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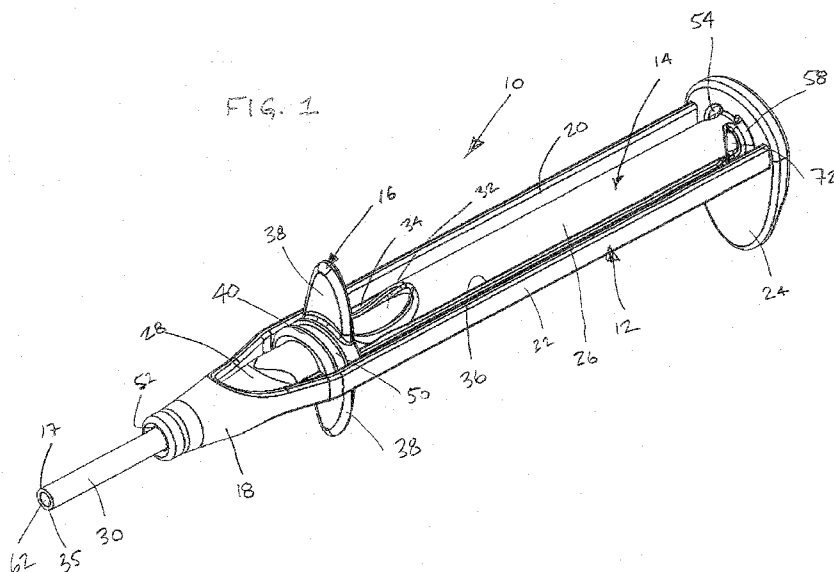
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(54) Title: INTRAOCULAR LENS DEPLOYMENT DEVICES AND METHODS



(57) Abstract: Devices to deploy intraocular lenses to an eye of a patient. The intraocular lens deployment devices include at least one conveyor and other features that allow a lens to be loaded onto or into the conveyor at a first stage of deployment. Actuation of the conveyor causes the lens to be transported and deployed according to second and third stages of deployment. Loading an intraocular lens onto and/or into the conveyor is easily accomplished, thereby minimizing handling of the intraocular lens and advantageously reducing potential damage to the intraocular lens. During actuation, features of the device and the conveyor help to cause the conveyor and lens to roll up and compress, which reduces the risk of lens scratching as the lens is transported and compressed through the device to achieve deployment.

INTRAOCULAR LENS DEPLOYMENT DEVICES AND METHODS

Cross-Reference to Related Application

This patent application claims the benefit of U.S. Provisional Patent
5 Application No. 61/485,441, filed on May 12, 2011 and titled "Intraocular Lens
Deployment Devices and Methods", the entire disclosures of which are incorporated
herein by reference

Technical Field

The present invention relates to devices used to deploy intraocular lenses to an
10 eye of a patient. More particularly, the present invention relates to devices
comprising at least one movable conveyor configured to transport, at least partially
wrap, and protect an intraocular lens during deployment of such lens.

Background of the invention

An intraocular lens (sometimes referred to as an IOL in the industry) is an
15 implanted prosthesis that replaces the lens in the human eye. An IOL usually replaces
the existing crystalline lens because the existing lens has been clouded by a cataract,
or as a form of refractive surgery to change the optical power of the eye. An IOL
usually comprises a small plastic lens with plastic side struts, called haptics, to hold
the lens in place within the capsular bag inside the eye. IOLs were traditionally made
20 of an inflexible material (PMMA), although this has largely been superseded by the
use of flexible materials. Most IOLs fitted today are fixed monofocal lenses matched
to distance vision. However, other types are available, such as multifocal IOLs, which
provide the patient with multiple-focused vision at far and reading distance, and
adaptive IOLs, which provide the patient with limited visual accommodation.

25 Deployment devices are used to implant IOLs at the desired implant site in an
eye. IOL implant procedures generally involve at least three stages. In one stage, a
suitable lens is loaded into the deployment device. In some instances, the lens may be
folded or otherwise compressed at this stage to facilitate deployment. In a second stage,
the device is actuated to cause transport of the lens from its loaded position to a position
30 in which the lens can be deployed from the device at the desired implant site.
Optionally, the second stage may involve at least a portion of the desired lens folding
and/or compression. In a third stage, the device actuation causes the lens to be

deployed at the implant site and implanted. Most conventional devices pose an undue risk of creasing, scratching, or otherwise damaging an IOL during an implant procedure.

Summary of the Invention

5 The present invention relates to improved devices used to deploy intraocular lenses to an eye of a patient. Intraocular lens deployment devices in accordance with the present invention are easy to use and provide a lower risk of potential damage to an intraocular lens during an implant procedure.

 Intraocular lens deployment devices of the present invention include at least one
10 conveyor and other features that allow a lens to be loaded onto or into the conveyor according to a first deployment stage. Actuation of the conveyor causes the lens to be transported and deployed according to second and third stages of deployment. Loading an intraocular lens onto and/or into the conveyor of a device in accordance with the present invention is easily accomplished, thereby minimizing handling of the
15 intraocular lens and advantageously reducing potential damage to the intraocular lens. During actuation, features of the device and the conveyor help to cause the conveyor and lens to roll up and compress. The rolling action reduces the risk of creasing the lens that might otherwise occur if the lens were to be folded up with too much direct folding force. Additionally, the conveyor rolls up the lens in a manner effective to at
20 least partially wrap the rolled up lens in a protective manner. This protective wrapping action reduces the risk that the lens will be scratched by device features as the lens is transported and compressed through the device to achieve deployment.

 In one particular embodiment, a device for deploying an intraocular lens comprises a body portion having an inner space, a loading port through the body portion
25 providing access to the inner space, a lens deployment portion having a lumen in communication with the loading port and the inner space, and a deployment orifice at a distal end of the deployment portion through which the lens is deployed. A conveyor is at least partially positioned within the inner space of the body portion and is configured so the lens can be positioned on and transported by the conveyor. An actuator may be
30 connected to the conveyor, which may be moveable to drive the conveyor relative to the body portion.

In another embodiment, a device comprises a body portion having an inner space, a lens deployment portion having a lumen in communication with the inner space of the body portion, and a deployment orifice at a distal end of the deployment portion through which the lens is deployed. A conveyor is at least partially positioned within
5 the inner space of the body portion and is accessible so the lens can be positioned on and transported by the conveyor. A second body portion surrounds the first body portion. An actuator may be connected to the conveyor, which may be moveable to drive the conveyor relative to the body portion to cause deployment of the lens.

In another embodiment, a device comprises a body portion having an inner
10 space, a loading port providing access to the inner space, a lens deployment portion having a lumen in communication with the loading port and the inner space, and a deployment orifice at a distal end of the deployment portion. A conveyor is at least partially positioned within the inner space of the body, the conveyor having a first end and a second end. The device includes an actuator moveable relative to the body
15 portion, the first end of the conveyor and the second end of the conveyor connected to the actuator to form a continuous loop. The second end of the conveyor may have plural legs.

In yet another embodiment, a device comprises at least one movable conveyor that conveys an intraocular lens from an initial position to a deployment orifice. The
20 device has a shaping zone between the initial position and the deployment orifice, the shaping zone comprising a tapering lumen that causes the conveyor to at least partially wrap around the intraocular lens when the intraocular lens is on the conveyor. The device also has a deployment zone comprising a lumen configured to transport the wrapped intraocular lens to the deployment orifice.

This invention also includes conveyors for deploying an intraocular lens with an
25 intraocular lens deployment device. In one embodiment, a conveyor has a first end that can be attached to an actuator of the deployment device, a closed tubular body portion configured to wrap the intraocular lens during movement of the tubular body portion and intraocular lens through a tapering portion of the deployment device, an loading
30 region adjacent the closed tubular portion, and a second end that can optionally be attached to the actuator of the deployment device. In an alternate embodiment, the conveyor has a first end that can be attached to an actuator of the deployment device, a

closed tubular body portion configured to wrap the intraocular lens during movement of the tubular body portion and intraocular lens through a portion of the deployment device, an loading region adjacent the closed tubular portion, and a second end that can be attached to the actuator of the deployment device. In either embodiment, the second
5 end can have plural legs, which may define the loading region.

This invention also includes methods for deploying an intraocular lens. In one embodiment, a method includes positioning an intraocular lens in contact with a conveyor that is at least partially positioned within an internal space of a body portion of a lens deployment device having a tapered portion, driving the conveyor relative to
10 the body portion of the lens deployment device, carrying the intraocular lens with the conveyor through the internal space of the body portion and the tapered portion and through a lumen of a deployment cannula in communication with the internal space of the body portion and the tapered body portion, and deploying the intraocular lens from the cannula.

Another embodiment of a method includes providing at least one movable conveyor, providing an intraocular lens on the conveyor, causing the conveyor to at least partially wrap the intraocular lens, causing movement of the conveyor to transport the at least partially wrapped intraocular lens to an implant site, and causing the intraocular lens to be deployed at the implant site. The method may include causing the
20 conveyor to at least partially wrap the intraocular lens by moving the conveyor and intraocular lens through a tapered deployment device.

The invention also includes methods for making a device for deploying an intraocular lens.

Brief Description of the Drawings

25 Figure 1 is a perspective view of a device of an intraocular lens deployment device.

Figure 2 is a perspective cross-sectional view of the intraocular lens deployment device.

Figure 3 is a perspective view of the outer body of the deployment device.

