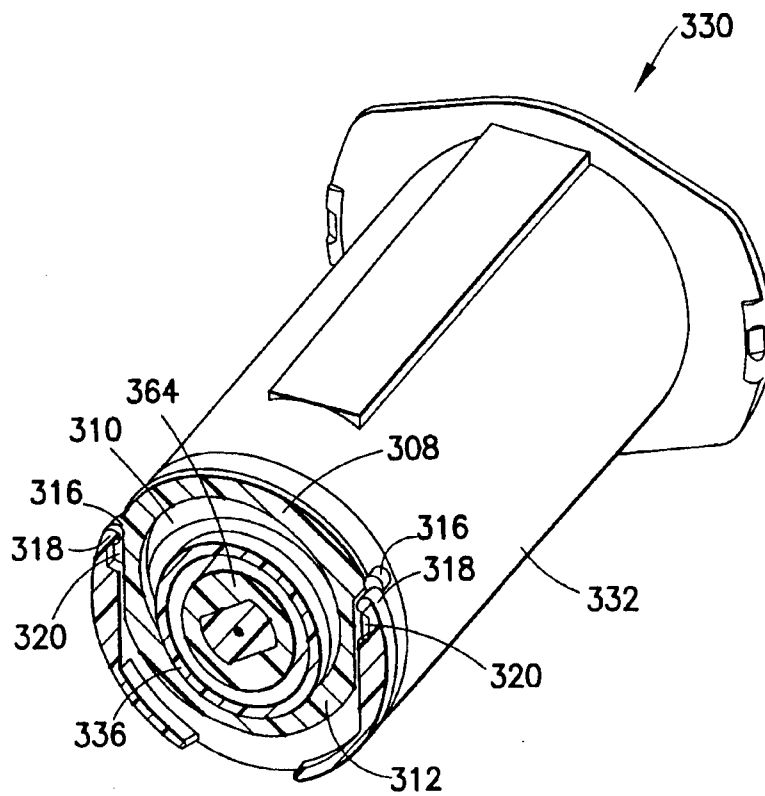


FIG.35

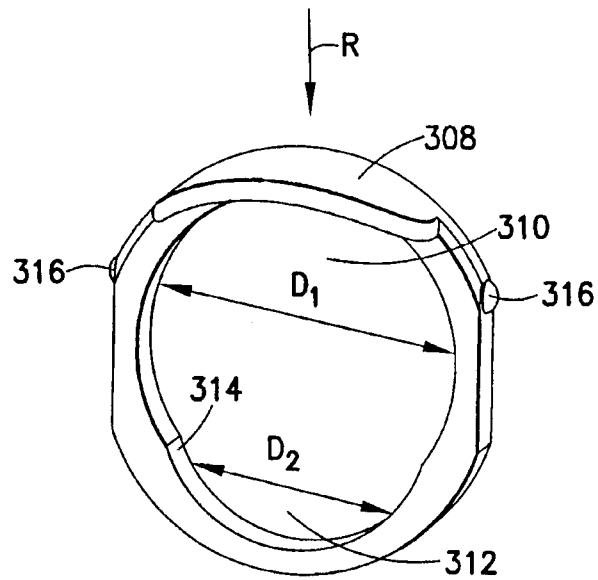


FIG.36

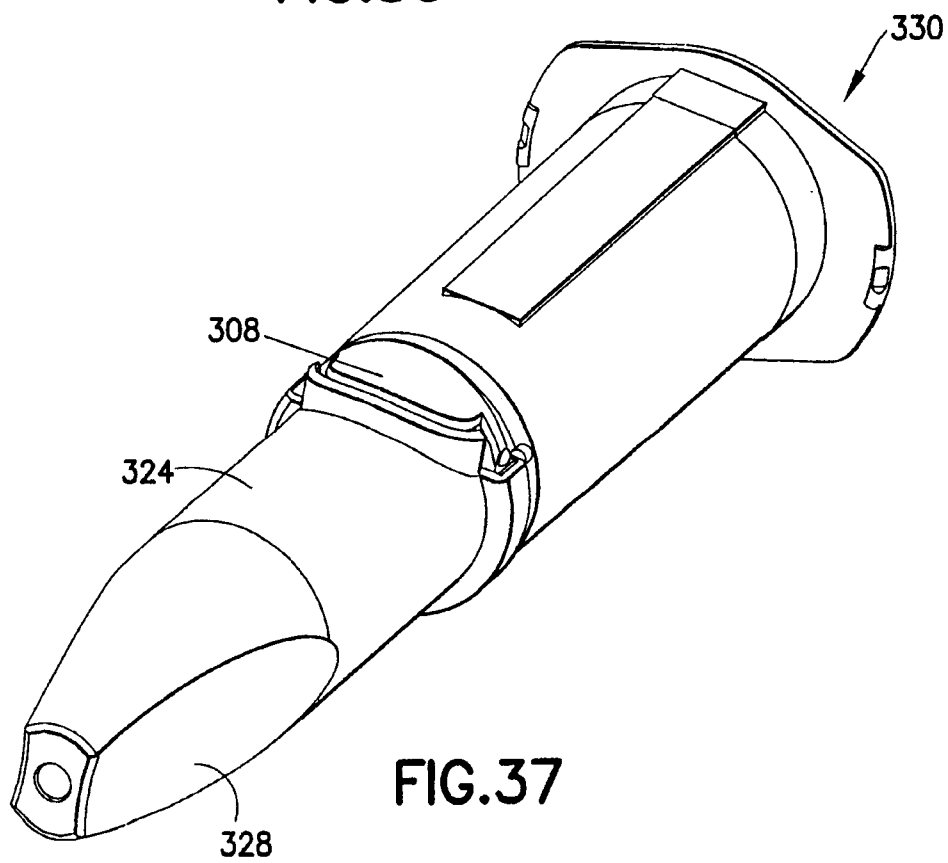


FIG.37

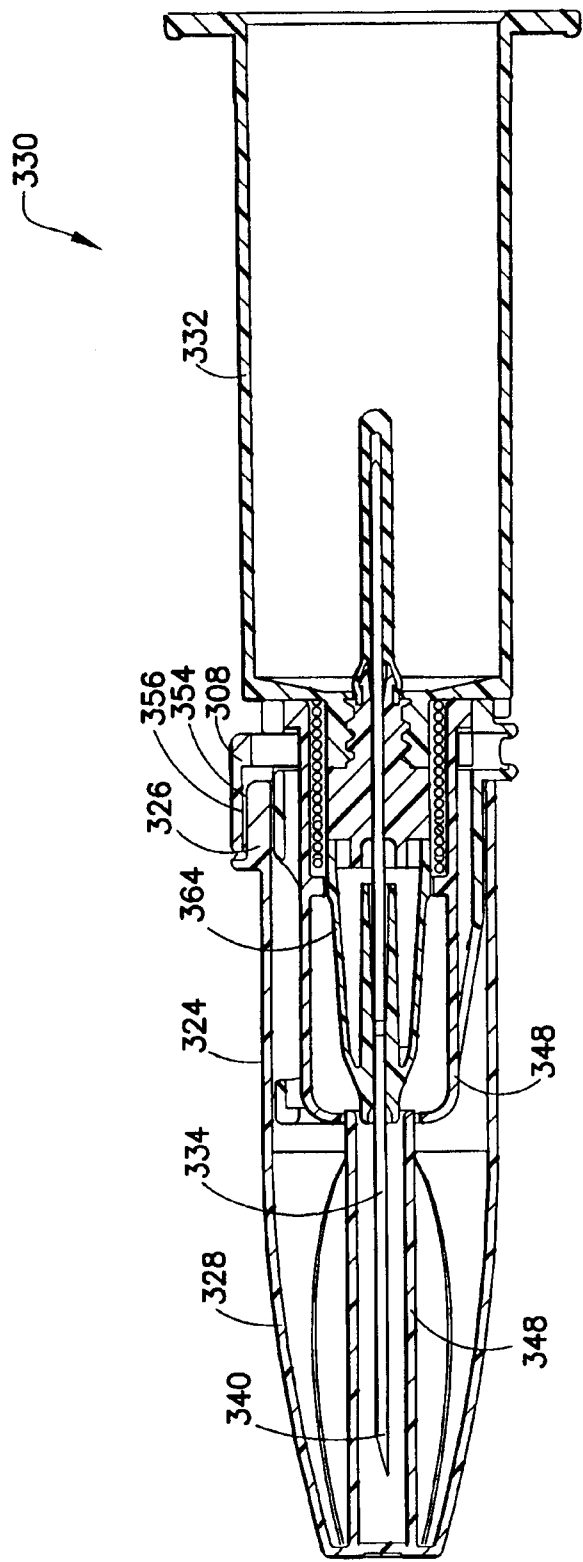


FIG.38

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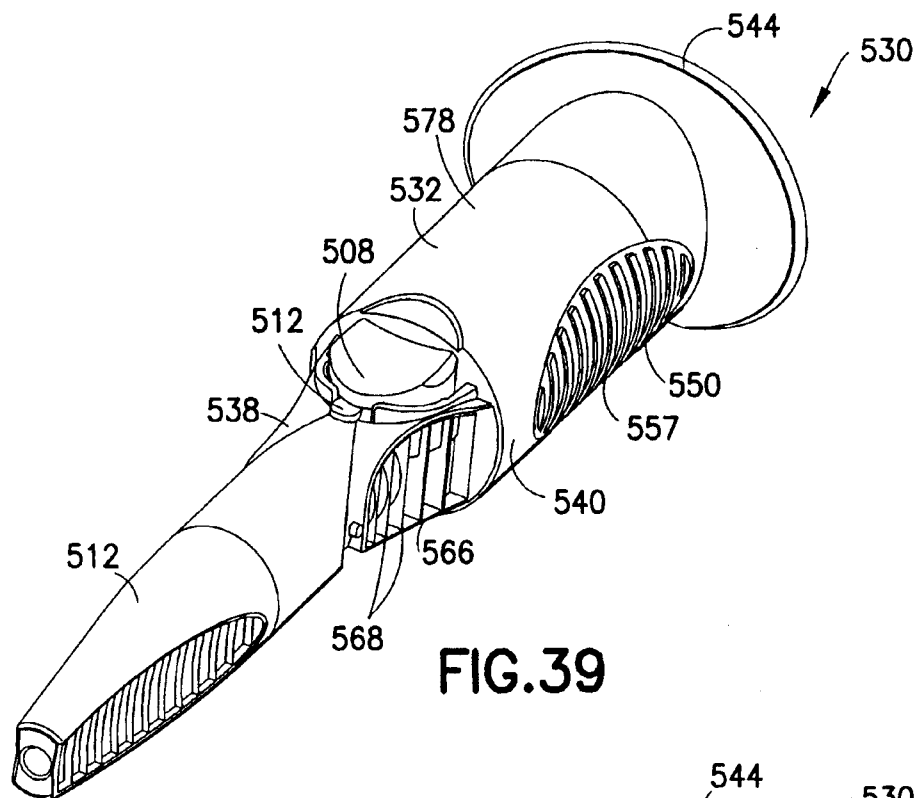


FIG. 39

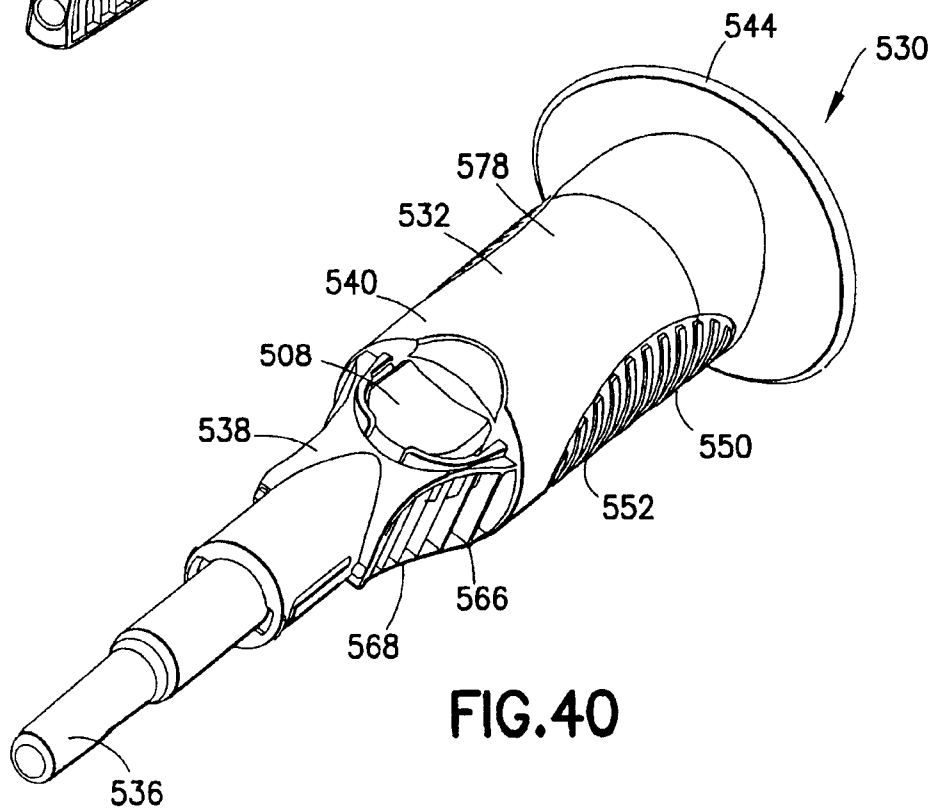


FIG. 40

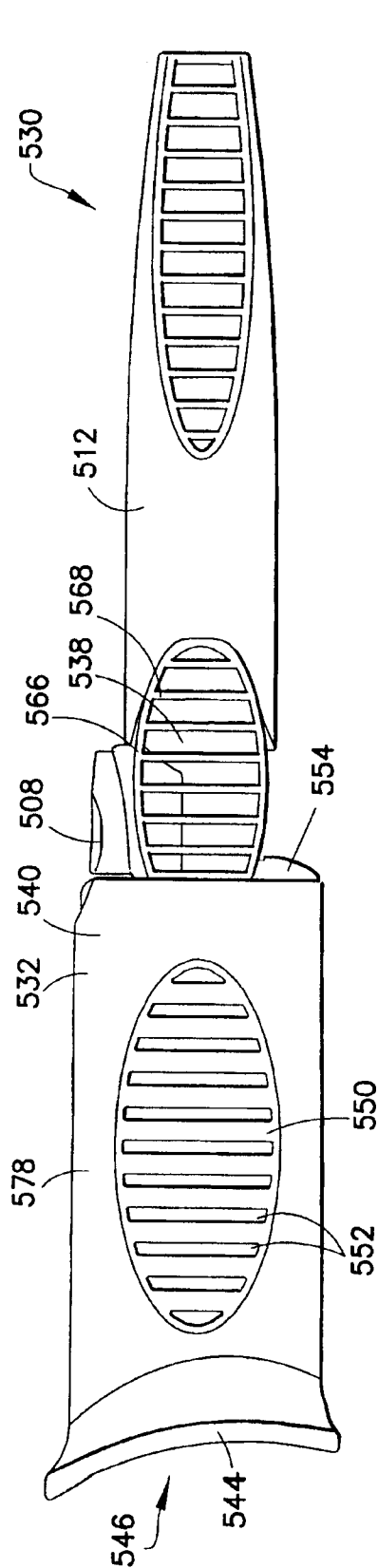


FIG. 41

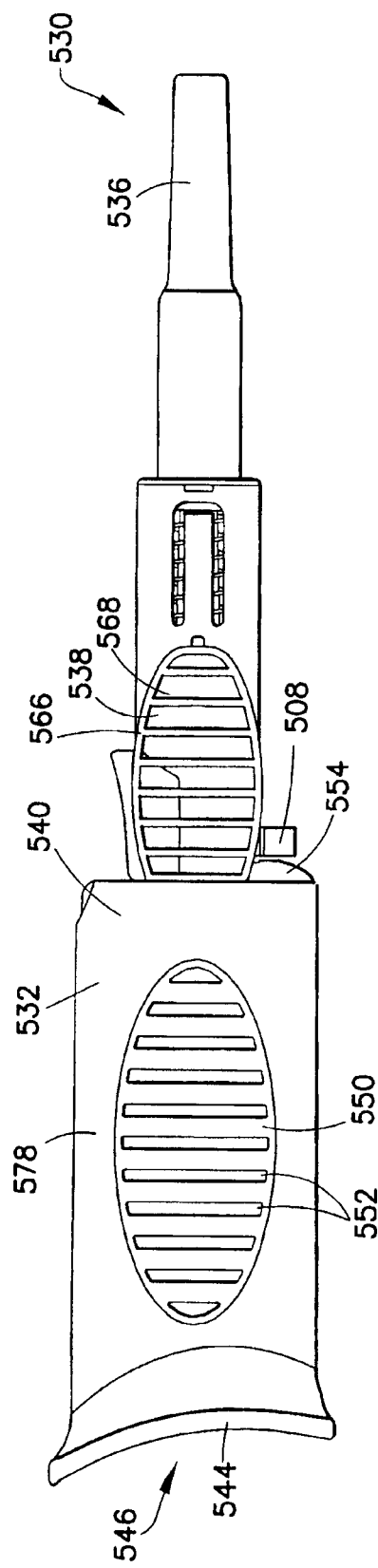


FIG. 42

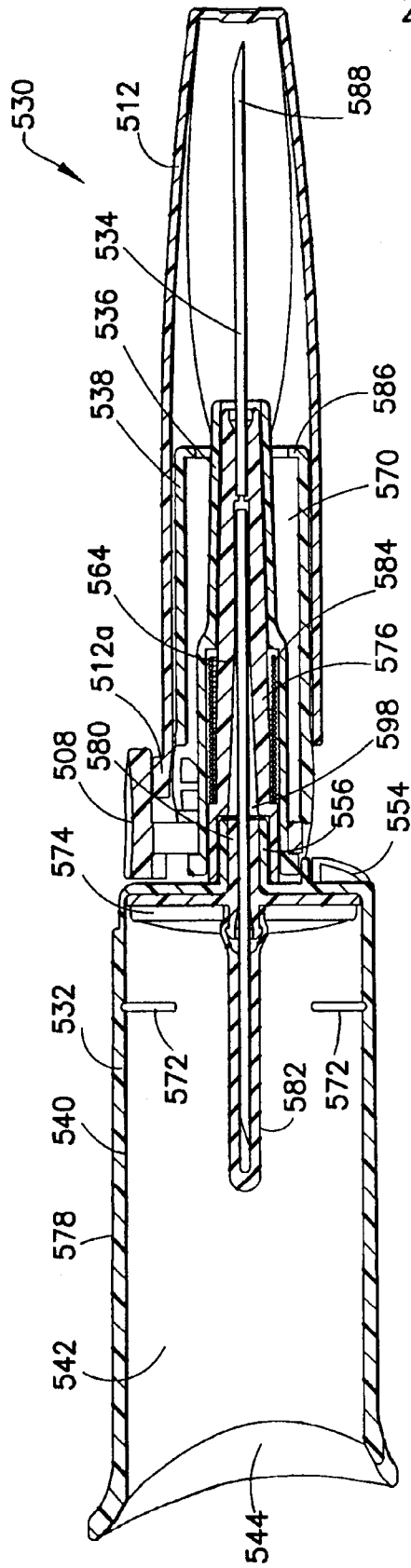


FIG. 43

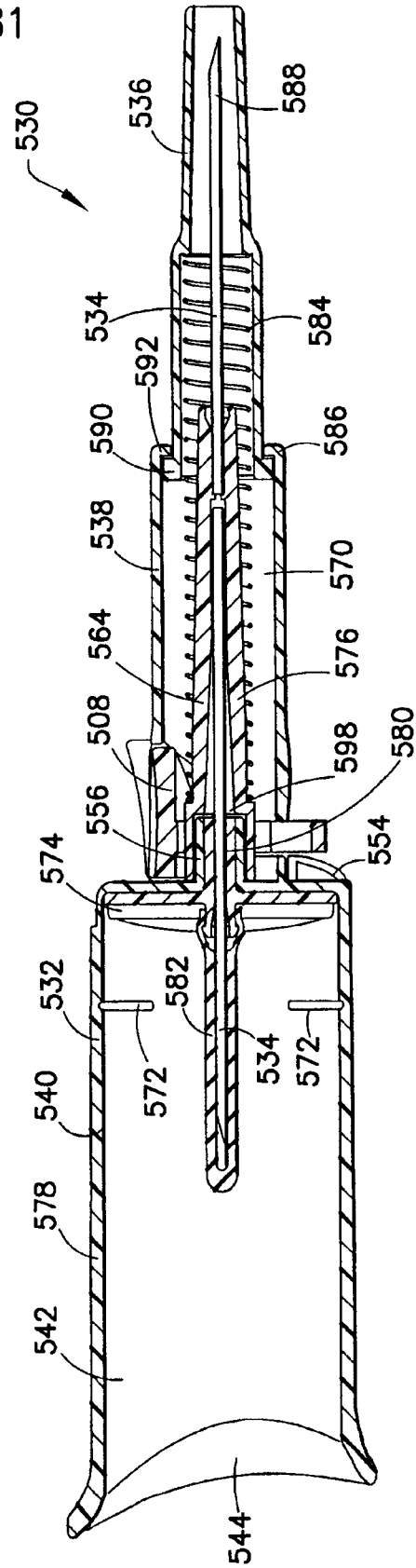
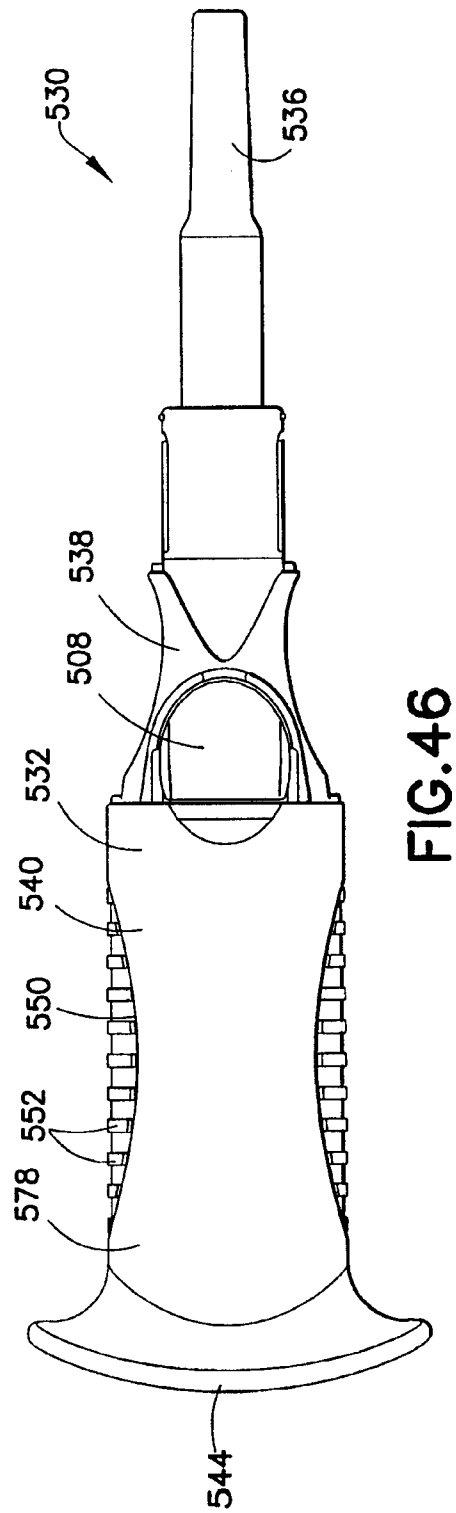
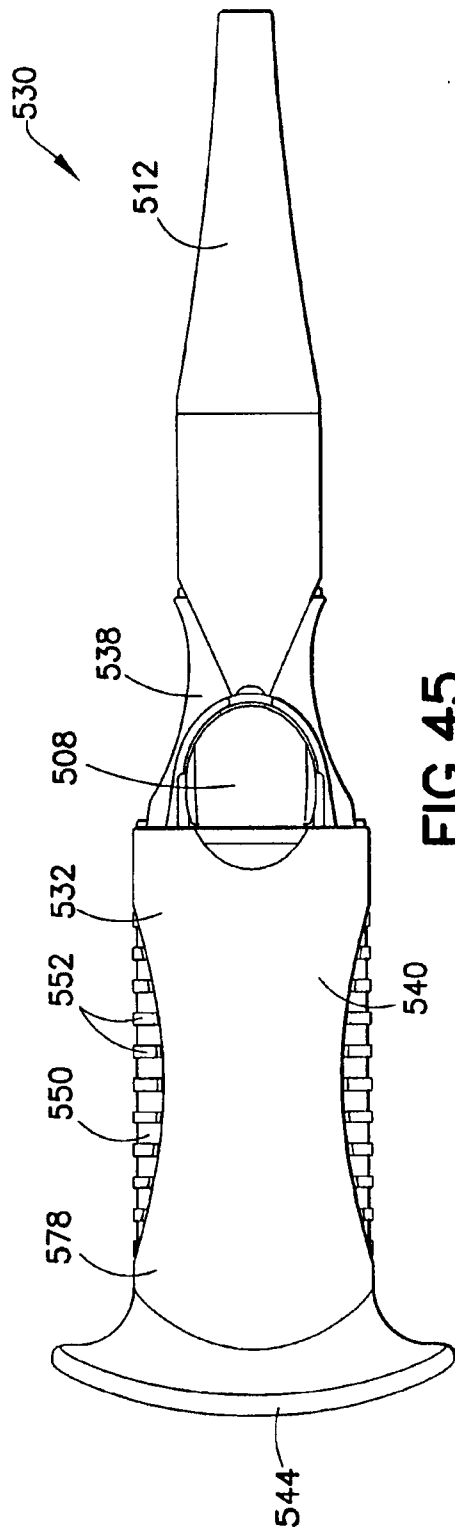


