

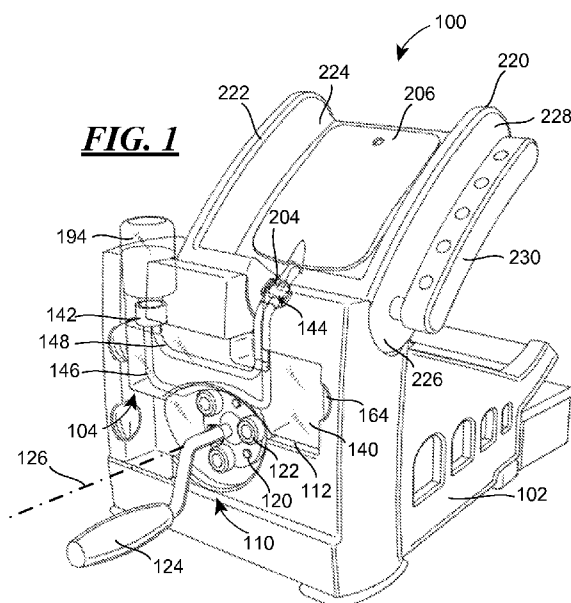


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Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))

[Continued on next page]

(54) **Title:** PUMP SYSTEM WITH REMOVABLE CARTRIDGE

(57) **Abstract:** A peristaltic pump includes a pump head (110) and a cartridge holder (112) disposed adjacent the pump head, and a removable cartridge (104) having a frame (140) disposed in the cartridge holder. The cartridge includes a first port (102) attached to the frame and configured to accept a first container type (194), a second port (144) attached to the frame and configured to accept a second container type (206) different than the first container type, and a fluid path (146) disposed in the frame in part and coupled at a first end to the first port and at a second end to the second port. The fluid path has a tubing defining a surface disposed in direct contact with the pump head to cause fluid to move along the fluid path between the first port and the second port. The peristaltic pump further comprises an adjustable container holder (220) adjacent the cartridge holder (112), the adjustable container holder having an upright position wherein the second container disposed within is in a first orientation relative to the second port (144), and an inverted position wherein the second container is in a second orientation different from and inverted relative to the first orientation.



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PUMP SYSTEM WITH REMOVABLE CARTRIDGE

Background

[0001] This patent is directed to a pump system with removable cartridges, and, in particular, to a peristaltic pump system with a family of interchangeable cartridges for a peristaltic pump.

[0002] As set forth in more detail below, the present disclosure sets forth a pump system embodying advantageous alternatives to prior art devices.

Summary

[0003] In one aspect, a family of disposable cartridges is provided for use with a peristaltic pump including a pump head and a cartridge holder disposed adjacent the pump head. The family of cartridges includes a first, a second and a third removable cartridge. Each of the first, second and third removable cartridges includes a standardized frame with a standardized coupling to removably couple the cartridge to the pump with the cartridge disposed in the cartridge holder. The cartridges also each include a first port attached to the frame and configured to accept a first container type, a second port attached to the frame and configured to accept a second container type different than the first container type, and a fluid path disposed in the frame in part and coupled at a first end to the first port and at a second end to the second port. The fluid path has tubing defining a surface to be disposed in direct contact with the pump head to cause fluid to move along the fluid path between the first port and the second port. The first port of the first removable cartridge is configured to accept a vial, the first port of the second removable cartridge is configured to accept a syringe, and the first port of the third removable cartridge is configured to accept an ampule, and the second port each of the first, second and third removable cartridges is configured to accept a flexible bag.

[0004] In another aspect, a pump system includes a peristaltic pump including a pump head and a cartridge holder disposed adjacent the pump head, and a removable cartridge having a frame disposed in the cartridge holder. The cartridge includes a first port attached to the frame and configured to accept a first container type, a second port attached to the frame and configured to accept a second container type

different than the first container type, and a fluid path disposed in the frame in part and coupled at a first end to the first port and at a second end to the second port. The fluid path has tubing defining a surface disposed in direct contact with the pump head to cause fluid to move along the fluid path between the first port and the second port.

[0005] In a further aspect, a pump system includes a peristaltic pump including a pump head and a cartridge holder disposed adjacent the pump head, and a first, a second and a third removable cartridge. Each of the first, second and third removable cartridges includes a frame configured to be disposed within the cartridge holder, a first port attached to the frame and configured to accept a first container type, a second port attached to the frame and configured to accept a second container type different than the first container type, and a fluid path disposed in the frame in part and coupled at a first end to the first port and at a second end to the second port. The fluid path has tubing defining a surface disposed in direct contact with the pump head to cause fluid to move along the fluid path between the first port and the second port. The first port of the first removable cartridge is configured to accept a vial, the first port of the second removable cartridge is configured to accept a syringe, and the first port of the third removable cartridge is configured to accept an ampule, and the second port each of the first, second and third removable cartridges is configured to accept a flexible bag.

[0006] Additional aspects of the disclosure are defined by the claims of this patent.

Brief Description of the Drawings

[0007] It is believed that the disclosure will be more fully understood from the following description taken in conjunction with the accompanying drawings. Some of the figures may have been simplified by the omission of selected elements for the purpose of more clearly showing other elements. Such omissions of elements in some figures are not necessarily indicative of the presence or absence of particular elements in any of the exemplary embodiments, except as may be explicitly delineated in the corresponding written description. None of the drawings is necessarily to scale.

[0008] Fig. 1 is a perspective view of a pump system having a first removable cartridge to couple a vial to a flexible bag, an adjustable container holder of the pump system in an upright position;

[0009] Fig. 2 is an enlarged, perspective view of the cartridge of Fig. 1;

- [0010] Fig. 3 is an enlarged, frontal view of the cartridge of Fig. 1;
- [0011] Fig. 4 is a perspective view of the pump system of Fig. 1 with the adjustable container holder of the pump system in an inverted position;
- [0012] Fig. 5 is a perspective view of a pump system having a second removable cartridge to couple a syringe to a flexible bag;
- [0013] Fig. 6 is an enlarged, perspective view of the cartridge of Fig. 5;
- [0014] Fig. 7 is a perspective view of a pump system having a third removable cartridge to couple an ampule to a flexible bag;
- [0015] Fig. 8 is an enlarged, perspective view of the cartridge of Fig. 7; and
- [0016] Fig. 9 is a perspective view of the pump system of Fig. 7 illustrating the pump system from the opposite side.

Detailed Description of Various Embodiments

[0017] According to the present disclosure, Figs. 1-4 illustrate a first embodiment of a pump system, while Figs. 5-6 illustrate a second embodiment of a pump system and Figs. 7-9 illustrate a third embodiment of a pump system. Alternatively, the present disclosure illustrates a common pump in combination with a family of removable cartridges, wherein the Figs. 1-4 illustrate an embodiment of a first cartridge, Figs. 5-6 illustrate an embodiment of a second cartridge, and Figs. 7-9 illustrate an embodiment of a third cartridge. According to the illustrated embodiments, either way of describing Figs. 1-9 is in keeping with the present disclosure.