30 Figure 4 is a perspective view of the inner body of the deployment device; Figure 4a is an enlarged view of an embodiment of an inner body.

Figure 5 is a side cross-sectional view of the inner body designating various functional zones.

Figure 6 is a perspective view of an actuator of the intraocular lens deployment device.

Figure 7 is an alternate perspective view of the intraocular lens deployment device.

Figure 8 is a side plan view of the intraocular lens deployment device.

Figure 9 is a side plan view of the intraocular lens deployment device.

Figure 10 is a perspective cross-sectional view of the intraocular lens
10 deployment device.

Figure 11a is perspective view of a conveyor; Figure 11b is a perspective view of a precursor to the conveyor; Figure 11c is side view of the precursor to the conveyor.

Figure 12 is a cross-sectional side view of the intraocular lens deployment device, with a lens loaded therein, with the tail of the conveyor attached to the actuator.

15 Figure 13 is an enlarged view of a portion of the deployment device.

Figure 14 is a side view of the intraocular lens deployment device with a lens loaded therein, with the tail of the conveyor free.

Figure 15 is a side view of the intraocular lens deployment device with a lens loaded therein, with the tail of the conveyor sealed.

20 Detailed Description

The exemplary embodiments of the present invention described herein are not intended to be exhaustive or to limit the present invention to the precise forms disclosed in the following detailed description. Rather the exemplary embodiments described herein are chosen and described so those skilled in the art can appreciate and understand the principles and practices of the present invention. Additionally, the accompanying drawings, which are incorporated in and constitute a part of this disclosure, illustrate several aspects of the present invention and together with description of the exemplary embodiments serve to explain the principles of the invention.

Referring to the figures, an exemplary intraocular lens deployment device 10 in accordance with the present invention is illustrated. Device 10, as shown, comprises, as main components, an outer body 12 around an inner body 14, an actuator 16, and a conveyor 74.

Outer body 12, best seen in Figure 3, preferably comprises tapering portion 18 and arms 20 and 22 that longitudinally extend to ends 23 and 25, respectively, from tapering portion 18. Arms 20, 22 help to support outer body 12 in the desired position around inner body 14. Arms 20, 22 can be integrally formed with tapering portion 18 as a single component, for instance. Alternatively, outer body 12 can comprise plural components connected together such as by using an adhesive, welding, a snap-fit, or other suitable technique. Other exemplary embodiments may include only a single arm or may include three or more arms.

Inner body 14, best seen in Figure 4, comprises base 24, tubular portion 26, tapering portion 28, and deployment cannula 30 having deployment orifice 35 at distal end 17. In the illustrated embodiment, base 24, tubular portion 26, tapering portion 28, and deployment cannula 30 are preferably provided as a single monolithic component. Any portion(s) of one or more of base 24, tubular portion 26, tapering portion 28, and deployment cannula 30 can be provided as a single monolithic component or as individual components joined together in any desired way. For example, tubular portion 26, tapering portion 28, and deployment cannula 30 can be provided as a single monolithic component while base 24 is provided as a distinct component that can be attached to the monolithic component comprising tubular portion 26, tapering portion 28, and deployment cannula 30.

Tubular portion 26 preferably comprises an oval cross-section. Tapering portion 28 preferably comprises a tapering cross-section that transitions from an oval cross-section proximate to tubular portion 26 to a circular cross-section proximal to cannula 30. Cannula 30 preferably comprises a circular cross-section. The oval cross-section of tubular portion 26 is compatible with the geometry of many lenses and facilitates the loading and rolling of a lens as described below. The circular cross-section of cannula 30 facilitates compact transport to orifice 35 from which the lens is deployed at the desired implant site.

End 17 of cannula 30 may have any desired geometry. As illustrated in Figure 4, end 17 of cannula 30 may be square (i.e., perpendicular) to the axis of cannula 30. In an alternative embodiment, distal end 17 may comprise a geometry that may facilitate easier entry into an incision through which an intraocular lens is to be deployed. For example, as shown in Figure 4a, end 17 of cannula 30 may comprise bevel 21.

Returning to Figure 4, tubular portion 26 also preferably comprises guide ribs 34 and 36. Guide ribs 34, 36 preferably strengthen tubular portion 26 and also slidingly guide actuator 16 (Figure 1) along tubular portion 26 of inner body 14 during use as described in more detail below. Lumen 62 preferably extends through inner body 14 from the end of body 14 that is proximal to base 24 to deployment orifice 35. Tubular portion 26 also preferably includes loading port 32 therein that provides access through tubular portion 26 to lumen 62 present in tubular portion 26.

Tubular portion 26, tapering portion 28, and cannula 30 of inner body 14 help to establish loading zone 27, staging zone 29, shaping zone 31, and deployment zone 33, shown in Figure 5, as subregions of inner body 14. The region of tubular portion 26 accessible via loading port 32 corresponds with loading zone 27. Staging zone 29 is preferably positioned between loading zone 27 and tapering portion 28. Shaping zone 31 preferably corresponds with tapering portion 28. Dispensing zone 33 corresponds with cannula 30 and deployment orifice 35.

Returning to Figure 4 and also referring to Figure 7, base 24 is preferably sized and shaped to function as a grip or handle during use of device 10. Base 24 includes various features that help to mount base 24 to outer body 12, or outer body 12 may be mounted to base 24. Outer body 12 and base 24 may be attached in any convenient way. In the exemplary illustrated embodiment, base 24 includes mounting openings 11 and 13 for receiving and attaching arms 20 and 22, respectively, to base 24.

As seen in Figures 1, 4 and 7, base 24 includes openings 54 and 58 therethrough. These openings 54, 58 optionally may be used as separation guides for legs 78 and 80 (see Figure 11a) of conveyor 74. Each of legs 78, 80 can be fed through a corresponding one of openings 54, 58, respectively, in order to hold the legs 78, 80 apart as the conveyor 74 is actuated. This helps to prevent the conveyor from collapsing onto itself. If the legs 78, 80 are not held apart, conveyor 74 may tend to collapse in some instances, making it more difficult to load. Additional description of conveyor 74 and its loading is provided below.

Referring to Figures 1, 2 and particularly Figure 6, actuator 16 of device 10 comprises handles 38 extending outward from boss 40, which comprises inside surface 42 that defines opening 45. Opening 45 is preferably sized and shaped to provide free sliding engagement between actuator 16 and tubular portion 26 of inner body 14 along

the length of tubular portion 26. Opening 45 has channels 44 and 46 sized and shaped to fit with and slidingly engage with guide ribs 34 and 36 of tubular portion 26 of inner body 14. Channels 44, 46 together with guide ribs 34, 36 also function to provide a consistent orientation of actuator 16 relative to inner body 14 as actuator 16 is moved longitudinally along tubular portion 26 during use.

Now referring to Figure 11a, an exemplary conveyor 74 is schematically illustrated. Conveyor 74 comprises tubular body portion 76, legs 78 and 80, first end 82, loading region 81, and ends 83 and 84 of legs 78 and 80, respectively. Preferably, body portion 76 comprises a circular cross-section but other cross-sections such as an oval cross-section or the like can be used. Conveyor 74 is made from a flexible material but is desirably low stretch so that suitable tension can be maintained on conveyor 74 during actuation. In one exemplary embodiment, conveyor 74 is derived from a material preferably having a thickness less than about 1 mil (0.001 inch or 0.0254 mm). Preferred exemplary materials include, low density polyethylene (LDPE), high density polyethylene (HDPE), a fluoropolymer such as polytetrafluoroethylene (PTFE) sold under the trade designation TEFLON, combinations of these, and the like.

Figures 11b and 11c schematically illustrate one method for forming conveyor 74 from a tube-shaped precursor 102. In Figure 11b, tube-shaped precursor 102 is slit from a starting point 104 to the end 83/84 of precursor 102 to define edges 105. Precursor 102 would be slit a second time as shown by broken line 108 starting from starting point 106 and extending to end 83/84 to define edges 110 and thereby arrive at the exemplary configuration of conveyor 74 shown in Figure 11a. Figure 11c shows how starting points 104 and 106 are longitudinally offset by a distance "d" (desirably from about 1 to 4 times the diameter of the lens to be implanted) so that the region of conveyor 74 between slit starting points 104 and 106 helps to define loading region 81. Loading region 81 is preferably positioned within tubular portion 26 of inner body 14 proximal to loading port 32. From one perspective, loading region 81 forms a protective basket to receive, wrap, and hold the intraocular lens that is to be deployed. Additionally, the offset starting points 104 and 106 form legs 78 and 80 that have a varying or irregular length; in other words, edges 105 of legs 78, 80 have a different length than edges 110 of legs 78, 80.

According to a typical procedure for assembling the components of exemplary device 10, actuator 16 is fit over inner body 14. Opening 45 and channels 44, 46 of actuator 16 are preferably sized so that actuator 16 slideably engages tubular portion 26 of inner body 14 for smooth sliding motion back and forth along tubular portion 26.

- 5 Note how channels 44, 46 fit over ribs 34, 36 so that ribs 34, 36 can help guide actuator 16 and hold actuator 16 in a desired orientation around tubular portion 26. Outer body 12 is fit over inner body 14 in a manner so that ends 23, 25 of arms 20, 22 are mounted to base 24 via mounting holes 11, 13. Tapering portion 18 of outer body 12 fits over tapering portion 28 of inner body 14 with a close fit but still is spaced apart from
- 10 tapering portion 28 in a manner effective to define an annular gap 52 (see Figures 1 and 2) between tapering portion 28 and tapering portion 18. Gap 52 provides a pathway for installation of and translation of conveyor 74 as described further below. Note how handles 38 of actuator 16 extend past outer body 12 between arms 20, 22; this allows actuator 16 to move along tubular portion 26 without undue interference from arms 20,
- 15 22.