FIG. 44



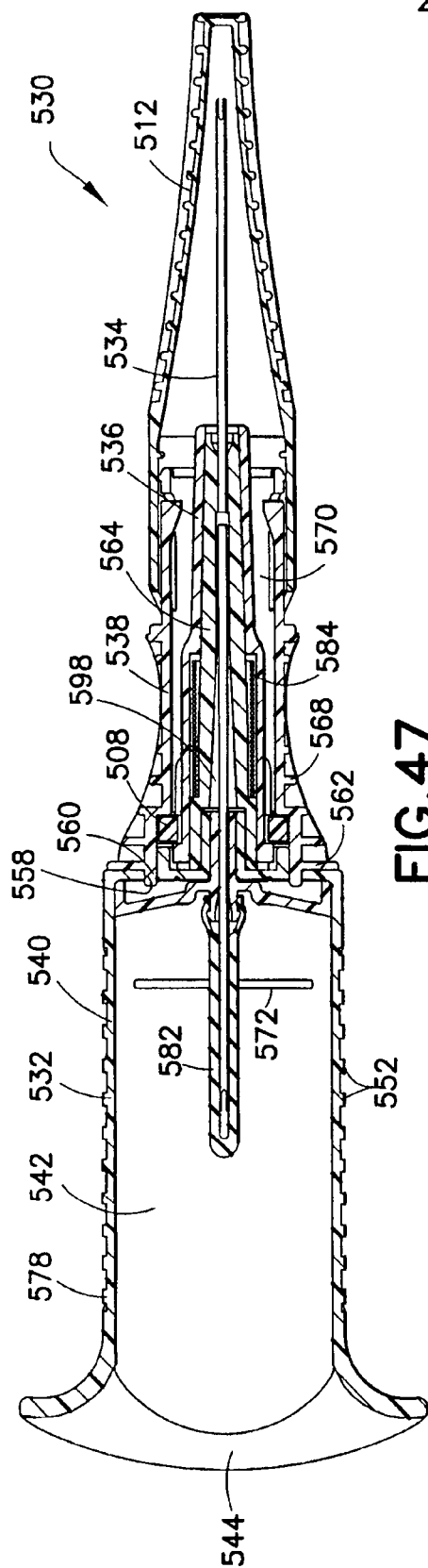


FIG. 47

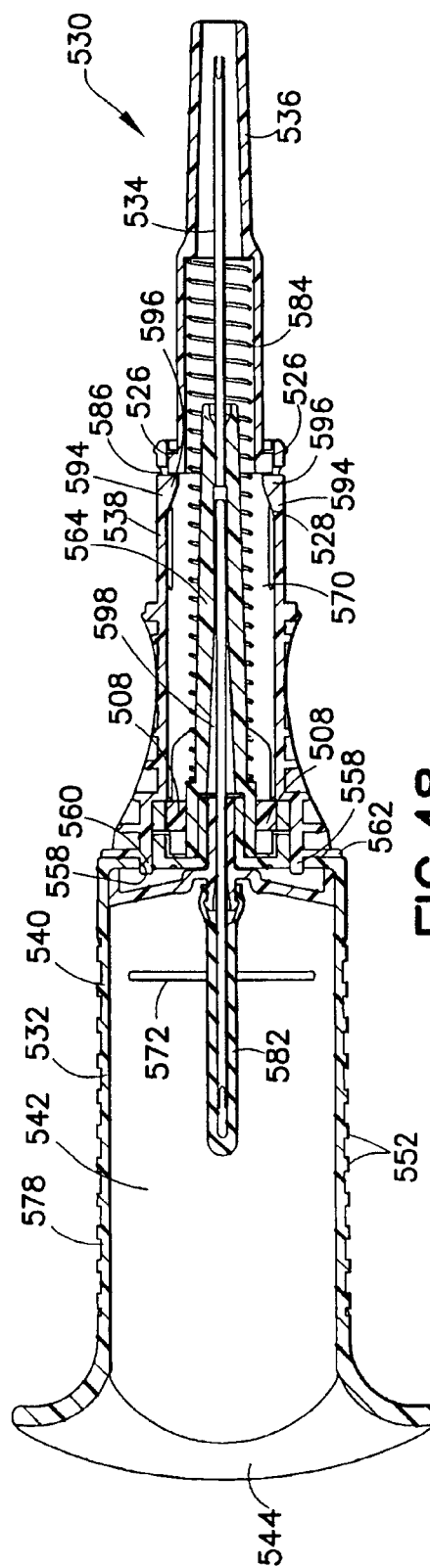


FIG. 48

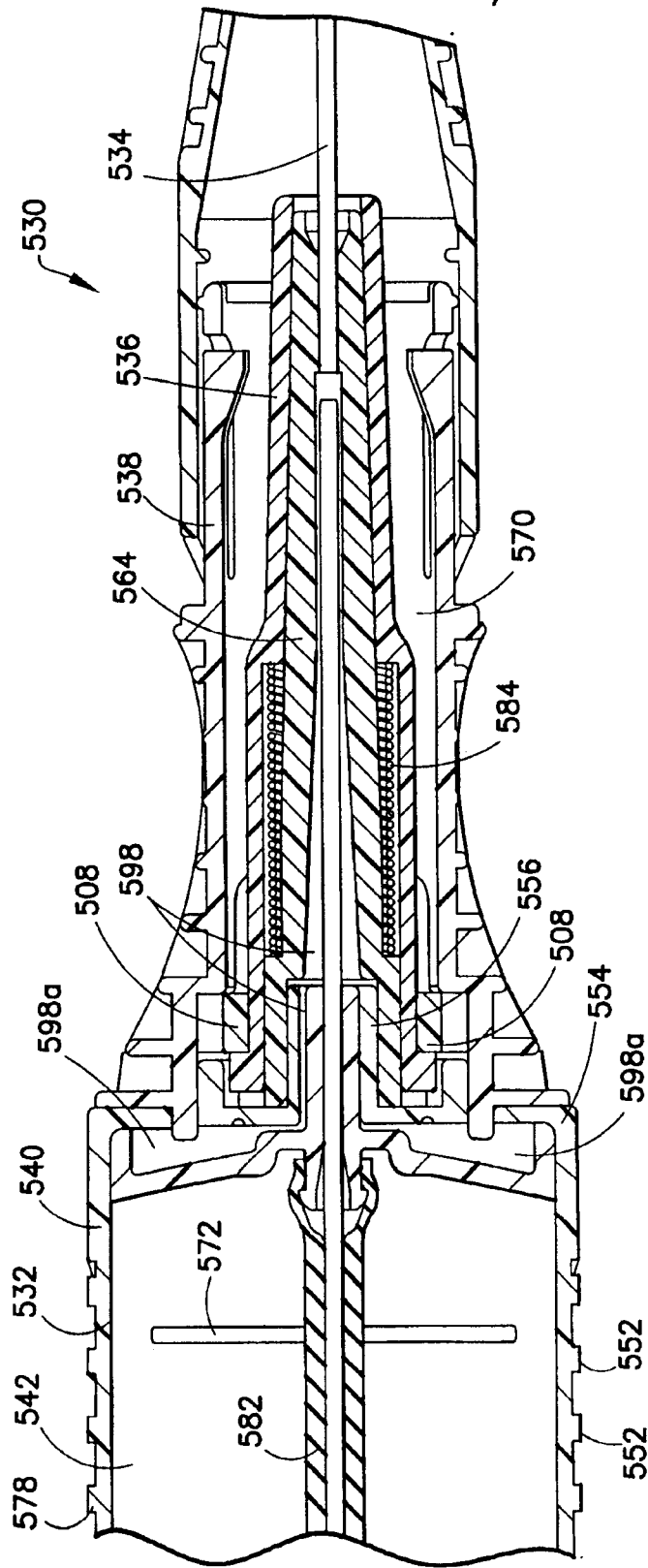


FIG.49

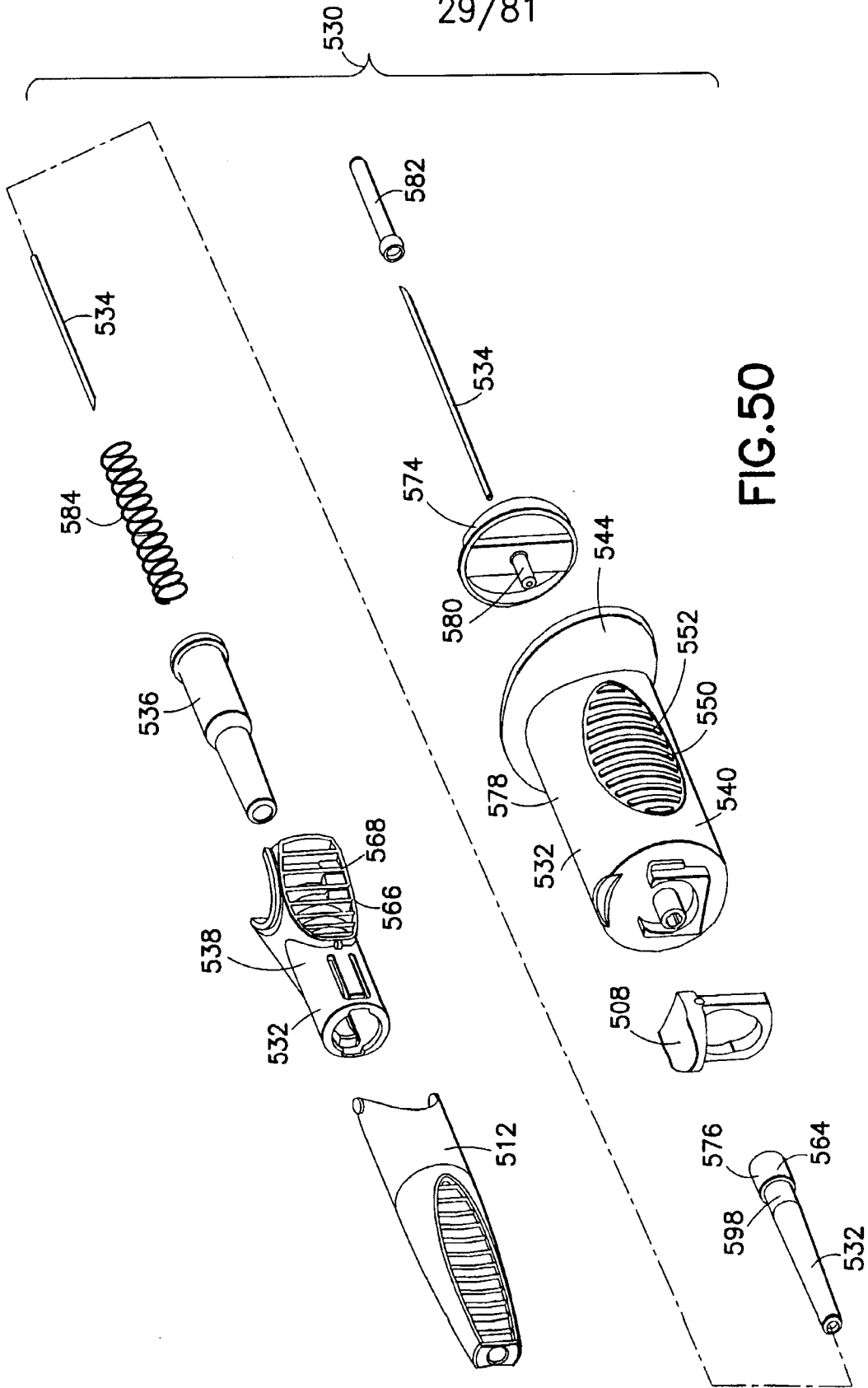


FIG. 50

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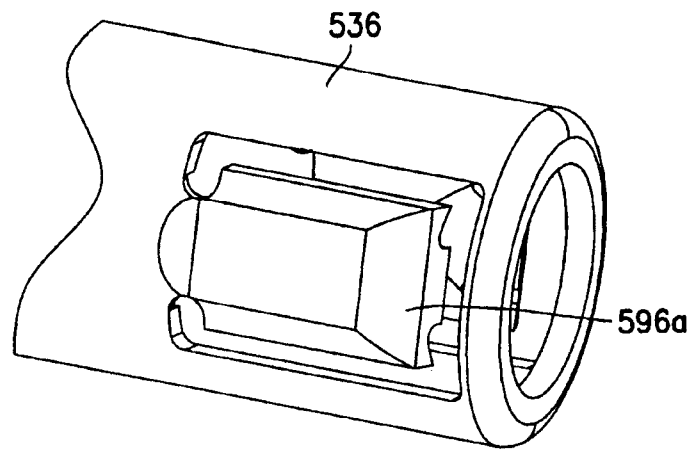


FIG. 51

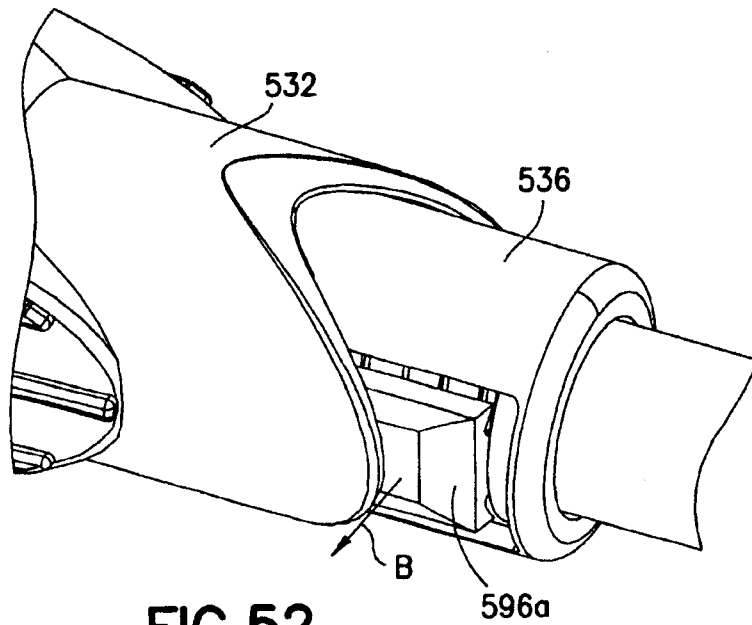
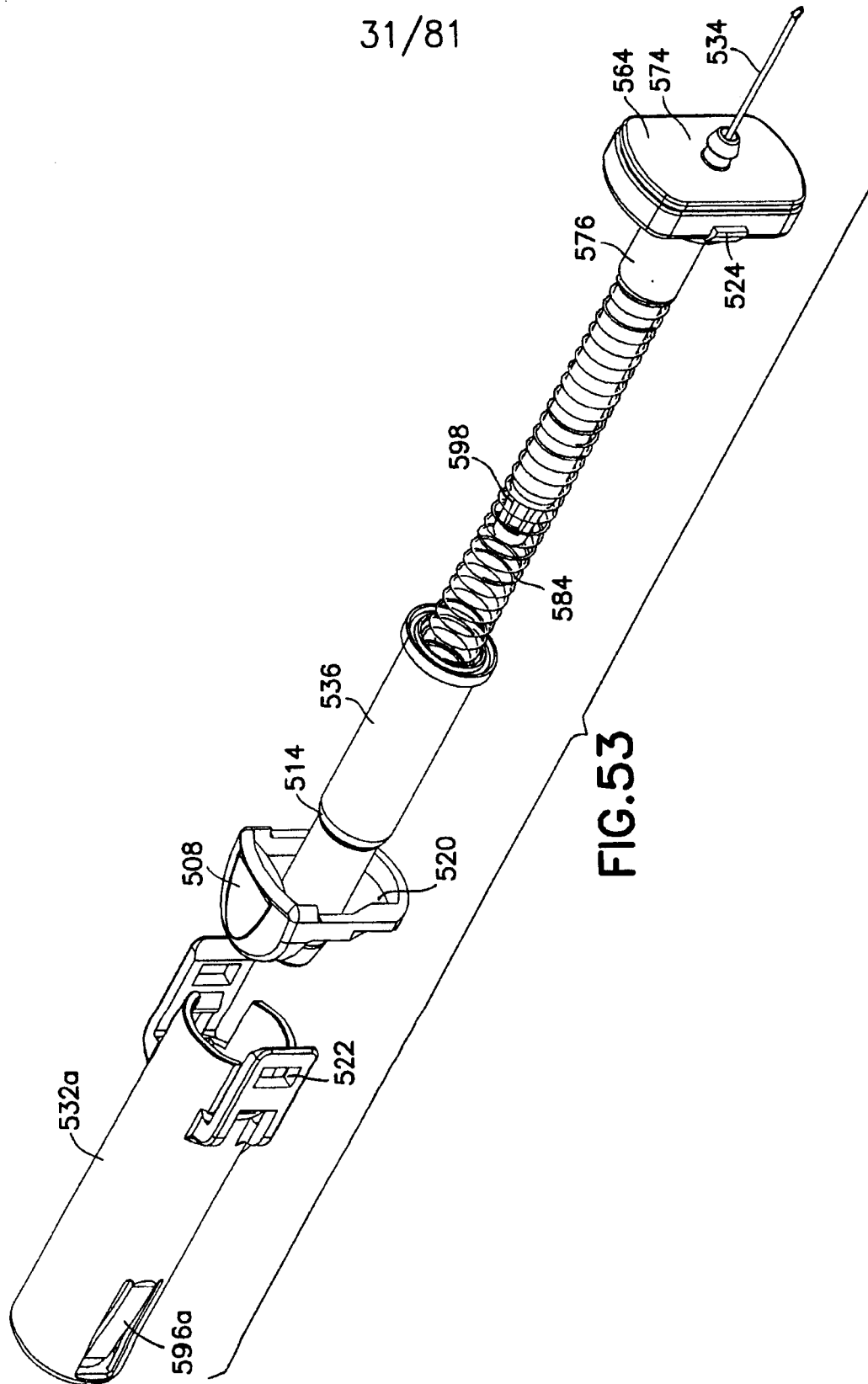


FIG. 52



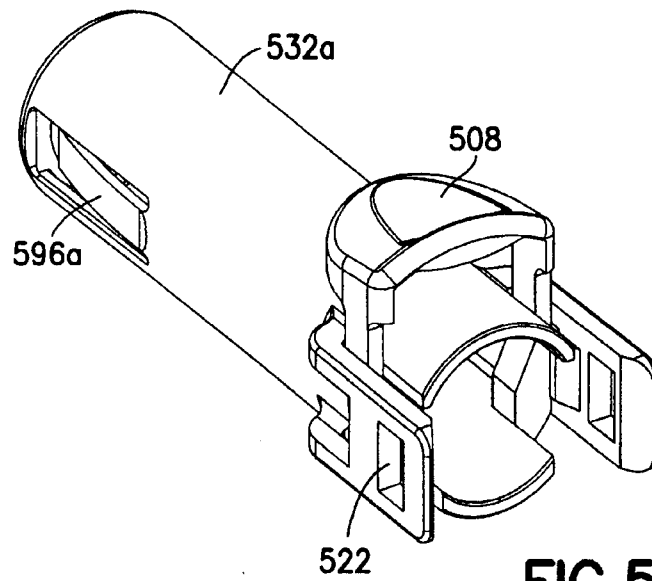


FIG.54

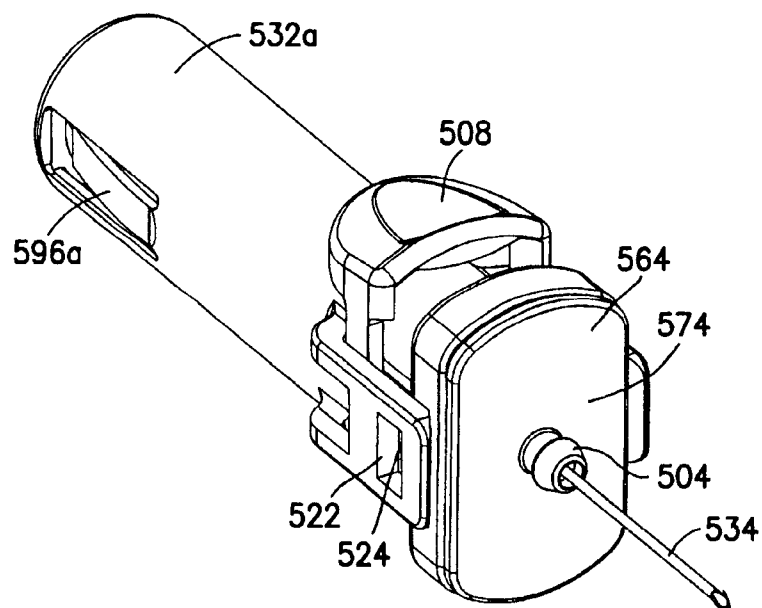
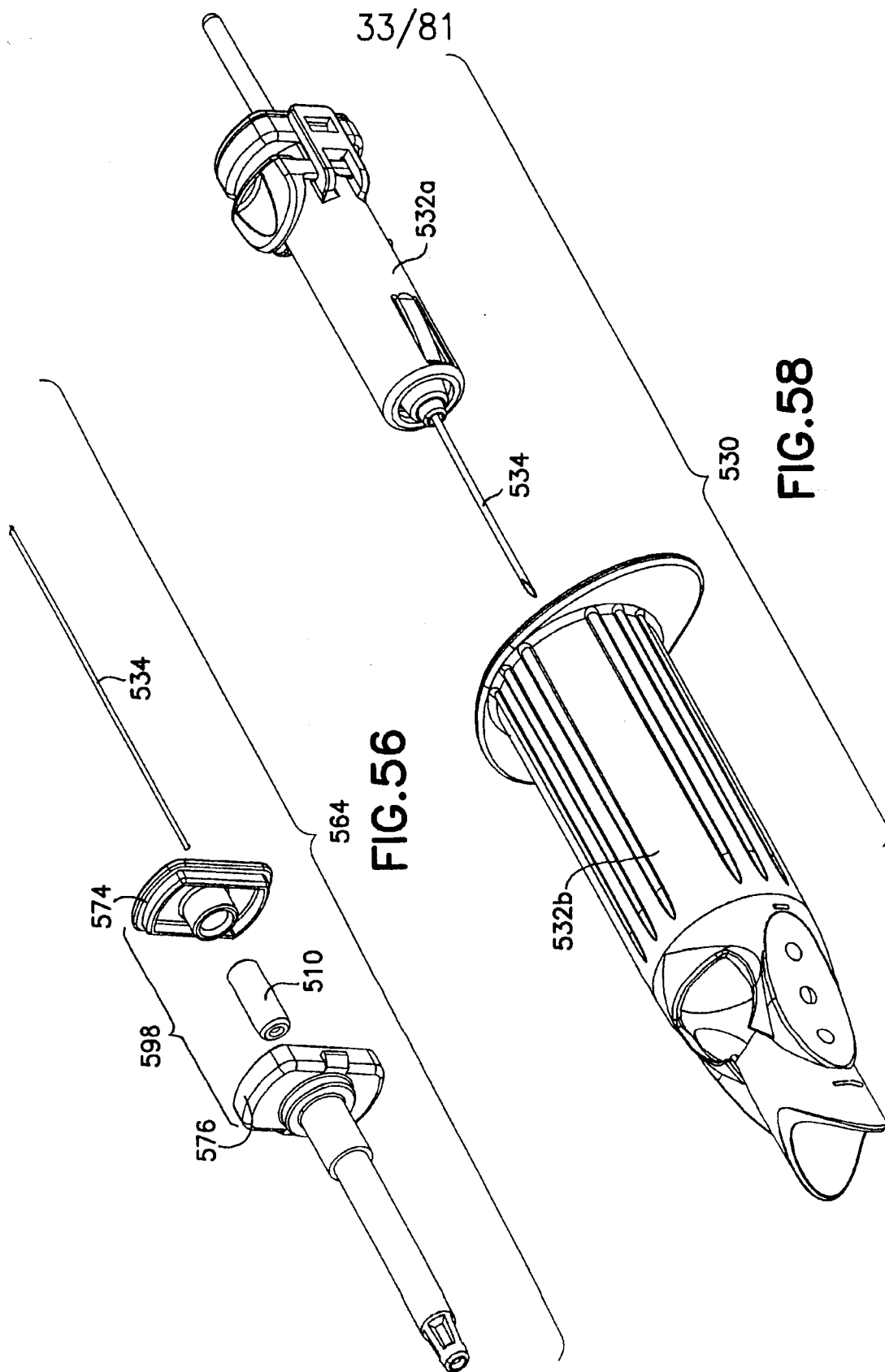
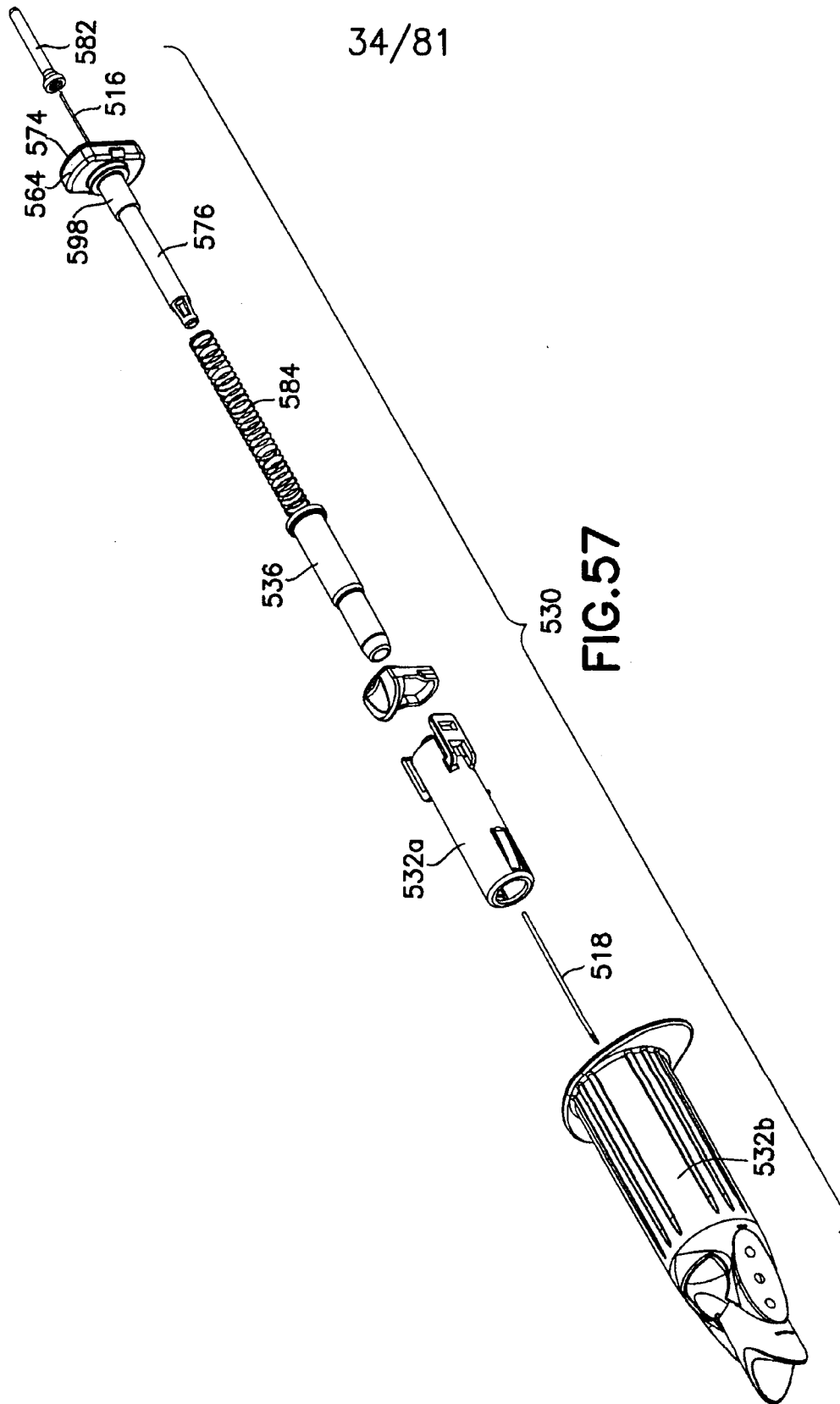
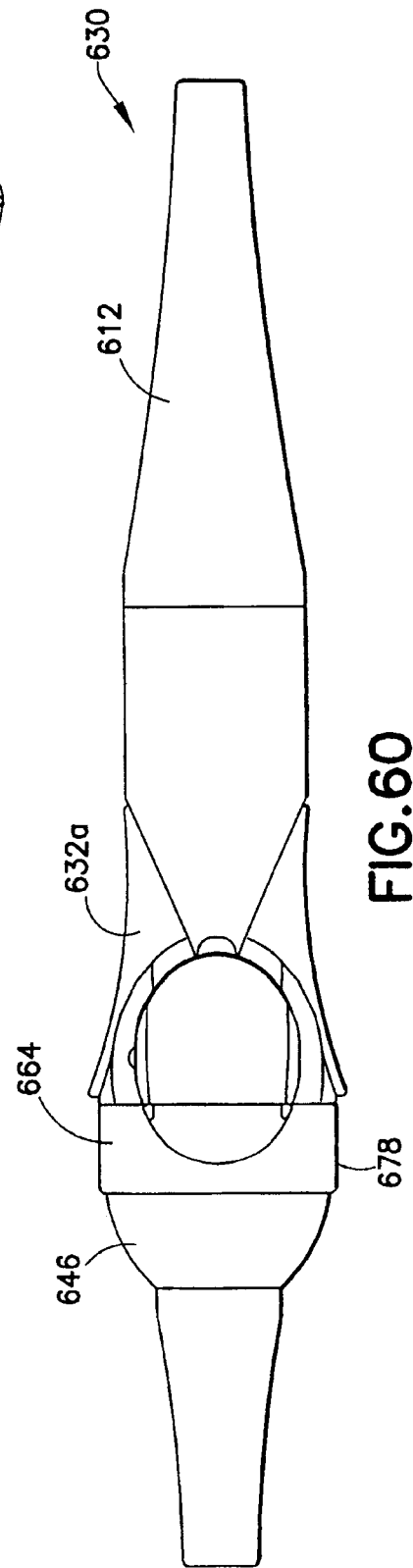
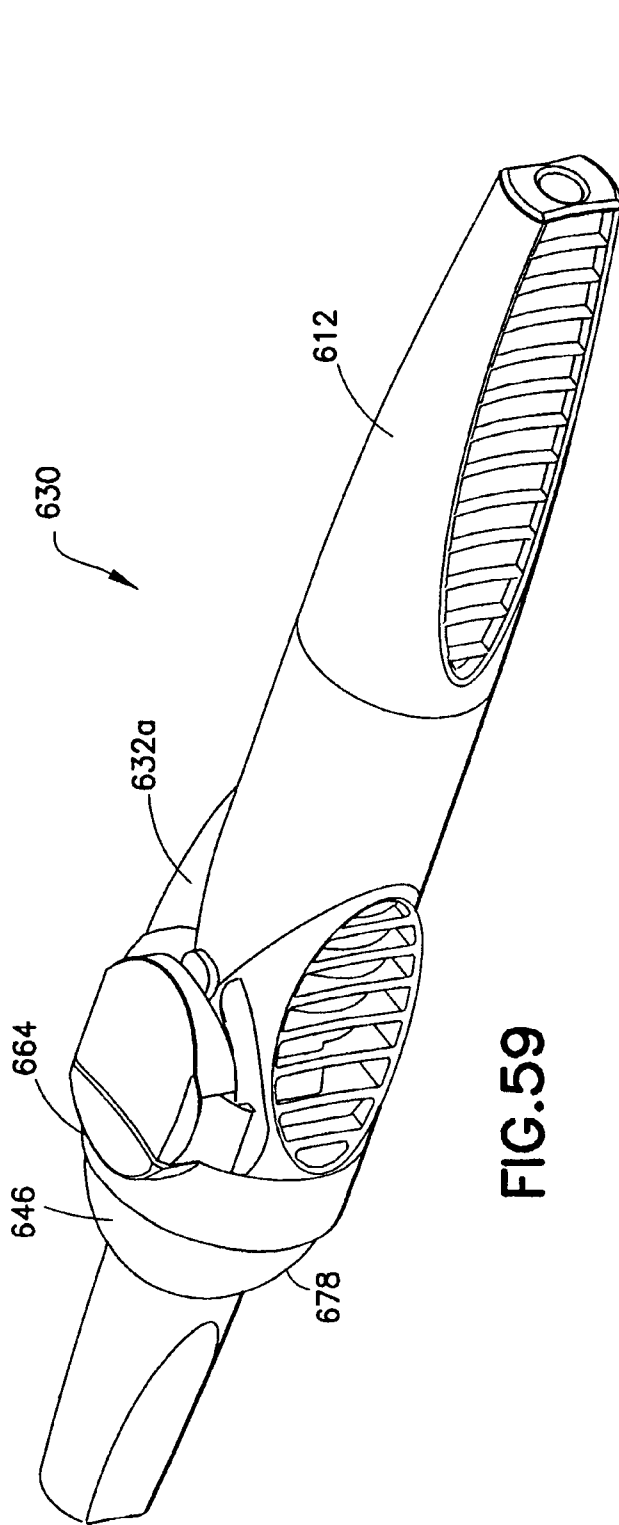


