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- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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AUTO-INJECTION DEVICE

RELATED APPLICATIONS

[0001] This international application claims priority, under the Patent Cooperation Treaty, to US Provisional Application No. 62/646,518, titled *Wearable Medical Drug Auto-Injector* and filed on March 22, 2018, the entire content of which is incorporated herein in its entirety.

FIELD OF TECHNOLOGY

[0002] The present disclosure relates generally to medical devices, and more specifically to a light and compact auto-injection device suitable for wearing or carrying.

BACKGROUND

[0003] Anaphylaxis is a life-threatening medical condition that affects millions of people across all ages. When an individual with this condition contacts or ingests an allergen they are sensitive to, such as nuts, insect venom, shellfish, etc., the individual's throat begins to swell and breathing becomes difficult. If the individual does not receive an adequate dose of proper medication administered in a prescribed way within a preferred time limit, the condition can be fatal. In the case of anaphylaxis, the procedure recommended by doctors is to administer epinephrine intramuscularly into the thigh within a few minutes of the onset of the medical condition.

[0004] Anaphylaxis patients are encouraged to carry an epinephrine auto-injection device, e.g. EpiPen, that contains an effective dose of epinephrine and is ready for use by patients themselves. The auto-injection device can be activated by a stabbing motion at the injection site. After activation, the drug is automatically administered. Patients with other potentially life-threatening conditions, e.g., hyperglycemia, can also benefit from carrying or wearing an auto-injection device for emergency use.

[0005] Prior art auto-injection devices are bulky and heavy. They are not convenient to be carried around. Nor can they be worn by users as a wearable device. The present application discloses an auto-injection device that is light and compact, suitable for wearing or carrying by users in their daily activities.

SUMMARY

[0006] Accordingly, it is an objective of the present disclosure to teach an auto-injection device that is light and compact and can be carried as a wearable device.

[0007] In some embodiments, an exemplary auto-injection device comprises a syringe, a needle, and two sets of springs. The syringe comprises a plunger and a chamber for storing an injection substance. The needle is connected to and in communication with the syringe. In one embodiment, the needle and the syringe are coaxial. Each set of springs comprises one or more springs. The first set of springs is coupled to the syringe and configured to push the needle. The second set of springs is coupled to the plunger and configured to push the plunger. The auto-injection device may be housed in a casing. In one embodiment, the casing is sealed to prevent contamination. In another embodiment, the needle may be protected by a protective cover to prevent contamination.

[0008] In some embodiments, each set of springs comprises a compressed state and a released state. The first set of springs is configured to move the needle outside of the casing when the first set of springs is in the released state. When the first set of springs is released, the second set of springs is released from its compressed state and drives the plunger to inject the substance stored in the chamber into the patient. In some embodiments, the first and second set of springs are released in sequence. The second set of springs is released after the first set of springs is released. In some embodiments, the first and second sets of springs may be released substantially simultaneously.

[0009] In some embodiments, the auto-injection device comprises a first activator configured to release the first set of springs. In one embodiment, the syringe of the auto-injection device is configured to compress the first set of springs when resting on one or more cantilevers. The first activator is configured to bend or push the cantilevers and move the syringe off the cantilevers in order to release the first set of springs. Once released from the compressed state, the first set of springs pushes the needle outside the casing.

[0010] In some embodiments, the auto-injection comprises a second activator configured to release the second set of springs. When the second set of springs is released from the compressed state, the second set of springs drives the plunger of the syringe to inject the substance stored in the chamber. In one embodiment, the second activator comprises a tube and a pin. The tube is configured with one or more cross-holes in the wall. The pin is inside the tube and is configured to

move from an inserted position to a pulled-up position. One or more identical balls are held inside the cross-holes. The size of the balls is larger than the thickness of the wall of the tube. When the pin is in the inserted position, the balls are pushed by the pin to extrude outside the outer-wall of the tube and act as a stopper to hold the second set of springs in the compressed state. When the pin is in the pulled-up position, the one or more balls are configured to move towards the interior of the tube to release the second set of the springs. The released springs in the second set push the plunger to inject a stored substance.

[0011] In some embodiments, the auto-injection device comprises a revolving sheath that blocks the needle after injection. The sheath is configured to move from a closed position to an open position. When in the closed position, the revolving sheath rests on the casing. When in the open position, the revolving sheath blocks the needle. In one embodiment, the revolving sheath is attached to the casing via a revolving peg.

[0012] In some embodiments, a wearable device comprising a watch-sized case and an auto-injection cartridge is disclosed. The case comprises a frame, a cover and one or more outer-covers. The frame comprises two cantilevers attached to two opposing interior sides of the frame respectively. The auto-injection cartridge is inset onto the cantilevers. When the auto-injection cartridge slides off the cantilevers, the wearable device is activated. In one embodiment of the wearable device, a revolving sheath is attached to the cover to block the needle of the auto-injection cartridge after use.

[0013] In some embodiments, a wearable device comprising a telescoping case and an auto-injection device is disclosed. The telescoping case changes shape by extension using a telescoping mechanism. In this embodiment, the case comprises two or more separate components that together enclose the auto-injection device. Attached to the rear section of the device are small snap-fit pieces that move parallel to the body of the device within a confined space. The confined space compresses the snap-fit pieces such that they are in a compressed state before being activated. When the snap-fit pieces exit the confined space, they are allowed to expand. In the expanded state, the snap-fit pieces cannot return to the confined space, so the rear section cannot be pushed back towards the needle tip. After the body of the device has expanded, the set of activation springs remain in a partially compressed state. This ensures that they can push the needle out of the device upon activation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] These and other features of the present disclosure will become readily apparent upon further review of the following specification and drawings. In the drawings, like reference numerals designate like parts having similar functionality throughout the views. Like parts may be designed differently in different embodiments. Components in the drawings are not necessarily drawn to scale, the emphasis instead being placed upon clearly illustrating the principles of the present disclosure.

[0015] Fig. 1 is a cross-section view of a first embodiment of an exemplary auto-injection device taught by the present disclosure.

[0016] Fig. 2 illustrates the exemplary auto-injection device in an activated state.

[0017] Fig. 3 illustrates the exemplary auto-injection device after injection.

[0018] Fig. 4 illustrates an exemplary embodiment of the first activator.

[0019] Figs. 5a-5c illustrate an exemplary embodiment of the second activator.

[0020] Fig. 6 illustrates different views of an exemplary syringe.

[0021] Fig. 7 illustrates an exemplary design of the frame.

[0022] Fig. 8 illustrates an exemplary design of the cover.

[0023] Fig. 9 illustrates an exemplary design of the revolving sheath.

[0024] Figs. 10a – 10b illustrate an exemplary design of the revolving peg as a safety feature.

[0025] Fig. 11 illustrates an exemplary design of a flap as another safety feature.

[0026] Fig. 12 illustrates different views of an assembled auto-injection device.

[0027] Fig. 13 illustrates an exploded view of a second exemplary embodiment of the syringe in an auto-injection device.

[0028] Fig. 14 illustrates an exploded view of a second exemplary embodiment of the assembled auto-injection device.

[0029] Figs. 15a – 15d illustrates a third exemplary embodiment of the auto-injection device.

[0030] Fig. 16 illustrates an exemplary wearable device comprising the auto-injection device.

DETAILED DESCRIPTION

[0031] Embodiments of the disclosure are described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the disclosure are shown. The various embodiments of the disclosure may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the disclosure to those skilled in the art.

[0032] In referring to Fig. 1, an auto-injection device 100 is depicted as comprising a needle 102, a syringe 104, a first set of springs 108 and a second set of springs 110. The needle 102 is connected to the syringe 104 and in communication with the syringe 104. In some embodiments, the needle 102 and the syringe 104 are coaxial. The syringe 104 comprises a plunger 106 and a chamber 105 for storing an injection substance. The first set of springs 108 is coupled to the syringe 104 and configured to push the needle 102. The second set of springs 110 is coupled to the plunger 106 and configured to push the plunger 106.

[0033] In the embodiment shown in Fig. 1, the first set of springs 108 and the second set of springs 110 each comprise two springs. In other embodiments, each of the first and second set of springs 108 and 110 may comprise one or more springs. For example, in the embodiments shown in Fig. 13 and Fig. 14, each set comprises one spring. (More detailed description of Fig. 13 and 14 can be found in later sections.)

[0034] In referring to Fig. 1, the auto-injection device 100 is housed in a casing 120. The casing 120 comprises one or more cantilevers 112 for supporting the syringe 104 or pushing the syringe 104 against the first set of springs 108 when the springs are in a compressed state. Each of the first and second set of springs 108 and 110 comprises a compressed state and a released state. In Fig. 1, both sets of springs are in a compressed state. Two activators 114 and 116 are configured to release the two sets of springs respectively. (The auto-injection device 100 further comprises a revolving peg 118, the functionality of which will be explained in detail in Figs. 10a and 10b.)

[0035] The first activator 114 (also see Fig. 4) is configured to release the first set of springs 108 from the compressed state. When the first activator 114 is pushed inwards, i.e., towards the casing 120, the straight bars 115 press the cantilevers 112 outward. The cantilevers 112 are pushed farther apart and the distance between the two cantilevers 112 increases.

[0036] Fig. 2 depicts a state of the first activator 114 during the activation process. The cantilevers 112 are bent towards the casing 120 under the pressure of the straight bars 115. In Fig. 2, the needle 102 is thrust outside of the casing 120 but the syringe 104 has not fallen off the cantilevers 112 yet. As the activator 114 continues to push upwards, the distance between the two cantilevers 112 increases until it is wider than the width of the syringe 104 and the syringe 104 moves off the cantilevers 112. The first set of springs 108 is released and pushes the syringe 104 downward to thrust the needle 102 out of the casing 120 and into the injection site.

[0037] As the syringe 104 moves downward, the second activator 116 (see also Figs. 5a and 5b) is activated to release the second set of springs 110 from a compressed state to a released state. The second set of springs 110 is coupled to the plunger 106 of the syringe 104. As the second set of springs 110 is released, the springs push the plunger 106 down. The chamber 105 underneath the plunger 106 stores the substance to be injected, e.g., epinephrine. As the plunger 106 moves downward, the substance is pushed into the needle 102, which is in communication with the syringe 104. Through the needle 102, the substance is injected into a person. See Fig. 3.

[0038] Fig. 4 illustrates one exemplary embodiment in which the first activator 114 and the second activator 116 are activated in sequence. In Fig. 4, the first activator 114 is shown to have been fully activated. The first activator 114 is pressed inside the casing 120. The syringe 104 has moved off the cantilevers 112 and the first set of springs 108 has pushed the needle 102 partially outside of the casing 120. The second activator 116 however has not been activated and the second set of springs 110 is still in a compressed state.

[0039] Figs. 5a and 5b illustrate an exemplary embodiment of the second activator 116. The second activator 116 comprises a pin 502 and a tube 504. The tube 504 includes one or more cross-holes 506. Inside each cross-hole 506 sits a ball 508. The size of the ball 508 is larger than the thickness of the wall of the tube 504. The second activator 116 is situated inside a T-shaped plunger 106 shown in Fig. 5c. The plunger 106 also comprises cross-holes 510 that can be aligned with the cross-holes 506 of the tube 504. When the pin 502 is fully inserted inside the tube 504, it pushes the balls 508 outward partially into the cross-holes 510 of the plunger 106. When the pin 502 is pulled up as shown in Fig. 5b, under the pressure from the plunger 106, the balls 508 are pushed towards the inner side of the tube 504. When the balls 508 roll outside of the cross-holes 510 into the cross-holes 506, the plunger 106 is unblocked to move downward under the force of the compressed

springs of the second set 110. As the plunger 106 moves downward, the stored substance, which may be medicinal or non-medicinal, is injected into the injection site through the needle 102. Fig. 3 illustrates the configuration of the auto-injection device 100 after use. The chamber 105 is empty. The first set 108 and the second set 110 of the springs are relaxed.

[0040] As shown in Figs. 1 - 3, the pin 502 of the second activator 116 is tied to two lugs (708 in Fig. 7 and Fig. 10a) using a string or wire 130. When the syringe 104 begins to move downward under the pressure from the first set of springs 108, the pin 502 is pulled up by the string or wire 130, activating the second set of springs 110.

[0041] Fig. 6 illustrates different views of the syringe 104. In the exploded view, the different parts of the syringe 104 are depicted. At the top is the second activator 116, which is placed onto the plunger 106 through a syringe cap 608. The syringe cap 608 is configured with a hole at the center for receiving the second activator 106 and two protrusions at the bottom to plug into one end of the springs in the second set 110. The other end of the springs in the second set 110 rests on the flange 610 of the plunger 106. A ribbed plunger plate 604 made of rubber or plastic beneath the plunger 106 seals the chamber 105. The second activator 116, the syringe cap 608, the second set of springs 110, the plunger 106, the plunger plate 604, and the needle 102 are then assembled into the syringe shell 602. The front view, a side view, and a perspective view of the assembled syringe 104 are depicted in Fig. 6 as well.

