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EP-A1- 1 607 117
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Description

[0001] This invention relates to a device for the dispensing of a powder. The device is of particular utility in surgical procedures or other medical applications, for the topical delivery of a powder to an internal or external surface of the body.

[0002] Devices for the dispensing of powder onto a surface of the body, or for other purposes, are well known. Examples of such devices are disclosed in the following published documents:

GB-A-472,355
GB-A-539,351
GB-A-572,015
GB-A-572,112
GB-A-607,237
GB-A-628,675
GB-A-649,506
GB-A-668,341
GB-A-808,273
GB-A-878,106
US-A-1,929,154
US-A-2,151,418
US-A-2,501,279
US-A-5,884,621
US-A-2005/0205087
FR-A-2 863 503

[0003] EP 1 607 117 and US 5 366 122 which discloses the preamble of claim 1.

[0004] There is an ongoing need for a device that can be used to deliver a powder to a surface of the body, whether an external surface or an internal surface, eg a surface exposed during a surgical procedure, in a controlled fashion. It may be necessary or desirable for the powder to be delivered to a highly localised site, ie with precision, and/or in a highly uniform manner. There is also an ongoing need for a powder delivery device that achieves these objectives, yet is simple and inexpensive to manufacture and to use.

[0005] There has now been devised an improved form of powder delivery device that addresses these needs and/or overcomes or substantially mitigates disadvantages associated with the prior art.

[0006] Thus, according to a first aspect of the invention, there is provided a device for the dispensing of a powder, the device comprising, or being adapted, in use, to be coupled to, a powder receptacle and a gasflow generator adapted, in use, to cause gas to flow through the device, and the device further comprising an agitator by which the powder receptacle can be mechanically agitated,
the gasflow generator and the agitator being operably linked such that actuation of the gasflow generator, which causes gas to flow through the device and to entrain powder from the powder receptacle, thereby to dispense powder from the device, is accompanied by actuation of the agitator, causing the powder receptacle to be mechanically agitated, thereby facilitating the release of powder from the powder receptacle, characterized in that the agitator is driven by the gasflow, such that the agitator operates for as long as the gas flows and is disengaged when the flow of gas is halted, and the agitator includes a moveable element that is positioned within the gasflow path.

[0007] In the device according to the invention, actuation of the gasflow generator, which results in dispensing of powder from the device, is accompanied by mechanical agitation of the powder receptacle. Such agitation facilitates the release of powder from the powder receptacle, and may also give a more uniform distribution of powder material dispensed from the device.

[0008] The powder receptacle may be an integral part of the device according to the invention, such that the device is supplied with a quantity of powder contained within the powder receptacle. In such a case, the device may be a disposable device, which is discarded after the desired quantity of powder has been dispensed from the powder receptacle.

[0009] Alternatively, the powder receptacle may be a separate component that is coupled to the device prior to use. In such a case, the powder receptacle, containing a quantity of powder, is typically supplied with a closure that is removed to enable the receptacle to be coupled to the device. The device and the receptacle may be formed with cooperating formations that enable them to be coupled together. For example, the device may be formed with an upstand or spigot that is received within or about a neck of the powder receptacle.

[0010] In currently preferred embodiments, the powder receptacle is supplied in the form of a sealed vial, eg of glass, that contains a quantity of powder. The vial has a neck that is sealed by a removable closure. When the closure is removed, a device according to the invention is engaged with the vial, by insertion into the neck of the vial of a tubular spigot that has an interference fit with the interior of the neck. When the vial, which is coupled to the device, is then inverted, powder in the vial falls into the spigot. In such an arrangement, loss of powder from the spigot is preferably inhibited or prevented by a perforated base member that extends across the interior of the spigot. Other embodiments of powder receptacle that may be used include cartridges, eg of plastics materials. Such receptacles may be supplied with closures that are removed prior to attachment of the cartridge to the device, or the device and the powder receptacle may be configured such that engagement of the powder receptacle with the device brings about opening of the powder receptacle. For instance, the powder receptacle may comprise a foil closure that is ruptured by appropriate formations on the device when the receptacle is engaged with the device.

[0011] The perforated base member retains the bulk of the powder within the powder receptacle prior to actuation of the gasflow generator, but permits powder to pass through the base member when the powder is en-

trained in the gasflow generated by actuation of the gasflow generator. The nature of the base member should therefore be such that the perforations in the base member are small enough that, when the powder rests upon the base member, its packing characteristics and angle of repose are such that the powder does not pass to any significant extent through the base member. On the other hand, the perforations should be such that, when the powder resting upon the base member is energised and entrained in the gasflow, it is able to pass through the perforations in the base member and be dispensed.

[0012] Conveniently, the base member takes the form of a perforated plate, which will typically be circular. Preferably, a substantial proportion, or the full extent, of the plate is perforated. The perforations in the base member may have any suitable shape, eg circular, square or hexagonal, and will typically be arranged in a regular array and/or uniformly across a substantial proportion, or even the full extent, of the base member.

[0013] In some embodiments, the gasflow may enter the powder receptacle through the base member, thereby energising powder resting upon the base member and causing said powder to be entrained in the gasflow and to pass through the base member into an outlet conduit, thereby to dispense said powder from the device. Gas is caused to flow through the perforated base member and this gasflow energises the particles of powder resting upon the base member, in the sense of imparting kinetic energy to those particles and entraining them in the gasflow. In other embodiments, a channel or conduit is provided to conduct the gasflow to a point within the powder receptacle that is spaced from the perforated base member, so that the gasflow emerges into the powder bulk at a point that is above the powder particles resting on the base member. The energised particles are able to pass through the base member into an outlet conduit from which the powder particles entrained in the gasflow are dispensed.

[0014] In other embodiments, the gasflow is not directed at and through the perforated base member, but is caused to enter the outlet conduit in such a manner that powder is drawn from the powder receptacle and entrained in the gasflow. For instance, the gasflow may be directed into the outlet conduit through an appropriately shaped inlet, eg a slot, so that a jet of gas passes into the outlet conduit beneath the powder receptacle. The jet of gas may have a form that is dictated by the shape of the inlet and which is conducive to entrainment of powder material from the powder receptacle. For instance, the inlet may have the form of a slot that is disposed orthogonally to the plane of the perforated base member (ie, in most configurations of the device, a vertical slot). In other embodiments, the inlet may have the form of a slot that is parallel to the plane of the perforated base member (ie usually a horizontal slot). Such a horizontal slot may conveniently be created as a clearance between components of the device that together define the outlet conduit (or at least that part of the outlet conduit that lies beneath the powder receptacle). In all such cases, a shaped jet of air is directed into the outlet conduit, beneath the powder receptacle. The relatively high velocity of that jet creates a venturi-type effect that draws air into it from the surroundings, thereby energising powder at the base of the powder receptacle, drawing that powder from the powder receptacle, and entraining it in the gasflow.

[0015] Apart from retaining the powder material within the powder receptacle until energised by the gasflow, the perforated base member functions as a sieve, preventing large agglomerated particles passing through, and enhancing the uniformity of the powder material dispensed from the device. The high energy of the gasflow through the outlet conduit may also assist in deagglomerisation of the powder as it is dispensed from the device.

[0016] The gasflow generator may be either an integral part of the device according to the invention, or an external component to which the device is coupled.

[0017] Where the gasflow generator is part of the device, it may take various forms. For instance, the gasflow generator may comprise a compressible bulb or bellows that can be manually compressed by the user. In such a case, the bulb or bellows is preferably resilient and may include a one-way valve or an opening that permits the ingress of air to permit the bulb or bellows to return to its expanded condition after pressure applied to it is released. In such embodiments, the gas is generally ambient air.

[0018] In other embodiments, the gasflow generator is a canister of a compressed gas or a liquefied propellant. Compressed gases include compressed air, and compressed hydrocarbons. Liquefied propellants include chlorofluorocarbons and hydrofluoroalkanes. In all such embodiments, the canister will generally be provided with a valve by which the gasflow can be controlled.

[0019] In yet further embodiments, the gasflow generator does not itself form part of the device according to the invention, but is an external gas source to which the device is coupled. In such embodiments the device may, for instance, be coupled to a compressed gas source by an appropriate conduit, eg a flexible tube. The gas line may be a compressed air line, though other compressed gases may be used, eg nitrogen or carbon dioxide. Again, the arrangement will generally include means by which the gasflow can be controlled. Typically, the device will include an actuator, eg of the push button type, by which the flow of gas can be controlled.

[0020] In the device according to the invention, actuation of the gasflow generator is effectively synchronised with actuation of the agitator. The arrangement may be such that actuation of the gasflow generator causes actuation of the agitator, or vice versa.

[0021] In the device according to the invention, the agitator is driven by the gasflow, such that the agitator operates for as long as the gas flows and is disengaged when the flow of gas is halted, and the agitator includes a moveable element that is positioned within the gasflow

path. Such a moveable element is preferably mounted such that its movement generates mechanical disturbances or vibrations within the device, leading to physical agitation of the powder contained within the powder receptacle. In particularly preferred embodiments, the path along which gas is caused to flow includes a loop within which an agitator element is driven. Conveniently, such a loop has the form of a circular track and the agitator element is a ball or the like that is driven around the track by the gas flow. The movement of the ball generates vibratory forces that are transmitted through the device to the powder receptacle.