[0018] Because of the similarities between the three cartridges, the same reference numerals have been used for similar parts of the cartridges. The reference numerals for the similar parts are distinguished for the different cartridges through the use of one or more primes. According to the illustrated embodiments, a common pump is used, and has a singular set of reference numerals applied thereto.

[0019] Starting with Fig. 1, the pump system 100 includes a pump 102 and a removable cartridge 104.

[0020] As best seen in Fig. 1, the pump 102 is a peristaltic pump, and may include a pump head 110 and a cartridge holder 112 disposed adjacent the pump head 110. As illustrated, the pump head 110 may include a wheel or rotor 120 (which may in turn include one or more rollers 122), and the pump head 110 may include a hand

crank 124 attached to the rotor 120 to cause the rotor 120 to revolve about an axis 126. It will be recognized that according to other embodiments, the pump head may have other configurations (e.g., linear), and the elements of the pump head (e.g., the rotor) may be attached to a motor through a transmission to cause the elements to move. According to the illustrated embodiment, a ratchet/pawl assembly may be attached to the rotor 120 to allow the rotor 120 to rotate only in one direction or the other (i.e., clockwise or counterclockwise); the ratchet/pawl assembly may be selectable, such that the assembly may permit either clockwise or counterclockwise rotation depending on the state or position of a switch or other actuator, for example.

[0021] As best seen in Figs. 2 and 3, the removable cartridge 104 may have a frame 140, first and second ports 142, 144, and at least one fluid path 146, 148. The cartridge 104 may also include a coupling, as explained in greater detail below, which may be used to removably attach the cartridge 104 to the pump 102 in the cartridge holder 112.

[0022] The frame 140 may include a box 150 having a front 152, a back 154, left and right sides or ends 156, 158 and top and bottom edges 160, 162. The front 152 of the box 150 may be defined by a first section of the box (e.g., a lid) and the remainder of the box 150 may be defined by a receptacle closed on all sides but the front, the front 152 of the box 150 being attached to the remainder of the box 150 to define the box 150. The box 150 may have an outer perimeter defined by the left and right sides 156, 158 and top and bottom edges 160, 162, and the cartridge holder 112 may have an inner perimeter, the outer perimeter being exactly complementary to the inner perimeter. As a consequence, when the frame 140 is disposed in the cartridge holder 112, as seen in Fig. 1 and 3, only the front 152 of the box 150 is visible and the remainder of the box 150 (specifically the left and right sides 156, 158) is accessible only through recesses 164 provided along the inner perimeter of the cartridge holder 112.

[0023] As seen in Figs. 2 and 3, the bottom edge 162 may have an arcuate section 166 with a surface 168 that operationally interacts with the fluid path 146 and the rotor 120 of the pump head 110 to provide a pumping function as will be described below. This arcuate section 166 is part of the bottom edge 162, and thus defines the outer perimeter of the box 150, in part.

[0024] While a box 150 having a substantially rectangular outer perimeter is illustrated in Fig. 2, the box 150 need not have this shape according to all embodiments of the present disclosure. For example, the box 150 could be oval or circular, or may have an asymmetrical appearance as viewed from the front 152. As will be explained in greater detail below, according to embodiments of the present disclosure illustrated, the outer perimeter may be of a standard shape and size for all cartridges that are members of a common family of cartridges (such as those illustrated in Figs. 1-9).

[0025] The port 142 is attached to the frame 140 and configured to accept a first container type (e.g. a vial). The second port 144 also is attached to the frame 140 and configured to accept a second container type (e.g., a flexible bag) different than the first container type. Further, the cartridge 104 includes at least one fluid path 146, 148, the fluid path 146 disposed in the frame 140 in part and the fluid path 148 fully or completely disposed in the frame 140. According to the illustrated embodiment, the first port 142 may be attached at a first (left) end 156 of the box 150, the second port 144 may be attached at the second (right) end 158 of the box 150, and the at least one fluid path 146, 148 may be fully disposed within the box 150 between the first and second ends 156, 158 of the box 150 except as noted below.

[0026] As illustrated, the fluid path 146 is coupled at a first end 170 to the first port 142 and at a second end 172 to the second port 144. The fluid path 146 has tubing defining a surface 174 disposed to be in operational contact with the surface 168 and the pump head 110 to cause fluid to move along the fluid path 146 between the first port 142 and the second port 144. According to an embodiment, the fluid path 146 is defined by tubing disposed within the box 150 except for the surface 174 in direct contact with the pump head 110.

[0027] According to the embodiment of the cartridge illustrated in Figs. 1-4, the cartridge 104 includes a second fluid path 148 disposed within the frame 140. The second fluid path 148 is coupled at a first end 176 to the first port 142 and at a second end 178 to the second port 144. Unlike the fluid path 146, the second fluid path 148 not in direct contact with the pump head 110. According to an embodiment, the fluid path 148 may also include tubing disposed within the box 150 to define the fluid path 148.

[0028] According to an embodiment, such as illustrated, wherein the fluid paths 146, 148 include tubing, the ends of the fluid paths 146, 148 may be disposed closely adjacent to each other. For example, the second end 178 of the second path 148 may be closely adjacent to the first end 170 of the first path 146 and the second end 172 of the first path 148 may be closely adjacent to the first end 176 of the second path 148. In fact, the ports 142, 144 may be configured to each have a connector with two adjacent lumens, one lumen connected to an end of the first path 146 and the other lumen connected to an end of the second path 148.

[0029] As mentioned above, the first port 142 is configured to accept a first container type, and the second port 144 is configured to accept a second container type. As best seen in Fig. 2, the first port 142 includes a cannula 190 (e.g., a needle or spike) having a sharp point 192 useful in penetrating the stopper/seal of a conventional vial 194 (see Figs. 1 and 4). The first port may also include a plate/collar 196 disposed opposite the sharp point 192, the plate/collar 196 limiting the distance the cannula 190 can depend into the vial 194. As also best seen in Fig. 2, the second port 144 includes a cannula 200 (e.g., a spike) having a sharp point 202 useful in penetrating a septum/port 204 of a conventional flexible bag 206. The second port 144 also may include a plate 208 having a plurality of fingers 210 depending therefrom in the direction of the sharp point 202 of the cannula 200. The fingers 210 may abut and therefore cooperate with a locking rim disposed about the port 204 to limit the removal of the second port 144 once the sharp point 202 of the cannula 200 has been disposed into the port 204.

[0030] The pump illustrated in Figs. 1-8, and particular in Figs. 1-4, further includes an adjustable container holder 220 adjacent the cartridge holder 112. The adjustable container holder 220 has an upright position (Fig. 1) wherein the second fluid container (bag 206) disposed within the adjustable container holder 220 is in a first orientation relative to the second port 144. The adjustable container holder 220 also includes an inverted position (Fig. 4) wherein the second fluid container 206 is in a second orientation different from and inverted relative to the first orientation.

