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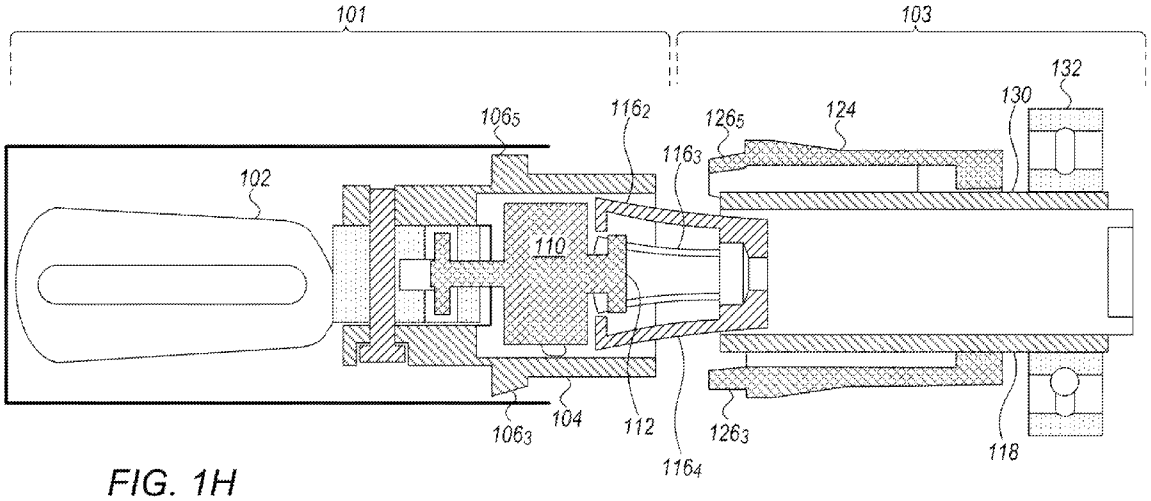


FIG. 1H

(57) Abstract: A tool actuation connector, which includes a tool activation interface, a longitudinal lock interface and a rotation lock interface. The tool actuation connector includes a latching spring, an inner sleeve and an outer sleeve. The latching spring includes a plurality of spring hooks, for coupling with the tool activation interface. The inner sleeve is operable to longitudinally move relative to said latching spring. The inner sleeve couples the latching spring to the activation interface when said inner sleeve is located over said latching spring and releases the latching spring from the activation interface when the inner sleeve moves away from the latching spring toward the proximal direction. The outer sleeve is rotationally locked with the inner sleeve and is operable to longitudinally move relative to the inner sleeve. The outer sleeve is further operable to rotationally lock with said tool via said rotation lock interface.

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AN ACTUATION CONNECTOR FOR A TOOL

FIELD OF THE DISCLOSED TECHNIQUE

The disclosed technique relates to tools in general in general, and to tool mechanism, in particular.

BACKGROUND OF THE DISCLOSED TECHNIQUE

In many technological fields, different tools are employed to perform different operations. In the medical field, and specifically in the surgical filed, the different tools may included forceps, needle drivers, scissors, scalpels and the like. Often, it may be required to change a tool during operation (e.g., surgery).

U.S. Patent 7,297,142 to Brock, entitled "Interchangeable Surgical Instrument" directs to interchangeable surgical instrument in which a magazine of tools is positioned outside the body. The tool is held within the magazine. The engagement hooks of the tool are spring biased outwardly in an open configuration. To engage the tool driver with the tool, the tool driver is pushed against the tool. As the tool starts to move within the passage, the walls of passage press against the engagement hooks until the engagement hooks lock with the driver hooks.

U.S. Patent Application Publication 2013/0184690 to Doyle, entitled "Systems, Apparatuses and Methods of Tool, Exchange" directs to engaging and disengaging of an end tool, with an holster or tool exchange device, may be accomplished by moving the instrument to which the end tool is attached sequentially along two motions, a first motion and a second motion. Each motion may be bi-directional and the two directions may be used to perform engaging and/or disengaging operations as described below. The first motion occurs along linear path, and the second motion is in rotational path. Moving the instrument along the first and then the second motion will: 1) engage the end tool with the

holster via a tool engaging system components 2) engage an instrument via the holster further via operating instrument engaging features operable with holster, 3) allow the end tool to be disconnected from the instrument and features operable with holster, and 4) disengage the instrument from the holster. The instrument may then be moved in the reverse of the first motion direction along path to allow the instrument to be moved independently of the holster. Moving the instrument again in the first and then the second motion will: 1) engage the instrument with the holster, 2) allow the end tool to be connected to the instrument, and, upon moving again in the first direction allow the instrument to disengage from the holster with the engaged end tool connected, and allow the instrument and end tool to be used as a unit.

U.S. Patent Application Publication 2007/0270640 to Dimitriou et al, entitled “Endoscope Tool Coupling” directs to a connector apparatus attachable to the proximal end of an endoscope, through which tool can be inserted or extracted from the endoscope. The connector apparatus includes a connector body that has a plurality of fingers that are configured to engage and securely lock onto a port of the endoscope. The connector body locks onto the port with a connector nut that is threaded on the connector body to tighten or loosen the connector fingers from the endoscope port mount. The endoscope includes fingres which rotationally lock the connector apparatus with the endoscope.

U.S. Patent Application Publication 2009/0221873A1 to McGrath directs to an adaptor to orient an elongate medical device in relation to an endoscope. The adaptor includes a first portion and a second portion. The distal end of the first portion is connected and rotationally secured to an endoscope at the proximal end thereof. The first portion includes a first lumen longitudinally therethrough either an orienting key or a keyway extending longitudinally at least partially there along the first portion. The second portion connects with the first portion

and includes a second lumen extending longitudinally therethrough. The second portion connects with the first lumen and also includes a key or the keyway extending longitudinally at least partially there along. The keyway configured to releasably mate with the key to orient and rotationally secure the second portion relative to the first portion. A medical device is inserted through the second portion while being and rotationally secured relative to the second portion. When the medical device is inserted through the endoscope, the adaptor orients the tip thereof relative to the distal portion of the endoscope portion.

SUMMARY OF THE PRESENT DISCLOSED TECHNIQUE

It is an object of the disclosed technique to provide a novel tool actuation connector. In accordance with the disclosed technique, there is thus provided a tool actuation connector, where the tool includes a tool activation interface, a longitudinal lock interface and a rotation lock interface. The tool actuation connector includes a latching spring, an inner sleeve and an outer sleeve. The latching spring includes a plurality of spring hooks, for coupling with the tool activation interface. The inner sleeve is operable to longitudinally move relative to said latching spring. The inner sleeve couples the latching spring to the activation interface when said inner sleeve is located over said latching spring and releases the latching spring from the activation interface when the inner sleeve moves away from the latching spring toward the proximal direction. The outer sleeve is rotationally locked with the inner sleeve and is operable to longitudinally move relative to the inner sleeve. The outer sleeve is further operable to rotationally lock with said tool via said rotation lock interface.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosed technique will be understood and appreciated more fully from the following detailed description taken in conjunction with the drawings in which:

Figures 1A and 1B depict the components of tool mechanism in accordance with an embodiment of the disclosed technique;

Figure 1C-1D depicts tool mechanism in an assembled and connected state in accordance with an embodiment of the disclosed technique;

Figures 1F-1I depicts the process of releasing actuation connector from a tool section in accordance with an embodiment of the disclosed technique; and

Figures 2A-2D are schematic illustrations of a manifold apparatus, constructed and operative in accordance with another embodiment of the disclosed technique.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The disclosed technique overcomes the disadvantages of the prior art by providing a tool actuation connector mechanism, for connecting with a selected tool or to release the tool which is employed, during operation (e.g., surgery). In other words, the tool mechanism according to the disclosed technique enables exchanging tools of a tool guide during operation. The tool actuation connector includes a tool activation interface, a longitudinal lock interface and a rotation lock interface. The actuation connector includes a latching spring, an inner sleeve and an outer sleeve. The latching spring includes a plurality of spring hooks, for coupling with the tool activation interface. The inner sleeve is operable to longitudinally move relative to said latching spring. The inner sleeve couples the latching spring to the activation interface when said inner sleeve is located over said latching spring and releases the latching spring from the activation interface when the inner sleeve moves away from the latching spring toward the proximal direction. The outer sleeve is rotationally locked with the inner sleeve and is operable to longitudinally move relative to the inner sleeve. The outer sleeve is further operable to rotationally lock with said tool via said rotation lock interface.

Reference is now made to Figures 1A-1I, which are schematic illustrations of a tool mechanism, generally referenced 100, constructed and operative in accordance with an embodiment of the disclosed technique. Tool mechanism 100 includes a tool section 101 and an actuation connector 103. Figures 1A and 1B depict the components of tool mechanism 100. Figure 1C-1D depicts tool mechanism 100 in an assembled and connected state. Figures 1E-1I depicts the process of releasing actuation connector 103 from tool section 101.

For the sake of the description which follows, the direction toward the tool section 101 is referred to as ‘distal direction’ or ‘distal end’ and the toward actuation connector 103 is referred to as ‘proximal

direction' or 'proximal end'. Tool section 101 includes a tool 102, a tool housing 104 and a tool activation interface such as a push-pull rod 110. Tool housing 104 includes a rotation lock interface. In exemplary tool mechanism 100, the rotation lock interface includes a plurality of rotation lock protrusions at the distal end thereof. In exemplary too mechanism 100 tool housing 104 includes five rotation lock protrusions 106_1, 106_2, 106_3, 106_4 and 106_5. Rotation lock protrusions 106_1-106_5 create a plurality of tool rotation lock grooves 108_1, 108_2, 108_3, 108_4 and 108_5. Tool housing 104 includes at a longitudinal lock interface. In the example brought forth in Figures 1A-1I, longitudinal lock interface is in the form of two L-shaped cutouts 109_1 and 109_2. Each one of L-shaped cutouts 109_1 and 109_2 includes a longitudinal section and a lateral section. Push-pull rod 110 includes a mushroom pin 112.