[0022] Powder is preferably discharged from the device according to the invention via a discharge tube or barrel. Such a discharge tube or barrel may be capable of a limited degree of orientational movement relative to the rest of the device, in order that the direction of flow of the discharged powder may be adjusted to suit the needs of the situation in which the device is used, eg to facilitate optimal delivery of the powder during a surgical procedure.

[0023] The device according to the invention will most commonly comprise components manufactured wholly or largely of plastics materials. Where appropriate, however, other materials such as metals, eg stainless steel, and glass, eg for the powder receptacle, may be employed. For medical applications, the materials used may be of suitable medical grade and sterilisable.

[0024] For ease of use, the components of the device according to the invention may be incorporated into an outer housing that facilitates operation of the device. For instance, the device may be configured such that it can be readily held and operated in one hand.

[0025] The device according to the invention may be used to deliver a wide variety of powders to a surface of the body. Such powders include agents intended to have a therapeutic effect, either in terms of a pharmacological effect on the body or as disinfectants or the like useful in the prevention or treatment of infections. One particular field in which the device of the invention is useful, however, is for the delivery of haemostatic powder compositions to internal tissues exposed during surgical procedures or after traumatic injury. Such haemostatic compositions, which may also be described as tissue sealants, may for instance comprise dry powder mixtures of fibrinogen and thrombin. Such a mixture is essentially inert when formulated in the dry state, but once hydrated, eg upon application to a bleeding wound, the mixture leads to the production of fibrin which cross-links to form a blood clot.

[0026] Thus, according to a further aspect of the invention, there is provided a device as described above, for the delivery of a haemostatic composition to internal tissues exposed during surgical procedures or after traumatic injury.

[0027] Embodiments of the invention will now be described in greater detail, by way of illustration only, with reference to the accompanying drawings, in which

Figure 1 is a schematic side view of a powder delivery device (not according to the invention), partly in section, and showing a trigger mechanism in a rest condition;

Figure 2 is a view similar to Figure 1, but from the other side of the device, and showing the trigger mechanism in an actuated condition;

Figure 3 is a side view of a first embodiment of a powder delivery device according to the invention;

Figure 4 is a perspective view of the device of Figure 3;

Figure 5 is a partial exploded view of the device of Figure 3;

Figure 6 is a schematic diagram illustrating the mechanism by which mechanical vibrations are generated during actuation of the device of Figure 3;

Figure 7 is a cross-sectional view of a valve forming part of the device of Figure 3;

Figure 8 is a perspective view of an alternative form of an intermediate component that forms part of a second powder delivery device according to the invention, that has a similar general form to that of Figure 3;

Figure 9 is a cross-sectional view of the intermediate component of Figure 8;

Figure 10 is a fragmentary perspective view of an upper housing component employed in conjunction with the intermediate component of Figures 8 and 9;

Figure 11 is a fragmentary underside view of the upper housing component of Figure 10; and

Figure 12 is a fragmentary sectional view of a third embodiment of a powder delivery device according to the invention.

[0028] Referring first to Figure 1, a powder delivery device (not according to the invention) is generally designated 1 and comprises a main body 3 to which is fitted an upstanding tubular spigot 5 and a bellows 7. A glass vial 9 containing a quantity of the powder to be dispensed is engaged with the spigot 5, as described below.

[0029] The main body 3 is injection moulded in plastics material with the general shape of a pistol. A downwardly (as viewed in Figure 1) depending hollow limb 3a of the main body 3 is adapted to be held by a user, and has a socket 4 with which the bellows 7 is engaged. A horizontal (as viewed in Figure 1) limb of the main body 3 has an internal bore 3c and constitutes a barrel 3b along which

powder is dispensed from the device 1.

[0030] The spigot 5 is also moulded in plastics material. The spigot 5 comprises an upwardly (as viewed) directed tubular connector 5a with a peripheral flange 5b at its lower extremity. The flange 5b is received within a correspondingly shaped recess in the upper surface of the main body 3, the flange 5b and main body 3 being bonded together.

[0031] The internal bore of the spigot 5 is tapered such that it has a funnel-like form, the base of the bore being closed by a perforated plate 5c that is formed integrally with the rest of the spigot 5. The bore 3c within the barrel 3b terminates beneath the perforated plate 5c. The end of the bore 3c that lies beneath the plate 5c is upwardly open so as to be in communication with the perforations in the plate 5c and hence with the internal bore of the spigot 5 and the vial 9.

[0032] The bellows 7 comprises a concertina-type chamber, one end of which is fitted with a nozzle. The bellows 7 is formed in plastics material and has a certain degree of resilience, such that it can be manually compressed, but returns to the expanded configuration shown in Figure 1 when the pressure applied to it is released. The other end of the bellows 7 may be provided with a one-way valve, eg a flap valve (not visible in Figure 1) to permit the bellows 7 to fill with air when it expands back to the condition shown in Figure 1. Alternatively, the end of the bellows 7 may simply be provided with an opening that is occluded, eg by the user's thumb, when the bellows is compressed and then exposed to permit the bellows 7 to expand back to the condition shown in Figure 1.

[0033] The nozzle of the bellows 7 has an interference fit within the socket 4. A conduit 3d connects the interior of the downwardly depending limb 3a and the spigot 5. In particular, the conduit 3d provides for the passage of air expelled from the bellows 7 through a region of the perforated plate 5c adjacent to that part which overlies the end of the bore 3c.

[0034] The vial 9 has a neck 9a that receives the tubular connector 5a with an interference fit. The vial 9 is supplied with a closure that seals the neck 9a. With the vial 9 in an upright position, the closure is removed and the tubular connector 5a inserted into the neck 9a. The assembly is then an inverted condition, relative to the orientation shown in Figure 1. The assembly is turned through 180°, to the condition shown in Figure 1, whereupon powder contained within the vial 9 falls under gravity and fills the internal bore of the tubular connector 5a. The powder rests upon the perforated plate 5c, little or no powder falling through the perforations in the plate 5c.

[0035] A trigger 11 is pivotally mounted adjacent to the rear (ie the side distal to the barrel 3b) of the vial 9. The trigger 11 carries a striker 13 that is mounted to an arcuate track 15, such that the striker 13 is capable of a restricted range of movement relative to the trigger 11. A tension spring 17 (see Figure 2) is mounted between the striker 13 and an upstand 18 on the main body 3, close to the front of the vial 9, so as to draw the striker 13 towards the vial 9.

[0036] As can be seen in Figure 1, the trigger 11 and the striker 13 are formed with cooperating detents 11 a, 13a, such that when the trigger 11 is pressed down by a user (as described below), the striker 13 is drawn away from the surface of the vial 9, against the action of the spring 17.

[0037] The rear part of the main body 3 is formed with a ramp 19. As the trigger 11 is depressed, the ramp 19 comes into contact with the striker 13. Continued depression of the trigger 11 causes the ramp 19 to displace the striker 13 and to disengage the detents 11a,13a. When released from the trigger 11 by the ramp 19, the striker 13 is drawn by the action of the spring 17 into contact with the vial 9, thereby jarring the vial 9.

[0038] In practical embodiments of the device 1, the trigger 11 is housed within a push button-type actuator (not shown), depression of which also results in compression of the bellows 7. Thus, generation of an airflow is synchronised with mechanical jarring of the vial 9, thereby facilitating entrainment of powder in the airflow and releasing powder from the vial 9.

[0039] To dispense powder from the device 1, the user holds the device 1 in a generally upright orientation, as shown in Figure 1, and directs the barrel 3b at the intended site of application of the powder. The user then depresses the actuator, compressing the bellows 7 and depressing the trigger 11. Appropriate formations (not shown) may be provided on the device 1 to facilitate gripping of it, eg so that the actuator can be depressed by the thumb. Compression of the bellows 7 causes a jet of air to be directed through the conduit 3d. This jet of air passes through the perforated plate 5c and impacts upon the powder resting upon that plate 5c. Simultaneously, the striker 13 is drawn away from the vial 9, then released from the trigger 11 by the action of the ramp 19, with the result that the striker 13 impacts upon the vial 9 as the jet of air impacts upon the powder. The energised powder is entrained in the flow of air that escapes from the device 1 by passing back through the perforated plate 5c and along the internal bore 3c of the barrel 3b. The powder is blown out of the device 1 and deposited on the site of application.

[0040] When pressure is removed from the actuator, the bellows 7 relaxes to the condition shown in Figure 1, air being drawn into the bellows through the one-way valve or opening in the free end of the bellows 7. At the same time, the trigger 11 returns to its rest condition, as shown in Figure 1, in which the detents 11 a,13a re-engage. Actuation may then be repeated as often as required. Powder may continue to be dispensed until the desired amount of powder has been dispensed, or until the vial 9 is exhausted, all the powder contained within it having been dispensed. Where the vial 9 becomes exhausted, it may be appropriate for it to be removed from the spigot 5 and replaced with a fresh vial, ie for the device to be reused with a fresh vial of powder. In other circum-

stances, the device may be used only once and then discarded.

[0041] Turning now to Figures 3 to 7, a first embodiment of a powder delivery device in accordance with the invention is generally designated 20. This embodiment differs from the device 1 in that it is used in conjunction with an external source of compressed gas, and in that the mechanism by which the vial is agitated during dispensing of powder is different.