[0031] According to the illustrated embodiment, the adjustable container holder includes a tray 222 with a recess 224 configured to accept the bag 206. The tray 222 is pivotably coupled at a first end 226 adjacent the cartridge holder 112 and has a second end 228 cantilevered from the first end 226. For example, the pump 102 may

include a hinge disposed at the first end 226 to pivotally couple the tray 222 to the remainder of the housing of the pump 102. The tray 222 may include a handle 230 attached to the tray 222 so that a user may grip the handle 230 and apply a force to the tray 222 to move the tray 222 between the upright and inverted positions (Figs. 1 and 4).

[0032] Having thus discussed the structure of the system 100, the operation of the pump 102 and cartridge 104 is discussed relative to Figs. 1-4. In particular, the purpose of the operation of the pump system 100 according to the embodiment illustrated in Figs. 1-4 is to move materials contained in one or more vials 194 into the bag 206.

[0033] To begin, the user may remove sterile caps (not shown) from the ports 142, 144, and the cartridge 104 is disposed in the cartridge holder 112 of the pump 102. The bag 206 may then be placed in the recess 224 of the tray 222 of the holder 220, and the port 204 of the bag 206 may be connected to the port 144 of the cartridge. A vial 194 may then be inverted and disposed on the cannula 190 of the first port. The vial 194 may be advanced in a downward direction (with reference to the orientation of the system 100 illustrated in Figs. 1-4) until the cannula 190 is disposed a sufficient distance into the vial 194 to permit the first and second fluid paths 146, 148 to be in fluid communication with the interior of the vial 194.

[0034] At this point, the tray 222 is in the upright position illustrated in Fig. 1. As a consequence, the liquid in the bag 206 is in the portion of the bag 206 closest to the port 204, while the air/gasses in the bag 206 are in the portion furthest from the port 204. This may be described as the first operational state of the pump 102.

[0035] Rotating the crank 124 in the counterclockwise direction causes the pump roller 122 to operationally engage the tubing surface 174 and rollingly press it against the arcuate surface 166 in a peristaltic pumping engagement causing liquid from the bag 206 to be drawn or pulled into the vial 194 via the fluid path 148, while air from the vial 194 is transported along the fluid path 146 into the bag 206. At the outset, there is a considerable amount of air in the vial 194, and only a small amount of material in the vial 194. Over time, liquid from the bag 206 will also be transported along the path 146, and may partially or substantially fill the vial 194. At this point, the user may elect to empty the fluid in the vial 194 completely or nearly completely into the bag 206.

[0036] To empty the fluid in the vial 194, the user applies a force to the holder 220 in a downward direction, as illustrated by the arrow in Fig. 4. In particular, the user may apply a force to the handle 230. This action causes the holder 220 to be moved from the upright position illustrated in Fig. 1 to the inverted position illustrated in Fig. 4. The inversion of the bag 206 causes the air/gasses in the bag 206 to be in the portion of the bag 206 closest to the port 204, while the liquid is in the portion furthest from the port 204. This may be described as the second operational state of the pump 102.

[0037] Rotating the crank 124 further in the counterclockwise direction now causes air/gasses from the bag 206 to be drawn or pulled into the vial 194 via the fluid path 148 as fluid from the vial 194 is transported along the fluid path 146 into the bag 206. Over time, the contents of the vial 194 will be completely or nearly completely emptied into the bag 206 thereby emptying the vial 194 of its contents. Once the contents of the vial 194 have been completely or nearly completely emptied, the vial 194 may be disconnected from the port 142 so that a new vial 194 may be connected. At this point, the tray 222 may be returned to the upright position, and the process of the preceding paragraphs may be repeated to transfer the contents of the new vial 194 into the bag 206.

[0038] Once the contents of the desired number of vials 194 have transferred to the bag 206, the port 204 may be disconnected from the port 144 of the cartridge. The bag 206 may then be connected to one or more sets and administered intravenously to a patient, for example.

[0039] As mentioned above, the pump 102 may be used with other cartridges as well other instances of the cartridge 104. Figs. 5 and 6 illustrate a second cartridge that may be used with the pump 102, while Figs. 7-9 illustrate a third cartridge that may be used with the pump 102. As discussed above, the cartridges of Figs. 5-6 and 7-9 may be described as different embodiments of the cartridge, or alternatively the combination of the pump 102 and the cartridge may be discussed as different embodiments of the pump system 100.

[0040] As illustrated in Figs. 5 and 6, the system 100' includes the pump 102, which pump is identical to that described with reference to Figs. 1-4. Consequently, a detailed description of the pump 102 is not repeated in the interests of brevity,

although certain features are referred to in conjunction with the second cartridge 104' below.

[0041] The second cartridge 104' has many of the features of the first cartridge 104 discussed above. In particular and with reference to Fig. 6, the cartridge 104' includes a frame 140', a first port 142', a second port 144', and at least one fluid path 146'. The frame 140' is defined by a box 150' having a front 152', back 154', left and right sides or ends 156', 158', and top and bottom 160', 162'. The box 150' also has the arcuate section 166' along the bottom edge 162', which section 166' has a surface 168' that is in operational engagement with the fluid path and pump head 110 as is described below.

[0042] In fact, frame 140' (or more particularly box 150') is selected so that the frames 140, 140' or the cartridges 104, 104' are standardized. That is, the frames 140, 140' are designed to be used with the pump 102 without requiring modification of the pump 102 or the pump head 110. This may be achieved, at least in part, by providing that the front, back, left and right ends, top and bottom edges, and arcuate sections have the same or nearly the same dimensions, and that the same shape is used for the boxes 150, 150'. This may also be achieved by adopting a common distance between the first and second ports 142, 144, 142', 144'. This may further be achieved by providing a standardized coupling that is used by all of the cartridges 104, 104'. According to certain embodiments, the coupling between the cartridges 104, 104' and the cartridge holder 112 may be defined by the common inner and outer perimeters of the cartridges 104, 104' and the holder 112, the common perimeters limiting removal of the cartridges 104, 104' from the holder 112, thereby achieving a coupling between the cartridges 104, 104' and the holder 112 when the cartridge 104, 104' is moved in the direction of the holder 112. The coupling is detachable or the cartridge 104, 104' is removably coupled in that the cartridge 104, 104' may be grasped using the recesses 164 in the face of the pump 102 and moved in the opposite direction away from the holder 112.

[0043] As mentioned previously, the cartridge 140' has a first port 142', a second port 144' and at least one fluid path 146', like the cartridge 140. Unlike the cartridge 140, the cartridge 140' includes only one fluid path 146', coupled at a first end 170' to the first port 142' and a second end 172' coupled to the second port 144'. The fluid path 146' has tubing defining a surface 174' disposed in direct contact with the pump

head and the surface 168' of the arcuate section 166' to cause the fluid to move along the fluid path 146' between the first port 142' and the second port 144'. As above, according to the illustrated embodiment, the entire fluid path 146' may be defined by tubing.