[0042] The assembled syringe 104 and the first set of springs 108 can then be assembled into the casing 120. Figs 7 – 11 illustrate the casing system. Fig. 12 illustrates different views of the assembled auto-injection device 100.

[0043] Fig. 7 shows the frame 700 of an exemplary casing 120. Different views of the frame 700 are depicted to show different parts. In both the perspective view and the front view, the cantilevers 112 are shown as being affixed to two opposing interior sides of the frame 700. The bottom view shows a hole 702, configured to receive the first activator 114. The side view shows a bump 704 on the outer side of the frame 700 (with another bump on the hidden side not shown). The bumps 704 function to align the frame 700 with matching depressions on the internal side of the outer-cover 1202 (see Fig. 12, depressions not shown). This ensures that the frame 700 (with the auto-injection device 100 inset in it) does not slip off the outer-cover 1202 easily. Some force is required to remove the frame 700 from the outer-cover 1202 by unseating the bumps 704 from the

depressions. The front view also shows two stubs or protrusions 706 for holding the first set of springs 108 (see Fig. 12), and two lugs 708 for tying the string or wire 130 that is used to suspend the second activator 116.

[0044] Fig. 8 illustrates the perspective view, front and back view, and a side view of a cover 800 for the frame 700. In some embodiments, the cover 800 can be placed on top of the frame 700 to seal the casing 120.

[0045] Fig. 9 illustrates a post-injection safety feature that can be installed on the cover 800. The safety feature is a revolving sheath 900. The perspective (left image), front (top-right image) and bottom view (bottom-right image) of the revolving sheath 900 are depicted in Fig. 9. The revolving sheath 900 can be attached to the cover 800 via the aperture 902 and can be open or closed. When in the closed position, the revolving sheath 900 rests on the cover 800 to which it is attached. The revolving sheath 900 can be swirled open after the auto-injection device 100 has been used for injection. In the open position, the revolving sheath 900 covers the needle 102 for safety protection. The slot 904 on the side wall of the revolving sheath 900 accommodates the needle 102. A lock mechanism (shown in Figs. 10a and 10b) locks the revolving sheath 900 in the open position so that the used needle 102 remains covered.

[0046] In one embodiment, the revolving sheath 900 is attached to the frame 700 via a revolving peg 118 illustrated in Figs. 10a - 10b. As shown in Fig. 10a, the revolving peg 118 is the cylindrical peg located in the lower left corner of the frame 700. The revolving peg 118 comprises a D-shaped button 1002 at the top that matches the shape of the aperture 902 on the sheath 900 and allows the revolving sheath 900 to be attached. The revolving peg 118 further comprises a slot 1004, which can be aligned with the slot 1006 located at the base of the revolving peg 118 through rotation. When the revolving sheath 900 is pushed open, the revolving peg 118 is turned by the coupling force via the D-shaped button 1002. The revolving peg 118 includes a spring 1014 and a revolving key 1018, as shown in Fig. 10b. The revolving key 1018 can be fitted into the slot 1004 when the spring 1014 is compressed. The revolving peg 118 rotates with the revolving sheath 900, which also rotates the revolving key 1018 as the key 1018 is fitted inside the slot 1004. Once the two slots 1004 and 1006 become aligned, the spring 1014 pushes the key 1018 down so that the key 1018 engages the slot 1006. Because the height of the key 1018 is greater than that of the slot 1006, the key 1018 sits fully within the slot 1006 and partially within the slot 1004. This prevents relative

rotation between the slot 1006 and the revolving peg 118, thus locking the revolving sheath 900 in front of the needle 102.

[0047] Fig. 11 illustrates another safety feature. In Fig. 11, the cantilevers 112 (only one is shown) stand against a flap 1122 of the outer-cover (1204 or 1202 shown in Fig. 12). When the auto-injection device 100 is stowed inside the outer-cover 1204 and 1202, the flaps 1122 jam the first activator 114 and prevents the first activator 114 from bending the cantilever 112. This safety feature ensures that the auto-injection device 100 will not activate until it is taken out of the outer-covers 1204 and 1202.

[0048] Fig. 12 shows different views of an assembled auto-injection device 100. On the left are four views of the assembled auto-injection device 100 enclosed in the outer-covers. Starting from the top left and going clockwise, the views are a side view, the front view, the bottom view, and a perspective view of the enclosed device 100. On the right is an exploded view of the assembled auto-injection device 100. The first set of springs 108, the syringe 104, and the first activator 114 are assembled into the syringe shell (602, not labeled) before being fitted into the frame 700, with the two stubs 706 of the frame 700 being inserted into the springs 108 and a string or wire 130 tying the second activator 116 to the lugs of the frame 700 (not shown). The revolving sheath 900, the cover 800, and the revolving peg 118 (along with the revolving key 1018 and the revolving spring 1014) are then assembled onto the frame 700. The two outer-covers 1202 and 1204 are protective covers. As illustrated in Fig. 11, one or both of the two outer-covers 1202 and 1204 may include one or more flaps 1122. When the auto-injection device 100 is stowed inside the outer-covers, the flaps 1122 are pressed against the cantilevers 112, preventing the cantilevers 112 from bending or moving outwardly so that the syringe 104 does not fall off the cantilevers 112 by accident.

[0049] Fig. 13 and Fig. 14 illustrate a second embodiment of the syringe 104. Instead of using sets of two springs, the embodiment in Figs. 13 and 14 uses one spring for each set. In Fig. 13, the pin 502 is inserted into the tube 504. Along with the two identical balls 508, they form the second activator 116, which is placed onto the second spring 110, installed on top of the plunger 106 along with the plunger plate 604, and inserted into the syringe shell 602 that also accommodates the needle 102. After the syringe 104 is assembled, it is then placed into a frame 1410, a cover 1412, and out-covers 1402 and 1404 to produce an assembled auto-injection device 100 as shown in Fig.

14.

[0050] Fig. 14 depicts an exploded view of the second embodiment of the auto-injection device 100. In Fig. 14, the assembled syringe 104 (shown in Fig. 13) is inserted into a first activator 114, along with a first spring 108 and a cap 1408. The assembled system is then encased by different parts of the casing 120, e.g., 1410 and 1412. The encased auto-injection device 100 are covered by a top outer-cover piece 1402 and a bottom out-cover piece 1404. Similar to the out-covers shown in Fig. 12, the out-covers 1402 and 1404 can jam the first activator 114 and prevent the auto-injection device 100 from being activated when it is stowed inside the out-covers.

[0051] It is noted that the frame 1410, shown in Fig. 14 as comprising two separate pieces, can in fact comprise one or multiple pieces. For instance, the frame 1410 may be an annular ring and the cantilevers 112 is a one-piece component within the annular ring. For another instance, the frame 1410 may comprise two or more arcs that can be made into one annular ring and each arc of the frame 1410 includes a cantilever structure 112.

[0052] Figs. 15a – 15d illustrate a third embodiment of the auto-injection device 100. In this embodiment, the auto-injection device 100 has a casing 120 (e.g., frame 700 and cover 800) that changes shape by extending along the axis of the needle 102 using a telescoping mechanism. In this embodiment, the casing comprises three separate components that together enclose the internal mechanisms. The set of activation spring(s) 108 begin compressed and pushes the rear section of the casing 120 away from the tip of the needle 102 once the outer cover 1402 is removed. Attached to the rear section of the casing 120 are small snap-fit pieces that move parallel to the body of the device 100 within a confined space. The confined space compresses the snap-fit pieces such that they begin in a compressed state.

[0053] When the rear section of the casing 120 reaches the end of its moving path, the snap-fit pieces (1502 in Figs.15a-15d) exit the confined space and are allowed to expand. In their expanded state, the snap-fit pieces cannot return to the confined space, so the rear section of the casing 120 cannot be pushed back towards the tip of the needle 102. After the body has expanded, the set of activation springs 108 remain in a partially compressed state. This ensures that they can push the needle 102 out of the device 100 upon activation.

[0054] Figs. 15a – 15b show the mid-plane views of the auto-injection device 100 in a compressed state. Fig. 15a is a mid-plane view of the springs 108 being compressed. Fig. 15b is a

mid-plane view of the snap-fit pieces in a compressed position.

[0055] Figs. 15c – 15d show the mid-plane views of the auto-injection device 100 in an extended state. Fig. 15c is a mid-plane view of the springs 108 that has partially expanded. Fig. 15d is a mid-plane view of the snap-fit pieces. In Fig. 15d, the snap-fit pieces 1502 are in an extended position that prevents them from moving back. A cap 1504 of the case moves outwards to complete the telescoping action.

[0056] Fig. 16 illustrates an embodiment of a wearable auto-injection device 100. In some embodiments, the assembled auto-injection device 100 is light and compact and made in the shape of a watch. The out-covers (1202 and 1204 in Fig. 12 and 1402 and 1404 in Fig. 14) are fitted with lugs to accommodate straps 1602 so that the auto-injection device 100 can be worn like a watch. The wrist-mounted device 100 in Fig. 16 can be carried by a patient for emergency use. In other embodiments, the out-covers can be made to resemble a piece of jewelry or toy.

[0057] The auto-injection devices 100 disclosed herein have many applications, medical or non-medical. The size of the chamber 105 in the auto-injection device 100 can be manufactured in accordance with the requirement of each application. In some applications, the size of the chamber 105 can be made fairly standard. In other applications, the size of the chamber 105 may be personalized. As mentioned in the background section, the auto-injection device 100 is useful in anaphylaxis and hyperglycemia emergency situations. The auto-injection device 100 can be useful in opioid overdose emergencies as well. Indeed, in many life-threatening situations, auto-injection devices disclosed herein can save lives by providing timely relief of the symptoms.

[0058] Although the disclosure is illustrated and described herein with reference to specific embodiments, the disclosure is not intended to be limited to the details shown. Rather, various modifications may be made in the details within the scope and range of equivalents of the claims and without departing from the disclosure.

CLAIMS

What is claimed is:

1. An auto-injection device comprising:
 - a syringe comprising a plunger and a chamber for storing a substance to be injected;
 - a needle connected to the syringe and configured to be coaxial with the syringe;
 - a first set of springs coupled to the syringe and configured to push the needle; and
 - a second set of springs coupled to the plunger and configured to push the plunger;wherein each of the first and the second set of springs comprises one or more springs.
2. The auto-injection device of claim 1, further comprising a casing for housing the needle, the syringe, the first set of springs, and the second set of springs.
3. The auto-injection device of claim 1, wherein each of the first and the second set of springs comprises a compressed state and a released state, wherein the first set of springs is configured to push the needle outside of the casing when the first set of springs is in the released state.
4. The auto-injection device of claim 3, wherein, upon the first set of springs being released, the second set of springs is released from its compressed state and drives the plunger to inject the substance stored in the chamber.
5. The auto-injection device of claim 1, further comprising a first activator configured to release the first set of springs.

6. The auto-injection device of claim 5, wherein the syringe is configured to compress the first set of springs when the syringe rests on one or more cantilevers.
7. The auto-injection device of claim 6, wherein the first activator is configured to move the syringe off the cantilevers to release the first set of springs, and wherein when the first set of springs is released, the first set of springs pushes the needle outside the casing.
8. The auto-injection device of claim 1, further comprising a second activator configured to release the second set of springs.
9. The auto-injection device of claim 8, wherein the second activator is activated by the first set of springs.
10. The auto-injection device of claim 9, wherein, when the second activator is activated by the first set of springs to release the second set of springs from the compressed state to the released state, the second set of springs drives the plunger of the syringe to inject the substance stored in the chamber.
11. The auto-injection device of claim 8, wherein the second activator comprises:
 - a tube configured with one or more cross-holes in the wall of the tube;
 - a pin inside the tube, wherein the pin is configured to move from an inserted position to a pulled-up position; and
 - one or more identical balls, each of which is situated inside the cross-holes, wherein the size of the balls is larger than the thickness of the wall of the tube;wherein, when the pin is in the inserted position, the one or more balls are pushed by the pin to extrude outside the tube and act as a stopper to hold the second set of springs in the compressed state;

wherein, when the pin is in the pulled-up position, the one or more balls are configured to move along the cross-holes to release the second set of the springs.

12. The auto-injection device of claim 11, wherein when the pin is in the pulled-up position, the second set of springs is released to push the plunger and to inject the stored substance.
13. The auto-injection device of claim 2, wherein the casing comprises a revolving sheath, the revolving sheath configured to move from a closed position to an open position; and

wherein, when in the closed position, the revolving sheath rests on the casing and, when in the open position, the revolving sheath blocks the needle.
14. The auto-injection device of claim 13, wherein the revolving sheath is attached to the casing via a revolving peg.
15. The auto-injection device of claim 1, further comprising a protective needle cover to prevent the needle from contamination.
16. The auto-injection device of claim 2, wherein the casing is sealed to prevent the needle from being contaminated.
17. The auto-injection device of claim 2, wherein the casing comprises two lugs to connect straps for wearing.
18. The auto-injection device of claim 17, wherein the auto-injection device is a wrist-mounted wearable device.

