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(54) Title: CONNECTOR SYSTEM FOR RELEASABLY CONNECTING FLUID CONDUITS

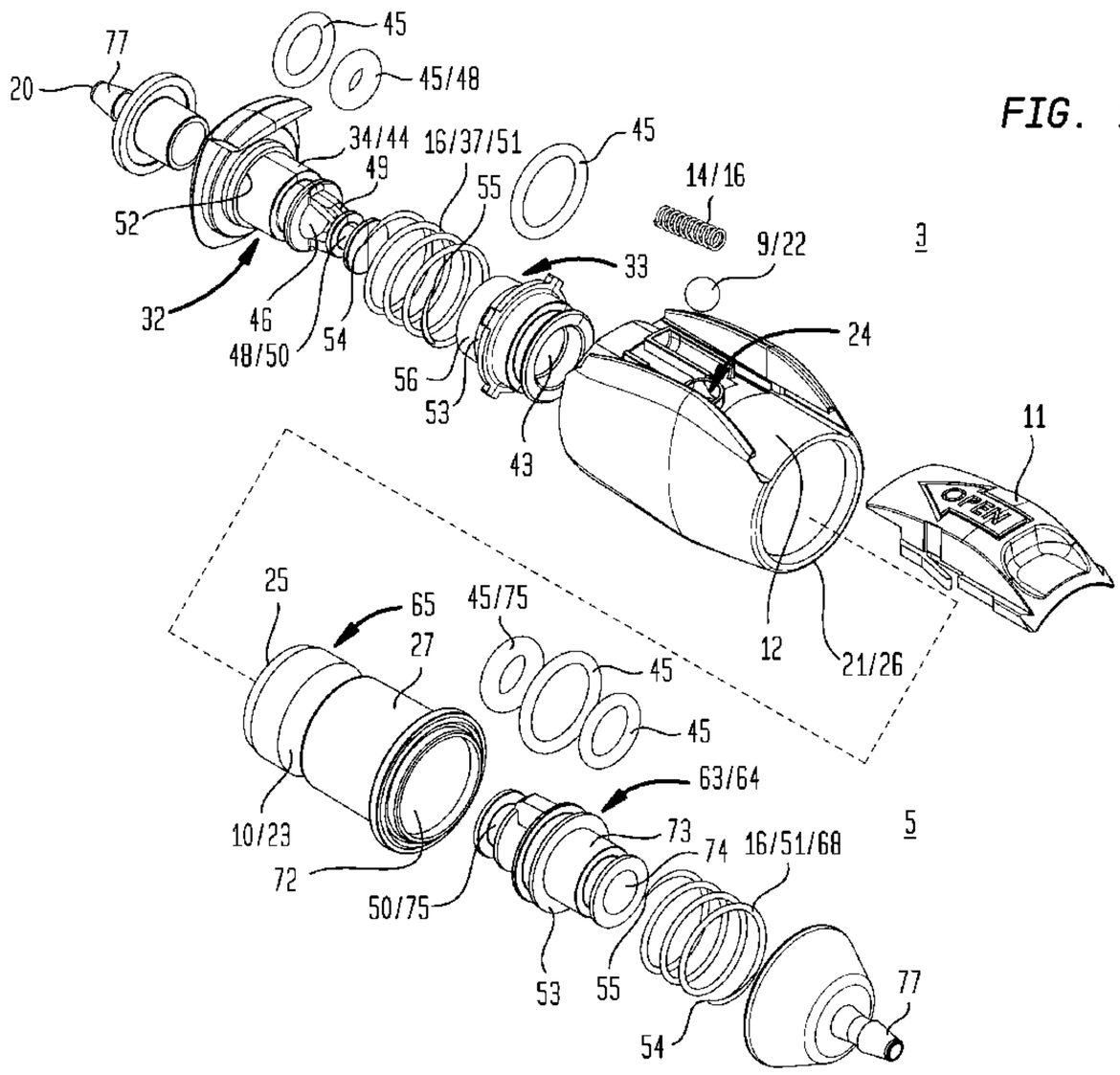

FIG. 1B

(57) Abrégé/Abstract:
Disclosed herein are embodiments of a connector system for releasably connecting together tubes, for example medical tubing, and methods of making and using such a connector system, whereby the connector system includes a female coupler having a first passageway, a male coupler having a second passageway, a catch movably coupled to the female coupler, and a catch-receiving element coupled to the male coupler. The connector system further includes a release element movably coupled to the female coupler, whereby travel of the release element along or over a female coupler outer surface of the female coupler disengages the catch from the catch-receiving element to achieve a disconnected condition of the connector system. Further disclosed herein are embodiments of a connector system for releasably connecting together tubes, whereby the connector system includes at least one valve biased by a valve-biasing member disposed external to or outside of the fluid flow path.

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[Continued on next page]

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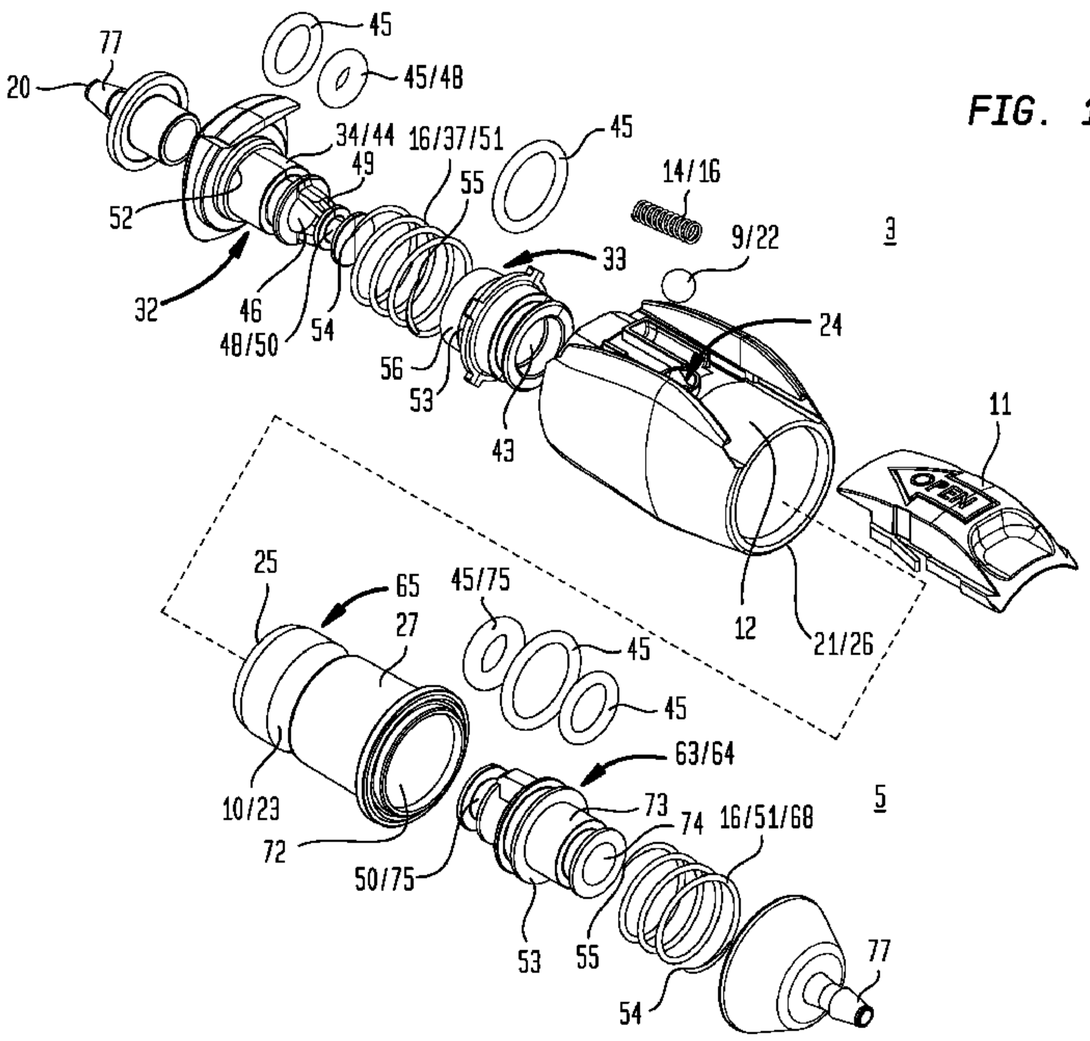

FIG. 1B

(57) Abstract: Disclosed herein are embodiments of a connector system for releasably connecting together tubes, for example medical tubing, and methods of making and using such a connector system, whereby the connector system includes a female coupler having a first passageway, a male coupler having a second passageway, a catch movably coupled to the female coupler, and a catch-receiving element coupled to the male coupler. The connector system further includes a release element movably coupled to the female coupler, whereby travel of the release element along or over a female coupler outer surface of the female coupler disengages the catch from the catch-receiving element to achieve a disconnected condition of the connector system. Further disclosed herein are embodiments of a connector system for releasably connecting together tubes, whereby the connector system includes at least one valve biased by a valve-biasing member disposed external to or outside of the fluid flow path.

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CONNECTOR SYSTEM FOR RELEASABLY CONNECTING FLUID CONDUITS

This International Patent Cooperation Treaty Patent Application is a continuation of United States Non-Provisional Patent Application No. 15/410,636, filed January 19, 2017, which claims the benefit of United States Provisional Patent Application No. 62/299,499, filed February 24, 2016, and United States Provisional Patent Application No. 62/280,354, filed January 19, 2016, each hereby incorporated by reference herein.

I. DISCLOSURE OF THE INVENTION

A broad object of a particular embodiment of the invention can be to provide a connector system for releasably connecting together tubes, for example medical tubing, and methods of making and using such a connector system, whereby the connector system includes a female coupler having a first passageway, a male coupler having a second passageway, a catch movably coupled to the female coupler, and a catch-receiving element coupled to the male coupler. Upon releasable matable axial coupling of the female and male couplers, the catch engages with the catch-receiving element to fix an axial position of the female coupler in relation to the male coupler, thereby achieving a connected condition of the connector system in which the first and second passageways dispose in fluidic communication to provide a fluid flow path. The connector system further includes a release element movably coupled to the female coupler, whereby travel of the release element along or over a female coupler outer surface of the female coupler disengages the catch from the catch-receiving element to achieve a disconnected condition of the connector system.

Another broad object of a particular embodiment of the invention can be to provide the connector system as described above, further including at least one valve operable to interrupt fluid flow through a passageway, whereby the valve is biased by a valve-biasing member disposed external to or outside of the passageway and accordingly, external to or outside of the fluid flow path when the female and male couplers releasably matably couple to achieve the connected condition of the connector system.

Naturally, further objects of the invention are disclosed throughout other areas of the specification, drawings, and claims.

II. BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1A is an illustration of a method of using a particular embodiment of the connector system.

Figure 1B is an exploded perspective view of the particular embodiment of the connector system shown in Figure 1A and Figure 2A through Figure 4G.

Figure 2A is a perspective view of a particular embodiment of the connector system, whereby first and male couplers are releasably matably engaged.

Figure 2B is a side view of the particular embodiment of the connector system shown in Figure 2A.

Figure 2C is a top view of the particular embodiment of the connector system shown in Figure 2A.

Figure 2D is a bottom view of the particular embodiment of the connector system shown in Figure 2A.

Figure 2E is a first end view of the particular embodiment of the connector system shown in Figure 2A.

Figure 2F is a second end view of the particular embodiment of the connector system shown in Figure 2A.

Figure 2G is a cross-sectional view of the particular embodiment of the connector system shown in Figure 2E, whereby first and male couplers are releasably matably engaged.

Figure 2H is a cross-sectional view of the particular embodiment of the connector system shown in Figure 2E, whereby first and male couplers are in adjacent axial relation but are not releasably matably engaged.

Figure 3A is a perspective view of a particular embodiment of a female coupler of the connector system.

Figure 3B is a side view of the female coupler of the connector system shown in Figure 3A.

Figure 3C is a top view of the female coupler of the connector system shown in Figure 3A.

Figure 3D is a bottom view of the female coupler of the connector system shown in Figure 3A.

Figure 3E is a first end view of the female coupler of the connector system shown in Figure 3A.

Figure 3F is a second end view of the female coupler of the connector system shown in Figure 3A.

Figure 3G is a cross-sectional view of the female coupler of the connector system shown in Figure 3E.

Figure 3H is a cross-sectional view of the female coupler of the connector system shown in Figure 3B.

Figure 3I is a cross-sectional view of the female coupler of the connector system shown in Figure 3H.

Figure 4A is a perspective view of a particular embodiment of a male coupler of the connector system.

Figure 4B is a side view of the male coupler of the connector system shown in Figure 4A.

Figure 4C is a top view of the male coupler of the connector system shown in Figure 4A.

Figure 4D is a bottom view of the male coupler of the connector system shown in Figure 4A.

Figure 4E is a first end view of the male coupler of the connector system shown in Figure 4A.

Figure 4F is a second end view of the male coupler of the connector system shown in Figure 4A.

Figure 4G is a cross-sectional view of the male coupler of the connector system shown in Figure 4E.

Figure 5A is a perspective view of a particular embodiment of the connector system, whereby first and male couplers are releasably matably engaged.

Figure 5B is a side view of the particular embodiment of the connector system shown in Figure 5A.

Figure 5C is a top view of the particular embodiment of the connector system shown in Figure 5A.

Figure 5D is a bottom view of the particular embodiment of the connector system shown in Figure 5A.

Figure 5E is a first end view of the particular embodiment of the connector system shown in Figure 5A.

Figure 5F is a second end view of the particular embodiment of the connector system shown in Figure 5A.

Figure 5G is a cross-sectional view of the particular embodiment of the connector system shown in Figure 5C, whereby first and male couplers are releasably matably engaged.

Figure 5H is a cross-sectional view of the particular embodiment of the connector system shown in Figure 5C, whereby first and male couplers are in adjacent axial relation but are not releasably matably engaged.

Figure 6A is a perspective view of a particular embodiment of a female coupler of the connector system.

Figure 6B is a side view of the female coupler of the connector system shown in Figure 6A.

Figure 6C is a top view of the female coupler of the connector system shown in Figure 6A.

Figure 6D is a bottom view of the female coupler of the connector system shown in Figure 6A.

Figure 6E is a first end view of the female coupler of the connector system shown in Figure 6A.

Figure 6F is a second end view of the female coupler of the connector system shown in Figure 6A.

Figure 6G is a cross-sectional view of the female coupler of the connector system shown in Figure 6C.

Figure 7A is a perspective view of a particular embodiment of a male coupler of the connector system.

Figure 7B is a side view of the male coupler of the connector system shown in Figure 7A.

Figure 7C is a top view of the male coupler of the connector system shown in Figure 7A.

Figure 7D is a bottom view of the male coupler of the connector system shown in Figure 7A.

Figure 7E is a first end view of the male coupler of the connector system shown in Figure 7A.

Figure 7F is a second end view of the male coupler of the connector system shown in Figure 7A.

Figure 7G is a cross-sectional view of the male coupler of the connector system shown in Figure 7C.

Figure 8A is a perspective view of a release element of the connector system, whereby the release element is depicted as a pair of arrows to illustrate travel of the release element along or over a female coupler outer surface which can be achieved by the application of forces directed along or over the female coupler outer surface.

Figure 8B is a side view of the release element of the connector system shown in Figure 8A.

Figure 8C is a first end view of the release element of the connector system shown in Figure 8A.

Figure 8D is a second end view of the release element of the connector system shown in Figure 8A.

Figure 9A is a perspective view of a release element of the connector system, whereby the release element is depicted as an arrow to illustrate circumferential travel of the release element about a female coupler outer surface which can be achieved by the application of forces directed circumferentially along or over the female coupler outer surface.

Figure 9B is a side view of the release element of the connector system shown in Figure 9A.

Figure 9C is a first end view of the release element of the connector system shown in Figure 9A.

Figure 9D is a second end view of the release element of the connector system shown in Figure 9A.

Figure 10A is a perspective view of a release element of the connector system, whereby the release element is depicted as an arrow to illustrate circumferential travel of the release element about a female coupler outer surface which can be achieved by the application of forces directed circumferentially along or over the female coupler outer surface.

Figure 10B is a cross sectional view of the release element of the connector system shown in Figure 10A, whereby a catch disposes in an opening first portion defined by a release element inner surface first portion to provide a release element first position.

Figure 11A is a perspective view of a release element of the connector system, whereby the release element is depicted as an arrow to illustrate circumferential travel of the release element about a female coupler outer surface which can be achieved by the application of forces directed circumferentially along or over the female coupler outer surface.

Figure 11B is a cross sectional view of the release element of the connector system shown in Figure 11A, whereby a catch disposes in an opening second portion defined by a release element inner surface second portion to provide a release element second position.

Figure 12A is a perspective view of a release element of the connector system, whereby the release element is depicted as an arrow to illustrate helical travel of the release element about a female coupler outer surface which can be achieved by the application of forces directed helically along or over the female coupler outer surface.

Figure 12B is a side view of the release element of the connector system shown in Figure 12A.

Figure 12C is a first end view of the release element of the connector system shown in Figure 12A.

Figure 12D is a second end view of the release element of the connector system shown in Figure 12A.

Figure 13A is a perspective view of a particular embodiment of a valve-biasing member configured as a resiliently flexible member disposed in axially-adjacent relation to an angled surface, whereby the resiliently flexible member is in a non-flexed condition.

Figure 13B is a side view of the particular embodiment of the valve-biasing member shown in Figure 13A.

Figure 13C is a top view of the particular embodiment of the valve-biasing member shown in Figure 13A.

Figure 13D is a bottom view of the particular embodiment of the valve-biasing member shown in Figure 13A.

Figure 13E is a first end view of the particular embodiment of the valve-biasing member shown in Figure 13A.

Figure 13F is a second end view of the particular embodiment of the valve-biasing member shown in Figure 13A.

Figure 13G is a cross-sectional view of the particular embodiment of the valve-biasing member shown in Figure 13E.

Figure 14A is a perspective view of a particular embodiment of a valve-biasing member configured as a resiliently flexible member disposed in axially-adjacent relation to an angled surface, whereby the resiliently flexible member is in a flexed condition.

Figure 14B is a side view of the particular embodiment of the valve-biasing member shown in Figure 14A.

Figure 14C is a top view of the particular embodiment of the valve-biasing member shown in Figure 14A.

Figure 14D is a bottom view of the particular embodiment of the valve-biasing member shown in Figure 14A.

Figure 14E is a first end view of the particular embodiment of the valve-biasing member shown in Figure 14A.

Figure 14F is a second end view of the particular embodiment of the valve-biasing member shown in Figure 14A.

Figure 14G is a cross-sectional view of the particular embodiment of the valve-biasing member shown in Figure 14E.

Figure 15A is a perspective view of a particular embodiment of the connector system including a J-loop coupled to a connector system first end, whereby first and male couplers of the connector system are releasably matably engaged.

Figure 15B is a perspective view of the particular embodiment of the connector system shown in Figure 15A, but whereby the first and male couplers are in adjacent axial relation but are not releasably matably engaged.

III. MODE(S) FOR CARRYING OUT THE INVENTION

Now referring primarily to Figure 1A, which illustrates a method of using a particular embodiment of a connector system (1) for releasably connecting together tubes (2), such as medical tubing employed in a bio-medical environment. Advantageously, the connector system (1) can be relatively easily and securely connected, and yet relatively easily intentionally disconnected.

Now referring primarily to Figure 1B through Figure 7F, the connector system (1) includes a female coupler (3) having a first passageway (4) and a male coupler (5) having a second passageway (6). Upon releasable matable axial (or longitudinal) coupling of the female and male couplers (3)(5) (or, stated more concisely, upon connection of the female and male couplers (3)(5)), a connected condition (7) of the connector system (1) is achieved, disposing the first and second passageways (4)(6) in fluidic communication to provide a fluid flow path (8).

For the purposes of the present invention, a longitudinal direction can considered parallel to the first passageway (4), the second passageway (6), and/or the fluid flow path (8).

As to particular embodiments, the connector system (1) can further include a catch (9) movably coupled to the female coupler (3) and a catch-receiving element (10) coupled to the male coupler (5). Upon connection of the female and male couplers (3)(5), the catch (9) engages with the catch-receiving element (10) to fix an axial position of the female coupler (3) in relation to the male coupler (5), thereby achieving the connected condition (7) of the connector system (1).

As to particular embodiments, the connector system (1) can further include a release element (11) movably coupled to the female coupler (3), whereby travel of the release element (11) along or over a female coupler outer surface (12) of the female coupler (3) disengages the catch (9) from the catch-receiving element (10) to achieve a disconnected condition (13) of the connector system (1).

For the purposes of the present invention, the term "catch" means a restraint which, upon matable engagement with a catch-receiving element (10), can function to partially or completely restrain travel of an associated component, such as a female coupler (3).

For the purposes of the present invention, the term "catch-receiving element" means a restraint which, upon matable engagement with a catch (9), can function to partially or completely restrain travel of an associated component, such as a male coupler (5).

As to particular embodiments, the connector system (1) can be configured to provide a connection indicium upon successful releasable matable axial coupling of the female and male couplers (3)(5) to achieve the connected condition (7), whereby the connection indicium can be a visible indicium, an audible indicium, a tactile indicium, or the like, or combinations thereof.

Release Element

Now referring primarily to Figure 2G, Figure 2H, and Figure 3G through Figure 3I, as to particular embodiments, the release element (11) can be configured as a cam and the catch (9) can function as a follower, whereby the release element (11) can transform input motion into reciprocating motion of the catch (9).

For the purposes of the present invention, the term "cam" means a movable element in a mechanical linkage, whereby the cam can have an irregular periphery and may be useful in transforming motion, for example transforming motion in a first direction into motion in a second direction.

For the purposes of the present invention, the term "follower" means a movable element in a mechanical linkage, whereby movement of the follower results from movement of the cam.

For example, linear or sliding motion of the release element (11) along the female coupler outer surface (12) can be transformed into inward or outward motion of the catch (9) such that the catch (9) can move either inwardly toward the interior of the female coupler (3) or outwardly away from the interior of the female coupler (3).

The release element (11) can be biased by a release element-biasing member (14) which biases the release element (11) toward a release element first position (15), as shown in the examples of Figure 2G and Figure 3G through Figure 3I.

As to particular embodiments, when in the release element first position (15), the release element (11) can bias the catch (9) inwardly toward the interior of the female coupler (3) to engage the catch (9) with the catch-receiving element (10) and achieve the connected condition (7) of the connector system (1).

As but one illustrative example, the release element-biasing member (14) can be configured as a resiliently compressible member (16), such as a spring (for example, a coil spring), whereby when the resiliently compressible member (16) disposes in a non-compressed condition (17), which is the normal biased condition, the release element (11) disposes in the release element first position (15). However, the release element-biasing member (14) need not be limited to this particular configuration.

Now referring primarily to Figure 2H, upon forcible urging, the resiliently compressible member (16) can be compressed toward a compressed condition (18), disposing the release element (11) in a release element second position (19), allowing the catch (9) to outwardly move away from the interior of the female coupler (3) and disengage with the catch-receiving element (10) to achieve the disconnected condition (13) of the connector system (1).

Travel of the release element (11) along or over the female coupler outer surface (12) can be achieved by the application of forces directed along or over the female coupler outer surface (12), such as forces directed at an angle of between 0° to about ±45° in relation to the female coupler outer surface (12). This is in stark contrast to conventional "quick release" couplers which typically have a release element configured to travel upon the application of forces directed along an axis generally normal (or generally perpendicular) to the coupler outer surface, whereby one illustrative example of this type of release element is a pushbutton release element or a depressible release element. The instant release element (11) is advantageous over the conventional art, as only forces directed at an angle of between 0° to about ±45° in relation to the female coupler outer surface (12) can disengage the catch (9) from within the catch-receiving element (10) to achieve the disconnected condition (13) of the connector system (1), thus precluding inadvertent disconnecting by forces unintentionally applied at an angle of between about ± 45° to about 90° in relation to the female coupler outer surface (12).

Now referring primarily to Figure 2A through Figure 3I and Figure 8A through Figure 8D, as to particular embodiments, travel of the release element (11), which can forcibly urge the resiliently compressible member (16) toward the compressed condition (18), can be longitudinal travel along the female coupler outer surface (12). As but one illustrative example, the longitudinal travel can be between female coupler first and second ends (20)(21).

As to particular embodiments, the longitudinal travel can be sliding travel along the female coupler outer surface (12). Further, as to particular embodiments, the longitudinal travel can be linear or generally parallel to the female coupler outer surface (12), having an angle of about 0° in relation to the female coupler outer surface (12).

Now referring primarily to Figure 9A through Figure 12D, as to other particular embodiments, travel of the release element (11), which can forcibly urge a resiliently compressible member (16) toward a compressed condition (18), can be circumferential travel about the female coupler outer surface (12).

As to particular embodiments, the circumferential travel can be rotating travel about the female coupler outer surface (12), whereby the circumferential travel can be any amount of travel about the circumference of the female coupler outer surface (12), whether partially or completely about the circumference of the female coupler outer surface (12). Further, as to particular embodiments, the circumferential travel can be generally parallel to the female coupler outer surface (12).

Now referring primarily to Figure 12A through Figure 12D, as to particular embodiments, the circumferential travel can be helical travel about the female coupler outer surface (12).

Embodiment of Catch and Catch-Receiving Element

Now referring primarily to Figure 2G, Figure 2H, Figure 3G, Figure 3H, and Figure 4G, as to particular embodiments, the catch (9) can be configured a spherical element, such as a ball (22), and the catch-receiving element (10) can be configured as a retention groove (23) configured to receive a portion or an entirety of the ball (22). However, the catch (9) and catch-receiving element (10) need not be limited to these particular configurations and can be configured as any matable catch (9) and catch-receiving element (10) as would be known to one of ordinary skill in the art.

The ball (22) can be movably coupled to the female coupler (3) proximate the female coupler outer surface (12). For example, the ball (22) can be movably disposed within an opening (24) defined by the female coupler outer surface (12) (as shown in the example of Figure 1B), whereby the opening (24) can be sufficiently configured to allow movement of the ball (22) through the opening (24) and inwardly toward the interior of the female coupler (3) or outwardly away from the interior of the female coupler (3). Further, the ball (22) can be movably coupled to the female coupler (3) beneath the release element (11).

The retention groove (23) can be coupled to the male coupler (5) proximate a male coupler matable end (25) which is matably received within a female coupler matable end (26) upon releasable matable axial coupling of the female and male couplers (3)(5) to provide the connected condition (7) of the connector system (1). For example, the retention groove (23) can be disposed within a male coupler outer surface (27) proximate the male coupler matable end (25).

Just as engagement of the catch (9) with the catch-receiving element (10) can fix an axial position of the female coupler (3) in relation to the male coupler (5), receipt of the ball (22) within the retention groove (23) correspondingly fixes an axial position of the female coupler (3) in relation to the male coupler (5) to achieve the connected condition (7) of the connector system (1).

Inward movement of the ball (22) can facilitate engagement of the ball (22) within the retention groove (23) upon matable reception of the male coupler matable end (25) within the female coupler matable end (26).

Conversely, outward movement of the ball (22) can facilitate disengagement of the ball (22) from within the retention groove (23), thereby allowing the female and male couplers (3)(5) to disconnect by axial movement away from one another.

Movement of the ball (22) inward and outward and correspondingly, into and out of the retention groove (23), can be controlled, at least in part, by the release element (11), whereby the release element (11) can function as a cam and the ball (22) can function as a follower (as generally described above). Accordingly, linear or sliding motion of the release element (11) along the female coupler outer surface (12) can be transformed into inward or outward movement of the ball (9), causing the ball (9) to move either inwardly toward the retention groove (23) or outwardly away from the retention groove (23).

Now referring primarily to Figure 2G, Figure 2H, and Figure 3G, a release element inner surface (28), which disposes proximate (or adjacent) the female coupler outer surface (12), can provide a cam surface (29) having a ball locking surface (30) and a ball unlocking surface (31).

The ball locking surface (30) downwardly extends toward the female coupler outer surface (12) a greater distance than the ball unlocking surface (31), thereby disposing the ball locking surface (30) closer to the female coupler outer surface (12) than the ball unlocking surface (31). Said another way, the ball unlocking surface (31) upwardly extends away from the female coupler outer surface (12) a greater distance than the ball locking surface (30), thereby disposing the ball unlocking surface (31) farther from the female coupler outer surface (12) than the ball locking surface (30).

Correspondingly, movement of the cam surface (29) over the ball (22) to align (or contact) the ball locking surface (30) with the ball (22) biases the ball (22) inwardly and toward engagement within the retention groove (23) to achieve the connected condition (7) of the connector system (1). Conversely, movement of the cam surface (29) over the ball (22) to align (or contact) the ball unlocking surface (31) with the ball (22) permits the ball (22) to outwardly move away from the retention groove (23), thereby allowing the ball (22) to disengage from within the retention groove (23).

Now referring primarily to Figure 2G and Figure 3G through Figure 3I, the release element-biasing member (14), for example a resiliently compressible member (16), can bias the release element (11) toward a release element first position (15) when in a non-compressed condition (17). When in the release element first position (15), the ball locking surface (30) aligns with (or contacts) the ball (22) and correspondingly biases the ball (22) inwardly and toward engagement within the retention groove (23) to achieve the connected condition (7) of the connector system (1).

Now referring primarily to Figure 2H, upon forcible urging, the resiliently compressible member (16) can be compressed toward a compressed condition (18), disposing the release element (11) in a release element second position (19) in which the ball unlocking surface (31) aligns with (or contacts) the ball (22), allowing the ball (22) to outwardly move away from the retention groove (23) to achieve the disconnected condition (13) of the connector system (1).

First Valve

As to particular embodiments, the connector system (1) can further include at least one conduit and at least one valve operable to interrupt fluid flow through the conduit.

Now referring primarily to Figure 2G, Figure 2H, Figure 3G, Figure 3I, Figure 5G, Figure 5H, and Figure 6G, the female coupler (3) can include a first conduit (32) defining a first passageway (4) (which as to particular embodiments, may include a fixed or removable filter) and a first valve (33) operable to interrupt fluid flow through the first passageway (4). The first valve (33) can be movable within a first valve seat (34) to sealably occlude a first port (35) in fluid communication with the first passageway (4), thereby providing a first passageway closed condition (36) in which fluid flow through the first port (35) and accordingly, through the first passageway (4), is interrupted.

