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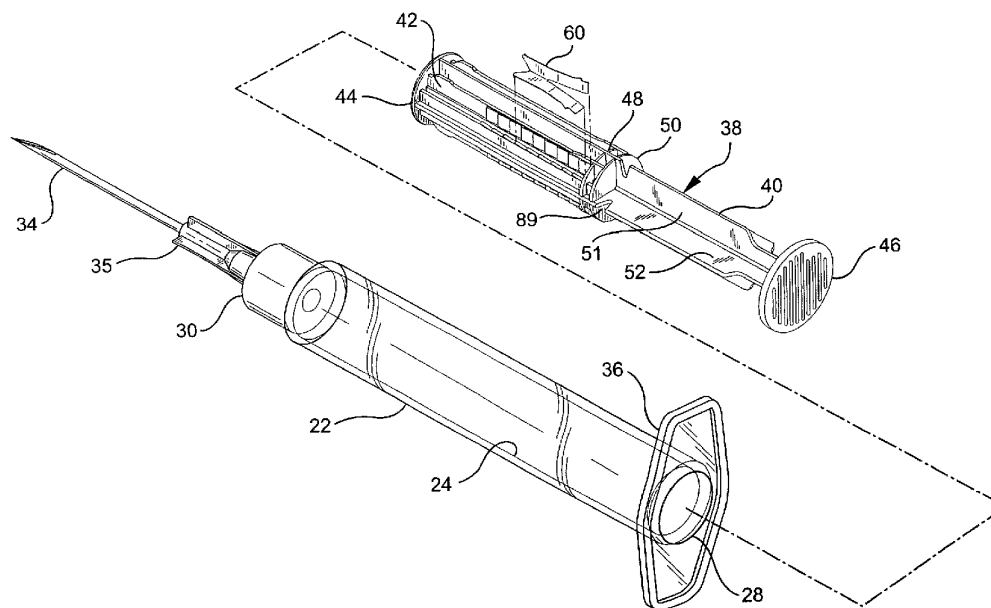
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(54) Title: SINGLE USE SYRINGE AND PLUNGER ROD LOCKING DEVICE THEREFOR



(57) Abstract: A single use syringe and a plunger rod assembly for such a syringe are provided. The syringe includes features that cause the plunger rod to be locked with respect to the syringe barrel upon completion of an injection stroke. The locking device may include barbs for engaging the syringe barrel and relatively long, proximally extending legs. The legs include barbs for engaging the syringe barrel and end portions for engaging the plunger rod. The plunger rod assembly includes a recess defined by converging surfaces, the recess being displaced from the longitudinal axis thereof. A locking element that fits a smaller syringe can thereby be used in a larger syringe as well.

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SINGLE USE SYRINGE AND PLUNGER ROD LOCKING DEVICE THEREFOR

BACKGROUND OF THE INVENTION

5 Field of the Invention

[0001] The field of the invention relates to single use syringes and locking devices for locking the plunger assemblies of such syringes.

Brief Description of the Related Art

10 [0002] In the United States and throughout the world the multiple use of hypodermic syringe products that are intended for single use only is instrumental in drug abuse and more particularly in the transfer of diseases. Intravenous drug users who routinely share and reuse syringes are a high risk group with respect to the AIDS virus. Also, the effects of multiple use are a major concern in under-developed countries where repeated use of syringe products may be responsible for the spread of many diseases.

15 Reuse of single use hypodermic syringe assemblies is also instrumental in the spread of drug abuse even in the absence of infection or disease.

20 [0003] Many attempts have been made to remedy this problem. Some of these attempts have required a specific act to destroy the syringe after use either by using a destructive device or providing a syringe assembly with frangible zones so that the syringe could be rendered inoperable by the application of force. Other attempts have involved the inclusion of structure which would allow the destruction or defeating of the syringe function through a conscious act by the syringe user. Although many of these devices work quite well, they do require the specific intent of the user followed by the actual act to destroy or render the syringe inoperable. None of these devices is effective with a user

25 having the specific intent to reuse the hypodermic syringe.

30 [0004] Single use hypodermic syringes that become inoperative or incapable of further use automatically without any additional act on the part of the user have been developed. One such syringe is disclosed in U.S. Patent No. 4,961,728. The syringe disclosed in this patent includes a locking element positioned in the syringe barrel. The locking element includes proximally and outwardly facing barbs that engage the inner surface of the syringe barrel and an inwardly facing driving edge adapted to interact with

the plunger rod to move the locking element along the barrel as the stopper is advanced. The plunger rod includes a ledge positioned at a distance from the proximal side of a support wall that approximates the length of the locking element. The driving edge of the locking element engages the ledge, thereby ensuring that the locking element moves distally with the plunger rod and stopper. A syringe including a similar locking element is disclosed in U.S. Patent No. 5,989,219.

[0005] U.S. Patent Nos. 5,021,047, 5,062,833 and 5,562,623 disclose single use syringes having plunger rods that have teeth or ridges and locking elements that engage the teeth or ridges. The locking elements of these syringes also include outwardly extending teeth or prongs that engage the inside surface of the syringe barrel. The plunger rods of these syringes can be retracted to draw fluid into the syringe barrel while the locking elements remain stationary. Distal movement of the plunger rods causes the fluid to be expelled, the locking elements moving distally with the plunger rods and substantially preventing further plunger rod retraction.

[0006] Syringes are available in many different sizes, and have plunger rods that are commensurate in size with the syringe barrels in which they are used. This generally necessitates the use of a different size locking element for each size syringe.

[0006A] Any discussion of documents, acts, materials, devices, articles or the like which has been included in the present specification is solely for the purpose of providing a context for the present invention. It is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the present invention as it existed before the priority date of each claim of this application.

SUMMARY OF THE INVENTION

[0006B] Throughout this specification the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

5 [0007] The invention relates to a syringe assembly including a locking element capable of locking a plunger rod with respect to a syringe barrel. The assembly includes a syringe barrel, a plunger rod assembly and a locking element. The syringe barrel includes an inside surface defining a chamber, an open end, and a distal end. The plunger rod assembly includes an elongate body portion and a stopper. The locking element is slidably positioned within the chamber of the syringe barrel, engaging the inside surface thereof such that the locking element is substantially immovable in the direction of the open end of the syringe. It is also engageable with the plunger rod assembly such that the plunger rod assembly and locking element can be moved distally together toward the distal end of the syringe barrel. In a preferred embodiment, the plunger rod assembly can initially be moved proximally with respect to the locking element to aspirate fluid into the syringe barrel. The body portion of the plunger rod includes one or more axially extending recesses. Each recess is defined by a pair of converging surfaces. At least one of the

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recesses is defined by surfaces that converge along a line that is displaced from the longitudinal axis of the plunger rod. The locking element is positioned within the recess and is engageable with one or both converging surfaces. It accordingly is movable in the distal direction with the plunger assembly.

5 [0008] A plunger rod assembly is further provided. The plunger rod assembly includes an elongate body and a stopper mounted near the distal end of the body. The body includes a longitudinal axis that is co-linear with the longitudinal axis of rotation of the body. An axially extending recess is defined by the body, and includes a pair of
10 converging surfaces that converge along a line that is generally parallel to but displaced from the longitudinal axis. The stopper is positioned distal to the recess. In a preferred embodiment, the elongate body includes radially extending walls that converge at or near the longitudinal axis and one or more additional walls extending from the radially
15 extending walls. The additional walls define one or more surfaces of the recess.

15 **BRIEF DESCRIPTION OF THE DRAWINGS**

 [0009] Fig. 1 is an exploded, perspective view of a single use syringe assembly according to the invention;

 [0010] Fig. 2 is a top perspective view showing the syringe assembly as provided to a user;

20 [0011] Fig. 3 is a top perspective view thereof showing the syringe assembly following retraction of the plunger rod assembly thereof;

 [0012] Fig. 4 is a top perspective view of the syringe assembly with the plunger rod assembly in a locked position following an injection;

25 [0013] Fig. 5 is a top perspective view thereof showing the operation of a tamper-resistance feature of the syringe assembly upon attempted retraction of the plunger rod assembly from the locked position of Fig. 4;

 [0014] Fig. 6 is a partial cross-sectional view thereof showing the plunger rod assembly in a position prior to initial retraction;

30 [0015] Fig. 6A is an enlarged cross-sectional view of the distal end of the syringe assembly of Fig. 6;

[0016] Fig. 7 is a partial cross-sectional view thereof showing the plunger rod assembly as retracted by the user to draw fluid into the syringe barrel;

[0017] Fig. 7A is an enlarged cross-sectional view showing the distal end of the plunger rod assembly;

5 [0018] Fig. 8 is a partial cross-sectional view of the syringe assembly following the injection stroke;

[0019] Fig. 8A is an enlarged cross-sectional view of the distal end thereof;

[0020] Fig. 9 is an enlarged cross-sectional view thereof showing the operation of a tamper-resistance feature upon attempted retraction of the plunger rod assembly from
10 the position shown in Fig. 8;

[0021] Fig. 10 is a cross-sectional view taken along line 10-10 of Fig. 6;

[0022] Fig. 11 is a perspective view of a plunger rod assembly in accordance with a preferred embodiment of the invention;

[0023] Fig. 12 is a perspective view of a locking element;

15 [0024] Fig. 13 is another perspective view of the locking element;

[0025] Fig. 14 is an enlarged elevation view of the distal end of the locking element;

[0026] Fig. 15 is a side elevation view of the locking element;

[0027] Fig. 16 is a cross-sectional view of the locking element taken along line
20 16-16 of Fig. 15;

[0028] Fig. 17 is a cross-sectional view of the locking element taken along line 17-17 of Fig. 15; and

[0029] Fig. 18 is an end view of the locking element.