FIG.55







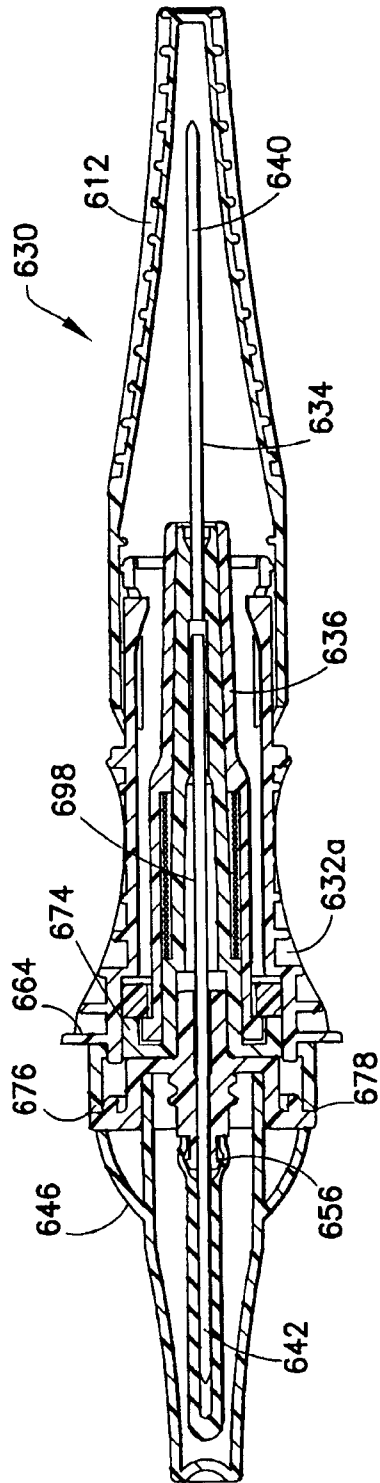


FIG. 61

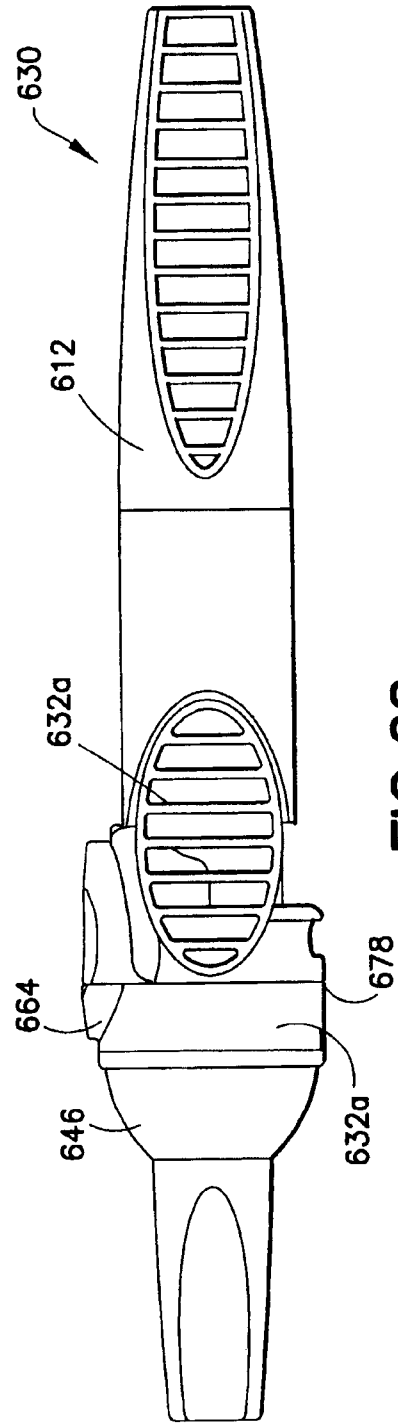


FIG. 62

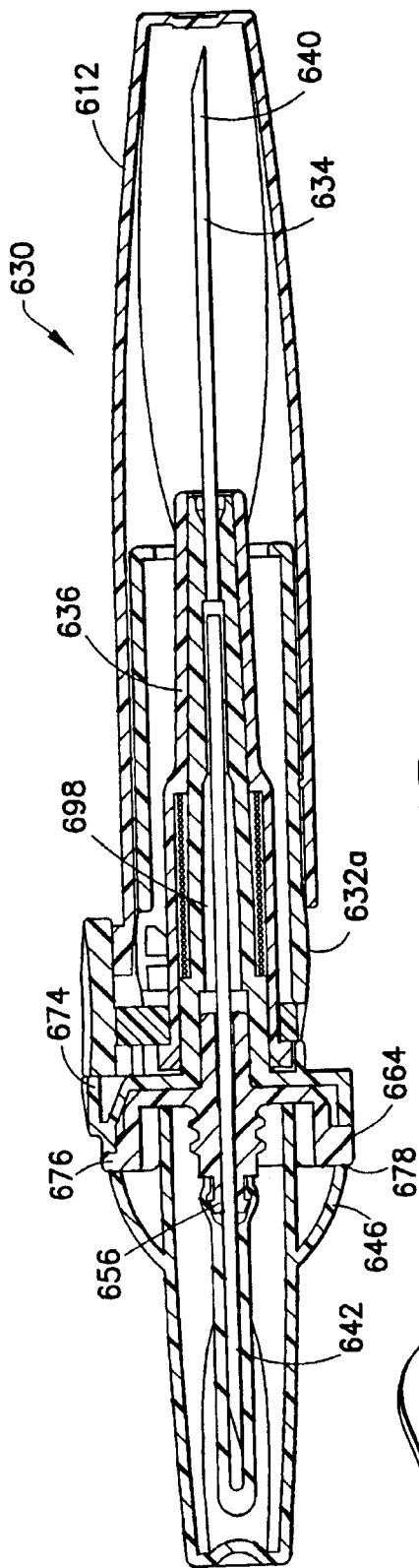


FIG. 63

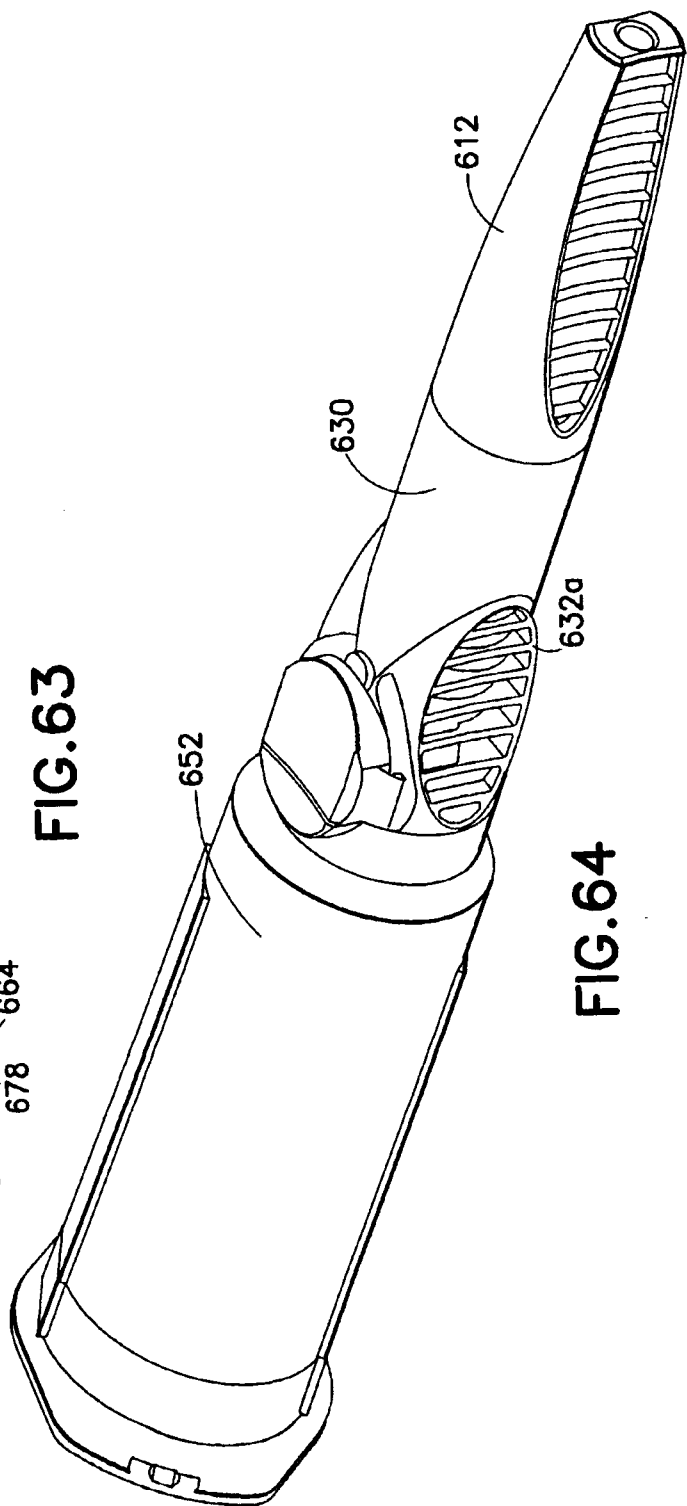


FIG. 64

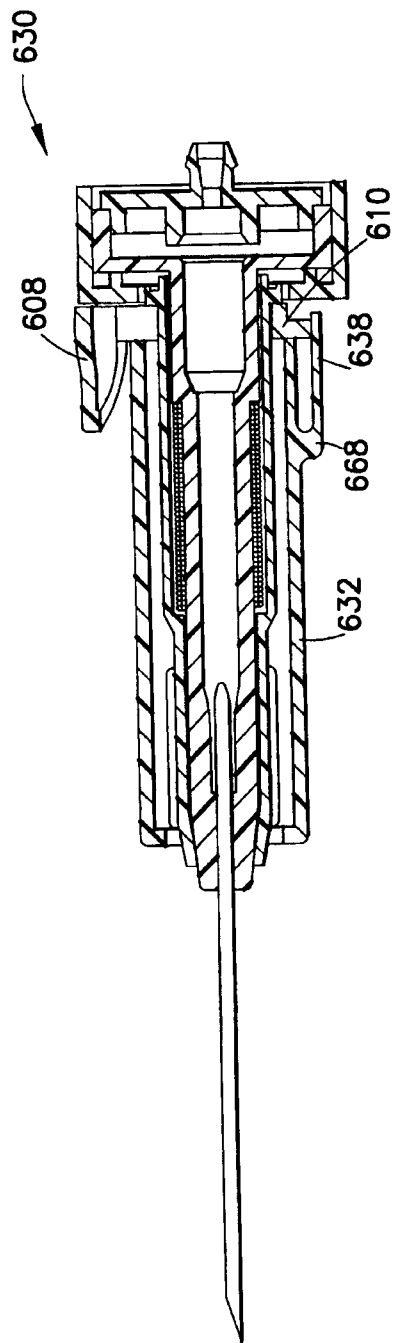


FIG. 65

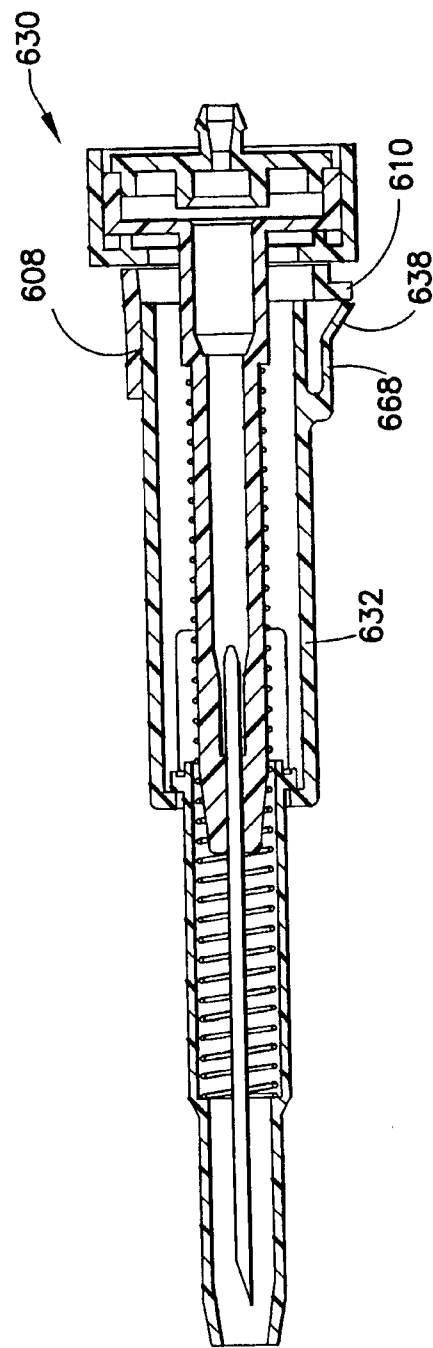
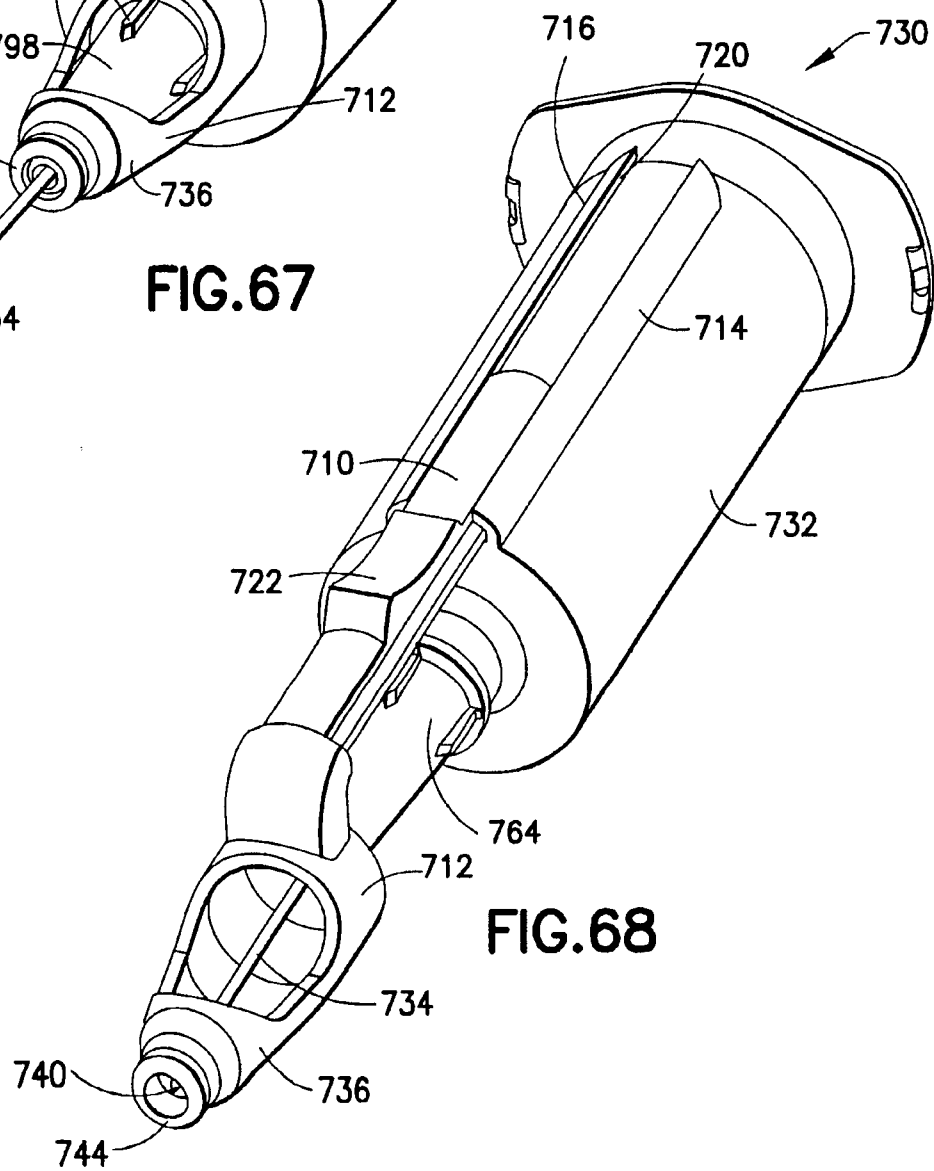
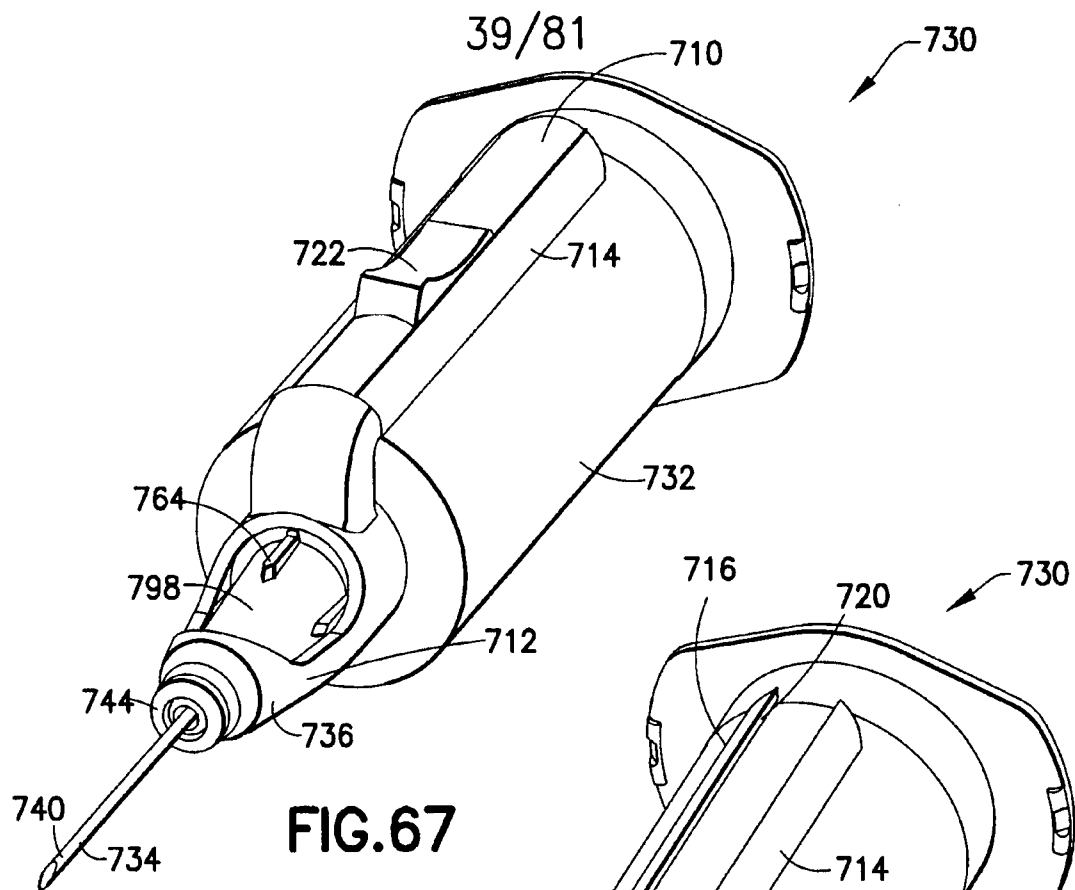
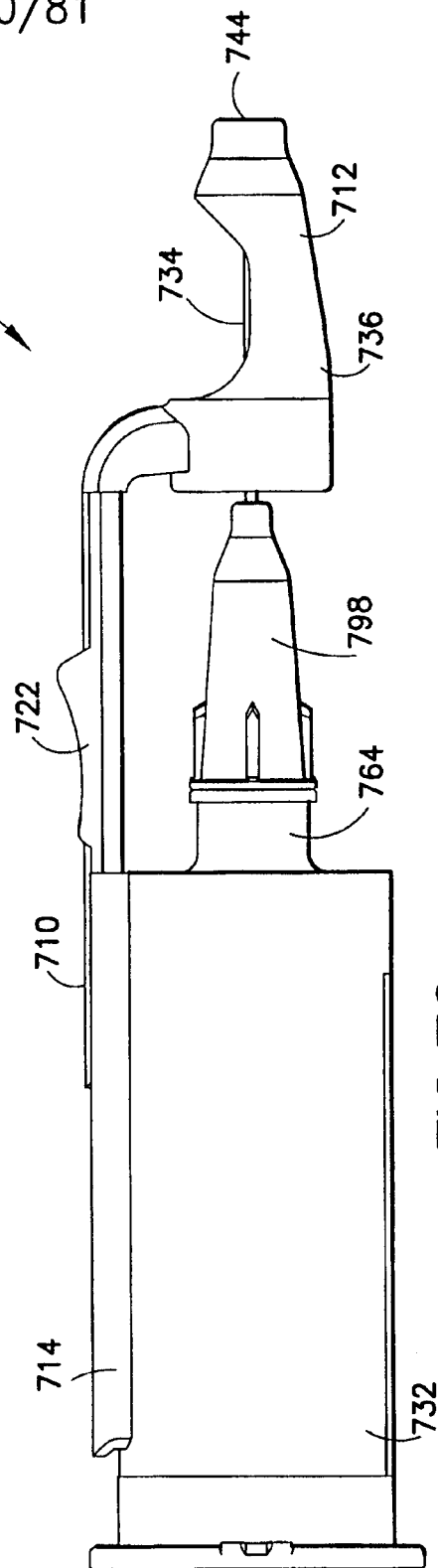
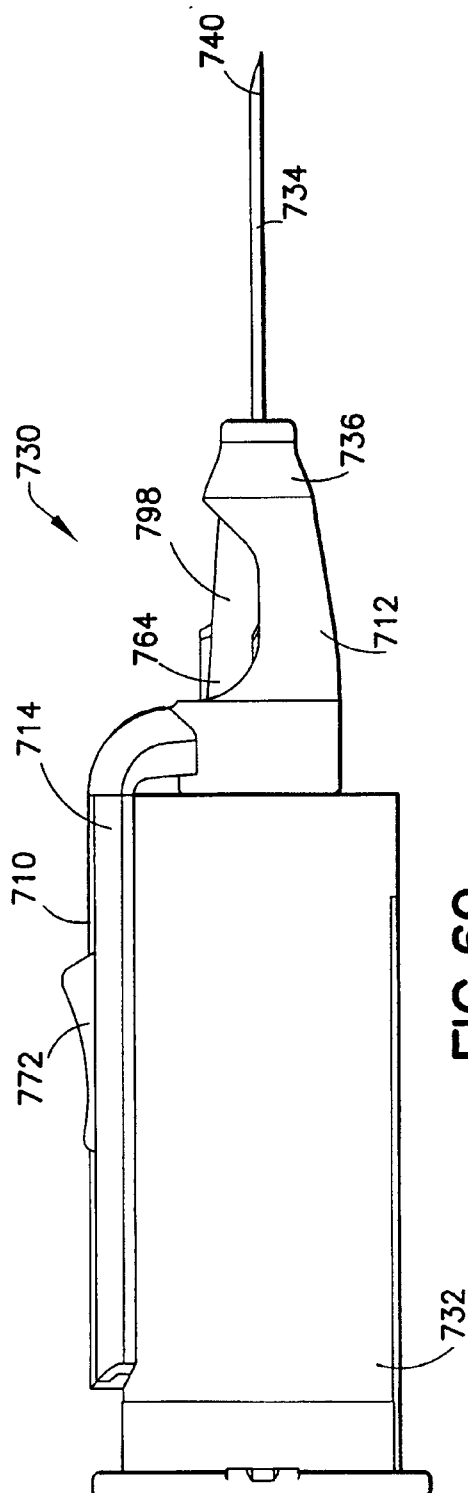


FIG. 66





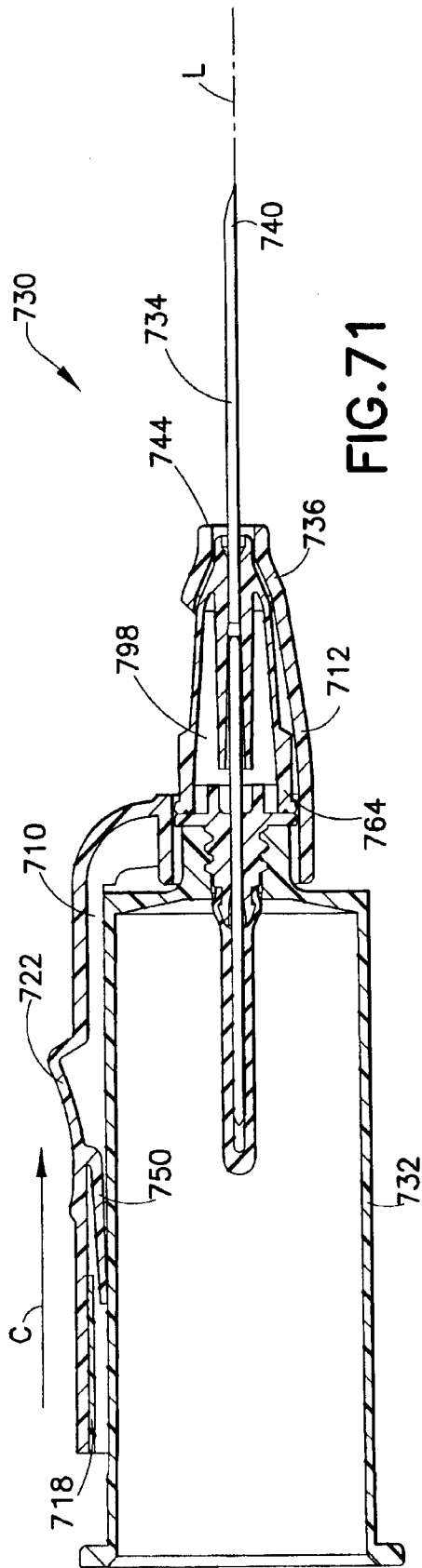


FIG. 71

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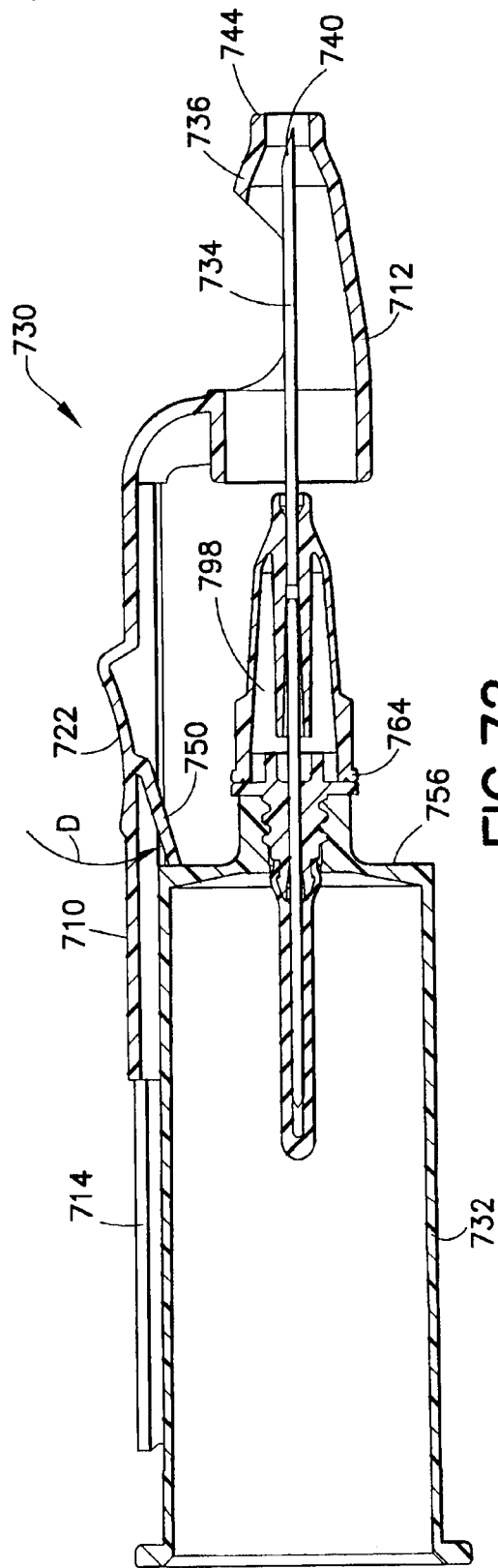