[0042] Referring first to Figures 3 and 4, the device 20 has a main body that comprises upper and lower housing components 23a,23b that are formed in plastics material by injection moulding. The main body has the general form of an elongate cylinder that is adapted to be held a user's hand, the underside of the lower component 23b being shaped to facilitate such grip. A push button-type actuator 27 is mounted in the top of the main body such that, when the device 20 is held by the user, the actuator 27 can be depressed by the thumb of the hand that holds the device 20.

[0043] A flexible tube 25 extends from the rear end of the device 20 and is adapted to be connected to a gas source, eg a source of compressed air (not shown). A suitable connector (not shown) is provided at the distal end of the tube 25.

[0044] The front end of the device 20 is provided with a tubular barrel 29, through which powder is dispensed from the device 20. A glass vial 31 is coupled to the device 20 in a similar manner to the way in which the vial 9 is coupled to the device 1. As can be seen in Figure 5, the upper component 23a is formed with an upstanding spigot 33 that is received within the mouth of the vial 31. A pair of clips 35 engage with a peripheral lip of the vial 31, so as to hold it securely in place. As in the device 1, the interior of the spigot 33 is tapered such that it has a funnel-like form, the base of the spigot 33 being closed by a perforated plate 34.

[0045] Referring again to Figure 5, an intermediate component 41 is captivated between the upper and lower components 23a,23b of the main body 23. The intermediate component 41 is formed with a circular opening 61 near its rear, which receives a downwardly depending boss (not visible in Figure 5) formed integrally on the underside of the upper housing component 23a. A circular track 43 is formed in the lower component 23b, with air inlet 45 and outlet 46 channels. The intermediate component 41 cooperates with the lower component 23b to close the track 43. A ball 50 (not shown in Figure 5) is held within the track 43 such that it can rotate freely around the circular track 43.

[0046] The tube 25 is connected to a valve 51 that is held within an upstanding boss 52 formed integrally with the lower component 23b. The valve 51 is in turn connected to the intermediate component 41 by means of a short length of tubing 25a that is engaged with a tubular connector 47 formed integrally with that component and which, when the intermediate component 41 and lower component 23b are engaged, is in registration with the air inlet channel 45.

[0047] The valve 51 is positioned beneath the actuator 27, which is biased to the position shown in Figure 3. The actuator 27 includes a cam (not visible in the drawings) which bears on the valve 51 to control the operation of the valve 51. When the actuator is depressed, the valve 51 is opened to permit air to flow from the external source of compressed air through the device 20, and when the actuator 27 is released the flow of air is halted.

[0048] The valve 51 is shown in cross-section in Figure 7. It is of the type commonly referred to as a trumpet valve, and comprises a valve body 71 within which a valve stem 72 is capable of restricted reciprocating movement. The lower part of the valve stem 72 is of reduced dimensions, relative to the lower part of the valve body 71, so that an annular space exists between those two components. A valve cap 73 is mounted about the upper part of the valve stem 72. The range of movement of the valve stem 72 is restricted by engagement of an inwardly directed lip 74 at the base of the valve cap 73 with an outwardly directed flange 75 at the top of the valve stem body 71. The valve stem 72 is biased to the position shown in Figure 7 by an arrangement of two compression springs 76 that act between the flange 75 and the underside of the top of the valve cap 73.

[0049] A pair of spaced apart O-rings 77,78 provide for sealing engagement between the valve stem 72 and the internal walls of the valve body 71. A valve inlet 79 receives the end of the tube 25, and a similar valve outlet 80 is connected to the short tube 25a that leads to the intermediate component 41.

[0050] In the position shown in Figure 7, the valve 51 is closed. Passage of gas from the supply tube 25 to the valve outlet 80 is blocked. Depression of the valve stem 72, for example by the user pressing on the actuator 27, displaces the lower O-ring 78 to a position below the valve outlet 80, thereby opening the valve 51 and enabling flow of gas through the annular space surrounding the valve stem 72 to the valve outlet 80.

[0051] When the valve 51 is open, gas flows into the track 43 and drives the ball (not shown) around the track 43. An air feed hole 48 is formed in the intermediate component 41, above the rear portion of the track 43. This creates a flow of a certain amount of air from the track 43, that airflow being directed at the rear part of the perforated plate 34 and into a short feed pipe 49 that is formed integrally with the internal wall of the spigot 33 and terminates a short distance above the perforated plate 34, within the powder that, as in the first embodiment, rests upon the perforated plate 34. The feed hole 48 and feed pipe 49 direct a minor proportion of the airflow into the powder. The greater proportion of the airflow, however, is simply vented via the outlet channel 46. Openings 59 at the rear of the device permit vented air to escape. The proportion of the airflow that is directed into the vial 31 can be adjusted to suit the intended application of the device (ie to suit the amount of powder to be delivered, the nature of the powder, and so on) by

varying the sizes of the feed hole 48 and/or the outlet channel 46.

[0052] The upper surface of the intermediate component 41 is formed, in the region beneath the perforated plate 34, with a shallow well 53 with a forwardly-directed outlet 54. The outlet 54 is connected, via a short tube 55, to the barrel 29. A nose 56 is formed integrally with the barrel 29 and is captivated between the forward ends of the upper and lower components 23a,23b. The nose 56 is generally hemispherical in shape, and is held within the end of the housing in the manner of a ball-and-socket joint, which permits a restricted range of orientational movement of the barrel 29 (as is most readily apparent from Figure 4).

[0053] To dispense powder from the device 20, the user holds the device 20 in one hand, directs the barrel 29 at the intended site of application of the powder, and depresses the actuator 27 with the thumb. This opens the valve 51, permitting air to flow through the device 20. Air flows along the tubes 25 and 25a into the track 43. The circulation of air within the track 43 causes the ball 50 to rotate rapidly around the track 43. The movement of the ball 50 causes a degree of mechanical vibration that is transmitted to the intermediate component 41, the upper component 23a and the vial 31.

[0054] Most of the airflow is vented from the device 20 via the outlet 46 and openings 59. However, a small proportion of air escapes from the track 43 via the feed hole 48, from which it is directed at the underside of the perforated plate 34 and into the feed pipe 49. This jet of air passes into the powder resting upon that plate 34. The mechanical agitation of the device 20 caused by rotation of the ball 50 within the track 43 facilitates the release of the powder from the vial 31. The powder is entrained in the flow of air that escapes from the device 20 by passing back through the perforated plate 34 into the well 53 and through the barrel 29. The powder is blown out of the device 1 and deposited on the site of application.

[0055] Mechanical agitation of the device continues for as long as the actuator 27 is depressed. When the actuator 27 is released, the flow of air is halted and the ball 50 ceases its rotary motion within the track 43. The device may be actuated for a continuous period, or intermittently.

[0056] As for the device 1, powder may continue to be dispensed until the desired amount of powder has been dispensed, or until the vial 31 is exhausted, all the powder contained within it having been dispensed. Where the vial 31 becomes exhausted, it may be removed from the spigot 33 and replaced with a fresh vial, or the device may be discarded, as appropriate.

[0057] Turning now to Figures 8 to 11, a second embodiment of a powder delivery device according to the invention is generally similar to that of Figures 3 to 7, but differs in the manner in which the gasflow entrains powder from the powder receptacle. Elements of the second embodiment that correspond to those of the first embodiment are identified by the same reference numbers, but with the prefix "1". Thus, the intermediate component 143 corresponds to the intermediate component 43 of the first embodiment, the perforated base member 134 corresponds to the base member 34, and so on.

[0058] Figures 8 and 9 show, in perspective and cross-sectional views respectively, an intermediate component 141 similar in general form to the intermediate component 41 of the embodiment of Figures 3 to 7. Figures 10 and 11 show fragmentary views of the part of the upper housing component 123a that contains the perforated base plate 134. In this embodiment, the lower housing component, barrel, valve and actuator (not shown) are identical to those of the first embodiment. The principal difference between the first and second embodiments lies in the manner in which air flows from the track 43 to the well 153 in the intermediate component 141 that is located beneath the perforated plate 134. In the first embodiment (Figure 5), that air passes through feed hole 48 and feed pipe 49 to a position within the spigot 33 that is above the perforated plate 34. In the second embodiment, on the other hand, there is no feed pipe. Instead, feed hole 148 terminates in a vertical slot 149, the upper end of which is closed by an abutting part 158 of the undersurface of the upper housing component 123a (see Figure 11).

[0059] As can be seen in Figure 10, the upper surface of the upper housing component 123a is similar to that of the first embodiment, in that it is formed with an upstanding spigot 133, the base of which comprises the perforated plate 134. However, the rear part of the interior of the spigot 133, that in the first embodiment is occupied by the feed pipe 49, is in this embodiment a simple ramp 163. The interior side walls of the spigot 133 are also formed as ramps 164, giving the interior of the spigot 133 a funnel-like form. The ramps 164 may be omitted, so that the perforated base plate 134 is generally circular, in which case the parallel ribs evident in Figure 11 may also be omitted. In fact, the presently most preferred embodiment of the device has such modifications.

[0060] As in the first embodiment, the intermediate component 141 is formed with a circular opening 161 that receives a corresponding downwardly-depending boss 162 formed on the underside of the upper housing component 123a (see

[0061] Figure 11).