25 **DETAILED DESCRIPTION OF THE INVENTION**

[0030] There is shown in the drawings and will be described in detail herein a preferred embodiment of the invention with the understanding that the present disclosure is to be considered as exemplary of the principles of the invention and is not intended to limit the invention to the embodiment illustrated.

[0031] Referring first to Figs. 1-9, a single use syringe assembly 20 includes a barrel 22 having an inside surface 24 defining a chamber 26 for retaining fluid. The barrel 22 includes an open end 28 and a distal end 30 having a passageway 32 therethrough in communication with the chamber. A needle cannula 34 projects outwardly from the distal barrel end. The needle cannula has a lumen (not shown) therethrough in fluid communication with the passageway and a sharpened distal tip. The syringe assembly of the present invention is shown with a needle cannula assembly including a hub 35 that is removably attached to the distal end of the barrel. It will be appreciated that the invention could be applied to syringe assemblies having permanently affixed needles or needle/hub assemblies, or fixed or removable blunt cannulas. While intended for reconstitution of vaccines, the syringe assembly can be used for general curative purposes or other purposes.

[0032] As used in the preceding paragraph and hereafter, the term "distal end" refers to the end furthest from the person holding the syringe assembly. The term "proximal end" refers to the end closest to the holder of the syringe assembly. In the preferred embodiment, the proximal end of the barrel 22 includes a flange 36 to facilitate handling and positioning of the syringe assembly and to maintain the relative position of the barrel with respect to the plunger rod during filling and medication administration.

[0033] A plunger rod assembly 38 used in the syringe assembly 20 includes an elongate body portion 40 including a plurality of elongate recesses 42 running substantially parallel to the longitudinal axis of rotation thereof. The distal end of the elongate body portion includes an integral stopper 44. A disc-shaped flange 46 is provided at the proximal end of the plunger rod for allowing the user to apply the force necessary to move the plunger rod with respect to the barrel. The elongate body portion 40 includes a pair of discs 48, 50 intermediate the proximal and distal ends thereof. The sections between the relatively proximal disc 50 and the flange 46 and the relatively distal disc 48 and the stopper 44 include radially extending walls 51, 52, both of which preferably traverse the longitudinal axis of rotation of the plunger rod assembly 38. Additional walls 53 that resemble fins extend perpendicularly from both sides of one wall 52 of the radially extending walls in the section between the distal disc 48 and stopper 44. In this preferred embodiment, the walls 53 are substantially parallel to each other. The areas between walls could be filled in to provide additional rigidity if necessary. Ratchet-like teeth 54 are formed on selected surfaces of the walls 53, as best shown in Figs. 10 and

11. Each tooth 54 includes a distally facing surface or shoulder 56. The wall surfaces 55, 57 including the teeth converge along an imaginary line that runs substantially parallel to the longitudinal axis of the plunger rod assembly, but radially displaced therefrom. As shown in the drawings, the surfaces 55, 57 do not necessarily adjoin each other. They
5 together define recesses 42 for positioning of a locking element 60. While four recesses are provided, a greater or lesser number may be employed. It will be appreciated that the recesses 42 can be formed by surfaces that actually meet along the line of convergence. It will further be appreciated that while the plunger rod assembly as shown and described herein is of integral construction, it may in fact be comprised of two or more separate
10 elements. The stopper may, for example, be a separate component made from a material that is different from the material comprising the remainder of the plunger rod assembly. In this preferred embodiment, the syringe barrel is comprised of polypropylene, and contains an internal lubricant, and the plunger rod assembly is comprised of polyethylene.

[0034] The locking element 60 is positioned within the barrel 22 and within
15 one of the elongate recesses 42 defined by the additional walls 53. The recess 42 acts as a pathway for longitudinal motion of the locking element relative to the plunger rod assembly. As the recesses are displaced from the longitudinal axis of the plunger rod assembly, the same size locking element can be used that is employed in a smaller syringe. In the smaller syringe, the locking element would be positioned in a recess adjoining the
20 longitudinal axis or at least closer to this axis than in the syringe disclosed herein. U.S. Patent Nos. 4,961,728 and 5,989,219 disclose the placement of a locking element at or near the longitudinal axis. A syringe as disclosed in these patents could be provided for administering doses of about 0.5ml. The invention allows the same size locking element to be used in such very small syringes as well as those exceeding five milliliters.

25 [0035] The locking element 60, as best shown in Figs. 12-18, includes a generally V-shaped body portion 61 comprising first and second radially extending walls 62, 64 joined along a longitudinal axis. The walls 62, 64 preferably form an angle of greater than ninety degrees, and preferably about one hundred degrees. A first leg 66 extends proximally from the first wall and a second leg 68 extends proximally from the
30 second wall 64. The legs flare outwardly with respect to the V-shaped body portion 61, as best shown in Fig. 15. The legs 66, 68 are preferably substantially longer than the length of the body portion 61. In a locking element having an overall length of about seventeen millimeters, the legs 66, 68 may be about ten millimeters in length.

[0036] Each of the legs 66, 68 includes a proximal end portion 70, 72 that is angled towards one of the walls 53 of the plunger rod assembly. They further include inner and outer edges. (The terms "inner" and "outer" are relative terms as used herein.) The inner edges thereof are substantially adjacent to each other, separated by a longitudinal gap 74. Barbs 76, 78 are integral with the outer edges of the first and second legs. The barbs face proximally, and are preferably located slightly distally of the angled end portions 70, 72. The barbs may be different in appearance from those shown in the drawings so long as they are capable of engaging the inside surface 24 of the syringe barrel to prevent proximal movement of the locking element.

[0037] A second pair of legs extends distally from the V-shaped body portion 61. One of these legs 80 extends from the first wall 62 and the other 82 from the second wall 64. Barbs 84, 86 extend proximally from the distal ends of the legs 80, 82. The barbs are formed on the outer edges of the distally extending legs. Each leg further includes a cutting edge 87 capable of penetrating the stopper 44.

[0038] The locking element is preferably formed from a thin sheet of metal such as stainless steel. The thickness in a preferred embodiment thereof is about 0.20 mm. The dimensions of the locking element are selected in accordance with the barrels and plunger rod assemblies with which it is to be used. The angle formed between the two halves of the locking element, as shown in Fig. 16, is preferably greater than ninety degrees, and preferably about one hundred degrees. When placed in one of the recesses 42 in the plunger rod assembly, the locking element will accordingly exert a force against the two of the converging wall surfaces 55, 57 that define the recess. The cutting edges 87 are preferably formed by providing bevels on one side of the substrate from which the locking element is constructed. It will be appreciated that the substrate could be ground on both sides thereof to form cutting edges for disabling the stopper 44. Alternatively, barbs (not shown) or other cutting members can be provided on the locking element for piercing the stopper. Fig. 9 shows the penetration of the stopper by the cutting edges that will occur should one attempt to reuse the syringe following an injection.

[0039] The syringe assembly is easily constructed from the component parts thereof. The locking element 60 is positioned in one of recesses 42 in the plunger rod assembly such that the angled end portions of the legs 66, 68 adjoin the relatively distal disk 48, as shown in Figs. 2 and 6. Alternatively, the end portions of the legs can initially abut selected teeth 54 should a smaller dosage be required. The legs 66, 68 and spring

member extend proximally, and the barbs 76, 78, 84, 86 are angled proximally with respect to the plunger rod assembly. The plunger rod/locking element assembly is then inserted into the barrel 22 through the proximal end thereof. As the assembly is moved distally within the barrel, the angular orientation of the barbs allows them to slide along while engaging inside surface 24 of the barrel. The locking element moves distally with the plunger rod due to the engagement of the ends of legs 66, 68 with the disc 48. The gap 74 is maintained between the legs 66, 68 even after installation of the locking element. The maintenance of the gap and the relatively long lengths of the legs, which act as cantilever springs, provide a relatively reduced force on the barrel and facilitate use and installation. The plunger rod/locking element assembly is moved distally until the stopper engages the end wall of the barrel as shown in Figs. 2 and 6. It is then ready for use or storage. A needle cover 90 can be mounted to the distal end of the barrel to protect the needle cannula. The cover is removed prior to use.

[0040] In use, plunger rod assembly 38 is retracted from the position shown in Figs. 2 and 6 to the position shown in Figs. 3 and 7 in order to draw fluid through needle cannula 34 and passageway 32 and into chamber 26 of barrel 22. Locking element 60 remains stationary during such retraction, and the plunger rod assembly is moved proximally with respect to both barrel 22 and the locking element. This is due to the engagement of barbs 76, 78, 84, 86 with inside surface 24 of the barrel. The barbs are preferably made from a harder material than the barrel, which enhances their ability to resist proximal movement. Angled ends 70, 72 of legs 66, 68 of the locking element ride over teeth 54 of the plunger rod assembly during retraction thereof. The user may feel and/or hear the movement of the legs over the teeth.