FIG. 72

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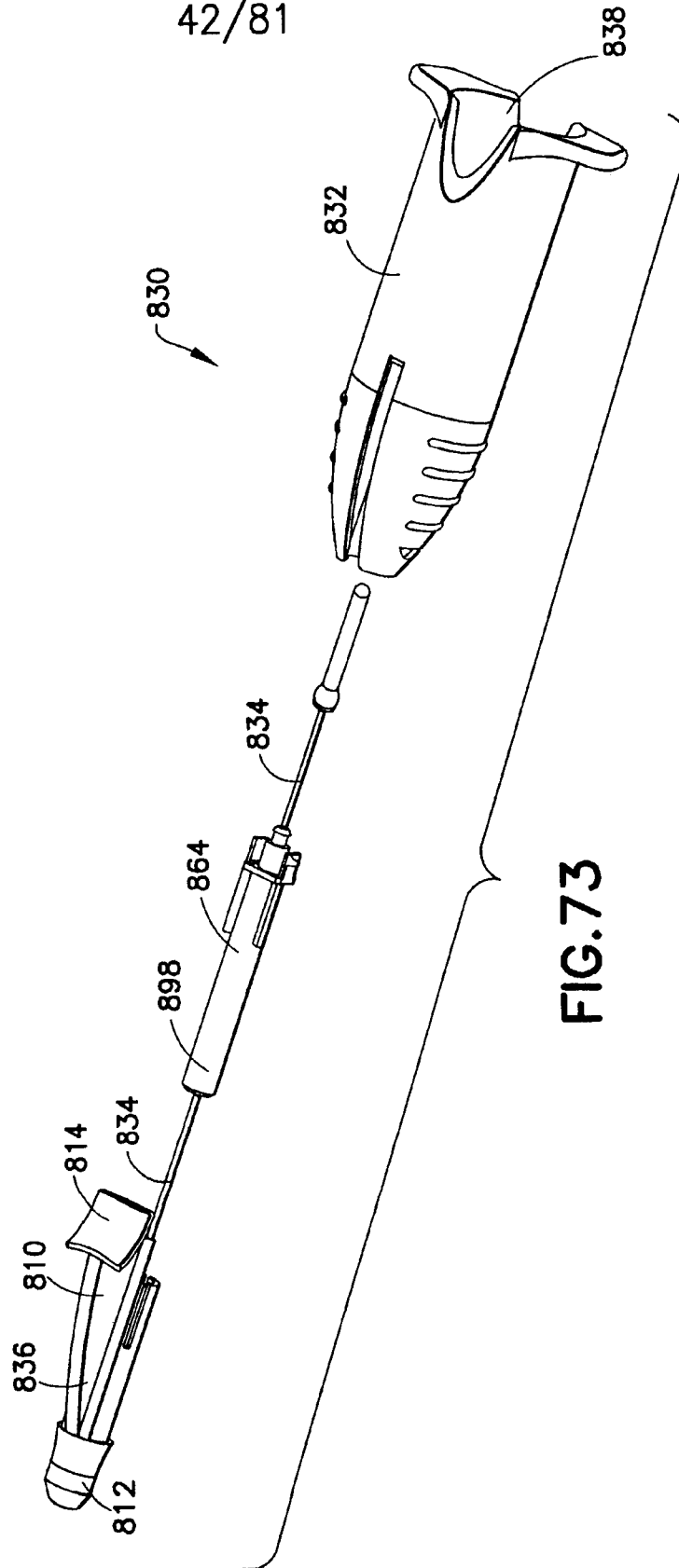


FIG. 73

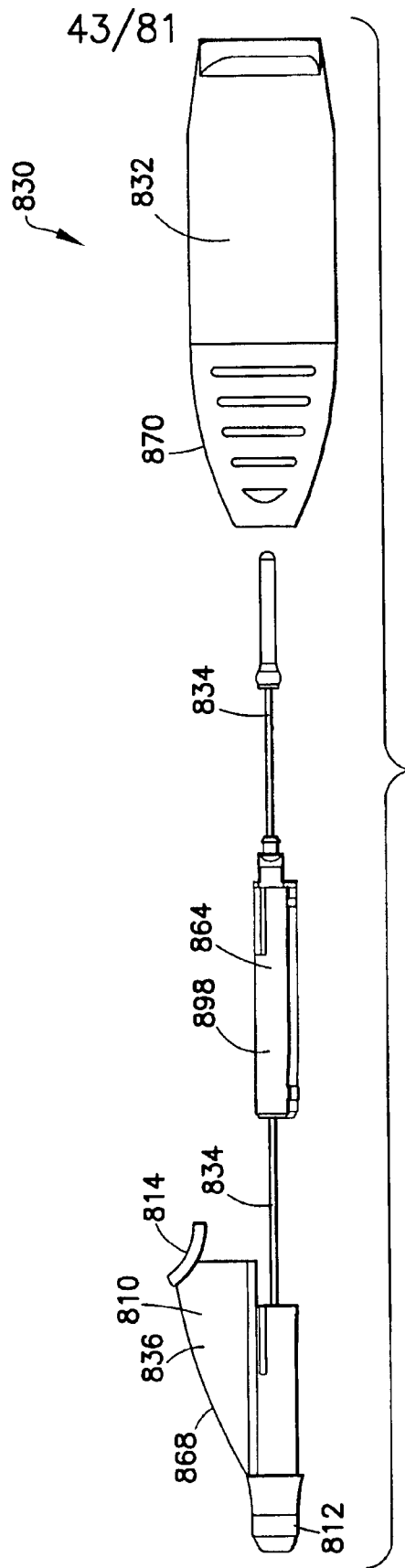


FIG.74

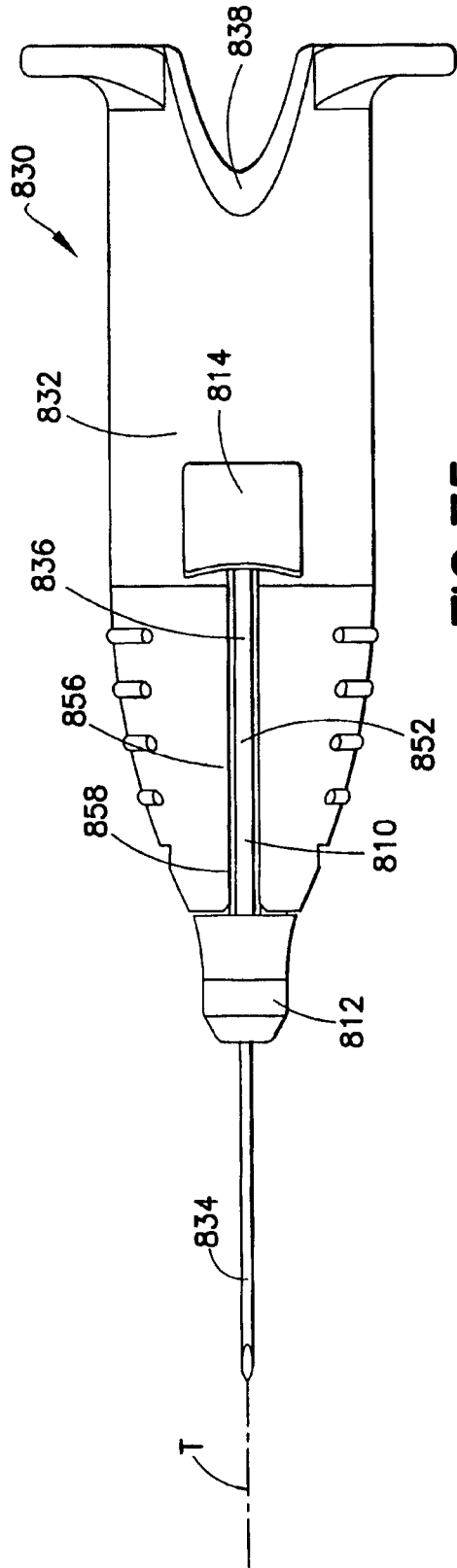


FIG. 75

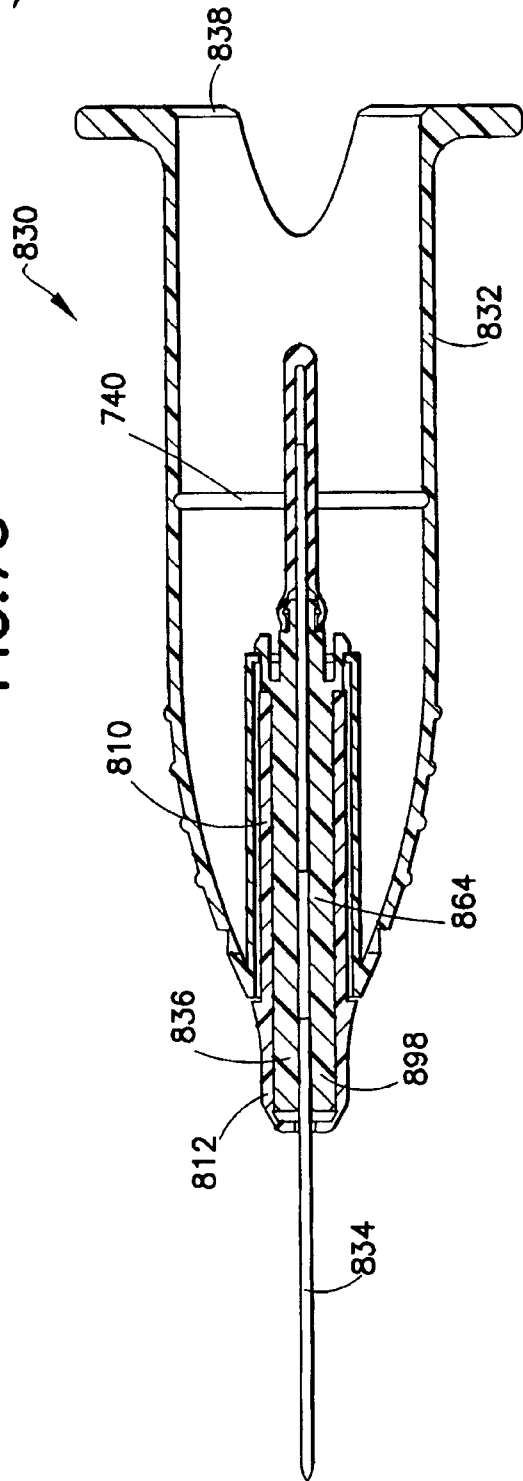


FIG. 76

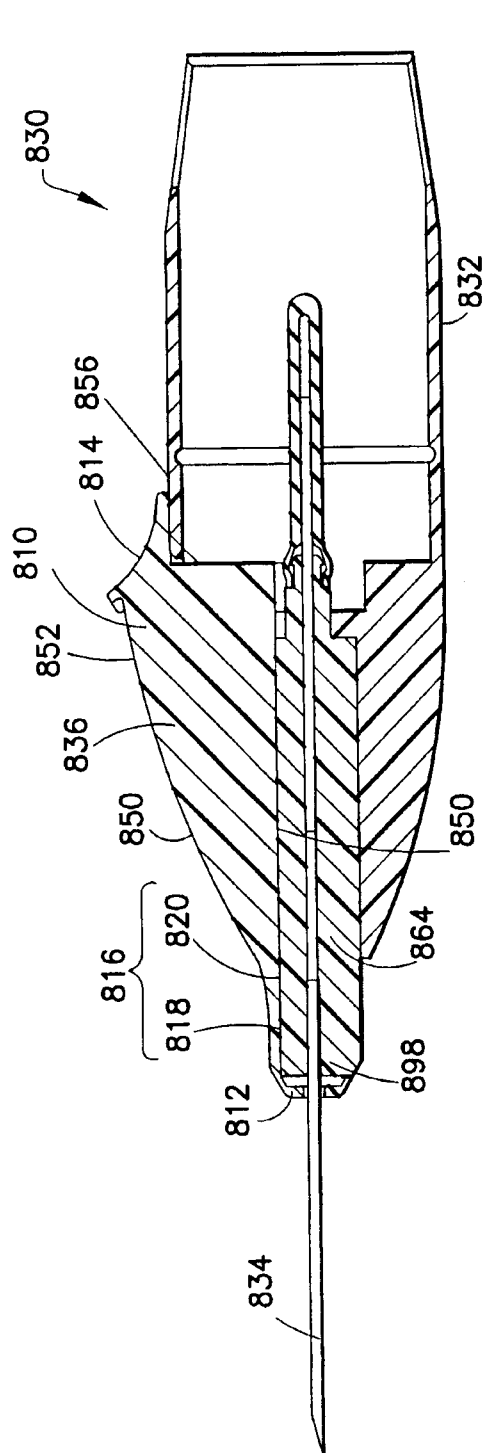


FIG. 77

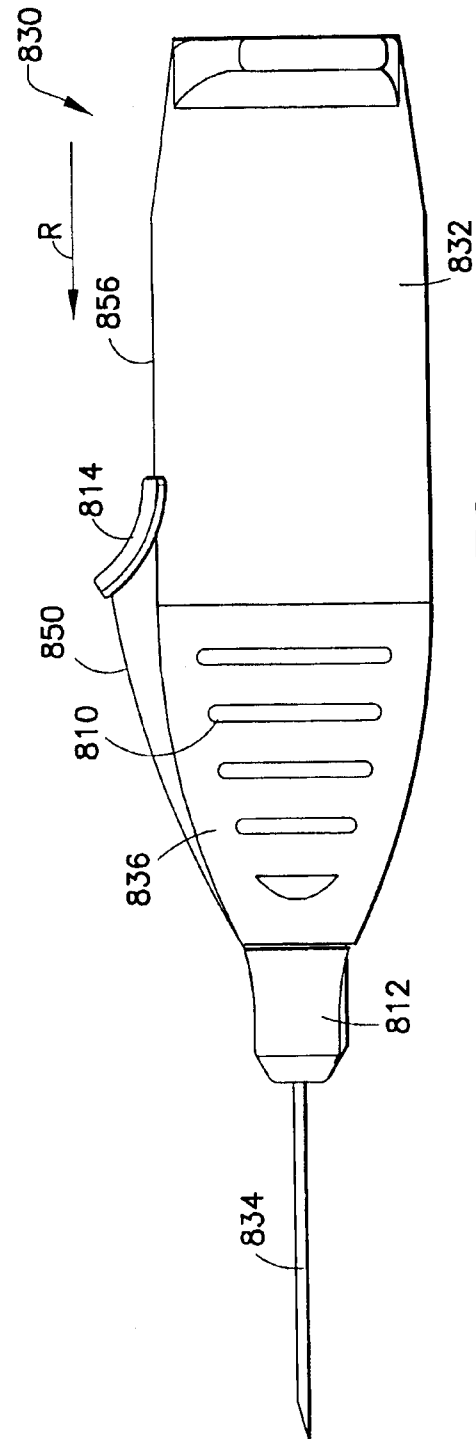
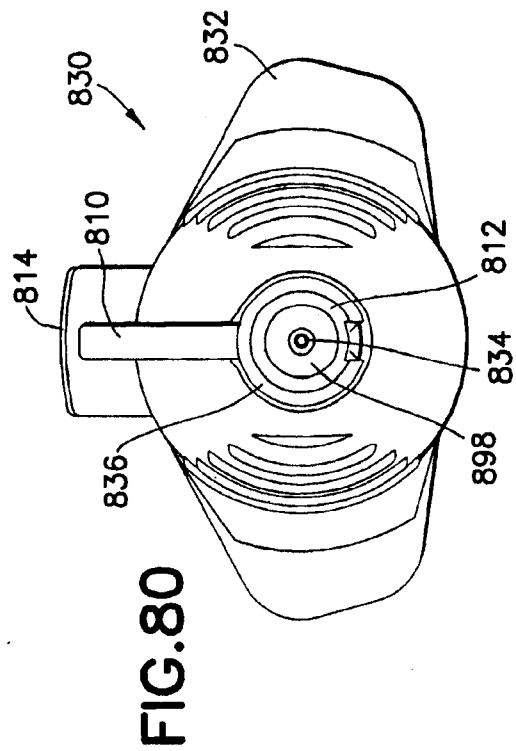
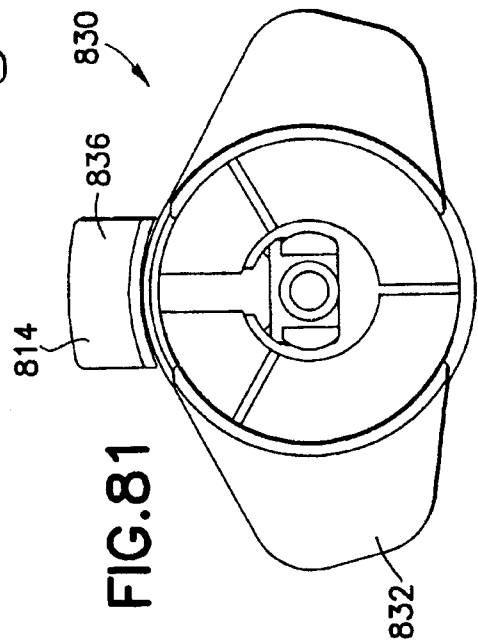
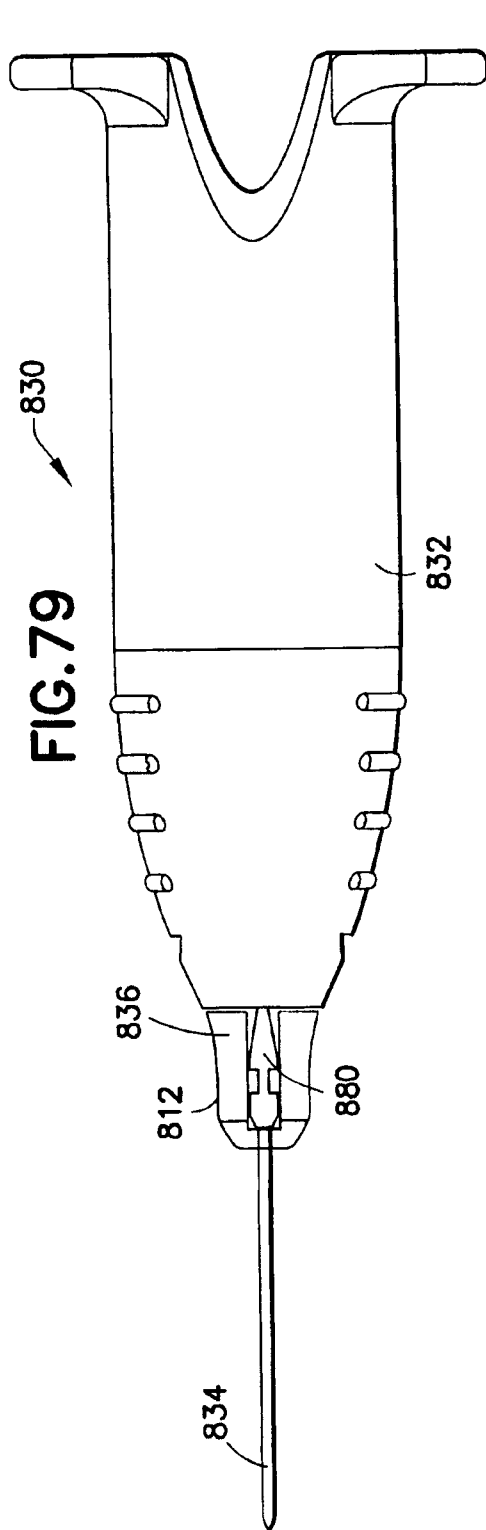
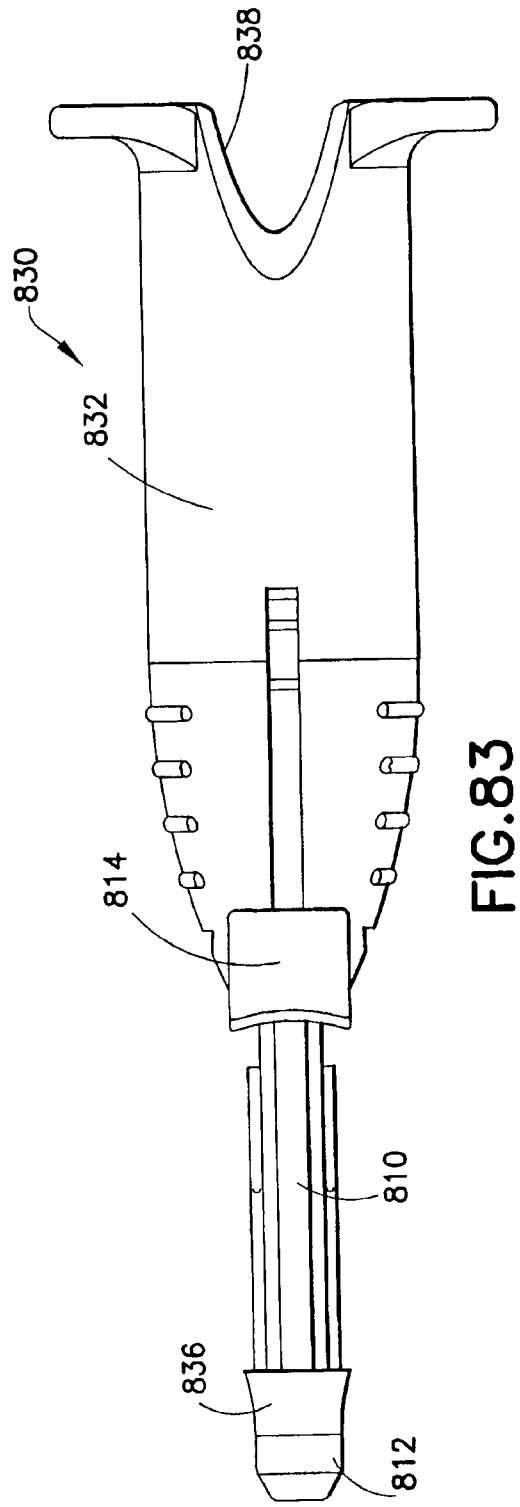
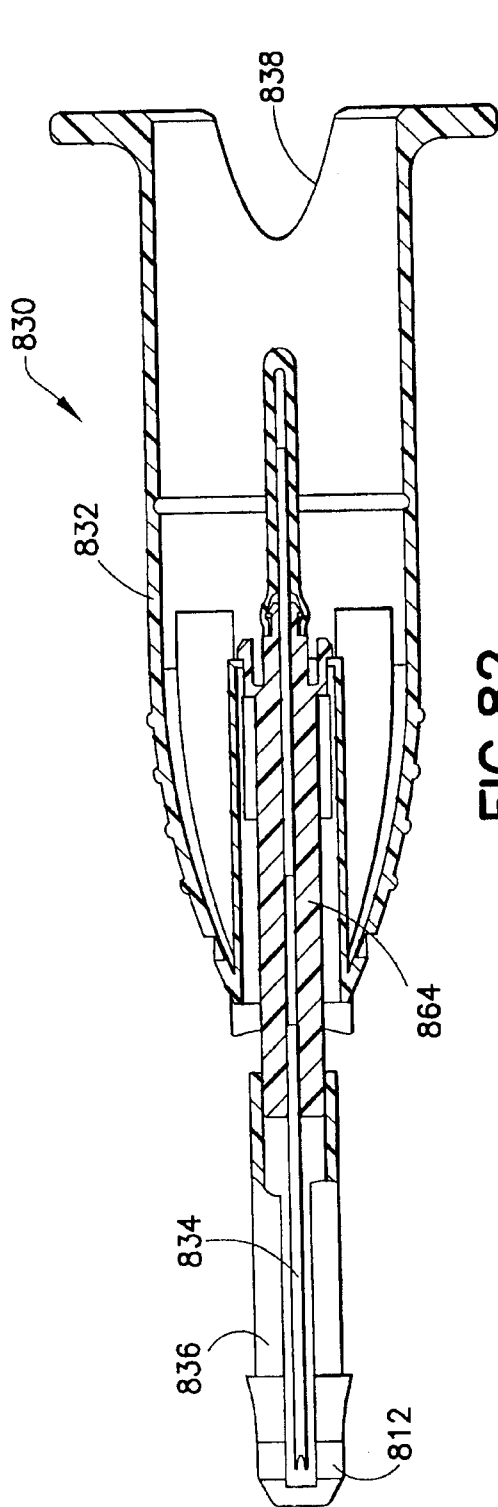