Actuation connector 103 includes a latching spring 114, an inner sleeve 118 and an outer sleeve 124. Latching spring 114 includes a plurality of spring hooks. In the example brought forth in Figures 1A-1I latching spring 114 includes four spring hook 116_1, 116_2, 116_3 and 116_4. Inner sleeve 118 includes at least one sleeve rotation lock pin and at least one sleeve longitudinal lock pin. In exemplary tool mechanism 100, inner sleeve 118 includes two sleeve rotation lock pins 120_1 and 120_2 and two sleeve longitudinal lock pin 122_1 and 122_2. Outer sleeve 124 includes a plurality of rotation lock teeth at the distal end thereof and at least one sleeve rotation lock groove. In exemplary tool mechanism 100, outer sleeve 124 includes five rotation lock teeth 126_1, 126_2, 126_3, 126_4 and 126_5 extending from said inner sleeve toward the distal direction. Outer sleeve 124 two sleeve rotation lock grooves 128_1 and 128_2 located on the lateral surface of outer sleeve 124. Tool mechanism further includes a spring 130 and a rotation bearing 132. Inner sleeve 118 is coupled with a tool guide, which controls the actuation of tool mechanism 100.

Inner sleeve 118 and outer sleeve 124 exhibit a cylindrical shape. Tool housing 104 also exhibits a cylindrical shape with two prongs extending from the distal base thereof. When tool mechanism 100 is in the assembled and connected state, inner sleeve 118, outer sleeve 124 and tool housing 104 are concentric. The term 'longitudinal direction' or 'longitudinally' relate herein to any direction parallel to the concentric axis of inner sleeve 118, outer sleeve 124 and tool housing 104. The term 'longitudinally move' relates to movement in a longitudinal direction. The term 'actuation' relates herein to the motion (i.e., longitudinal motion, rotation motion) and to the activation of tool 102.

With reference to Figure 1C, spring 130 applies a force on outer sleeve 124 in the distal direction and each rotation lock teeth 126_1-126_5 is located in one of tool rotation lock grooves 108_1-108_5. Consequently, each rotation lock teeth 126_1-126_5 rotationally lock with two adjacent rotation lock protrusions 106_1-106_5, such that when outer sleeve 124 rotates, tool housing 104, and thus tool 102 rotates as well (i.e., outer sleeve 124 and tool 102 are rotationally locked one with respect to the other). Also, each of sleeve rotation lock pins 120_1 and 120_2 of inner sleeve 118 is located in one of sleeve rotation lock grooves 128_1 and 128_2 such that when inner sleeve 118 rotates, outer sleeve 124 rotates as well (i.e., inner sleeve 118 and outer sleeve 124 are rotationally locked one with respect to the other). Thus, when inner sleeve 118 rotates, tool housing 104 and thus tool 102 also rotates (i.e., inner sleeve 118 and tool 102 are rotationally locked one with respect to the other). Also, the longitudinal length of sleeve rotation lock grooves 128_1 and 128_2 is larger than the longitudinal length of sleeve rotation lock pins 120_1 and 120_2, to enable relative motion between outer sleeve 124 and inner sleeve 118 in a longitudinal direction. This relative motion between outer sleeve 124 and inner sleeve 118 is limited by the longitudinal length of sleeve rotation

lock grooves 128_1 and 128_2, and is equal or larger than the longitudinal length of rotation lock teeth 126_1-126_5.

With reference to Figure 1D, which depicts tool mechanism 100 in an assembled and connected state with outer sleeve 124 removed, sleeve longitudinal lock pin 122_1 is inserted into the L-shaped cutout 109_1, toward the end of the lateral section, such that, in the assembled and connected state, tool housing 104 and inner sleeve 118 do not move one with respect to the other in a longitudinal direction (i.e., tool housing 104 and inner sleeve are longitudinally locked). It is noted that, although not depicted in Figure 1D, in an assembled and connected state longitudinal lock pin 122_2 is inserted into the L-shaped cutout 109_2.

With reference to Figure 1E, which depicts and cross-section tool mechanism 100 in the assembled connected state, inner sleeve 118 is located over latching spring 114, and presses on spring hooks 116_1-116_4, such that spring hooks 116_1-116_4 latch on mushroom pin 112, and thus on push-pull rod 110. Thus, latching spring 114 is coupled with push-pull rod 110 (i.e., with tool activation interface). It is noted that latching spring 114 and inner sleeve 118 may move independently one with respect to the other in a longitudinal direction.

To release of actuation connector 103 from tool section 101, a force is applied on outer sleeve 124 in the proximal direction. With reference to Figure 1F, as tool mechanism 100 is inserted into a container 134, the rim of container 134 applies a force on outer sleeve 124 in the proximal direction until rotation lock teeth 126_1-126_5 are out of tool rotation lock grooves 108_1-108_2 and outer sleeve 124 is rotationally unlocked from tool housing 104. Thereafter, and with reference to Figure 1G, inner sleeve 118 is rotated to align longitudinal lock pins 122_1 and 122_2 with the longitudinal section of L-shaped cutouts 109_1 and 109_2, longitudinally unlocking inner sleeve 118 from tool housing 104 (i.e., inner sleeve and tool housing can longitudinally move one with respect to the other).

Thereby, actuation connector 103 is longitudinally unlocked from tool section 101. As inner sleeve 118 rotates, outer sleeve 124 rotates as well. It is noted that, for the sake clarity of the explanation, in Figure 1G, tool mechanism 100 is depicted with outer sleeve 124 removed. With reference to Figure 1H, when longitudinal lock pins 122_1 and 122_2 are aligned with the longitudinal section of L-shaped cutouts 109_1 and 109_2, inner sleeve 118 is pulled toward the proximal direction while the position of latching spring 114 is maintained, to remove inner sleeve 118 from latching spring 114, such that spring hooks 116_1-116_4 release mushroom pin 112. With reference to Figure 1I, actuation connector 103 is released from tool section 101, and may than connect with a different tool, similar to tool 102.

To connect actuation connector 103 to tool section 101, the above described process is reversed. Actuation connector 103 is position such that spring hooks 116_1-116_4 are located over mushroom pin 112 and the rim containing 134 pushes on outer sleeve 124. Each one of longitudinal lock pins 122_1 and 122_2 is aligned with the longitudinal section of one of L-shaped cutouts 109_1 and 109_2. Inner sleeve 118 is then pushed over latching spring 114 such that inner sleeve presses on spring hooks 116_1-116_4 and spring hooks 116_1-116_4 latch onto mushroom pin 112. Outer sleeve 124 is then rotated by rotating Inner sleeve 118 until each of rotation lock teeth 126_1-126_5 is aligned with one of tool rotation lock grooves 108_1-108_5. As tool mechanism 100 is extracted from container 134, spring 130 applies a force on outer sleeve 124 in the distal direction such that each one of rotation lock teeth 126_1-126_5 is inserted into one of tool rotation lock grooves 108_1-108_5.

It is noted that container 134 (Figures 1A-1I) may be a part of a manifold of containers, where each container is operable to hold a separate tool. In the case of medical surgery, the manifold may be located within the operated cavity (e.g., the abdomen during laparoscopic

surgery). The entire tool release and coupling procedures described above occur within the operated cavity. This eliminates the need to insert and/or withdraw the tool from the operated cavity each time a tool is to be changed, as long as the required tool is stored in one of the containers in the manifold. Reference is now made to Figures 2A-2D, which are schematic illustrations of a manifold apparatus, generally referenced 200, constructed and operative in accordance with another embodiment of the disclosed technique. Manifold apparatus 200 includes a containers manifold 202 and an arm 204. Manifold 202 includes a distal section 206 and a proximal section 208. Manifold 202 further includes a plurality of containers. In the example depicted in Figure 2, manifold 202 includes five containers 210_1, 210_2, 210_3, 210_4 and 210_5. In each of containers $210_1 - 210_5$, the diameter thereof at the distal section 206 is smaller than the diameter thereof at the proximal section 208. Thus a tool may be inserted completely into one of containers $210_1 - 210_5$, and the rim of the distal section of the container shall apply a force on the outer sleeve of the tool as the tool is pushed into the container. Manifold 202 further includes a plurality of tool passage cavities, such as through tool passage cavities 212_1, 212_2 and 212_3. During operation, various tools, located at the distal end of respective articulation arms, may pass through a respective one of tool passage cavities 212_1, 212_2 and 212_3. For example, and referring to Figure 2C, at the beginning of the operation, tools 218_1 and 218_2, which are located at the distal end of articulation arms 220_1 and 220_2 respectively, as well as a camera 214, which is located at the distal end of articulation arm 216, are to be inserted into the operated cavity along with manifold 202. Manifold 202 is inserted into the operated cavity with at least one of containers 210_1-210_5 empty (i.e., to allow storage of the tool being replace). The remaining ones containers 210_1-210_5 include various tools. It is noted that at least each one of articulation arms 220_1 and 220_2 includes at the distal end thereof an actuation connector, such as

actuation connector 103 described herein above in conjunction with Figures (1A-1I). It is also note that at least each one of tools 218_1 and 218_2 include a tool activation interface, a longitudinal lock interface and a rotation lock interface as described above in conjunction with Figures (1A-1I).

With reference to Figure 2D, once within the operated cavity, tools 218_1 and 218_2 passes through tool passage cavities 212_2 and 212_3 respectively and camera 214 passes through tool passage cavity 212_1. Consequently, tools 218_1 and 218_2 may be employed within the operated cavity while camera 214 acquires an image or images of thereof. When a tool is to be replaced, for example, tool 218_1, then tool 218_1 is retracted beyond manifold 202. Tool 218_1 is then aligned with an empty container and released as described above. Articulation arm 220_1 is then aligned with the selected one of containers 210_1-210_5 (i.e., which stores the required tool) and articulation arm 220_1 is then coupled with the selected tool as described above. Tool 218_2 may similarly be exchanged.