19. A wearable device, comprising:

an auto-injection cartridge; and

a casing, wherein the casing comprises two cantilevers positioned on two opposing interior sides respectively; and

an outer-cover

wherein the auto-injection cartridge is inset onto the cantilevers, and wherein the wearable device is activated when the auto-injection cartridge is pushed off the cantilevers.

20. The wearable device of claim 19, wherein the auto-injection cartridge comprises:

a syringe comprising a plunger and a chamber for storing an injection substance;

a needle connected to the syringe and configured to be coaxial with the syringe;

a first set of springs coupled to the syringe and configured to push the needle; and

a second set of springs coupled to the plunger and configured to push the plunger;

wherein each of the first and the second set of springs comprises one or more springs.

21. The wearable device of claim 19, further comprising a revolving sheath attached to the casing via a revolving peg, said revolving sheath configured to rotate off the back cover to block the needle of the auto-injection cartridge after use.

22. The wearable device of claim 19, wherein the cover is configured to extend or retract via a telescoping mechanism to accommodate the auto-injection cartridge.

23. The wearable device of claim 19, wherein the out-cover comprises one or more flaps to jam the cantilevers when the auto-injection cartridge is stowed in the out-covers, to prevent the auto-injection cartridge from being activated accidentally.

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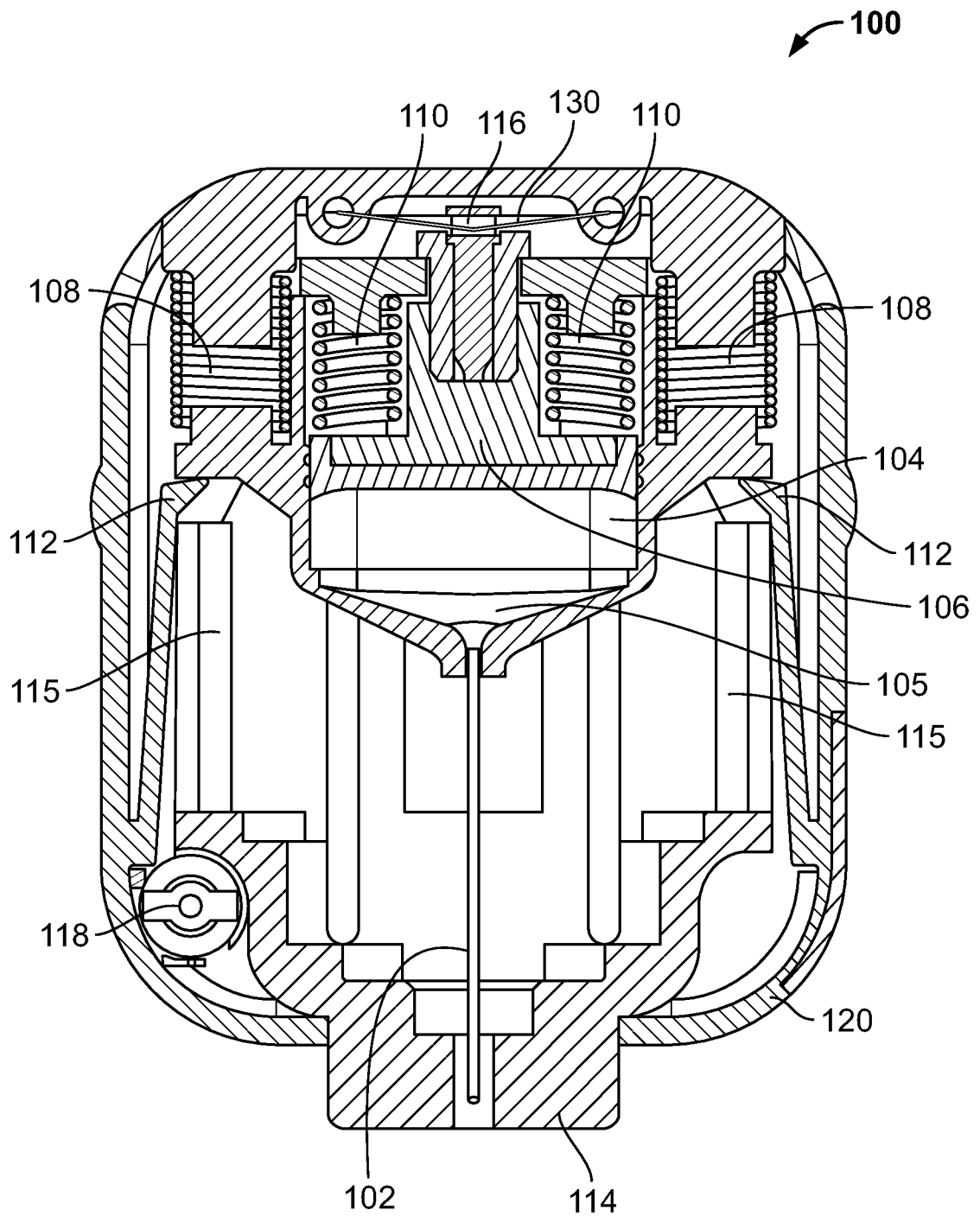


FIG. 1

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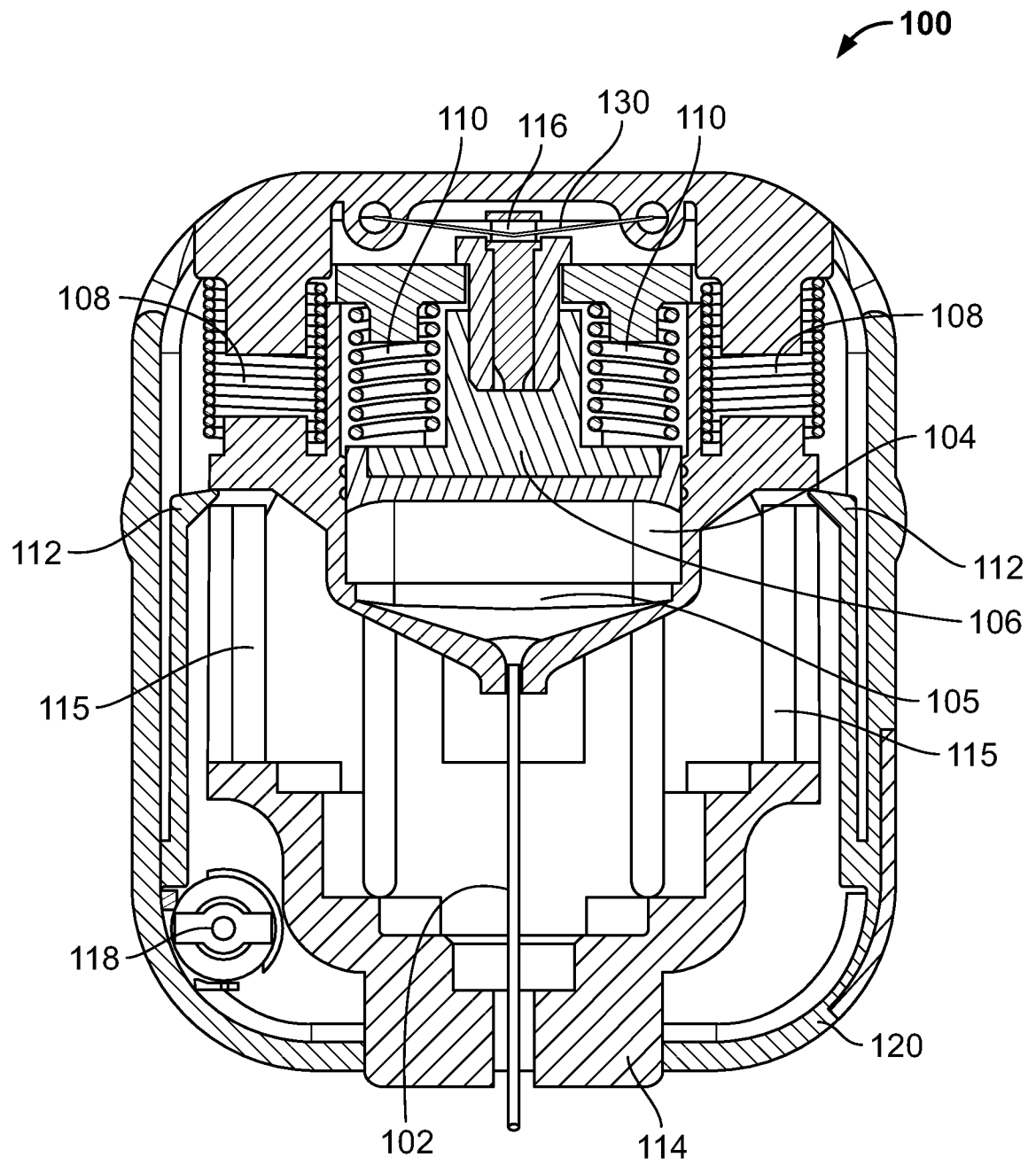


FIG. 2

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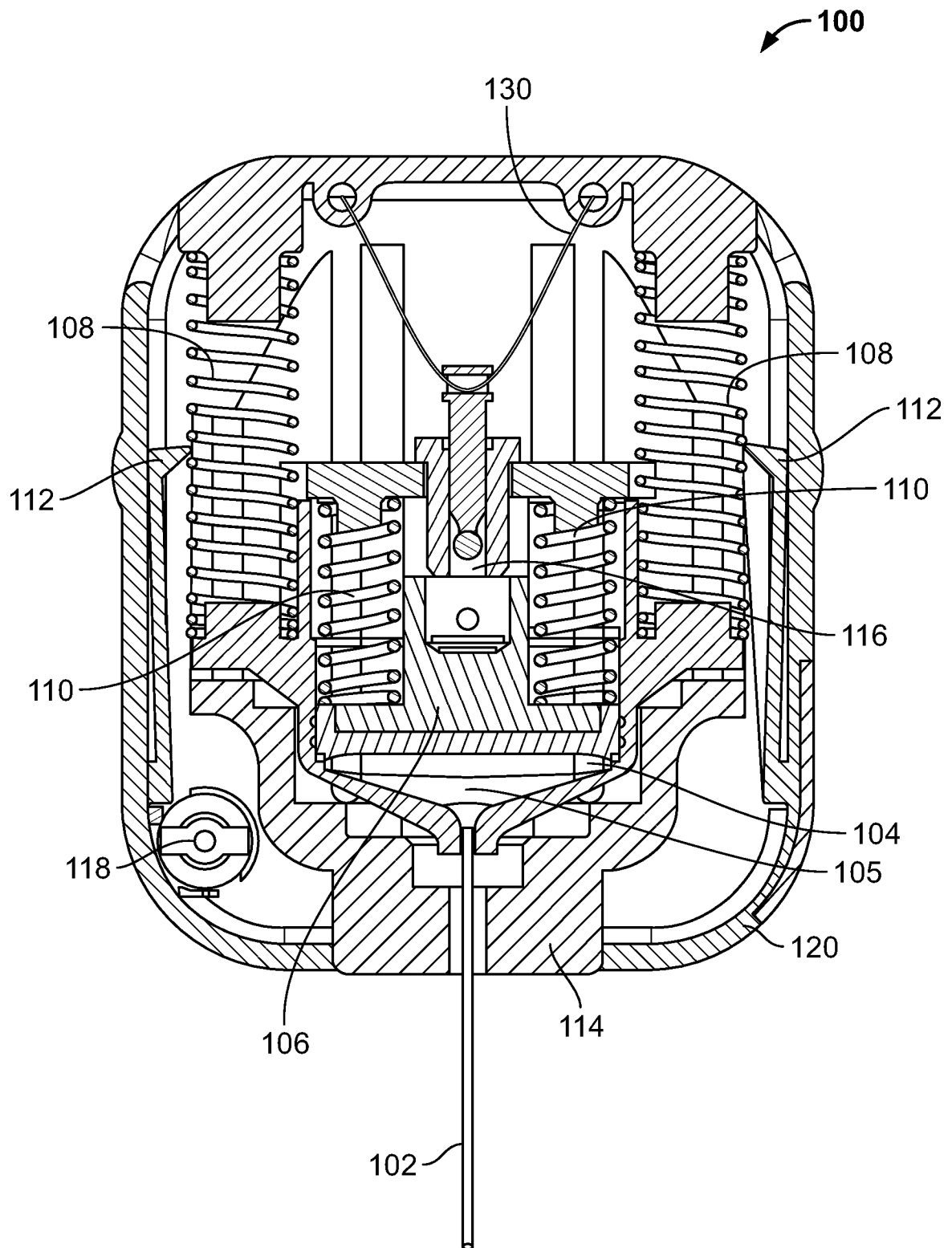