- According to one exemplary technique for installing conveyor 74 in device 10, conveyor 74 is fed through lumen 62 of inner body 14 and is positioned so that an intraocular lens can be loaded onto loading region 81 of conveyor 74 via loading port 32. Legs 78, 80 of conveyor 74 are fed through and extend from openings 70 and 72
- 20 (best seen in Figure 9) of inner body 14 near base 24. Tubular portion 76 of conveyor 74 is fed through to extend from deployment orifice 35, and is preferably rolled back over cannula 30 thereby reversing the direction of conveyor 74 and causing tubular portion 76 of conveyor 74 to turn inside out (i.e., invert). First end 82 of conveyor 74 is preferably fed over tapering portion 28 of inner body 14 through gap 52 and extended to
- 25 and attached to a portion of actuator 16, such as boss 40, using o-ring 48 in groove 50 (see Figures 9 and 12) or other suitable attachment technique. Tapering portion 18 of outer body 12 surrounds underlying tubular portion 76 of conveyor 74, helping to hold underlying tubular portion 76 of conveyor 74 in a reasonably close fit around inner body 14. Additionally, legs 78, 80 of conveyor 74 extend from openings 70, 72 of
- 30 tubular portion 26 and preferably extend back to actuator 16 and attach to boss 40 via o-ring 48. It is understood that these steps for installing conveyor 74 in device 10 may be done in alternate sequences.

Installed in this way, conveyor 74 from one perspective forms a continuous loop in which legs 78, 80 of conveyor 74 are linked to actuator 16 as is first end 82 to provide a continuous loop. The loop is suitably tensioned with minimal slack so that a lens loaded onto conveyor 74 can be deployed with smooth action.

5 Figure 12 illustrates the arrangement of legs 78, 80 and first end 82 linked to actuator 16 to forming a loop. Figure 14 illustrates an alternate arrangement, where legs 78, 80 are free, extending out lumen 62 proximate base 24. Figure 15 illustrates another alternate arrangement, where conveyor 74 does not have two individual and separate legs, but has a sealed end opposite first end 82.

10 In use, an intraocular lens can be positioned within loading region 81 of conveyor 74 at any desired time. For example, the intraocular lens can be pre-loaded in conveyor 74 before conveyor 74 is loaded in device 10. Alternatively, the intraocular lens can be loaded after conveyor 74 is loaded in device 10, for example, at the time of use. The intraocular lens desirably is positioned within loading region 81 of conveyor
15 74 with the convex side of the lens positioned down (convex side in contact with conveyor 74). Loading port 32 provides a convenient access for placement of the intraocular lens and allows device 10 to be configured for single use or multiple uses. See Figures 12, 14 and 15 for intraocular lens 19 positioned in loading region 81 via loading port 32.

20 Actuator 16 desirably is pre-positioned at a location so that the stroke length of actuation is sufficient to cause deployment of intraocular lens 19 through orifice 35 and to the desired implant site. In the exemplary illustrated embodiment, a desired starting location involves positioning actuator 16 near tapering portion 28 to provide a maximum stroke length down tubular portion 26 during actuation. Conveyor 74 is
25 sized so that this desirable initial position of actuator 16 allows loading zone 81 to be accessible via loading port 32.

To deploy intraocular lens 19, actuator 16 is pulled proximally towards base 24, thus causing the portion of conveyor 74 inside lumen 62 to be pulled distally, forward toward deployment orifice 35. This conveys intraocular lens 19 from loading zone 27
30 through staging zone 29 and shaping zone 31 toward deployment orifice 35; see Figure 5. As intraocular lens 19 moves through shaping zone 31, tapering portion 28 of inner body 14 causes conveyor 74 and intraocular lens 19 to roll up and compress before

reaching deployment cannula 30 of deployment zone 33. This shaping action also causes conveyor 74 to wrap and protect intraocular lens 19.

Advantageously as a consequence, as intraocular lens 19 moves through device 10, intraocular lens 19 generally only comes into contact with conveyor 74. Conveyor 74 generally is substantially stationary and does not unduly move, if at all, relative to intraocular lens 19 except for the rolling and compressing action. Instead, relative movement mainly occurs between conveyor 74 and inner body 14 so that the friction of sliding contact is taken by the interface between conveyor 74 and inner body 14. Avoiding undue relative motion between conveyor 74 and intraocular lens 19 helps to isolate intraocular lens 19 from sliding contact that might scratch or otherwise damage intraocular lens 19 during deployment.

Continued translation of actuator 16 proximally toward base 24 causes conveyor 74 to carry rolled up and wrapped intraocular lens 19 through lumen 62 within cannula 30. The relative tight geometry of cannula 30 helps to maintain the protective wrapping and compression of intraocular lens 19 until intraocular lens 19 is deployed from deployment orifice 35. Further actuation causes conveyor 74 to be pulled back over device 10, allowing intraocular lens 19 to deploy and spring open for placement at the desired implant site.

The present invention has now been described with reference to several exemplary embodiments thereof. The entire disclosure of any patent or patent application identified herein is hereby incorporated by reference for all purposes. The foregoing disclosure has been provided for clarity of understanding by those skilled in the art of intraocular lenses. No unnecessary limitations should be taken from the foregoing disclosure. It will be apparent to those skilled in the art that changes can be made in the exemplary embodiments described herein without departing from the scope of the present invention. Thus, the scope of the present invention should not be limited to the exemplary structures and methods described herein, but only by the structures and methods described by the language of the claims and the equivalents of those claimed structures and methods.

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What is claimed is:

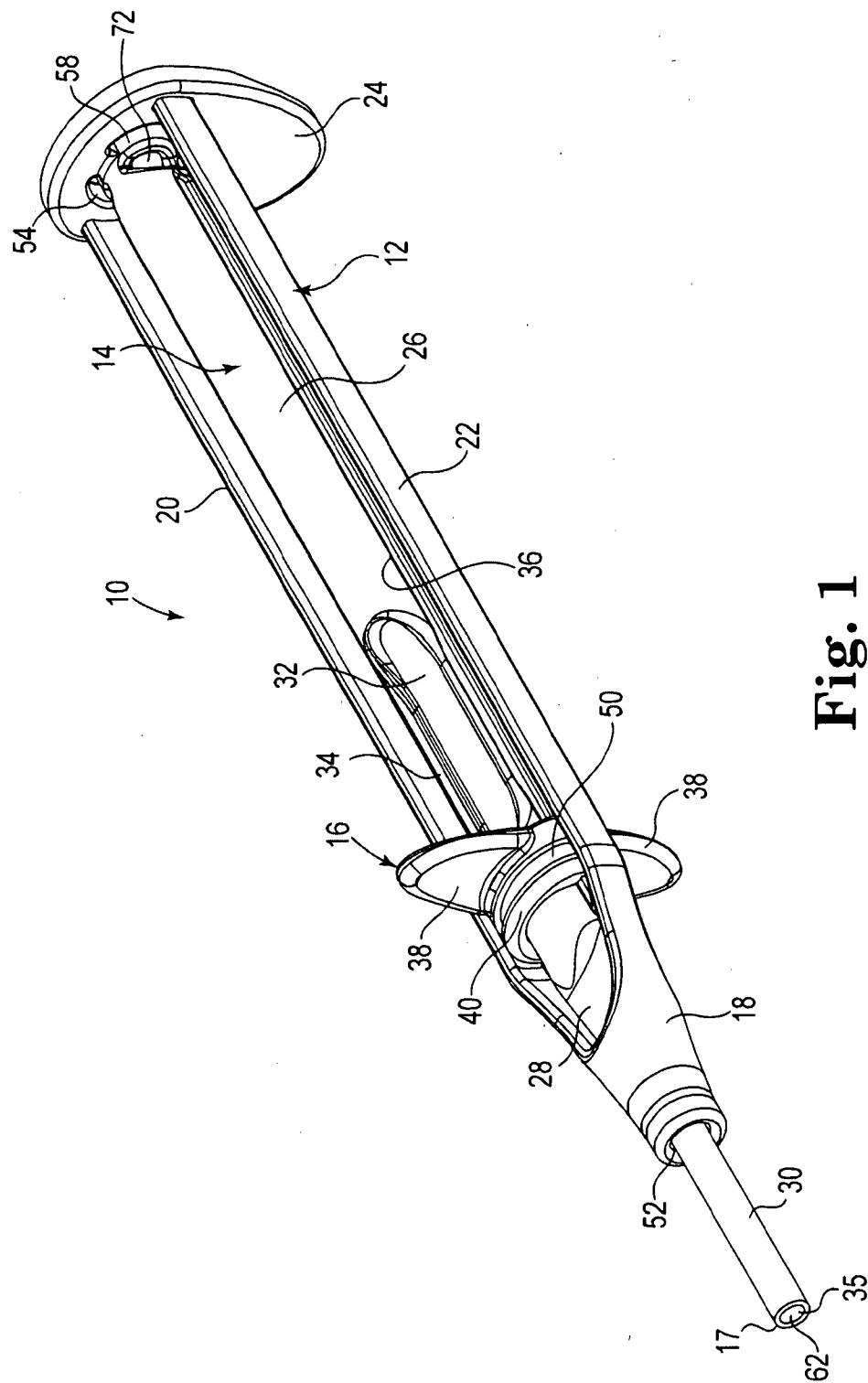
1. A device for deploying an intraocular lens, the device comprising:
a body portion having an inner space, a loading port through the body portion
5 providing access to the inner space, a lens deployment portion having a
lumen in communication with the loading port and the inner space, and a
deployment orifice at a distal end of the deployment portion through
which the lens is deployed; and
a conveyor at least partially positioned within the inner space of the body
10 portion and configured so the lens can be positioned on and transported
by the conveyor.
2. The device of claim 1, comprising an actuator connected to the conveyor and
moveable to drive the conveyor relative to the body portion.
3. The device of any of claims 1-2, comprising a second body portion surrounding
15 the first body portion.
4. The device of any of claims 1-3, comprising a tapering portion having an inner
space in communication with the body portion, the tapering portion positioned
between the body portion and the lens deployment portion.
5. The device of claim 4, wherein upon movement of the conveyor relative to the
20 body portion, the conveyor passes through the inner space of the body portion,
the inner space of the tapering portion, and the lumen of the lens deployment
portion.
6. The device of claim 5, wherein the conveyor exits the deployment orifice of the
lens deployment portion, reverses direction, extends over the lens deployment
25 portion, tapering portion, and at least a portion of the body portion, and attaches
to an actuator connected to the conveyor and moveable to drive the conveyor
relative to the body portion to cause deployment of the lens.
7. The device of claim 6, wherein the conveyor exits the body portion at a
proximal end thereof.
- 30 8. The device of claim 7, wherein the conveyor that exits the body portion at a
proximal end thereof is attached to the actuator.