It will be appreciated by persons skilled in the art that the disclosed technique is not limited to what has been particularly shown and described hereinabove. Rather the scope of the disclosed technique is defined only by the claims, which follow.

CLAIMS

1. An assembly operative to be employed during surgery comprising:

at least one tool, each of said at least one tool including a tool activation interface, a longitudinal lock interface and a rotation lock interface; and

actuation connector for connecting with each said at least one tool including:

a latching spring, including a plurality of spring hooks, for coupling with said tool activation interface;

an inner sleeve, operable to longitudinally move relative to said latching spring, said inner sleeve coupling said latching spring to said activation interface when said inner sleeve is located over said latching spring and releasing said latching spring from said activation interface when said inner sleeve moves away from said latching spring toward the proximal direction; and

an outer sleeve, rotationally locked with said inner sleeve, operable to longitudinally move relative to said inner sleeve, said outer sleeve further being operable to rotationally lock with said tool via said rotation lock interface,

wherein when said actuation connector is connected to said tool, to disconnect said actuation connector from said tool, said outer sleeve is longitudinally moved toward a proximal direction, thereby rotationally unlocking said outer sleeve from said rotation lock interface and thereby rotationally unlocking said actuation connector from said tool,

wherein when said outer sleeve is rotationally unlocked from said rotation lock interface, said inner sleeve is rotated in a first direction, thereby longitudinally unlocking said actuation connector from said tool,

wherein when said actuation connector is disconnected from said tool, to connect said actuation connector to said tool, said inner sleeve is rotated in a second direction different from said first direction, to longitudinally lock said actuation connector with said tool,

wherein, when said inner sleeve is longitudinally locked with said actuation connector, said outer sleeve is longitudinally moved toward a distal direction to rotationally lock with said rotation lock interface, thereby rotationally locking said actuation connector with said tool.

2. The actuation connector according to claim 1, wherein said outer sleeve includes a plurality of rotation lock teeth,

wherein said rotation lock interface includes a plurality of tool rotation lock protrusions which create a plurality of tool rotation lock grooves, when said outer sleeve is rotationally locked with said rotation lock interface, each one of said rotation lock teeth is located in one of said tool rotation lock grooves and each one of said rotation lock teeth rotationally lock with two adjacent ones of said rotation lock protrusions.

3. The assembly according to claim 1, wherein said inner sleeve includes at least one sleeve rotation lock pin,

wherein said outer sleeve includes at least one sleeve rotation lock groove, and

wherein each of said at least one sleeve rotation lock pin is located in one of said at least one sleeve rotation lock grooves.

4. The assembly according to claim 1, wherein said longitudinal lock interface is at least one L-shaped cutout, each of said at least one L-shaped cutout including a longitudinal section and a lateral section,

wherein said inner sleeve includes at least one sleeve longitudinal lock pin, and

wherein when each of said at least one sleeve longitudinal lock pin is inserted to one of said at least one L-shaped cutout toward the end of said lateral section, such that said inner sleeve and said tool do not move one with respect to the other in a longitudinal direction.

5. The assembly according to claim 4, wherein said actuation connector further includes a spring applying a force on said outer sleeve in the distal direction, and

wherein when each of said rotation lock teeth is aligned with one of said tool rotation lock grooves, each one of said rotation lock teeth is inserted into one of said tool rotation lock grooves.

6. The assembly according to claim 5, wherein when a force is applied on said outer sleeve in the proximal direction, said outer sleeve moves until said rotation lock teeth are out of said tool rotation lock grooves thereby rotationally unlocking said actuation connector from said tool.

7. The assembly according to claim 6, wherein said inner sleeve is rotated to align said at least one longitudinal lock pin with said longitudinal section of said L-shaped cutout thereby longitudinally unlocking said actuation connector from said tool.

8. The assembly according to claim 7, wherein said inner sleeve is pulled toward the distal direction relative to said latching spring to remove said inner sleeve from said latching spring such that said spring hooks are releases from said activation interface.

9. The assembly according to claims 1 further comprising a manifold apparatus operative for containing medical tools during operation, said manifold apparatus comprising:

a containers manifold including a plurality of tool containers, for containing medical tools, said containers manifold further including a at least one tool passage cavity operative to enable at least one arm with said at least one tool attached thereto to pass through a respective one of said at least one tool passage cavity, toward an operated region; and

a manifold arm including articulation links, coupled with said containers manifold, operative to maneuver said containers manifold.

10. The assembly according to claim 9, wherein said containers manifold includes a proximal section and a distal section, and

wherein diameter of each container at said distal section is smaller than the diameter of each container at said proximal section.

11. The assembly according to claim 9, wherein at least one of said tool containers is empty during surgery.

12. The assembly according to claim 11, wherein at least one of said tool containers includes at least a second tool.

13. An actuation connector for connecting with a tool, said tool including a tool activation interface, a longitudinal lock interface and a rotation lock interface, said actuation connector comprising:

a latching spring, including a plurality of spring hooks, for coupling with said tool activation interface;

an inner sleeve, operable to longitudinally move relative to said latching spring, said inner sleeve coupling said latching spring to said

activation interface when said inner sleeve is located over said latching spring and releasing said latching spring from said activation interface when said inner sleeve moves away from said latching spring toward the proximal direction;

an outer sleeve, rotationally locked with said inner sleeve, operable to longitudinally move relative to said inner sleeve, said outer sleeve further being operable to rotationally lock with said tool via said rotation lock interface,

wherein when said actuation connector is connected to said tool, to disconnect said actuation connector from said tool said outer, sleeve is longitudinally moved toward a proximal direction, thereby rotationally unlocking said outer sleeve from said rotation lock interface and thereby rotationally unlocking said actuation connector from said tool,

wherein when said outer sleeve is rotationally unlocked from said rotation lock interface, said inner sleeve is rotated in a first direction, thereby longitudinally unlocking said actuation connector from said tool,

wherein when said actuation connector is disconnected from said tool, to connect said actuation connector to said tool, said inner sleeve is rotated in a second direction different from said first direction, to longitudinally lock said actuation connector with said tool,

wherein, when said inner sleeve is longitudinally locked with said actuation connector, said outer sleeve is longitudinally moved toward a distal direction to rotationally lock with said rotation lock interface, thereby rotationally locking said actuation connector with said tool.

14. The actuation connector according to claim 13, wherein said outer sleeve includes a plurality of rotation lock teeth,

wherein said rotation lock interface includes a plurality of tool rotation lock protrusions which create a plurality of tool rotation lock grooves, when said outer sleeve is rotationally locked with said rotation lock interface, each one of said rotation lock teeth is located in one of said tool rotation lock grooves and each one of said rotation lock teeth rotationally lock with two adjacent ones of said rotation lock protrusions.

15. The actuation connector according to claim 13, wherein said inner sleeve includes at least one sleeve rotation lock pin,

wherein said outer sleeve includes at least one sleeve rotation lock groove, and

wherein each of said at least one sleeve rotation lock pin is located in one of said at least one sleeve rotation lock grooves.

16. The actuation connector according to claim 13, wherein said longitudinal lock interface is at least one L-shaped cutout, each of said at least one L-shaped cutout including a longitudinal section and a lateral section,

wherein said inner sleeve includes at least one sleeve longitudinal lock pin, and

wherein when each of said at least one sleeve longitudinal lock pin is inserted to one of said at least one L-shaped cutout toward the end of said lateral section, such that said inner sleeve and said tool do not move one with respect to the other in a longitudinal direction.

17. The actuation connector according to claim 16, wherein said actuation connector further includes a spring applying a force on said outer sleeve in the distal direction, and

wherein when each of said rotation lock teeth is aligned with one of said tool rotation lock grooves, each one of said rotation lock teeth is inserted into one of said tool rotation lock grooves.

18. The actuation connector according to claim 17, wherein when a force is applied on said outer sleeve in the proximal direction, said outer sleeve moves until said rotation lock teeth are out of said tool rotation lock grooves thereby rotationally unlocking said actuation connector from said tool.

19. The actuation connector according to claim 18, wherein said inner sleeve is rotated to align said at least one longitudinal lock pin with said longitudinal section of said L-shaped cutout thereby longitudinally unlocking said actuation connector from said tool.

20. The actuation connector according to claim 19, wherein said inner sleeve is pulled toward the distal direction relative to said latching spring to remove said inner sleeve from said latching spring such that said spring hooks are releases from said activation interface.

21. Manifold apparatus for containing medical tools during operation, said manifold apparatus comprising:

a containers manifold including a plurality of tool containers, for containing medical tools, said containers manifold further including a at least one tool passage cavity operative to enable at least one arm with a medical tool attached thereto to pass through a respective one of said at least one tool passage cavity, toward an operated region; and

a manifold arm including articulation links, coupled with said containers manifold, operative to maneuver said containers manifold.

22. The assembly according to claim 21, wherein said containers manifold includes a proximal section and a distal section, and

wherein diameter of each container at said distal section is smaller than the diameter of each container at said proximal section.