[0044] Also unlike the embodiment of Figs. 1-4, the first port 142' is not defined by a cannula, because the cartridge 104' is intended to be used with a syringe 250, as illustrated in Fig. 5. The syringe 250 includes a barrel or bore 252 with a finger flange 254, a plunger 256, and a plunger rod 258 with a thumb rest 260. The bore 252 is in fluid communication with a tip 262. According to the illustrated embodiment of Fig. 5, the tip 262 of the syringe 250 is configured as a luer tip. More particularly, the tip 262 may be configured to be threadingly engaged with a luer connector 270 that defines the first port 142'. See Fig. 6.

[0045] The luer connector 270 may have valve incorporated therein, the valve controlling the passage of fluid through the luer connector 270. For example, such a valve may prevent the flow of fluid from the connector 270 unless a syringe 250 is attached to the luer connector 270. The luer connector 270 may have threads 272 formed on an external surface thereof that mate with and engage threads on an internal surface of a collar disposed about a male luer connector formed at the tip 262 of the syringe 250.

[0046] The second port 144' includes a cannula 200' (e.g., a spike) having a sharp point 202' useful in penetrating a septum/port 204 of a conventional flexible bag 206. The second port 144' also may include a plate 208' having a plurality of fingers 210' depending therefrom in the direction of the sharp point 202' of the cannula 200'. The fingers 210' may abut and therefore cooperate with a locking rim disposed about the port 204 to limit the removal of the second port once the sharp point 202' of the cannula 200' has been disposed into the port 204.

[0047] The cartridge 104' is used with the pump 102 of the system 100' in the following fashion. In particular, the pump system 100' may be used to move materials from the bag 206 to one or more syringes 250 (i.e., to fill one or more syringes 250).

[0048] Sterile caps (not shown) may be removed from the ports 142', 144', and the cartridge 104' is disposed in the cartridge holder 112 of the pump 102. The bag 206 may then be placed in the recess 224 of the tray 222 of the holder 220, and the

port 204 of the bag 206 may be connected to the port 144' of the cartridge. The syringe 250 may then be inverted and connected to the luer connector 260 of the first port 142'. The syringe 250 may be rotated and advanced in a downward direction (with reference to the orientation of the system 100' illustrated in Figs. 5-6) until the tip 262 is in fluid communication with the connector 270, and through the connector 270 the fluid path 146'.

[0049] At this point, the tray 222 is in the upright position illustrated in Fig. 5. As a consequence, the liquid in the bag 206 is in the portion of the bag 206 closest to the port 204, while the air/gasses in the bag 206 are in the portion furthest from the port 204.

[0050] Rotating the crank 124 in the counterclockwise direction causes liquid from the bag 206 to be drawn or pulled into the syringe 250 via the fluid path 146'. Once the syringe 250 has been filled to a desired point with fluid from the bag 206, the syringe 250 may be disconnected from the port 142'. A new syringe 250 may then be connected to the connector 270, and the process repeated. Alternatively, the port 204 may be disconnected from the port 144' of the cartridge 104'. The bag 206 may then be discarded, while the syringe(s) filled from the bag 106 may be administered to one or more patients.

[0051] As still further cartridge 104'' is illustrated in Figs. 7-9. The system 100'' includes the pump 102, which pump is identical to that described with reference to Figs. 1-6. Consequently, a detailed description of the pump 102 is not repeated for brevity, although the features are described with reference to the third cartridge 104'' below.

[0052] The third cartridge 104'' also has many of the features of the first and second cartridges 104, 104' discussed above. In particular and with reference to Fig. 7, the cartridge 104'' includes a frame 140'', a first port 142'', a second port 144'', and at last one fluid path 146''. As seen in Fig. 8, the frame 140'' is defined by a box 150'' having a front 152'', back 154'', left and right sides or ends 156'', 158'', and top and bottom 160'', 162''. The box 150'' also has the arcuate section 166'' along the bottom edge 162'', which section 166'' has a surface 168'' that is in operational engagement with the tubing and pump head 110 as described below. In fact, the frame 140'' (or more particularly box 150'') may be selected so that the frames 140, 140', 140'' or the cartridges 104, 104', 104'' are standardized.

[0053] As mentioned previously, the cartridge 140'' has a first port 142'', a second port 144'' and at least one fluid path 146'', like the cartridge 140. Unlike the cartridge 140 but similar to cartridge 140', the cartridge 140'' includes only one fluid path 146'', coupled at a first end 170'' to the first port 142'' and a second end 172'' coupled to the second port 144''. The fluid path 146'' has tubing defining a surface 174'' disposed in operational contact with the pump head to cause the fluid to move along the fluid path 146'' between the first port 142'' and the second port 144''. As above, according to the illustrated embodiment, the entire fluid path 146'' may be defined by tubing.

[0054] Also unlike the embodiment of Figs. 1-4, the first port 142'' is not defined by a cannula with a sharp point, because the cartridge 104'' is intended to be used with an ampule 280, as illustrated in Fig. 7. The ampule 280 includes a substantially cylindrical body 282 with a closed end 284 and an open end 286. The open end 286 is formed when a bulbous head is removed from the body 282, which removal may be performed manually by holding the body 282 in one hand and grasping the head in the other hand and snapping the head off from the body 282. Alternatively, a row of ampule breakers may be provided along either side of the pump 102 (compare Figs. 7 and 9), the ampule breakers having one or more structures used to grasp and snap the head from the body 282 when the head is passed through the open windows 290, the heads rolling down a ramp from the ampule breakers to a sharps container 292. The ampule breakers may be similar to those included as part of the Ampoule Breaking Fixture Assembly (Part No. H938 17 3) manufactured and sold by Baxa Corporation, Englewood, Colorado, now Baxter Corporation Englewood.

[0055] As best seen in Fig. 8, the first port 142'' is defined by an elongated straw-like cannula 300 that has a hub 302 disposed at a first end 304 of the cannula 300. The hub 302 may be a pivoting hub, to permit the cannula 300 to pivot or rotate about the first end 304. The cannula also has a tapered point 306 at a second end 308 of the cannula. Between the first and second ends 304, 308 is a bend 310. As illustrated, the bend 310 is approximately 90 degrees (i.e., a right angle bend), although the embodiments according to the present disclosure are not limited to only such an angle.

[0056] As best seen in Fig. 7, the distance between the tapered point 306 and the bend 310 is such that the point 306 may be disposed through the open end 286 to at or

near the closed end 284. In this fashion, the tapered point 306 would be disposed into ampule 280 to access a volume of fluid disposed within the ampule 280.

[0057] At some point along the fluid path 146'', a filter may be included. The filter may be used to remove air and/or glass that may otherwise be introduced into the bag 206'' when the contents of the ampule 280 are transferred to the bag 206''. However, this is not required according to all embodiments.

[0058] The second port 144'' includes a cannula 200'' (e.g., a spike) having a sharp point 202'' useful in penetrating a septum/port 204 of a conventional flexible bag 206. The second port 144'' also may include a plate 208'' having a plurality of fingers 210'' depending therefrom in the direction of the sharp point 202'' of the cannula 200''. The fingers 210'' may abut and therefore cooperate with a locking rim disposed about the port 204 to limit the removal of the second port once the sharp point 202'' of the cannula 200'' has been disposed into the port 204.