The first valve (33) can be biased by a first valve-biasing member (37) which biases the first valve (33) toward a first valve closed position (38) in which the first valve (33) sealably occludes the first port (35), for example by sealably overlaying the first port (35), to provide the first passageway closed condition (36).

Now referring primarily to Figure 2G, Figure 2H, Figure 3G, and Figure 3I, as but one illustrative example, the first valve-biasing member (37) can be configured as a resiliently compressible member (16), such as a spring; however, the first valve-biasing member (37) need not be limited to this particular configuration.

When in a non-compressed condition (17), which is the normal biased condition, the resiliently compressible member (16) can bias the first valve (33) toward the first valve closed position (38) in which the first valve (33) sealably occludes the first port (35) to provide the first passageway closed condition (36) (as shown in the examples of Figure 2H, Figure 3G, and Figure 3I).

Upon forcible urging, the resiliently compressible member (16) can be compressed toward a compressed condition (18), allowing the first valve (33) to travel within the first valve seat (34) away from the first port (35) toward a first valve open position (39), thus providing a first passageway open condition (40) permitting fluid flow through the first port (35) and accordingly, through the first passageway (4) (as shown in the example of Figure 2G).

Now referring primarily to Figure 2G, the resiliently compressible member (16) can be compressed toward the compressed condition (18) upon forcible urging resulting from connection of the female and male couplers (3)(5), thus allowing the first valve (33) to travel within the first

valve seat (34) away from the first port (35) toward the first valve open position (39), thus providing the first passageway open condition (40) which permits fluid flow through the first port (35) and accordingly, through the first passageway (4). Further, upon achievement of the connected condition (7) of the connector system (1), the first passageway (4) can fluidicly communicate with the second passageway (6) of the male coupler (5) to provide the fluid flow path (8) through which fluid can flow between connector system first and second ends (41)(42).

In contrast to conventional "quick release" couplers, the instant first valve-biasing member (37) is disposed external to or outside of the first passageway (4) and accordingly, external to or outside of the fluid flow path (8) when the female and male couplers (3)(5) connect to achieve the connected condition (7) of the connector system (1). Correspondingly, fluid flowing within the fluid flow path (8) does not contact the resiliently compressible member (16), which may be advantageous for a plurality of reasons, including elimination of a potential substrate for biofilm growth within the fluid flow path (8) and elimination of a physical impediment to fluid flow within the fluid flow path (8).

Now referring primarily to Figure 2G, Figure 2H, Figure 3G, and Figure 3I, as a first illustrative example, the first valve (33) can be configured to telescopingly engage with the first conduit (32) such that the first valve (33) telescopingly disposes about the first conduit (32) and can longitudinally travel over the first conduit (32) or longitudinally slide over the first conduit (32).

With this configuration, a first valve inner surface (43) of the first valve (33) can dispose adjacent a first conduit outer surface (44) of the first conduit (32), whereby a fluid-tight seal can exist between the first valve inner surface (43) and the first conduit outer surface (44). As to particular embodiments, an o-ring (45) can be coupled to the first conduit outer surface (44), for example the o-ring (45) can be at least partially recessed within the first conduit outer surface (44), whereby when overlaid by the first valve inner surface (43), the o-ring (45) can function to provide the fluid-tight seal between the first valve inner surface (43) and the first conduit outer surface (44).

The first valve (33) can either partially or entirely surround a portion of the first conduit (32) proximate (or adjacent) the first port (35), depending upon the configuration of the first conduit (32) and the first port (35). As shown in the particular embodiment illustrated in Figure 2G, Figure 2H, Figure 3G, and Figure 3I, the first valve (33) can entirely surround a portion of the first conduit (32) proximate the first port (35) such that the first valve (33) and that portion of

the first conduit (32) are coaxial. Thus, the first valve (33) and the portion of the first conduit (32) proximate the first port (35) can be disposed in concentric relation.

With this configuration, the first conduit (32) and the first valve (33) can together provide a portion of the first passageway (4). More specifically, a first conduit inner surface (46) and the first valve inner surface (43) can define a portion of the first passageway (4). As to particular embodiments, the first conduit inner surface (46) and the first valve inner surface (43) can define a first passageway (4) which is cylindrical or generally cylindrical, having a circular or generally circular cross section (as shown in the example of Figure 3F).

Again referring primarily to Figure 2G, Figure 2H, Figure 3G, and Figure 3I, as to particular embodiments, a portion of the first conduit outer surface (44) can provide a first valve seat (34) in which the first valve (33) can move and specifically, in which the first valve (33) can longitudinally travel over the first conduit (32).

The first valve (33) can travel within the first valve seat (34) in a first direction (47) to a first valve closed position (38) in which the first valve (33) sealably occlude the first port (35) in fluid communication with the first passageway (4) (as shown in the examples of Figure 2H, Figure 3G, and Figure 3I), thereby providing the first passageway closed condition (36) in which fluid flow through the first port (35) and accordingly, through the first passageway (4), is interrupted.

When in the first valve closed position (38), the first valve (33) can sealably engage with a first seal assembly (48) which is fixedly coupled to the first conduit (32) in axially spaced apart relation. For example, one or more spacers (49) can fixedly couple the first seal assembly (48) to the first conduit (32) to dispose the first seal assembly (48) in spaced apart relation to the first conduit (32) or to dispose the first seal assembly (48) a distance from the first conduit (32). To provide the first passageway closed condition (36), the first valve (33) can travel within the first valve seat (34) across the distance to sealably engage with the first seal assembly (48) and sealably occlude the first port (35) to interrupt fluid flow through the first passageway (4).

As to particular embodiments, the first conduit (32) and the first seal assembly (48) can be formed as a one-piece construct; however, the invention need not be so limited. As to particular embodiments, the first conduit (32), one or more spacers (49), and the first seal assembly (48) can be formed as a one-piece construct; however, the invention need not be so limited.

As to particular embodiments, the first seal assembly (48) can include an o-ring (45) coupled to an o-ring support (50), for example the o-ring (45) can be at least partially recessed within the o-ring support (50), whereby when overlaid by the first valve inner surface (43), the o-ring (45) can function to provide a fluid-tight seal between the first valve inner surface (43) and the first seal assembly (48).

Now referring primarily to Figure 2G, Figure 2H, Figure 3G, and Figure 3I, the first valve (33) can be biased by a first valve-biasing member (37) which biases the first valve (33) toward the first seal assembly (48) and correspondingly, toward the first valve closed position (38) to provide the first passageway closed condition (36).

As to particular embodiments, the first valve-biasing member (37) can be configured as a resiliently compressible member (16), such as a spring and for example, a coil spring or a helical spring (51). As to particular embodiments, the helical spring (51) can be disposed about a portion of the first valve (33) to entirely surround that portion of the first valve (33) such that the helical spring (51) and the first valve (33) are coaxial. Thus, the helical spring (51) and the first valve (33) can be disposed in concentric relation.

To reiterate, in contrast to conventional "quick release" couplers, the instant helical spring (51) is disposed external to or outside of the first passageway (4) and accordingly, external to or outside of the fluid flow path (8) when the female and male couplers (3)(5) connect to achieve the connected condition (7) of the connector system (1). Correspondingly, fluid flowing within the fluid flow path (8) does not contact the helical spring (51), which may be advantageous for a plurality of reasons, including elimination of a potential substrate for biofilm growth within the fluid flow path (8) and elimination of a physical impediment to fluid flow within the fluid flow path (8).

Again referring primarily to Figure 2G, Figure 2H, Figure 3G, and Figure 3I, the helical spring (51) can be disposed between a pair of projecting ribs (52)(53). For example, a helical spring first end (54) can bear against a first rib (52) outwardly extending from the first conduit outer surface (44) and an opposing helical spring second end (55) can bear against a second rib (53) outwardly extending from a first valve outer surface (56).

When in a non-compressed condition (17), which is the normal biased condition, the helical spring (51) can bias the first valve (33) toward sealable engagement with the first seal assembly (48) and correspondingly toward the first valve closed position (38) in which the first

valve (33) sealably occludes the first port (35) to provide the first passageway closed condition (36).

Upon forcible urging in a second direction (57) which opposes the first direction (47), the helical spring (51) can be compressed toward a compressed condition (18), allowing the first valve (33) to travel within the first valve seat (34) away from the first seal assembly (48) and away from the first port (35) toward a first valve open position (39), thus providing a first passageway open condition (40) permitting fluid flow through the first port (35) and accordingly, through the first passageway (4) (as shown in the example of Figure 2G).

Now referring primarily to Figure 2G, the helical spring (51) can be compressed toward the compressed condition (18) upon forcible urging resulting from connection of the female and male couplers (3)(5), thus allowing the first valve (33) to travel within the first valve seat (34) away from the first seal assembly (48) and away from the first port (35) toward the first valve open position (39), thus providing a first passageway open condition (40) permitting fluid flow through the first port (35) and accordingly, through the first passageway (4). Further, upon achievement of the connected condition (7) of the connector system (1), the first passageway (4) can fluidicly communicate with the second passageway (6) of the male coupler (5) to provide the fluid flow path (8) through which fluid can flow between the connector system first and second ends (41)(42).

Now referring primarily to Figure 5G, Figure 5H, Figure 6G, and Figure 13A through Figure 14G, as another illustrative example, the first valve-biasing member (37) can be configured as a resiliently flexible member (58); however, the first valve-biasing member (37) need not be limited to this particular configuration.

When in a non-flexed condition (59) (as shown in the examples of Figure 13A through Figure 13G), the resiliently flexible member (58) can bias the first valve (33) toward the first valve closed position (38) in which the first valve (33) sealably occludes the first port (35) (as shown in the examples of Figure 5H and Figure 6G).

Upon forcible urging, the resiliently flexible member (58) can be flexed toward a flexed condition (60) (as shown in the examples of Figure 14A through Figure 14G), allowing the first valve (33) to travel within the first valve seat (34) toward a first valve open position (39) away from the first port (35), thereby permitting fluid flow through the first port (35) and accordingly, through the first passageway (4) to provide a first passageway open condition (40) (as shown in the example of Figure 5G).

Now referring primarily to Figure 5G, the resiliently flexible member (58) can be flexed toward the flexed condition (60) upon forcible urging resulting from connection of the female and male couplers (3)(5), thus allowing the first valve (33) to travel within the first valve seat (34) toward the first valve open position (39) away from the first port (35), thereby permitting fluid flow through the first port (35) and accordingly, through the first passageway (4) to provide the first passageway open condition (40). Further, upon achievement of the connected condition (7) of the connector system (1), the first passageway (4) can fluidicly communicate with the second passageway (6) of the male coupler (5) to provide the fluid flow path (8) through which fluid can flow between the connector system first and second ends (41)(42).

Now referring primarily to Figure 13A through Figure 14G, as to particular embodiments, the resiliently flexible member (58) can be configured as a plurality of resiliently flexible members (58) which dispose in circumferentially spaced-apart relation to define an internal space (61). Additionally, an angled surface (62) can be disposed in axially-adjacent relation to the plurality of resiliently flexible members (58).

Upon forcible urging resulting from connection of the female and male couplers (3)(5), the plurality of resiliently flexible members (58) move axially toward the angled surface (62), whereby the angled surface (62) can be received within the internal space (61) while forcibly urging the plurality of resiliently flexible members (58) to flex about the angled surface (62) toward the flexed condition (60) (as shown in the examples of Figure 14A through Figure 14G). Correspondingly, the first valve (33) travels within the first valve seat (34) toward the first valve open position (39) away from the first port (35), thereby permitting fluid flow through the first port (35) and accordingly, through the first passageway (4) to provide the first passageway open condition (40).

Upon uncoupling of the female and male couplers (3)(5), the plurality of resiliently flexible members (58) are biased toward the non-flexed condition (59) (as shown in the examples of Figure 13A through Figure 13G), biasing the first valve (33) toward the first valve closed position (38) in which the first valve (33) sealably occludes the first port (35).

Again referring primarily to Figure 13A through Figure 14G, as to particular embodiments, the resiliently flexible member (58) and the first valve (33) can be formed as a one-piece construct; however, the invention need not be so limited.

Second Valve

Now referring primarily to Figure 2G, Figure 2H, Figure 4G, Figure 5G, Figure 5H, and Figure 7G, the male coupler (5) can include a second conduit (63) defining a second passageway (6) (which as to particular embodiments, may include a fixed or removable filter) and a second valve (64) operable to interrupt fluid flow through the second passageway (6).

The second valve (64) can be movable within a second valve seat (65) to sealably occlude a second port (66) in fluid communication with the second passageway (6), thereby providing a second passageway closed condition (67) in which fluid flow through the second port (66) and accordingly, through the second passageway (6), is interrupted.

The second valve (64) can be biased by a second valve-biasing member (68) which biases the second valve (64) toward a second valve closed position (69) in which the second valve (64) sealably occludes the second port (66), for example by sealably overlaying the second port (66), to provide the second passageway closed condition (67).

Now referring primarily to Figure 2G, Figure 2H, and Figure 4G, as but one illustrative example, the second valve-biasing member (68) can be configured as a resiliently compressible member (16), such as a spring; however, the second valve-biasing member (68) need not be limited to this particular configuration.

When in a non-compressed condition (17), which is the normal biased condition, the resiliently compressible member (16) can bias the second valve (64) toward the second valve closed position (69) in which the second valve (64) sealably occludes the second port (66) to provide the second passageway closed condition (67) (as shown in the examples of Figure 2H and Figure 4G).

Upon forcible urging, the resiliently compressible member (16) can be compressed toward a compressed condition (18), allowing the second valve (64) to travel within the second valve seat (65) away from the second port (66) toward a second valve open position (70), thus providing a second passageway open condition (71) permitting fluid flow through the second port (66) and accordingly, through the second passageway (6) (as shown in the example of Figure 2G).

Now referring primarily to Figure 2G, the resiliently compressible member (16) can be compressed toward the compressed condition (18) upon forcible urging resulting from connection of the female and male couplers (3)(5), thus allowing the second valve (64) to travel within the second valve seat (65) away from the second port (66) toward the second valve open position

(70), thus providing a second passageway open condition (71) which permits fluid flow through the second port (66) and accordingly, through the second passageway (6). Further, upon achievement of the connected condition (7) of the connector system (1), the first passageway (4) of the female coupler (3) can fluidicly communicate with the second passageway (6) to provide the fluid flow path (8) through which fluid can flow between the connector system first and second ends (41)(42).

In contrast to conventional "quick release" couplers, the instant second valve-biasing member (68) is disposed external to or outside of the second passageway (6) and accordingly, external to or outside of the fluid flow path (8) when the female and male couplers (3)(5) connect to achieve the connected condition (7) of the connector system (1). Correspondingly, fluid flowing within the fluid flow path (8) does not contact the resiliently compressible member (16), which may be advantageous for a plurality of reasons, including elimination of a potential substrate for biofilm growth within the fluid flow path (8) and elimination of a physical impediment to fluid flow within the fluid flow path (8).

Now referring primarily to Figure 2G, Figure 2H, and Figure 4G, as a first illustrative example, the second valve (64) can be provided by the second conduit (63) which can longitudinally travel or longitudinally slide within the second valve seat (65).

The second valve seat (65) can be configured to telescopingly engage with the second conduit (63) such that the second valve seat (65) telescopingly disposes about the second conduit (63) to allow longitudinal travel of the second conduit (63) within the second valve seat (65).

With this configuration, a second valve seat inner surface (72) of the second valve seat (65) can dispose adjacent a second conduit outer surface (73) of the second conduit (63), whereby a fluid-tight seal can exist between the second valve seat inner surface (72) and the second conduit outer surface (73). As to particular embodiments, an o-ring (45) can be coupled to the second conduit outer surface (73), for example the o-ring (45) can be at least partially recessed within the second conduit outer surface (73), whereby when overlaid by the second valve seat inner surface (72), the o-ring (45) can function to provide a fluid-tight seal between the second valve seat inner surface (72) and the second conduit outer surface (73).

The second valve seat (65) can either partially or entirely surround a portion of the second conduit (63) proximate (or adjacent) the second port (66), depending upon the configuration of the second conduit (63) and the second port (66). As shown in the particular embodiment illustrated in Figure 2G, Figure 2H, and Figure 4G, the second valve seat (65) can entirely

surround a portion of the second conduit (63) proximate the second port (66) such that the second valve seat (65) and that portion of the second conduit (63) are coaxial. Thus, the second valve seat (65) and the portion of the second conduit (63) proximate the second port (66) can be disposed in concentric relation.

With this configuration, the second conduit (63) and the second valve seat (65) can together provide a portion of the second passageway (6). More specifically, a second conduit inner surface (74) and the second valve seat inner surface (72) can define a portion of the second passageway (6). As to particular embodiments, the second conduit inner surface (74) and the second valve seat inner surface (72) can define a second passageway (6) which is cylindrical or generally cylindrical, having a circular or generally circular cross section (as shown in the example of Figure 4E).

The second valve (64) can travel within the second valve seat (65) in a first direction (47) to a second valve closed position (69) in which the second conduit (63) sealably occludes the second port (66) in fluid communication with the second passageway (6), thereby providing a second passageway closed condition (67) in which fluid flow through the second port (66) and accordingly, through the second passageway (6), is interrupted.

When in the second valve closed position (69), a second seal assembly (75) which is fixedly coupled to the second conduit (63) in axially spaced apart relation via one or more spacers (49) can sealably engage with an engagement surface (76) provided by an inwardly tapering portion of the second valve seat inner surface (72), thus providing the second passageway closed condition (67) in which the second port (66) is sealably occluded to interrupt fluid flow through the second passageway (6).

As to particular embodiments, the second conduit (63) and the second seal assembly (75) can be formed as a one-piece construct; however, the invention need not be so limited. As to particular embodiments, the second conduit (63), one or more spacers (49), and the second seal assembly (75) can be formed as a one-piece construct; however, the invention need not be so limited.

As to particular embodiments, the second seal assembly (75) can include an o-ring (45) coupled to an o-ring support (50), for example the o-ring (45) can be at least partially recessed within the o-ring support (50), whereby when overlaid by the engagement surface (76), the o-ring can function to provide the fluid-tight seal between the engagement surface (76) and the second seal assembly (75).

Again referring primarily to Figure 2G, Figure 2H, and Figure 4G, the second conduit (63) can be biased by a second valve-biasing member (68) which biases the second conduit (63) and correspondingly the second seal assembly (75) toward the engagement surface (76) and correspondingly, toward the second valve closed position (69) to provide the second passageway closed condition (67).

As to particular embodiments, the second valve-biasing member (68) can be configured as a resiliently compressible member (16), such as a spring and for example, a coil spring or a helical spring (51). As to particular embodiments, the helical spring (51) can be disposed about a portion of the second conduit (63) to entirely surround that portion of the second conduit (63) such that the helical spring (51) and the second conduit (63) are coaxial. Thus, the helical spring (51) and the second conduit (63) can be disposed in concentric relation.

To reiterate, in contrast to conventional "quick release" couplers, the instant helical spring (51) is disposed external to or outside of the second passageway (6) and accordingly, external to or outside of the fluid flow path (8) when the female and male couplers (3)(5) connect to achieve the connected condition (7) of the connector system (1). Correspondingly, fluid flowing within the fluid flow path (8) does not contact the helical spring (51), which may be advantageous for a plurality of reasons, including elimination of a potential substrate for biofilm growth within the fluid flow path (8) and elimination of a physical impediment to fluid flow within the fluid flow path (8).

Again referring primarily to Figure 2G, Figure 2H, and Figure 4G, the helical spring (51) can be disposed between a pair of projecting ribs (52)(53). For example, a helical spring first end (54) can bear against a first rib (52) and an opposing helical spring second end (55) can bear against a second rib (53) outwardly extending from the second conduit outer surface (73).

When in a non-compressed condition (17), which is the normal biased condition, the helical spring (51) can bias the second conduit (63) and correspondingly the second seal assembly (75) toward the engagement surface (76) and correspondingly, toward the second valve closed position (69), thereby sealably occluding the second port (66) and providing the second passageway closed condition (67).

Upon forcible urging in a second direction (57) which opposes the first direction (47), the helical spring (51) can be compressed toward a compressed condition (18), allowing the second conduit (63) to travel within the second valve seat (65) to dispose the second seal assembly (75) away from the engagement surface (76) and away from the second port (66) toward a second

valve open position (70), thus providing a second passageway open condition (71) permitting fluid flow through the second port (66) and accordingly, through the second passageway (6) (as shown in the example of Figure 2G).

Now referring primarily to Figure 2G, the helical spring (51) can be compressed toward the compressed condition (18) upon forcible urging resulting from connection of the female and male couplers (3)(5), thus allowing the second conduit (63) to travel within the second valve seat (65) to dispose the second seal assembly (75) away from the engagement surface (76) and away from the second port (66) toward a second valve open position (70), thus providing a second passageway open condition (71) permitting fluid flow through the second port (66) and accordingly, through the second passageway (6). Further, upon achievement of the connected condition (7) of the connector system (1), the first passageway (4) of the female coupler (3) can fluidicly communicate with the second passageway (6) to provide the fluid flow path (8) through which fluid can flow between the connector system first and second ends (41)(42).

Now referring primarily to Figure 5G, Figure 5H, Figure 7G, and Figure 13A through Figure 14G, as another illustrative example, the second valve-biasing member (68) can be configured as a resiliently flexible member (58); however, the second valve-biasing member (68) need not be limited to this particular configuration.

When in a non-flexed condition (59) (as shown in the examples of Figure 13A through Figure 13G), the resiliently flexible member (58) can bias the second valve (64) toward the second valve closed position (69) in which the second valve (64) sealably occludes the second port (66) (as shown in the example of Figure 5H and Figure 7G).

Upon forcible urging, the resiliently flexible member (58) can be flexed toward a flexed condition (60) (as shown in the examples of Figure 14A through Figure 14G), allowing the second valve (64) to travel within the second valve seat (65) toward the second valve open position (70) away from the second port (66), thereby permitting fluid flow through the second port (66) and accordingly, through the second passageway (6) to provide the second passageway open condition (71) (as shown in the example of Figure 5G).

Now referring primarily to Figure 5G, the resiliently flexible member (58) can be flexed toward the flexed condition (60) upon forcible urging resulting from connection of the female and male couplers (3)(5), thus allowing the second valve (64) to travel within the second valve seat (65) toward the second valve open position (70) away from the second port (66), thereby permitting fluid flow through the second port (66) and accordingly, through the second

passageway (6) to provide the second passageway open condition (71). Further, upon achievement of the connected condition (7) of the connector system (1), the first passageway (4) of the female coupler (3) can fluidicly communicate with the second passageway (6) to provide the fluid flow path (8) through which fluid can flow between the connector system first and second ends (41)(42).

Now referring primarily to Figure 13A through Figure 14G, as to particular embodiments, the resiliently flexible member (58) can be configured as a plurality of resiliently flexible members (58) which dispose in circumferentially spaced-apart relation to define an internal space (61). Additionally, an angled surface (62) can be disposed in axially-adjacent relation to the plurality of resiliently flexible members (58).

Upon forcible urging resulting from connection of the female and male couplers (3)(5), the plurality of resiliently flexible members (58) move axially toward the angled surface (62), whereby the angled surface (62) can be received within the internal space (61) while forcibly urging the plurality of resiliently flexible members (58) to flex about the angled surface (62) toward the flexed condition (60) (as shown in the examples of Figure 14A through Figure 14G). Correspondingly, the second valve (64) travels within the second valve seat (65) toward the second valve open position (70) away from the second port (66), thereby permitting fluid flow through the second port (66) and accordingly, through the second passageway (6) to provide the second passageway open condition (71).

Upon uncoupling of the female and male couplers (3)(5), the plurality of resiliently flexible members (58) are biased toward the non-flexed condition (59) (as shown in the examples of Figure 13A through Figure 13G), biasing the second valve (64) toward the second valve closed position (69) in which the second valve (64) sealably occludes the second port (66).

Again referring primarily to Figure 13A through Figure 14G, as to particular embodiments, the resiliently flexible member (58) and the second valve (64) can be formed as a one-piece construct; however, the invention need not be so limited.

Tubing

Now referring primarily to Figure 15A and Figure 15B, as to particular embodiments, the connector system (1), as described above, can further include at least one tube (2) coupled to a connector system end (41)(42), for example the connector system first end (41), which can be configured as a barb (77). Accordingly, the tube (2) can engage with the barb (77), for example

via frictional engagement about the barb (77), to securely couple the tube (2) to the connector system (1).

Again referring primarily to Figure 15A and Figure 15B, as to particular embodiments, the tube (2) can be configured as extension tubing (78), for example flexible extension tubing (78) such as a J-loop (79), having opposing J-loop first and second ends (80)(81), whereby the J-loop first end (81) can engage with the barb (77) outwardly extending from the connector system first end (41) to securely couple the J-loop (79) to the connector system (1), and the J-loop second end (81) can be configured to couple to an intravenous (IV) catheter, for example via an IV catheter connector (82) such as a luer lock fitting (83).

Again referring primarily to Figure 15A and Figure 15B, as to particular embodiments, the connector system second end (42) can also be configured as a luer lock fitting (83), which may be useful for connecting the connector system (1), J-loop (79), and IV catheter to a reservoir, whereby as but one illustrative example, the reservoir may contain fluids for intravenous delivery.

As to particular embodiments, the J-loop (79) can be configured to automatically disengage from the connector assembly (1) when a load force exceeds a predetermined threshold for safety.

A method of making a particular embodiment of a connector system (1) for releasably connecting tubes (2) can include providing a female coupler (3) having a first passageway (4), providing a male coupler (5) having a second passageway (6), movably coupling a catch (9) to the female coupler (3), coupling a catch-receiving element (10) to the male coupler (5), and movably coupling a release element (11) to the female coupler (3); wherein travel of the release element (11) along a female coupler outer surface (12) of the female coupler (3) disengages the catch (9) from the catch-receiving element (10) to achieve a disconnected condition (13) of the connector system (1).

A method of making another embodiment of a connector system (1) for releasably connecting tubes (2) can include providing a female coupler (3) comprising a first conduit (32) defining a first passageway (4), a first valve (33) operable to interrupt fluid flow through the first passageway (4), and a first valve-biasing member (37) disposed outside of the first passageway (4), whereby the first valve-biasing member (37) can be operable to bias the first valve (32) toward a first valve closed position (3); and providing a male coupler (5) comprising a second conduit (63) defining a second passageway (6).

The method of making the connector system (1) can further include providing additional components of the connector system (1) as described above and in the claims.

Components of the connector system (1) can be formed from one or more of any of a numerous and wide variety of materials capable of providing a functional connector system (1). By way of non-limiting example, the material can include or consist of: rubber, rubber-like material, plastic, plastic-like material, acrylic, polyamide, polyester, polypropylene, polyethylene, polyvinyl chloride-based materials, silicone-based materials, or the like, or combinations thereof. Additional non-limiting examples can include polymeric materials or resins, for example thermoplastics, such as acrylic, nylon, polybenzimidazole, polyethylene, polypropylene, polystyrene, polyvinyl chloride, polytetrafluoroethylene, or the like, or combinations thereof; thermosets, such as polyester fiberglass, polyurethanes, rubber, polyoxybenzylmethylenglycolanhydride, urea-formaldehyde foam, melamine resin, epoxy resin, polyimides, cynate esters, polycyanurates, polyester resin, or the like, or combinations thereof; elastomers, such as natural polyisoprene, synthetic polyisoprene, polybutadiene, chloropene rubber, butyl rubber, styrene-butadiene rubber, nitrile rubber, ethylene propylene rubber, epichlorohydrin rubber, polyacrylic rubber, silicone rubber, fluorosilicone rubber, fluoroelastomers, perfluoroelastomers, polyether block amides, chlorosulfonated polyethylene, ethylene-vinyl acetate, thermal plastic elastomer (TPE), or the like, or combinations thereof.

As to particular embodiments, one or more components of the connector system (1) can be formed from an antibacterial material(s).

As to particular embodiments, one or more components of the connector system (1) can be formed entirety from non-metallic material(s).

Additionally, components of the connector system (1) can be produced from any of a wide variety of processes depending upon the application, such as press molding, injection molding, fabrication, machining, printing, additive printing, or the like, or combinations thereof, as one piece or assembled from a plurality of pieces into a component of the connector system (1).

As to particular embodiments, one or more components of the connector system (1) can be disposable or reusable, depending upon the application.

A method of using a particular embodiment of a connector system (1) for releasably connecting tubes (2) can include obtaining the connector system (1) comprising: a female coupler (3) having a first passageway (4), a male coupler (5) having a second passageway (6), a catch (9)

movably coupled to the female coupler (3), a catch-receiving element (10) coupled to the male coupler (5), whereby upon releasable matable axial coupling of the female and male couplers (3)(5), the catch (9) engages with the catch-receiving element (10) to fix an axial position of the female coupler (3) in relation to the male coupler (5), thereby achieving a connected condition (7) of the connector system (1) in which the first and second passageways (4)(6) dispose in fluidic communication to provide a fluid flow path (8), and a release element (11) movably coupled to the female coupler (3), whereby travel of the release element (11) along a female coupler outer surface (12) of the female coupler (3) disengages the catch (9) from the catch-receiving element (10) to achieve a disconnected condition (13) of the connector system (1); coupling a first tube (2) to the female coupler (3); coupling a second tube (2) to the male coupler (5); and releasably coupling the female and male couplers (3)(5) to achieve the connected condition (7) of the connector system (1).

As to particular embodiments, the method can further include flowing fluid through the fluid flow path (8).

As to particular embodiments, the method can further include forcibly urging the release element (11) to travel along the female coupler outer surface (12) to disengage the catch (9) from the catch-receiving element (10) to achieve the disconnected condition (13) of the connector system (1).

A method of using another particular embodiment of a connector system (1) for releasably connecting tubes (2) can include obtaining the connector system (1) comprising a female coupler (3) including a first conduit (32) defining a first passageway (4), a first valve (33) operable to interrupt fluid flow through the first passageway (4); and a first valve-biasing member (37) disposed outside of the first passageway (4), whereby the first valve-biasing member (37) can be operable to bias the first valve (33) toward a first valve closed position (38), and a male coupler (5) including a second conduit (63) defining a second passageway (6), whereby upon releasable matable axial coupling of the female and male couplers (3)(5), a connected condition (7) of the connector system (1) can be achieved, and whereby in the connected condition (13), the first valve (33) is forcibly urged toward a first valve open position (39) to allow fluid to flow through the first passageway (4); coupling a first tube (2) to the female coupler (3); coupling a second tube (2) to the male coupler (5); and releasably coupling the female and male couplers (3)(5) to achieve the connected condition of the connector system (1).