FIG. 78





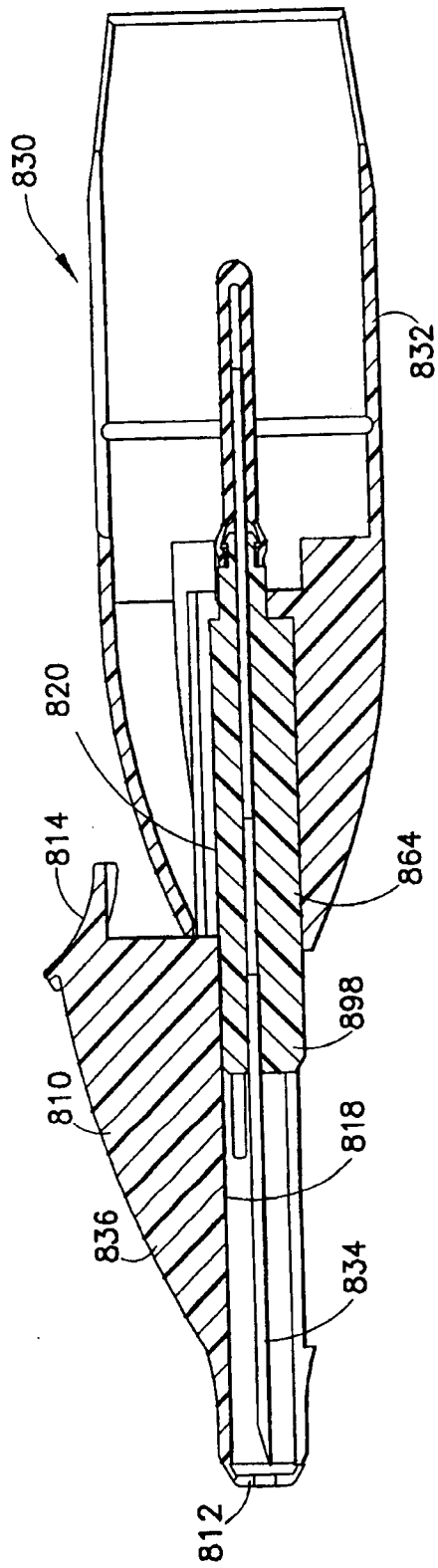


FIG. 84

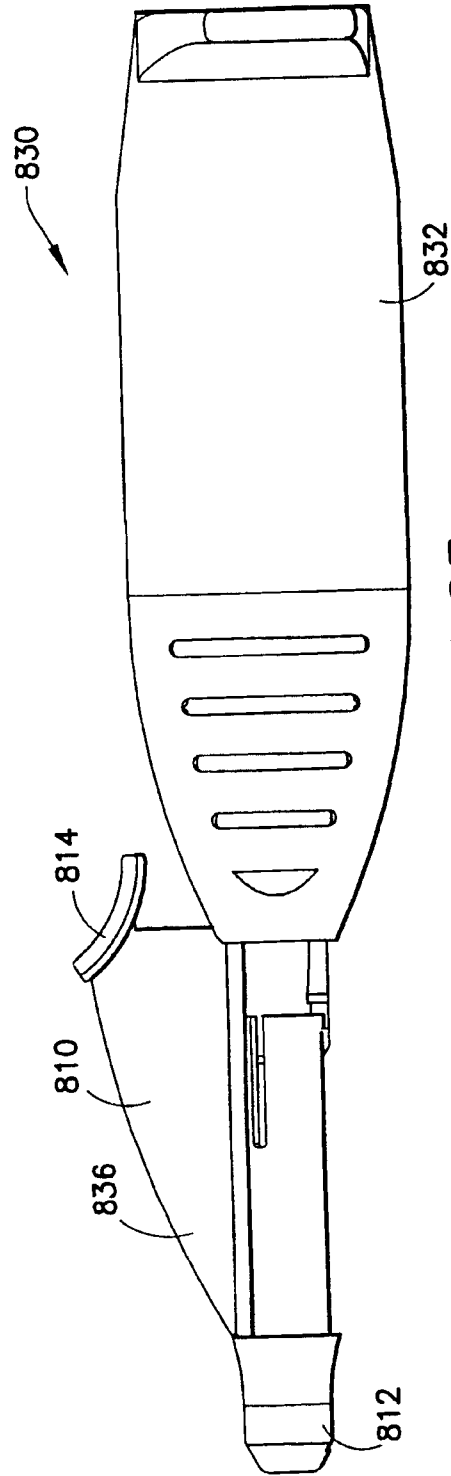


FIG. 85

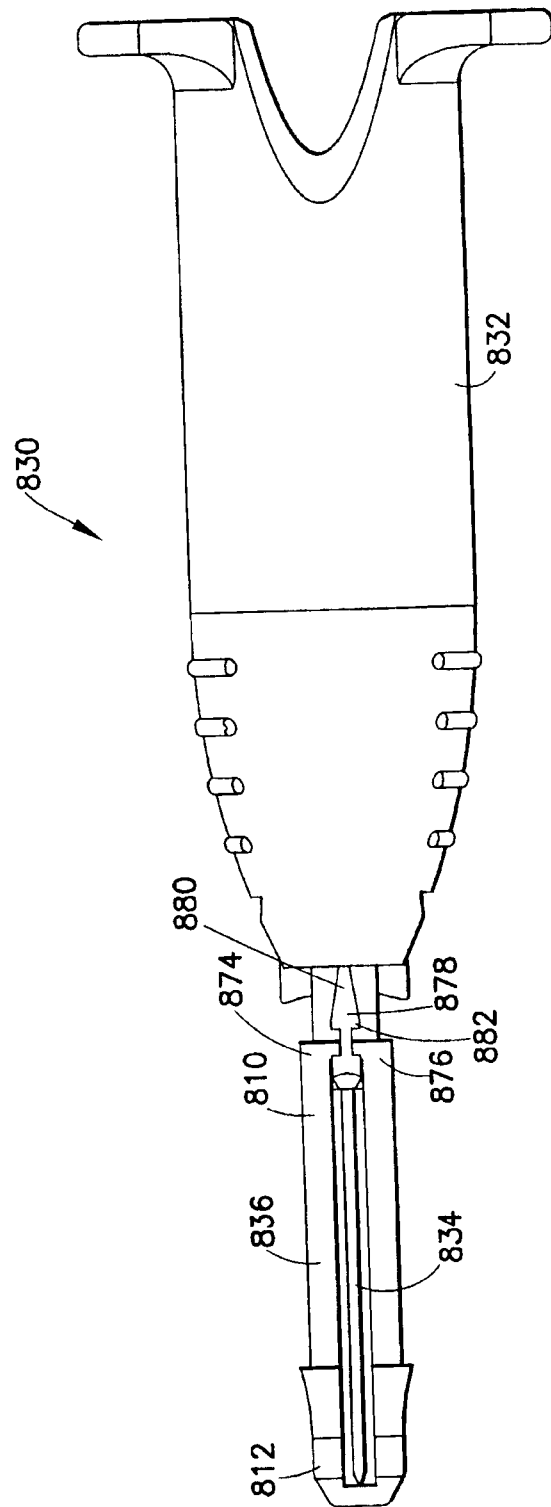
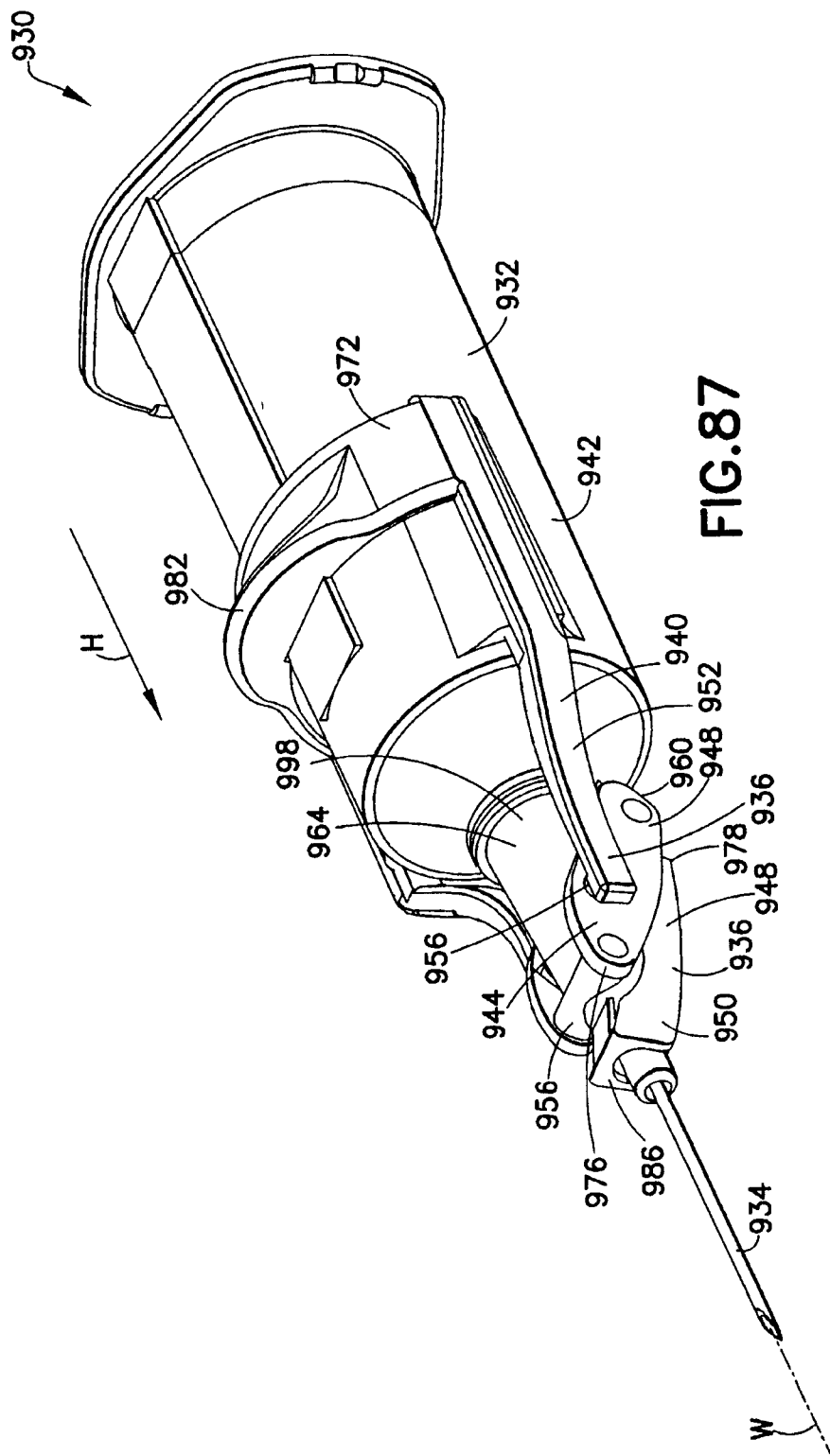
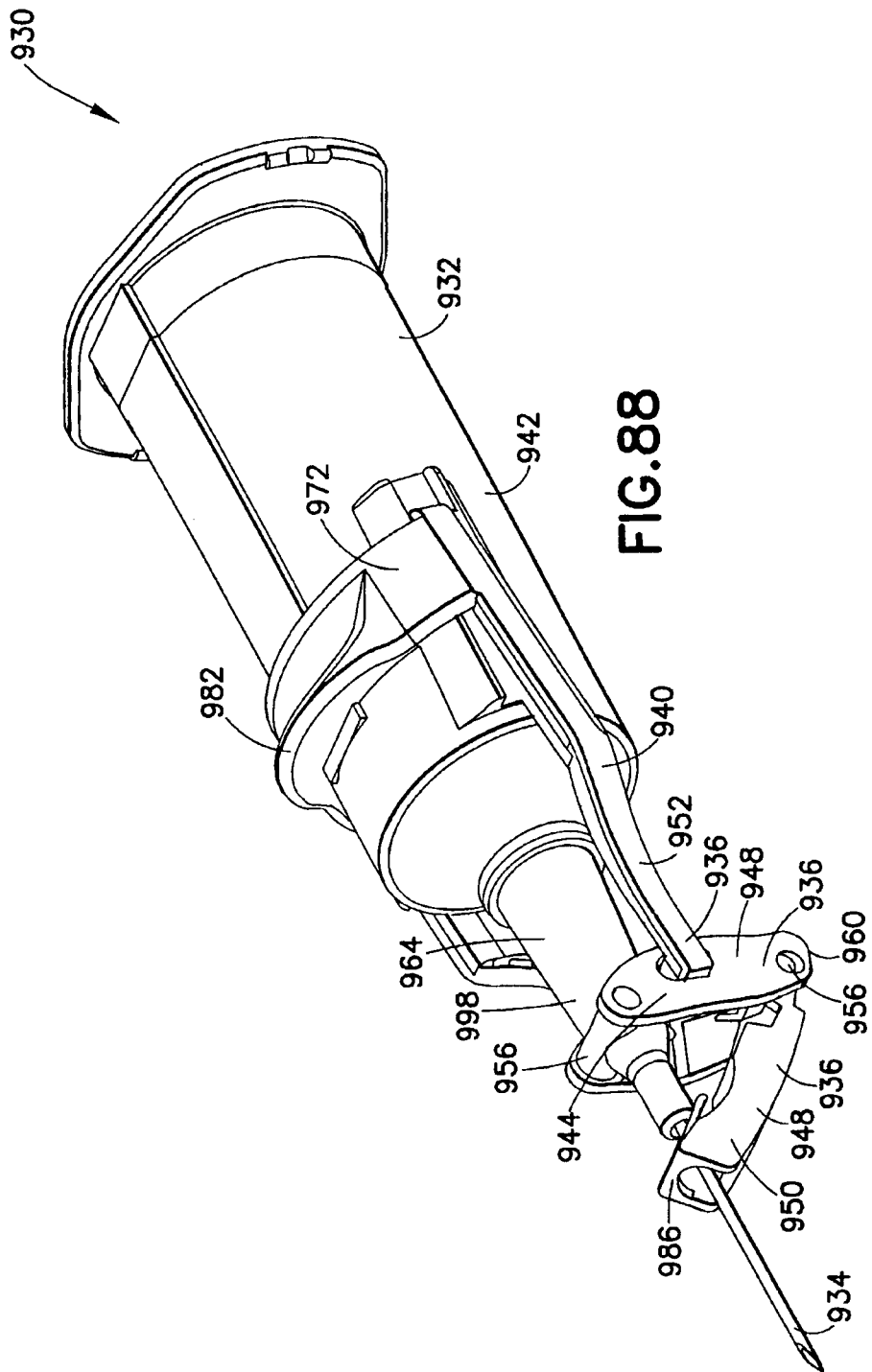
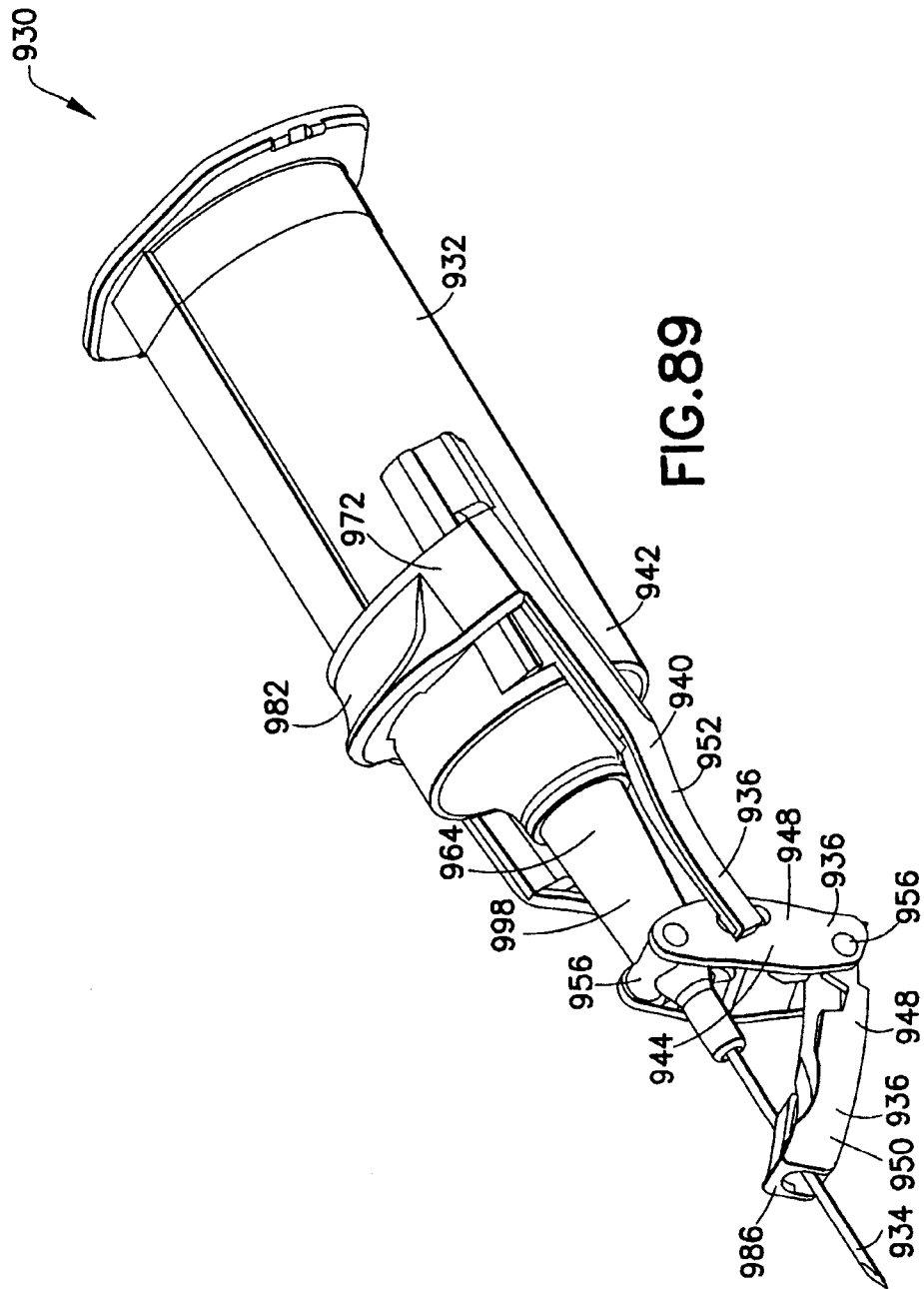
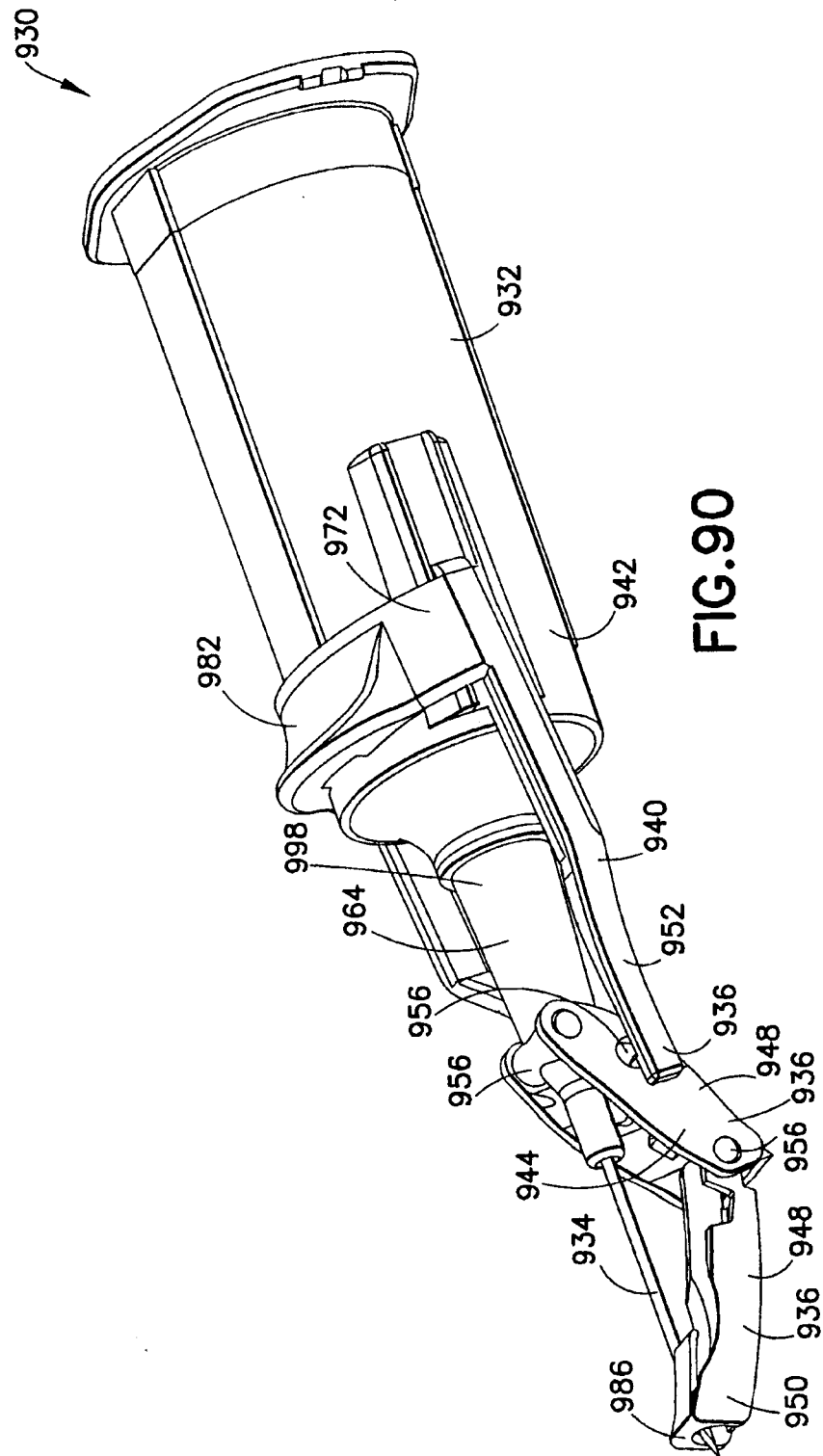


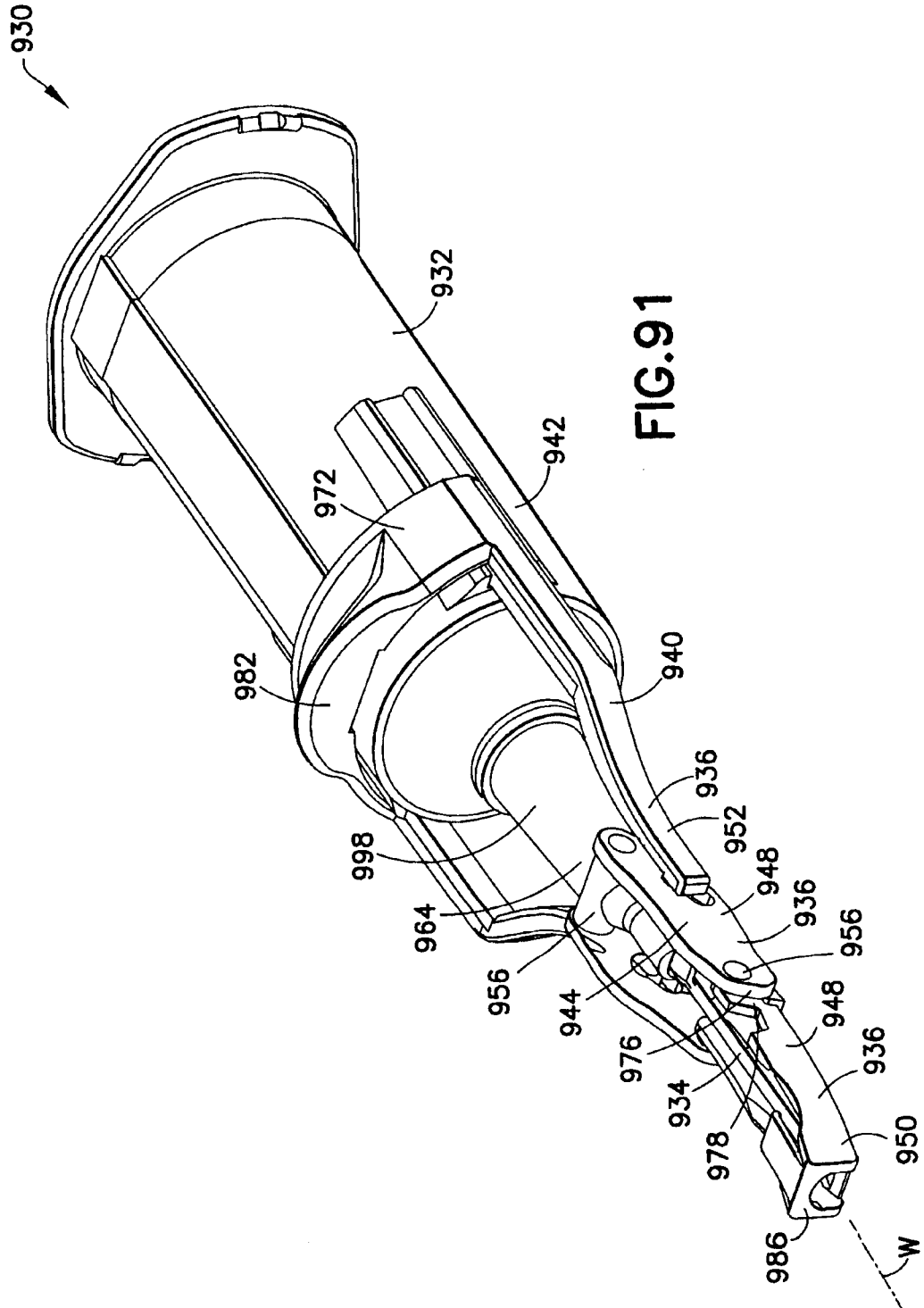
FIG. 86











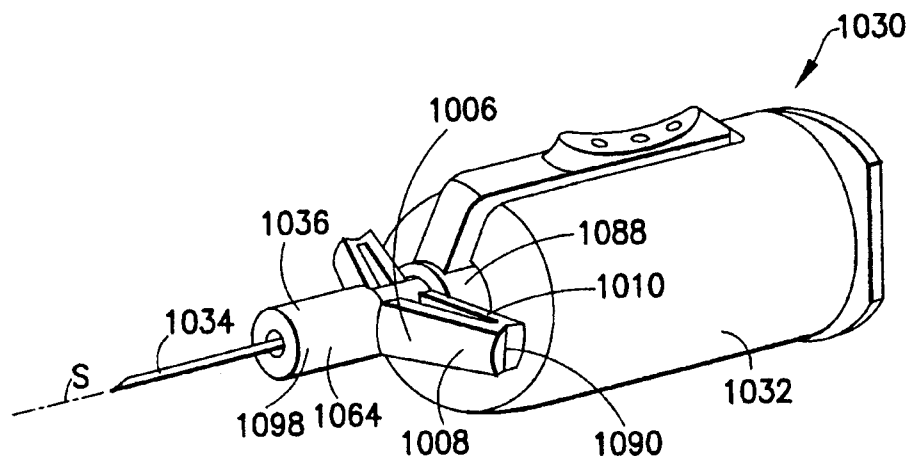


FIG.92

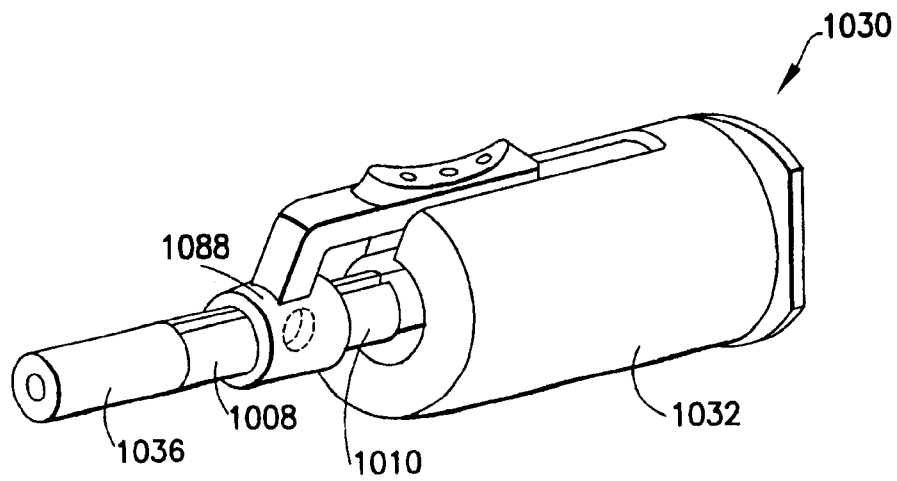
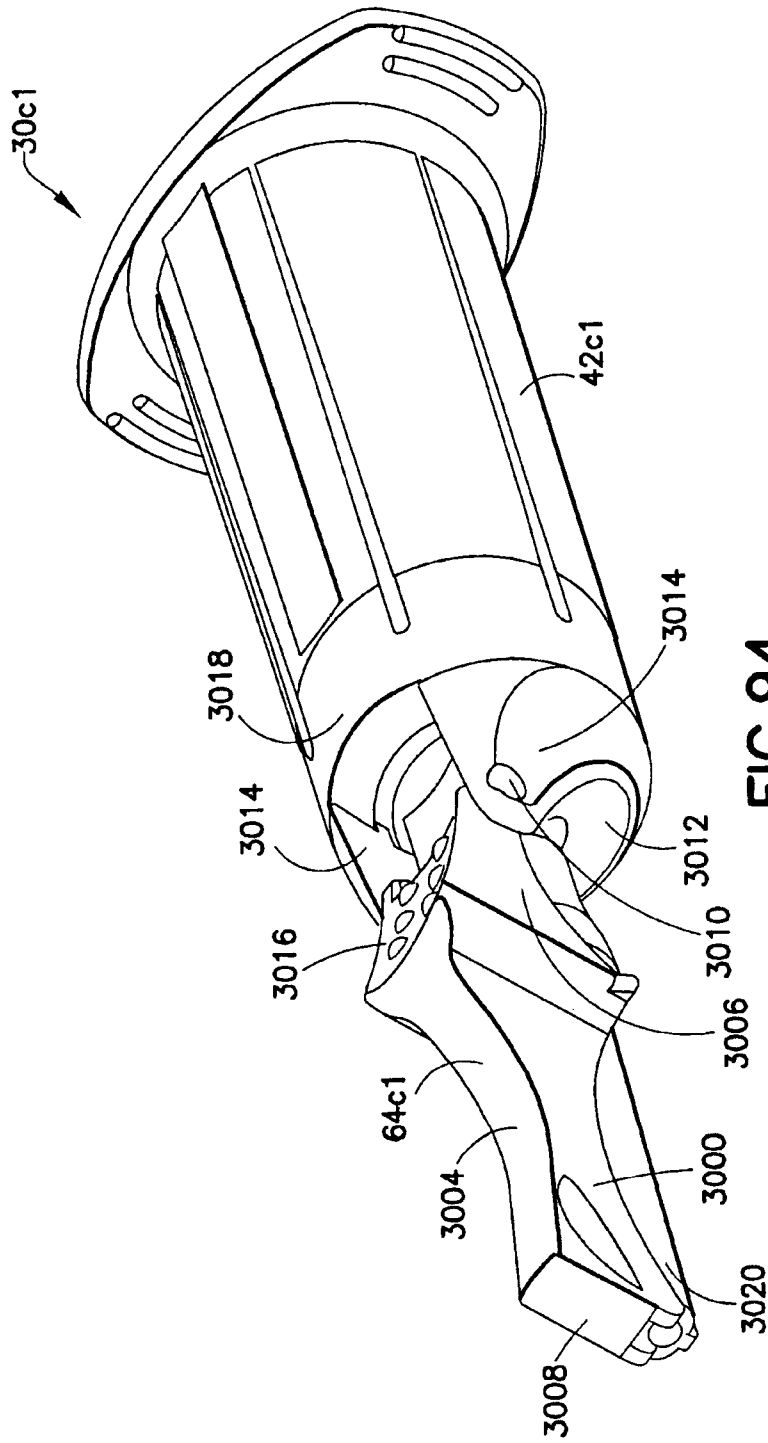