[0041] Retraction of the plunger rod assembly 38 is limited by the locking element. As shown in Figs. 7 and 7A, the proximal surface of stopper 44 engages the distal end of locking element 60. The user can feel this engagement. Cutting edges 87 do not penetrate the stopper as a result of the forces exerted during normal use. As the locking element cannot be moved proximally, further retraction of the plunger rod assembly is resisted. The amount of fluid that can be drawn into chamber 26 is accordingly limited by the distance between the proximal surface of the stopper and the disc 48 as well as the length of the locking element. It will be appreciated that the distance between the stopper and the relatively distal disc 48 and the length of the locking element 54 can be chosen to meet the needs of particular applications.

[0042] The proximal end portions of legs 66, 68 of the locking element adjoin the end of a relatively distal tooth 54 when the plunger rod assembly is retracted to the position shown in Figs. 7 and 7A. The distance between this end of the tooth 54 and the distal end surface of the relatively distal disc 48, being substantially the same as the distance between the distal end of the locking element and the proximal end portions of the legs, causes the locking element to be substantially immovable with respect to the plunger rod assembly. As discussed above, the locking element is substantially immovable in the proximal direction within the barrel due to the engagement of the barbs with the inside surface of the barrel 22. The syringe can also be provided to the end user as a prefilled syringe, in which case retraction of the plunger rod assembly would not be possible.

[0043] Once the fluid has been drawn into the barrel from a vial or other fluid source, the needle cannula can be removed from the fluid source and used for injection. During the injection of a patient, plunger assembly 38 and locking element both move distally from the positions shown in Figs. 7 and 7A to the positions shown in Figs. 8 and 8A. In Figs. 8 and 8A, stopper 44 again adjoins or engages the end wall of barrel 22. Locking element 54 remains positioned between disc 48 and most distal ratchet tooth 54. Both plunger rod assembly 38 and the locking element are substantially immovable from their positions. Syringe assembly 20 accordingly cannot be reused. Should a person use extraordinary force in an attempt to retract the plunger rod assembly from the position shown in Figs. 8 and 8A, the cutting edges 87 at the distal end of the locking element will penetrate the stopper, rendering it unusable, as shown in Fig. 9. Disabling of the stopper preferably occurs when the force exerted is approximately sufficient to dislodge the locking element in the proximal direction, or a lesser force. As discussed above, simple engagement of the cutting edges and stopper should not compromise the integrity of the stopper.

[0044] An additional tamper-resistance feature is comprised of notches 89 in the plunger rod assembly. If the plunger rod assembly is twisted forcefully, it will break prior to disablement of locking element 60.

[0045] The syringe barrel of the present invention may be constructed of a wide variety of rigid materials with thermoplastic materials such as polypropylene and polyethylene being preferred. Similarly, thermoplastic materials such as polypropylene, polyethylene and polystyrene are preferred for the plunger rod and integral stopper. A

wide variety of materials such as natural rubber, synthetic rubber, thermoplastic elastomers and combinations thereof are suitable for the stopper if the stopper is manufactured as a separate component. The choice of stopper material will depend on compatibility with the medication being used.

5 [0046] As previously recited, it is preferable that the locking element be fabricated from a material which is harder than the barrel so that the locking barbs may effectively engage the barrel. Resilient spring like properties are also desirable along with low cost, dimensionally consistent fabrication. With this in mind, sheet metal is the preferred material for the locking element with stainless steel being preferred for medical
10 applications. Although the locking element of the preferred embodiment is fabricated from a single sheet, it is within the purview of the instant invention to include locking elements made of other forms and/or containing multiple parts. Locking elements having structures other than that shown and described herein could also be successfully employed. One such locking element is disclosed in U.S. Patent No. 5,989,219, the disclosure of
15 which is incorporated by reference herein. The distal end of the locking element disclosed in the patent could be provided with a cutting edge similar to those described above. Alternatively, barbs (not shown) could be provided at the distal end of the locking element for rendering the stopper unusable.

 [0047] The syringe barrel employed in accordance with the invention may
20 have a varying wall thickness along its length. The portion of the barrel used for containing medication could be relatively thin and resilient to ensure proper sealing with the stopper. The remainder of the barrel could be relatively thick and less resilient such that it would tend to crack if squeezed by pliers or another device used for attempted tampering. Sufficient barrel crystallinity is desirable in the area of the locking element to
25 cause this area to crack upon deformation of the syringe barrel to an extent that would permit retraction of the plunger rod assembly with the locking element.

 [0048] Thus, it can be seen that the present invention provides a simple, reliable, easily fabricated, single use syringe which becomes inoperable or incapable of further use without any additional act on the part of the user. It further allows the use of a
30 locking element of the same size that is used on smaller or larger syringes.

What is claimed is:

1. A syringe assembly comprising:
a syringe barrel having an inside surface defining a chamber, an open end, and a
5 distal end;
a plunger rod assembly extending within said syringe barrel and including an
elongate body portion having a longitudinal axis, a stopper connected to said elongate
body portion, and an axially extending recess, said recess being bounded by a pair of
surfaces which are radially spaced from the longitudinal axis of the elongate body such
10 that said recess is radially offset from the longitudinal axis of said elongate body
portion, and
a locking element slidably positioned within said chamber and extending within
said recess, said locking element engaging said inside surface of said syringe barrel
such that said locking element is substantially immovable in the direction of the open
15 end of said syringe barrel, said locking element further being engageable with at least
one of said surfaces of said plunger rod assembly such that said plunger rod assembly
and locking element can be moved distally together toward the distal end of said
syringe barrel with said locking element being maintained in said recess and
substantially radially offset from the longitudinal axis of said elongate body portion.
- 20 2. The syringe assembly of claim 1 wherein said locking element is
comprised of an integral, resilient metal structure, said locking element being
positioned such that said plunger rod assembly can be moved proximally with respect
to said locking element.
- 25 3. The syringe assembly of claim 1 wherein said locking element includes
one or more proximally extending barbs engaging said inside surface of said syringe
barrel, and said locking element and stopper are positioned such that said plunger rod
assembly can be moved proximally with respect to said locking element.

4. The syringe assembly of claim 3 wherein said locking element includes a body portion having a distal end and proximal end, said body portion of said locking element being generally V-shaped and engageable with each of said pair of surfaces
5 bounding said recess.

5. The syringe assembly of claim 4 including a first pair of legs extending from and deflectable with respect to said proximal end of said body portion, said legs engaging said plunger rod assembly.

6. The syringe assembly of claim 5 including a first proximally extending
10 barb adjacent said distal end of said body portion and a second proximally extending barb extending from at least one of said legs, said first and second barbs engaging said inside surface of said syringe barrel.

7. The syringe assembly of any one of the preceding claims wherein said elongate body portion of said plunger rod assembly includes a plurality of radially
15 extending walls that converge near said longitudinal axis and a first additional wall extending from one of said radially extending walls in a non-radial direction, said first additional wall defining one of said surfaces bounding said recess.

8. The syringe assembly of claim 7 including a second additional wall extending from one of said radially extending walls, said second additional wall
20 defining one of said surfaces bounding said recess.

9. The syringe assembly of claim 8 wherein said second additional wall is substantially parallel to said first additional wall.

10. The syringe assembly of any one of the preceding claims wherein said elongate body portion of said plunger rod assembly includes a first wall proximal to
25 said stopper and a plurality of second walls projecting from a first side of first wall, two of said second walls defining said surfaces of said recess.

11. The syringe assembly of claim 10 wherein at least one of said surfaces of said recess includes a plurality of abutments for engaging said locking element.

12. The syringe assembly of claim 10 wherein said second walls extend
5 substantially perpendicularly with respect to said first wall.

13. The syringe assembly of claim 10 wherein said second walls extend from two sides of said first wall and define a plurality of recesses, each of said recesses capable of receiving said locking element.

14. The syringe assembly of claim 10 wherein said locking element includes a
10 generally V-shaped body portion engageable with each of said pair of surfaces bounding said recess.

15. The syringe assembly of claim 12 wherein said locking element includes a generally V-shaped body portion engageable with each of said pair of surfaces bounding said recess.

15 16. A plunger rod assembly for a syringe, comprising:

an elongate body having a longitudinal axis and a proximal end and a distal end, said longitudinal axis being substantially co-linear with the longitudinal axis of rotation of said elongate body;

a stopper mounted near the distal end of said elongate body, and

20 an axially extending recess defined by said elongate body including a pair of converging surfaces that converge along a line that is generally parallel to said longitudinal axis but spaced radially therefrom, said stopper being positioned distal to said recess.

17. The plunger rod assembly of claim 16 wherein said elongate body
25 includes a first wall and a plurality of second walls projecting from a first side of said first wall, two of said second walls defining said converging surfaces of said recess.

18. The plunger rod assembly of claim 17 wherein said second walls are substantially parallel to each other.

5 19. The plunger rod assembly of claim 18 wherein said second walls extend from two sides of said first wall and define a plurality of recesses bounded by converging surfaces.

20. The plunger rod assembly of claim 16 including a locking element having a generally V-shaped body portion extending within said recess and engageable with
10 said converging surfaces.