As to particular embodiments, the method can further include flowing fluid through the first passageway (4).

As can be easily understood from the foregoing, the basic concepts of the present invention may be embodied in a variety of ways. The invention involves numerous and varied embodiments of a connector system and methods for making and using such a connector system, including the best mode.

As such, the particular embodiments or elements of the invention disclosed by the description or shown in the figures or tables accompanying this application are not intended to be limiting, but rather exemplary of the numerous and varied embodiments generically encompassed by the invention or equivalents encompassed with respect to any particular element thereof. In addition, the specific description of a single embodiment or element of the invention may not explicitly describe all embodiments or elements possible; many alternatives are implicitly disclosed by the description and figures.

It should be understood that each element of an apparatus or each step of a method may be described by an apparatus term or method term. Such terms can be substituted where desired to make explicit the implicitly broad coverage to which this invention is entitled. As but one example, it should be understood that all steps of a method may be disclosed as an action, a means for taking that action, or as an element which causes that action. Similarly, each element of an apparatus may be disclosed as the physical element or the action which that physical element facilitates. As but one example, the disclosure of a "connector" should be understood to encompass disclosure of the act of "connecting" -- whether explicitly discussed or not -- and, conversely, were there effectively disclosure of the act of "connecting", such a disclosure should be understood to encompass disclosure of a "connector" and even a "means for connecting". Such alternative terms for each element or step are to be understood to be explicitly included in the description.

In addition, as to each term used it should be understood that unless its utilization in this application is inconsistent with such interpretation, common dictionary definitions should be understood to be included in the description for each term as contained in the Random House Webster's Unabridged Dictionary, second edition, each definition hereby incorporated by reference.

All numeric values herein are assumed to be modified by the term "about", whether or not explicitly indicated. For the purposes of the present invention, ranges may be expressed as

from "about" one particular value to "about" another particular value. When such a range is expressed, another embodiment includes from the one particular value to the other particular value. The recitation of numerical ranges by endpoints includes all the numeric values subsumed within that range. A numerical range of one to five includes for example the numeric values 1, 1.5, 2, 2.75, 3, 3.80, 4, 5, and so forth. It will be further understood that the endpoints of each of the ranges are significant both in relation to the other endpoint, and independently of the other endpoint. When a value is expressed as an approximation by use of the antecedent "about," it will be understood that the particular value forms another embodiment. The term "about" generally refers to a range of numeric values that one of skill in the art would consider equivalent to the recited numeric value or having the same function or result. Similarly, the antecedent "substantially" means largely, but not wholly, the same form, manner or degree and the particular element will have a range of configurations as a person of ordinary skill in the art would consider as having the same function or result. When a particular element is expressed as an approximation by use of the antecedent "substantially," it will be understood that the particular element forms another embodiment.

Moreover, for the purposes of the present invention, the term "a" or "an" entity refers to one or more of that entity unless otherwise limited. As such, the terms "a" or "an", "one or more" and "at least one" can be used interchangeably herein.

Further, for the purposes of the present invention, the term "coupled" or derivatives thereof can mean indirectly coupled, coupled, directly coupled, connected, directly connected, or integrated with, depending upon the embodiment.

Thus, the applicant(s) should be understood to claim at least: i) each of the connector systems herein disclosed and described, ii) the related methods disclosed and described, iii) similar, equivalent, and even implicit variations of each of these devices and methods, iv) those alternative embodiments which accomplish each of the functions shown, disclosed, or described, v) those alternative designs and methods which accomplish each of the functions shown as are implicit to accomplish that which is disclosed and described, vi) each feature, component, and step shown as separate and independent inventions, vii) the applications enhanced by the various systems or components disclosed, viii) the resulting products produced by such systems or components, ix) methods and apparatuses substantially as described hereinbefore and with reference to any of the accompanying examples, x) the various combinations and permutations of each of the previous elements disclosed.

The background section of this patent application, if any, provides a statement of the field of endeavor to which the invention pertains. This section may also incorporate or contain paraphrasing of certain United States patents, patent applications, publications, or subject matter of the claimed invention useful in relating information, problems, or concerns about the state of technology to which the invention is drawn toward. It is not intended that any United States patent, patent application, publication, statement or other information cited or incorporated herein be interpreted, construed or deemed to be admitted as prior art with respect to the invention.

The claims set forth in this specification, if any, are hereby incorporated by reference as part of this description of the invention, and the applicant expressly reserves the right to use all of or a portion of such incorporated content of such claims as additional description to support any of or all of the claims or any element or component thereof, and the applicant further expressly reserves the right to move any portion of or all of the incorporated content of such claims or any element or component thereof from the description into the claims or vice-versa as necessary to define the matter for which protection is sought by this application or by any subsequent application or continuation, division, or continuation-in-part application thereof, or to obtain any benefit of, reduction in fees pursuant to, or to comply with the patent laws, rules, or regulations of any country or treaty, and such content incorporated by reference shall survive during the entire pendency of this application including any subsequent continuation, division, or continuation-in-part application thereof or any reissue or extension thereon.

Additionally, the claims set forth in this specification, if any, are further intended to describe the metes and bounds of a limited number of the preferred embodiments of the invention and are not to be construed as the broadest embodiment of the invention or a complete listing of embodiments of the invention that may be claimed. The applicant does not waive any right to develop further claims based upon the description set forth above as a part of any continuation, division, or continuation-in-part, or similar application.

IV. CLAIMS

1. A connector system for releasably connecting tubes, comprising:

a female coupler having a first passageway;

a male coupler having a second passageway;

a catch movably coupled to said female coupler;

a catch-receiving element coupled to said male coupler;

wherein upon releasable matable axial coupling of said female and male couplers, said catch engages with said catch-receiving element to fix an axial position of said female coupler in relation to said male coupler, thereby achieving a connected condition of said connector system in which said first and second passageways dispose in fluidic communication to provide a fluid flow path; and

a release element movably coupled to said female coupler;

wherein travel of said release element along a female coupler outer surface of said female coupler disengages said catch from said catch-receiving element to achieve a disconnected condition of said connector system.

2. The connector system of claim 1, wherein said travel comprises linear motion along said female coupler outer surface.

3. The connector system of claim 2, wherein said linear motion comprises sliding motion along said female coupler outer surface.

4. The connector system of claim 1, wherein said travel of said release element along said female coupler outer surface is achieved by the application of forces directed at an angle of between 0° to about ±45° in relation to said female coupler outer surface.

5. The connector system of claim 1, wherein said travel of said release element along said female coupler outer surface comprises longitudinal travel along said female coupler outer surface between female coupler first and second ends.

6. The connector system of claim 5, wherein said longitudinal travel comprises sliding travel along said female coupler outer surface.

7. The connector system of claim 6, wherein said sliding travel is generally parallel to said female coupler outer surface.

8. The connector system of claim 1, wherein said travel of said release element along said female coupler outer surface comprises circumferential travel about said female coupler outer surface.

9. The connector system of claim 8, wherein said circumferential travel is generally parallel to said female coupler outer surface.

10. The connector system of claim 8, wherein said circumferential travel comprises helical travel about said female coupler outer surface.

11. The connector system of claim 2, wherein said release element is configured to transform said linear motion along said female coupler outer surface into reciprocating motion of said catch.

12. The connector system of claim 11, wherein said release element transforms said linear motion along said female coupler outer surface into inward motion of said catch toward an interior of said female coupler or outward motion of said catch away from said interior of said female coupler.

13. The connector system of claim 12, further comprising a release element-biasing member which biases said release element toward a release element first position in which said release element biases said catch inwardly toward said interior of said female coupler to engage said catch with said catch-receiving element and achieve said connected condition of said connector system.

14. The connector system of claim 13, wherein said release element-biasing member comprises a resiliently compressible member.

15. The connector system of claim 14, wherein said resiliently compressible member comprises a spring.

16. The connector system of claim 14, wherein when in a non-compressed condition, said resiliently compressible member biases said release element toward said release element first position.

17. The connector system of claim 16, wherein upon forcible urging toward a compressed condition, said resiliently compressible member allows said release element to dispose in a release element second position to allow said catch to outwardly move away from said interior

of said female coupler and disengage with said catch-receiving element to achieve said disconnected condition of said connector system.

18. The connector system of claim 1, wherein said catch-receiving element is coupled to said male coupler proximate a male coupler matable end which is matably received within a female coupler matable end upon releasable matable axial coupling of said female and male couplers.

19. The connector system of claim 18, wherein said catch-receiving element comprises a retention groove disposed within a male coupler outer surface proximate said male coupler matable end.

20. The connector system of claim 18, wherein said catch comprises a ball receivable within said retention groove.

21. A connector system for releasably connecting tubes, comprising:

a female coupler comprising:

a first conduit defining a first passageway;

a first valve operable to interrupt fluid flow through said first passageway; and

a first valve-biasing member disposed outside of said first passageway, said first valve-biasing member operable to bias said first valve toward a first valve closed position; and

a male coupler comprising a second conduit defining a second passageway;

wherein upon releasable matable axial coupling of said female and male couplers, a connected condition of said connector system is achieved; and

wherein in said connected condition, said first valve is forcibly urged toward a first valve open position to allow fluid to flow through said first passageway.

22. The connector system of claim 21, wherein said first valve telescopingly engages with said first conduit.

23. The connector system of claim 22, wherein said first valve telescopingly disposes about said first conduit.

24. The connector system of claim 23, wherein said first valve is capable of longitudinal travel over said first conduit.

25. The connector system of claim 24, wherein a first valve inner surface of said first valve disposes adjacent a first conduit outer surface of said first conduit.

26. The connector system of claim 25, further comprising a fluid-tight seal between said first valve inner surface and said first conduit outer surface.

27. The connector system of claim 26, further comprising an o-ring coupled to said first conduit outer surface;

wherein said o-ring provides said fluid-tight seal between said first valve inner surface and said first conduit outer surface.

28. The connector system of claim 26, wherein said first valve entirely surrounds a portion of said first conduit proximate a first port.

29. The connector system of claim 28, wherein a portion of said first conduit outer surface provides a first valve seat in which said first valve is movable.

30. The connector system of claim 29, wherein upon travel of said first valve within said first valve seat in a first direction to said first valve closed position, said first valve sealably occludes said first port in fluid communication with said first passageway to provide a first passageway closed condition in which fluid flow through said first passageway is interrupted.

31. The connector system of claim 30, further comprising a first seal assembly fixedly coupled to said first conduit in axially spaced apart relation;

wherein sealable engagement of said first valve with said first seal assembly provides said first valve closed position.

32. The connector system of claim 31, wherein said first seal assembly further comprises an o-ring coupled to an o-ring support;

wherein said o-ring provides a fluid-tight seal between said first valve inner surface and said first seal assembly.

33. The connector system of claim 31, wherein said first valve-biasing member biases said first valve toward said first seal assembly.

34. The connector system of claim 33, wherein said first valve-biasing member comprises a resiliently compressible member.

35. The connector system of claim 34, wherein said resiliently compressible member comprises a spring.

36. The connector system of claim 35, wherein said spring comprises a helical spring.

37. The connector system of claim 36, wherein said helical spring entirely surrounds a portion of said first valve.

38. The connector system of claim 37, wherein a helical spring first end of said helical spring bears against a first rib outwardly extending from said first conduit outer surface and an opposing helical spring second end of said helical spring bears against a second rib outwardly extending from said first valve outer surface.

39. The connector system of claim 38, wherein forcible urging in a second direction which opposes said first direction compresses said helical spring toward a compressed condition, allowing said first valve to travel within said first valve seat away from said first seal assembly and away from said first port toward a first valve open position, thus providing a first passageway open condition permitting fluid flow through said first port and accordingly, through said first passageway.

40. The connector system of claim 39, wherein said forcible urging in said second direction results from said releasable matable axial coupling of said female and male couplers.

41. The connector system of claim 21, wherein said male coupler further comprises:

a second valve operable to interrupt fluid flow through said second passageway, said second valve provided by said second conduit; and

a second valve-biasing member disposed outside of said second passageway, said second valve-biasing member operable to bias said second valve toward a second valve closed position.

42. The connector system of claim 41, further comprising a second valve seat in which said second conduit is movable

43. The connector system of claim 42, wherein said second valve seat telescopingly engages with said second conduit.

44. The connector system of claim 43, wherein said second valve seat telescopingly disposes about said second conduit.

45. The connector system of claim 44, wherein said second conduit is capable of longitudinal travel within said second valve seat.

46. The connector system of claim 45, wherein a second valve seat inner surface of said second valve seat disposes adjacent a second conduit outer surface of said second conduit.

47. The connector system of claim 46, further comprising a fluid-tight seal between said second valve seat inner surface and said second conduit outer surface.

48. The connector system of claim 47, further comprising an o-ring coupled to said second conduit outer surface;

wherein said o-ring provides said fluid-tight seal between said second valve seat inner surface and said second conduit outer surface.

49. The connector system of claim 47, wherein said second valve seat entirely surrounds a portion of said second conduit proximate a second port.

50. The connector system of claim 49, wherein upon travel of said second conduit within said second valve seat in a first direction to said second valve closed position, said second conduit sealably occludes said second port which fluidicly communicates with said second passageway to provide a second passageway closed condition in which fluid flow through said second passageway is interrupted.

51. The connector system of claim 50, further comprising a second seal assembly fixedly coupled to said second conduit in axially spaced apart relation;

wherein sealable engagement of said second seal assembly with an engagement surface provided by said second valve seat inner surface provides said second valve closed position.

52. The connector system of claim 51, wherein said second seal assembly further comprises an o-ring coupled to an o-ring support;

wherein said o-ring provides a fluid-tight seal between said engagement surface and said second seal assembly.

53. The connector system of claim 51, wherein said second valve-biasing member biases said second seal assembly toward said engagement surface.

54. The connector system of claim 53, wherein said second valve-biasing member comprises a resiliently compressible member.

55. The connector system of claim 54, wherein said resiliently compressible member comprises a spring.

56. The connector system of claim 55, wherein said spring comprises a helical spring.

57. The connector system of claim 56, wherein said helical spring entirely surrounds a portion of said second conduit.

58. The connector system of claim 57, wherein a helical spring first end of said helical spring bears against a first rib and an opposing helical spring second end of said helical spring bears against a second rib outwardly extending from said second conduit outer surface.

59. The connector system of claim 58, wherein forcible urging in a second direction which opposes said first direction compresses said helical spring toward a compressed condition, allowing said second conduit to travel within said second valve seat to dispose said second seal assembly away from said engagement surface and away from said second port toward a second valve open position, thus providing a second passageway open condition permitting fluid flow through said second port and accordingly, through said second passageway.

60. The connector system of claim 59, wherein said forcible urging in said second direction results from said releasable matable axial coupling of said female and male couplers.

61. A method of making a connector system for releasably connecting tubes, comprising:

providing a female coupler having a first passageway;

providing a male coupler having a second passageway;

movably coupling a catch to said female coupler;

coupling a catch-receiving element to said male coupler; and

movably coupling a release element to said female coupler;

wherein travel of said release element along a female coupler outer surface of said female coupler disengages said catch from said catch-receiving element to achieve a disconnected condition of said connector system.

62. The method of claim 61, wherein upon releasable matable axial coupling of said female and male couplers, said catch engages with said catch-receiving element to fix an axial position of said female coupler in relation to said male coupler, thereby achieving a connected condition of said connector system in which said first and second passageways dispose in fluidic communication to provide a fluid flow path.

63. The method of claim 62, further comprising providing said release element which is configured to transform linear motion along said female coupler outer surface into reciprocating motion of said catch.

64. The method of claim 63, further comprising providing a release element-biasing member which biases said release element toward a release element first position in which said release element biases said catch inwardly toward an interior of said female coupler to engage said catch with said catch-receiving element and achieve said connected condition of said connector system.

65. The method of claim 64, further comprising providing said release element-biasing member as a resiliently compressible member.

66. The method of claim 65, further comprising providing said resiliently compressible member as a spring.

67. The method of claim 61, further comprising coupling said catch-receiving element to said male coupler proximate a male coupler matable end which is matably received within a female coupler matable end upon releasable matable axial coupling of said female and male couplers.

68. The method of claim 67, further comprising providing said catch-receiving element as a retention groove disposed within a male coupler outer surface proximate said male coupler matable end.

69. The method of claim 68, further comprising providing said catch as a ball receivable within said retention groove.

70. A method of making a connector system for releasably connecting tubes, comprising:

providing a female coupler comprising:

a first conduit defining a first passageway;

a first valve operable to interrupt fluid flow through said first passageway; and

a first valve-biasing member disposed outside of said first passageway, said first valve-biasing member operable to bias said first valve toward a first valve closed position; and

providing a male coupler comprising a second conduit defining a second passageway.

71. The method of claim 70, wherein upon releasable matable axial coupling of said female and male couplers, a connected condition of said connector system is achieved.

72. The method of claim 71, wherein in said connected condition, said first valve is forcibly urged toward a first valve open position to allow fluid to flow through said first passageway.

73. The method of claim 72, further comprising telescopingly engaging said first valve with said first conduit.

74. The method of claim 73, further comprising telescopingly disposing said first valve about said first conduit.

75. The method of claim 74, further comprising disposing a first valve inner surface of said first valve adjacent a first conduit outer surface of said first conduit.

76. The method of claim 75, further comprising providing a fluid-tight seal between said first valve inner surface and said first conduit outer surface.

77. The method of claim 76, further comprising coupling an o-ring to said first conduit outer surface;

wherein said o-ring provides said fluid-tight seal between said first valve inner surface and said first conduit outer surface.

78. The method of claim 77, further comprising configuring a portion of said first conduit outer surface to provide a first valve seat in which said first valve is movable.

79. The method of claim 78, further comprising fixedly coupling a first seal assembly to said first conduit in axially spaced apart relation;

wherein sealable engagement of said first valve with said first seal assembly provides said first valve closed position.

80. The method of claim 79, further comprising providing said first seal assembly which comprises an o-ring coupled to an o-ring support;

wherein said o-ring provides a fluid-tight seal between said first valve inner surface and said first seal assembly.

81. The method of claim 79, further comprising providing said first valve-biasing member as a resiliently compressible member.

82. The method of claim 81, further comprising providing said resiliently compressible member as a spring.

83. The method of claim 82, further comprising providing said spring as a helical spring.

84. The method of claim 83, further comprising entirely surrounding a portion of said first valve with said helical spring.

85. The method of claim 70, further comprising providing said male coupler which further comprises:

a second valve operable to interrupt fluid flow through said second passageway, said second valve provided by said second conduit; and

a second valve-biasing member disposed outside of said second passageway, said second valve-biasing member operable to bias said second valve toward a second valve closed position.

86. The method of claim 85, further comprising providing a second valve seat in which said second conduit is movable.

87. The method of claim 86, further comprising telescopingly engaging said second valve seat with said second conduit.

88. The method of claim 87, further comprising telescopingly disposing said second valve seat about said second conduit.

89. The method of claim 88, further comprising disposing a second valve seat inner surface of said second valve seat adjacent a second conduit outer surface of said second conduit.

90. The method of claim 89, further comprising providing a fluid-tight seal between said second valve seat inner surface and said second conduit outer surface.

91. The method of claim 90, further comprising coupling an o-ring to said second conduit outer surface;

wherein said o-ring provides said fluid-tight seal between said second valve seat inner surface and said second conduit outer surface.

92. The method of claim 91, further comprising fixedly coupling a second seal assembly to said second conduit in axially spaced apart relation;

wherein sealable engagement of said second seal assembly with an engagement surface provided by said second valve seat inner surface provides said second valve closed position.

93. The method of claim 92, further comprising providing said second seal assembly which comprises an o-ring coupled to an o-ring support;

wherein said o-ring provides a fluid-tight seal between said engagement surface and said second seal assembly.

94. The method of claim 92, further comprising providing said second valve-biasing member as a resiliently compressible member.

95. The method of claim 94, further comprising providing said resiliently compressible member as a spring.

96. The method of claim 95, further comprising providing said spring as a helical spring.

97. The connector system of claim 96, further comprising entirely surrounding a portion of said second conduit with said helical spring.

98. A method of using a connector system for releasably connecting tubes, comprising:

obtaining said connector system comprising:

a female coupler having a first passageway;

a male coupler having a second passageway;

a catch movably coupled to said female coupler;

a catch-receiving element coupled to said male coupler;

wherein upon releasable matable axial coupling of said female and male couplers, said catch engages with said catch-receiving element to fix an axial position of said female coupler in relation to said male coupler, thereby achieving a connected condition of said connector system in which said first and second passageways dispose in fluidic communication to provide a fluid flow path; and

a release element movably coupled to said female coupler;

wherein travel of said release element along a female coupler outer surface of said female coupler disengages said catch from said catch-receiving element to achieve a disconnected condition of said connector system;

coupling a first tube to said female coupler;

coupling a second tube to said male coupler; and

releasably coupling said female and male couplers to achieve said connected condition of said connector system.

99. The method of claim 99, further comprising flowing fluid through said fluid flow path.

100. The method of claim 99, further comprising forcibly urging said release element to travel along said female coupler outer surface to disengage said catch from said catch-receiving element to achieve said disconnected condition of said connector system.

101. A method of using a connector system for releasably connecting tubes, comprising:

obtaining said connector system comprising:

a female coupler comprising:

a first conduit defining a first passageway;

a first valve operable to interrupt fluid flow through said first passageway; and

a first valve-biasing member disposed outside of said first passageway, said first valve-biasing member operable to bias said first valve toward a first valve closed position; and

a male coupler comprising a second conduit defining a second passageway;

wherein upon releasable matable axial coupling of said female and male couplers, a connected condition of said connector system is achieved; and

wherein in said connected condition, said first valve is forcibly urged toward a first valve open position to allow fluid to flow through said first passageway;

coupling a first tube to said female coupler;

coupling a second tube to said male coupler; and

releasably coupling said female and male couplers to achieve said connected condition of said connector system.

102. The method of claim 101, further comprising flowing fluid through said first passageway.

FIG. 1A

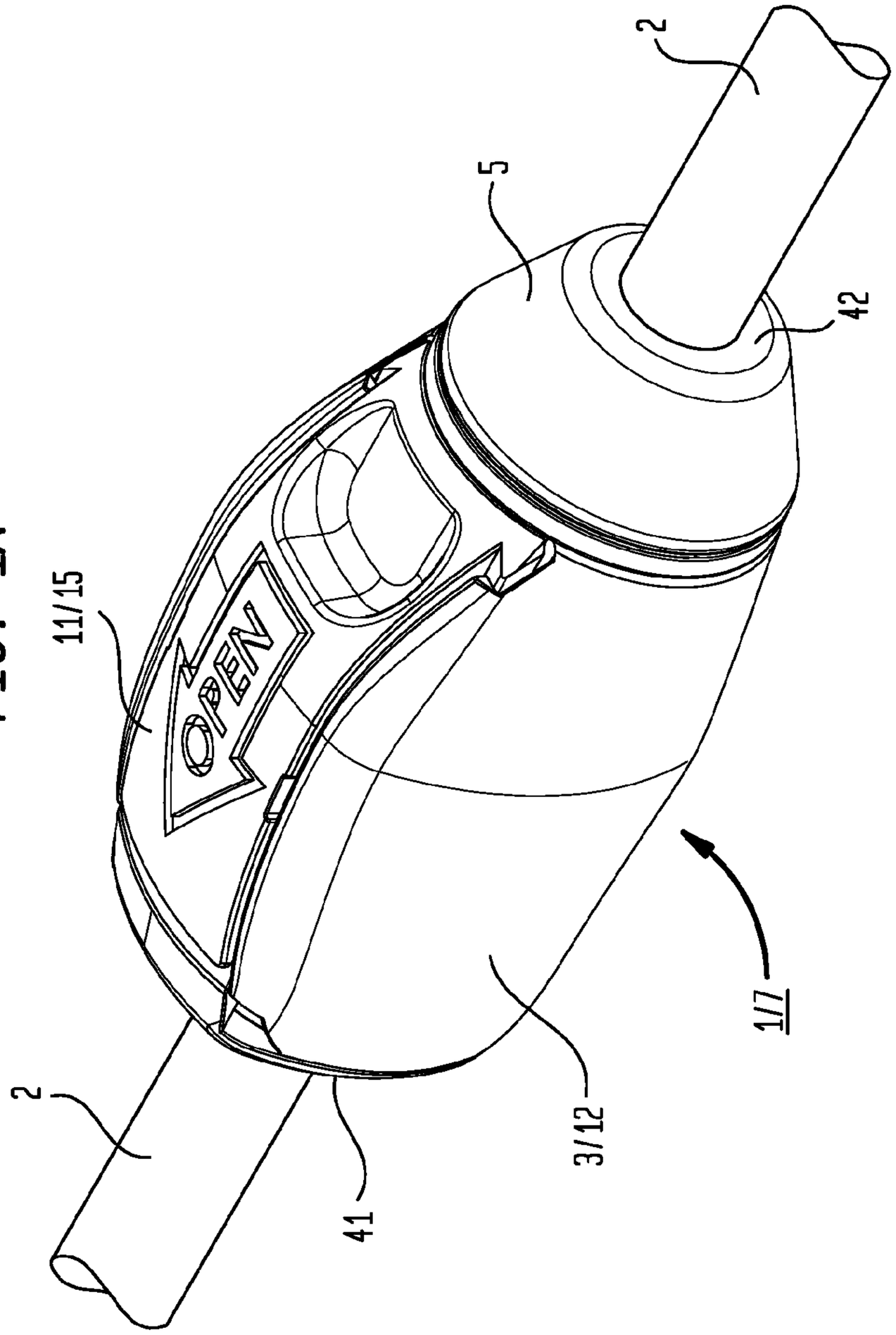

FIG. 1B

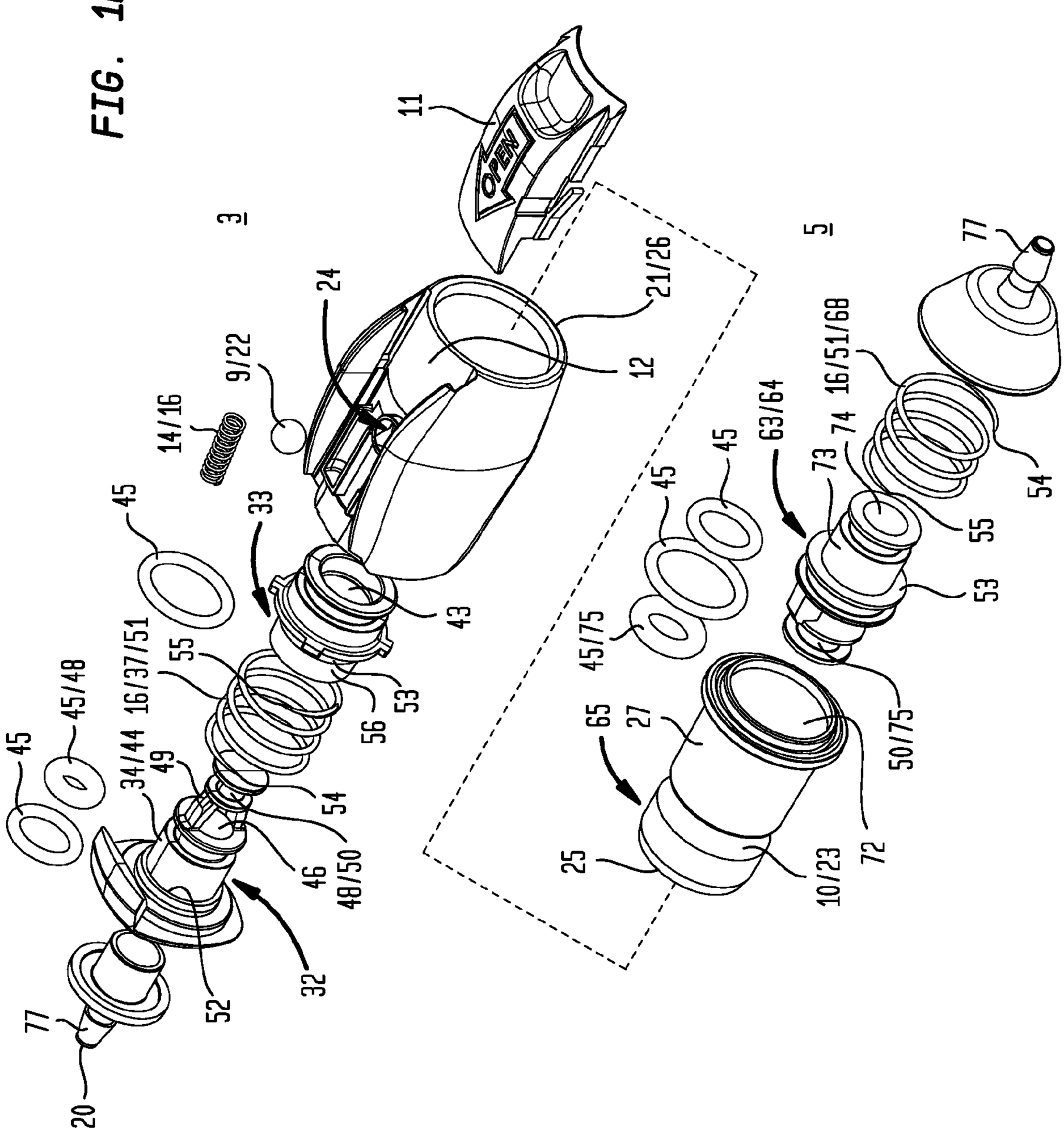
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FIG. 2A