[0062] The device of the second embodiment is actuated in precisely the same manner as the first embodiment, ie the user depresses the actuator, thereby opening the valve and causing gas to flow into the track and to drive the ball around that track. Movement of the ball creates vibrations that are transmitted to the vial containing the powder that is to be dispensed. Some of the gasflow escapes from the track via the feed hole 148 and slot 149. That gas is directed as a jet across the well 153 beneath the perforated plate 134, towards the outlet 154. The relatively high velocity jet of gas that traverses the well 153 creates a venturi-type effect that draws powder through the perforated plate 134 and entrains it in the gasflow.

[0063] Figure 12 shows a sectional view of a third embodiment of a powder delivery device according to the invention. Again, elements of this embodiment that correspond to those of the embodiment of Figures 3 to 7 are identified by corresponding reference numerals, but with the prefix "2". Thus, the intermediate component 243 corresponds to the intermediate component 43 of the first embodiment, the perforated base member 234 corresponds to the base member 34, and so on.

[0064] The third embodiment is again generally similar to the first and second embodiments just described. Thus, the third embodiment comprises upper and lower housing components 223a,223b and an intermediate component 241. The upper housing component 223a is formed with an upstanding spigot 233 about which the neck of a vial 231 is received. The base of the spigot 233 is formed as a perforated plate 234. A well 253 is formed in the upper surface of the intermediate component 241 and is located beneath the perforated plate 234. Cooperating parts of the intermediate component 241 and upper housing component 223a together form an outlet 253 that is connected to a tube 255. The intermediate component 241 and lower housing component 223b together define a track 243 within which a ball (not shown) is driven, in use.

[0065] The third embodiment differs from the second in that the feed hole 248, that leads from the track 243, terminates not in a feed pipe (Figure 5) or a vertical slot (Figure 8), but in a planar horizontal gap 249 between the juxtaposed surfaces of the intermediate component 241 and the upper housing component 223a that surround the well 253.

[0066] The effect of the gap 249 is to create a high velocity jet of gas in a plane parallel to the perforated plate 243. As for the second embodiment, that jet of gas creates a venturi-type effect that draws powder through the perforated plate 243.

Patentkrav

1. Indretningen (20) til topisk afgivelse af et pulver, idet indretningen omfatter, eller, under anvendelse, er indrettet til at blive koblet til, en pulverbeholder (31) og en gasstrømgenerator tilpasset, under anvendelse, til at tillade gas at strømme gennem indretningen,
og indretningen omfatter yderligere en omrører med hvilken pulveret i beholderen kan omrøres mekanisk,
idet gasstrømgeneratoren og omrøreren, under anvendelse, er operativt forbundet således, at aktivering (27) af gasstrømgeneratoren, der tillader gas at strømme gennem indretningen og iblande pulver fra pulverbeholderen, for derved at afgive pulveret fra indretningen, er ledsaget af aktivering af omrøreren, hvilket forårsager, at pulverbeholderen omrøres mekanisk, hvorved afgivelse af pulver fra pulverbeholderen lettere opnås,
kendetegnet ved, at omrøreren drives af gasstrømmen, således at omrøreren er i drift så længe gassen strømmer, og således, at driften ophører, når gasstrømmen ophører, og idet omrøreren omfatter et bevægeligt element (50), der er placeret i gassens strømningsvej.

2. Indretningen ifølge krav 1, hvor det bevægelige element er monteret således, at dets bevægelse skaber mekaniske forstyrrelser, eller vibrationer, inde i indretningen, hvilket under anvendelse fører til fysisk omrøring af pulveret indeholdt i pulverbeholderen.

3. Indretningen ifølge krav 1 eller krav 2, hvor den strømningsvej, langs hvilken gas bringes til at strømme, omfatter en løkke (43), inden i hvilken et omrørerelement bringes til at rotere.

4. Indretningen ifølge krav 3, hvor løkken (43) har form af en cirkulær bane og omrørerelementet (50) er en kugle, eller lignende, der drives rundt i banen af gasstrømmen.

5. Indretningen ifølge et hvilket som helst af de foregående krav, hvor pulverbeholderen (31) er en integreret del af indretningen, således, at indretningen forsynes med en pulvermængde indeholdt i pulverbeholderen.

6. Indretningen ifølge et hvilket som helst af kravene 1 til 4, hvor pulverbeholderen (231) er et separat element, der kobles til indretningen før brug.

7. Indretningen ifølge krav 6, hvor indretningen og beholderen er udformet med samvirkende udformninger, der tillader dem at blive koblet sammen.

8. Indretningen ifølge krav 7, hvor indretningen er udformet med en opretstående del eller studs (233), som modtages i eller rundet om en udskæring af pulverbeholderen.

9. Indretningen ifølge et hvilket som helst af kravene 6 til 8, hvor pulverbeholderen (231) er udformet som et forseglet hætteglas, fx af glas, der indeholder en mængde pulver.

10. Indretningen ifølge et hvilket som helst af de foregående krav, der er tilpasset tilkobling til en ekstern gasstrømgenerator.

11. Indretningen ifølge krav 10, hvor den eksterne gasstrømgenerator er en kilde med komprimeret gas.

12. Indretningen ifølge et hvilket som helst af kravene 1 til 9, hvor gasstrømgeneratoren omfatter en sammentrykkelig kugle eller bælg, der kan komprimeres manuelt af brugeren.

13. Indretningen ifølge et hvilket som helst af kravene 1 til 9, hvor gasstrømgeneratoren er en beholder med en komprimeret gas eller et flydende

drivmiddel.

14. Indretningen ifølge et hvilket som helst af de foregående krav, som omfatter et ydre hus, der letter brugen af indretningen.

15. Indretningen ifølge krav 14, som er udformet således, at den umiddelbart kan holdes og betjenes med en hånd.

16. Indretningen ifølge et hvilket som helst af de foregående krav til anvendelse ved afgivelse af en hæmostatisk sammensætning til internt væv, der eksponeres under kirurgiske indgreb eller efter traumatisk skade.