FIG. 3

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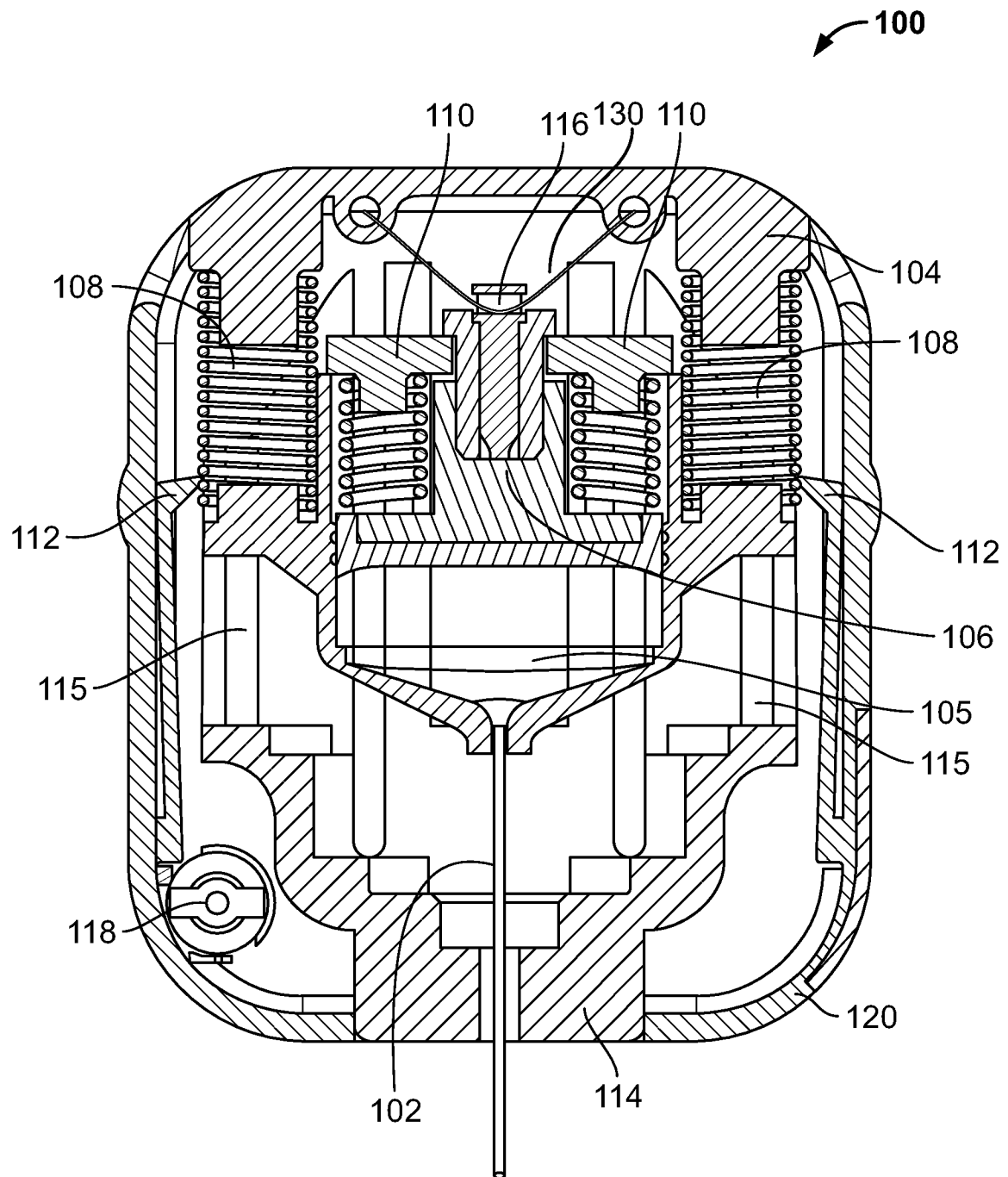


FIG. 4

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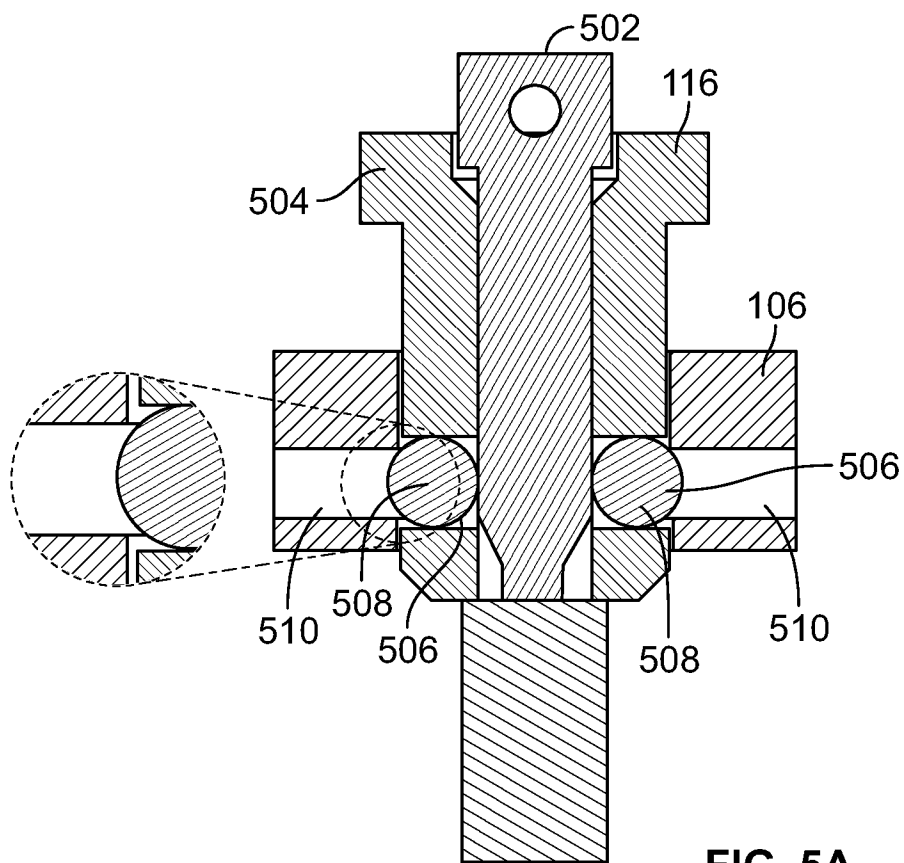


FIG. 5A

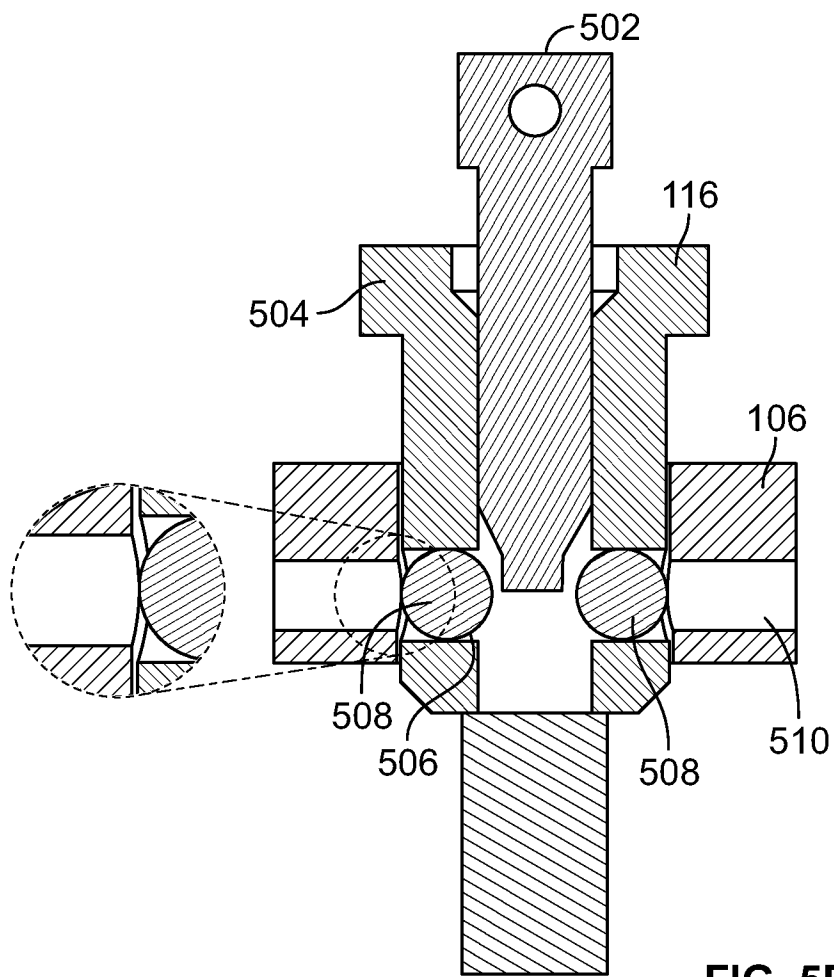


FIG. 5B

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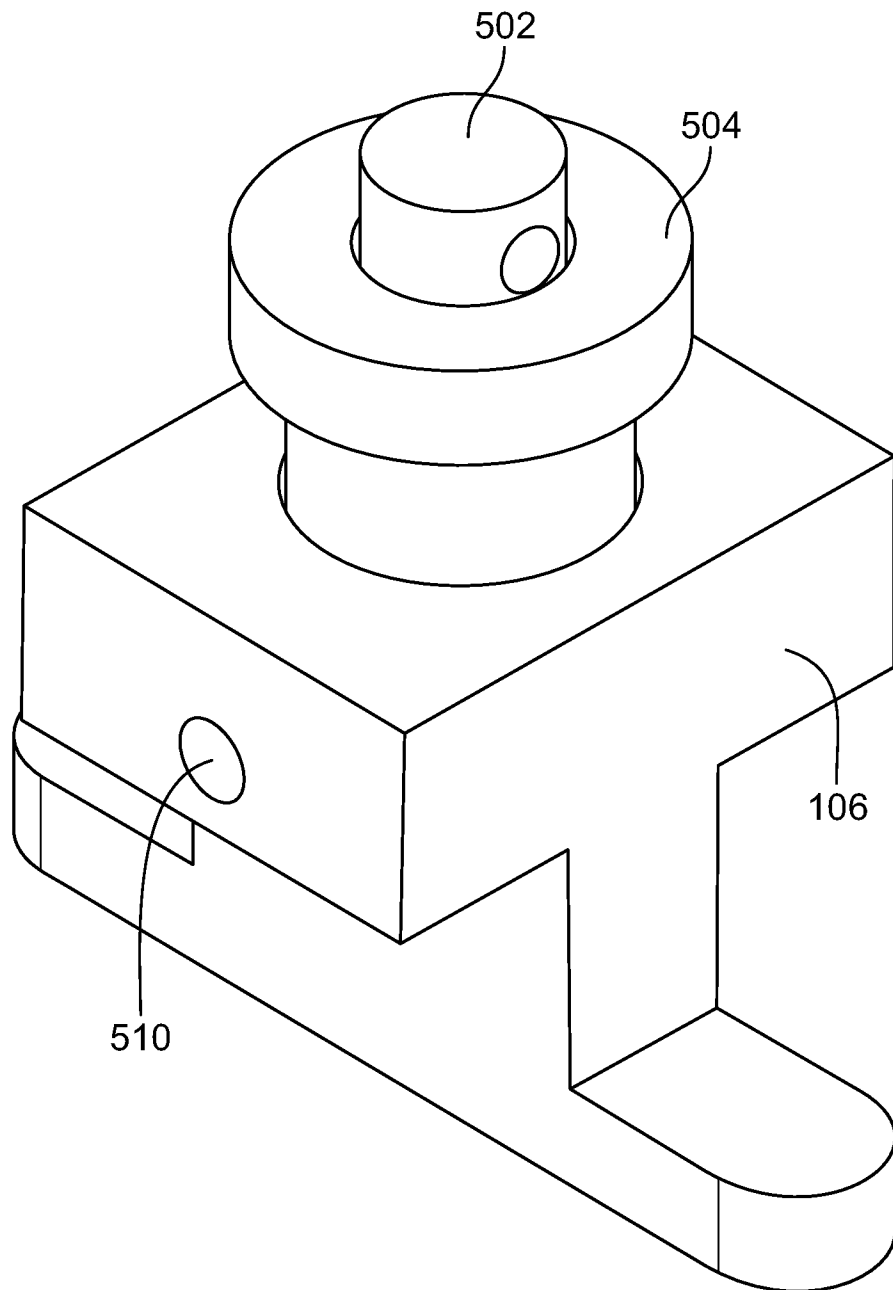