1/7

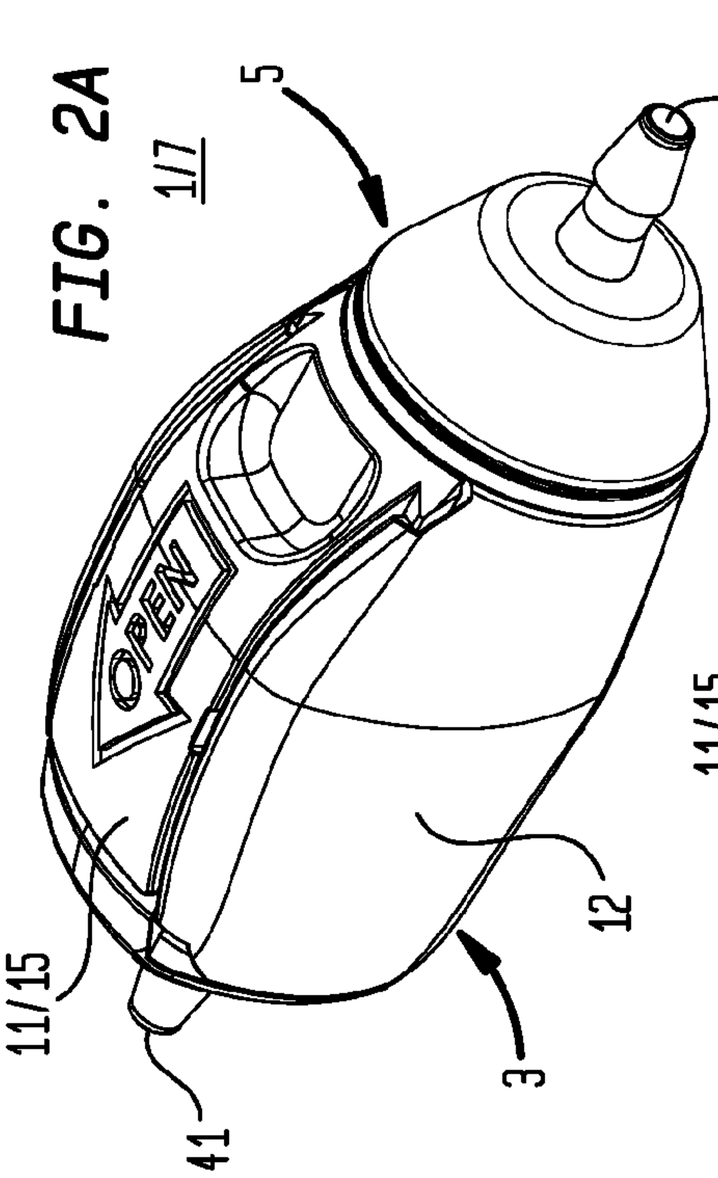


FIG. 2F

1/7

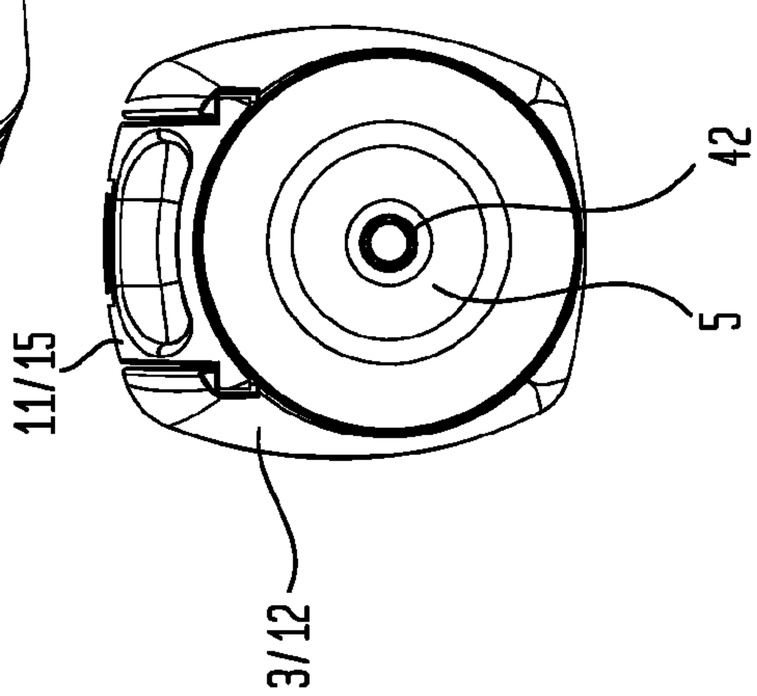
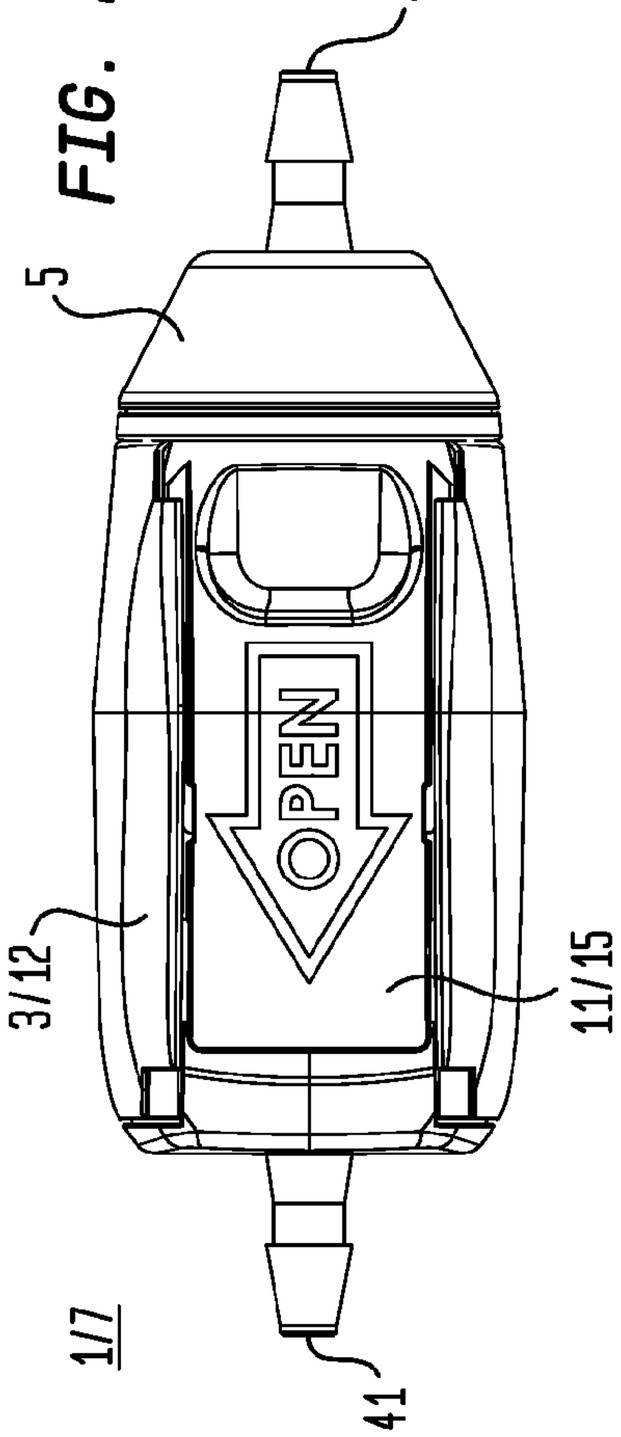
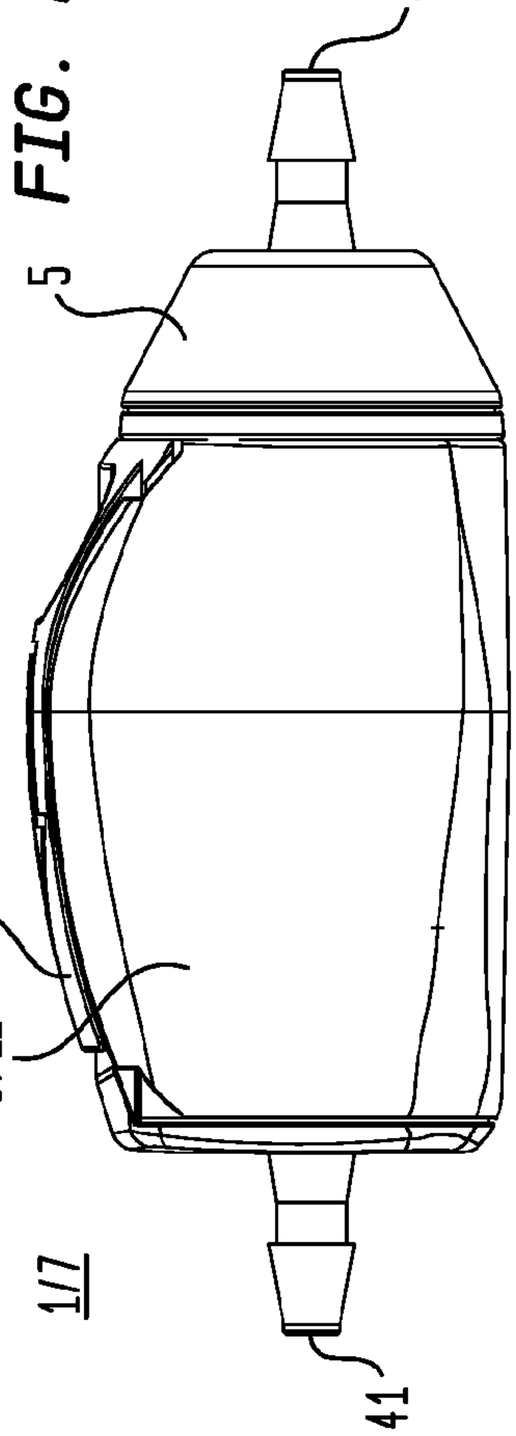


FIG. 2C



1/7

FIG. 2B



1/7

FIG. 2D

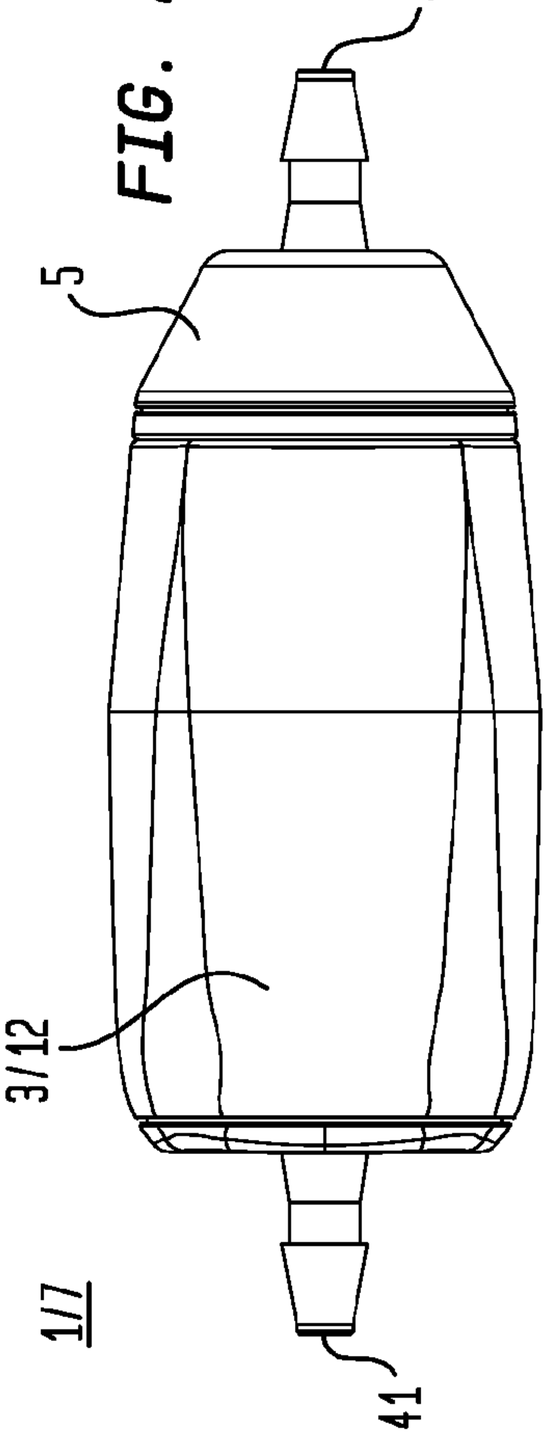


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FIG. 2E

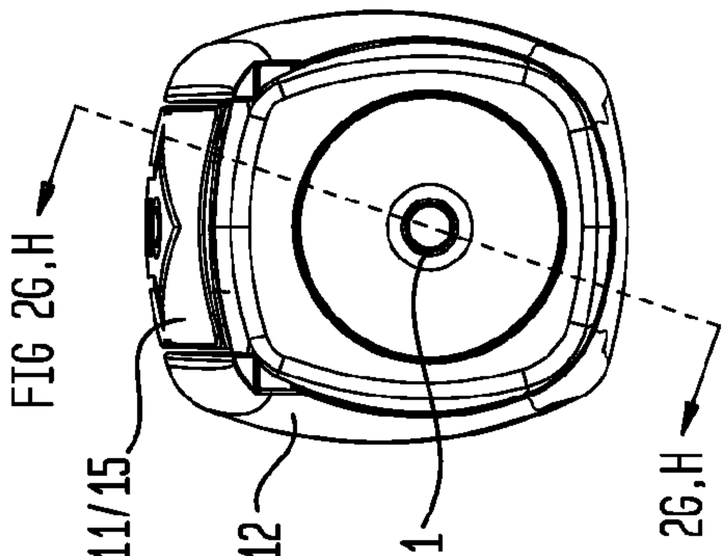
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FIG 2G,H
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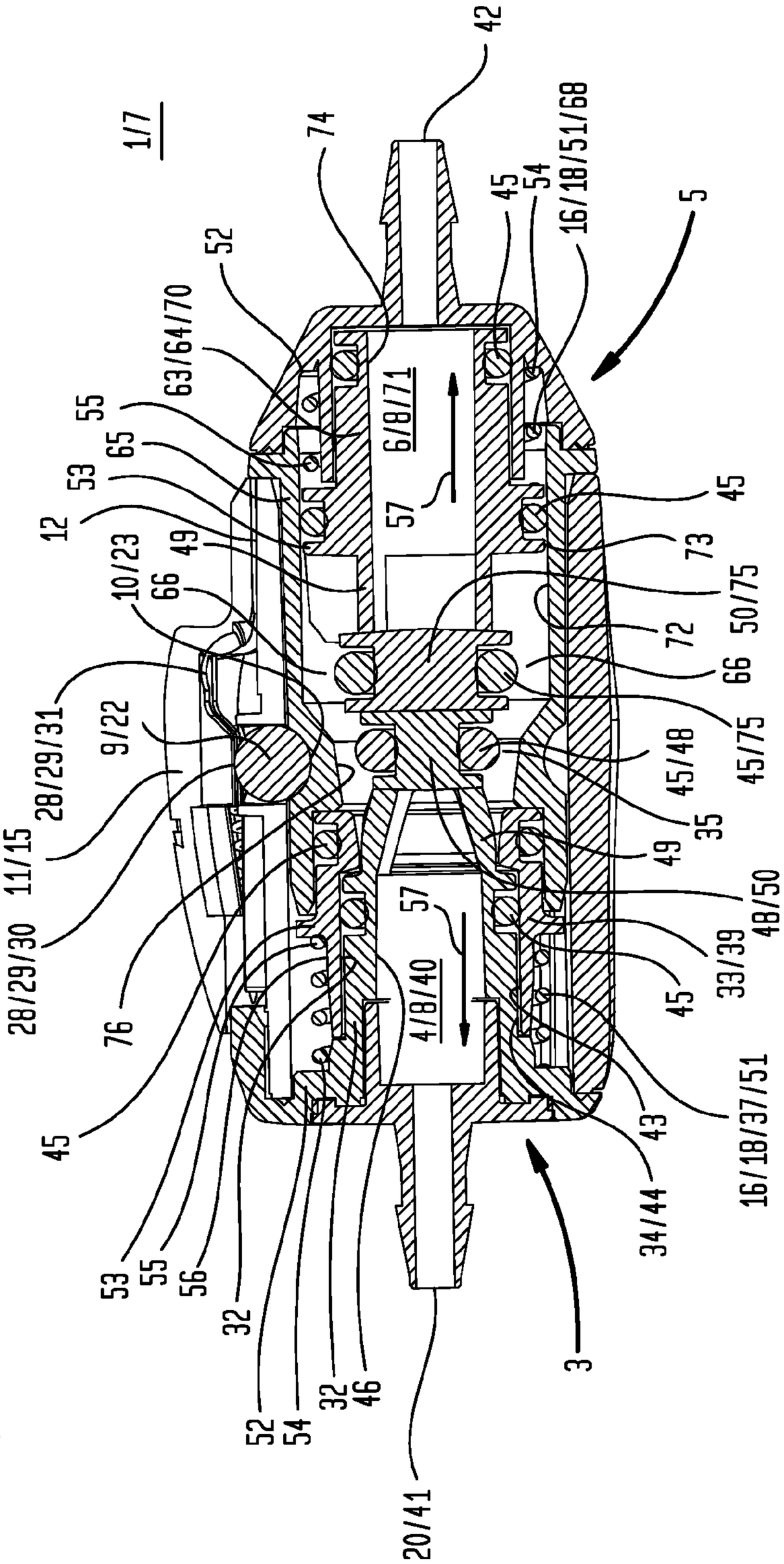
FIG 2G,H

FIG. 2G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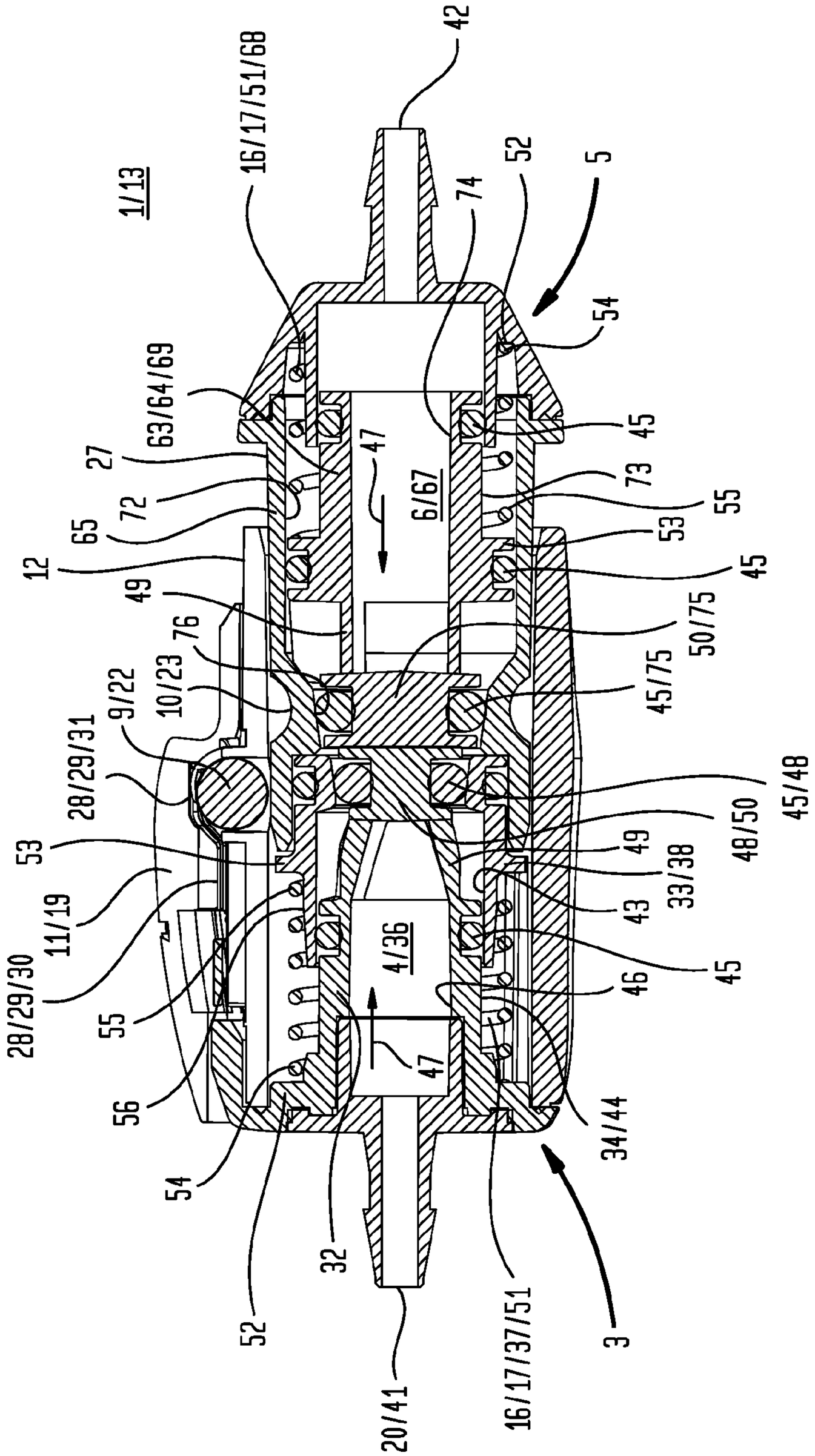
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FIG. 2H