9. A device for deploying an intraocular lens, the device comprising:
a body portion having an inner space, a lens deployment portion having a lumen
in communication with the inner space of the body portion, and a
deployment orifice at a distal end of the deployment portion through
5 which the lens is deployed;
a conveyor at least partially positioned within the inner space of the body
portion and accessible so the lens can be positioned on and transported
by the conveyor; and
a second body portion surrounding the first body portion.
- 10 10. The device of claim 9, comprising an actuator connected to the conveyor and
moveable to drive the conveyor relative to the body portion to cause deployment
of the lens.
11. The device of any of claims 9-10, comprising a loading port through the body
portion providing access to the inner space of the body portion.
- 15 12. The device of any of claims 9-11, comprising a tapering portion having an inner
space in communication with the body portion positioned between the body
portion and the lens deployment portion.
13. The device of any of claims 9-12, wherein the second body portion surrounds at
least a portion of the tapering portion.
- 20 14. The device of claim 13, wherein the tapering portion and the second body
portion are spaced apart to define a gap and wherein the conveyor passes
through the gap.
15. A device for deploying an intraocular lens, the device comprising:
a body portion having an inner space, a loading port providing access to the
25 inner space, a lens deployment portion having a lumen in communication
with the loading port and the inner space, and a deployment orifice at a
distal end of the deployment portion;
a conveyor at least partially positioned within the inner space of the body, the
conveyor having a first end and a second end; and
30 an actuator moveable relative to the body portion, the first end of the conveyor
and the second end of the conveyor connected to the actuator to form a
continuous loop.

16. The device of claim 15, wherein the second end of the conveyor comprises plural legs.
17. The device of claim 16, the body portion comprising first and second openings at its proximal end opposite the deployment orifice at the distal end, and each of the plural legs passing through one of the first and second openings.
- 5 18. A device for deploying an intraocular lens, the device comprising:
at least one movable conveyor that conveys the intraocular lens from an initial position to a deployment orifice;
a shaping zone between the initial position and the deployment orifice
10 comprising a tapering lumen that causes the conveyor to at least partially wrap around the intraocular lens when the intraocular lens is on the conveyor; and
a deployment zone comprising a lumen configured to transport the wrapped intraocular lens to the deployment orifice.
- 15 19. A method of making a device for deploying an intraocular lens, the method comprising:
providing a tube-shaped precursor having a first end and a second end;
slitting the tube-shaped precursor from a first starting point to the second end
and from a second starting point to the second end to form a conveyor,
20 the first starting point and the second starting point being longitudinally offset;
installing the conveyor within an inner space of a body portion, the inner space is communication with a lumen and a deployment orifice, so that the conveyor movable in relation to the deployment orifice to dispense the
25 intraocular lens through the deployment orifice.
20. The method of claim 19, further comprising connecting a first end of the conveyor to an actuator movable relative to the body portion.
21. The method of claim 20, further comprising connecting a second end of the conveyor to the actuator to form a continuous loop.
- 30 22. The method of any of claims 19-21, wherein the first starting point and the second starting point are longitudinally offset a distance from about 1 to 4 times the diameter of the intraocular lens to be deployed.

23. A method for deploying an intraocular lens, the method comprising:
positioning an intraocular lens in contact with a conveyor that is at least partially
positioned within an internal space of a body portion of a lens
deployment device having a tapered portion;
5 driving the conveyor relative to the body portion of the lens deployment device;
carrying the intraocular lens with the conveyor through the internal space of the
body portion and the tapered portion and through a lumen of a
deployment cannula in communication with the internal space of the
body portion and the tapered body portion; and
10 deploying the intraocular lens from the cannula.
24. A method for deploying an intraocular lens, the method comprising:
providing at least one movable conveyor;
providing an intraocular lens on the conveyor;
causing the conveyor to at least partially wrap the intraocular lens;
15 causing movement of the conveyor to transport the at least partially wrapped
intraocular lens to an implant site; and
causing the intraocular lens to be deployed at the implant site.
25. The method of claim 24 wherein causing the conveyor to at least partially wrap
the intraocular lens comprises moving the conveyor and intraocular lens through
20 a tapered deployment device.