FIG. 5C

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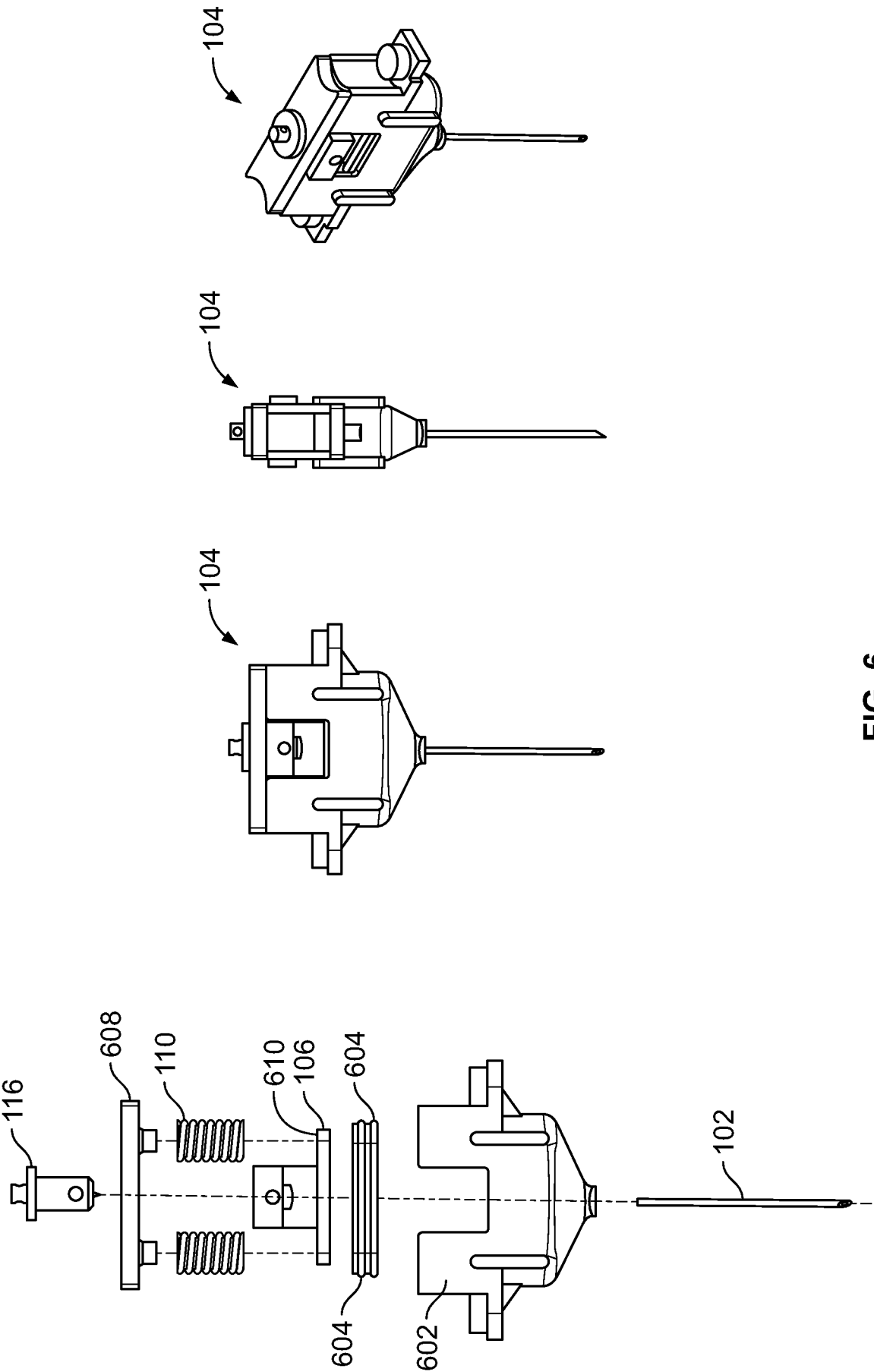


FIG. 6

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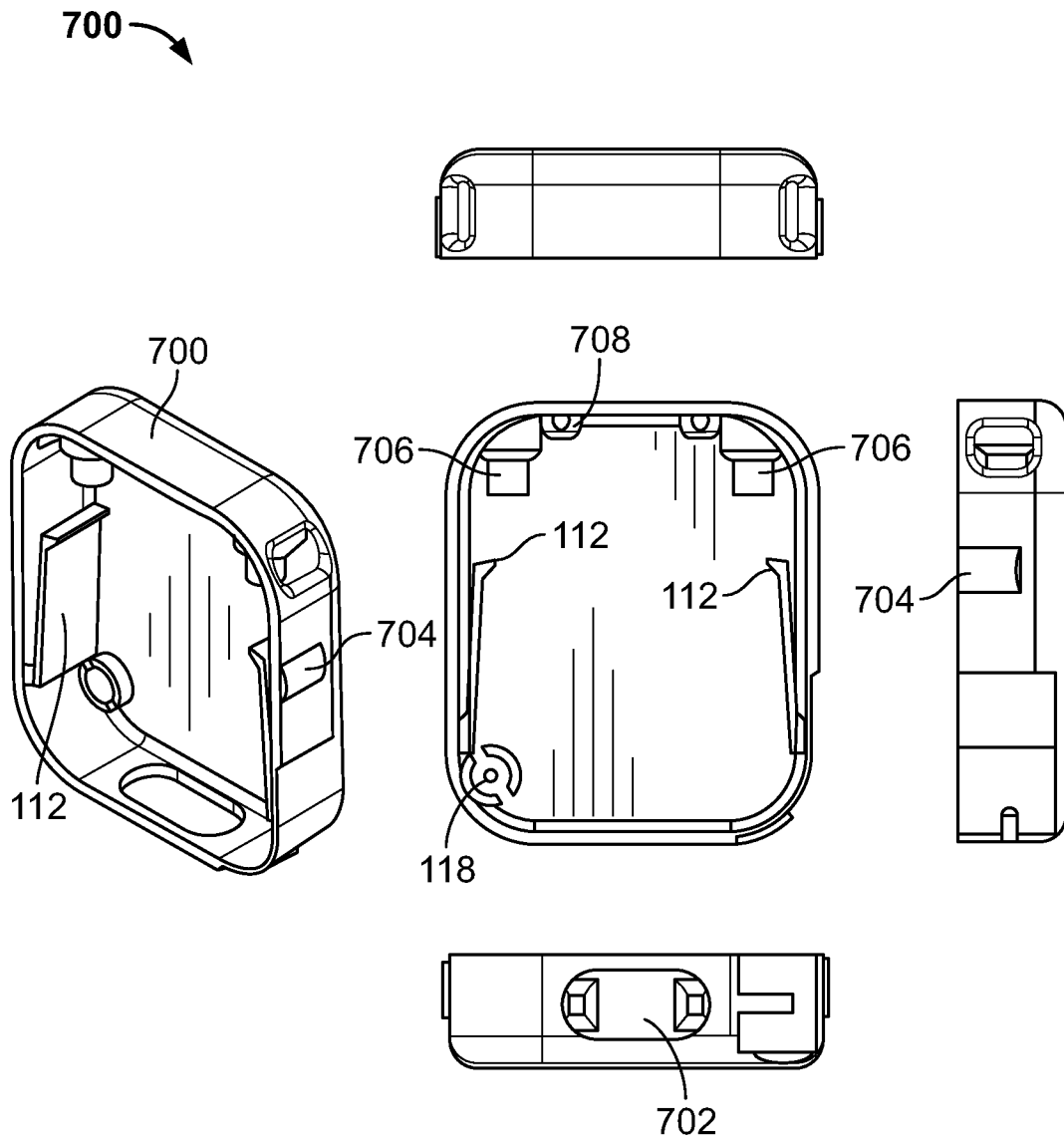


FIG. 7

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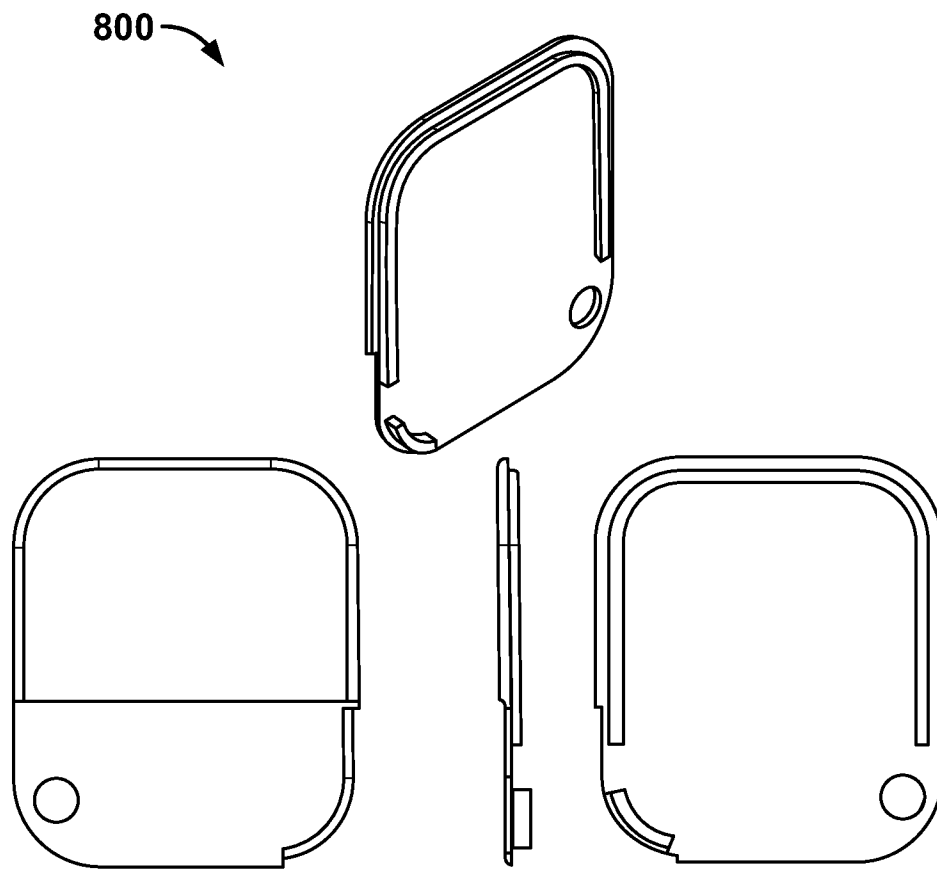