[0059] The cartridge 104'' is used with the pump 102 of the system 100'' in the following fashion. In particular, the pump system 100'' may be used to move materials from one or more syringes 250 to the bag 206 (i.e., to transfer the materials to or empty the ampules 280 into the bag 206).

[0060] Sterile caps (not shown) may be removed from the ports 142'', 144'', and the cartridge 104'' is disposed in the cartridge holder 112 of the pump 102. The bag 206 may then be placed in the recess 224 of the tray 222 of the holder 220, and the port 204 of the bag 206 may be connected to the port 144'' of the cartridge 104''. The head of the ampule 280 may then be snapped off (for example, using the ampule breakers provided in the pump 102) and the tapered point 306 of the cannula 300 of the first port 142'' disposed into the open end 286 to at or near the closed end 284. In this fashion, the fluid path 146'' is in fluid communication with the contents disposed in the body 282 of the ampule 280.

[0061] The tray 222 is in the upright position illustrated in Figs. 7 and 9. As a consequence, the liquid in the bag 206 is in the portion of the bag 206 closest to the port 204, while the air/gasses in the bag 206 are in the portion furthest from the port 204.

[0062] Rotating the crank 124 in the clockwise direction causes the pump head 110 to peristaltically engage the fluid path 146'' and arcuate section 166'' and draw or pull liquid from the ampule 280 into the bag 206 via the fluid path 146''. Once

contents of the ampule 280 have been transferred into the bag 206, the port 142” may be disconnected from the ampule 280. A new ampule 280 may then be connected to the port 142”, and the process repeated. Eventually, the port 204 may be disconnected from the port 144” of the cartridge 104”. The contents of the bag 206 may then be administered to the patient.

[0063] The illustrated embodiments may provide one or more of the following advantages. First, the cartridges 104, 104’, 104” provide a family of cartridges that allow the pump 102 to be used with a variety of first containers (e.g., vial, syringe, ampule) with a second container (e.g., bag) to transfer fluid therebetween without modifying the pump 102. Further, the cartridges 104, 104’, 104” may be used with a single bag 206, and then disposed of as waste once used with the bag 206. This limits the need to clean the reusable portion (e.g., pump 102) while using the disposable portion (e.g., the cartridges 104, 104’, 104”) with multiple first containers (e.g., vials, syringes, ampules). Further, it will be recognized that additional cartridge designs may be included in the family of cartridges to address still other connections with the second container 206 to provide uses other than those explained herein.

Consequently, the presently disclosed pump systems 100, 100’, 100” provide a system that is adaptable beyond even those particular configurations described herein.

[0064] Although the preceding text sets forth a detailed description of different embodiments of the invention, it should be understood that the legal scope of the invention is defined by the words of the claims set forth at the end of this patent. The detailed description is to be construed as exemplary only and does not describe every possible embodiment of the invention since describing every possible embodiment would be impractical, if not impossible. Numerous alternative embodiments could be implemented, using either current technology or technology developed after the filing date of this patent, which would still fall within the scope of the claims defining the invention.

[0065] It should also be understood that, unless a term is expressly defined in this patent using the sentence “As used herein, the term ‘_____’ is hereby defined to mean...” or a similar sentence, there is no intent to limit the meaning of that term, either expressly or by implication, beyond its plain or ordinary meaning, and such term should not be interpreted to be limited in scope based on any statement made in any section of this patent (other than the language of the claims). To the extent that

any term recited in the claims at the end of this patent is referred to in this patent in a manner consistent with a single meaning, that is done for sake of clarity only so as to not confuse the reader, and it is not intended that such claim term be limited, by implication or otherwise, to that single meaning. Finally, unless a claim element is defined by reciting the word “means” and a function without the recital of any structure, it is not intended that the scope of any claim element be interpreted based on the application of 35 U.S.C. §112, sixth paragraph.

WHAT IS CLAIMED IS:

1. A family of disposable cartridges for use with a peristaltic pump comprising a pump head and a cartridge holder disposed adjacent the pump head, the family of cartridges comprising:

a first, a second and a third removable cartridge,

each of the first, second and third removable cartridges comprising a standardized frame with a standardized coupling to removably couple the cartridge to the pump with the cartridge disposed in the cartridge holder,

a first port attached to the frame and configured to accept a first container type, a second port attached to the frame and configured to accept a second container type different than the first container type, and a fluid path disposed in the frame in part and coupled at a first end to the first port and at a second end to the second port, the fluid path having tubing defining a surface to be disposed in direct contact with the pump head to cause fluid to move along the fluid path between the first port and the second port,

wherein the first port of the first removable cartridge is configured to accept a vial, the first port of the second removable cartridge is configured to accept a syringe, and the first port of the third removable cartridge is configured to accept an ampule, and

wherein the second port each of the first, second and third removable cartridges is configured to accept a flexible bag.

2. The pump system according to claim 1, wherein the first removable cartridge comprises another fluid path disposed within the frame and coupled at a first end to the first port and at a second end to the second port, the another fluid path not in direct contact with the pump head.

3. The pump system according to claim 1, wherein the frame comprises a box, the first port attached at a first end of the box, the second port attached at the

second end of the box, and the fluid path disposed within the box between the first and second ends of the box except for the surface be disposed in direct contact with the pump head.

4. The pump system according to claim 3, the box having an outer perimeter, and the cartridge holder having an inner perimeter, the outer perimeter being exactly complementary to the inner perimeter.

5. The pump system according to claim 3, wherein the cartridge comprises tubing to define the entire fluid path.

6. A pump system comprising:

a peristaltic pump comprising a pump head and a cartridge holder disposed adjacent the pump head; and

a removable cartridge having a frame disposed in the cartridge holder,

the cartridge comprising a first port attached to the frame and configured to accept a first container type, a second port attached to the frame and configured to accept a second container type different than the first container type, and a fluid path disposed in the frame in part and coupled at a first end to the first port and at a second end to the second port, the fluid path having tubing defining a surface disposed in direct contact with the pump head to cause fluid to move along the fluid path between the first port and the second port.

7. The pump system according to claim 6, wherein the removable cartridge comprises another fluid path disposed within the frame and coupled at a first end to the first port and at a second end to the second port, the another fluid path not in direct contact with the pump head.

8. The pump system according to claim 6, wherein the frame comprises a box, the first port attached at a first end of the box, the second port attached at the second end of the box, and the fluid path disposed within the box between the first

and second ends of the box except for the surface be disposed in direct contact with the pump head.

9. The pump system according to claim 8, the box having an outer perimeter, and the holder having an inner perimeter, the outer perimeter being exactly complementary to the inner perimeter.

10. The pump system according to claim 8, wherein the cartridge comprises tubing to define the entire fluid path.

11. The pump system according to claim 6, wherein the pump comprises an adjustable container holder adjacent the cartridge holder, the adjustable container holder having an upright position wherein a second fluid container disposed within the adjustable container holder is in a first orientation relative to the second port, and an inverted position wherein the second fluid container is in a second orientation different from and inverted relative to the first orientation.