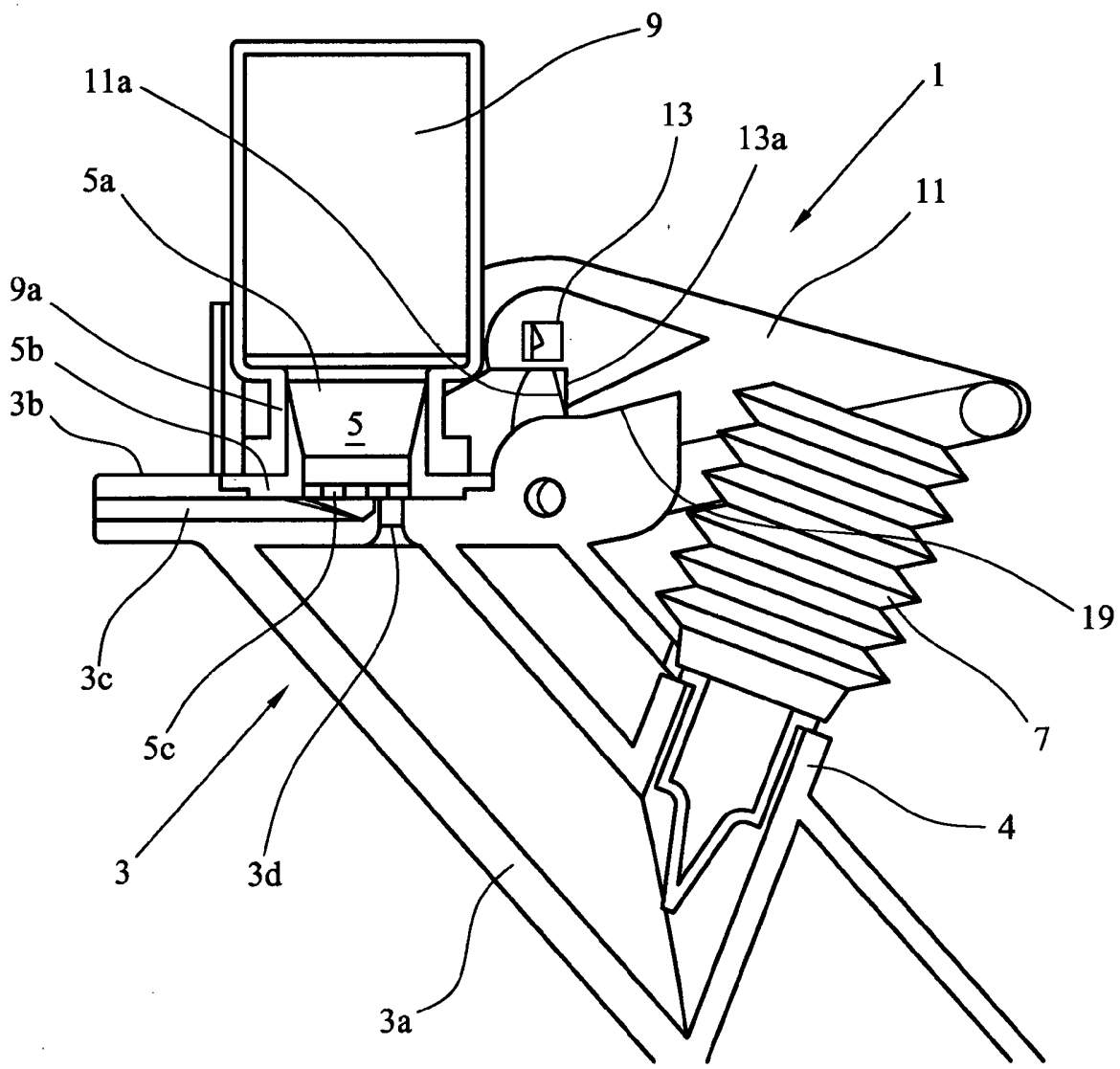


FIG. 1

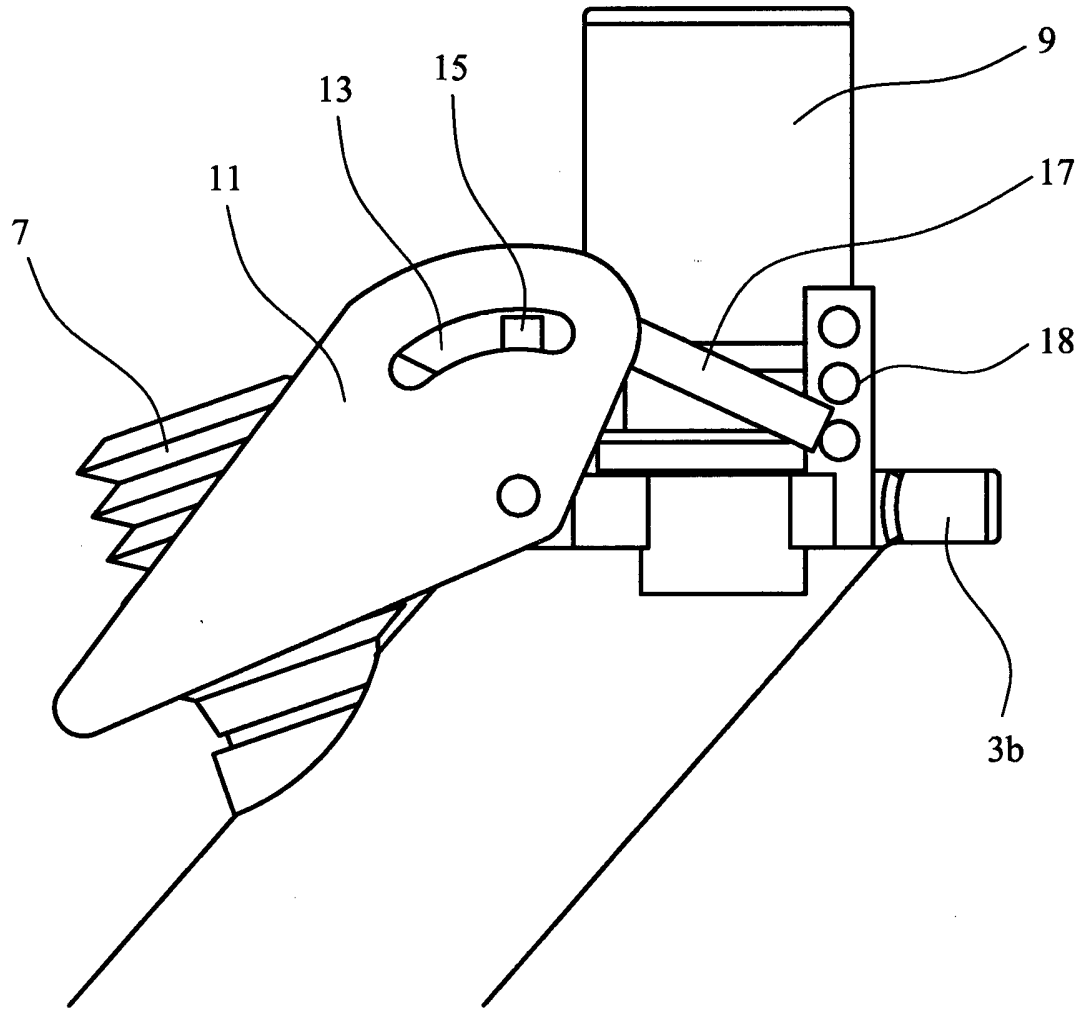


FIG. 2

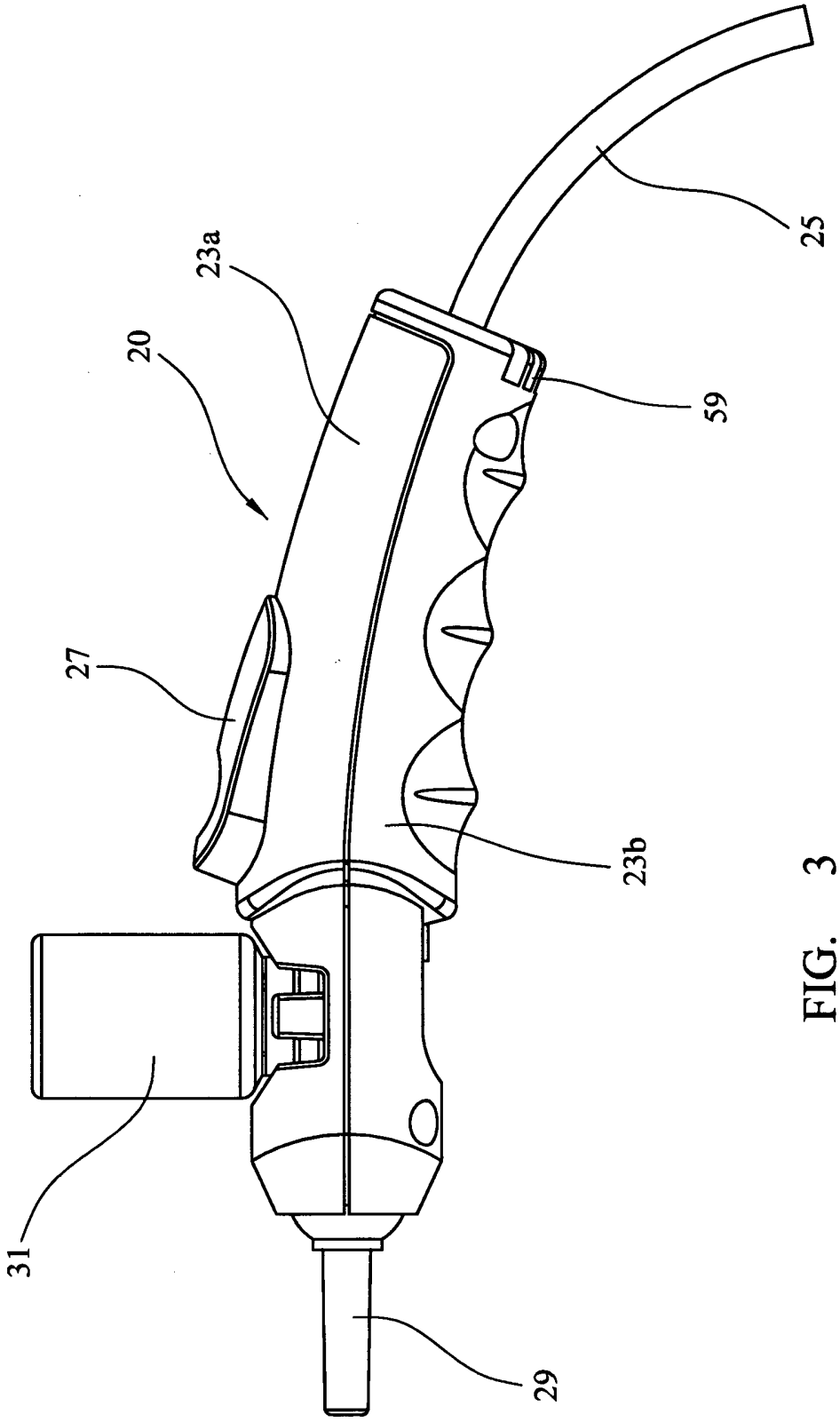


FIG. 3

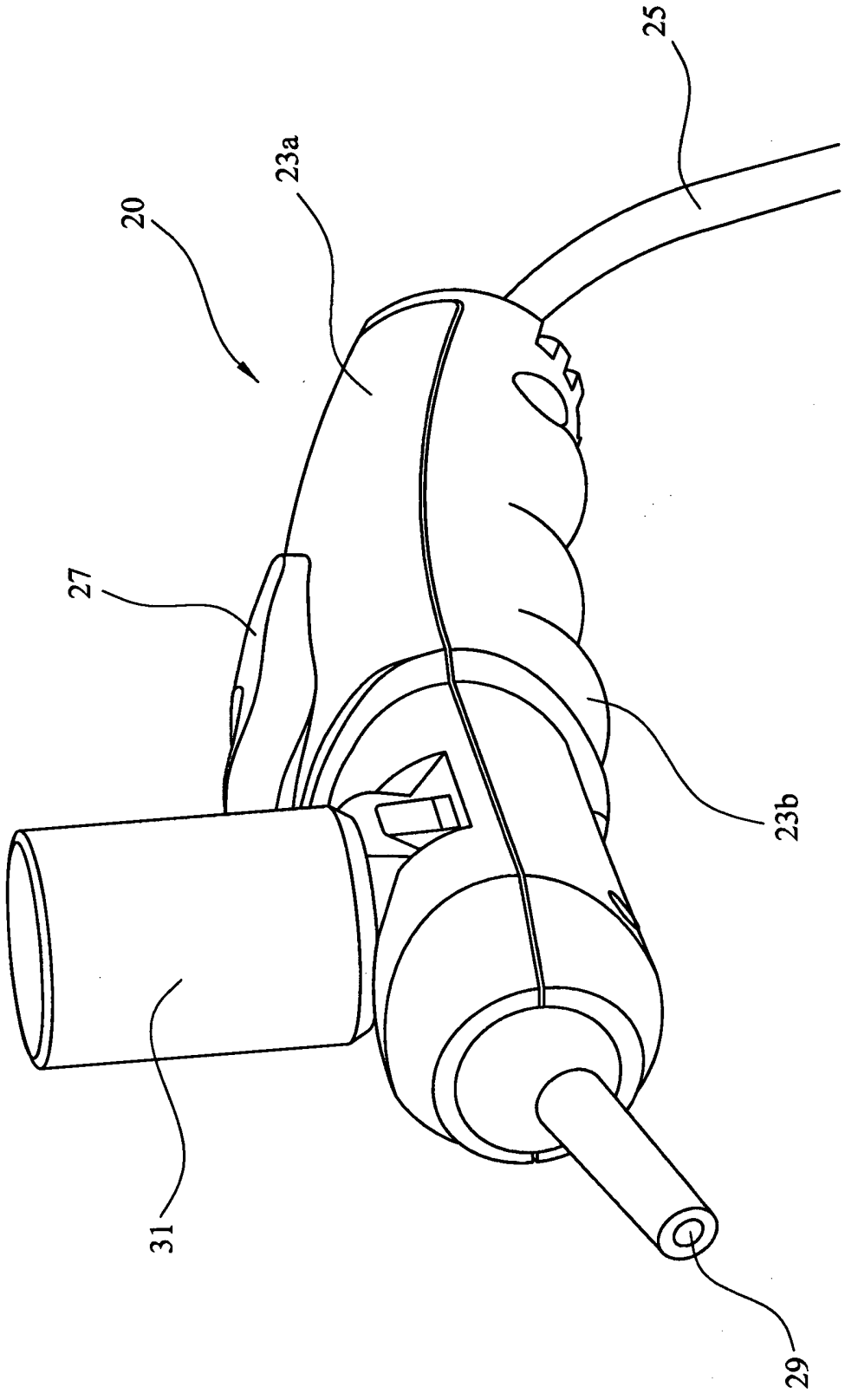
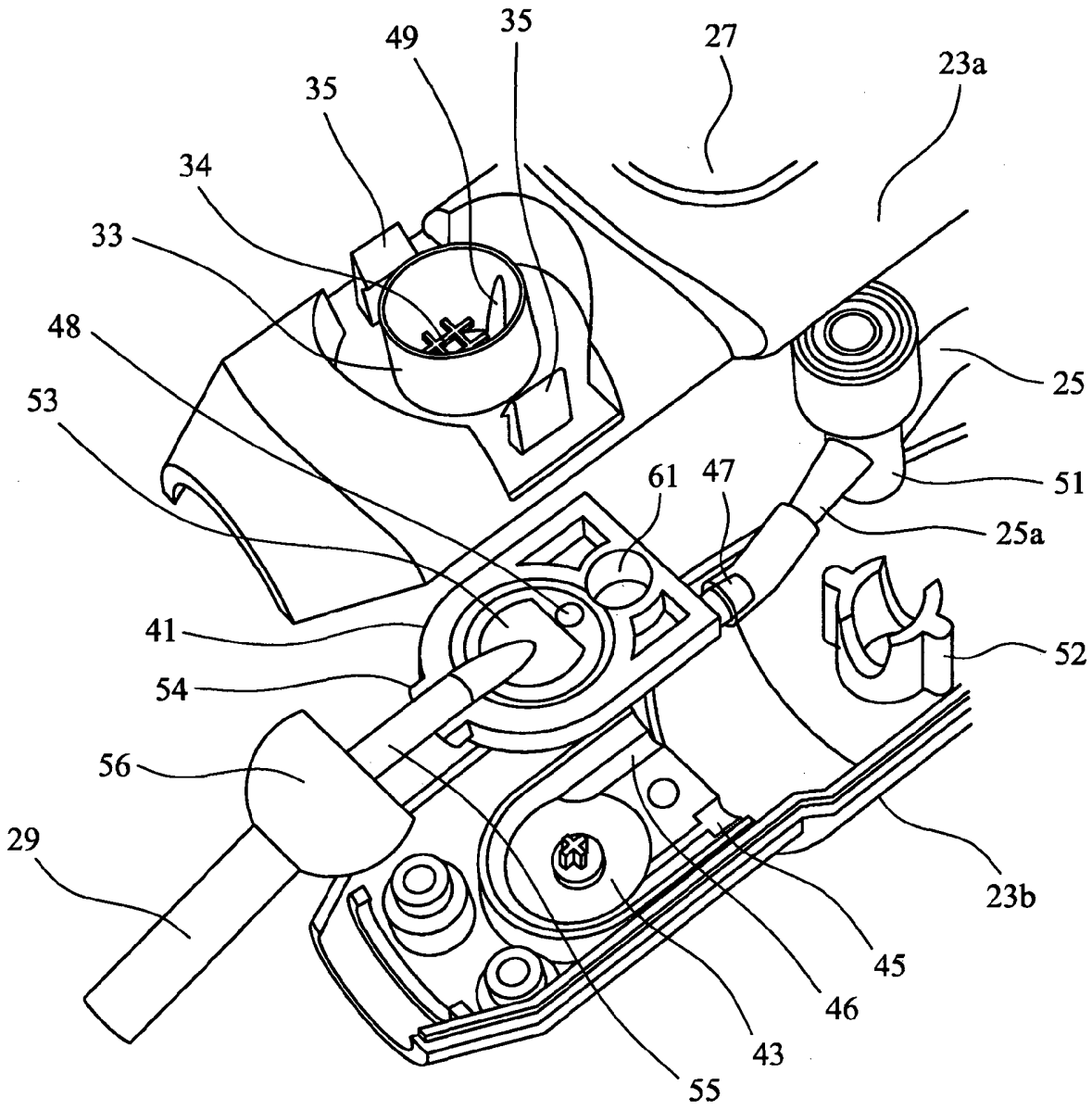


FIG. 4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35
27
23a
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34
33
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51
61
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25a
41
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29
23b
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43
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FIG. 5