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Fi. 1

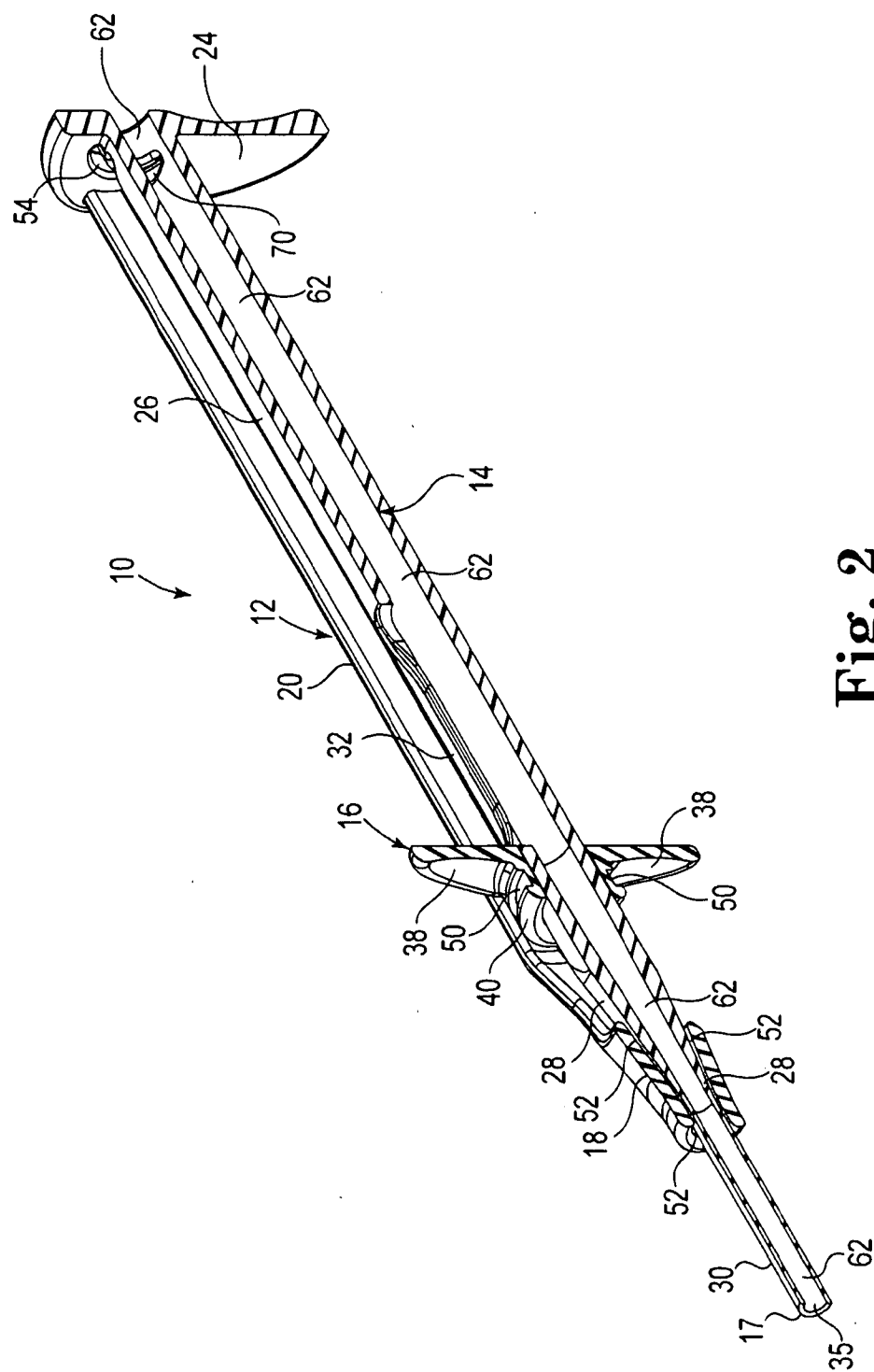


Fig. 2

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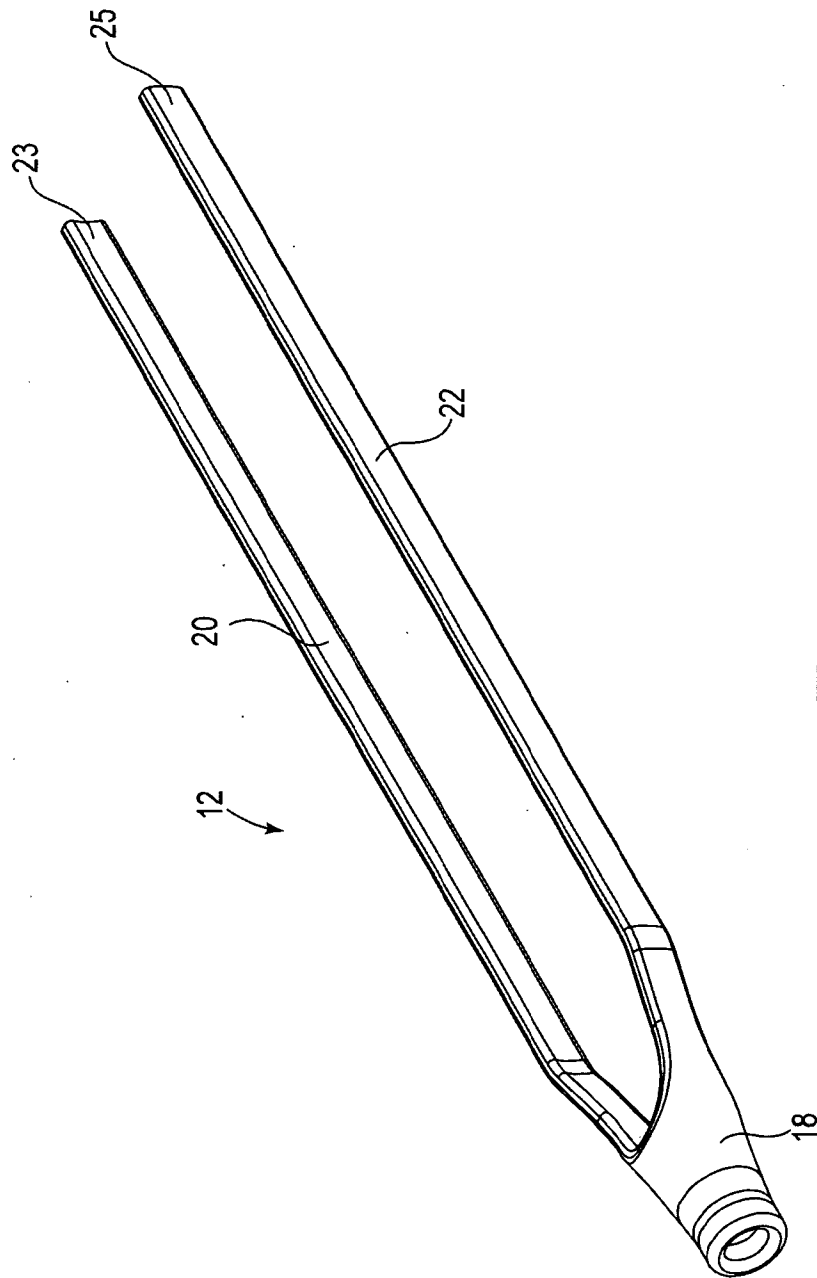


Fig. 3

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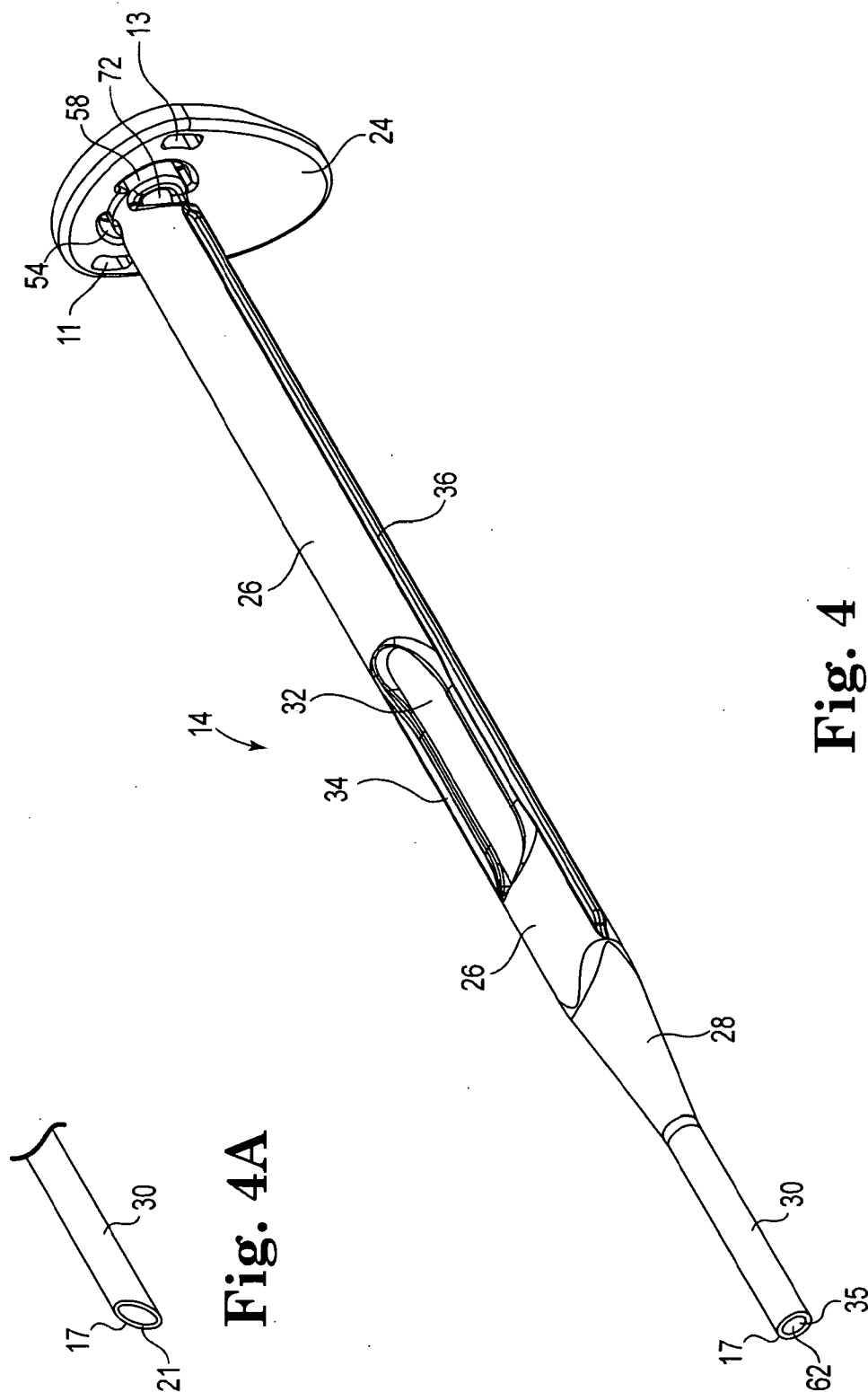
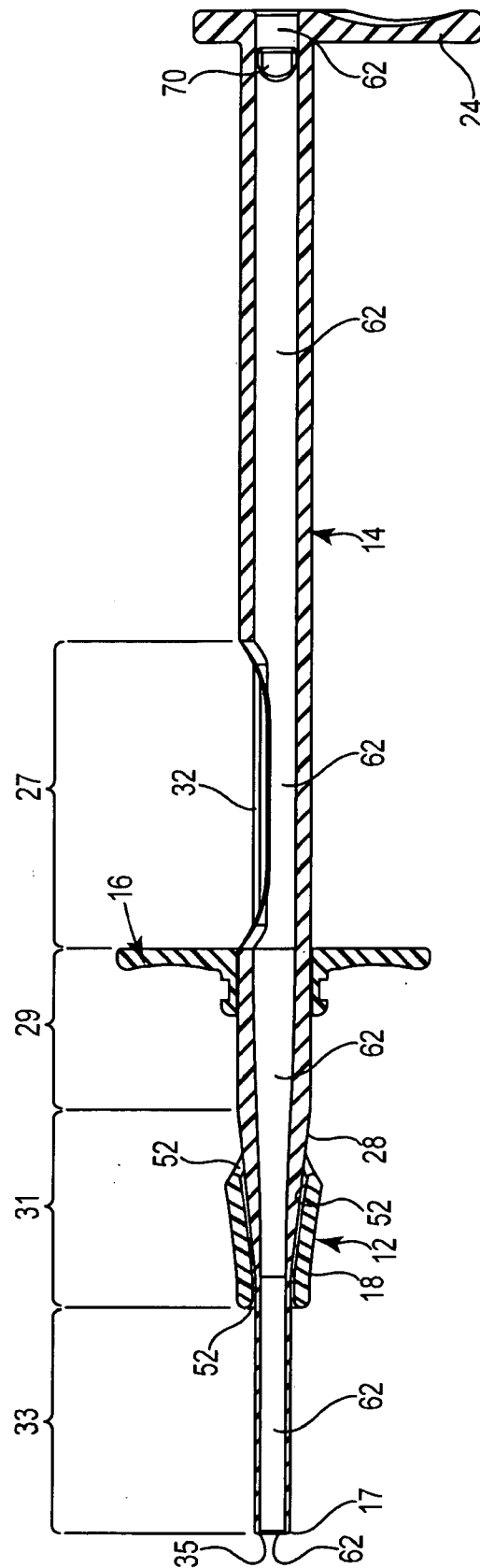