21. A syringe assembly comprising:

a syringe barrel having an inside surface defining a chamber, an open end and a distal end;

a plunger rod assembly extending within said syringe barrel and including an
15 elongate body having a longitudinal axis of rotation and a stopper mounted to said elongate body;

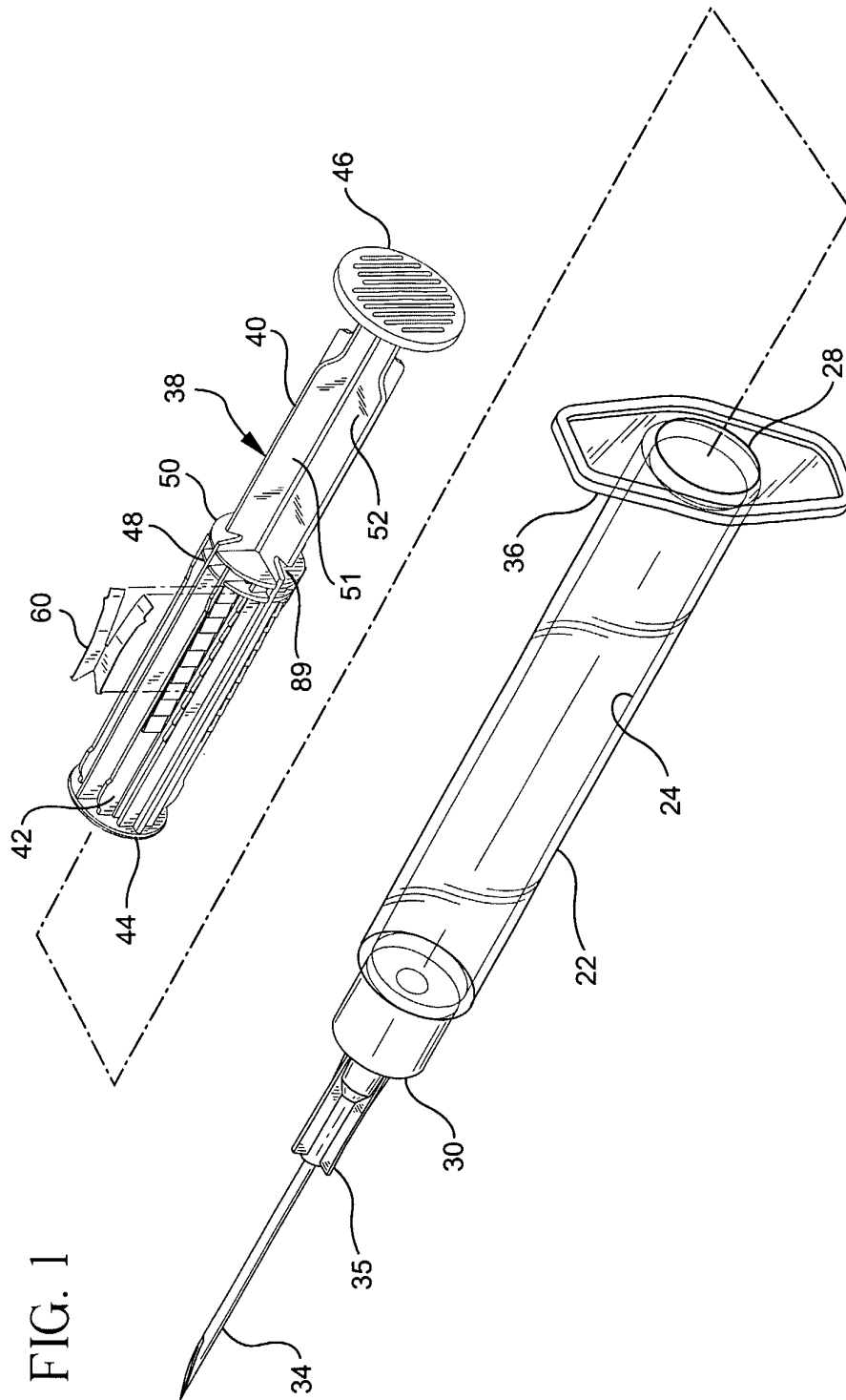
a locking element having a generally V-shaped body portion and including means for engaging said inside surface of said syringe barrel and means for engaging said plunger rod assembly such that said locking element is substantially immovable in
20 the direction of said open end and movable with the plunger rod towards said distal end, and

a pair of surfaces radially offset from said longitudinal axis of said elongate body, said pair of surfaces defining a recess for receiving said locking element and thus maintaining said locking element in a radially offset position at a substantial distance
25 from said longitudinal axis of said plunger rod assembly.

22. The syringe assembly of claim 21 wherein said recess is an axially extending recess in said plunger rod assembly, said locking element being positioned in

said recess such that said generally V-shaped body portion is positioned with a pointed end oriented towards but spaced from said longitudinal axis and a pair of free ends adjoining said inside surface of said syringe barrel, said pointed end being a substantial
5 distance from said longitudinal axis.

23. The syringe assembly of claim 22 wherein said plunger rod assembly includes a plurality of substantially parallel walls, portions of two of said walls defining said recess.



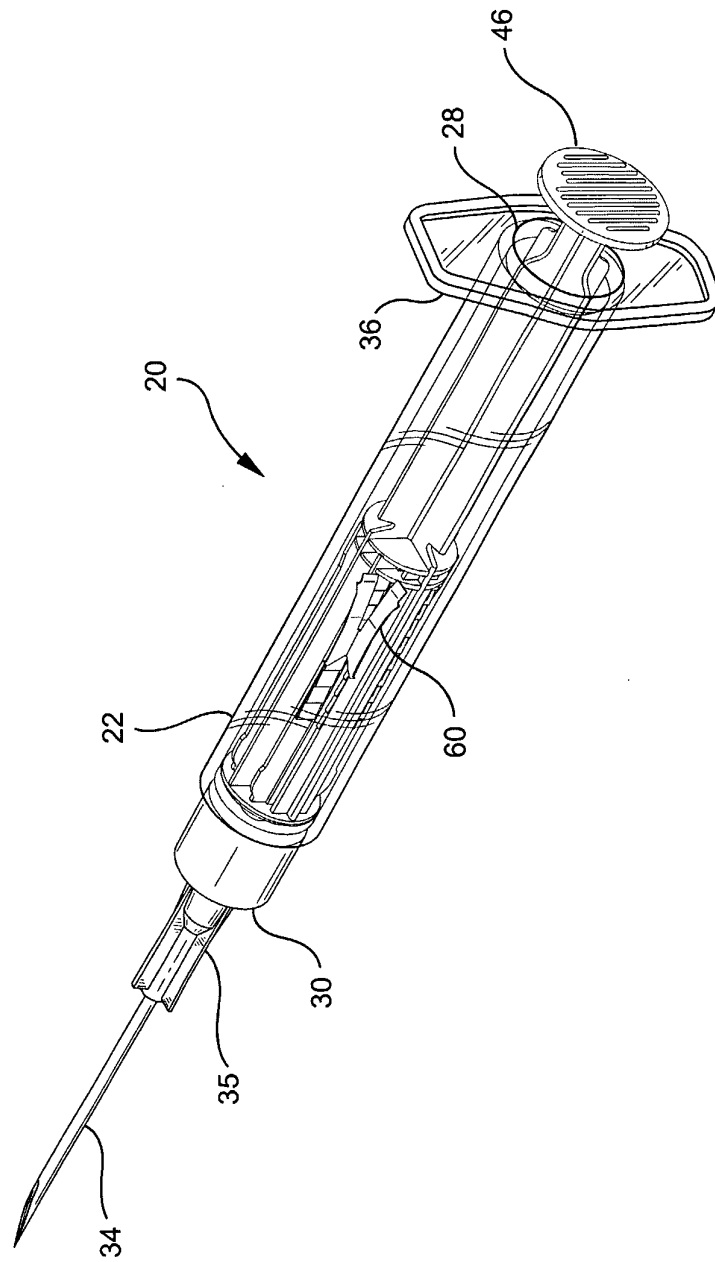
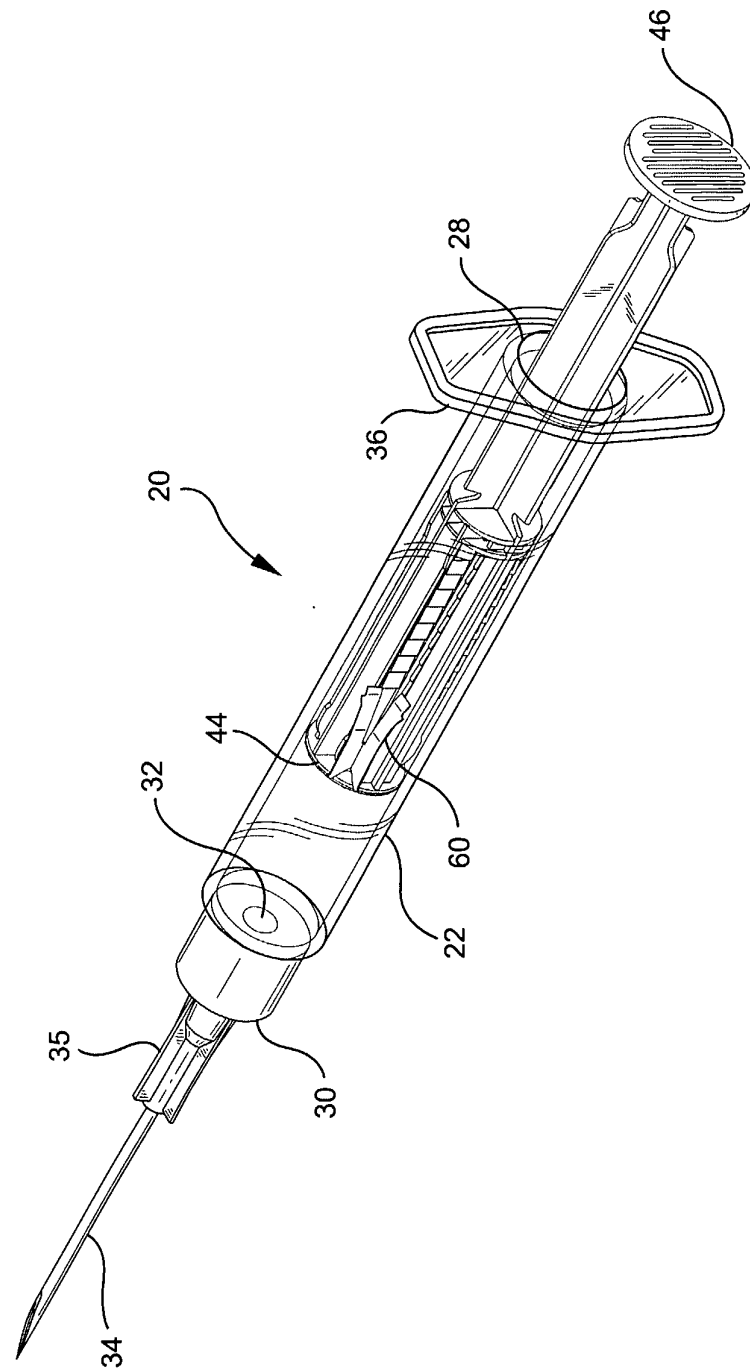