FIG.93



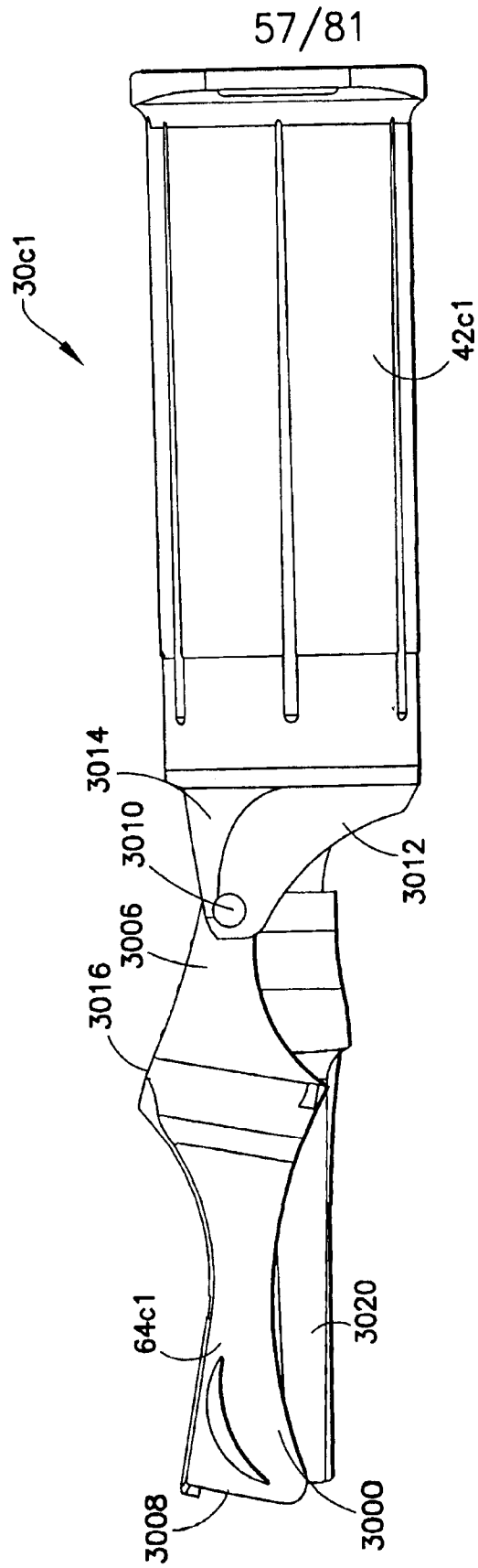
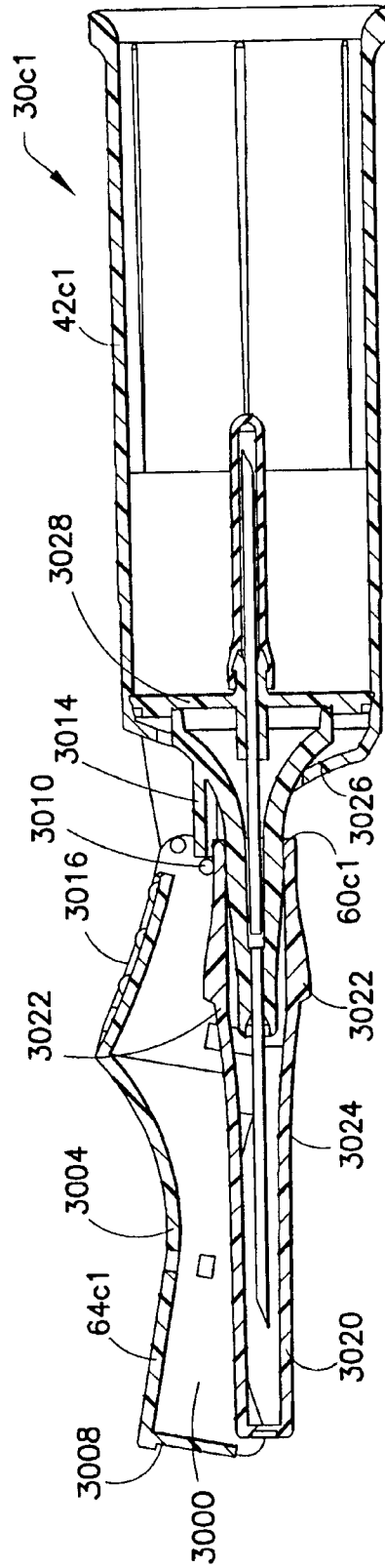
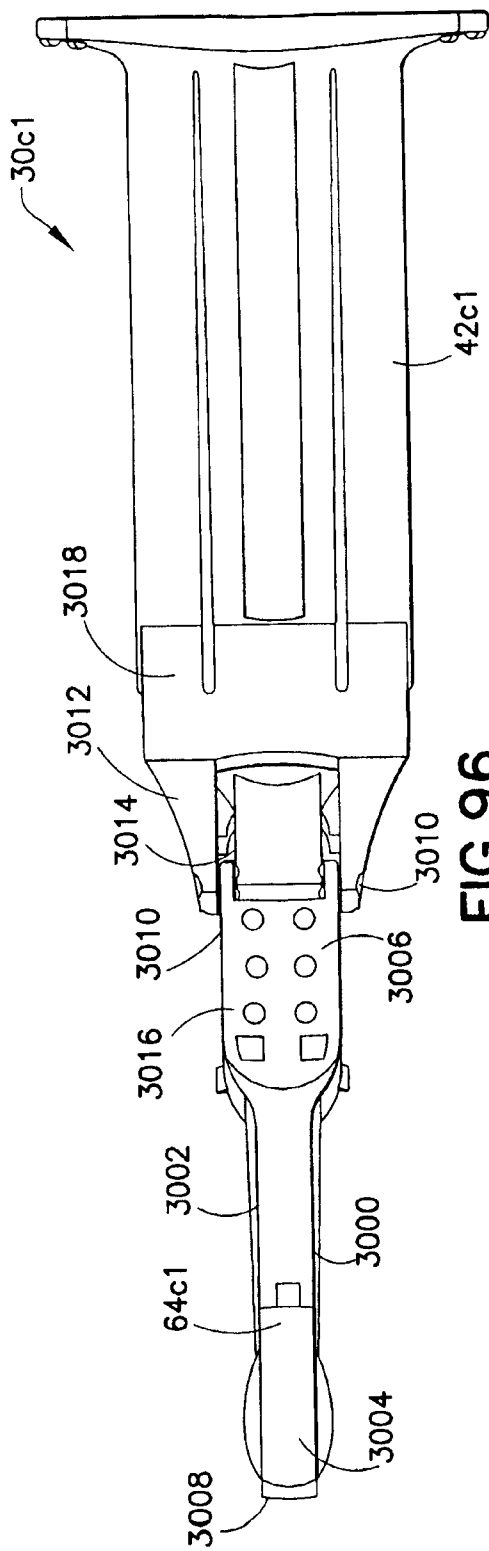


FIG. 95



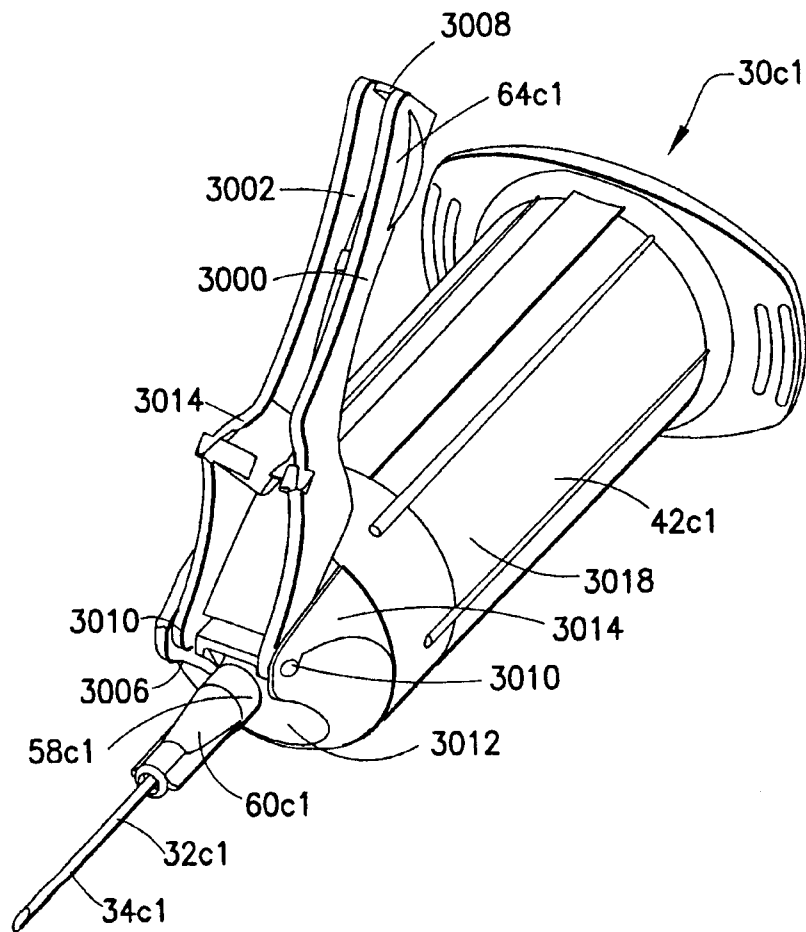


FIG.98

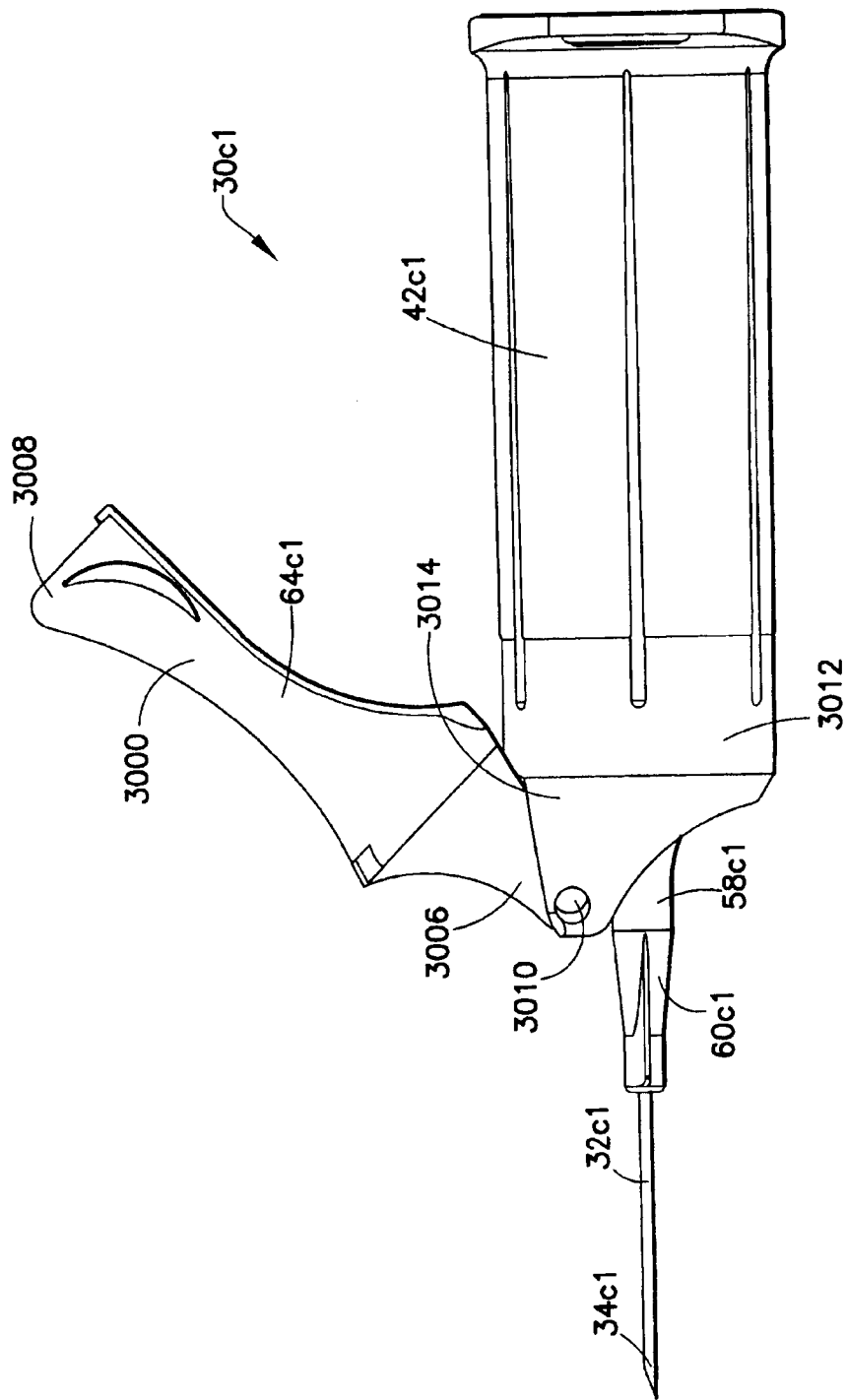


FIG. 99

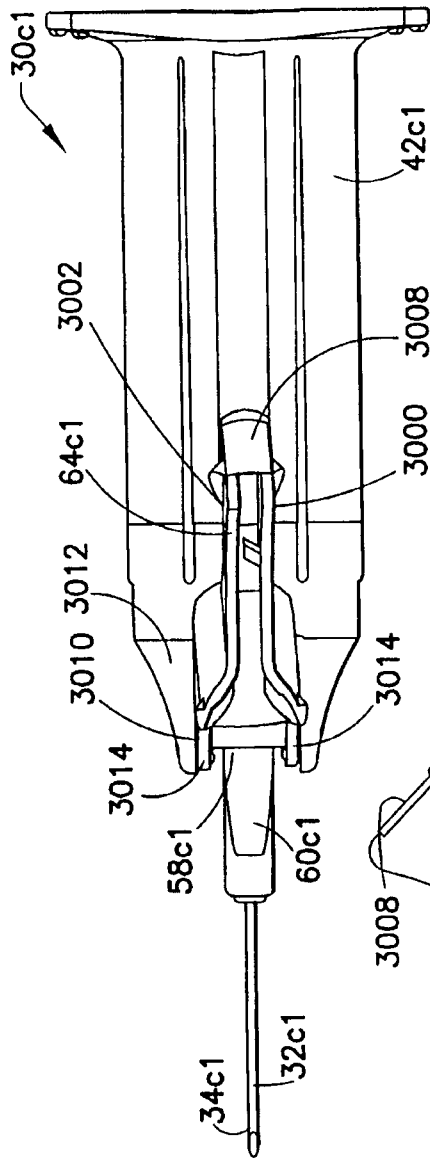


FIG. 100

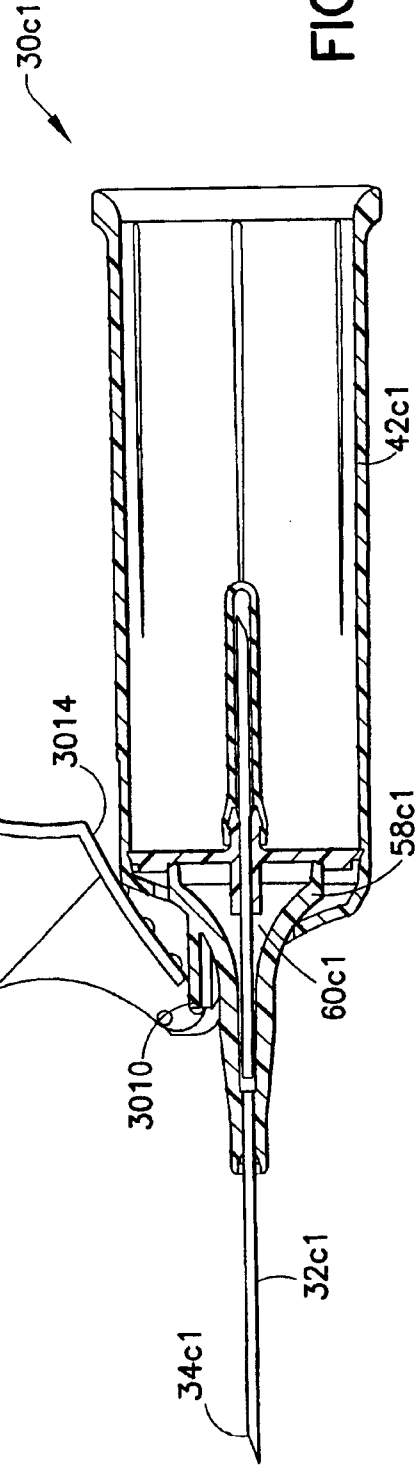
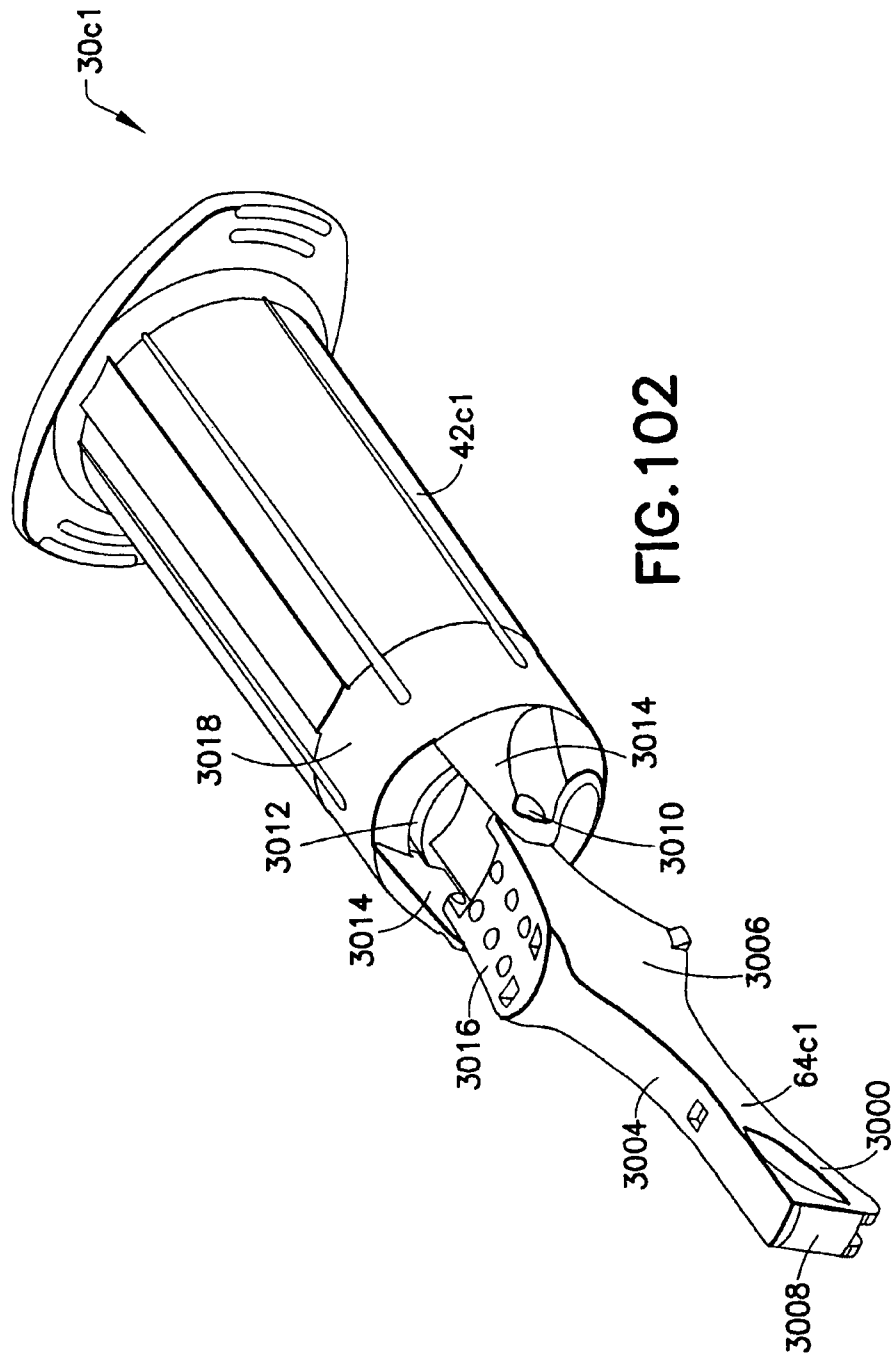


FIG. 101



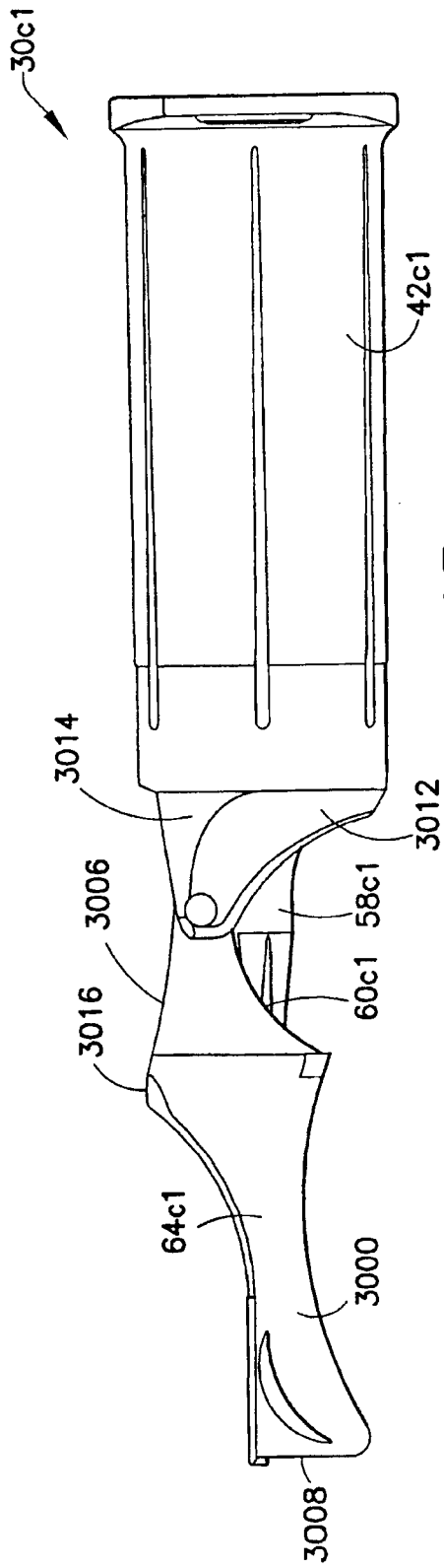


FIG. 103

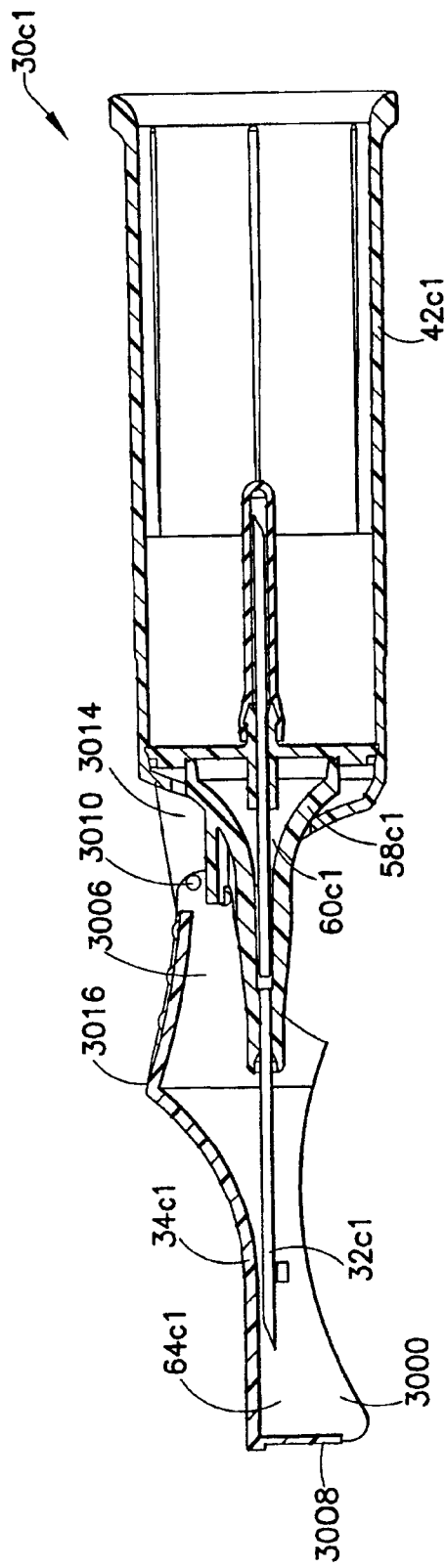
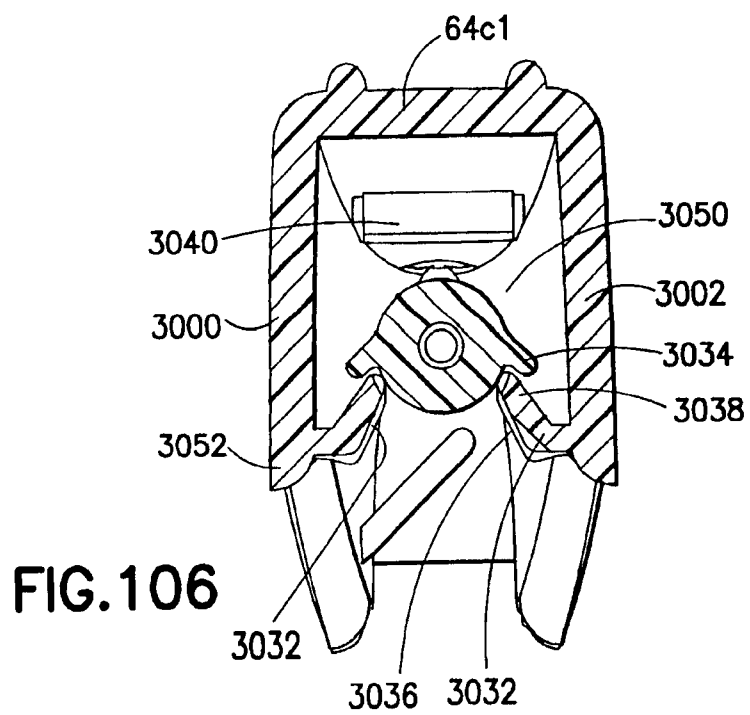
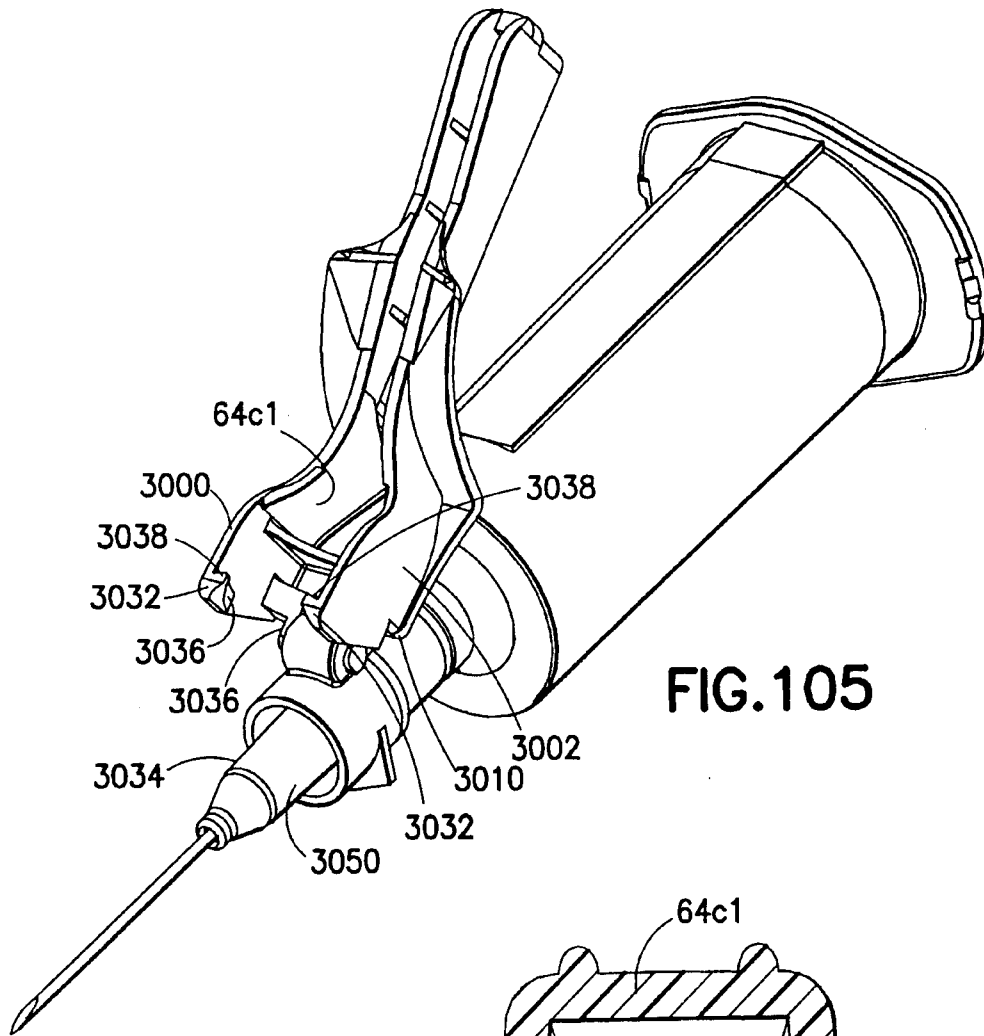