23. The assembly according to claim 21, wherein at least one of said tool containers is empty during surgery.

24. The assembly according to claim 23, wherein at least one of said tool containers includes at least a second tool.

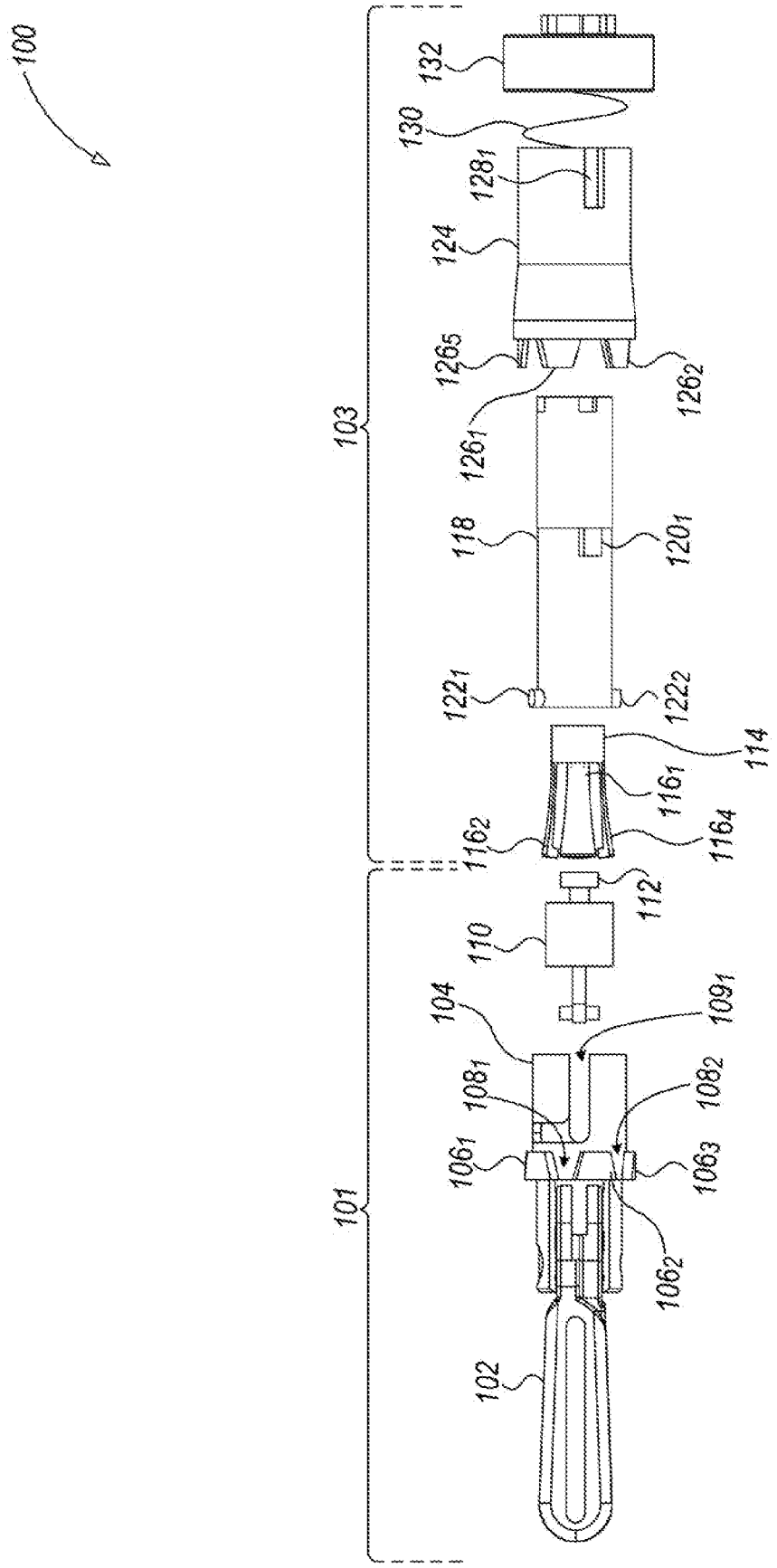

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FIG. 1A

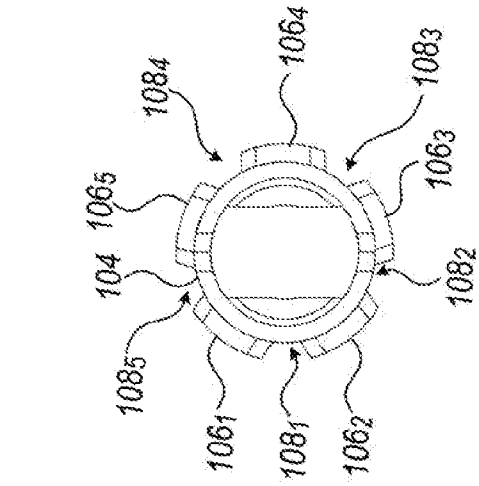


FIG. 1B3

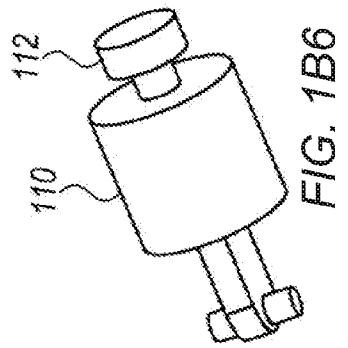


FIG. 1B6

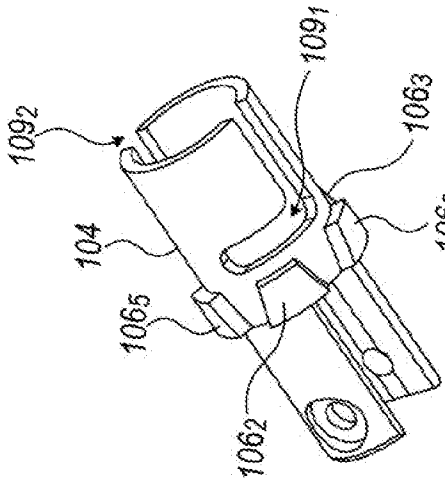


FIG. 1B2

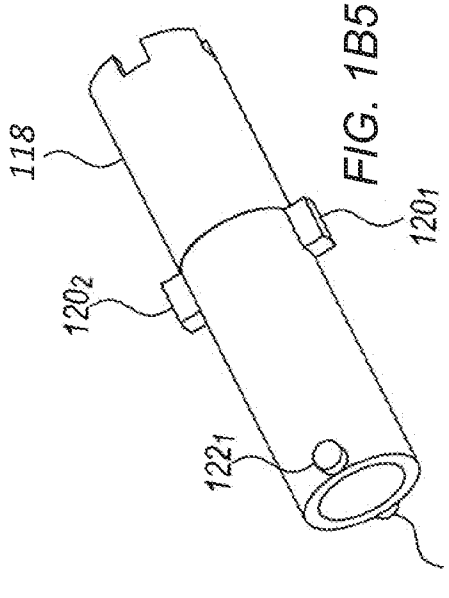


FIG. 1B5

FIG. 1B

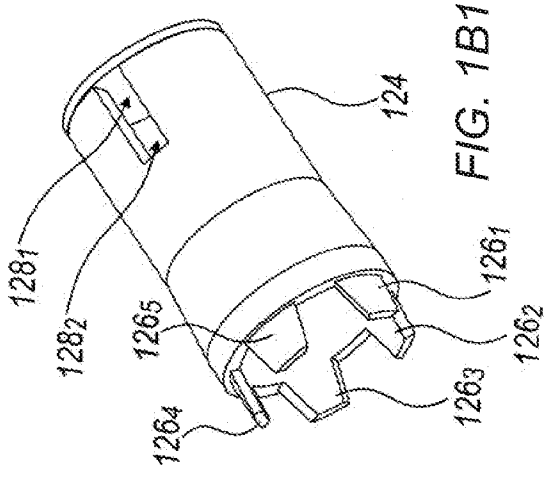


FIG. 1B1

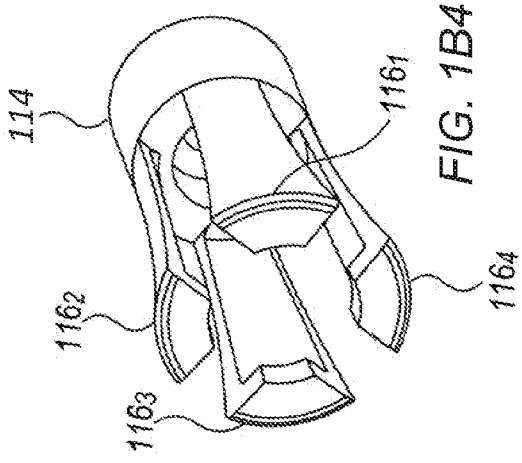


FIG. 1B4

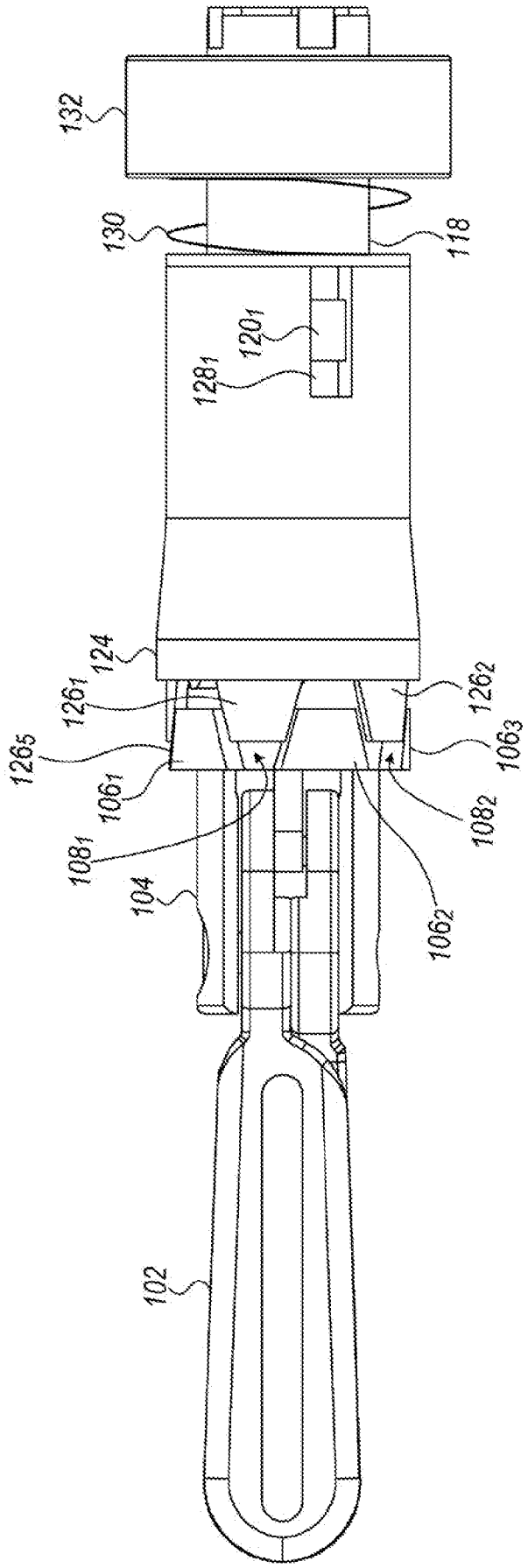

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FIG. 1C

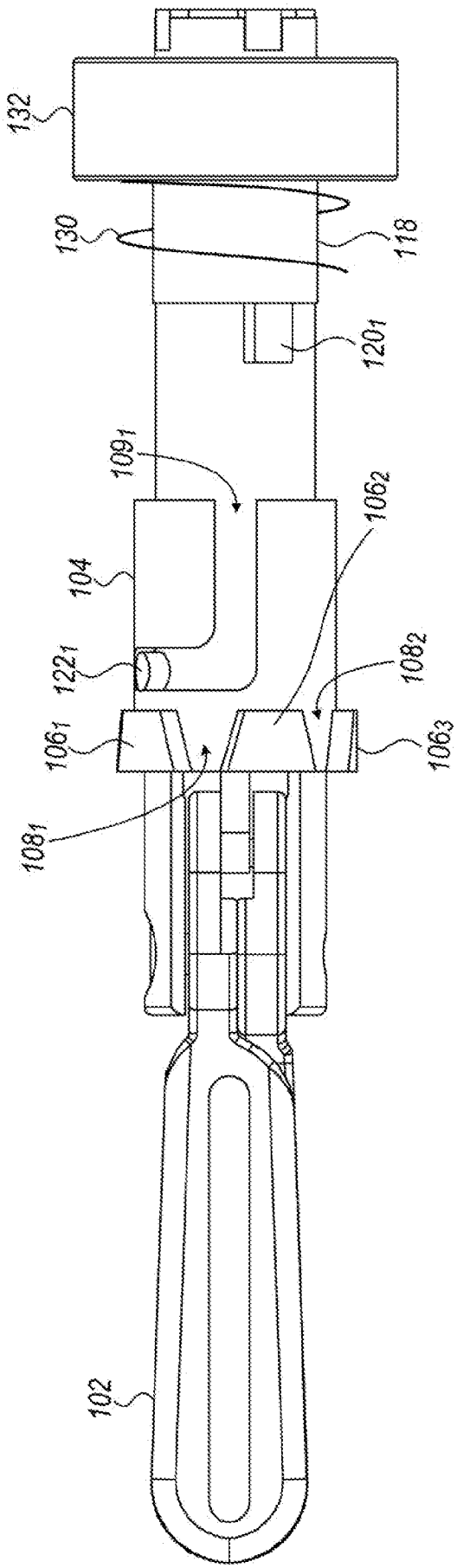


FIG. 1D

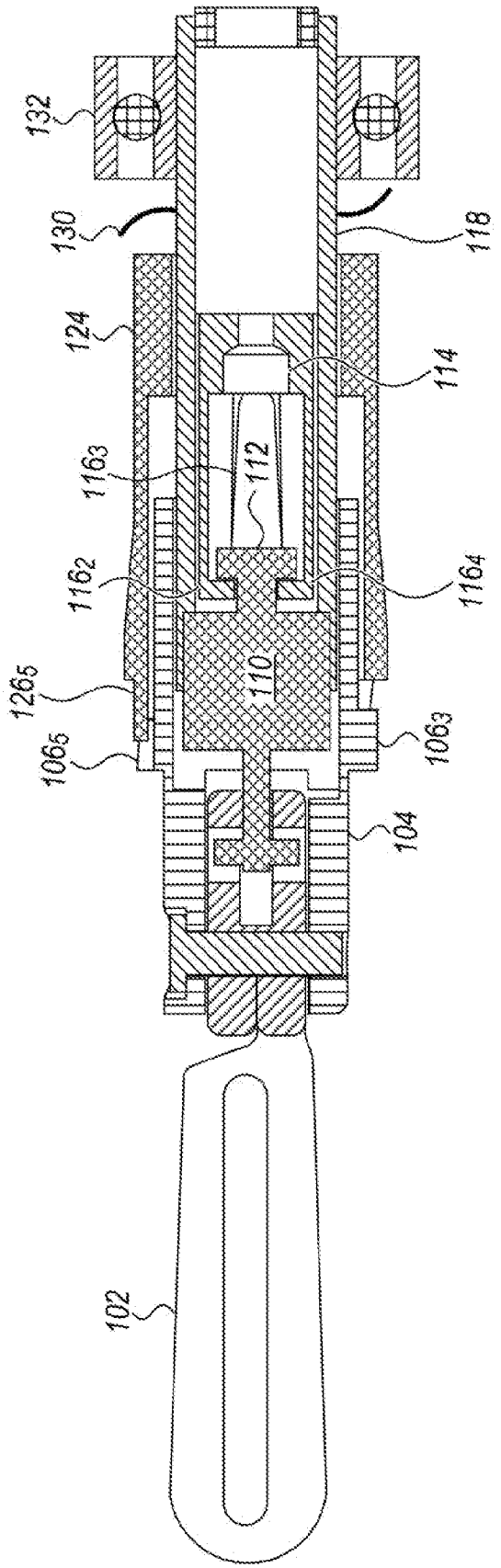

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FIG. 1E

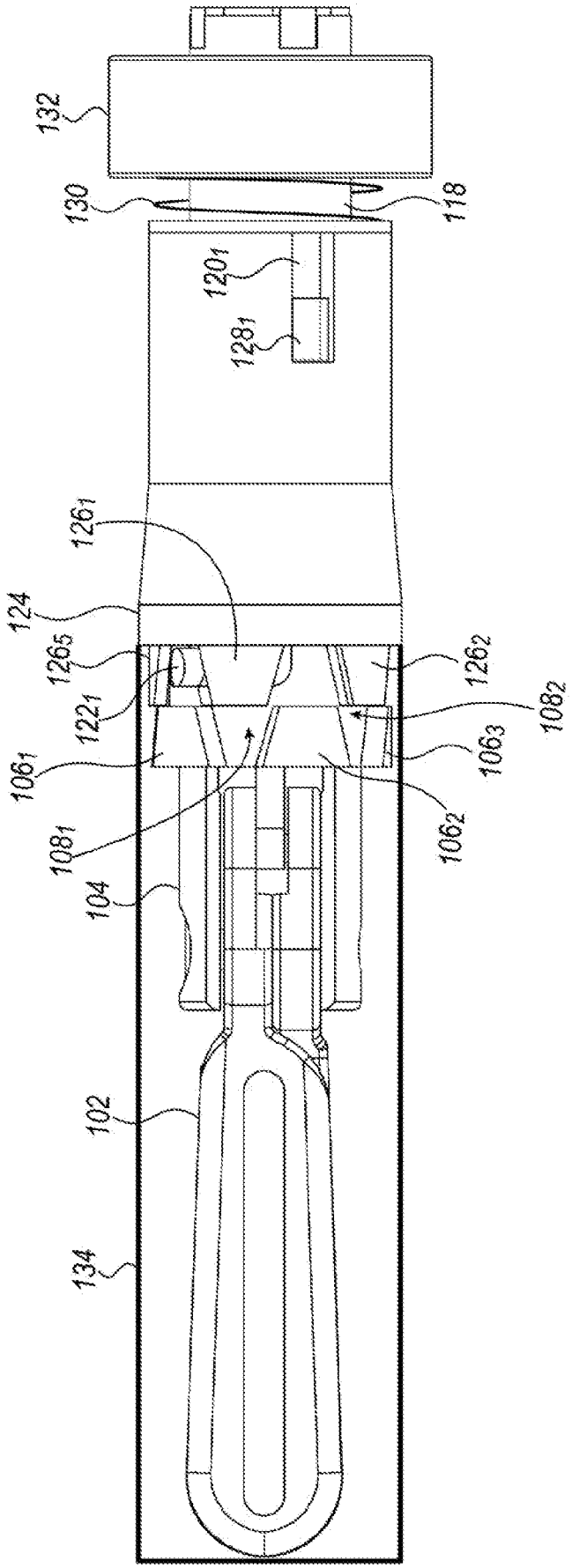

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FIG. 1F

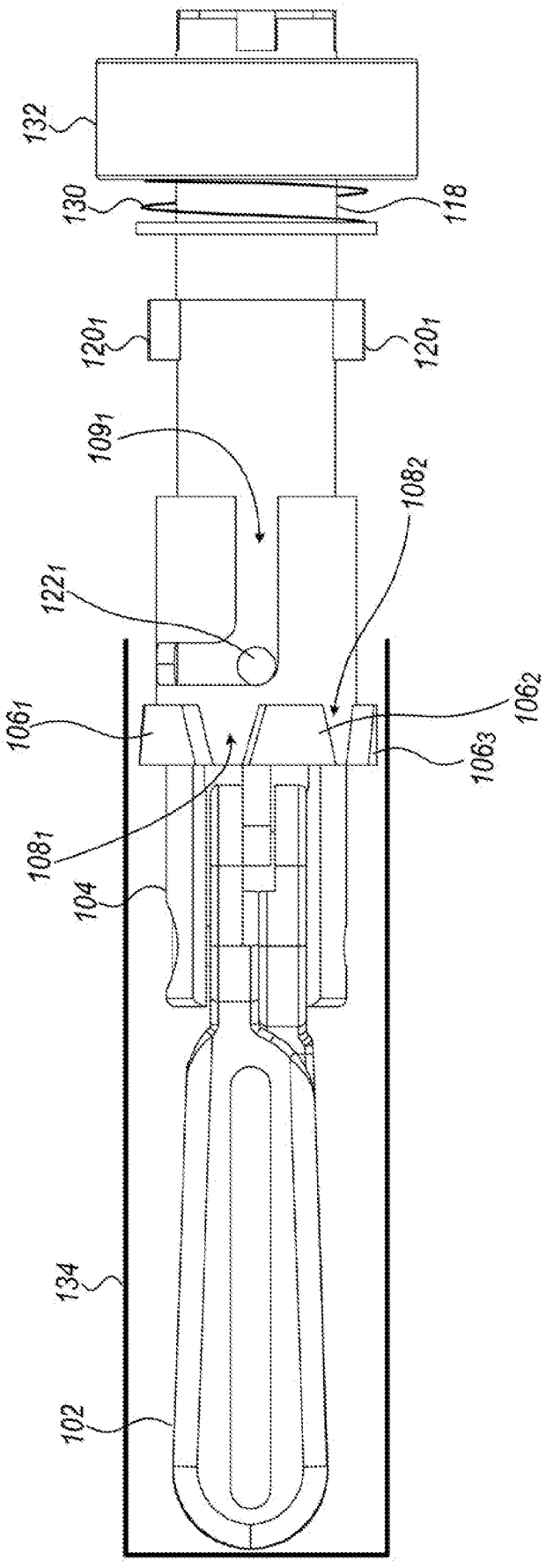

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FIG. 1G

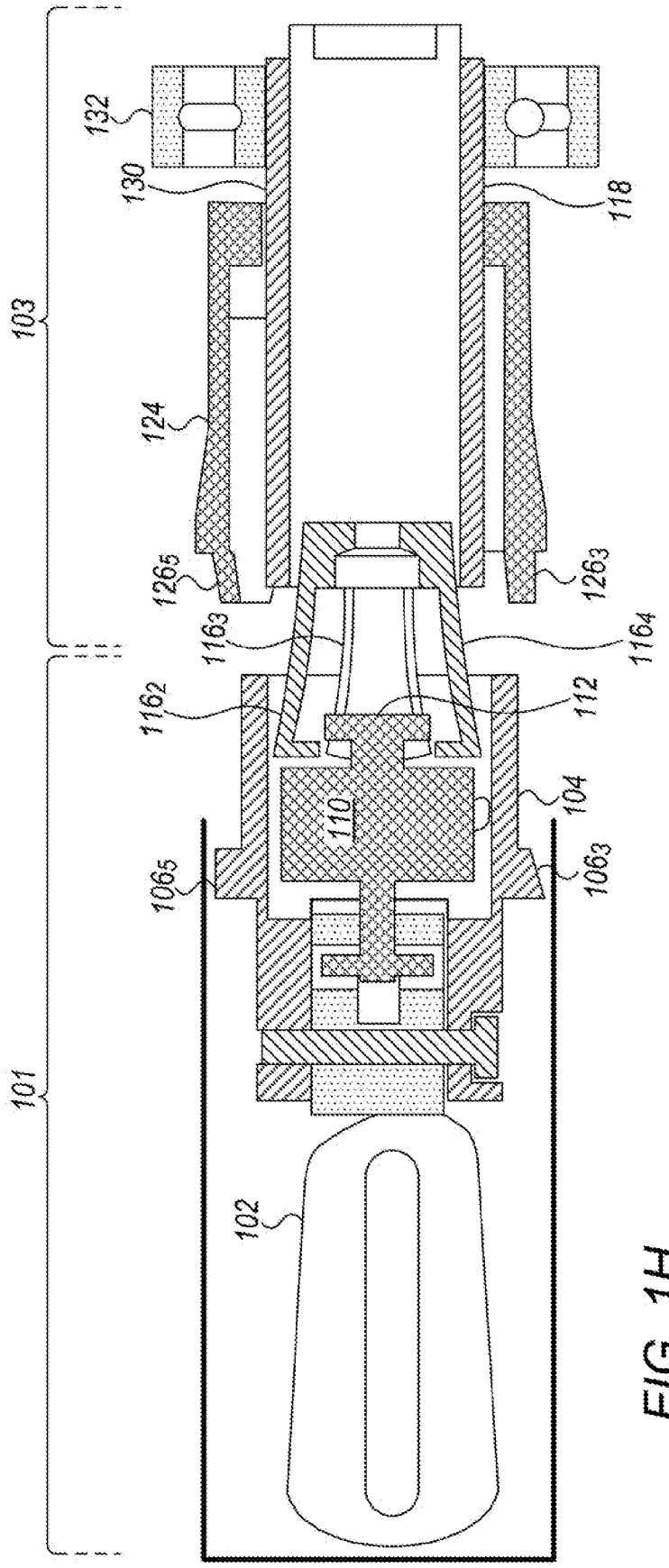

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FIG. 1H