FIG. 2

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FIG. 3



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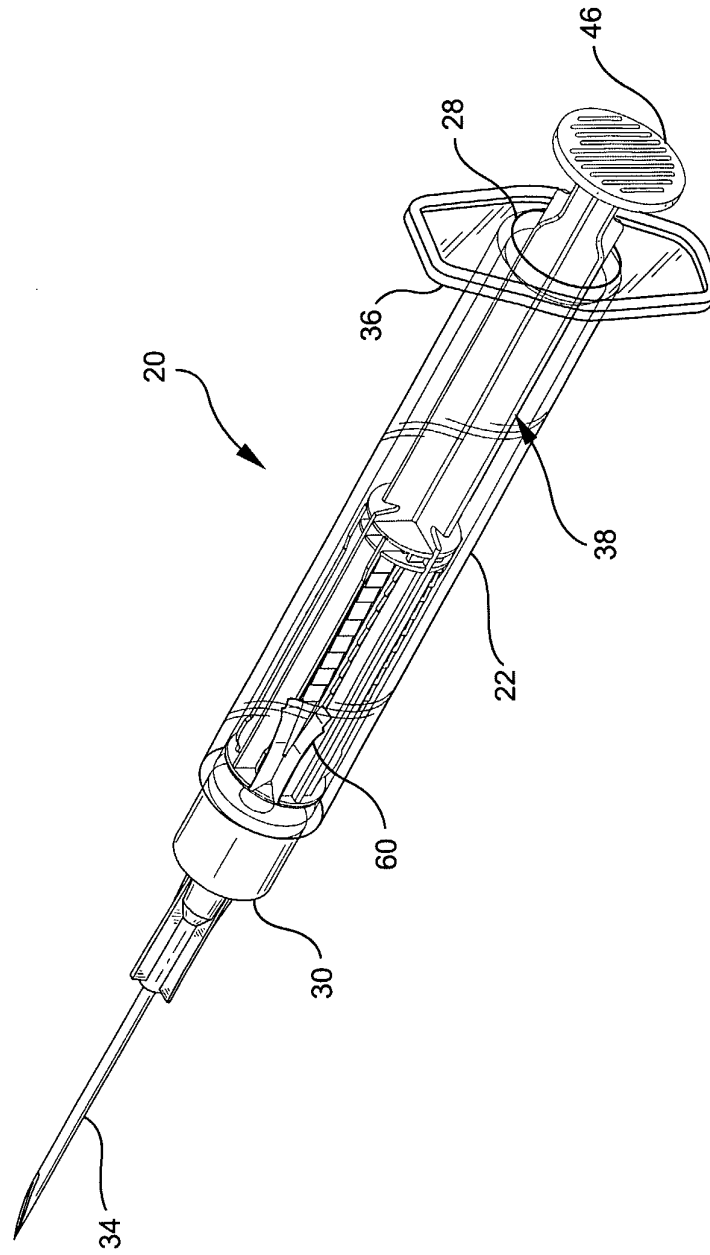