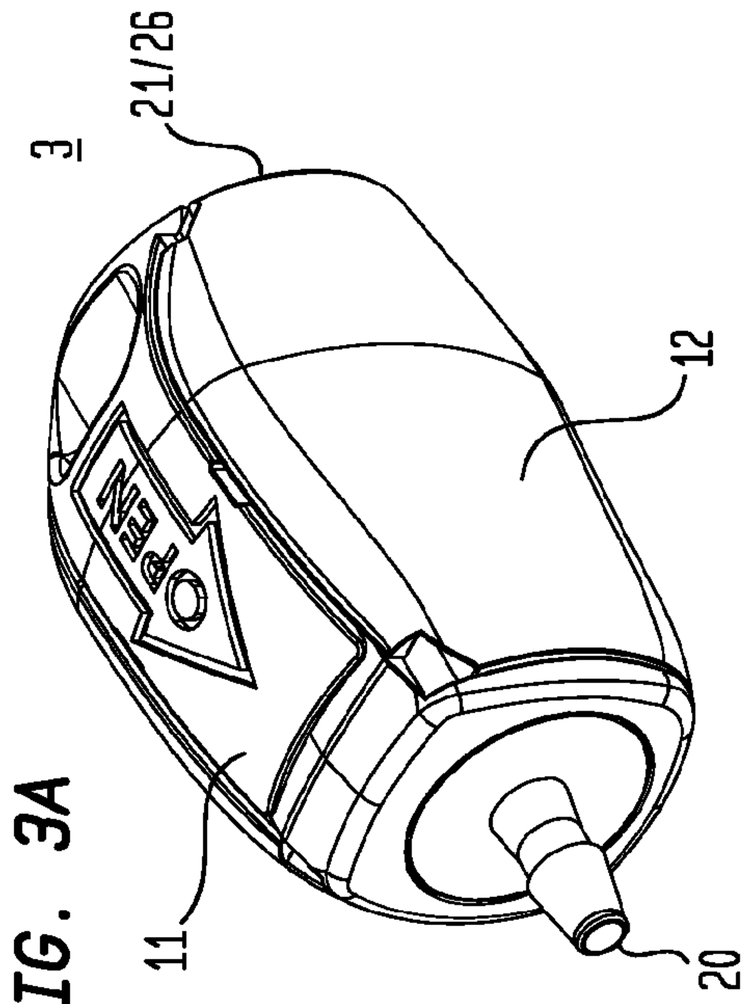


FIG. 3A

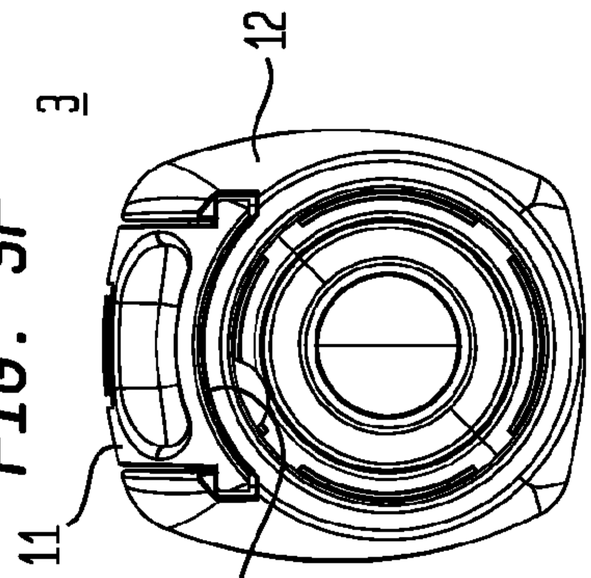


FIG. 3F

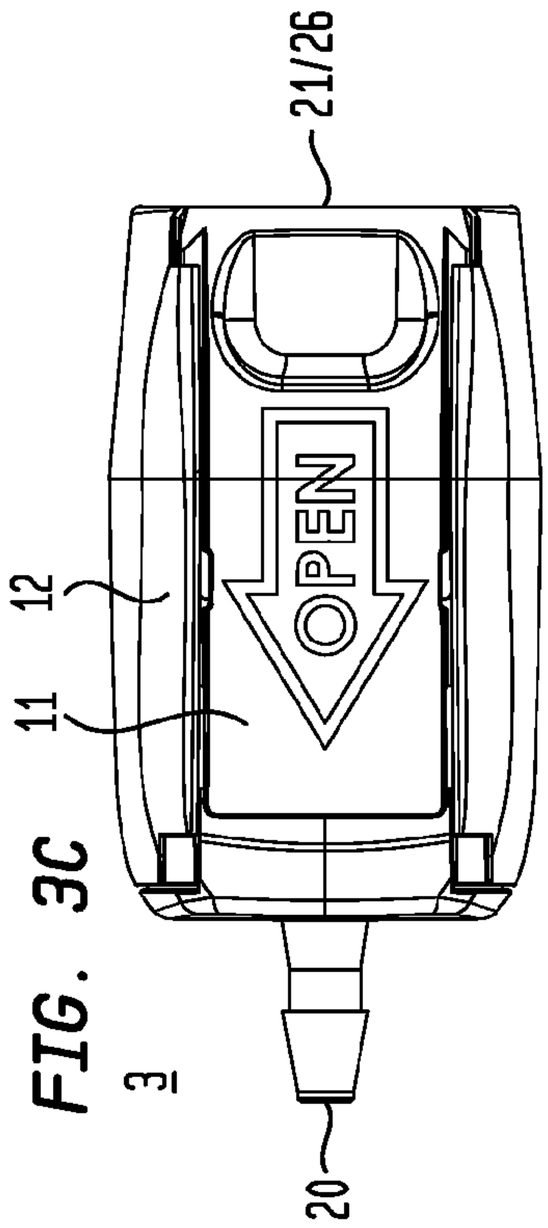


FIG. 3C

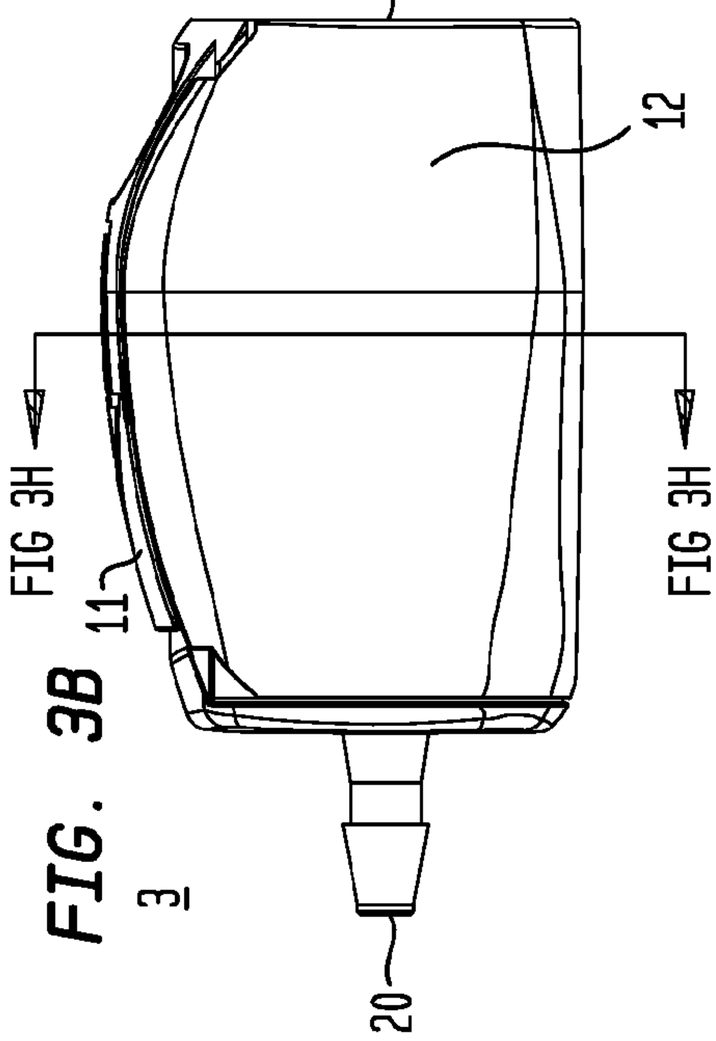


FIG. 3B

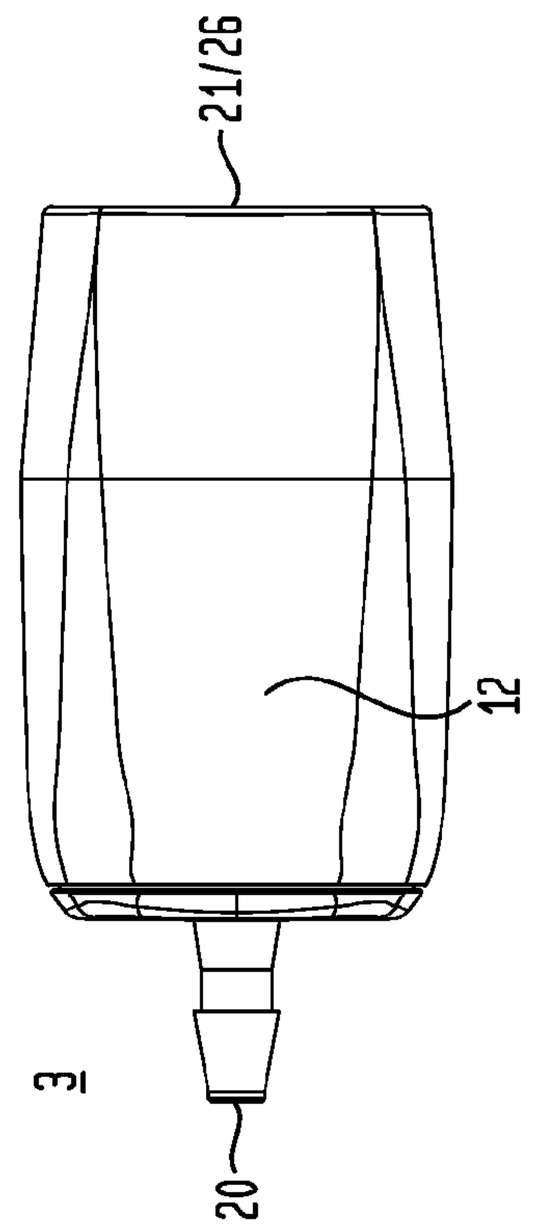


FIG. 3D

FIG. 3E

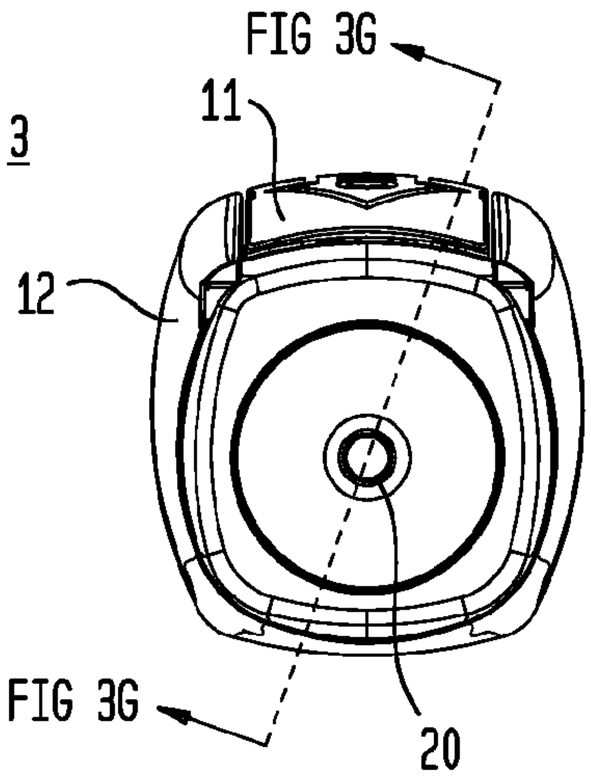


FIG. 3H

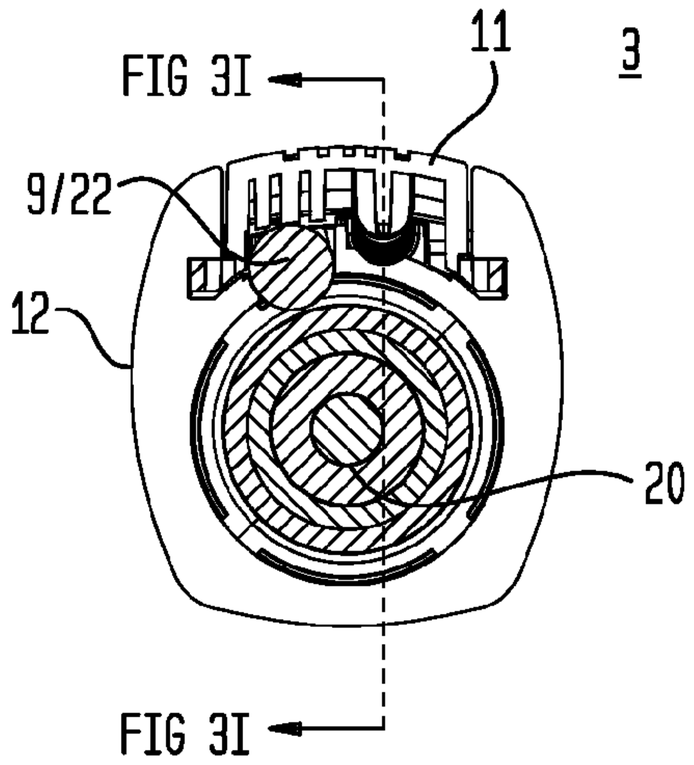


FIG. 3G

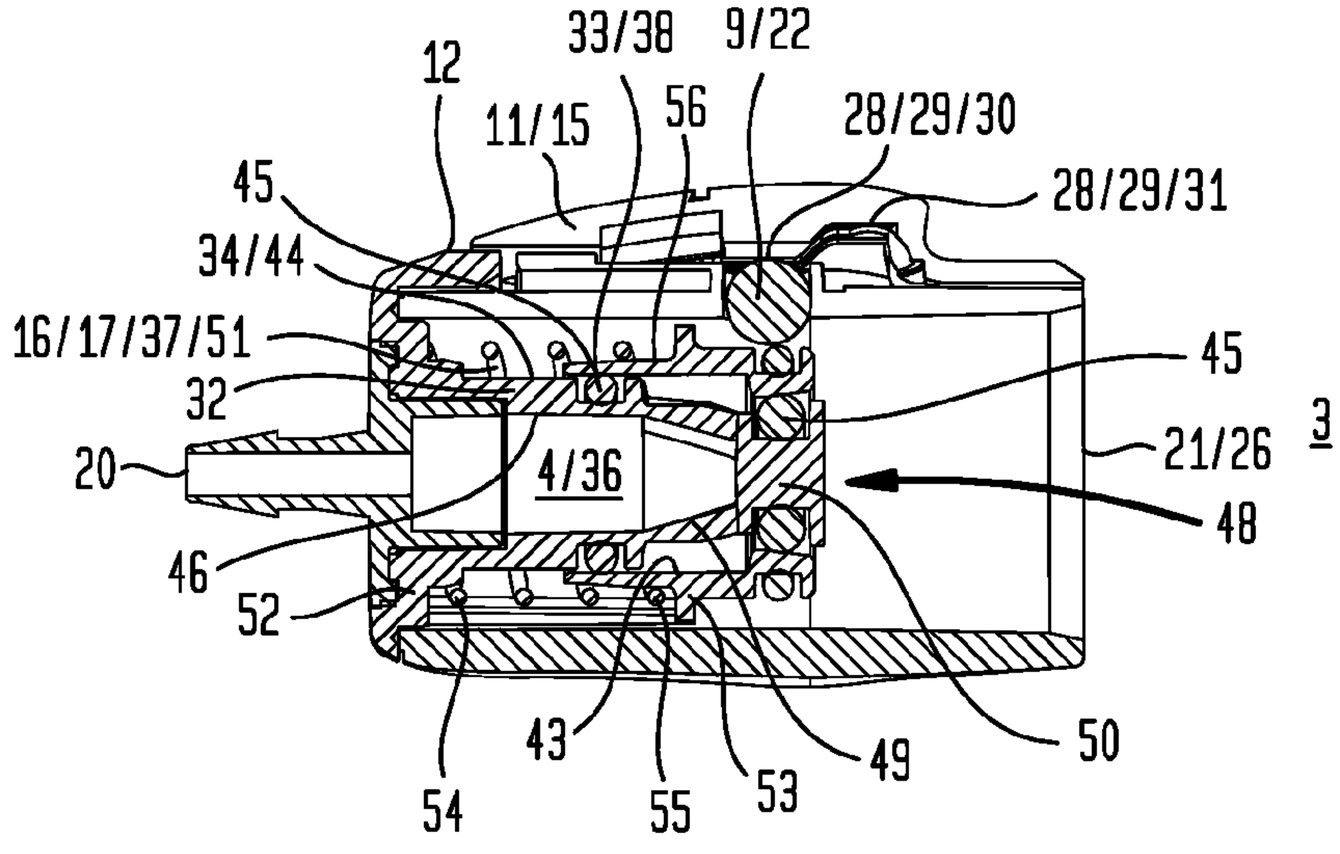


FIG. 3I

FIG. 4A

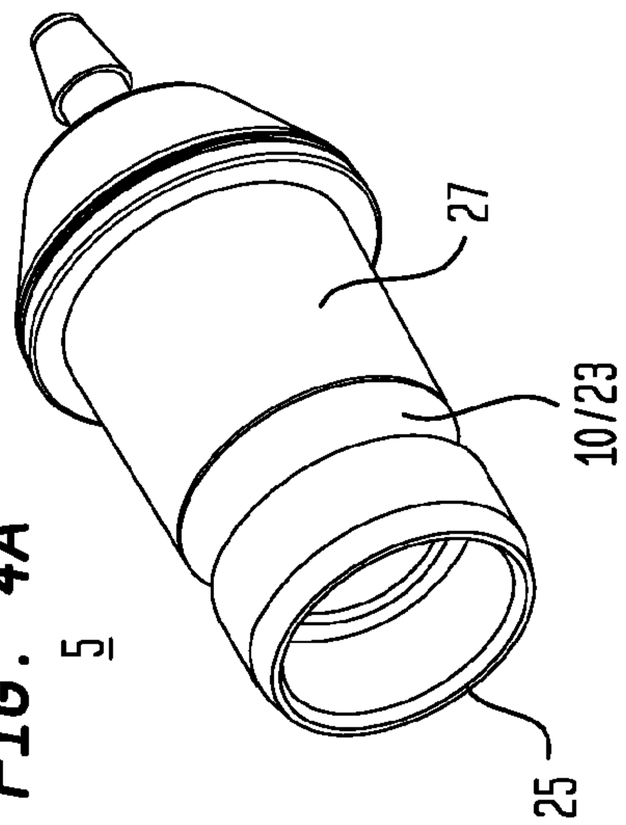


FIG. 4F

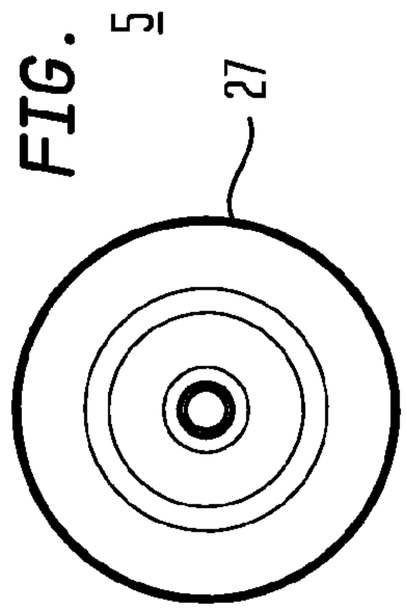


FIG. 4G

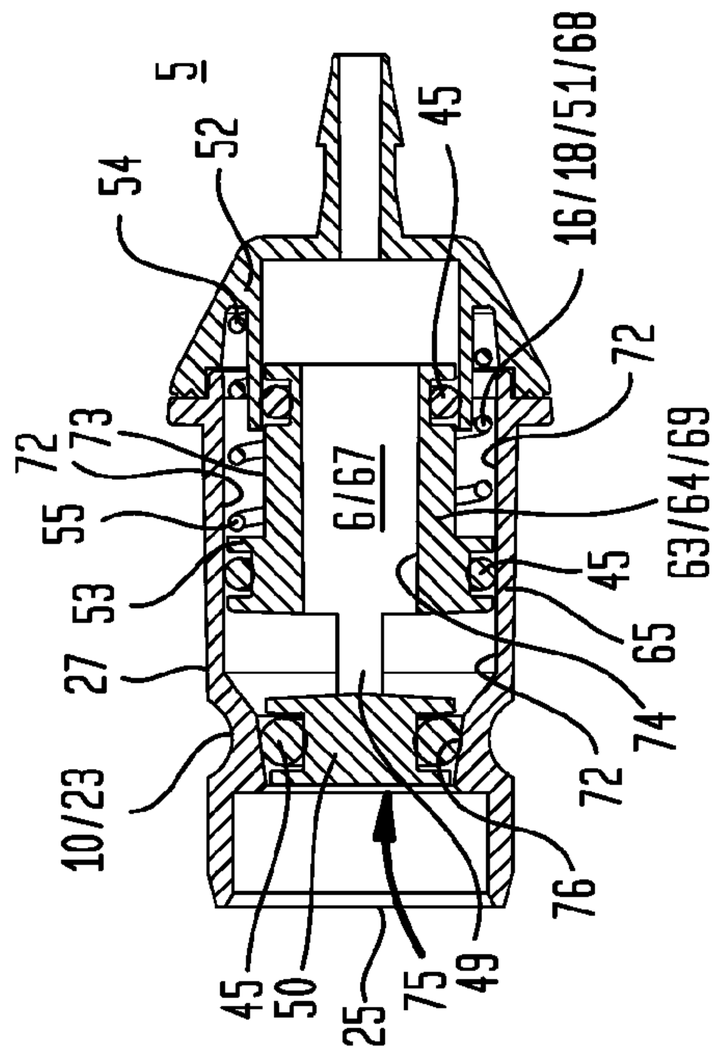


FIG. 4C

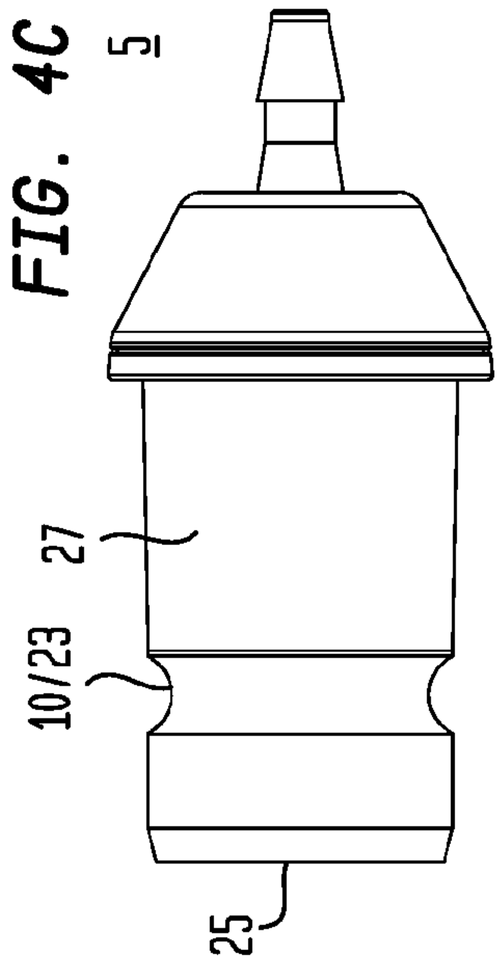


FIG. 4B

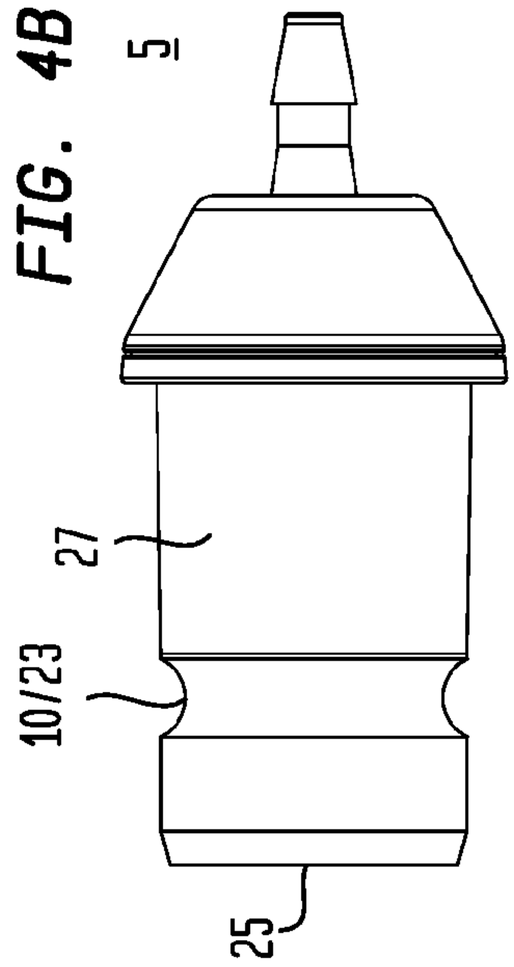


FIG. 4D

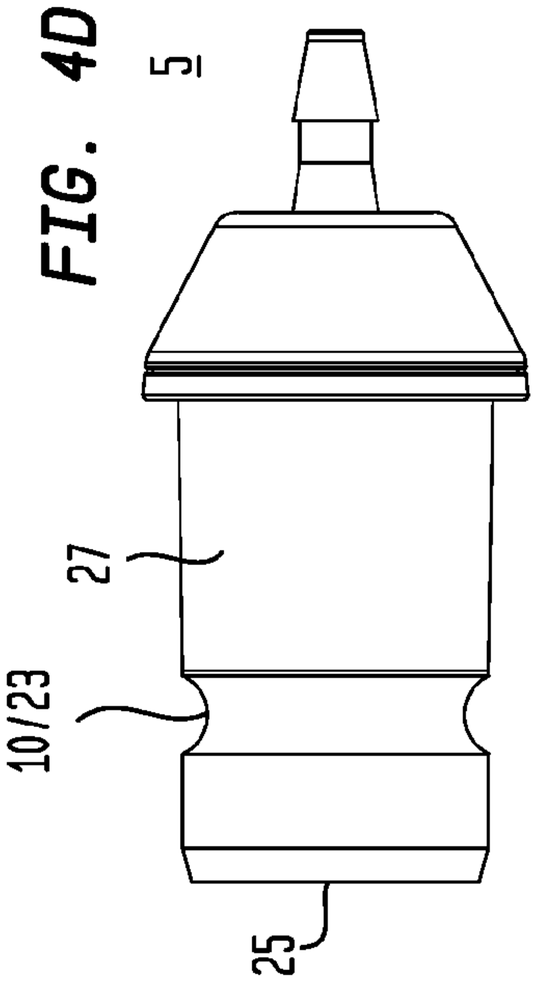
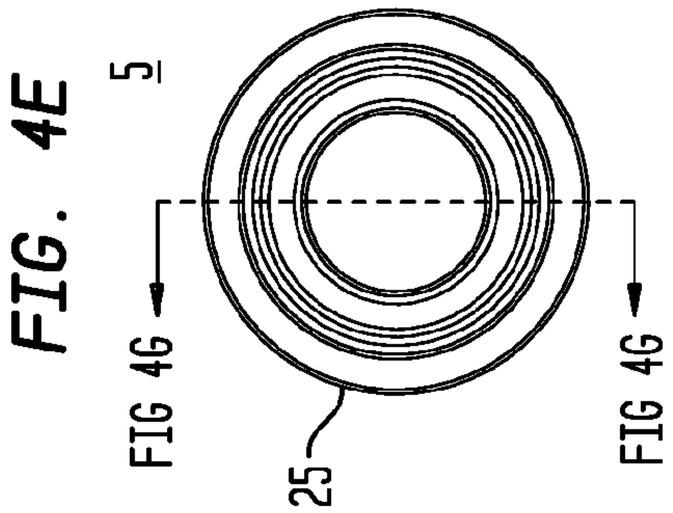


FIG. 4E



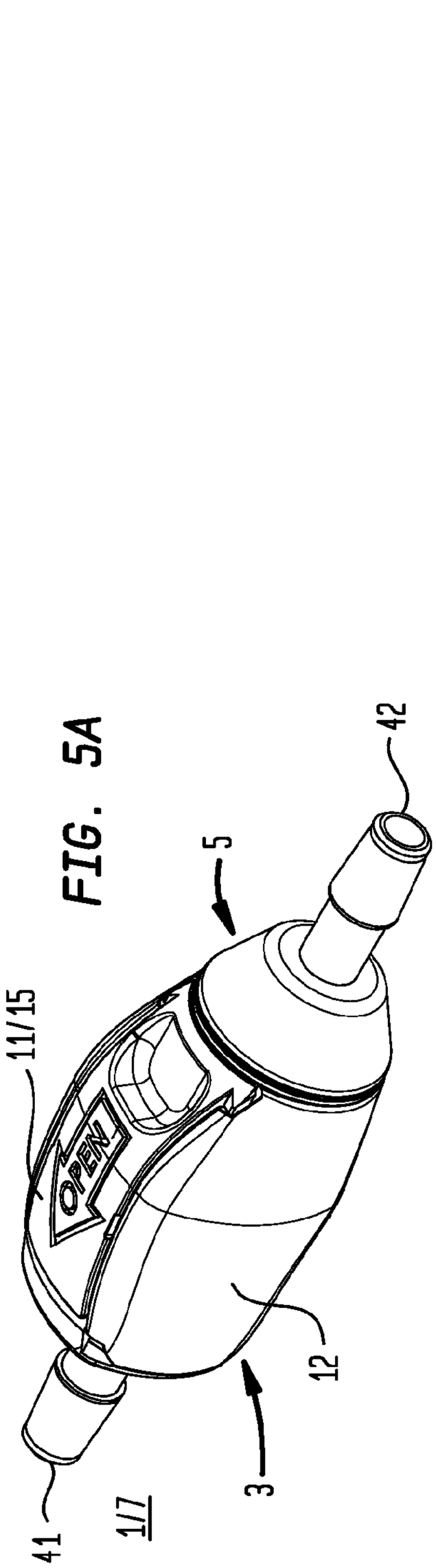


FIG. 5A

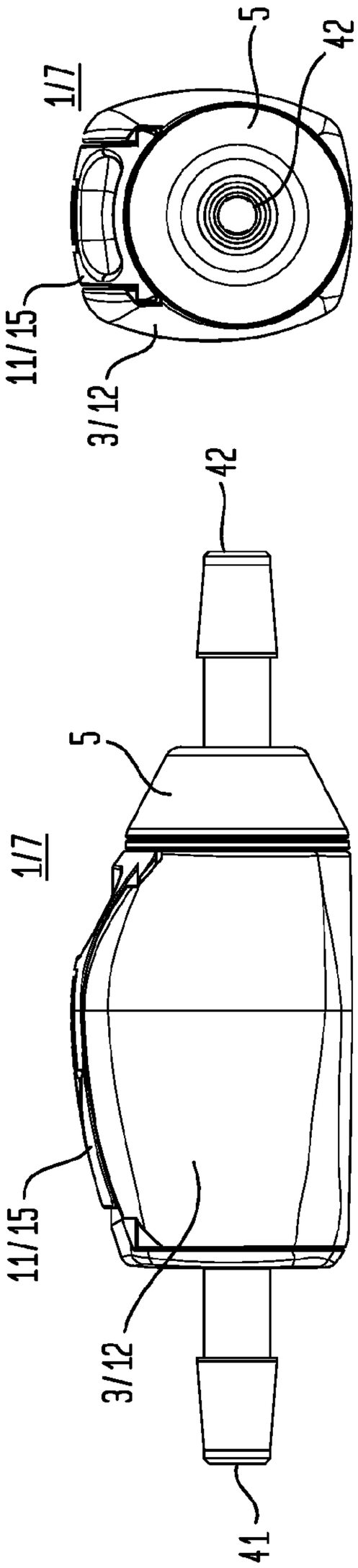


FIG. 5B

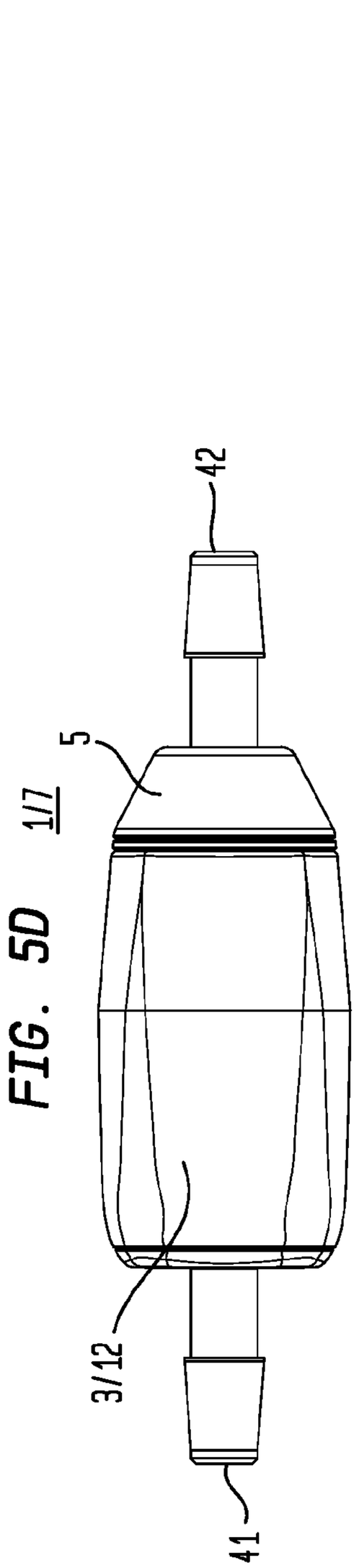


FIG. 5D

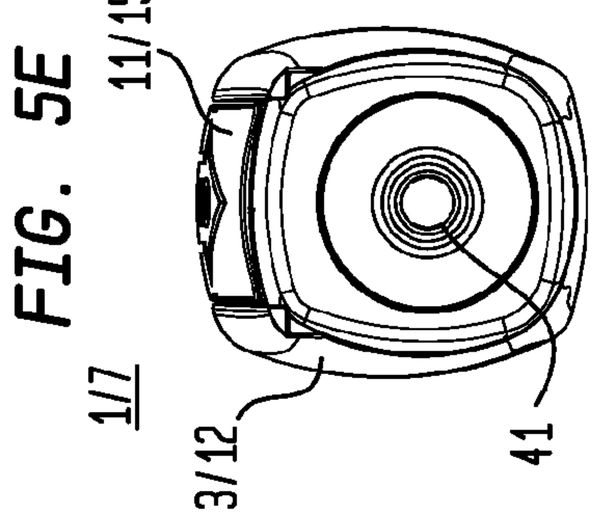


FIG. 5E

FIG. 5F

FIG. 5C

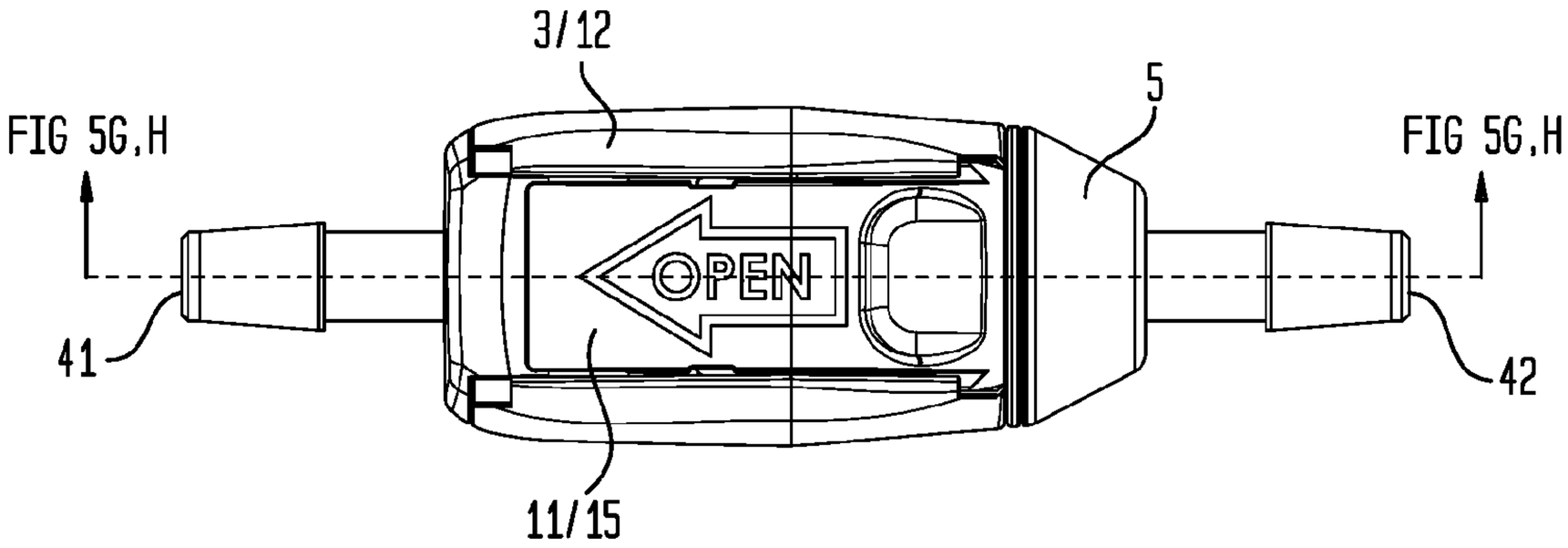


FIG. 5G

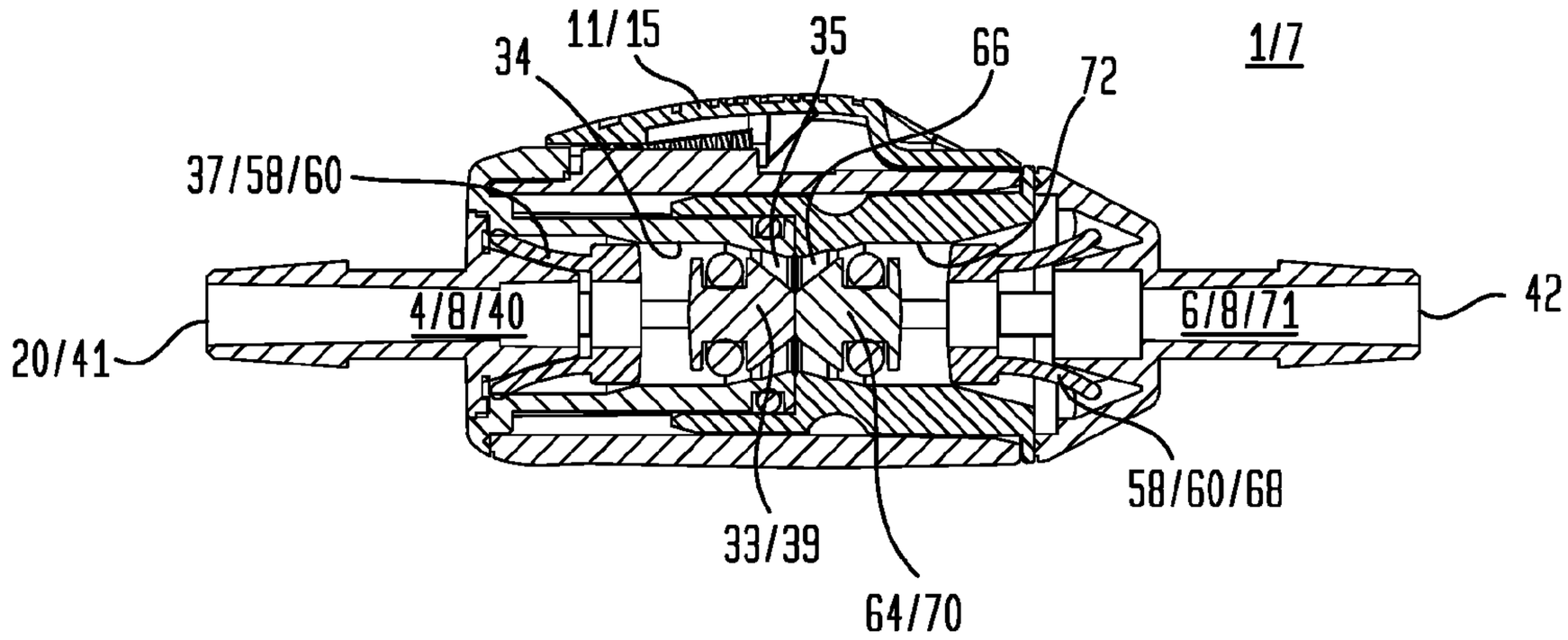
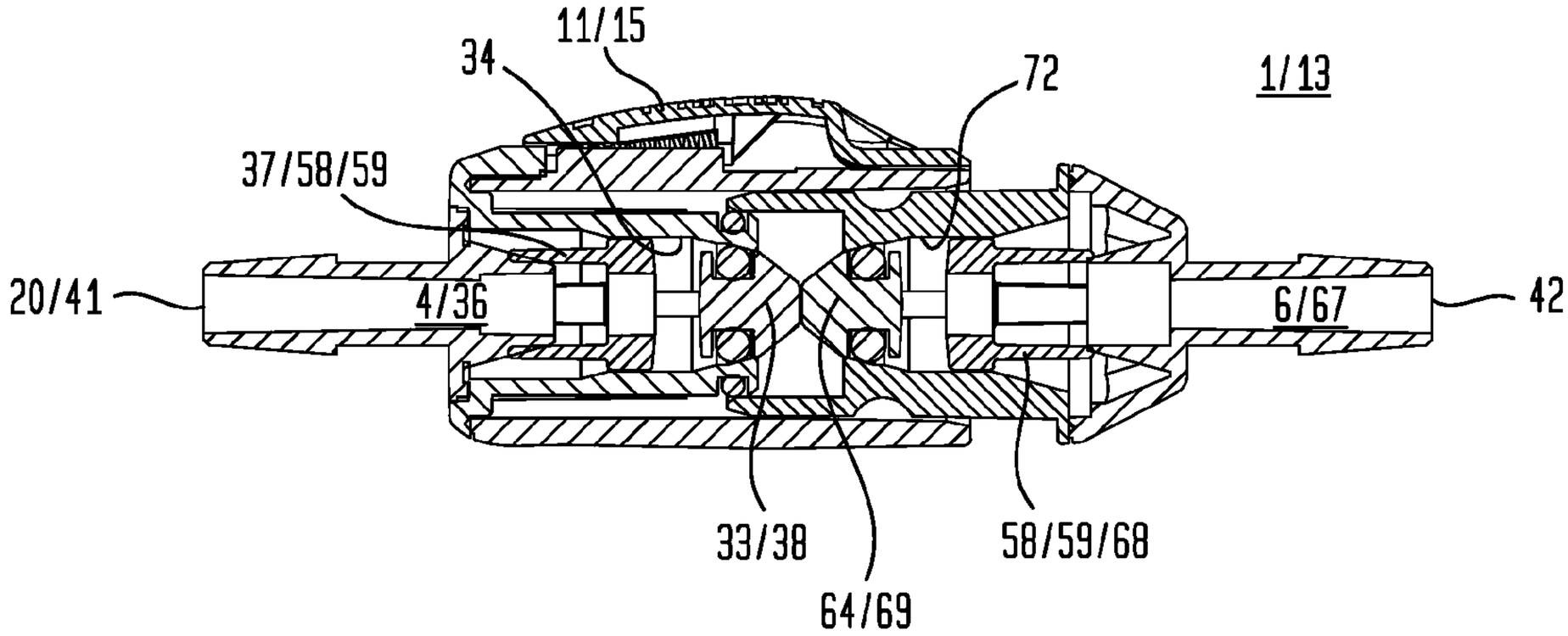