Fig. 4A

Fig. 4

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Fi. 5

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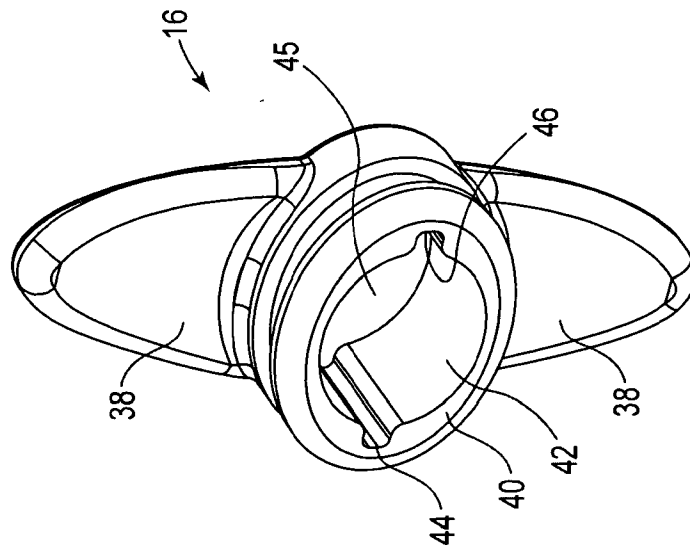


Fig. 6

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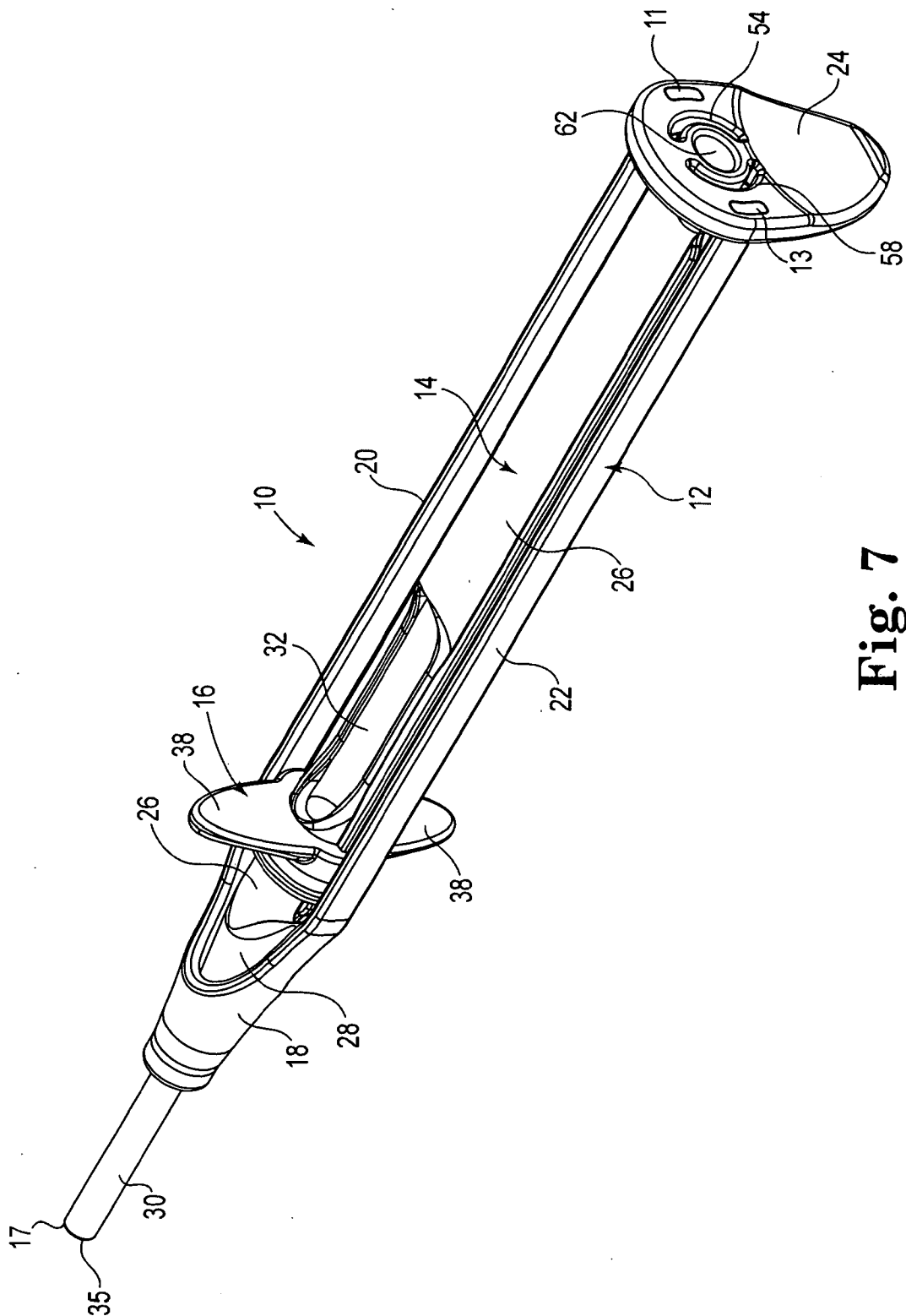


Fig. 7

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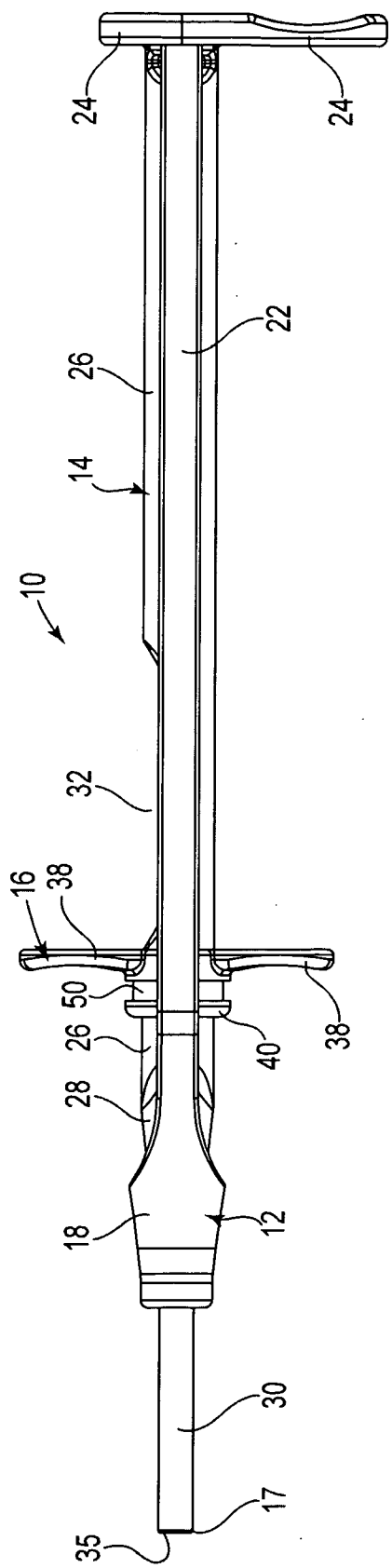