FIG. 4

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FIG. 5

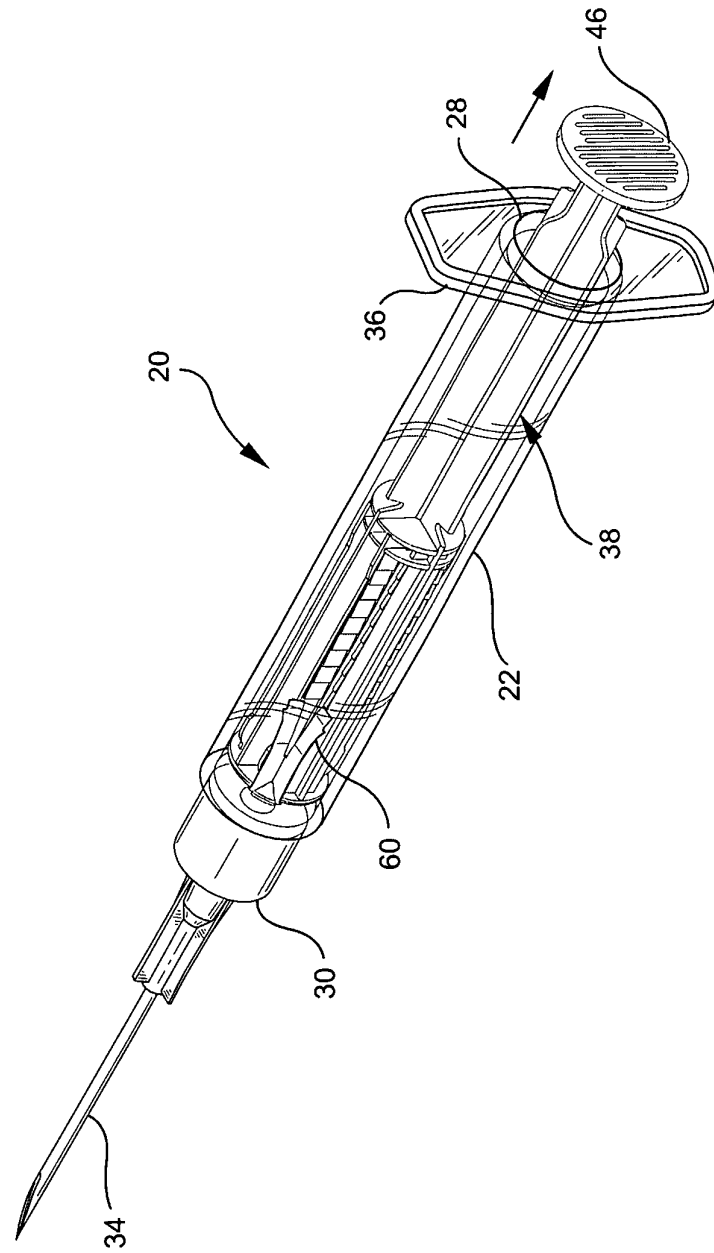


FIG. 6

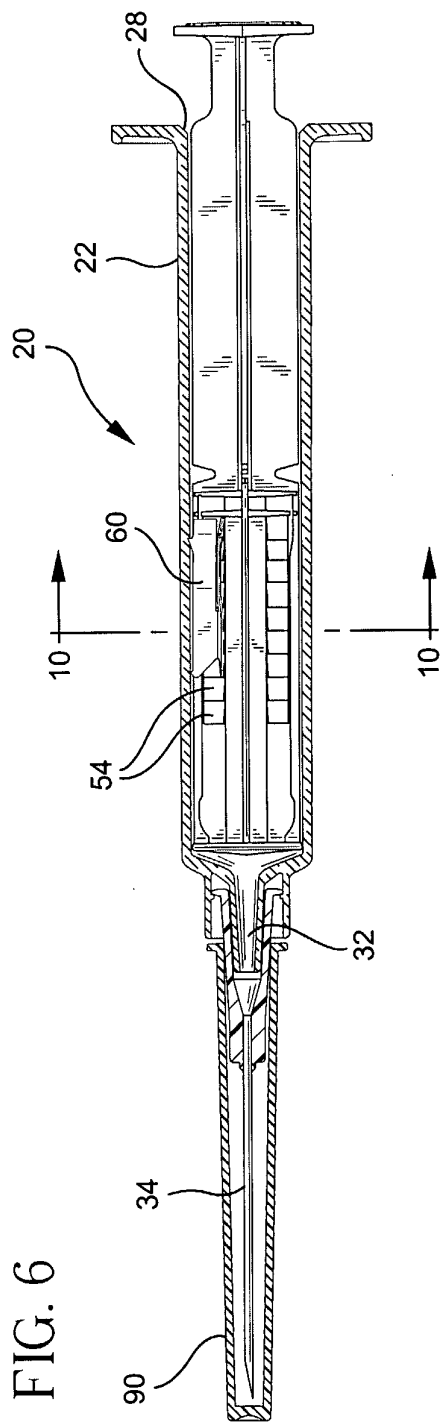
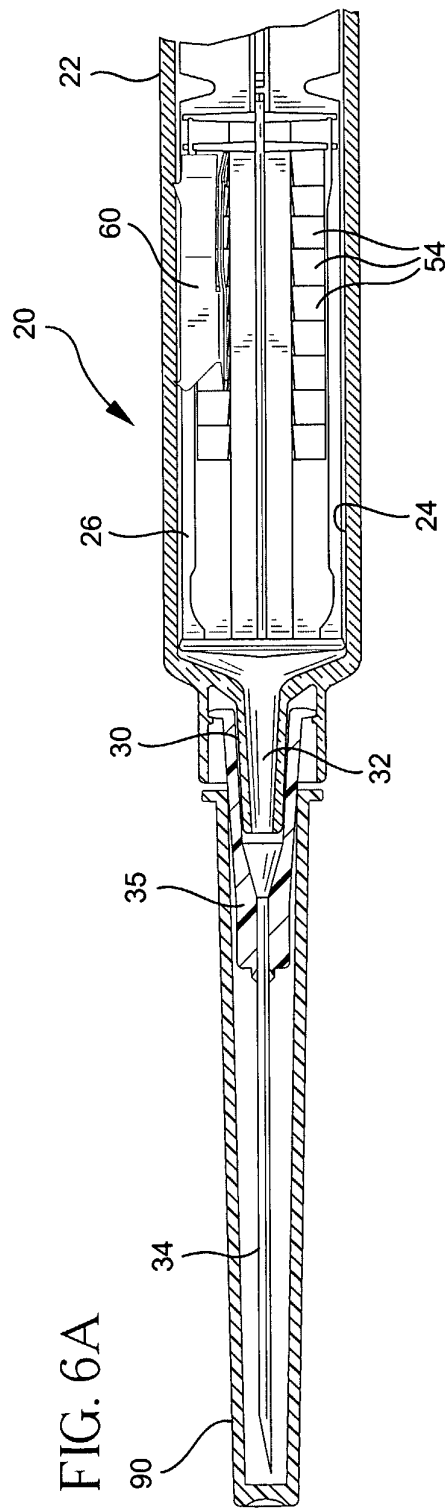


FIG. 6A



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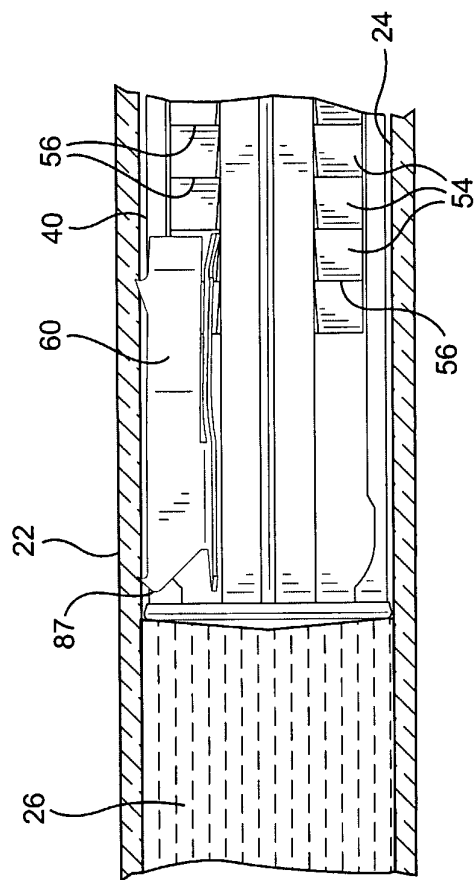
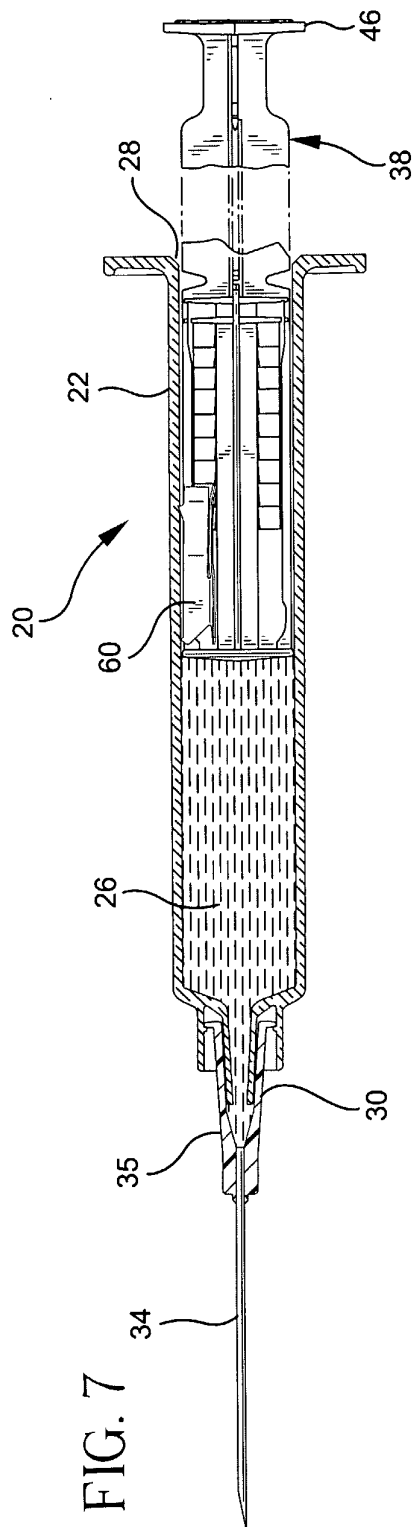
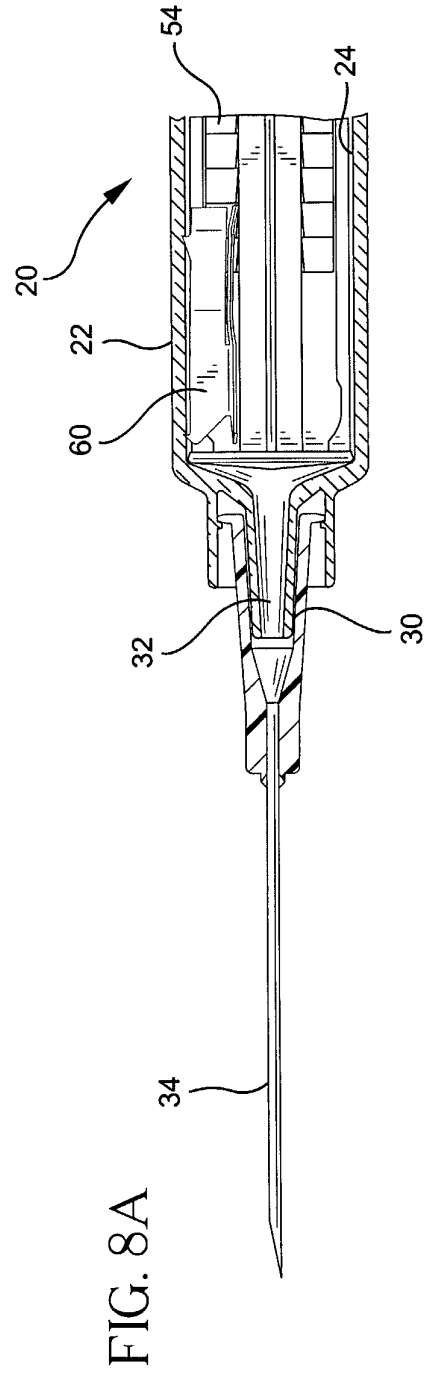
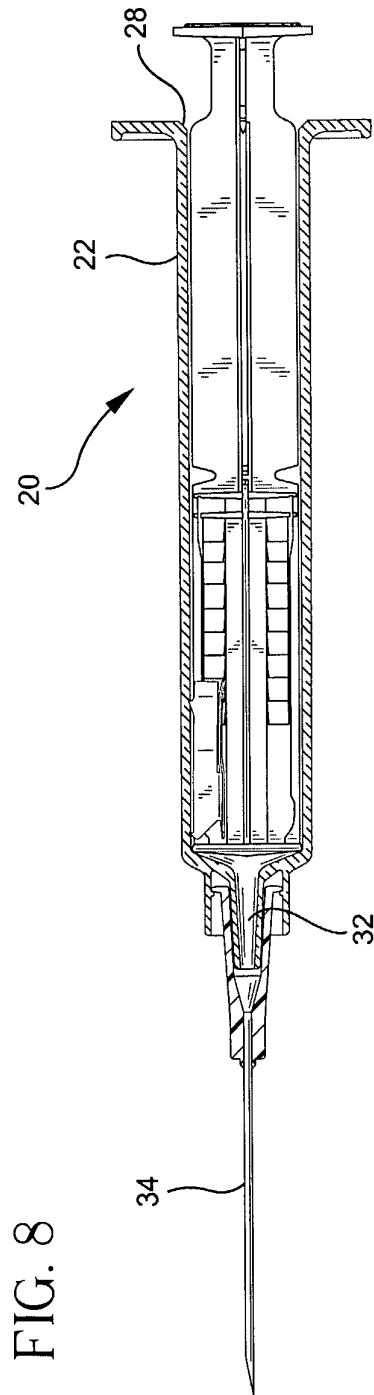
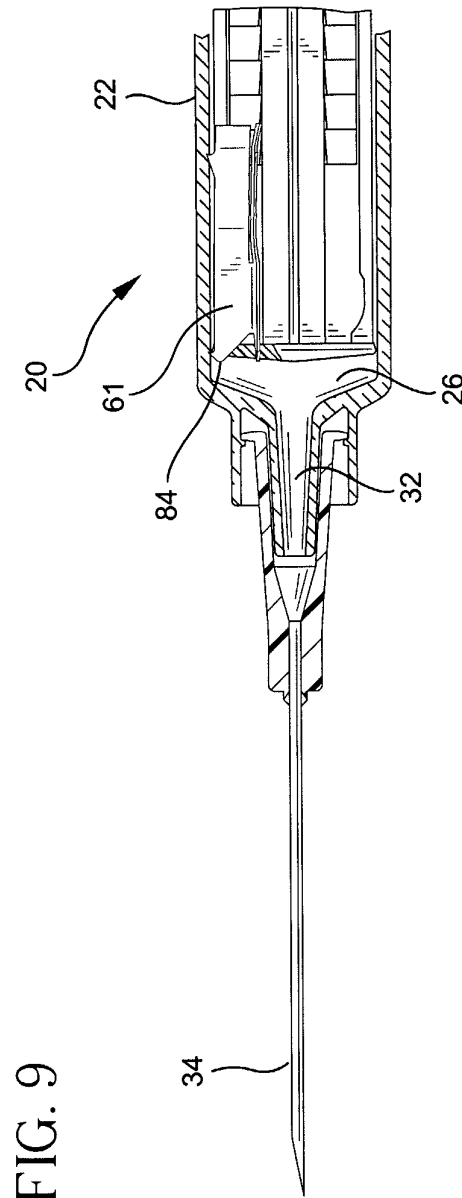