FIG. 5H



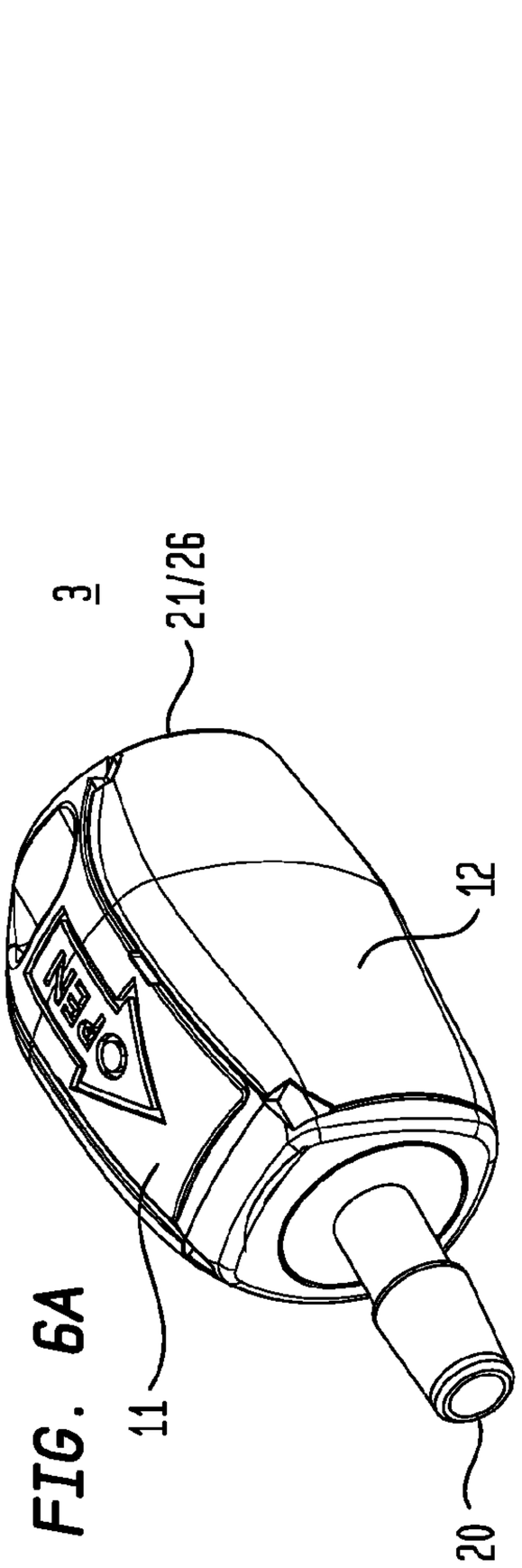


FIG. 6A

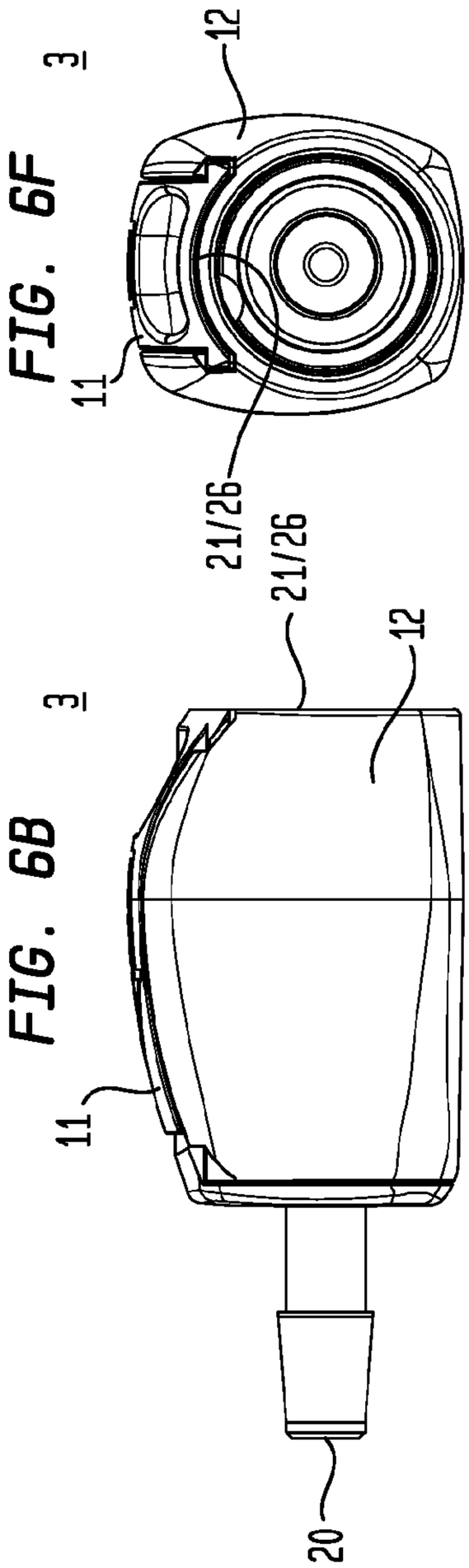


FIG. 6B

FIG. 6D

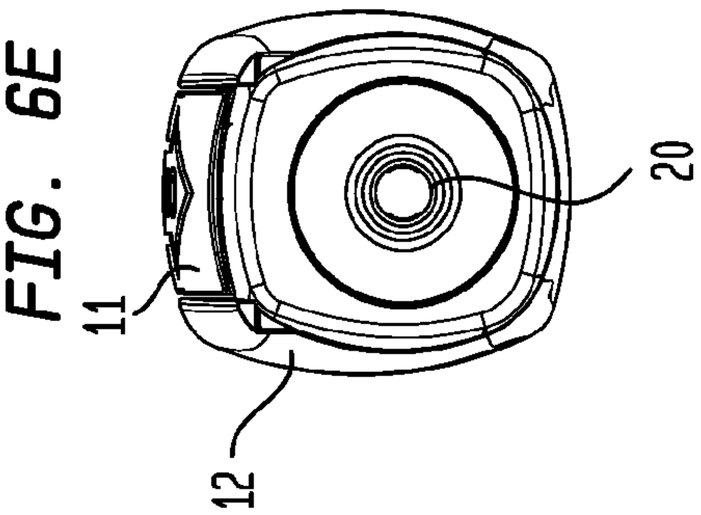


FIG. 6E

FIG. 6C

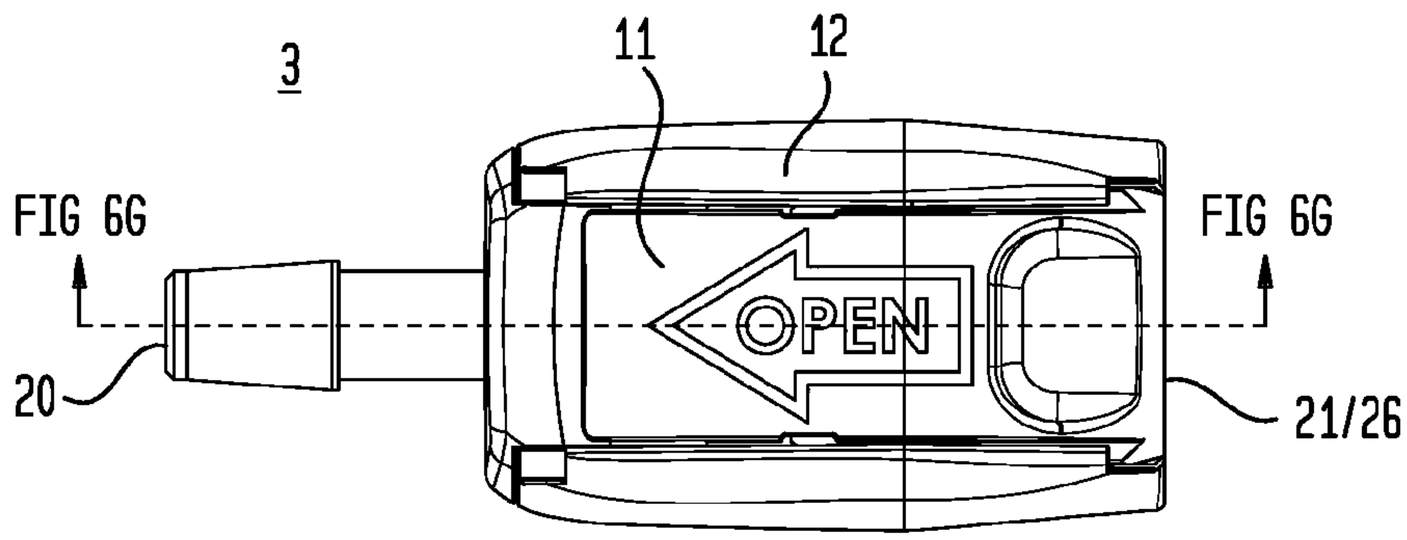

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FIG 6G
FIG 6G
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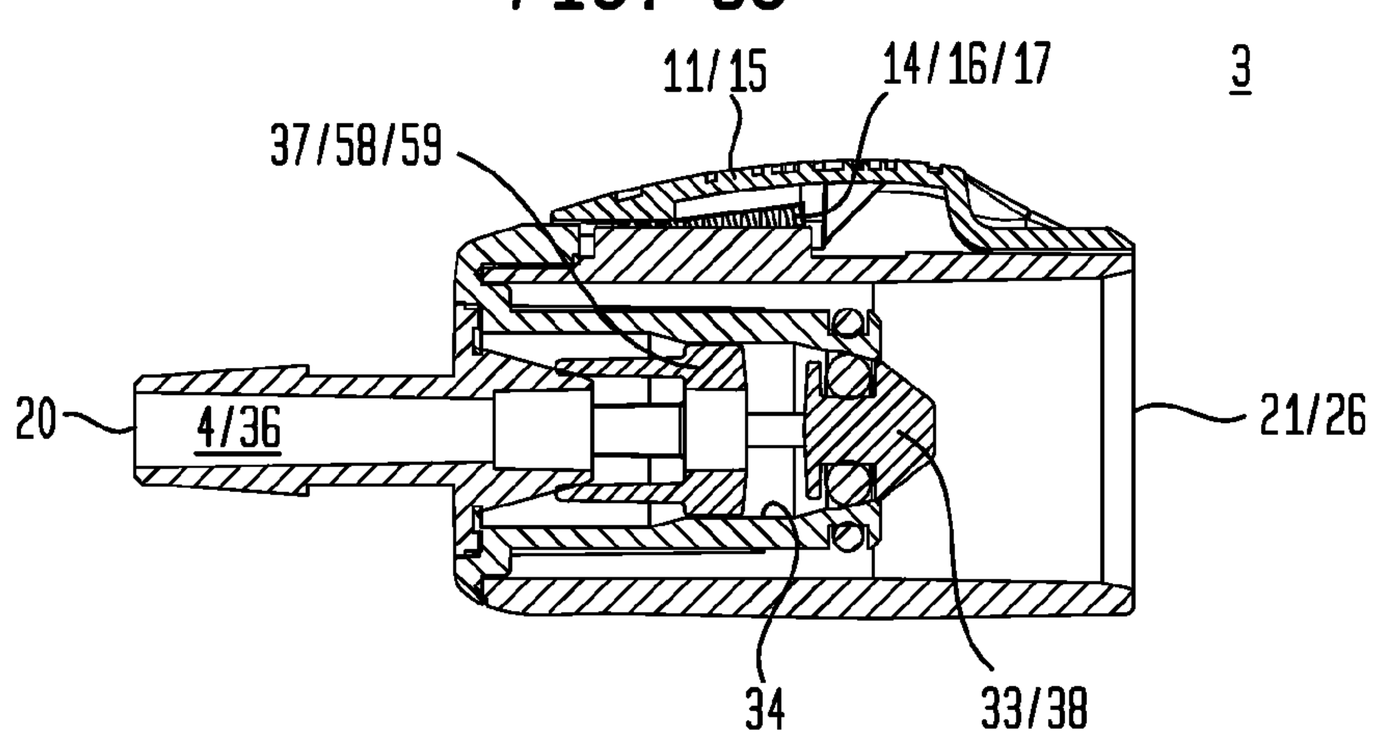
FIG. 6G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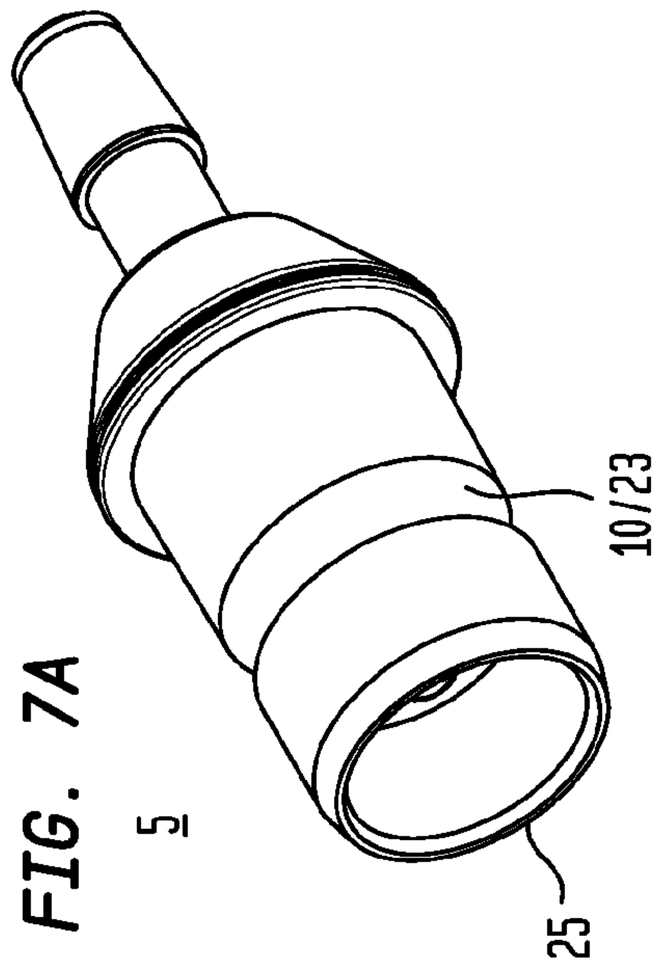