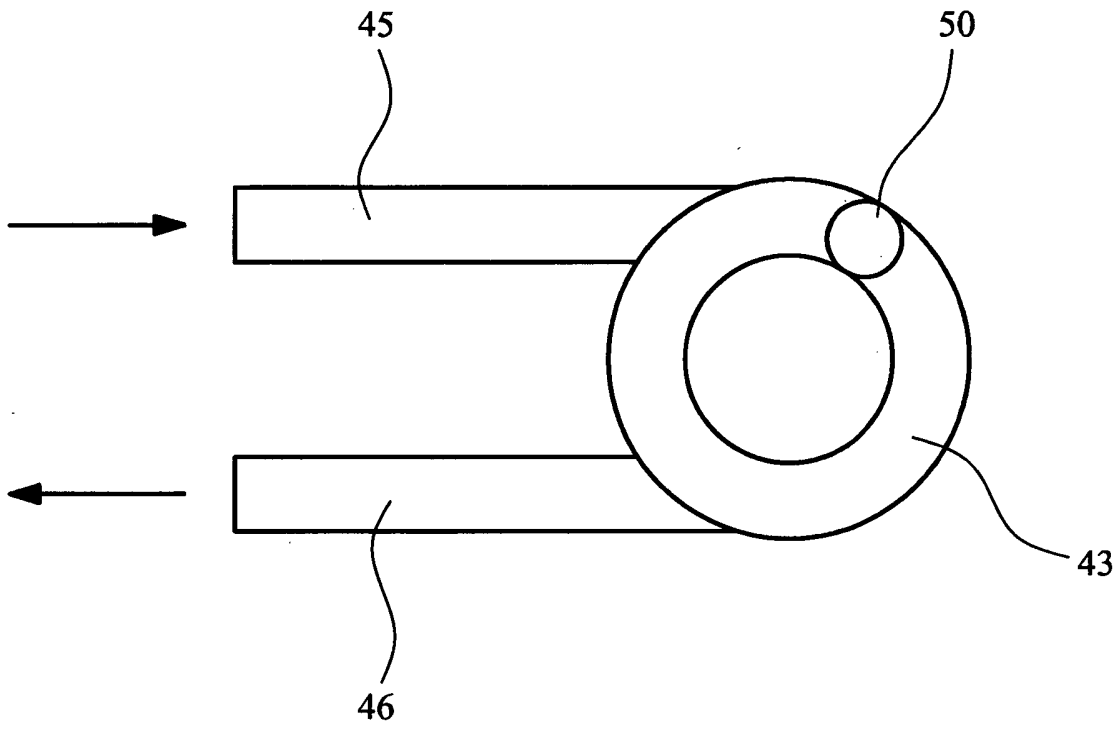

FIG. 6

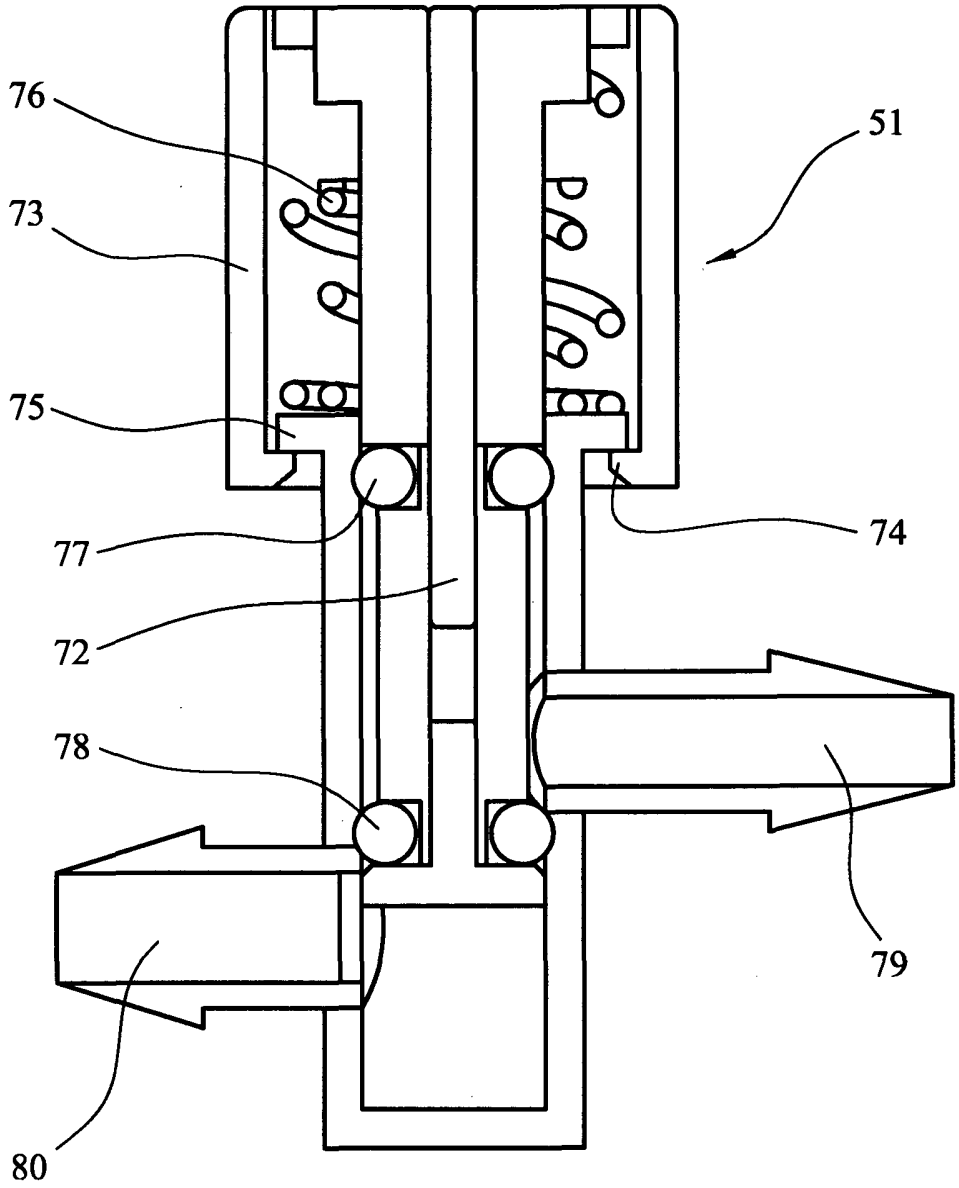

FIG. 7

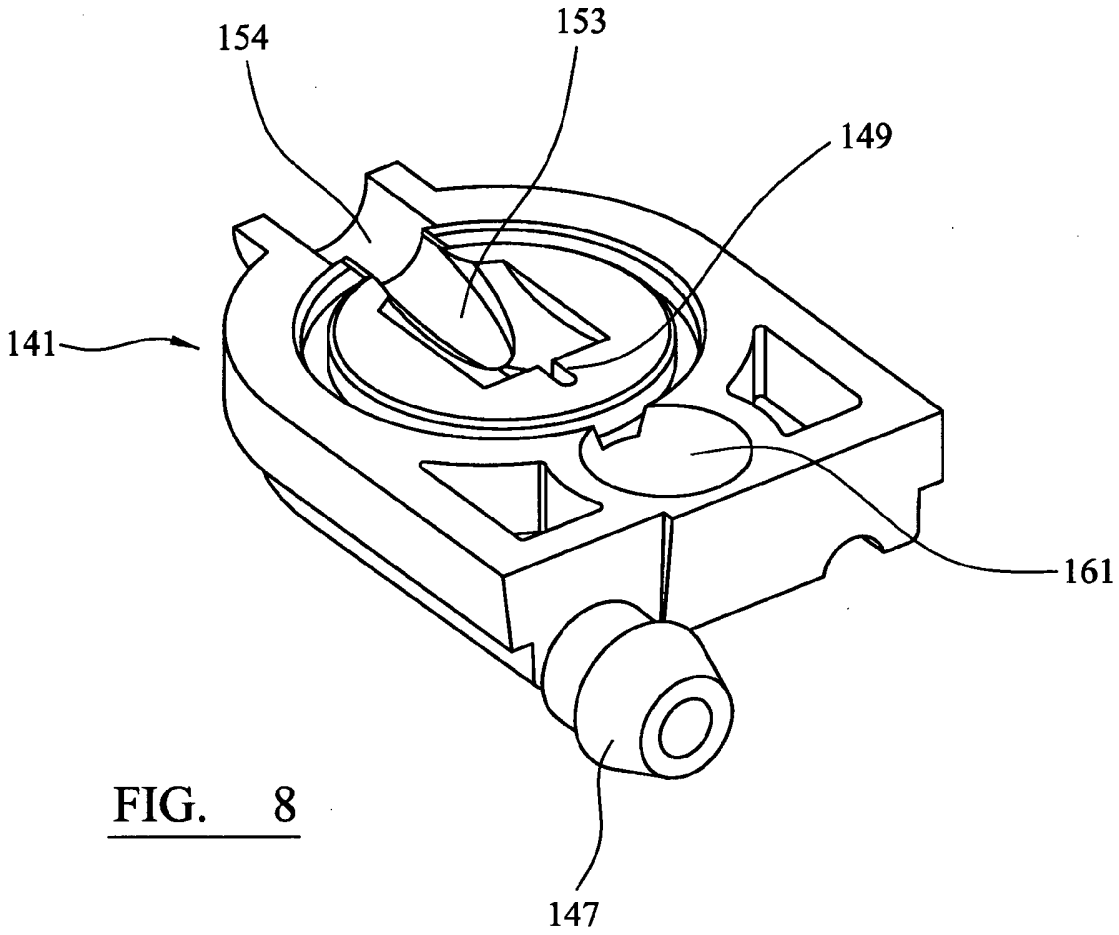

FIG. 8

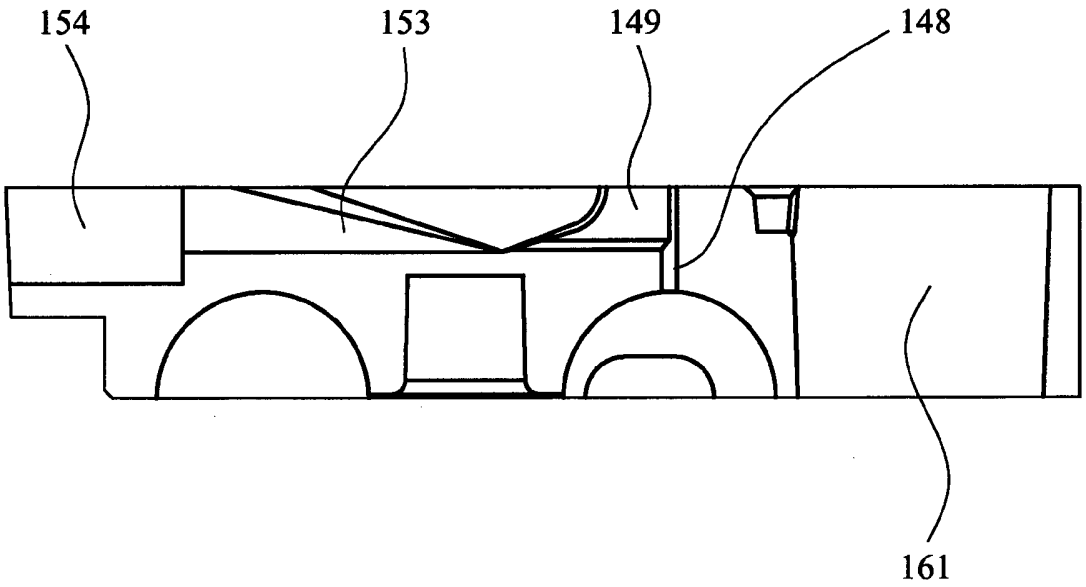