Fig. 8

9/1 5

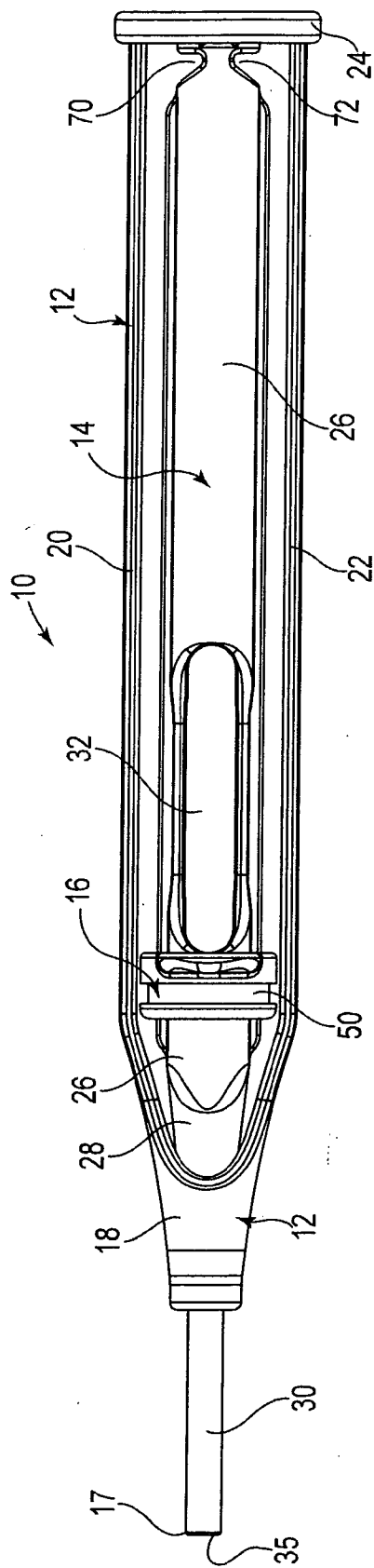


Fig. 9

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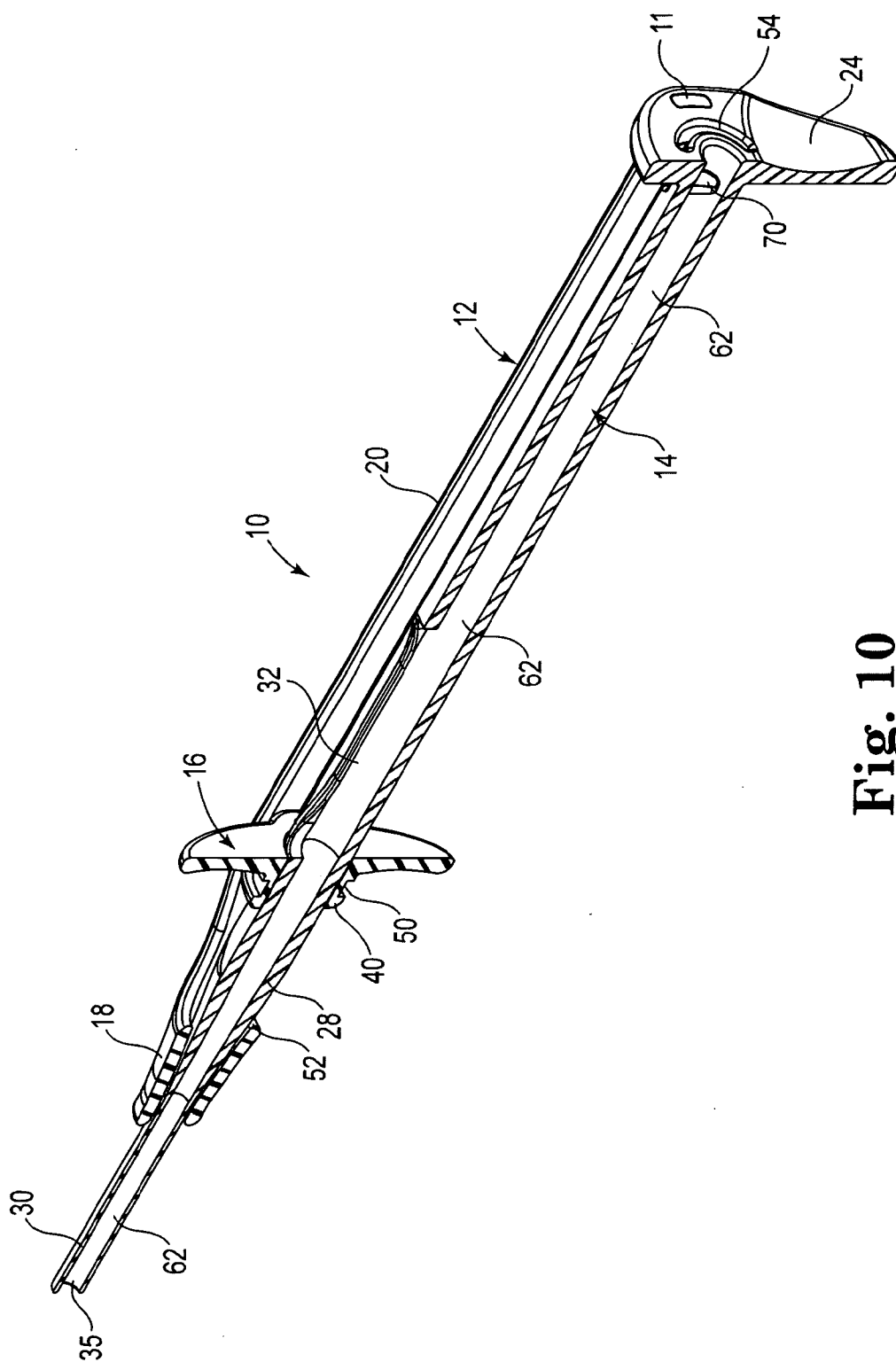


Fig. 10

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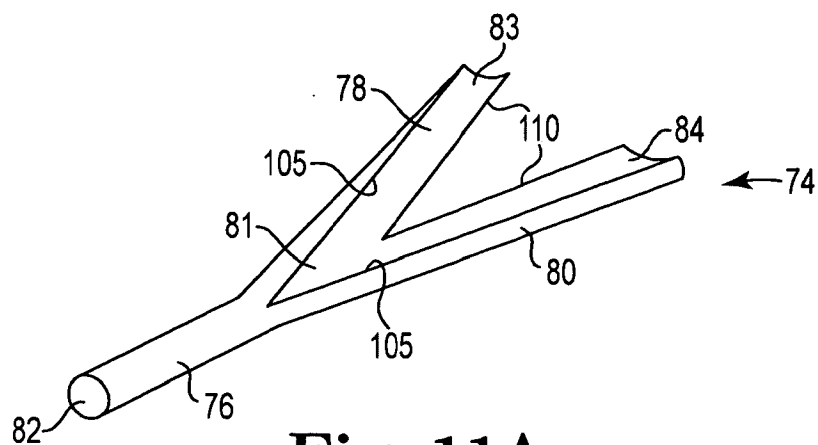