FIG. 7A

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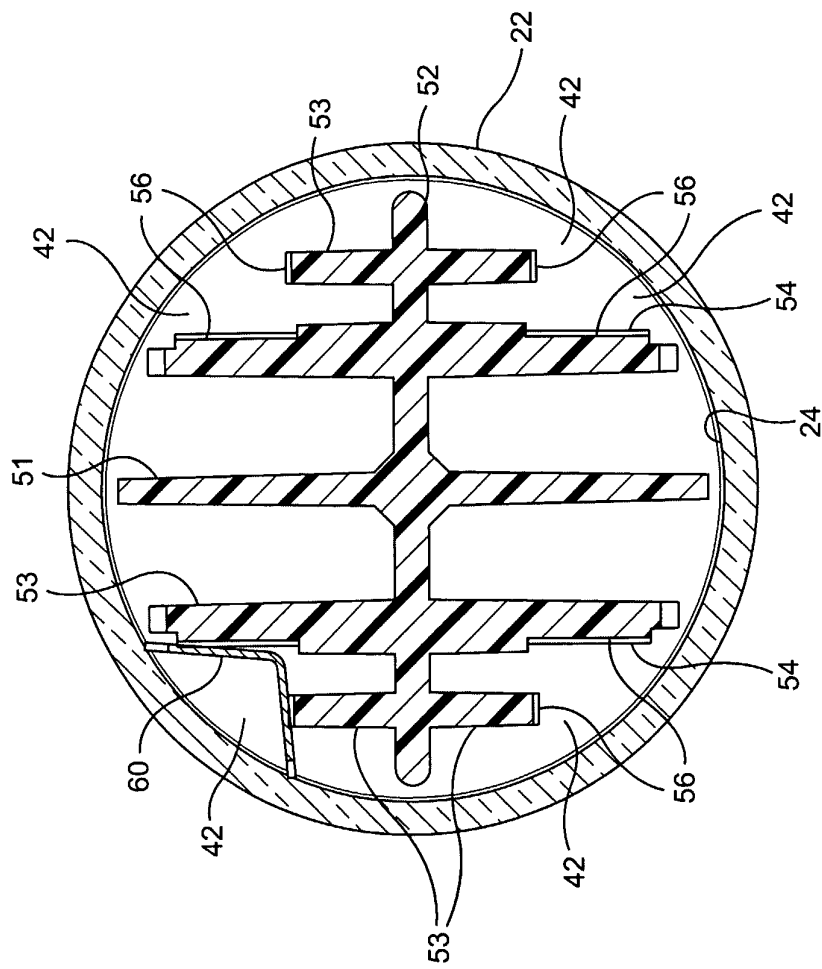
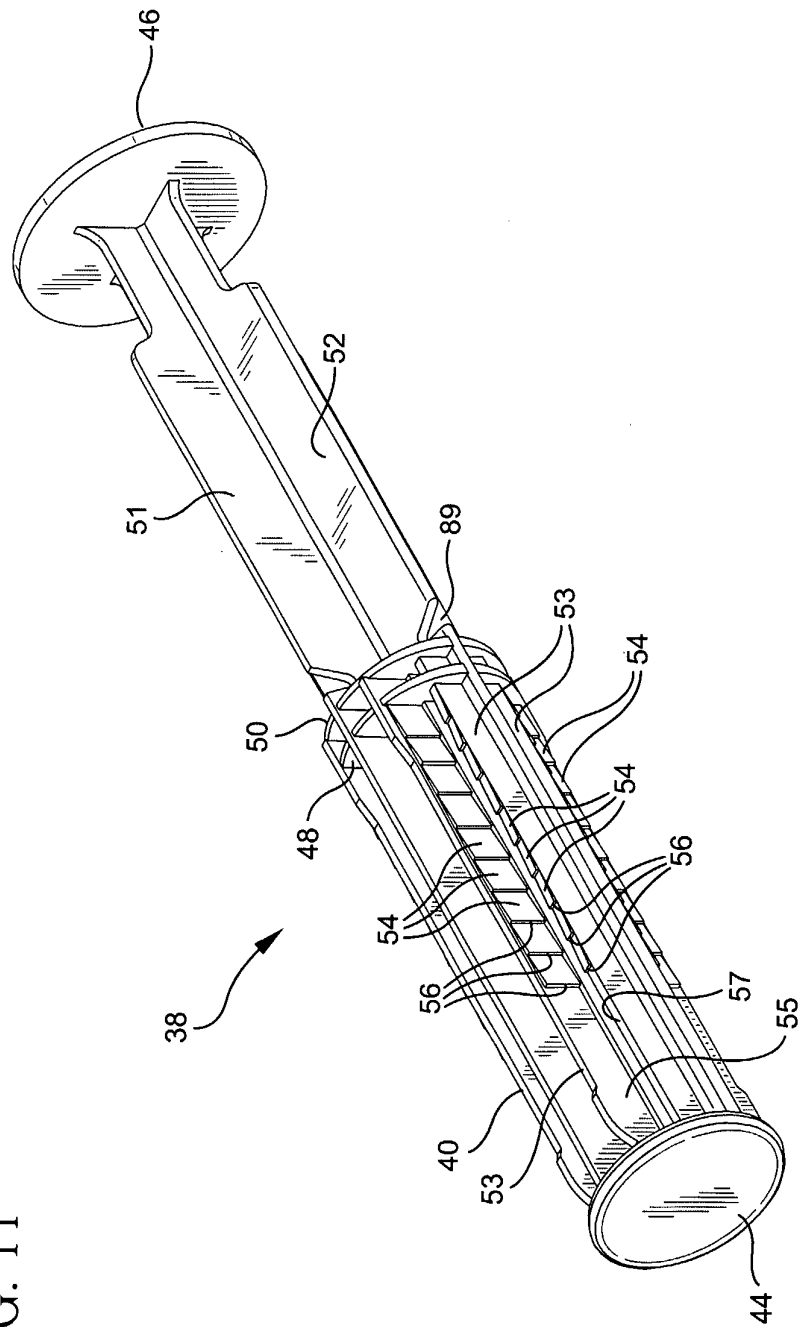