FIG. 9

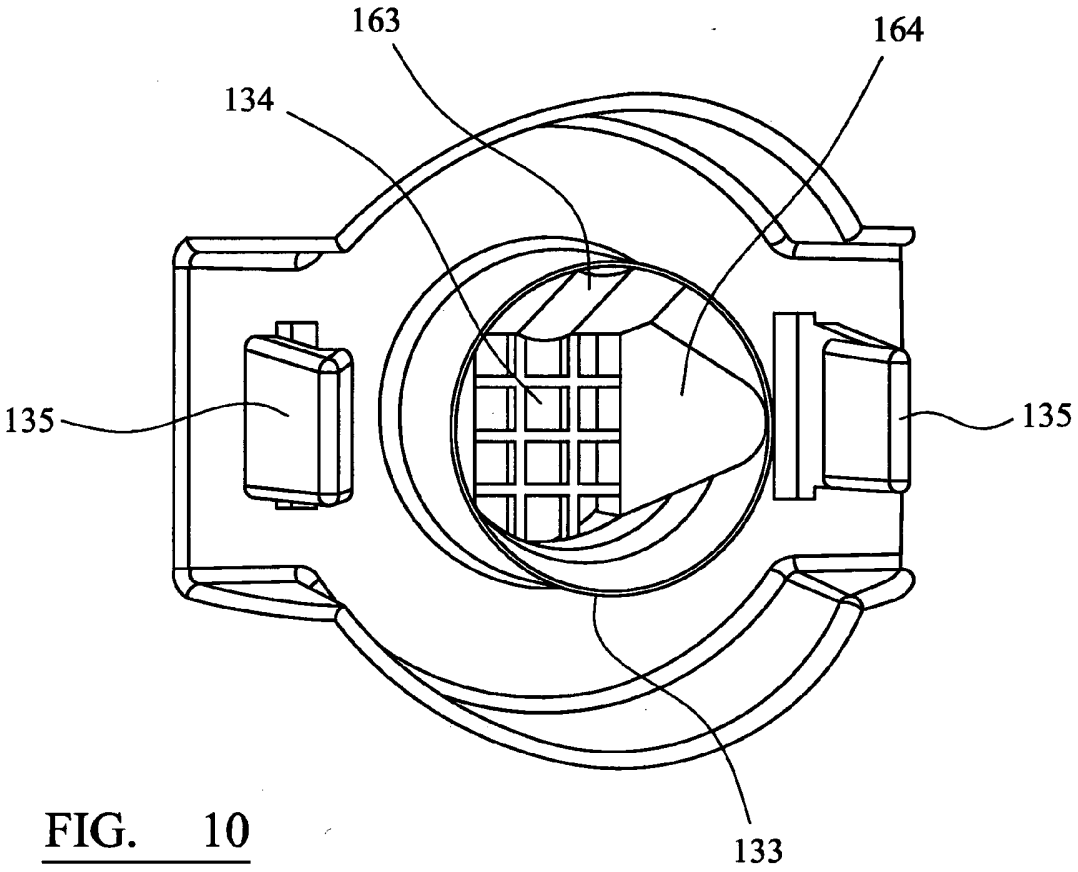

FIG. 10

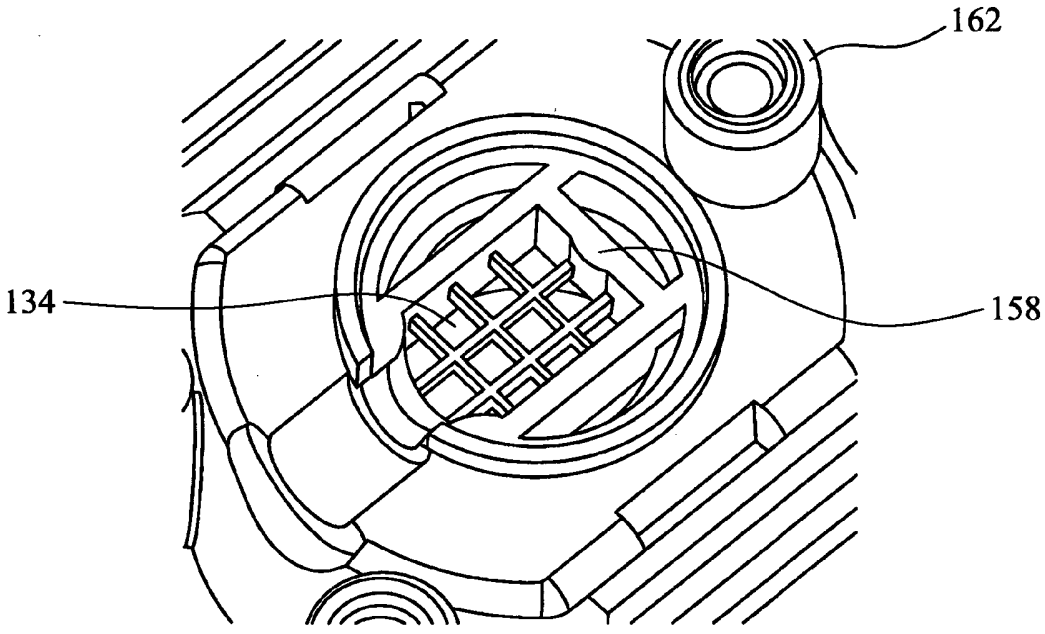

FIG. 11

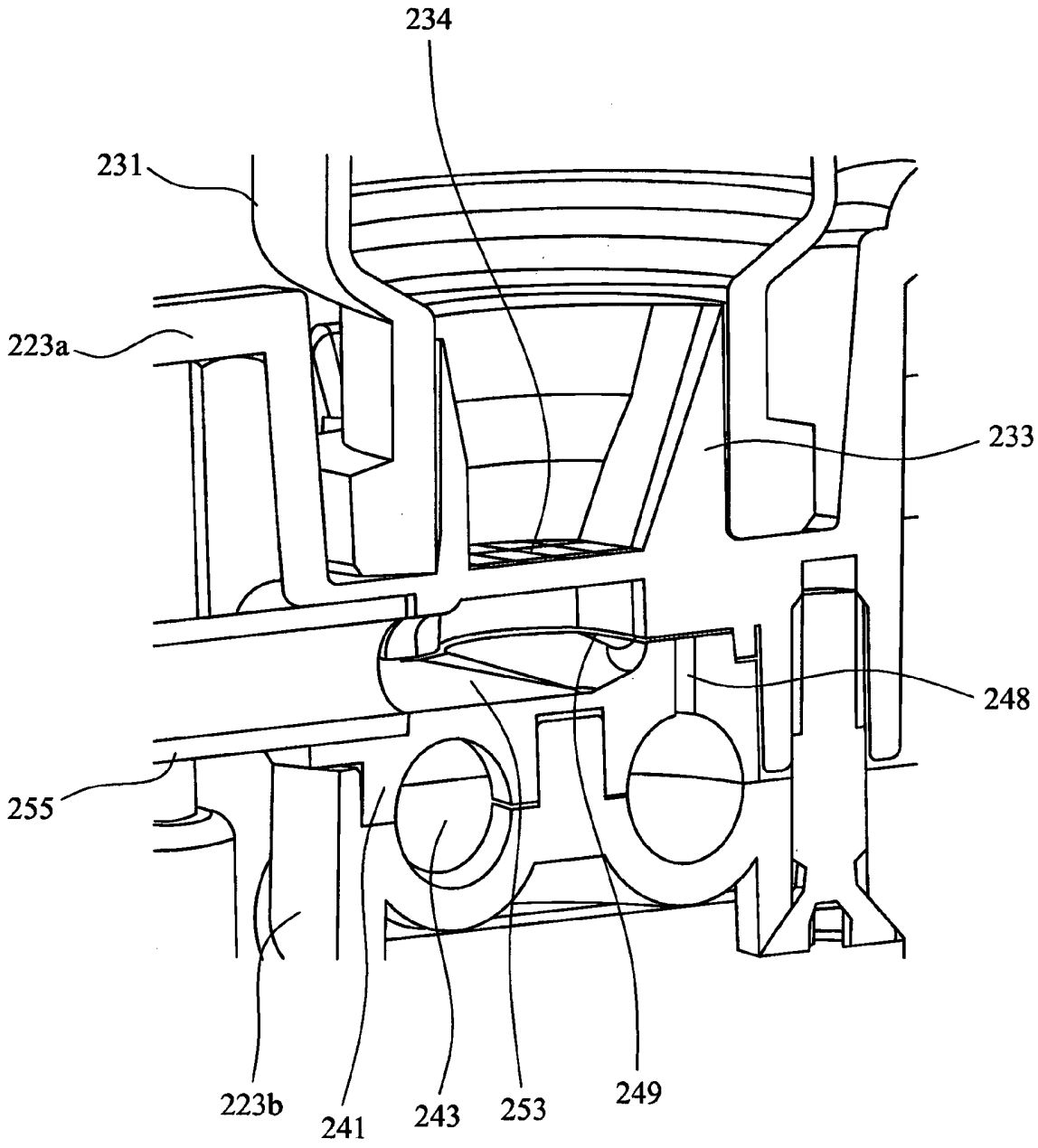

FIG. 12