12. The pump system according to claim 11, wherein the adjustable container holder comprises a tray with a recess configured to accept the second container, the tray pivotably coupled at a first end adjacent the cartridge holder and having a second end cantilevered from the first end.

13. The pump system according to claim 11, wherein the pump has a first operational state with the adjustable container holder in the upright position to draw air from a first container coupled to the first port and a second operational state with the adjustable container holder in the inverted position to draw air from a second container coupled to the second port.

14. The pump system according to claim 6, wherein the pump head comprises a rotor.

15. The pump system according to claim 14, wherein the pump head comprises a hand crank attached to the rotor to cause the rotor to revolve about an axis.

16. The pump system according to claim 6, further comprising a first fluid container of the first container type coupled to the first port, and a second fluid container of the second container type coupled to the second port.

17. The pump system according to claim 16, wherein the first container type is one of a vial, an ampule, and a syringe and the second container type is a flexible bag.

18. A pump system comprising:

a peristaltic pump comprising a pump head and a cartridge holder disposed adjacent the pump head; and

a first, a second and a third removable cartridge,

each of the first, second and third removable cartridges comprising a frame configured to be disposed within the cartridge holder, a first port attached to the frame and configured to accept a first container type, a second port attached to the frame and configured to accept a second container type different than the first container type, and a fluid path disposed in the frame in part and coupled at a first end to the first port and at a second end to the second port, the fluid path having tubing defining a surface disposed in direct contact with the pump head to cause fluid to move along the fluid path between the first port and the second port,

wherein the first port of the first removable cartridge is configured to accept a vial, the first port of the second removable cartridge is configured to accept a syringe, and the first port of the third removable cartridge is configured to accept an ampule, and

wherein the second port each of the first, second and third removable cartridges is configured to accept a flexible bag.