FIG. 10

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FIG. 11



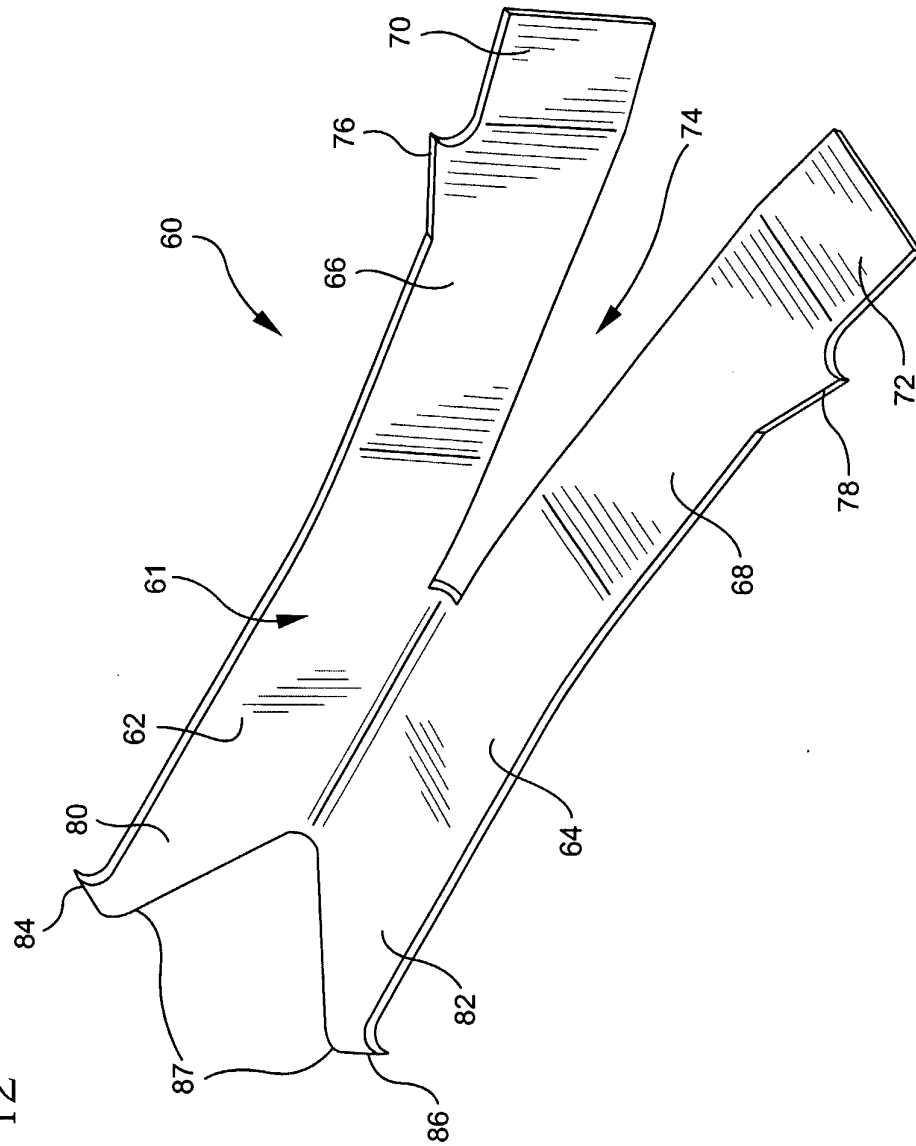
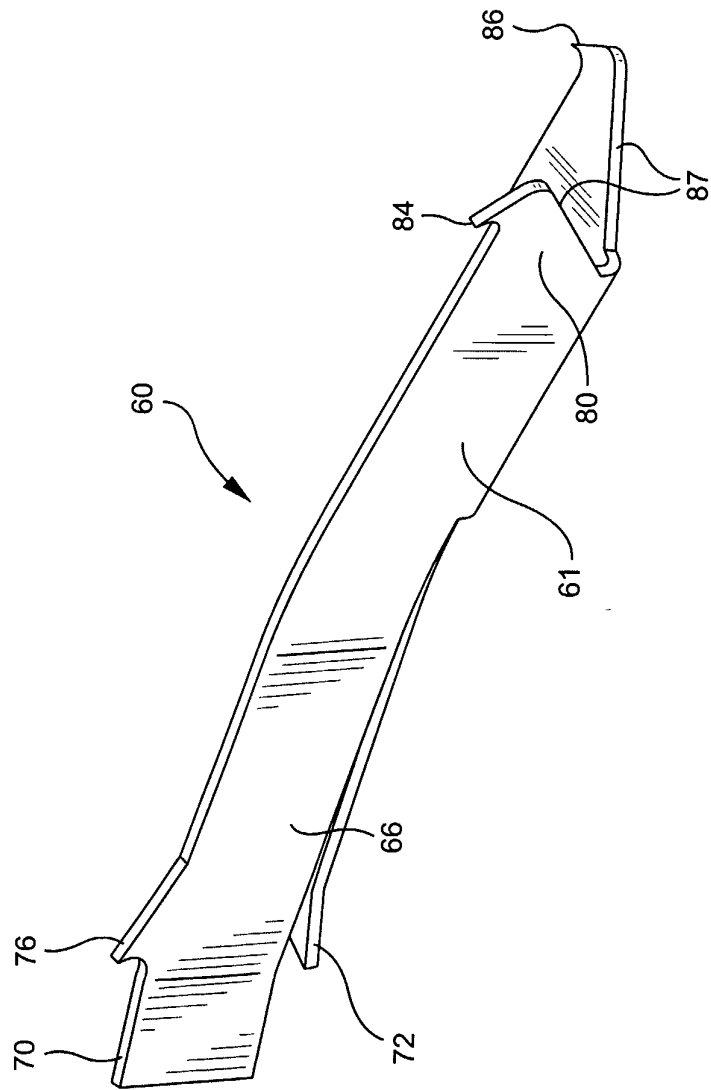


FIG. 12

FIG. 13



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FIG. 14

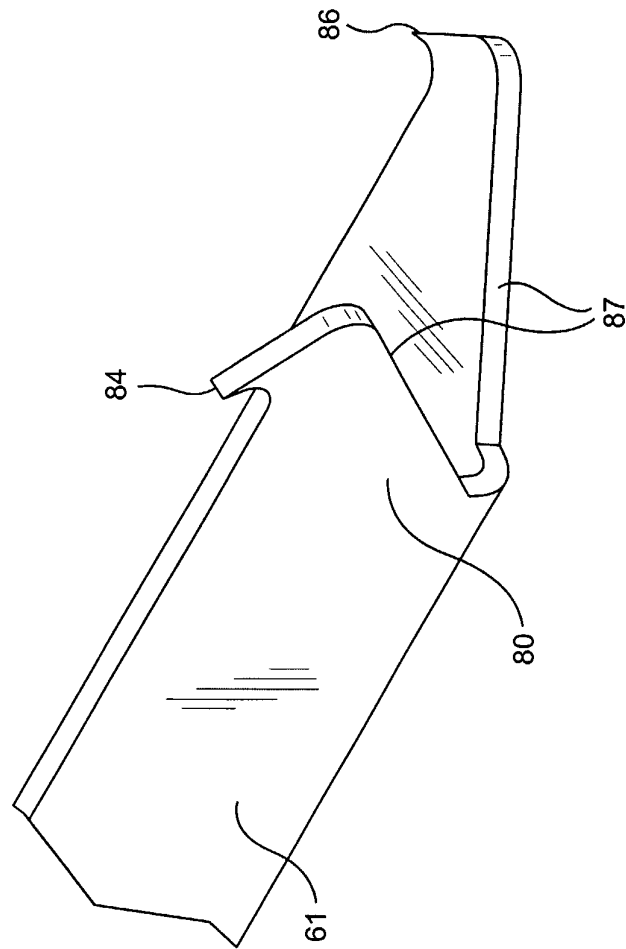


FIG. 15

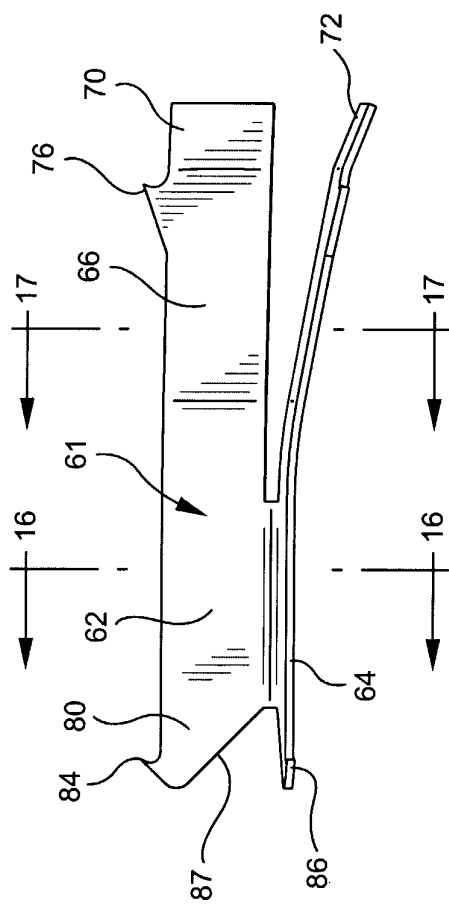


FIG. 16

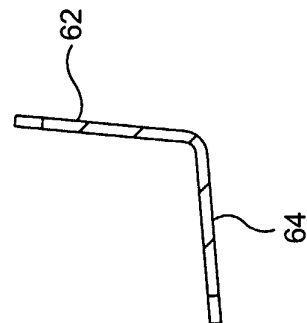


FIG. 17

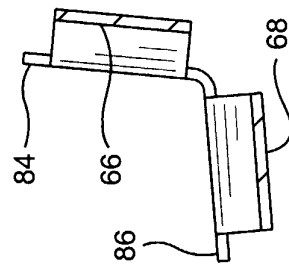


FIG. 18