FIG. 8

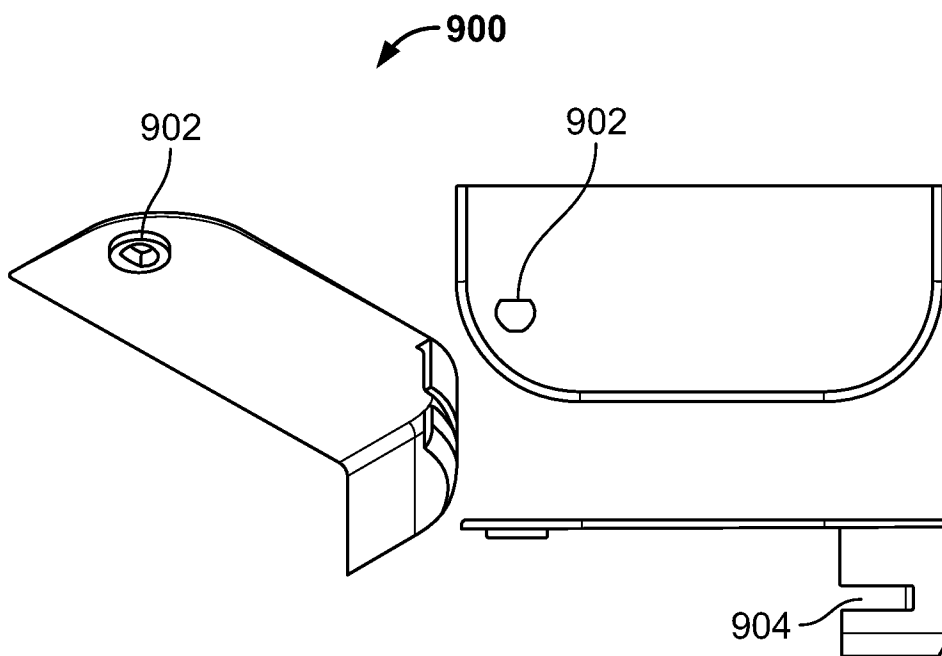


FIG. 9

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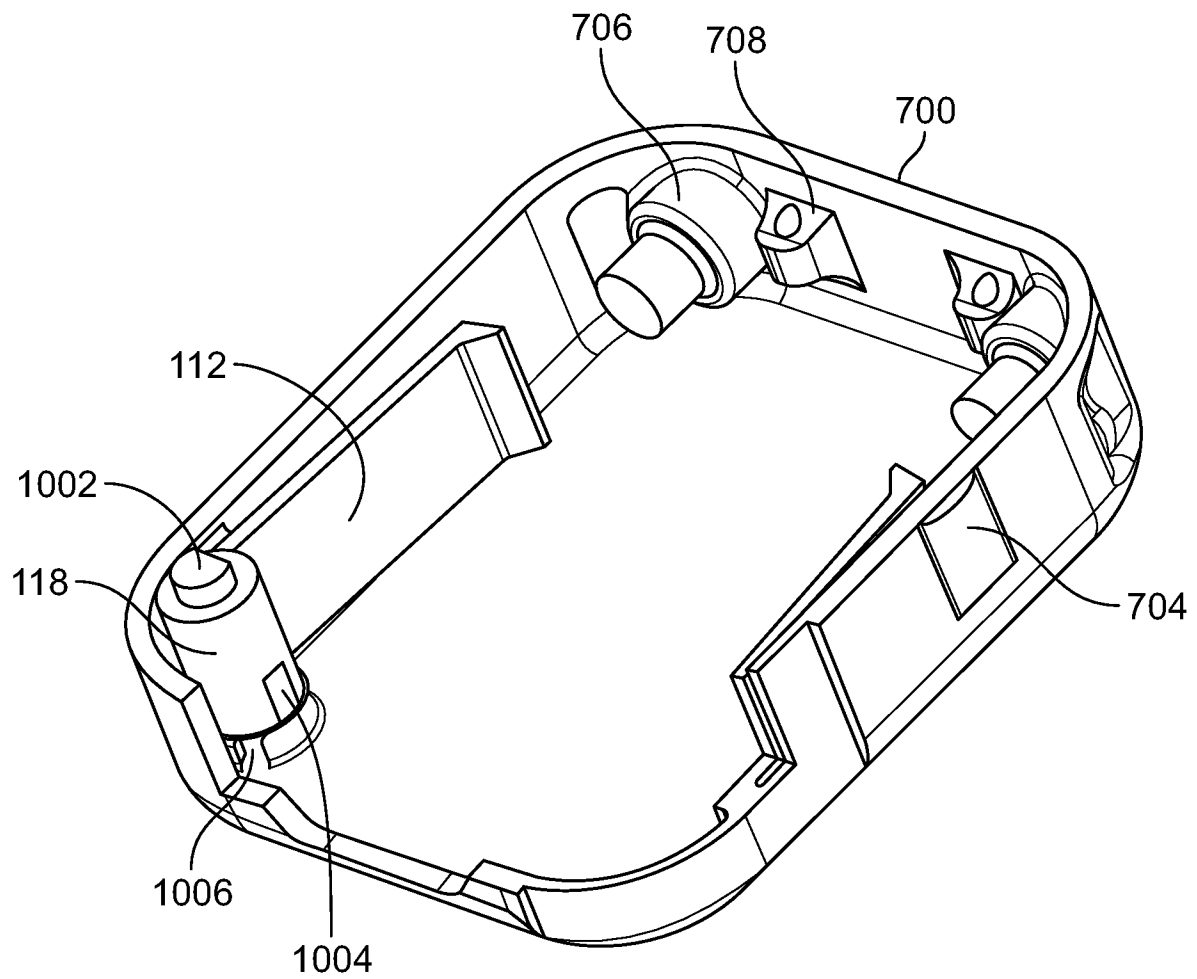


FIG. 10A

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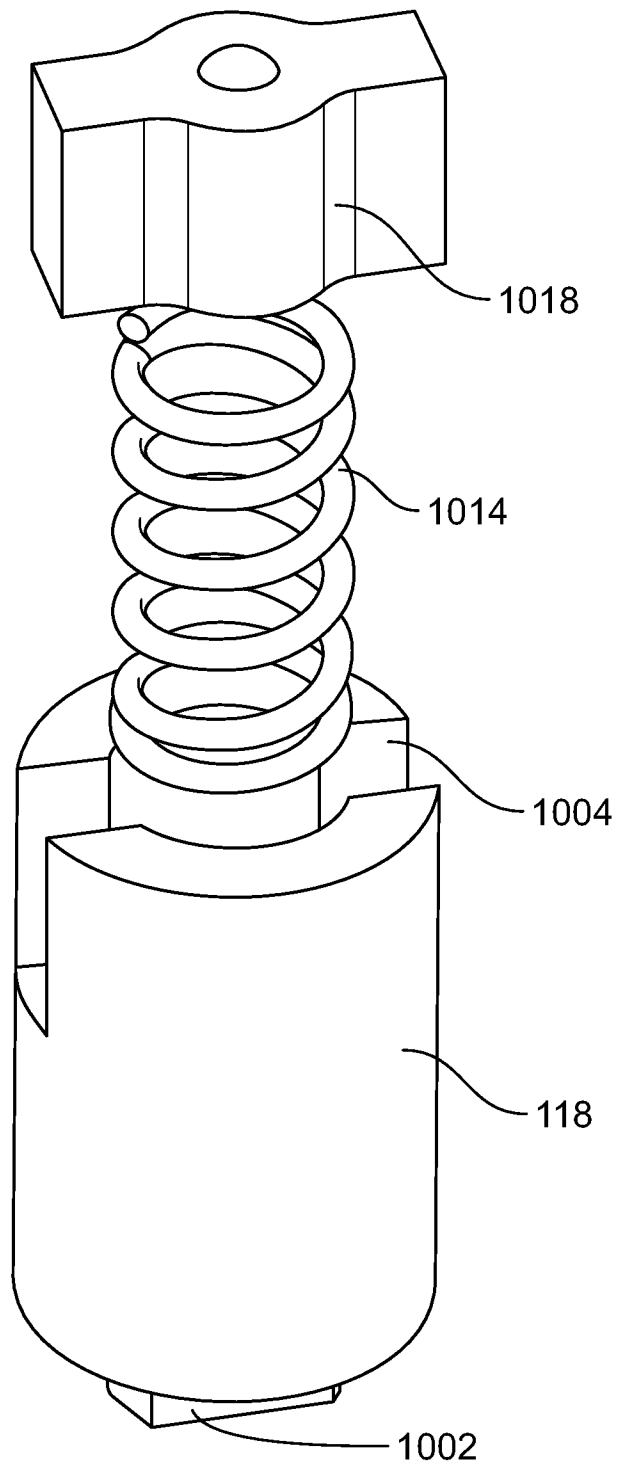