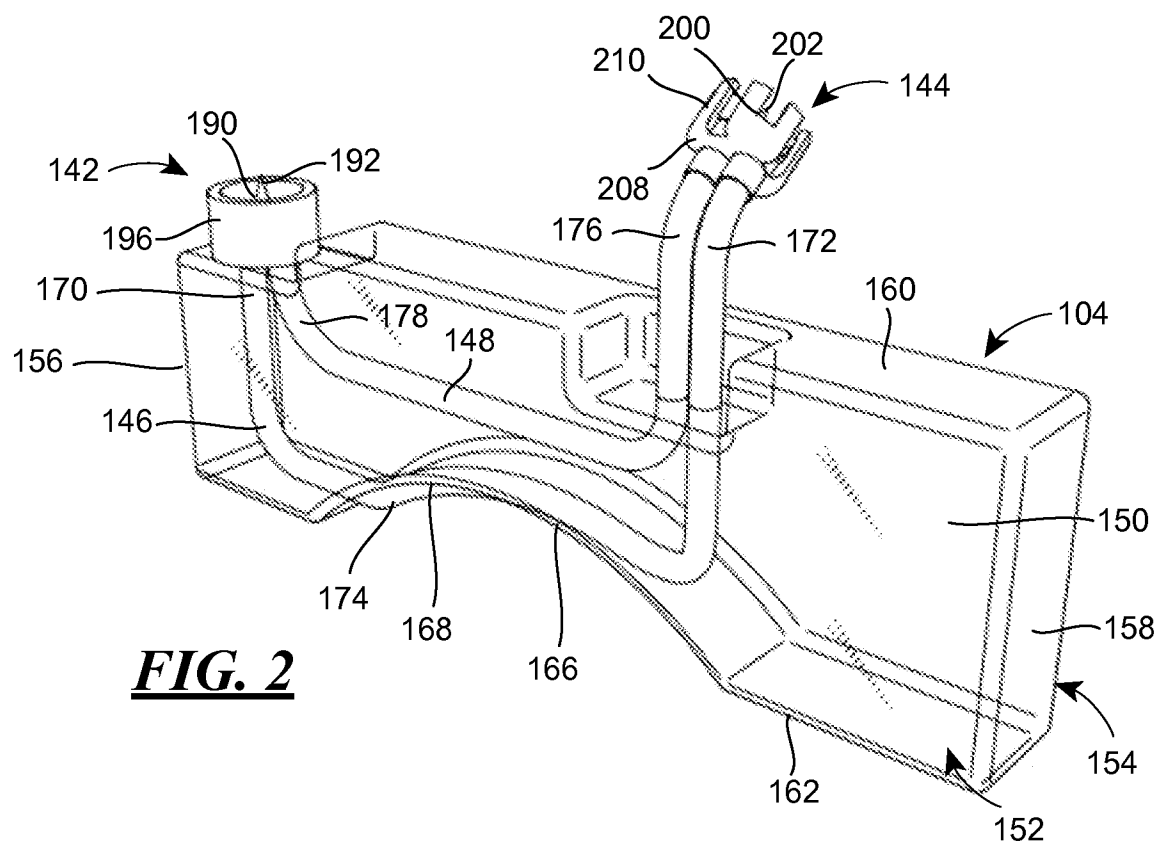
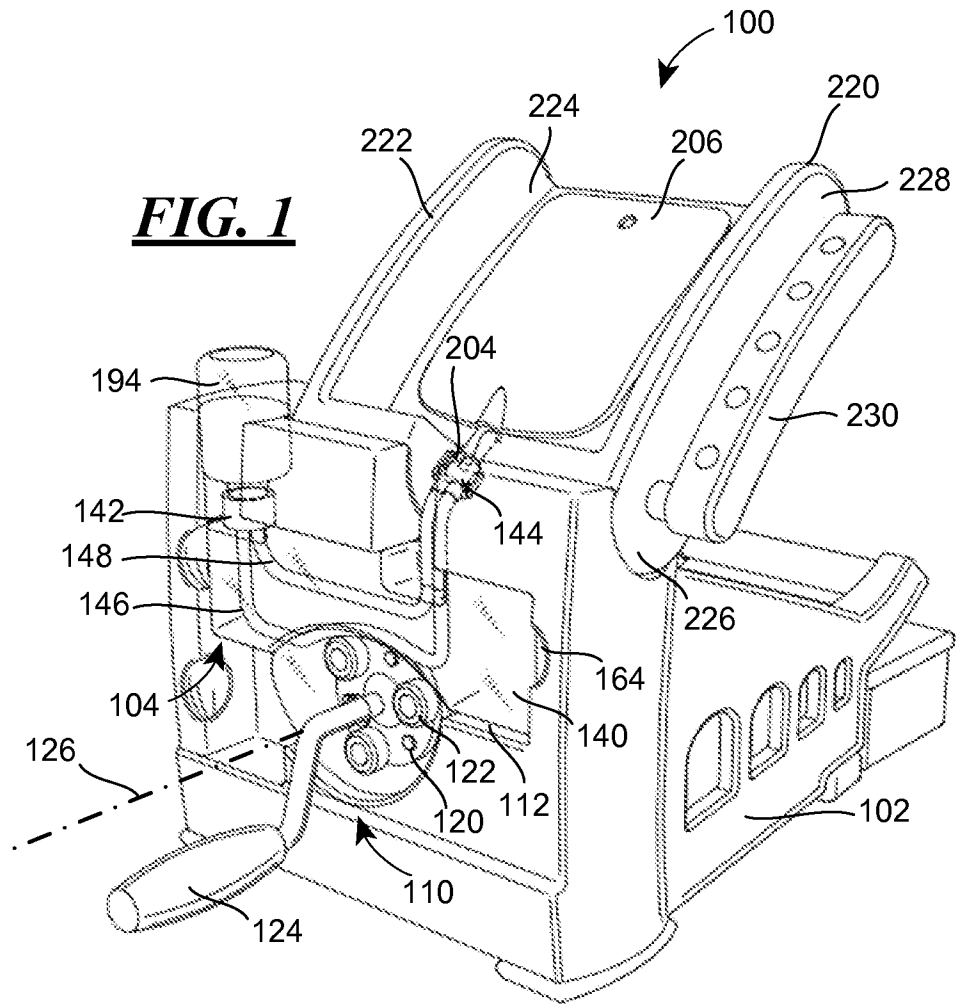
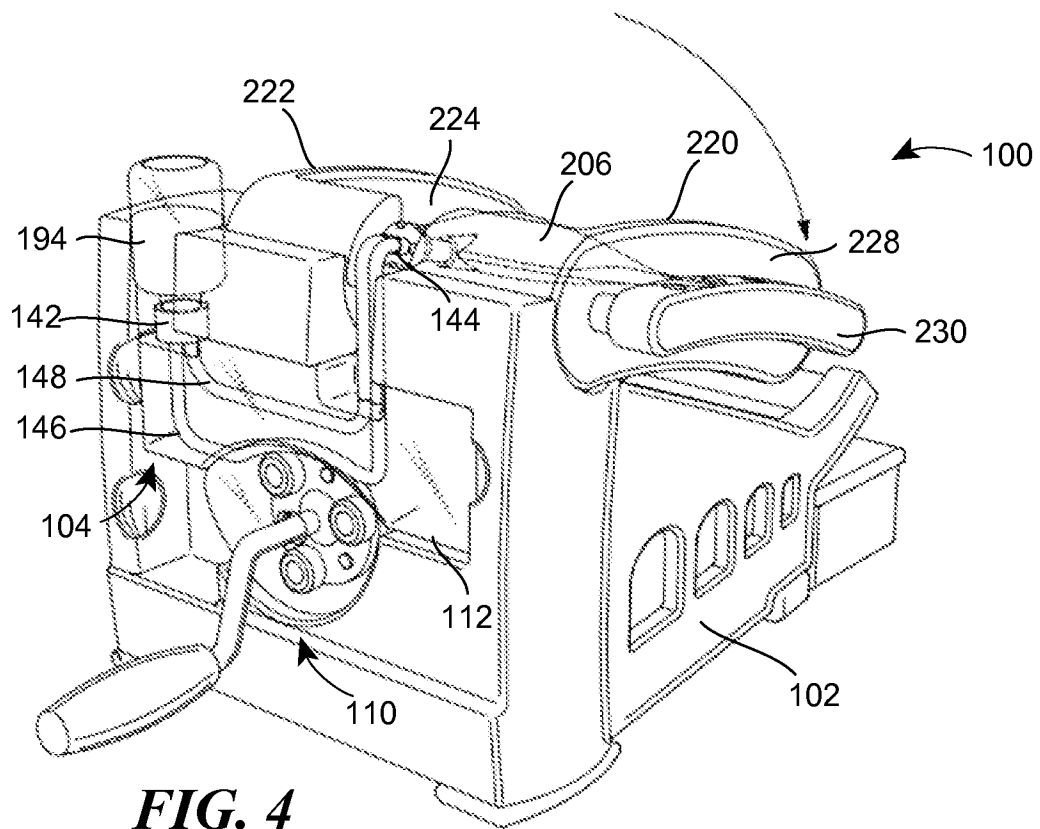
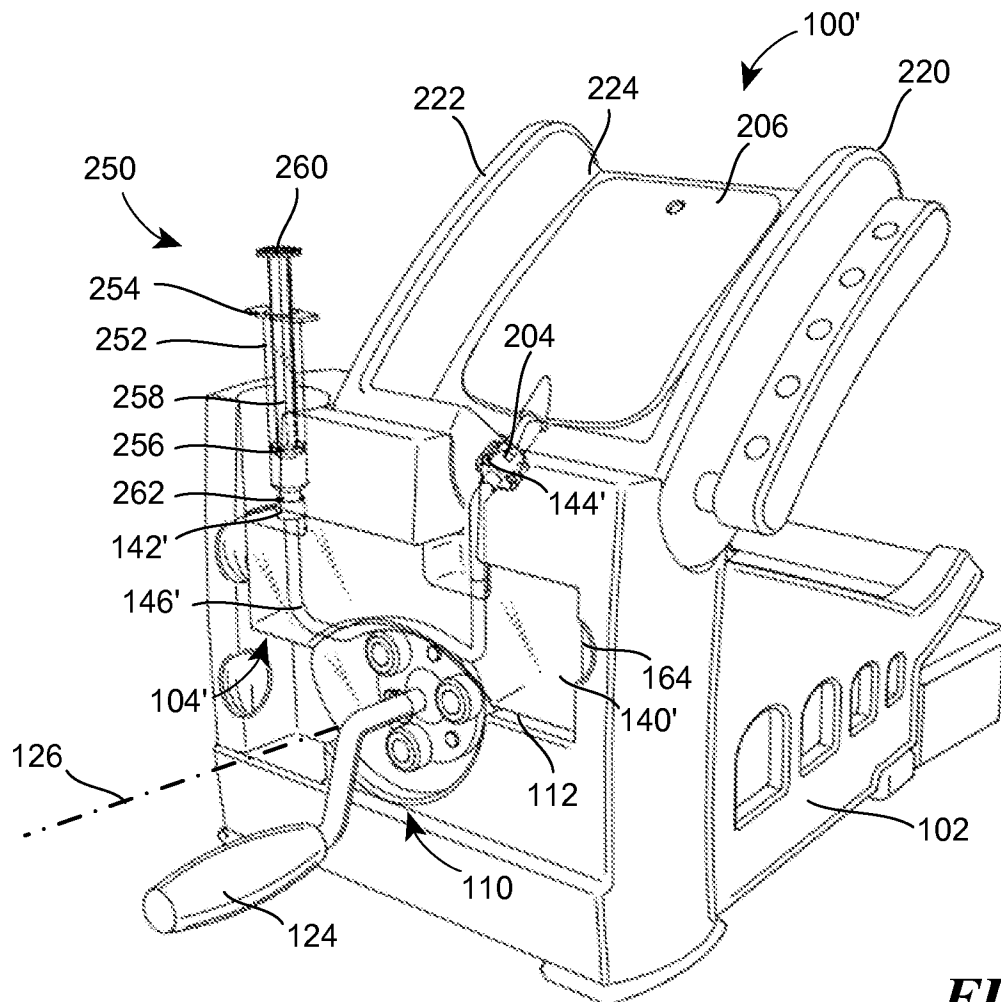
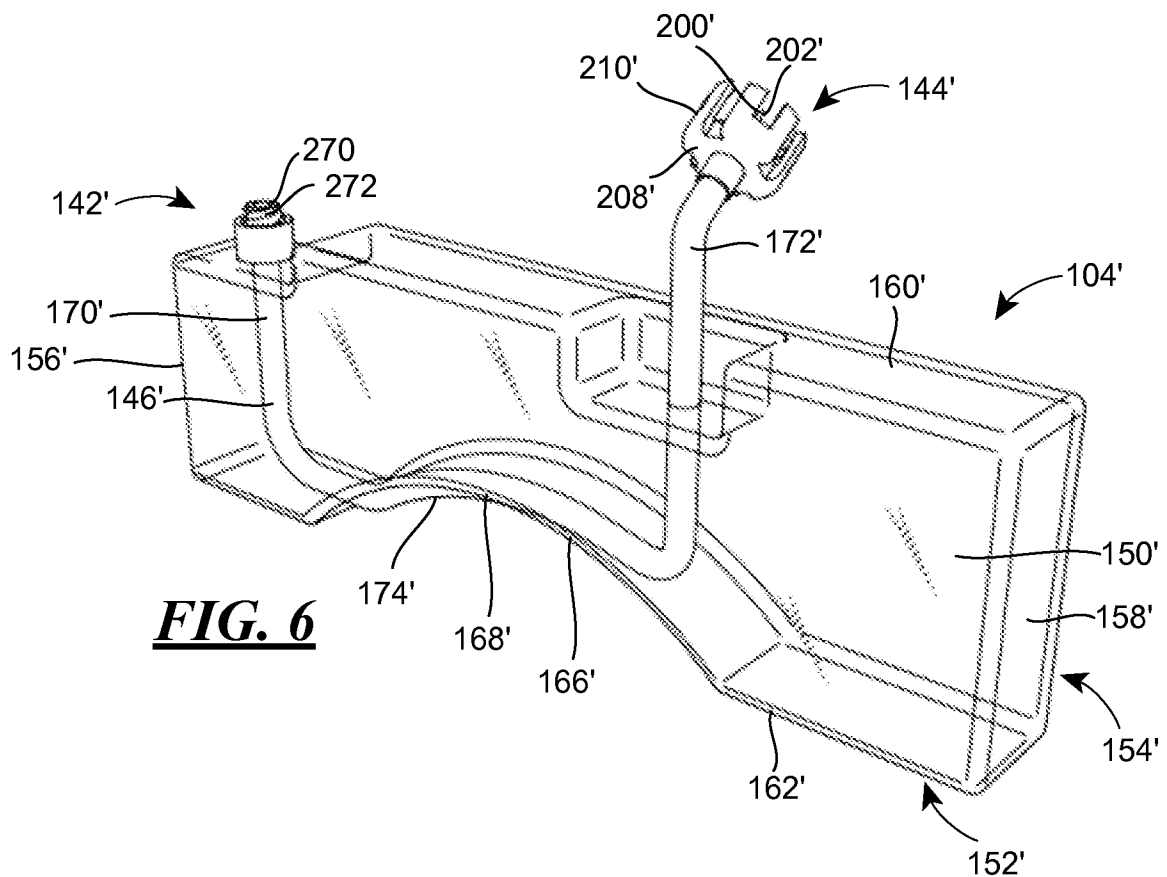
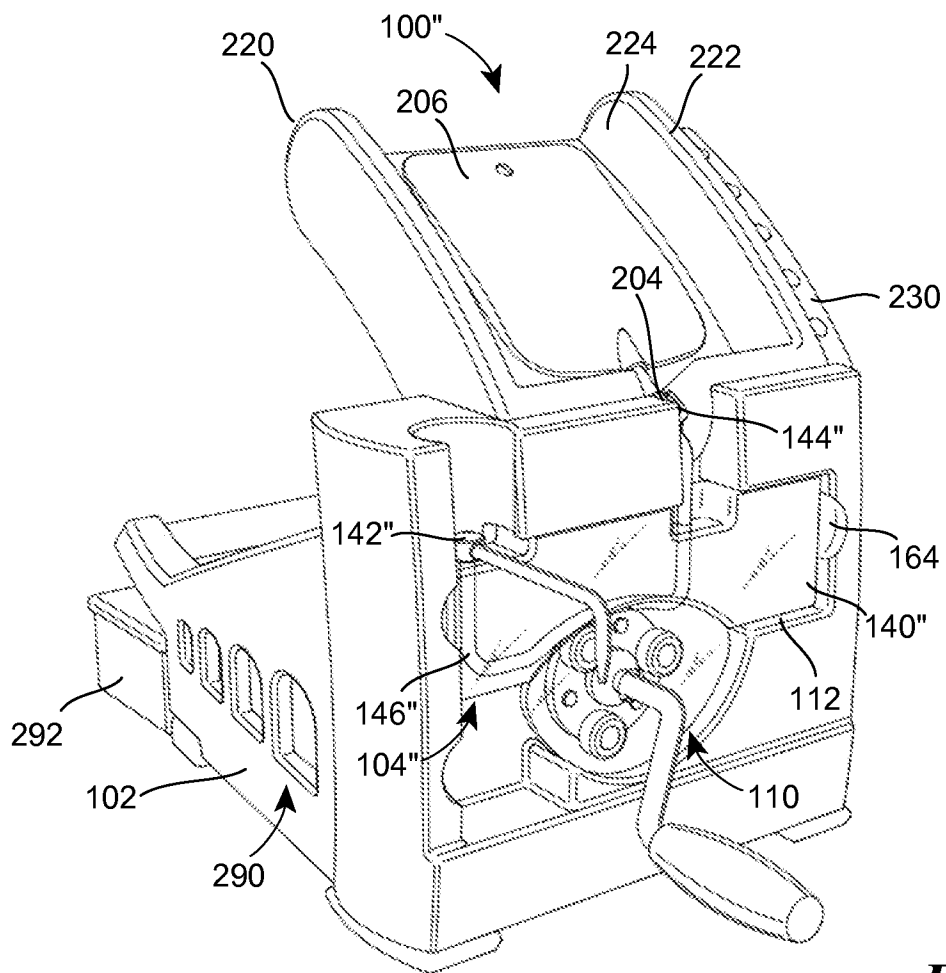
FIG. 1

FIG. 3



**FIG. 5****FIG. 6**

**FIG. 9**

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2014/057100

A. CLASSIFICATION OF SUBJECT MATTER

INV. F04B43/12 F04B9/14 A61M5/142
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04B A61M

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

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

EPO-Internal, WPI Data

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A	page 3, lines 95-104; figures 1,2,8,9-11 page 5, line 127 - page 6, line 17 -----	11-13
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Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No

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