FIG. 7A

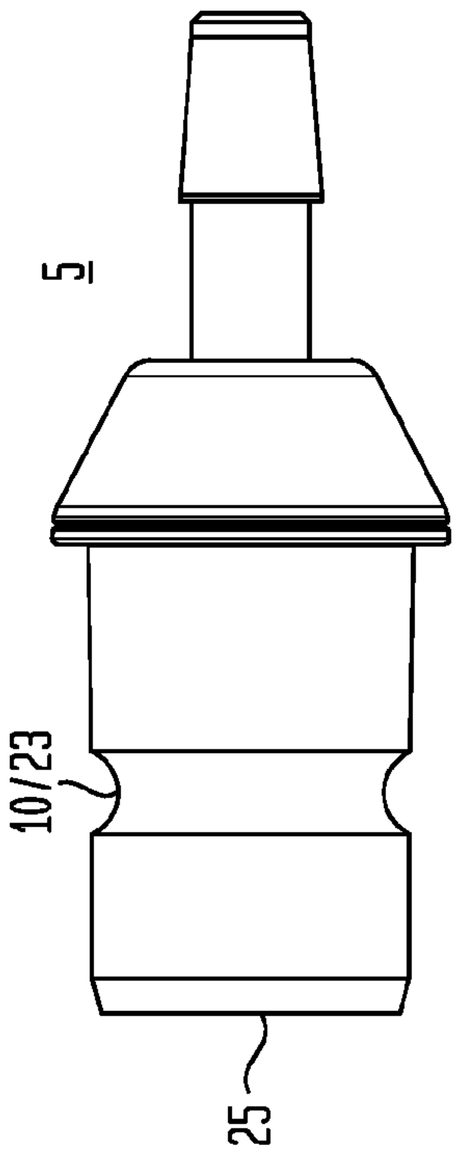


FIG. 7B

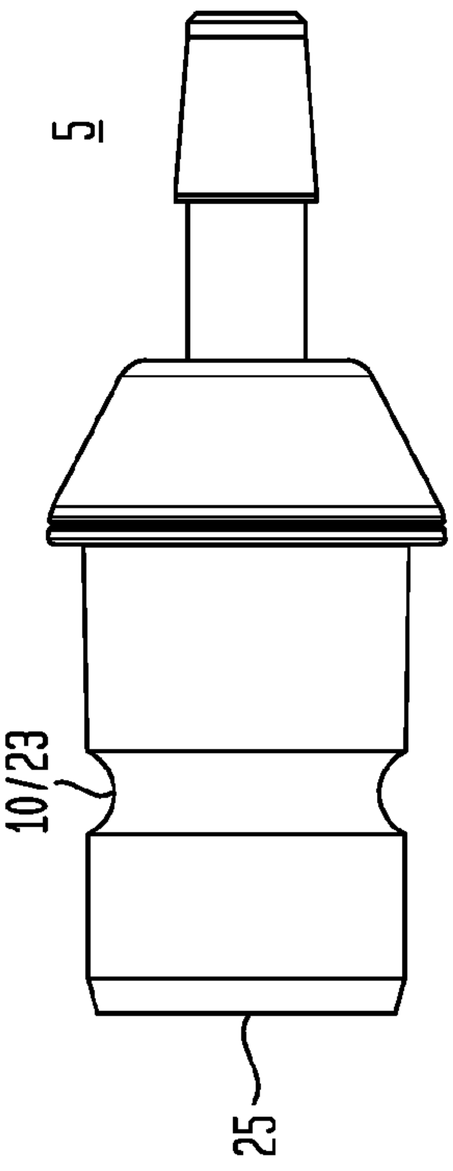


FIG. 7D

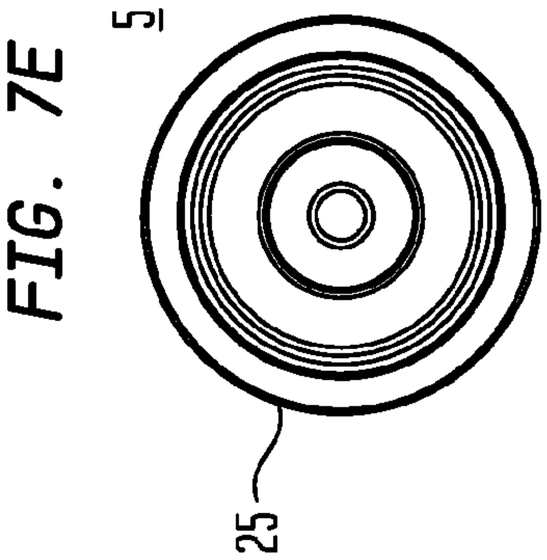


FIG. 7E

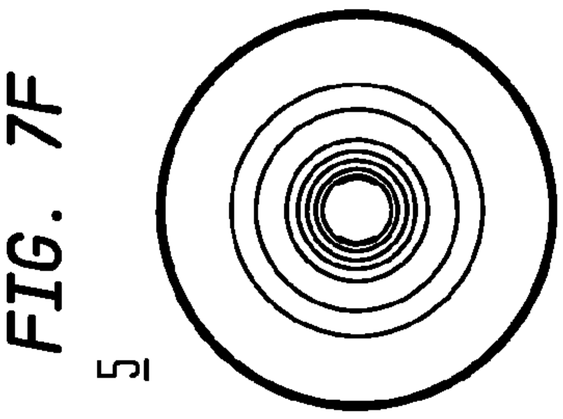


FIG. 7F

FIG. 7C

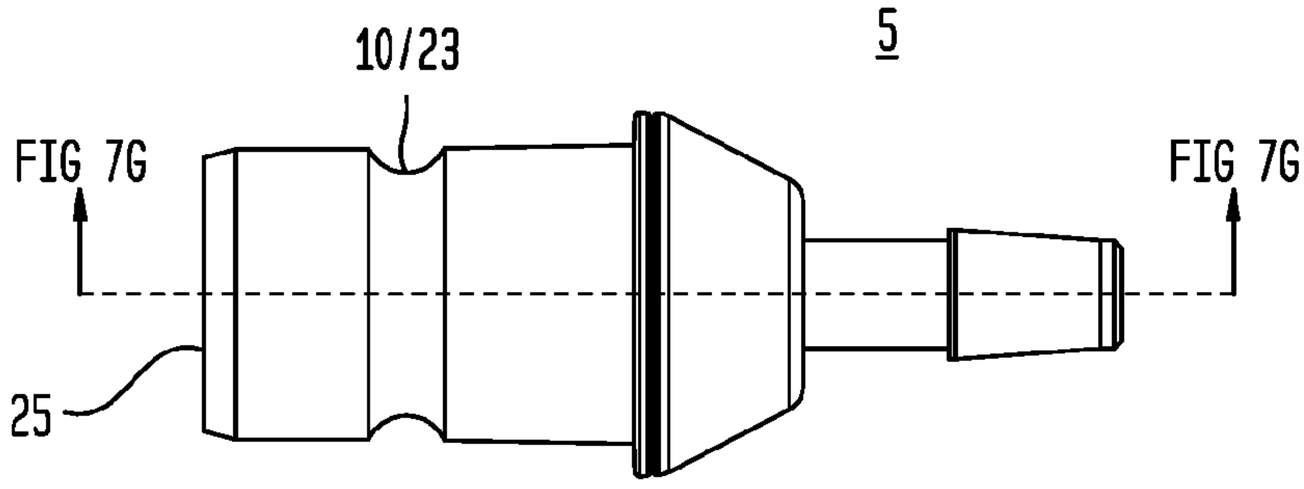


FIG. 7G

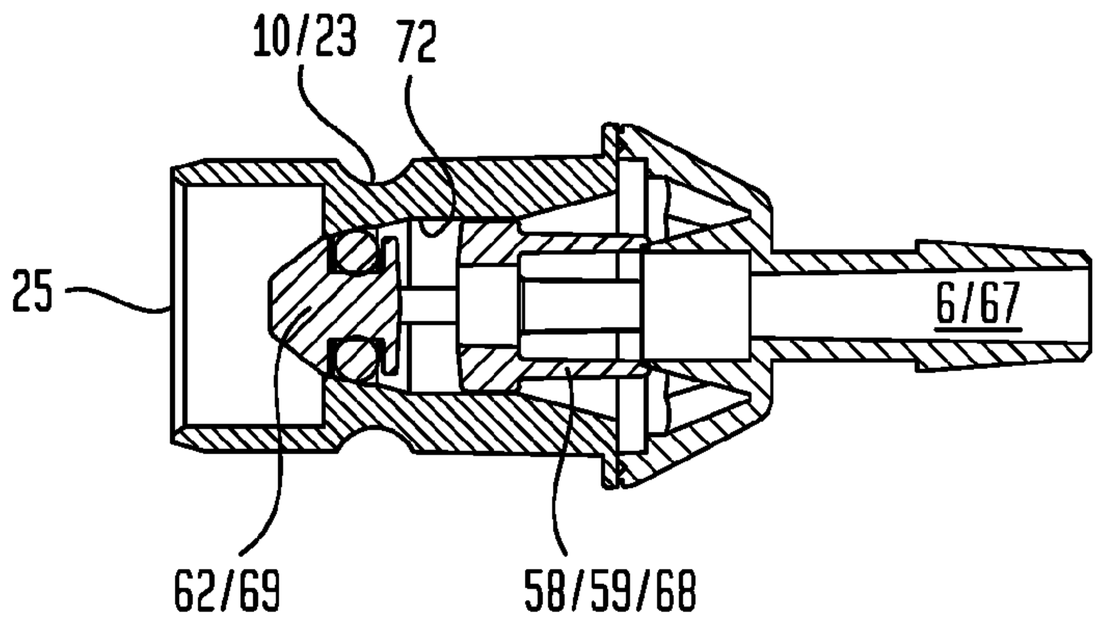


FIG. 8A

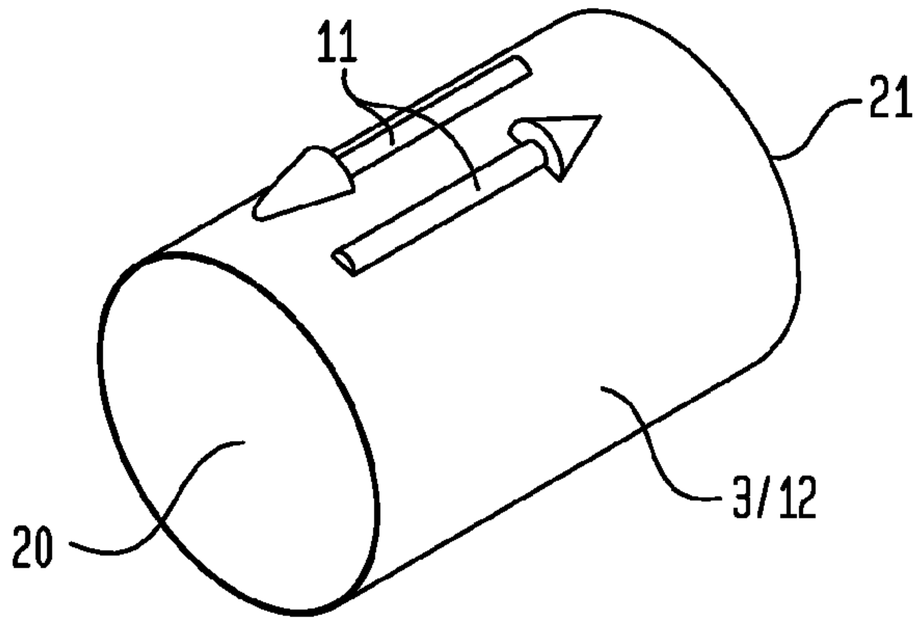


FIG. 8B

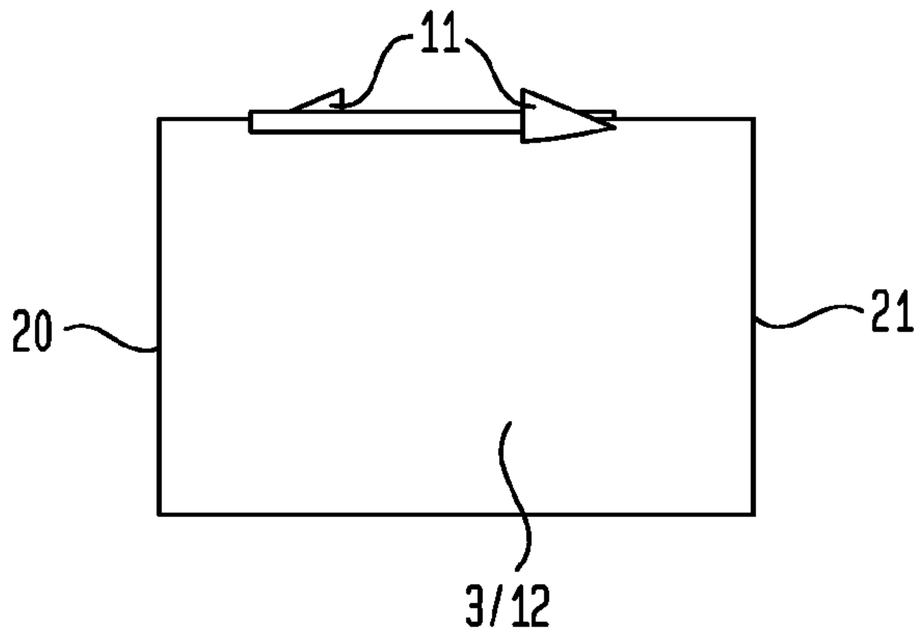


FIG. 8C

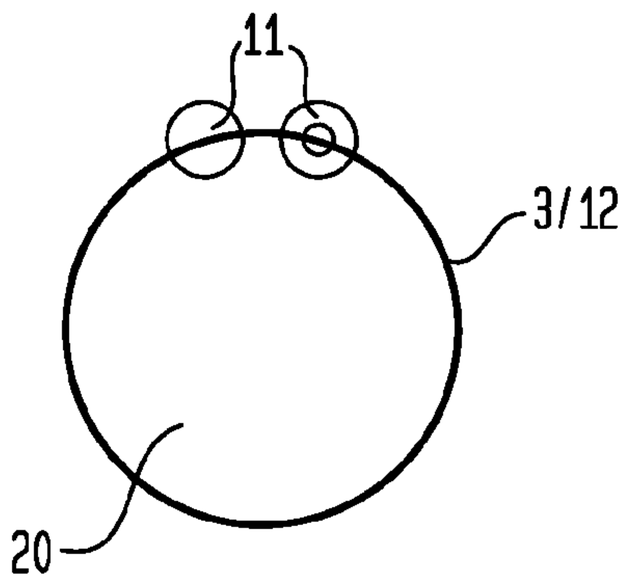


FIG. 8D

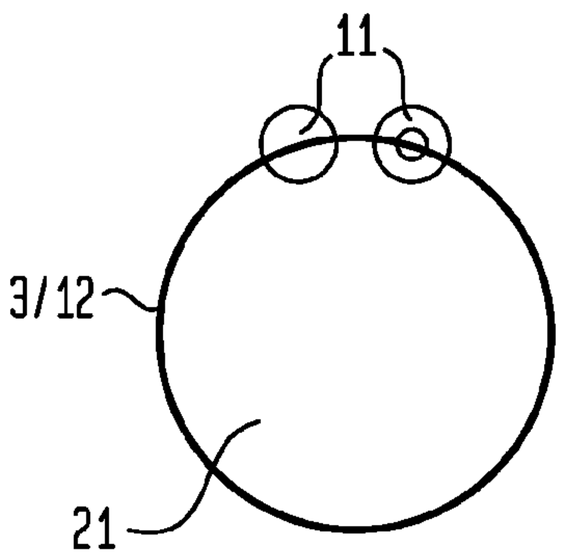


FIG. 9A

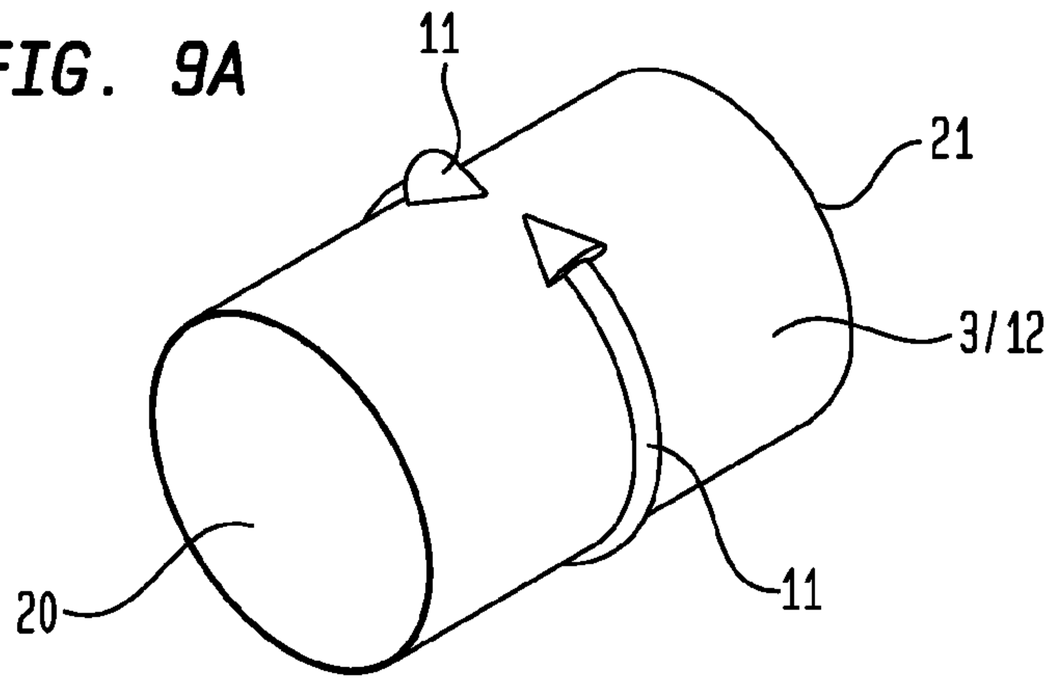


FIG. 9B

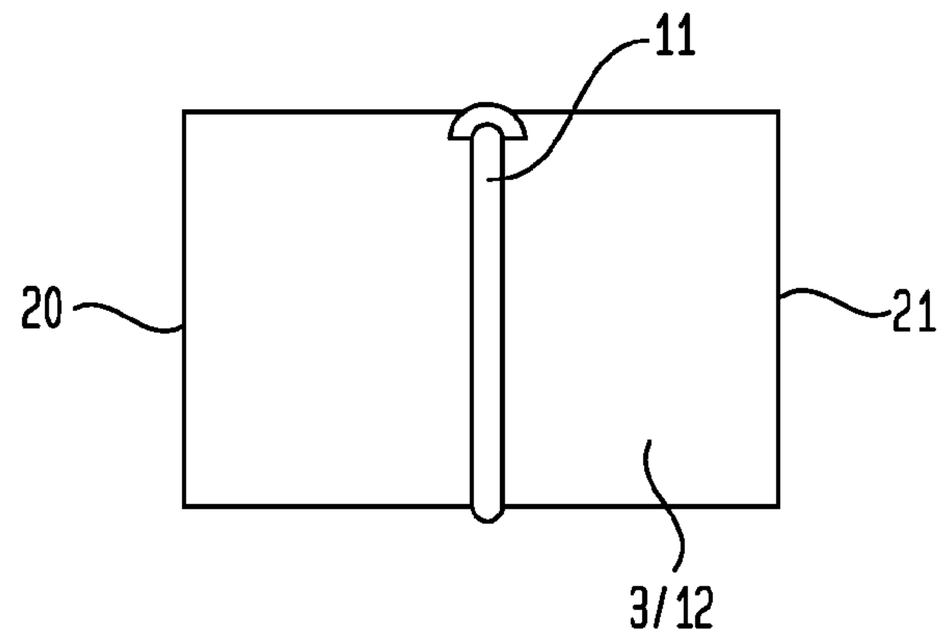


FIG. 9C

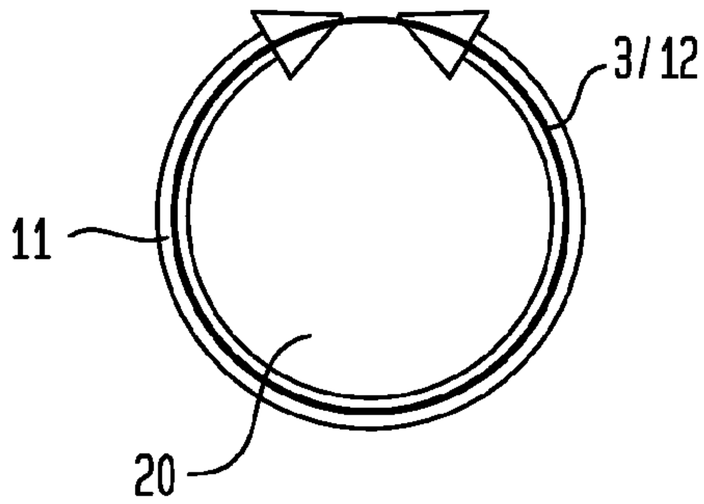


FIG. 9D

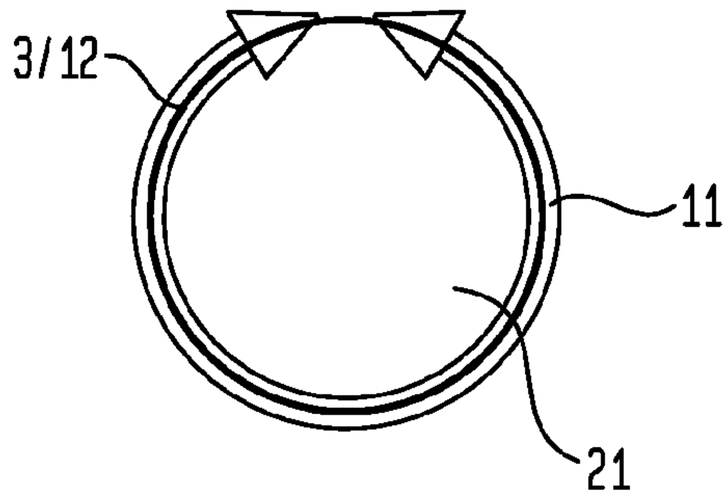


FIG. 10A

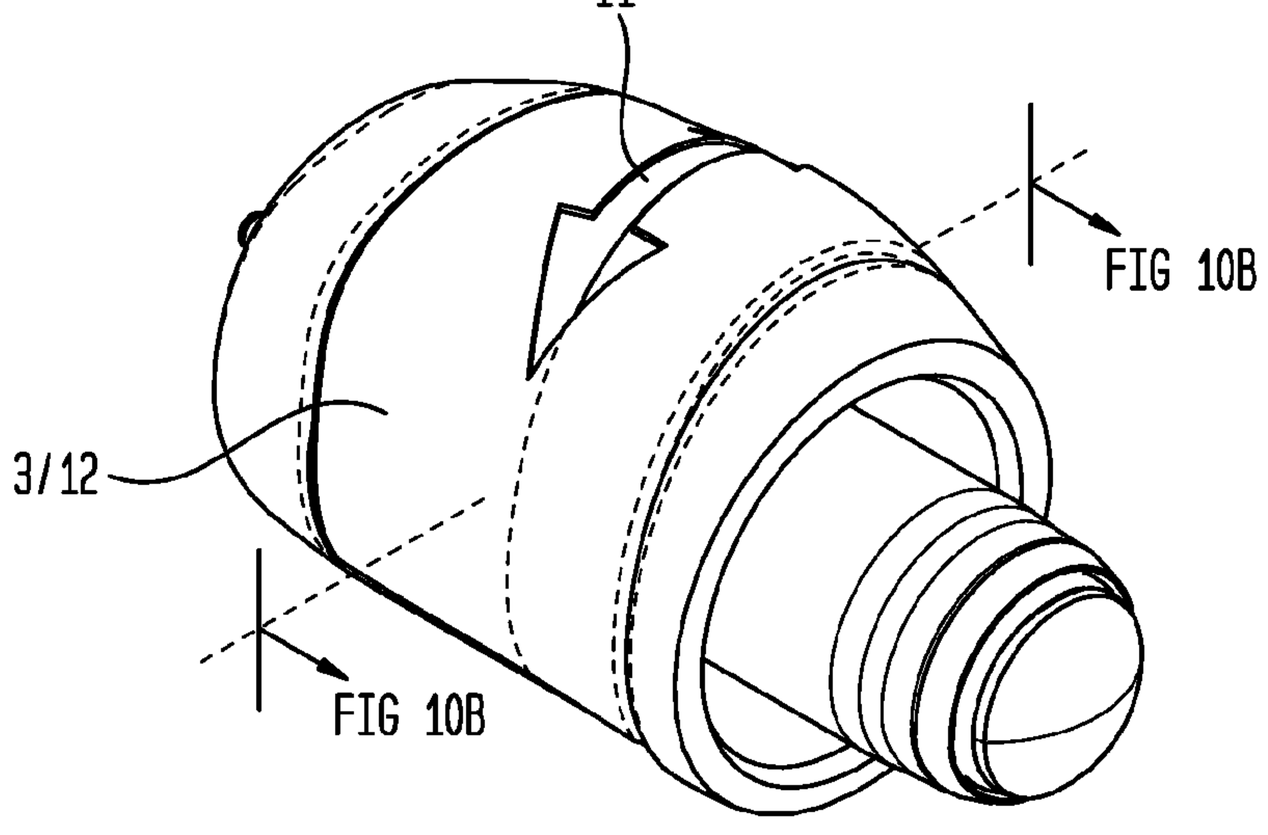


FIG. 10B

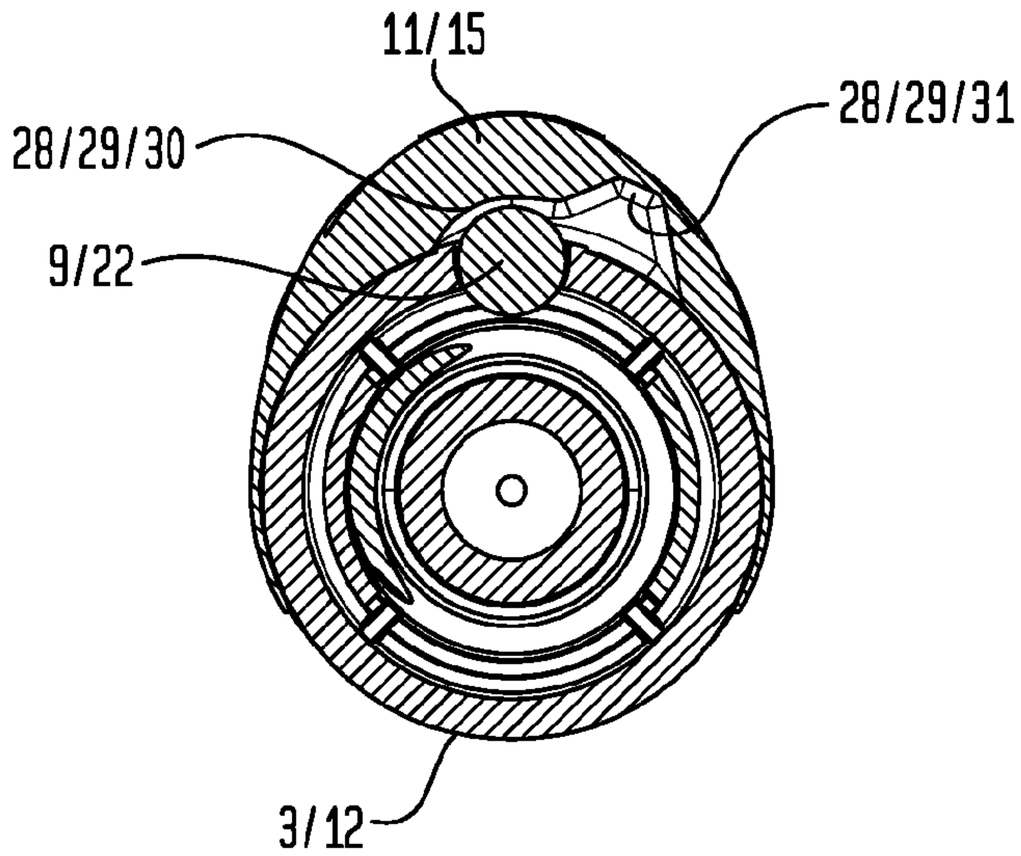


FIG. 11A

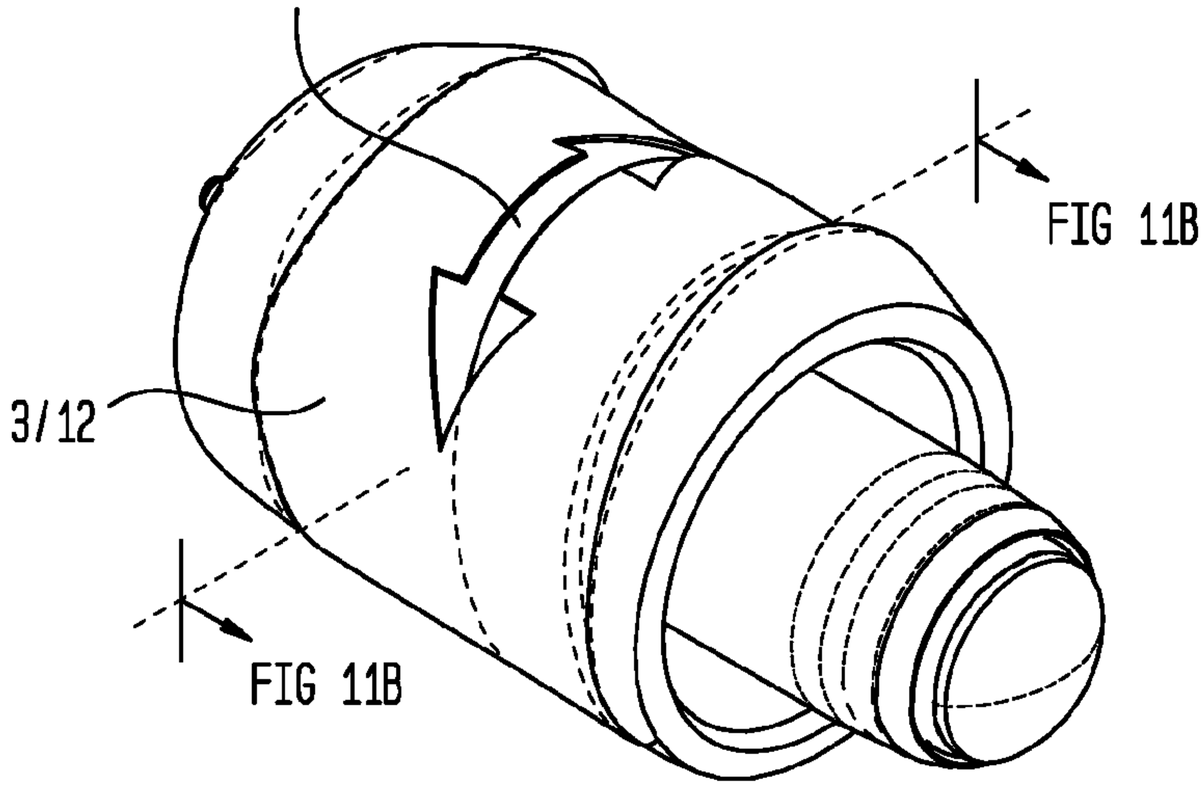


FIG. 11B

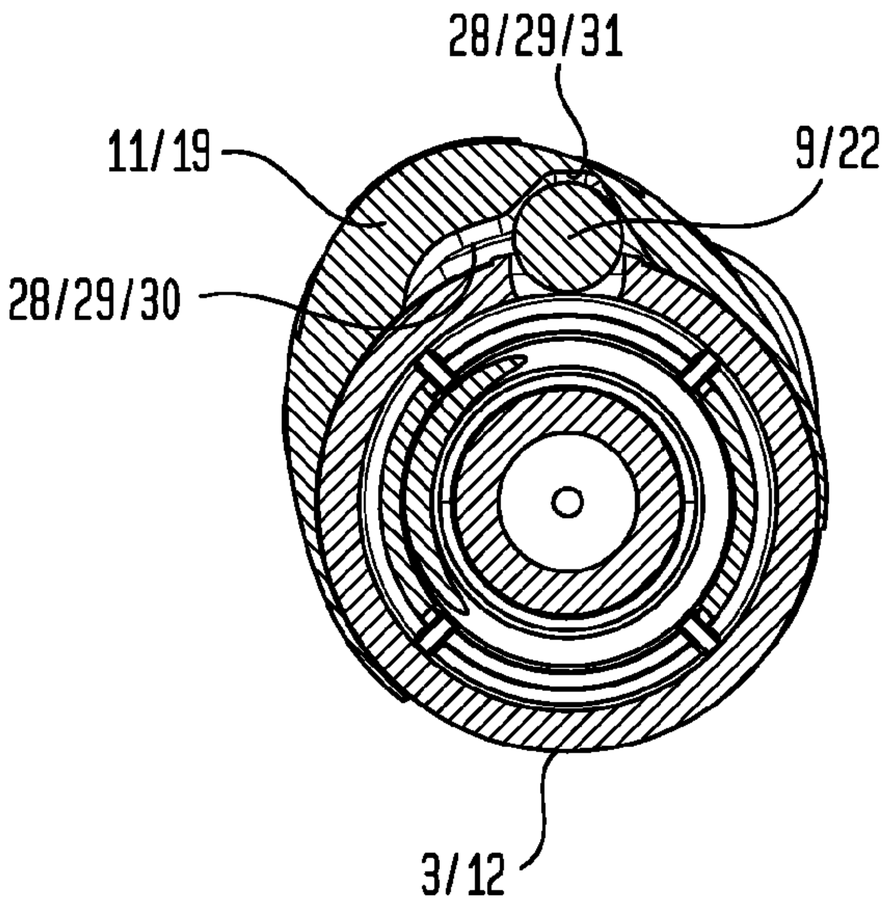


FIG. 12A

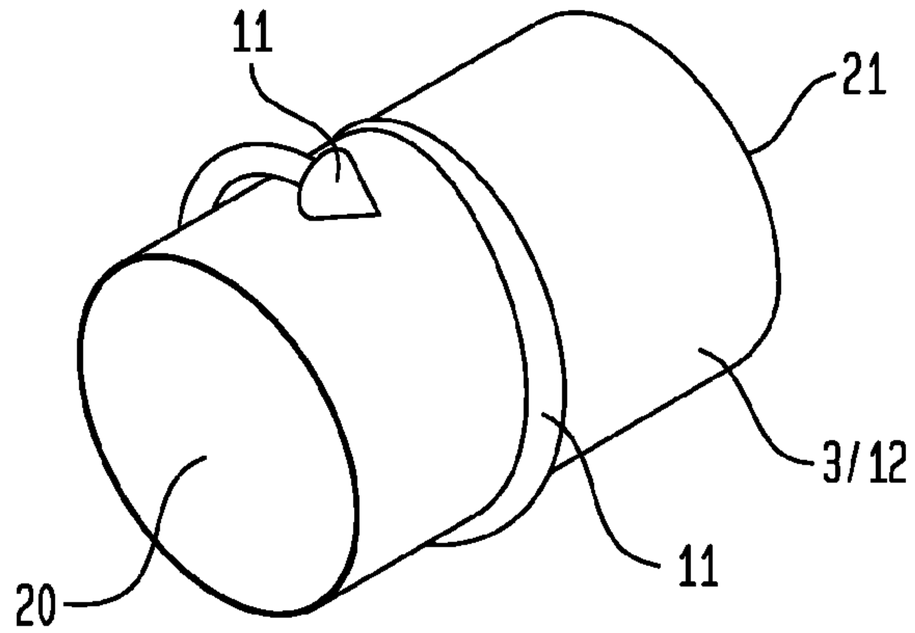


FIG. 12B

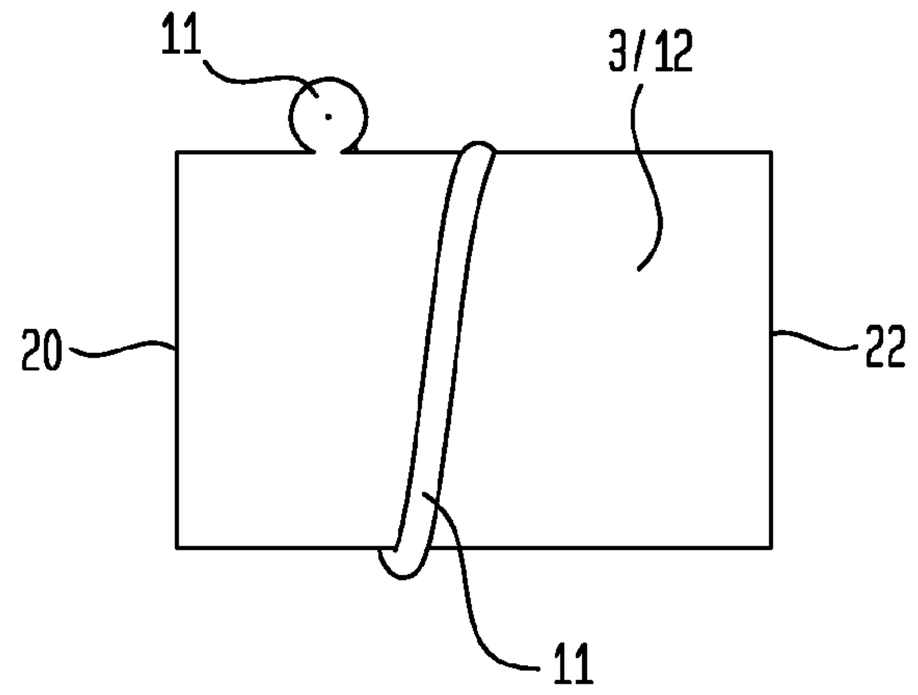