FIG. 10B

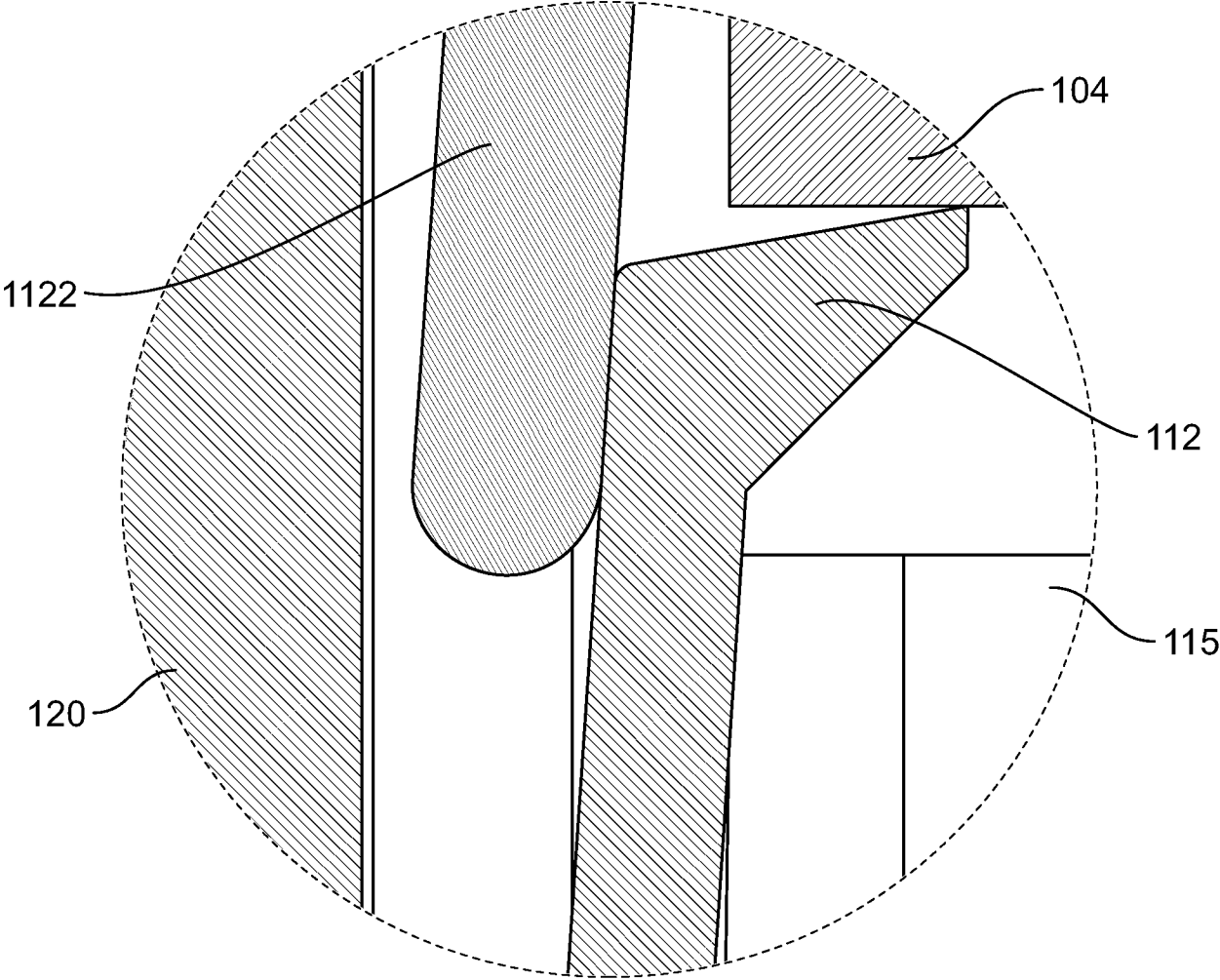


FIG. 11

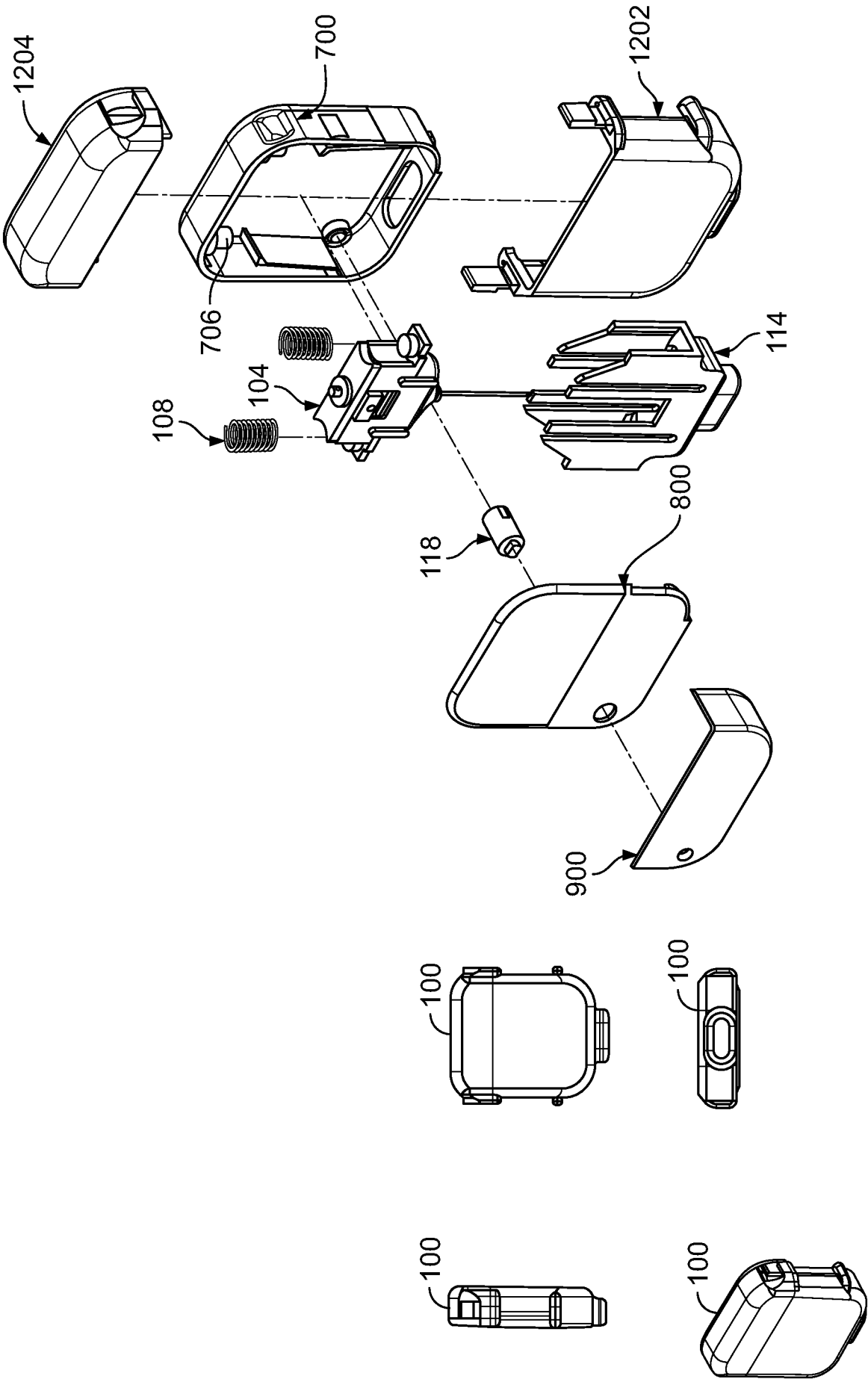


FIG. 12

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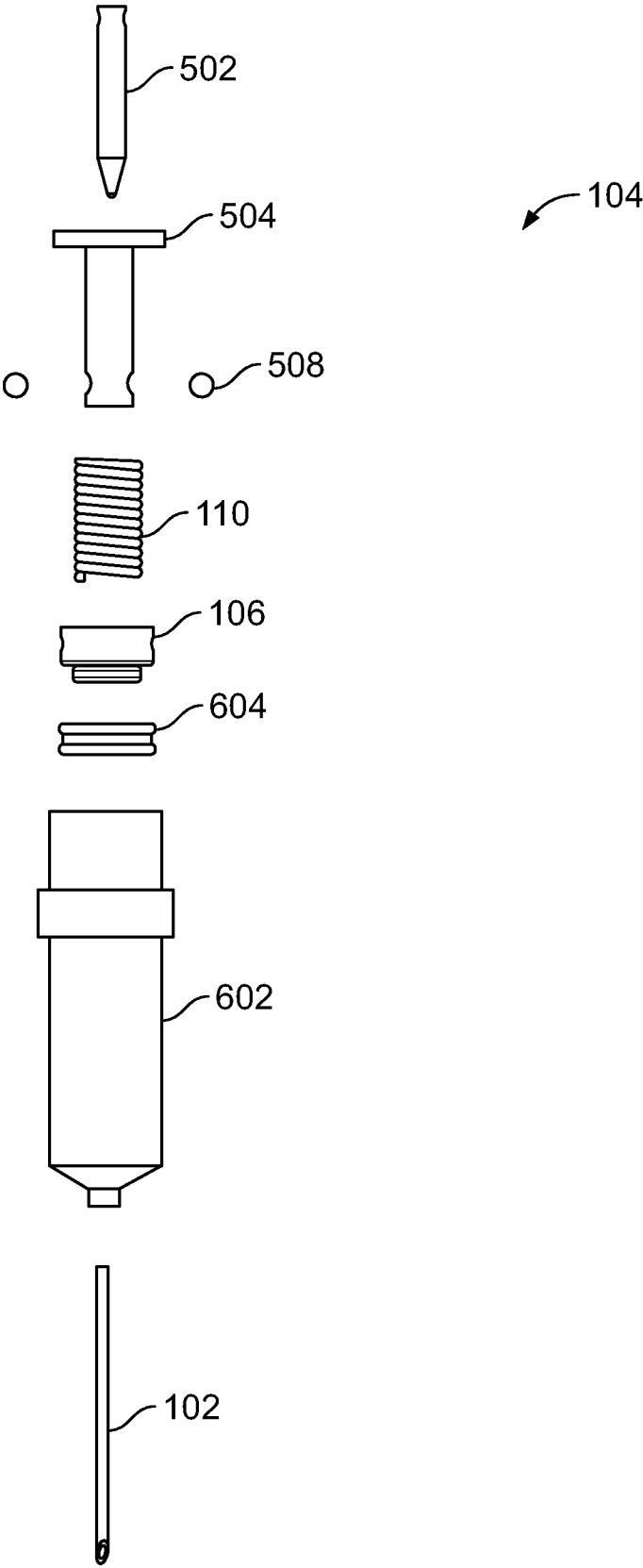


FIG. 13

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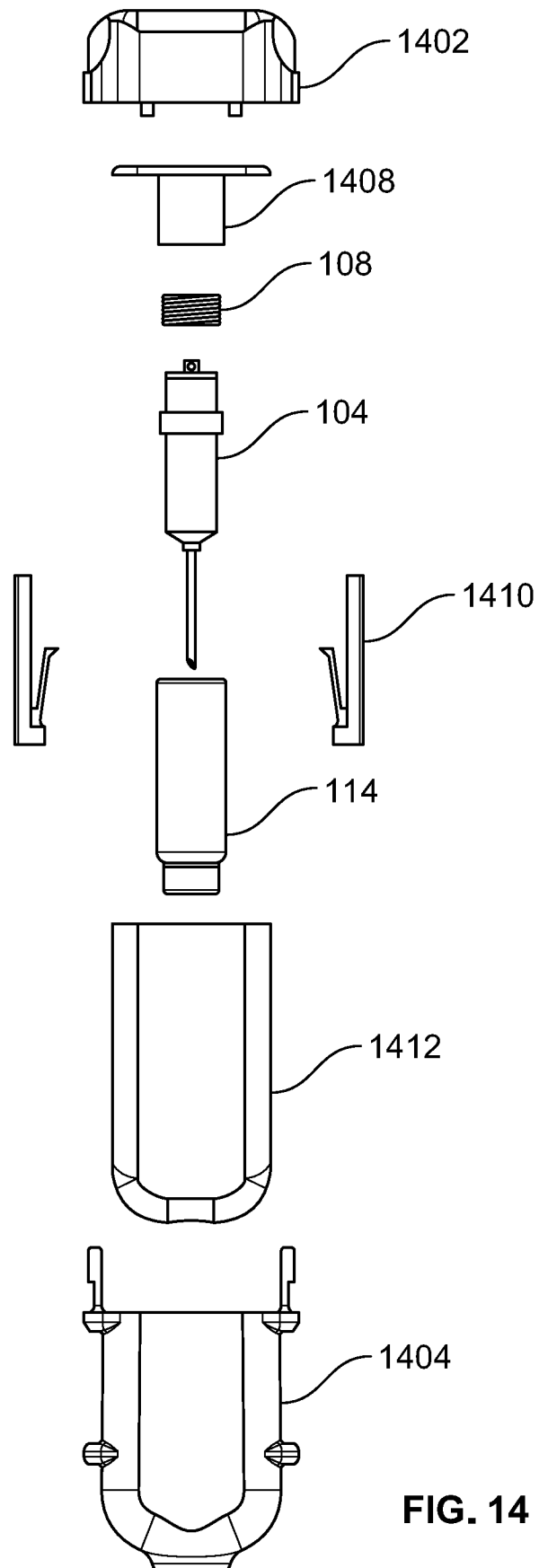