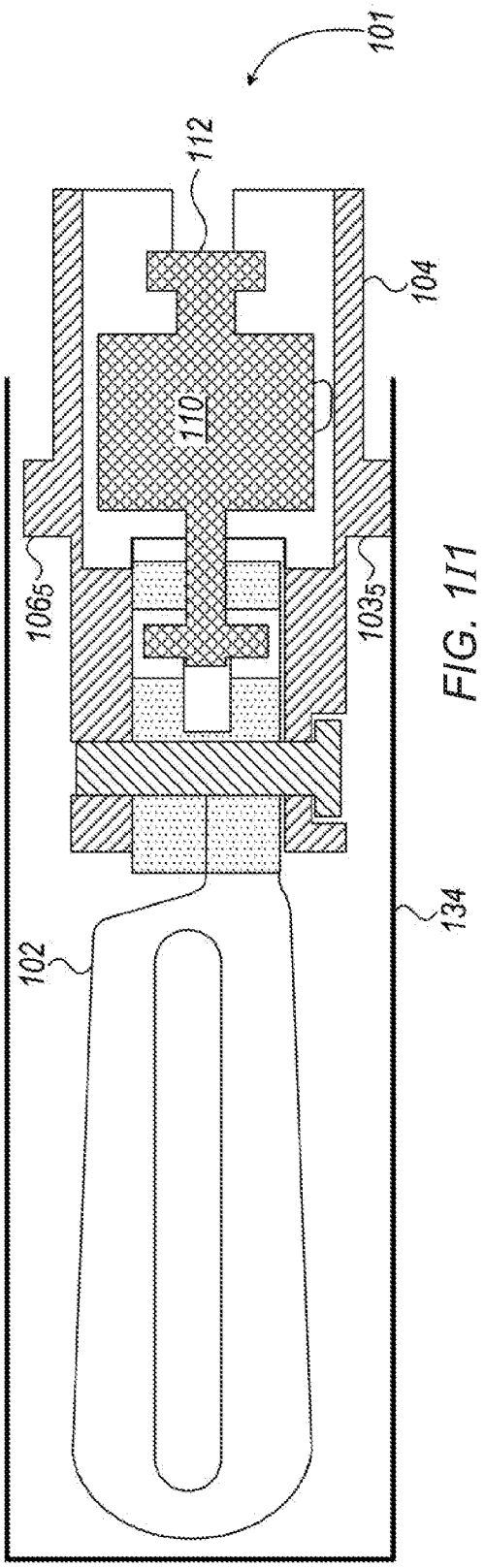


FIG. 1I1

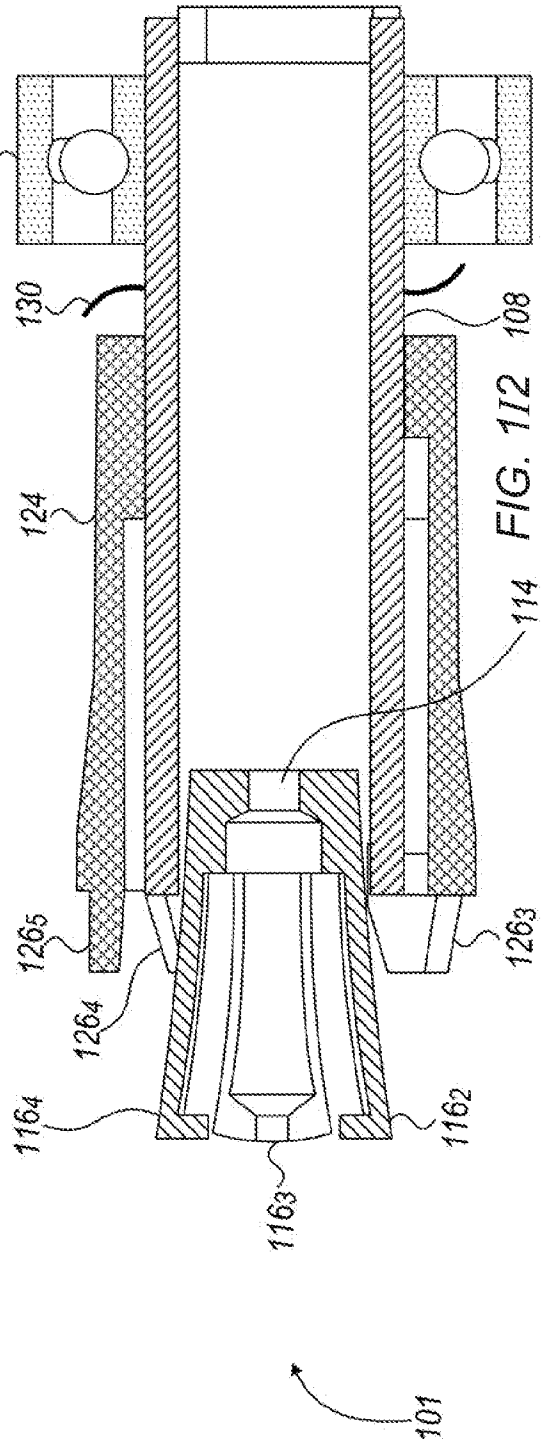


FIG. 1I2

FIG. 1I

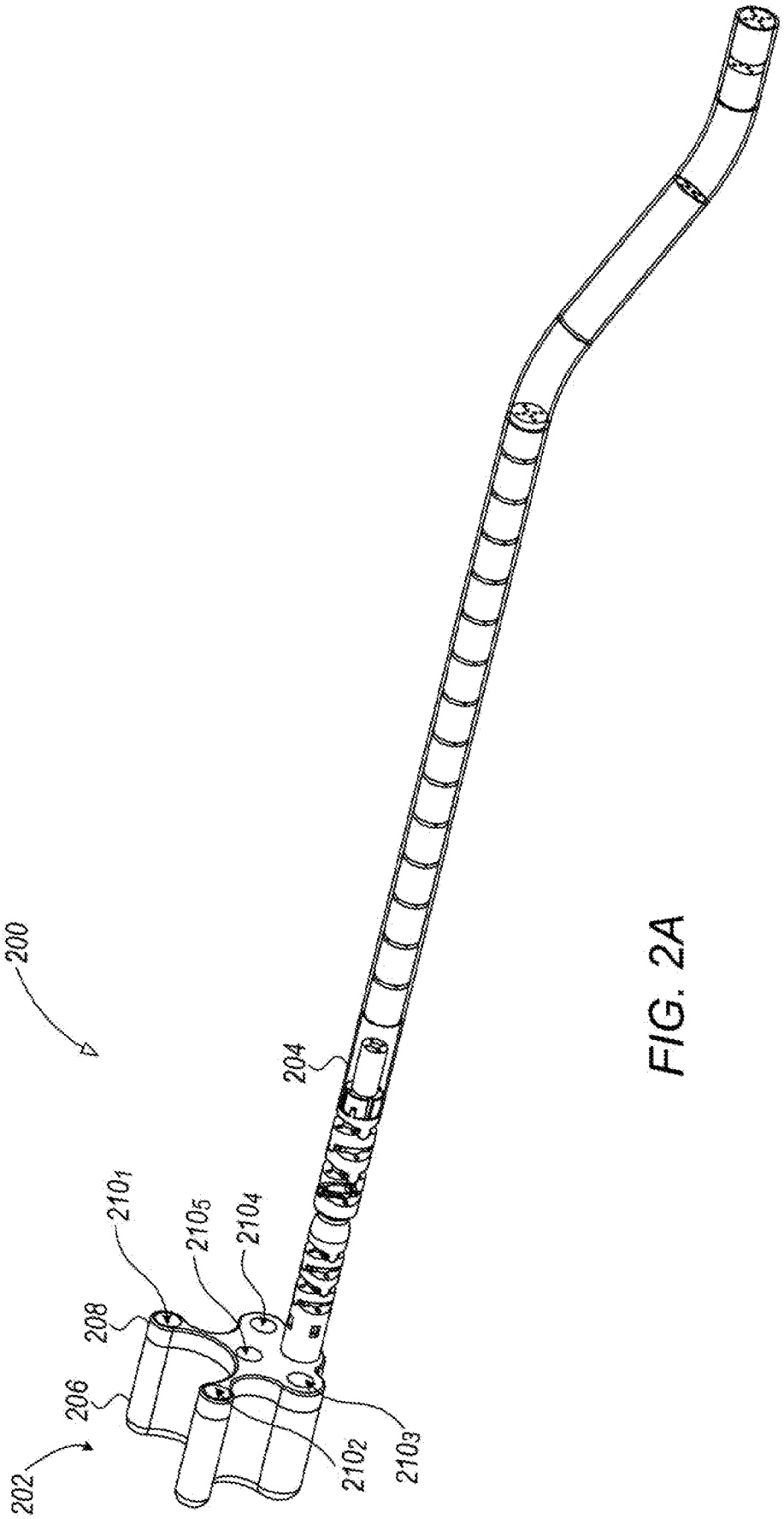


FIG. 2A

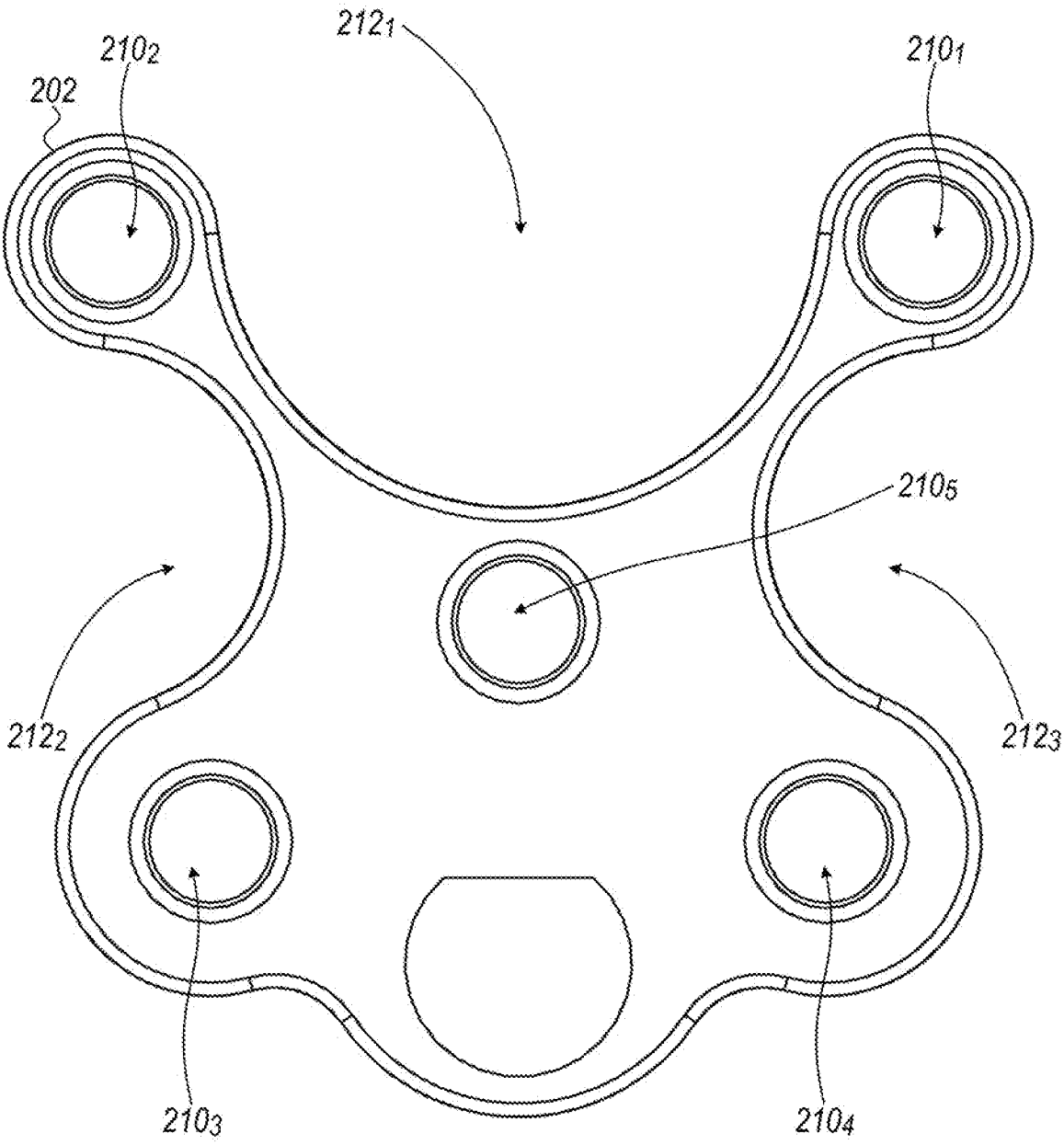


FIG. 2B

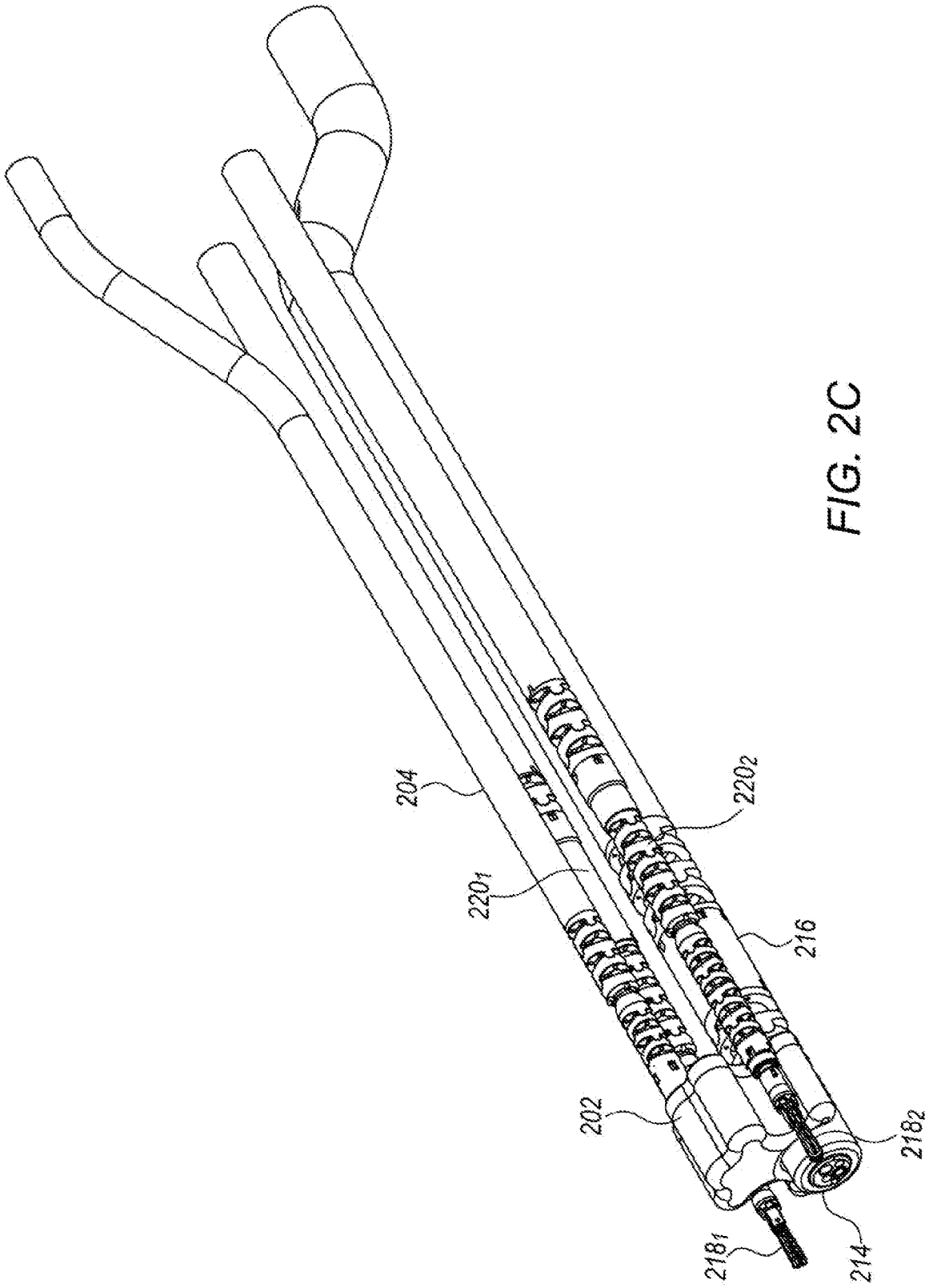


FIG. 2C

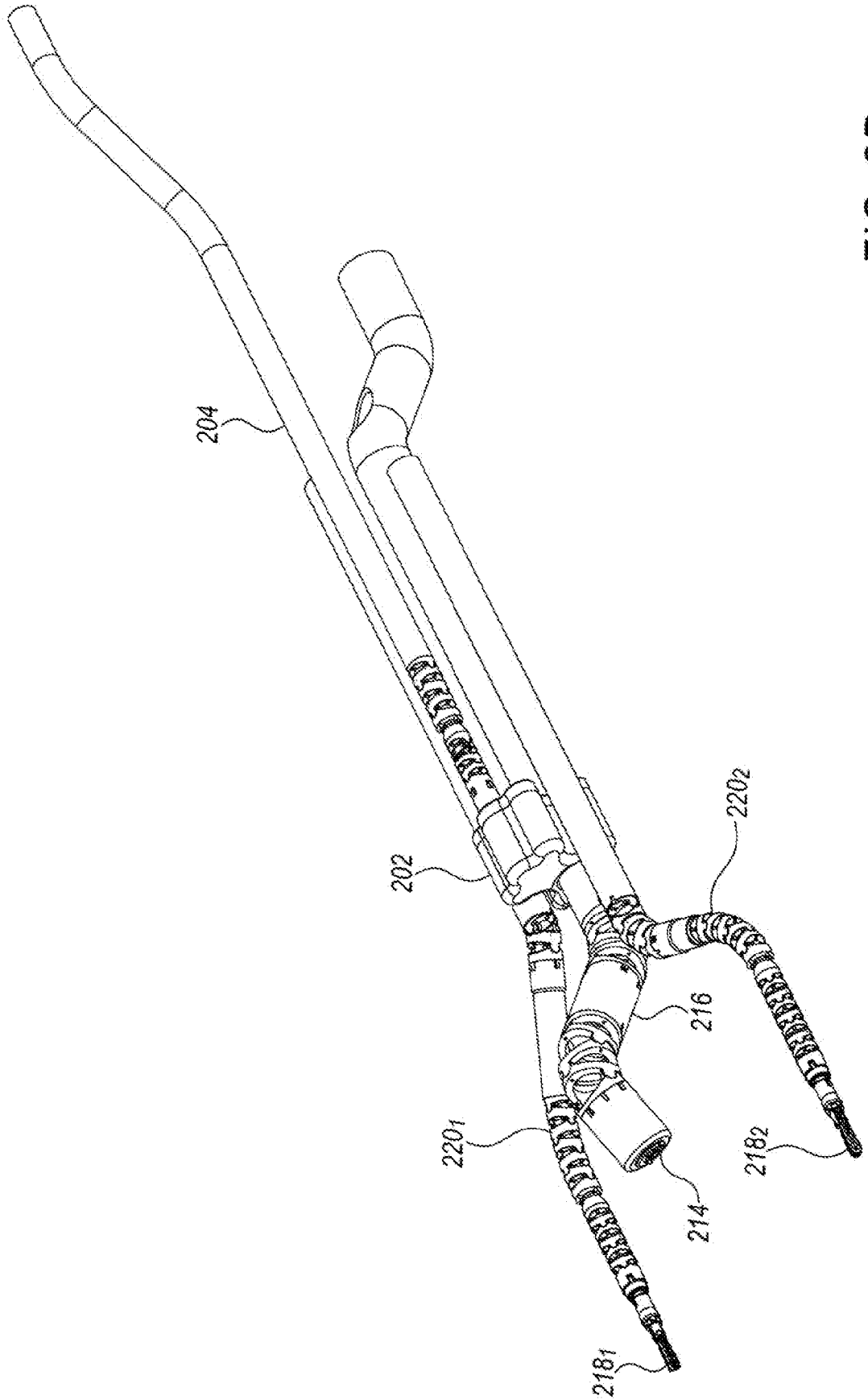


FIG. 2D

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2019/054640

A. CLASSIFICATION OF SUBJECT MATTER
IPC (20190101) A61B 34/30, A61B 17/00
CPC (20160201) A61B 34/30, A61B 2017/00477, A61B 2017/0046, A61B 2017/00464, A61B 17/00234
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC (20190101) A61B 34/30, A61B 17/00
CPC (20160201) A61B 34/30, A61B 2017/0046, A61B 2017/00464, A61B 2017/00477

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)
Databases consulted: Esp@cenet, Google Patents, Orbit
Search terms used: connector, tool, actuation, activation, interface, lock, longitudinal, rotational, robot, exchange, change, switch, store, surgical, manifold, medical, contain, arm, articulate, endoscope, catheter

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2016066999 A1 VALUEBIOTECH S R L 10 Mar 2016 (2016/03/10) The whole document	21-24