FIG. 12C

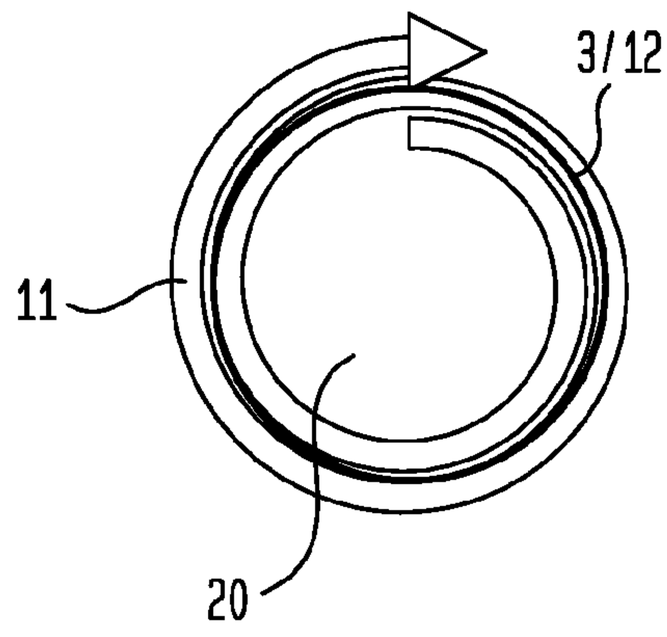


FIG. 12D

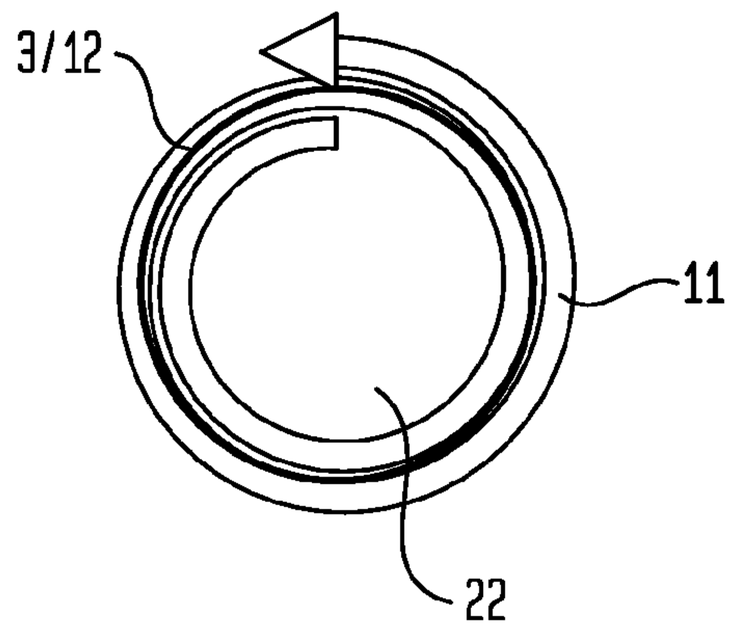


FIG. 13A

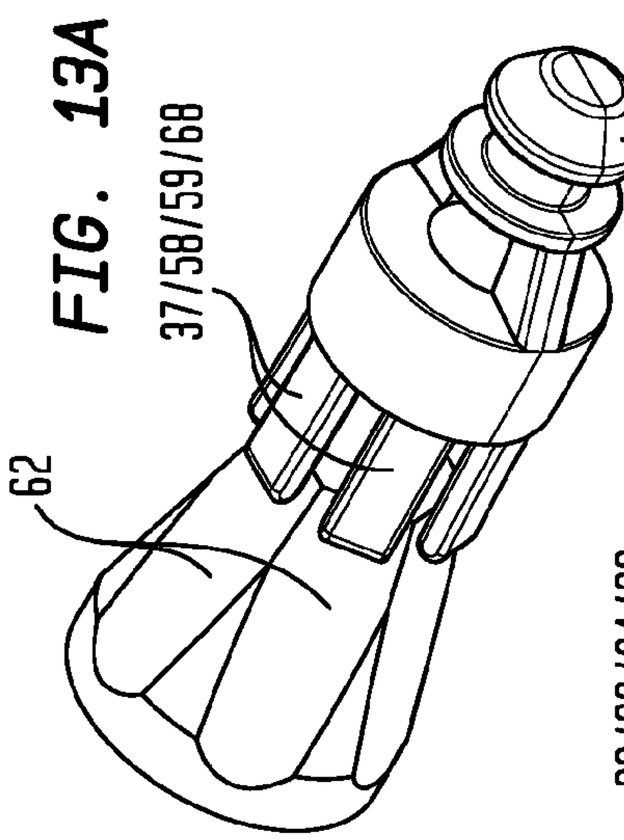


FIG. 13F

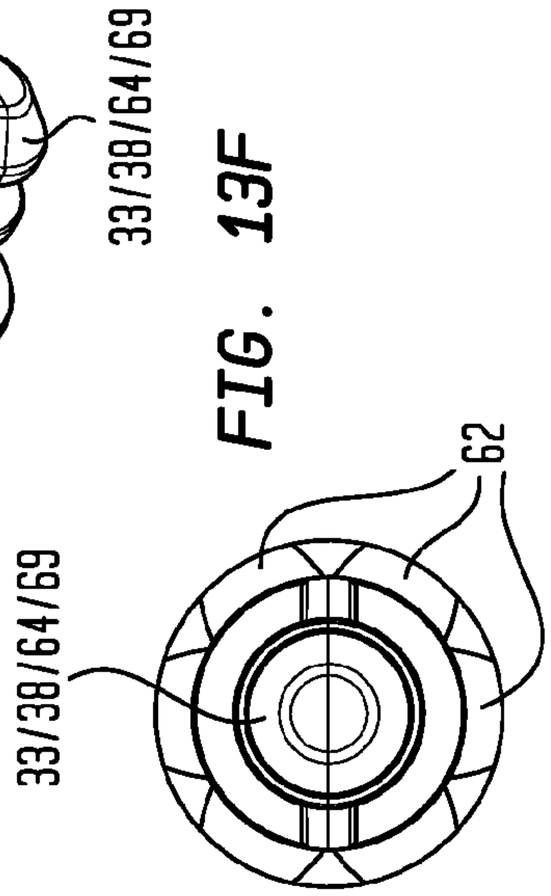


FIG. 13G

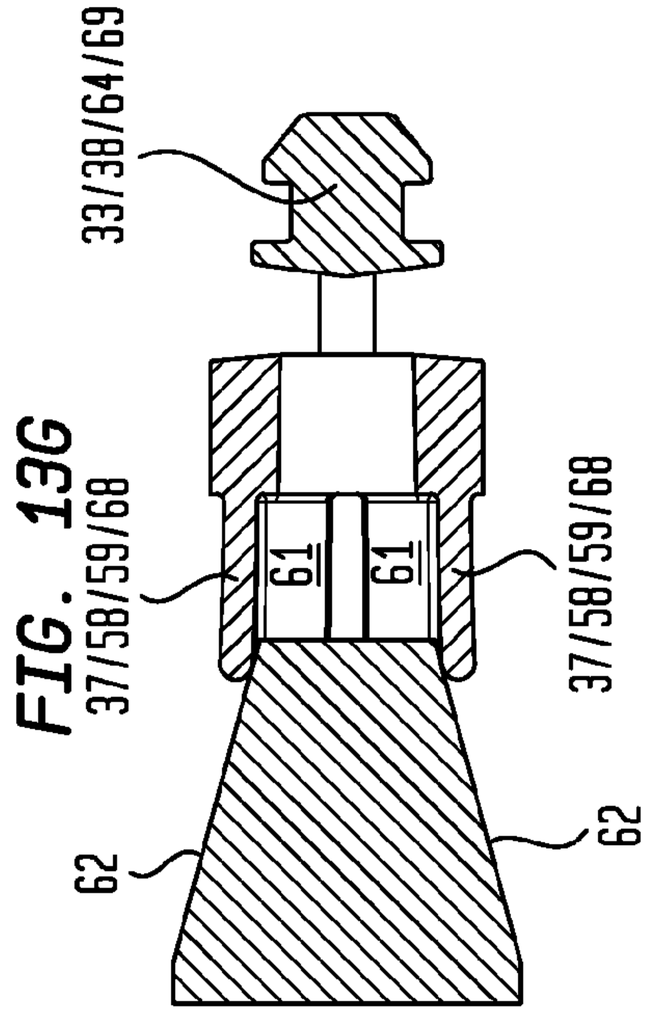


FIG. 13C

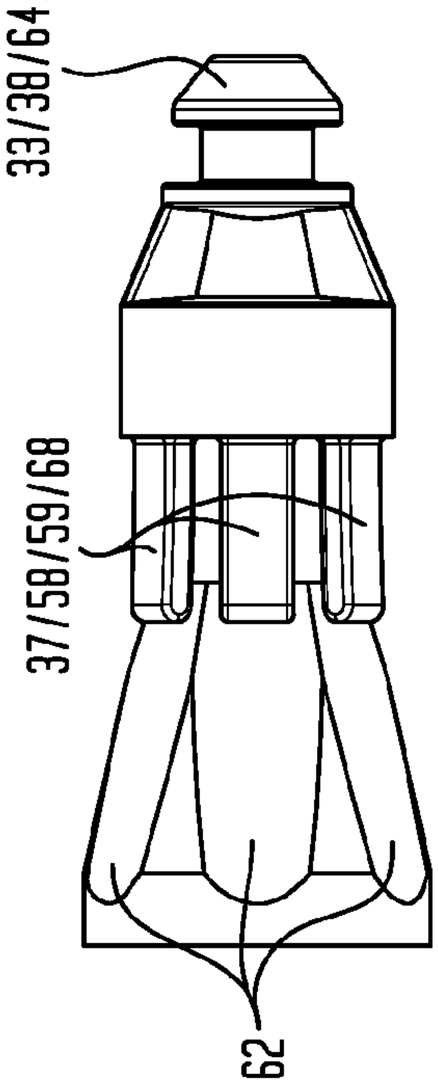


FIG. 13B

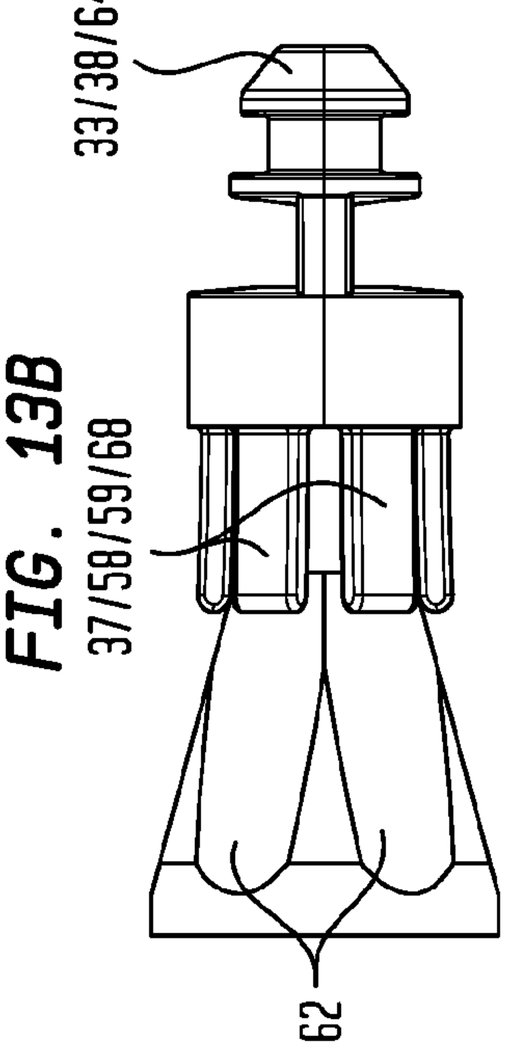


FIG. 13D

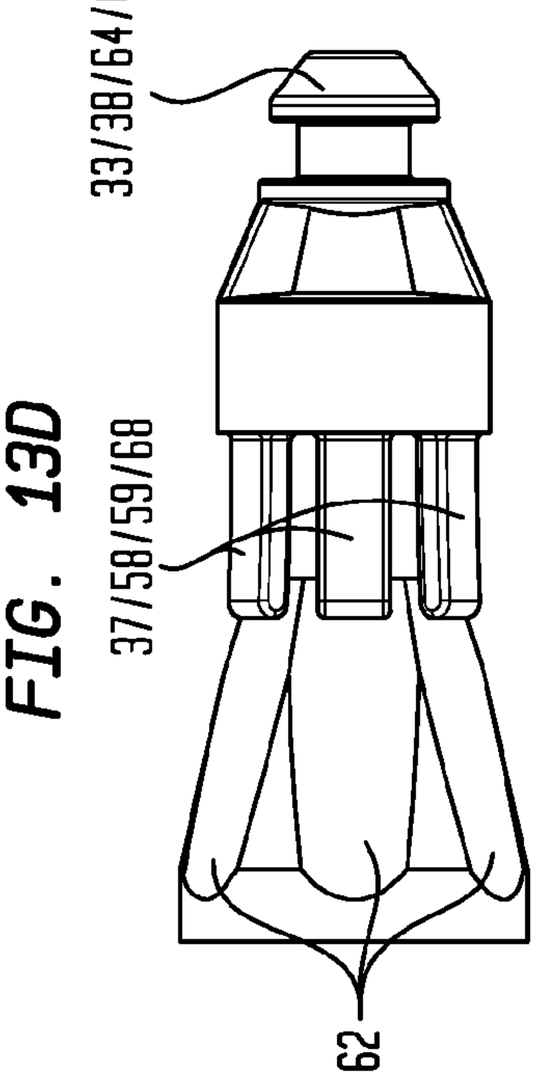


FIG. 13E

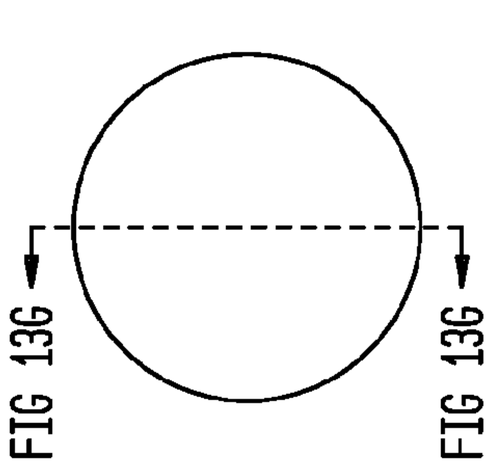


FIG. 14A

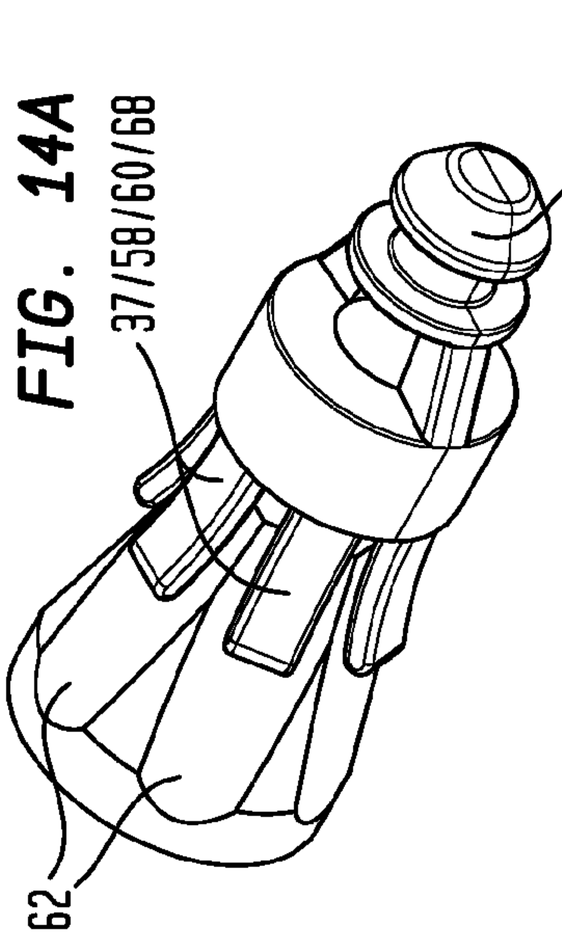


FIG. 14F

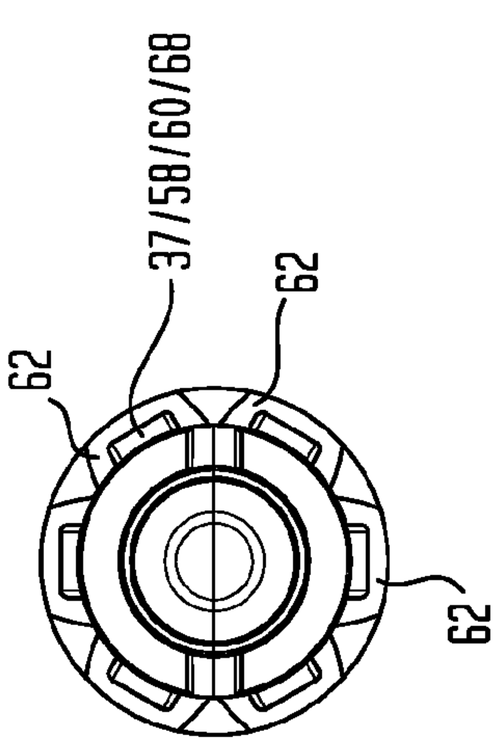


FIG. 14G

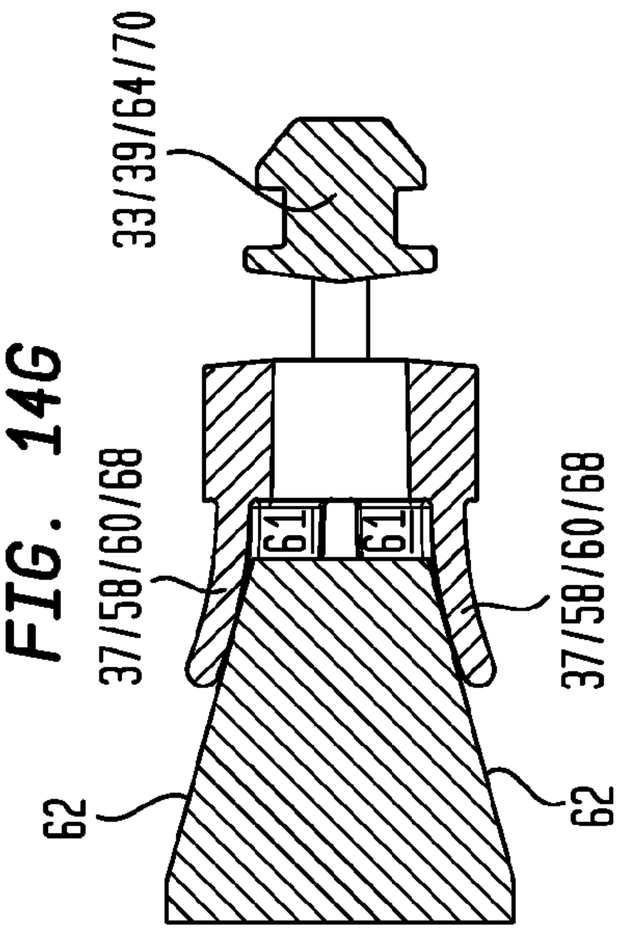


FIG. 14C

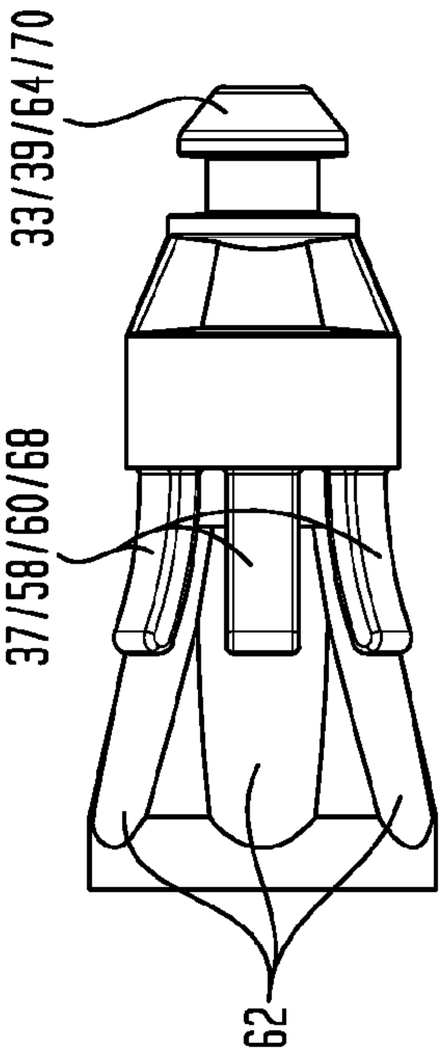


FIG. 14B

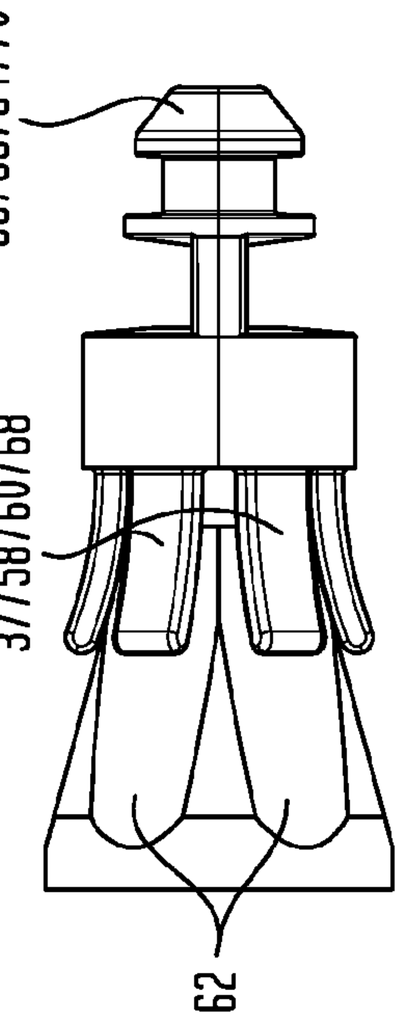


FIG. 14D

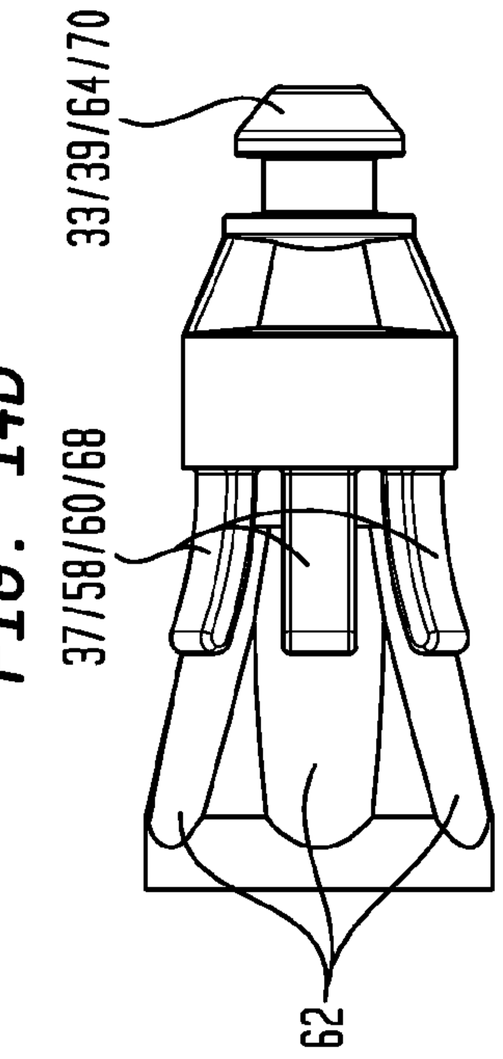


FIG. 14E

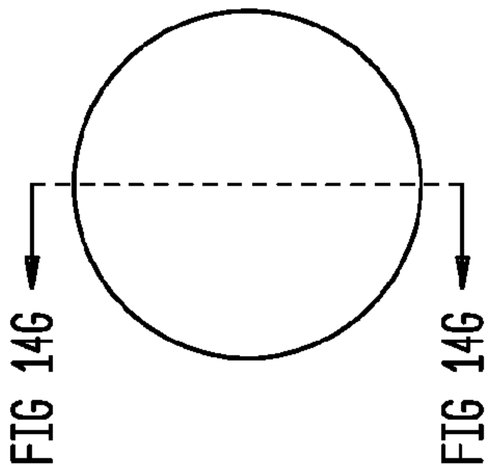


FIG. 15A

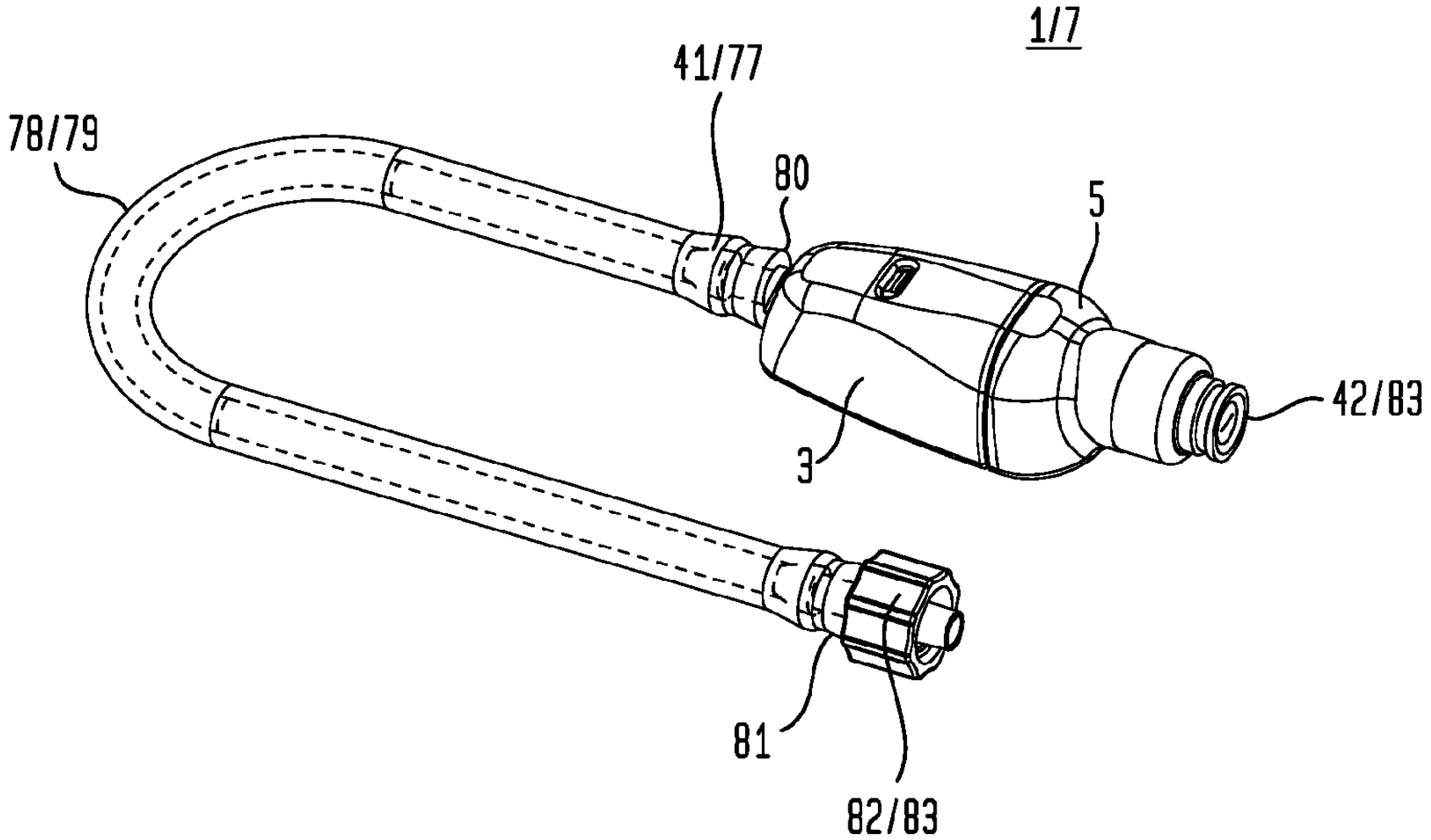
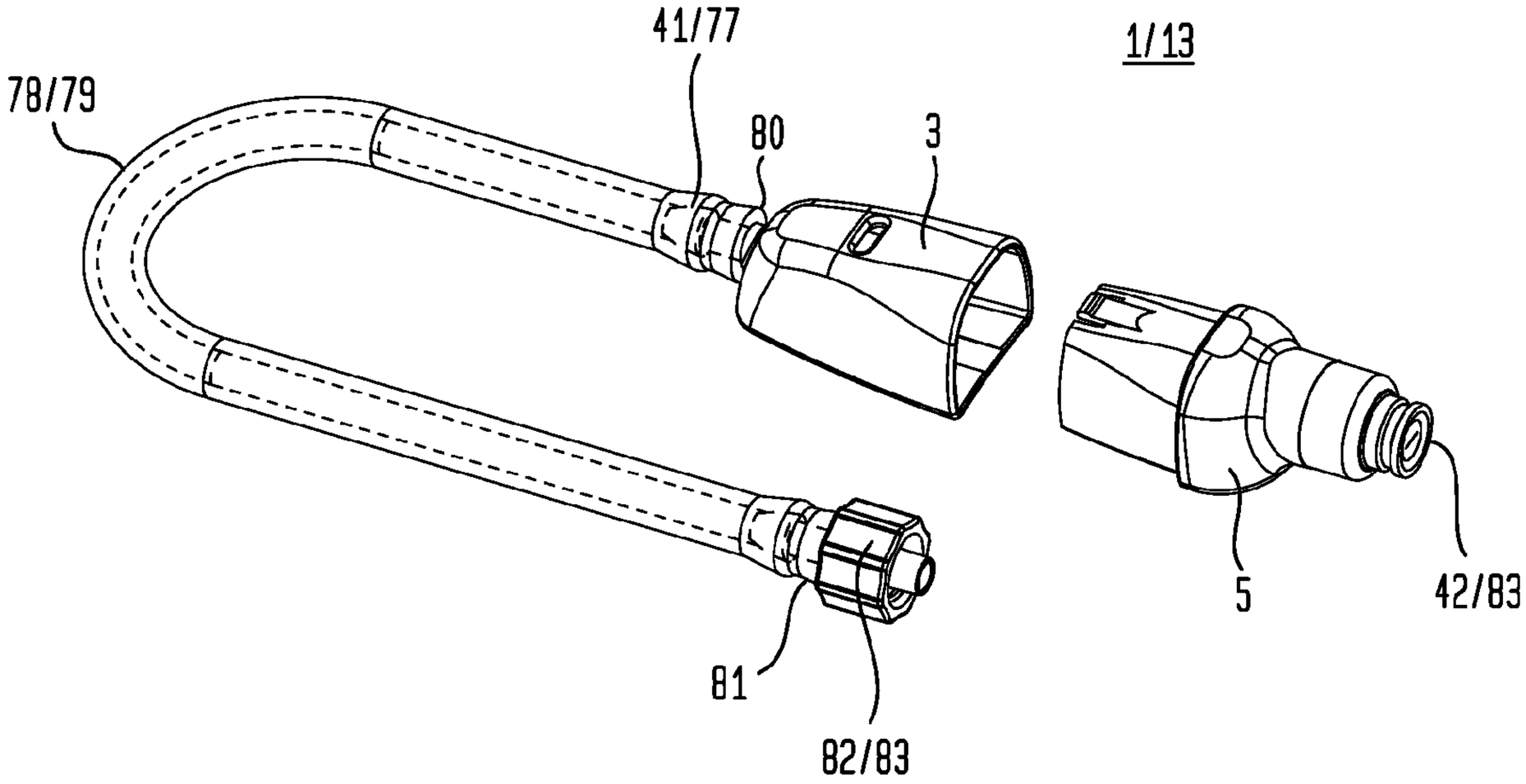


FIG. 15B



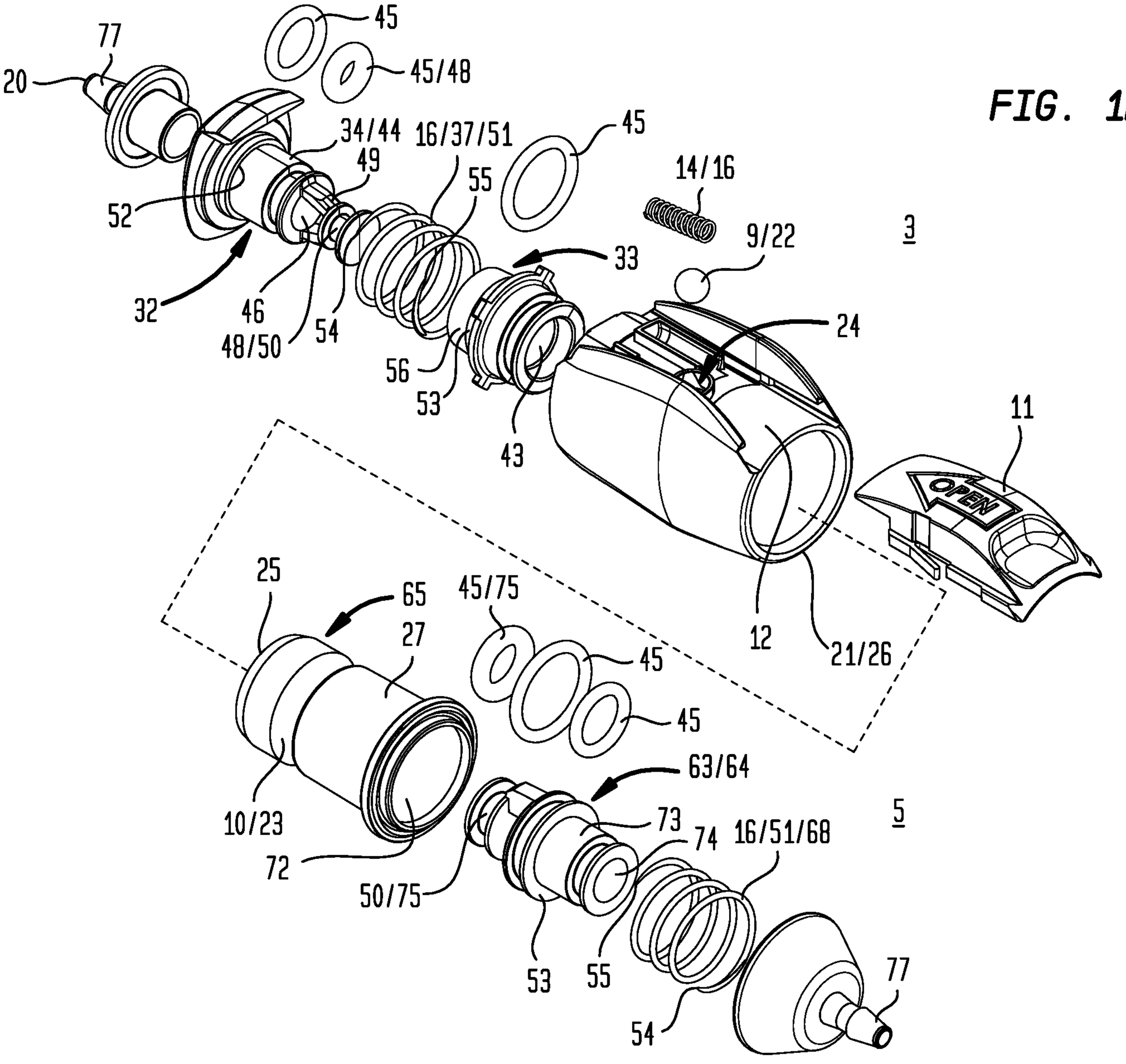

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FIG. 1B