FIG. 104



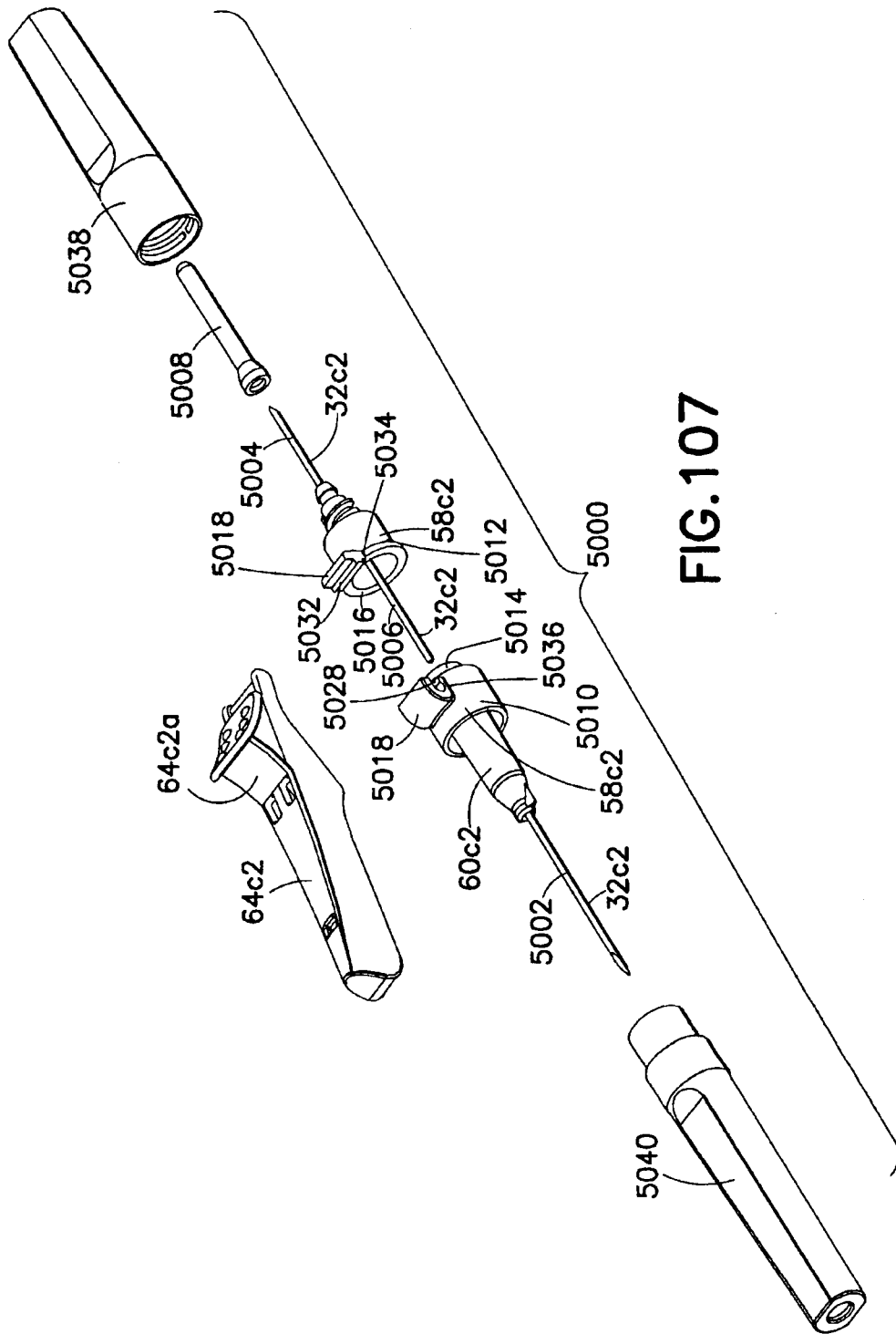
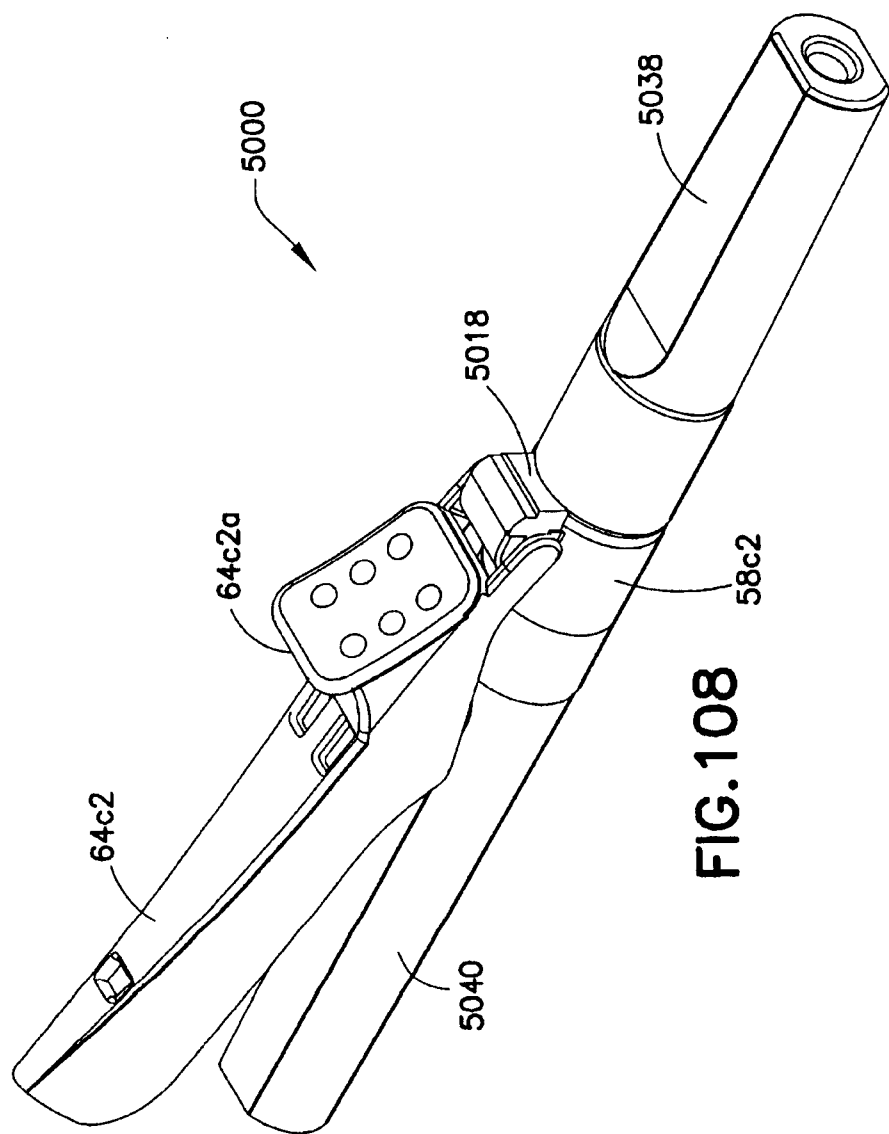


FIG.107



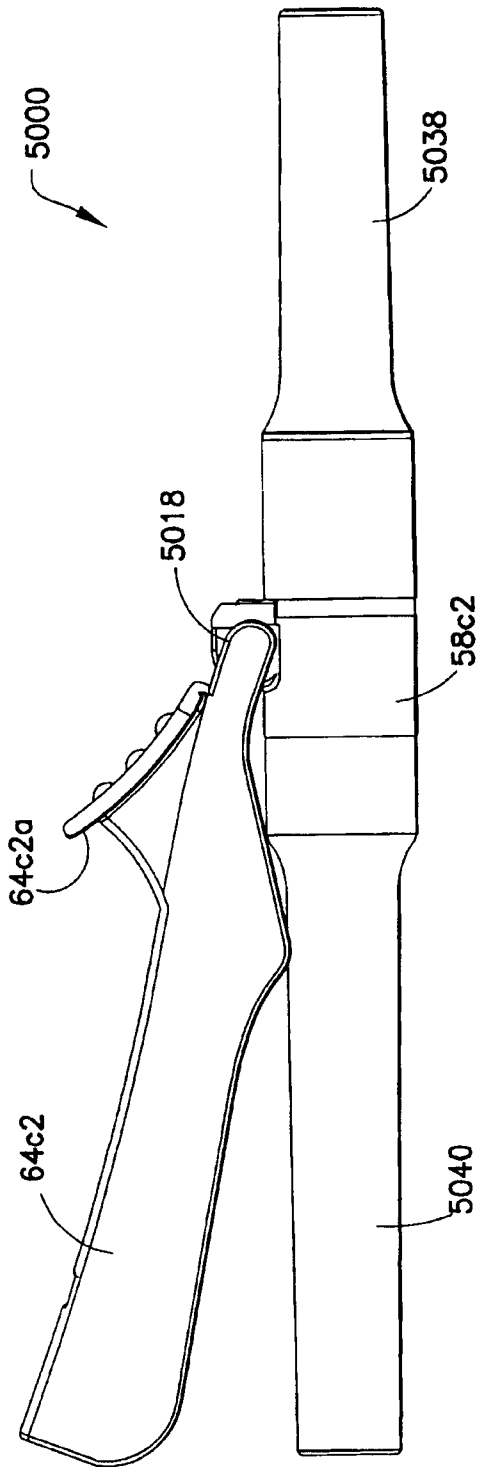


FIG. 109

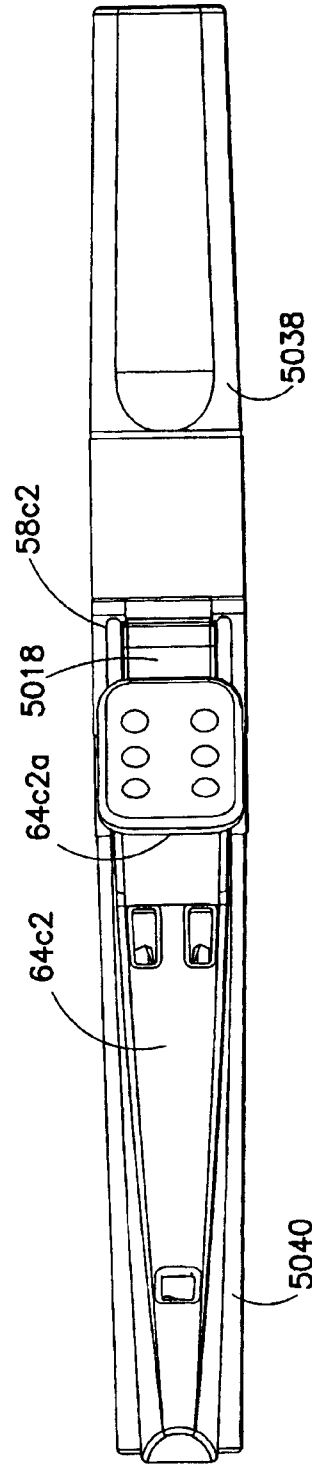


FIG. 110

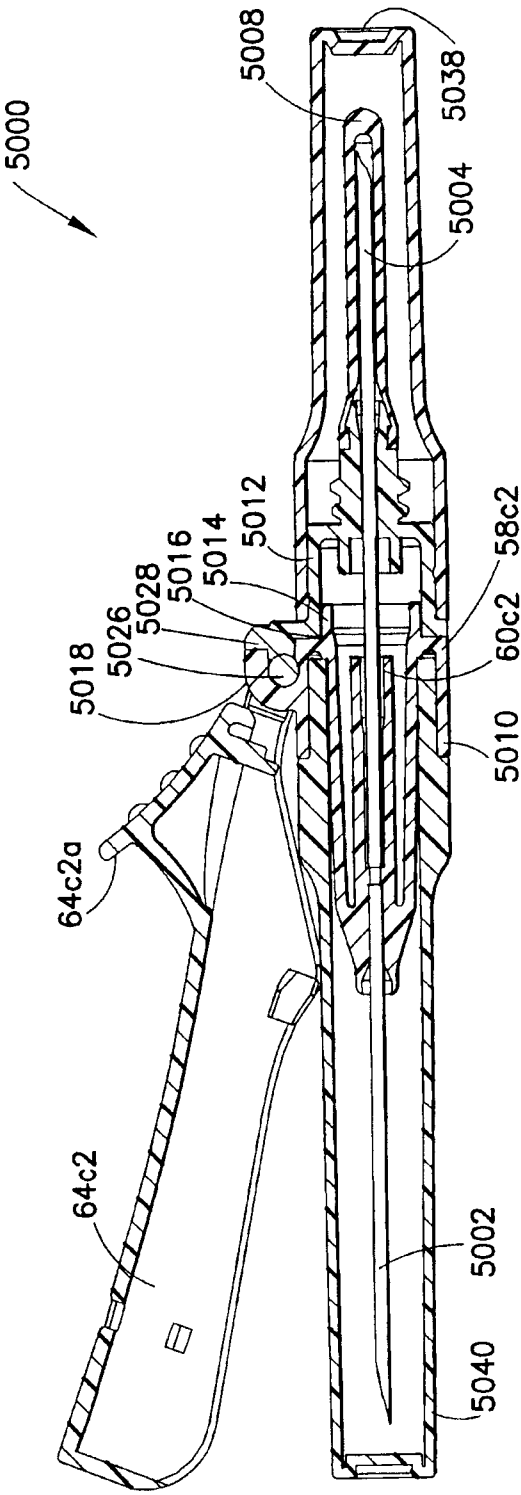


FIG.111

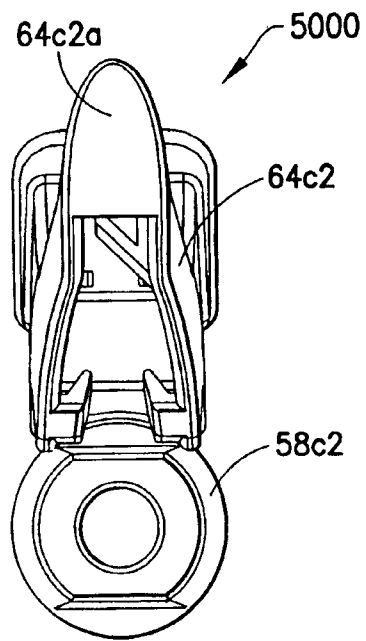


FIG. 112

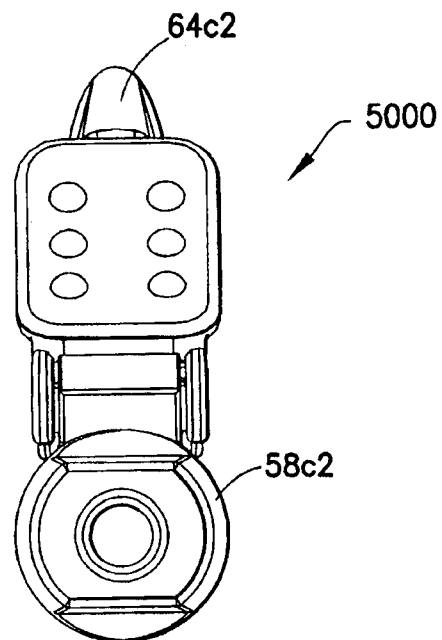


FIG. 113

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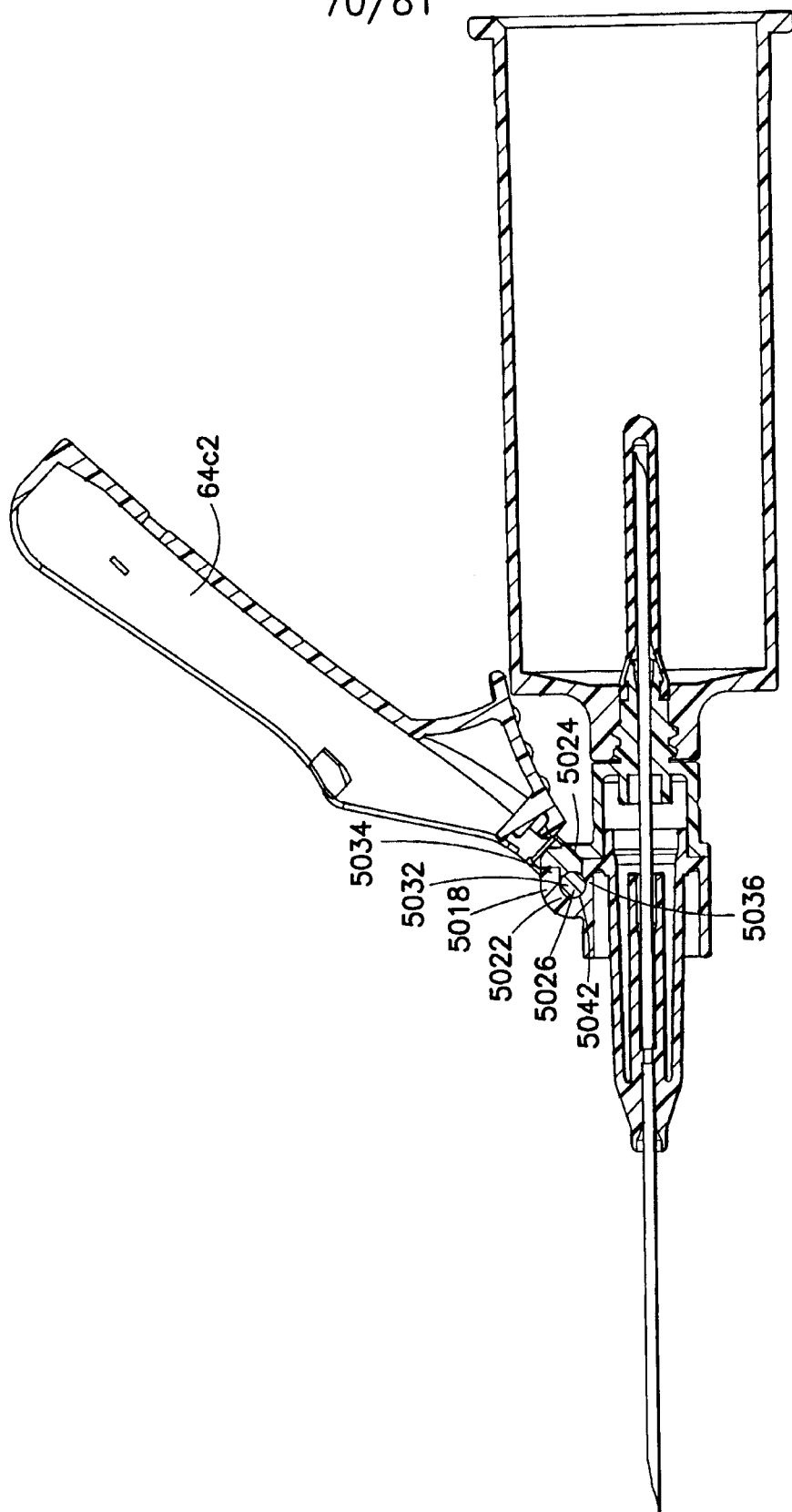
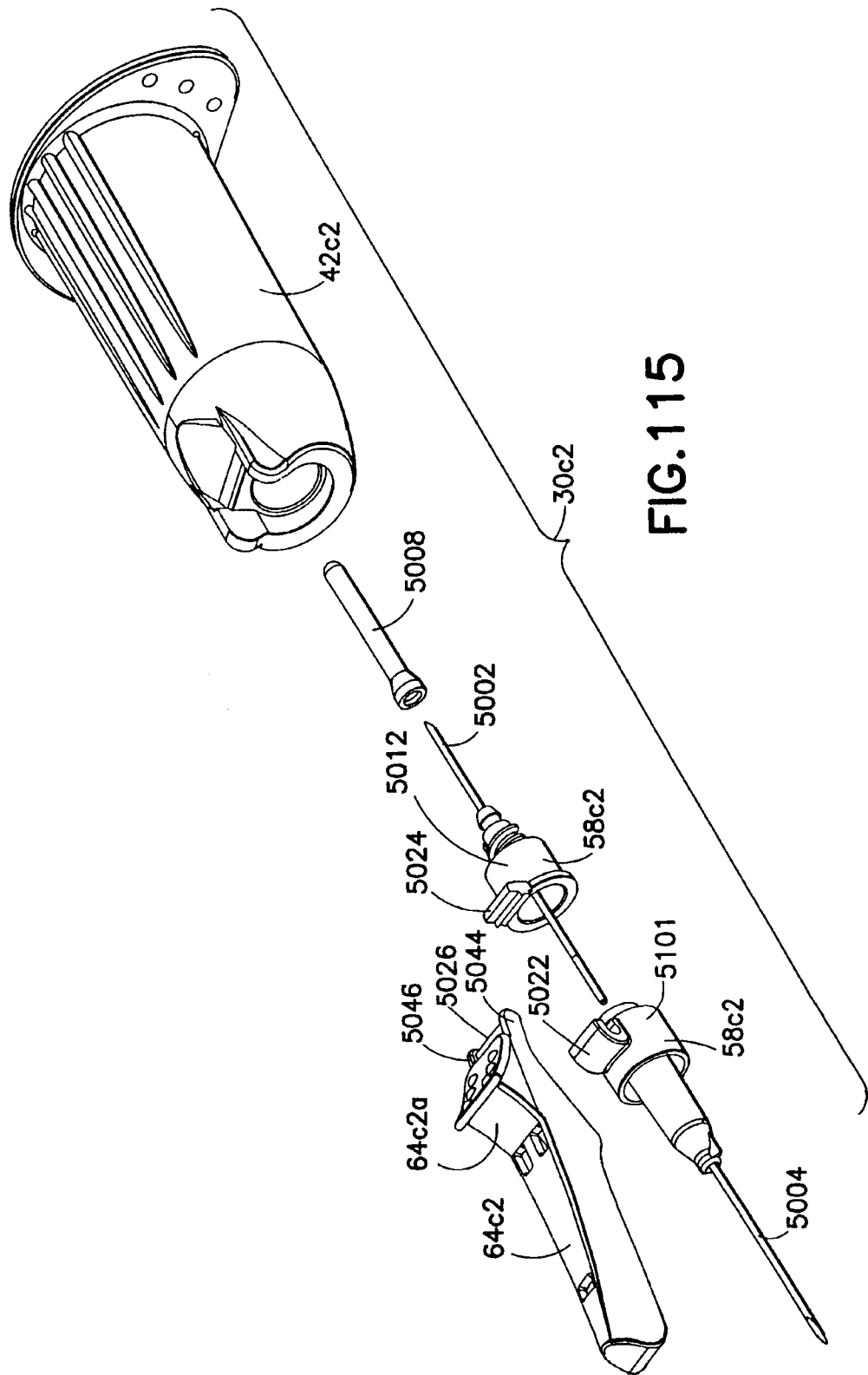
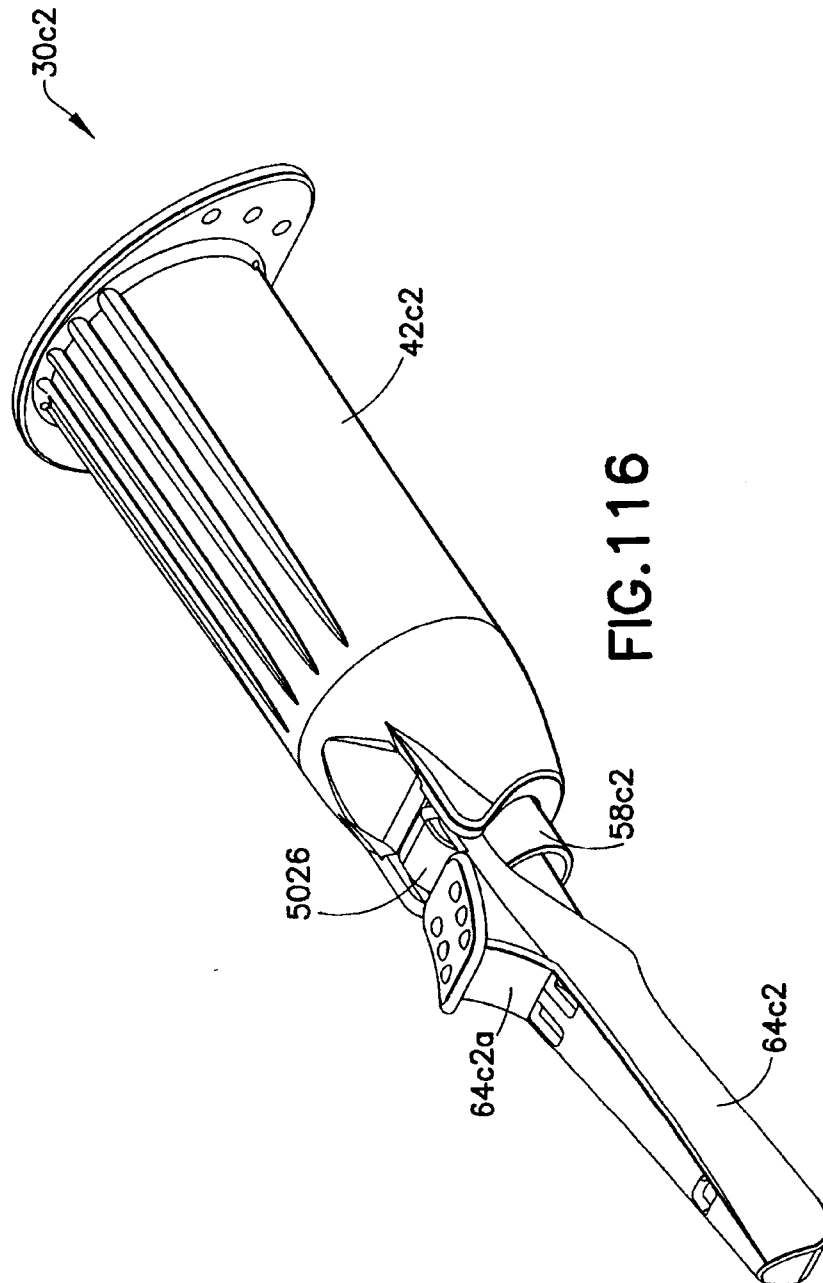