A	US 2007270640 A1 C.R. BARD, INC 22 Nov 2007 (2007/11/22) The whole document	1-20
A	US 2009221873 A1 COOK IRELAND LTD et al 03 Sep 2009 (2009/09/03) The whole document	1-20
A	WO 2018034965 A1 ETHICON LLC 22 Feb 2018 (2018/02/22) The whole document	1-20
A	EP 2772210 A2 ETHICON ENDO SURGERY INC 03 Sep 2014 (2014/09/03) The whole document	1-20

☐ 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
"D" document cited by the applicant in the international application
"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	Date of mailing of the international search report
07 Nov 2019	07 Nov 2019

Name and mailing address of the ISA:
Israel Patent Office
Technology Park, Bldg.5, Malcha, Jerusalem, 9695101, Israel
Email address: pctoffice@justice.gov.il

Authorized officer
ITIN Yulia
YuliaI@justice.gov.il
Telephone No. 972-2-5651680

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB2019/054640

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.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

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

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

International application No.
PCT/IB2019/054640

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:

Invention/s 1	An actuation connector for connecting with a tool.	Claim/s 1-20
Invention/s 2	A manifold apparatus for containing medical tools.	Claim/s 21-24

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2019/054640

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
US 2007270640 A1	22 Nov 2007	US 2007270640 A1	22 Nov 2007
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		IT MI20130666 A1	24 Oct 2014
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EP 2772210 A2	03 Sep 2014	EP 2772210 A2	03 Sep 2014
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		AU 2014223703 A1	06 Aug 2015
		AU 2014223703 B2	26 Oct 2017
		AU 2014223708 A1	06 Aug 2015
		AU 2014223708 B2	15 Feb 2018

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2019/054640

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
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		AU 2014223709 B2	22 Feb 2018
		AU 2014223712 A1	20 Aug 2015
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Information on patent family members

International application No.
PCT/IB2019/054640

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
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		CA 2903219 A1	04 Sep 2014
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		CN 105007835 A	28 Oct 2015
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		EP 2772205 A1	03 Sep 2014
		EP 2772206 A2	03 Sep 2014

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Information on patent family members

International application No.
PCT/IB2019/054640

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		EP 2772207 A2	03 Sep 2014
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PCT/IB2019/054640

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Information on patent family members

International application No.
PCT/IB2019/054640

Patent document cited search report	Publication date	Patent family member(s)		Publication Date
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		RU 2015141700	A	06 Apr 2017
		RU 2672520	C2	15 Nov 2018
		RU 2015141596	A	06 Apr 2017
		RU 2684177	C2	04 Apr 2019
		RU 2015141627	A	13 Apr 2017
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Information on patent family members

International application No.
PCT/IB2019/054640

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
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