FIG. 14

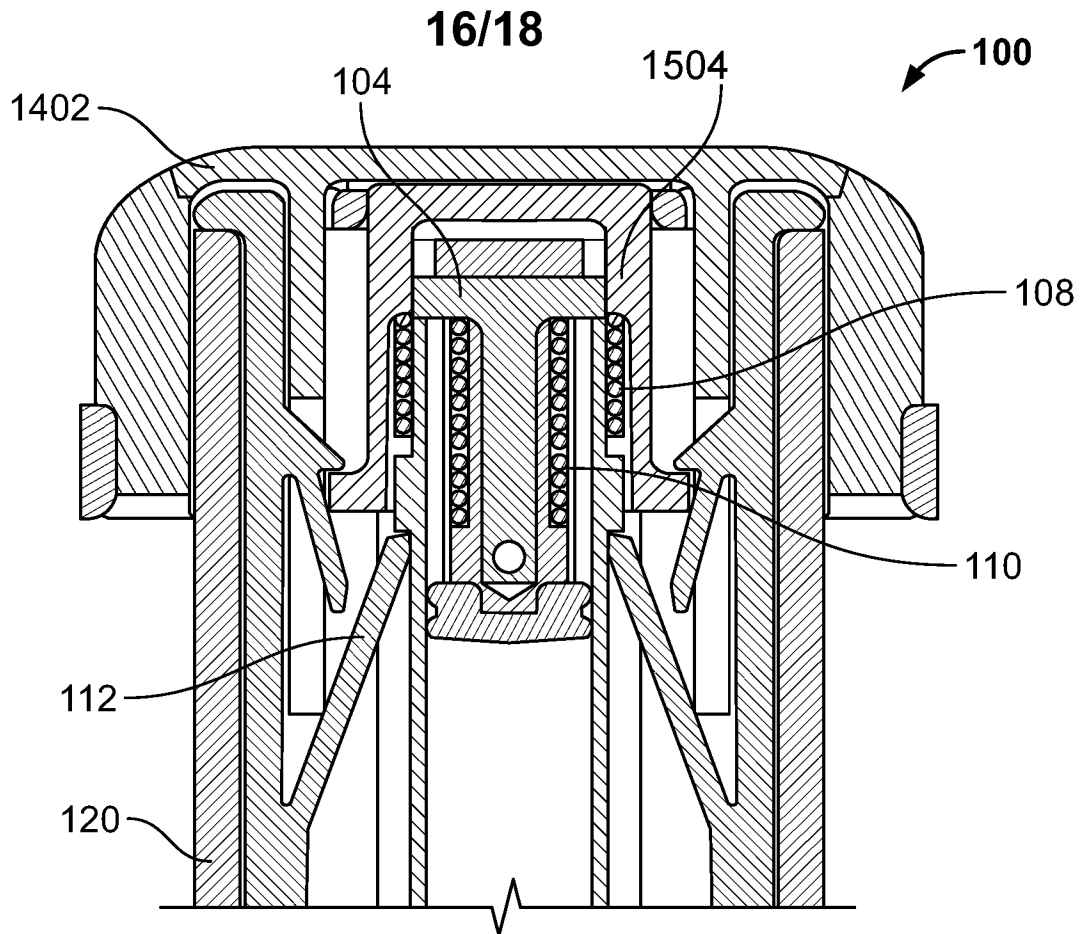


FIG. 15A

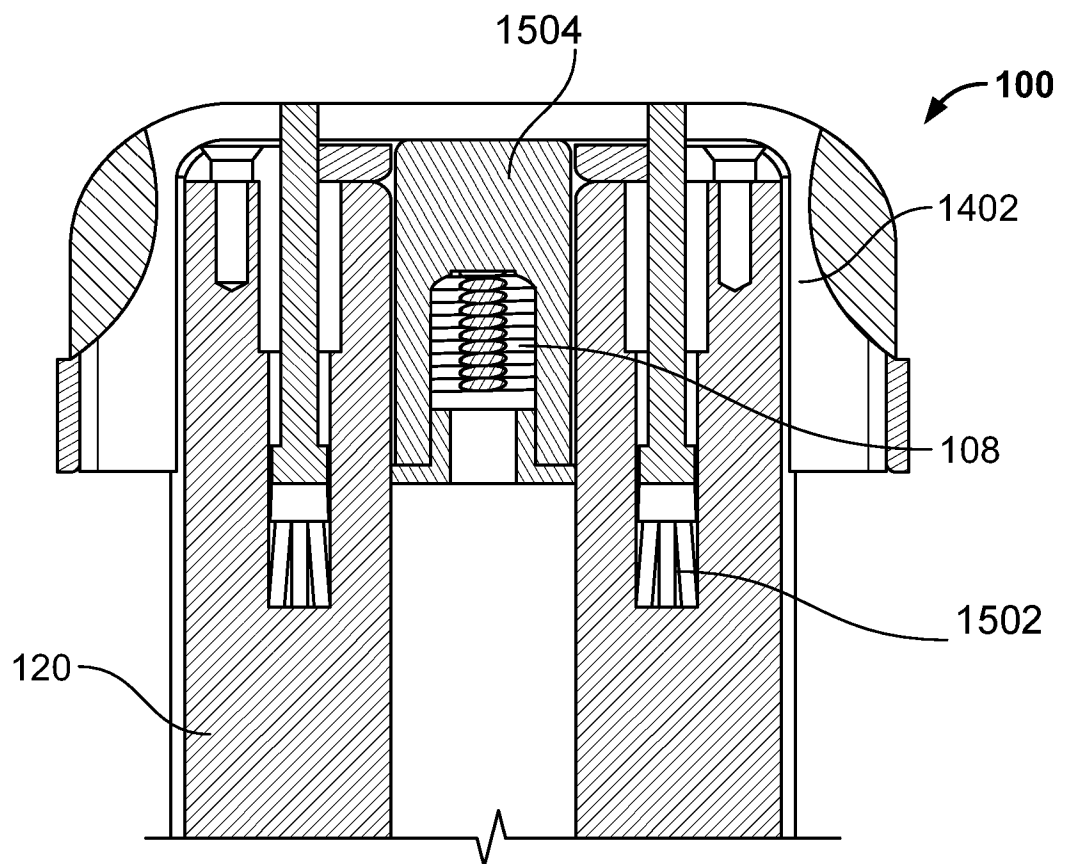
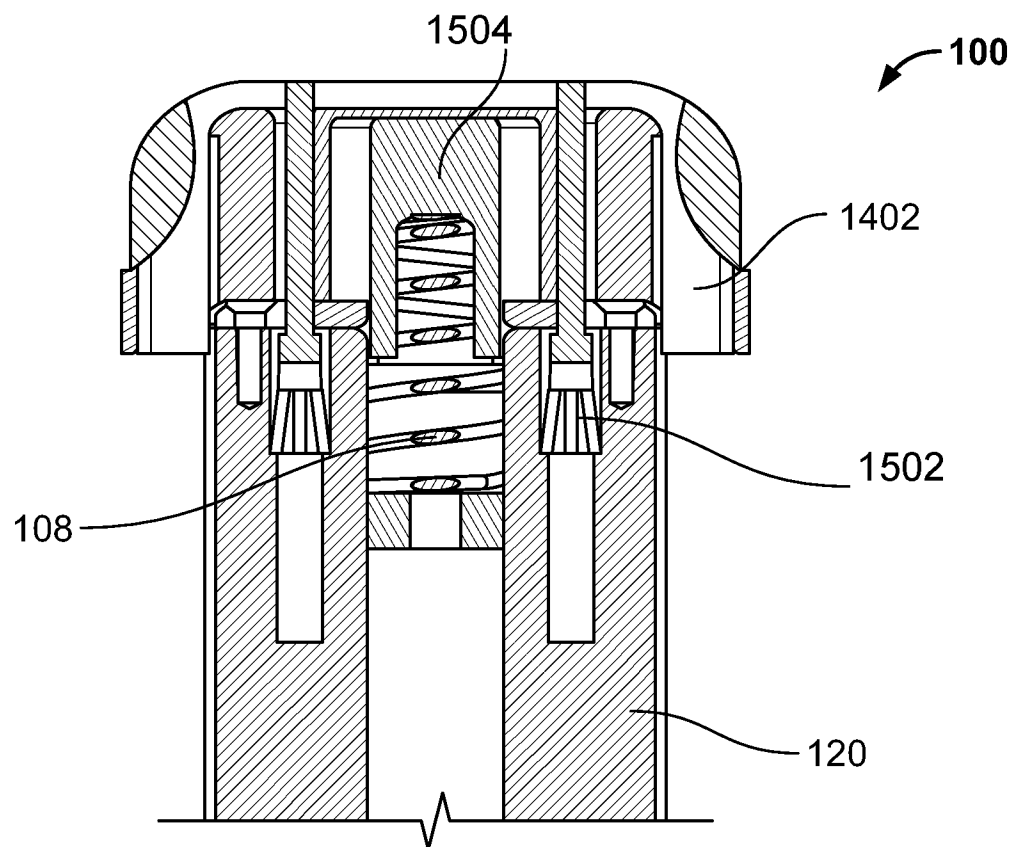
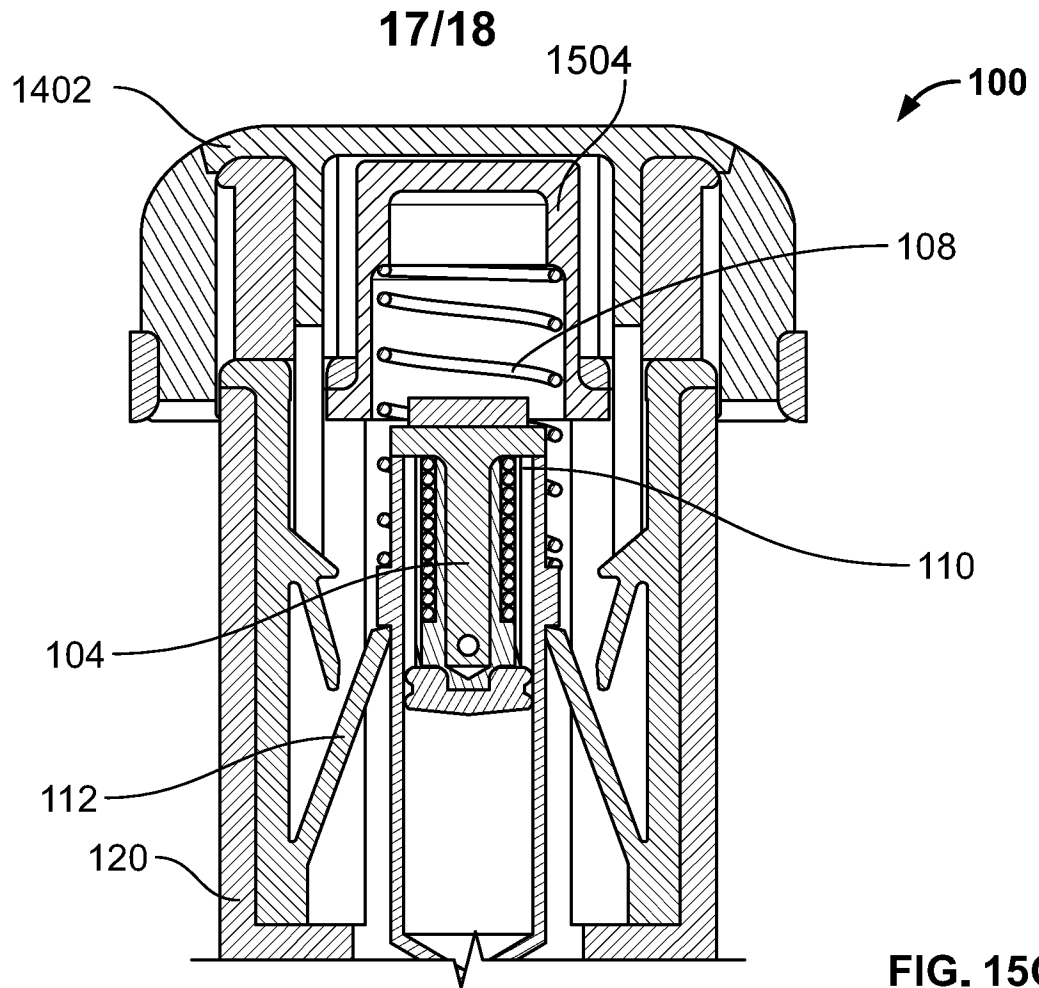


FIG. 15B



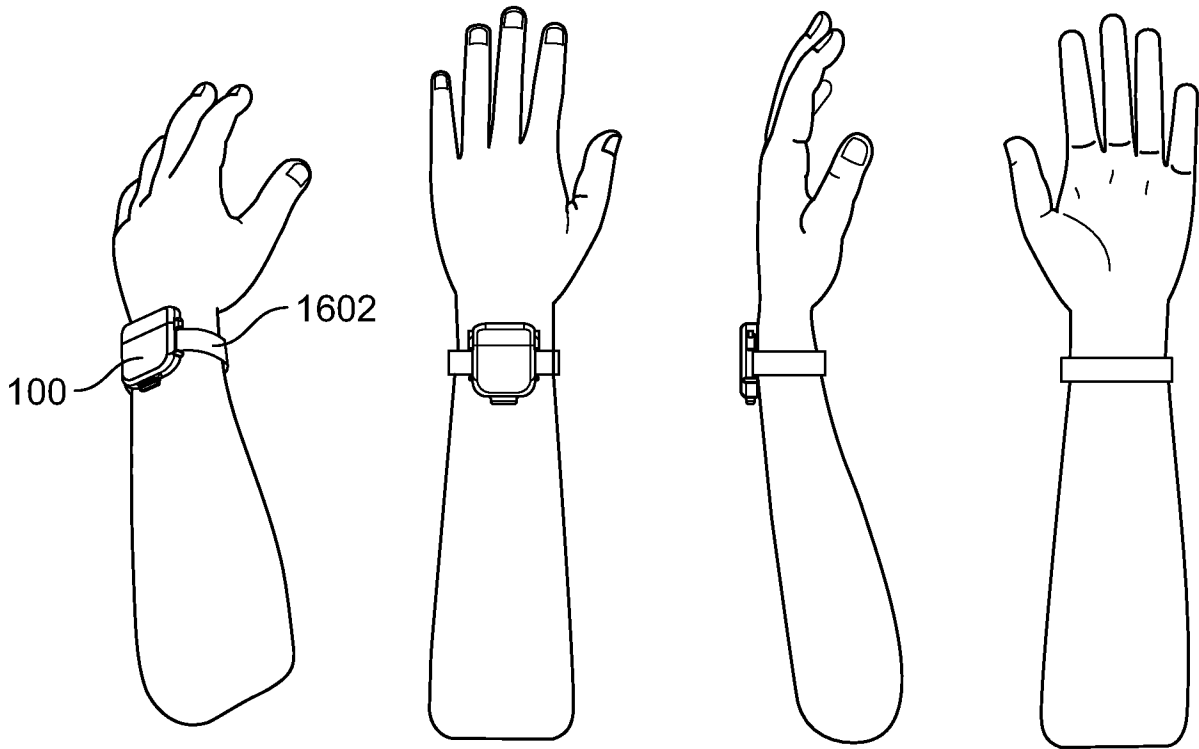


FIG. 16

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2019/023417

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

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

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

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

This International Searching Authority found multiple inventions in this international application, as follows:
See extra sheet(s).

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-18

Remark on Protest

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

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2019/023417

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A61M 5/20; A61M 5/00; A61M 5/31; A61M 5/315; A61M 5/32 (2019.01)

CPC - A61M 5/20; A61M 5/00; A61M 5/31; A61M 5/315; A61M 5/32 (2019.05)

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)

See Search History document

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

USPC - 604/135; 604/136; 604/137; 604/192; 604/198; 604/207 (keyword delimited)

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

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2014/0257185 A1 (BECHMANN et al) 11 September 2014 (11.09.2014) entire document	1-5, 8-10, 15, 16
---		---
Y		17, 18
Y	WO 2016/064266 A2 (WITTEMAN) 28 April 2016 (28.04.2016) entire document	17, 18
A	US 2007/0100288 A1 (BOZEMAN et al) 03 May 2007 (03.05.2007) entire document	1-18
A	US 2013/0274676 A1 (EKMAN et al) 17 October 2013 (17.10.2013) entire document	1-18
A	US 2013/0131602 A1 (KEMP et al) 23 May 2013 (23.05.2013) entire document	1-18

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

09 June 2019

Date of mailing of the international search report

01 JUL 2019

Name and mailing address of the ISA/US

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Blaine R. Copenheaver

PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2019/023417

Continued from Box No. III Observations where unity of invention is lacking

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claims 1-18, are drawn to an auto-injection device comprising: a syringe comprising a plunger and a chamber for storing a substance to be injected.

Group II, claims 19-23, are drawn to a wearable device, comprising: an auto-injection cartridge; and a casing, wherein the casing comprises two cantilevers positioned on two opposing interior sides respectively.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical feature of the Group I invention: a syringe comprising a plunger and a chamber for storing a substance to be injected; a needle connected to the syringe and configured to be coaxial with the syringe; a first set of springs coupled to the syringe and configured to push the needle; and a second set of springs coupled to the plunger and configured to push the plunger; wherein each of the first and the second set of springs comprises one or more springs as claimed therein is not present in the invention of Group II. The special technical feature of the Group II invention: an auto-injection cartridge; and a casing, wherein the casing comprises two cantilevers positioned on two opposing interior sides respectively; and an outer-cover wherein the auto-injection cartridge is inset onto the cantilevers, and wherein the wearable device is activated when the auto-injection cartridge is pushed off the cantilevers as claimed therein is not present in the invention of Group I.

Groups I and II lack unity of invention because even though the inventions of these groups require the technical feature of an auto-injection device, this technical feature is not a special technical feature as it does not make a contribution over the prior art.

Specifically, US 2007/0100288 A1 to Bozeman et al. teaches an auto injection device (Para. [0012]).

Since none of the special technical features of the Group I or II inventions are found in more than one of the inventions, unity of invention is lacking.