FIG. 114





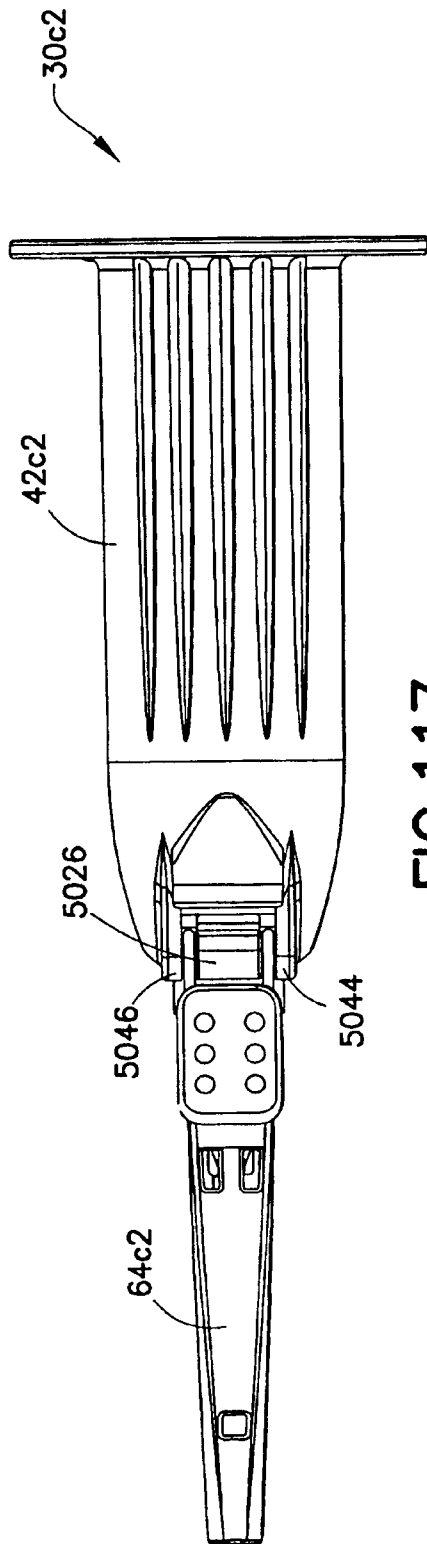


FIG. 117

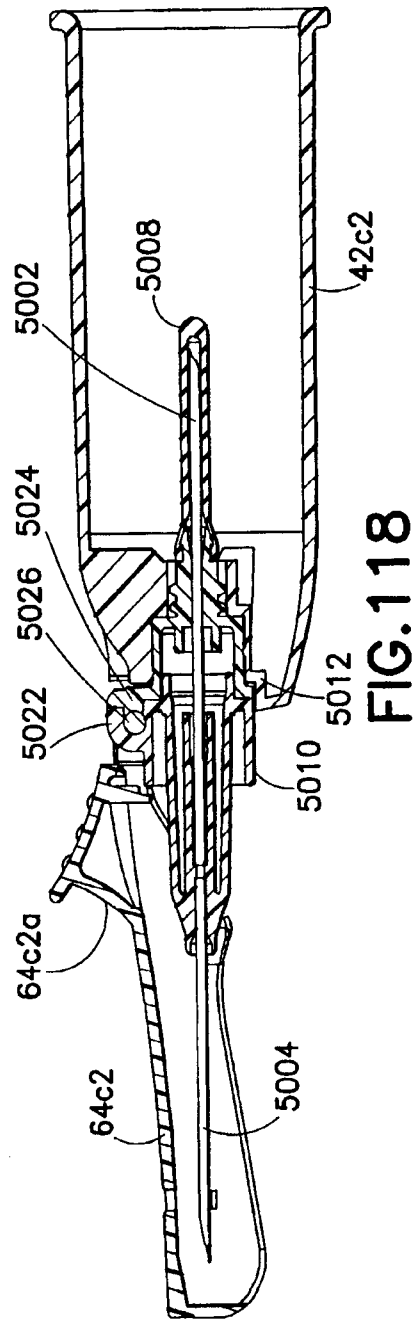


FIG. 118

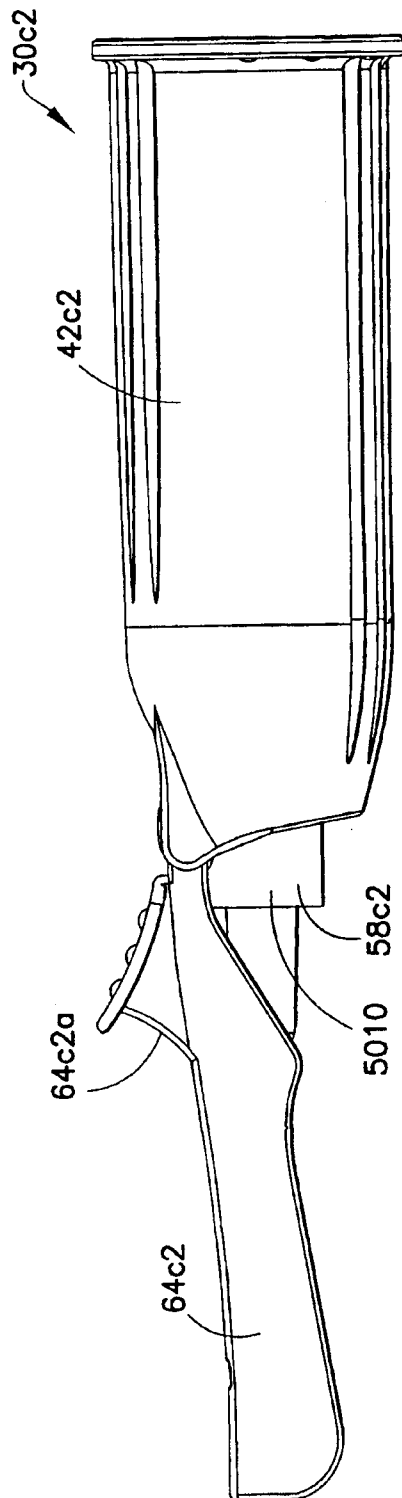


FIG. 119

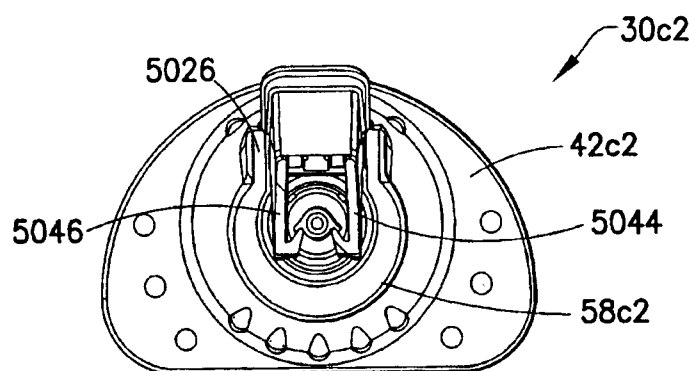


FIG.120

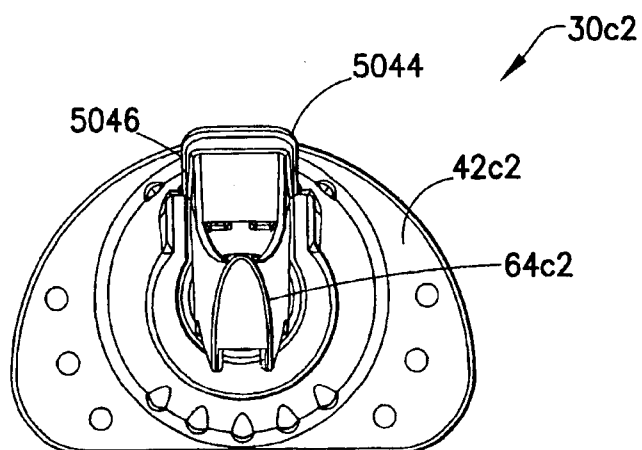


FIG.121

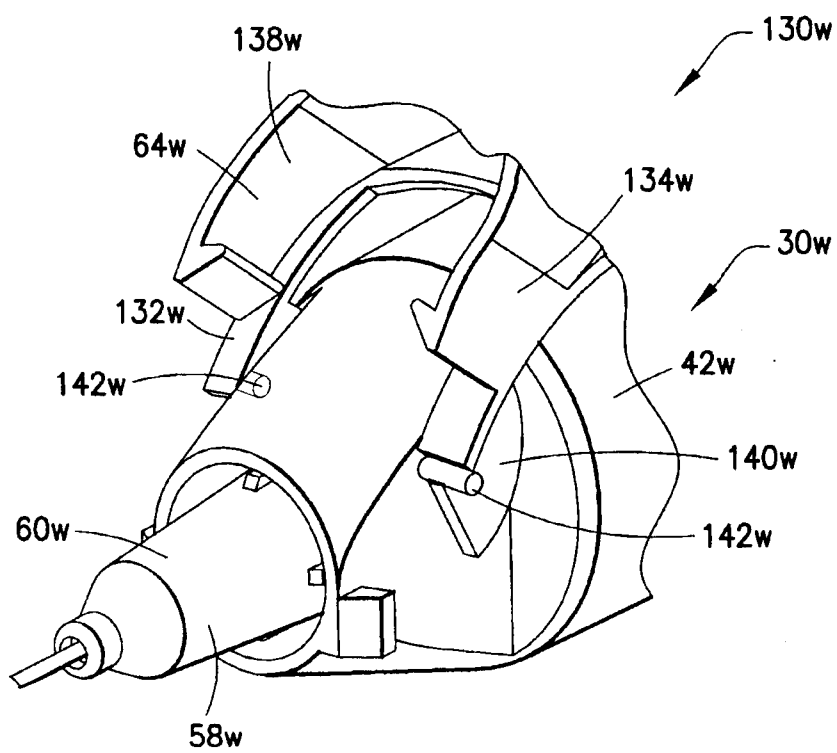


FIG.122

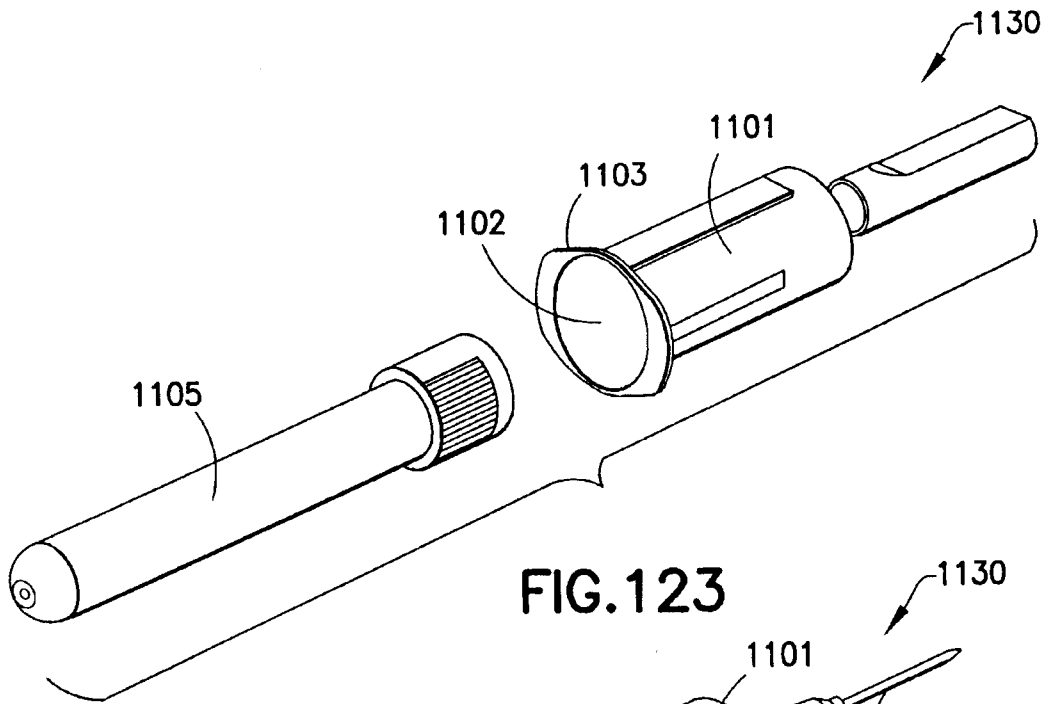


FIG. 123

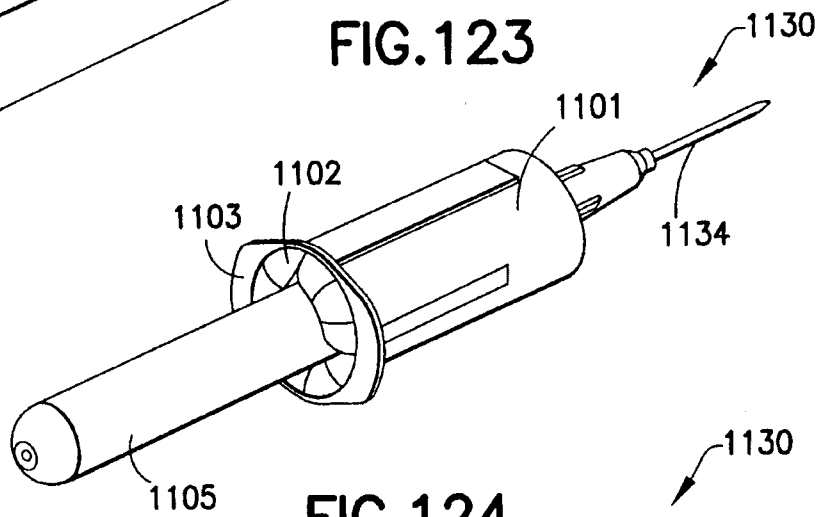


FIG. 124

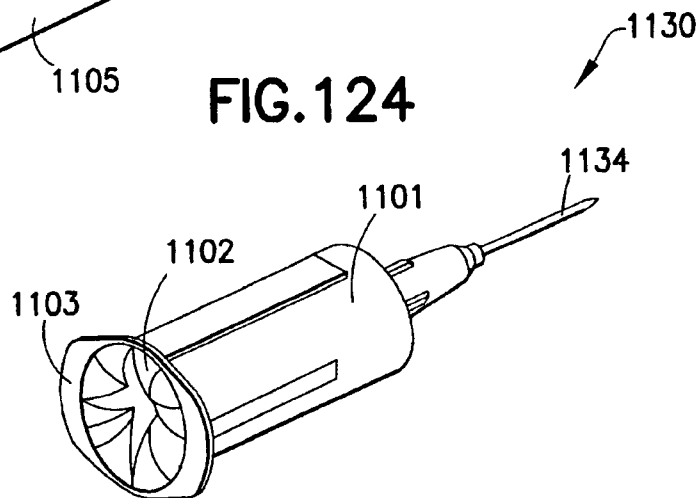
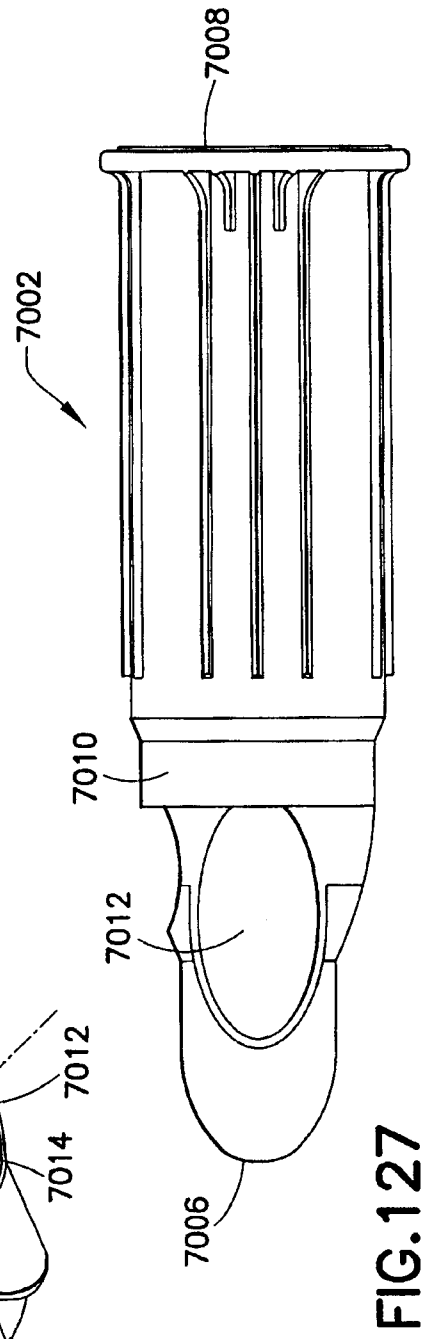
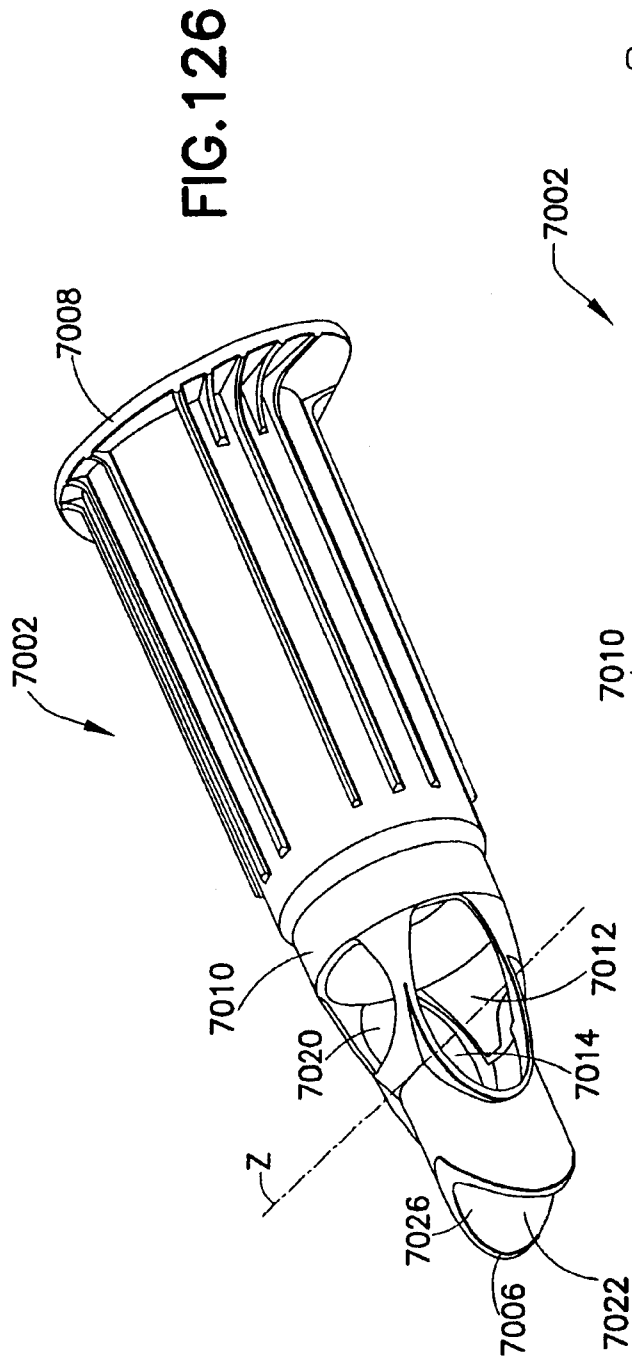


FIG. 125



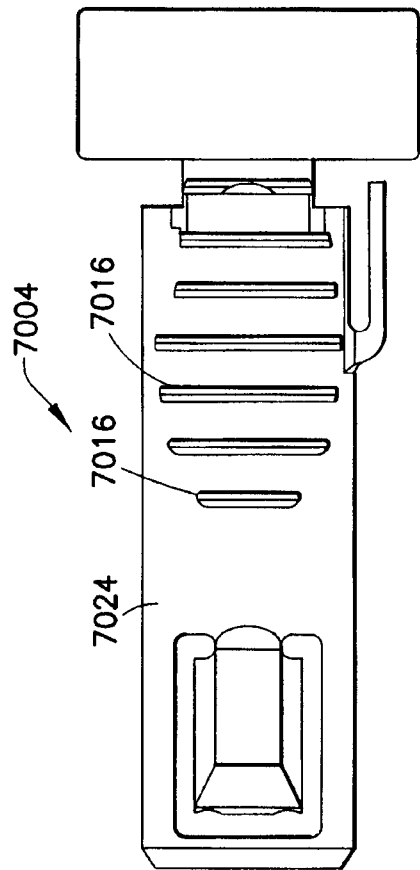
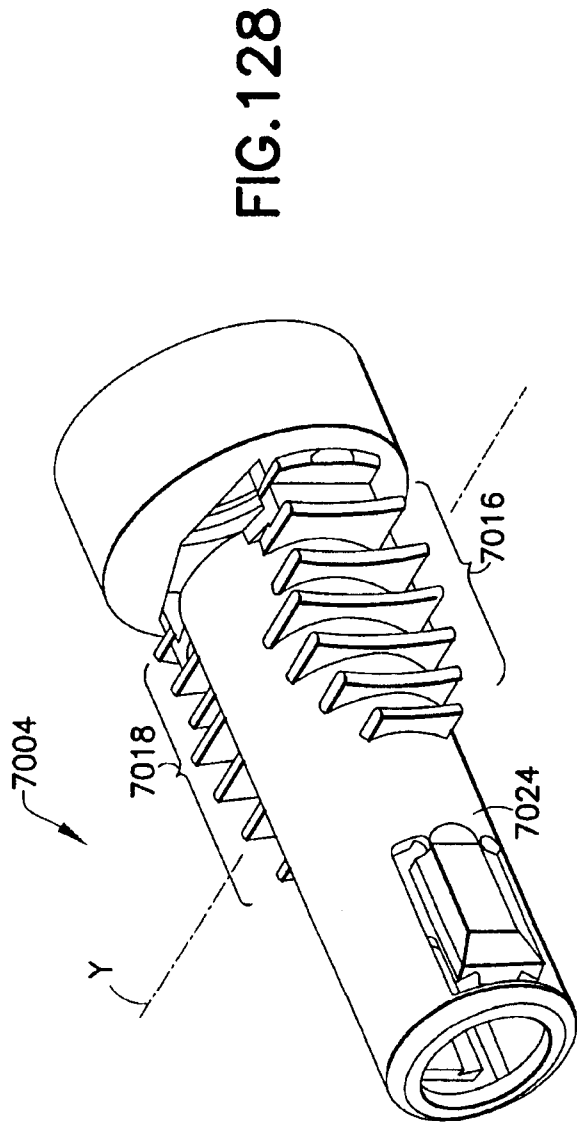
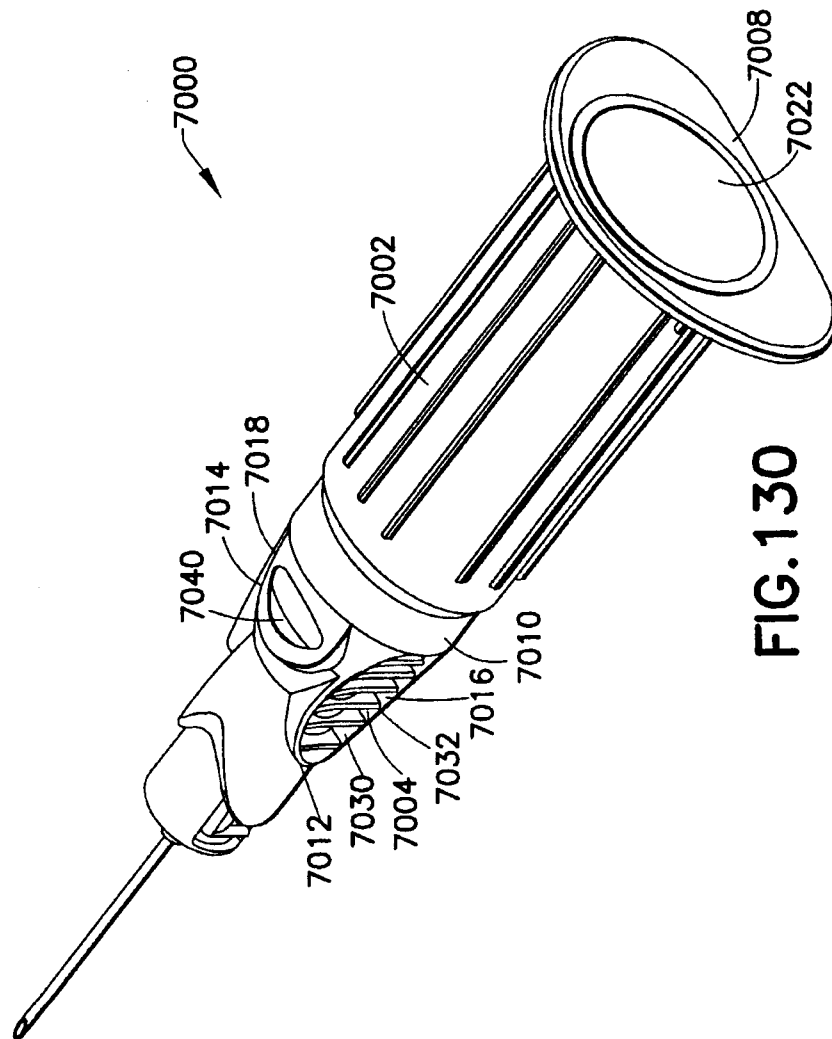


FIG.129



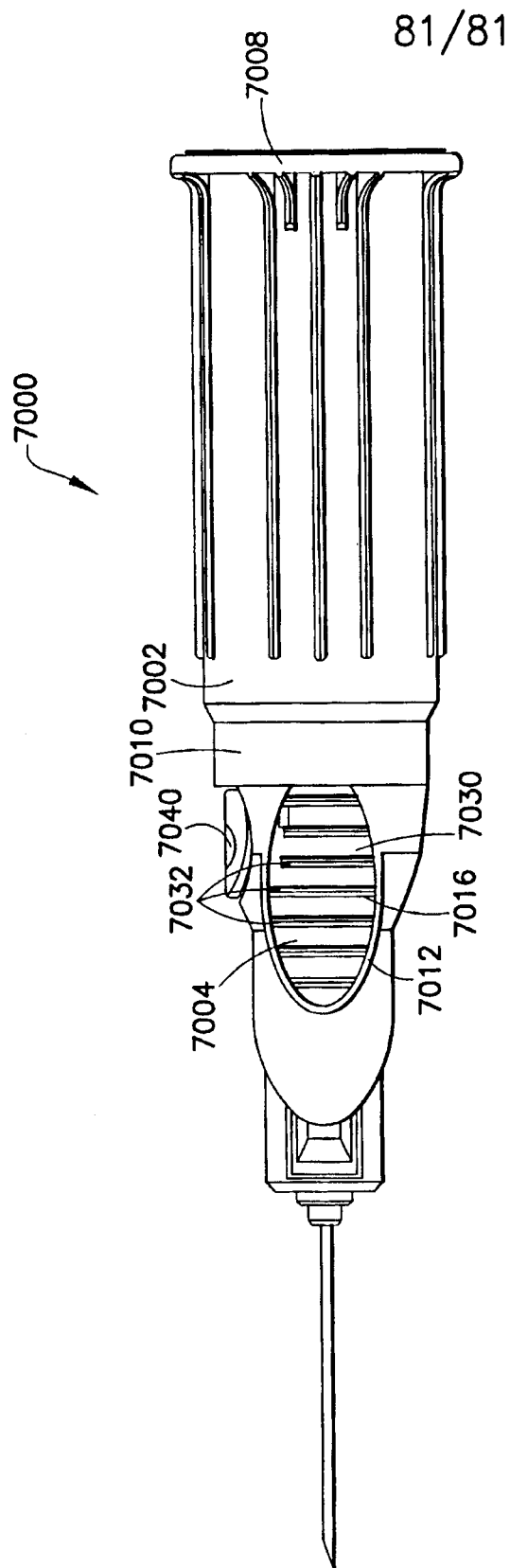


FIG.131