Fig. 11A

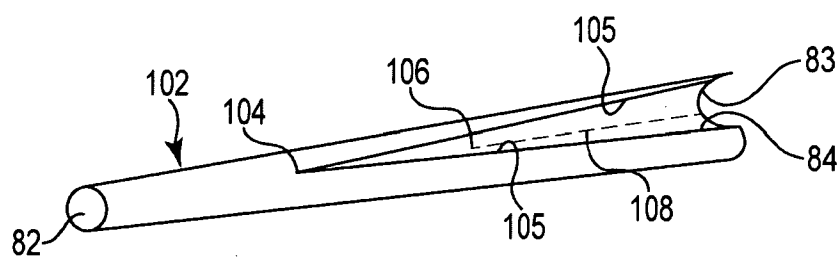


Fig. 11B

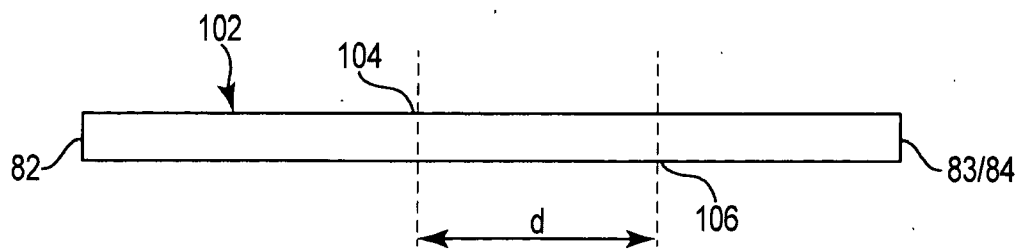


Fig. 11C

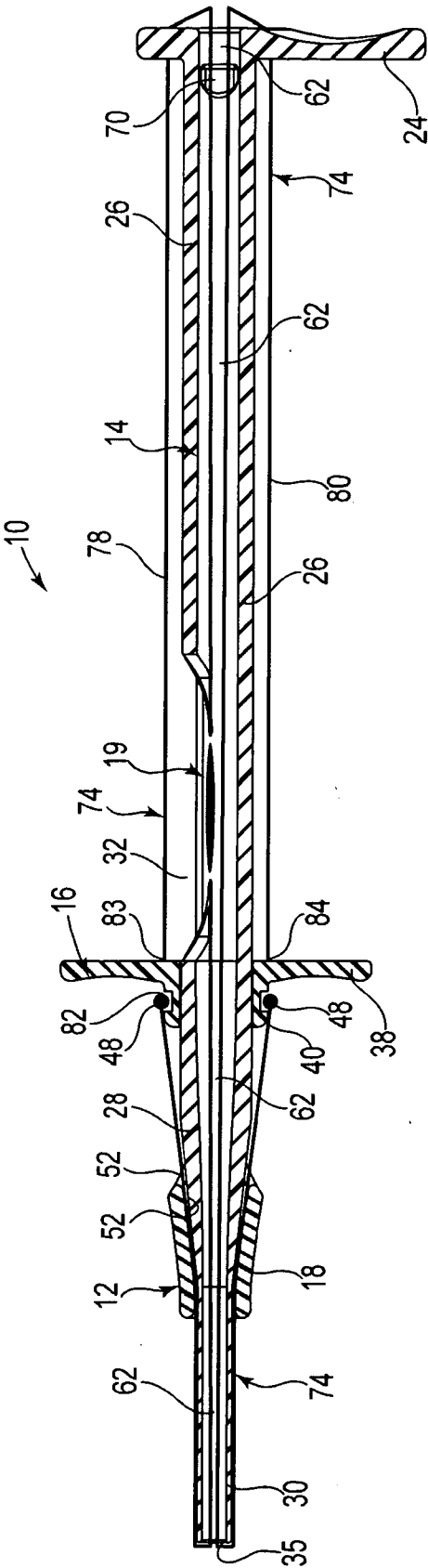


Fig. 12

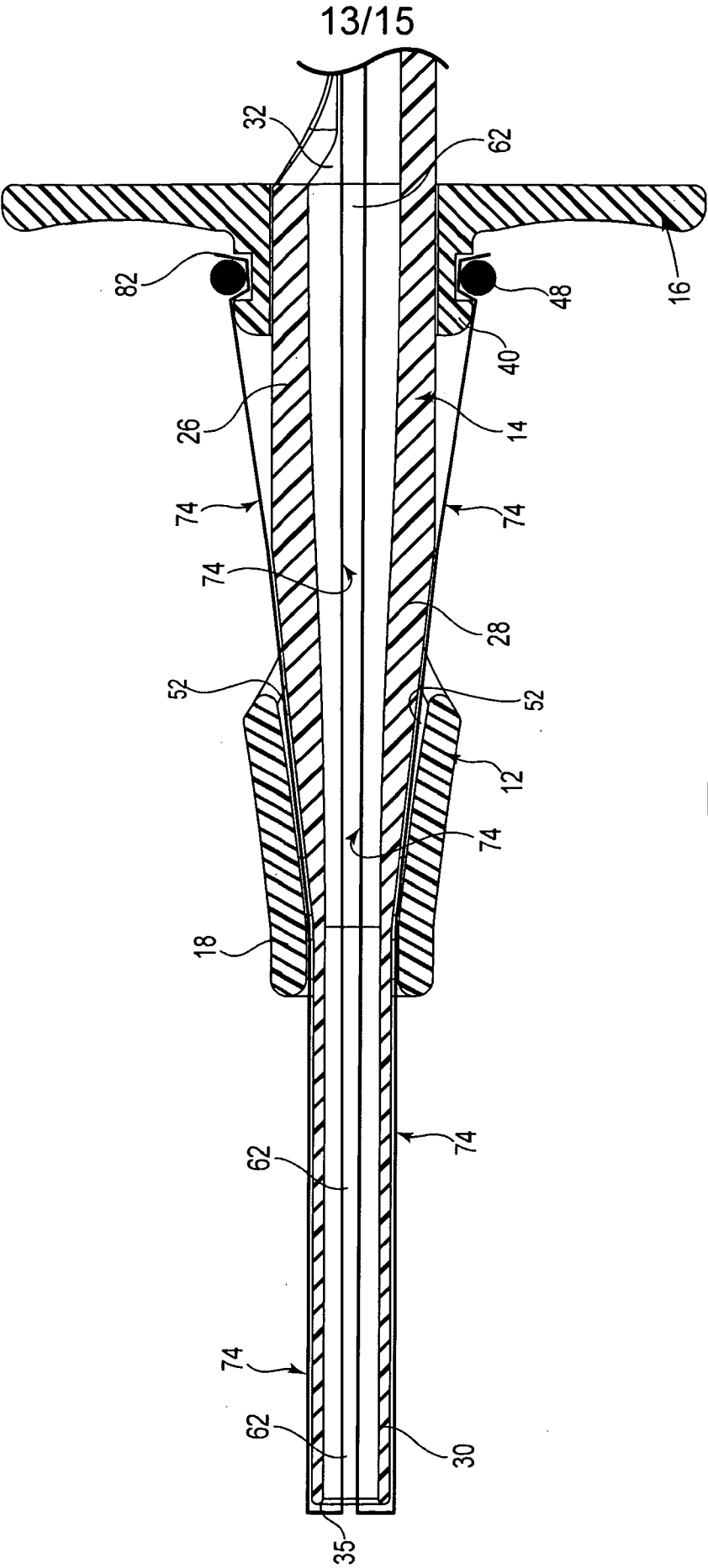


Fig. 13

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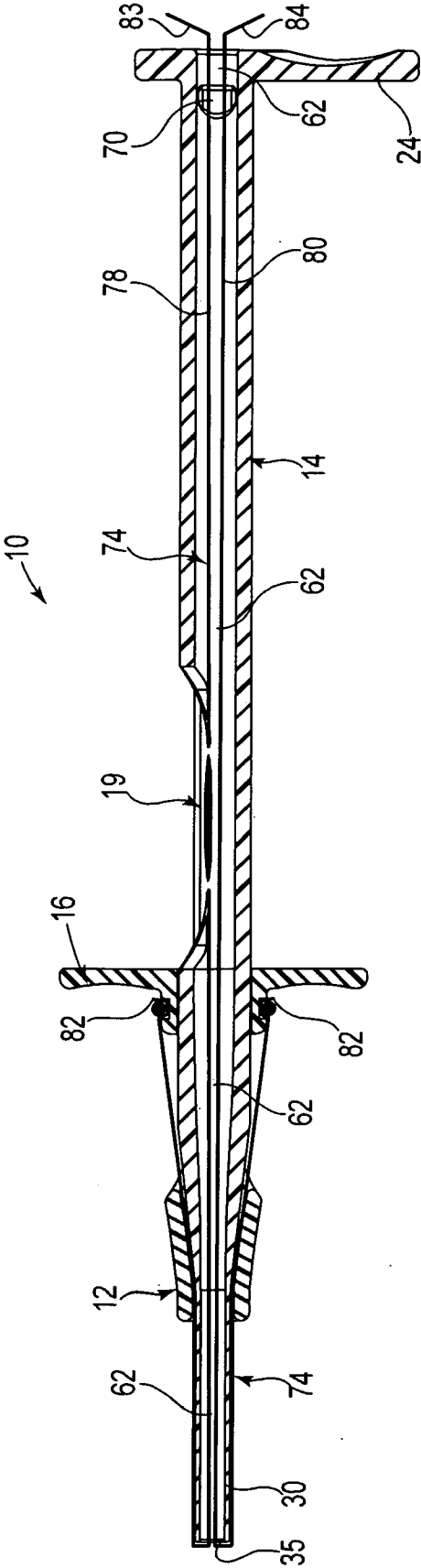


Fig. 14

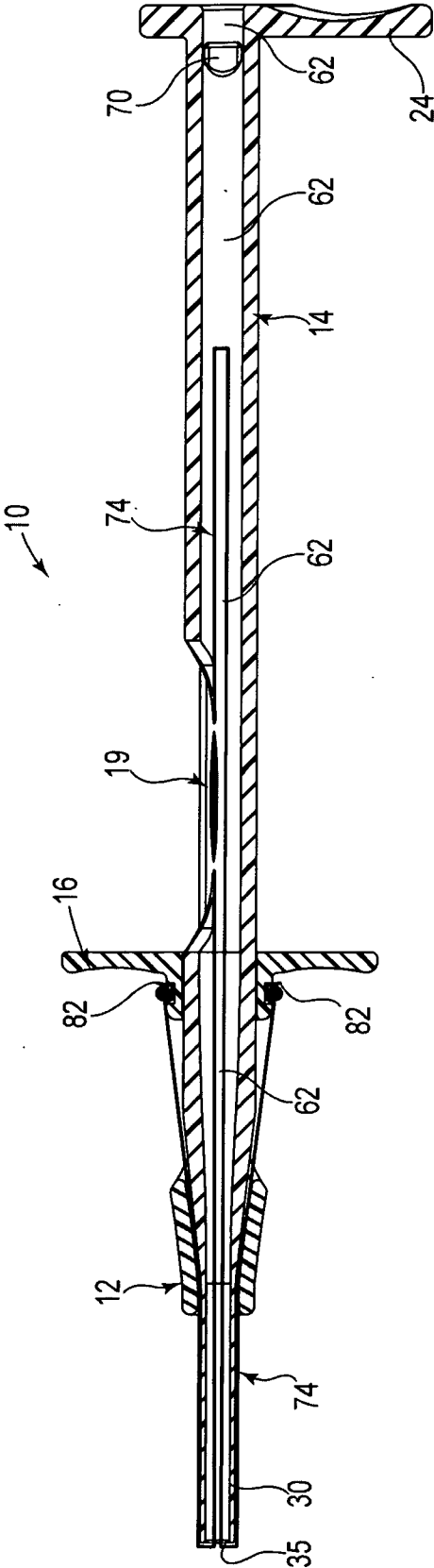


Fig. 15

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2012/037436

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A61F 9/007 (2012.01)

USPC - 606/107

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - A61F 9/00, 9/007 (2012.01)

USPC - 606/107; 623/1.11, 6.12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatBase, Google Patents

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009/0030425 A1 (SMILEY et al) 29 January 2009 (29.01.2009) entire document	18, 23-25
Y		1-3, 9-11
Y	US 2004/0243141 A1 (BROWN et al) 02 December 2004 (02.12.2004) entire document	1-3, 9-11, 15
Y	US 2010/0106160 A1 (TSAI) 29 April 2010 (29.04.2010) entire document	3, 9-11
Y	US 2010/0168834 A1 (RYAN et al) 01 July 2010 (01.07.2010) entire document	15
A	US 2008/0221584 A1 (DOWNER) 11 September 2008 (11.09.2008) entire document	1-3, 9-11, 15-25
A	US 7,935,141 B2 (RANDALL et al) 03 May 2011 (03.05.2011) entire document	1-3, 9-11, 15-25
	"	

☐ Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

08 August 2012

Date of mailing of the international search report

27 AUG 2012

Name and mailing address of the ISA/US

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Blaine R. Copenheaver

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2012/037436

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☒ Claims Nos.: 4-8, 12-14
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.