ELECTROSURGICAL APPARATUS WITH SAFETY INSULATION FEATURES

FIELD OF THE INVENTION

[0001] The present disclosure relates to an electrosurgical apparatus and, more particularly, relates to energy-based surgical forceps for treating and/or cutting tissue and having insulation features which address dielectric requirements while also enhancing assembly and wear resistance capabilities of the forceps.

BACKGROUND

[0002] An electrosurgical apparatus applies high frequency electric current to cut, coagulate and/or cauterize tissue. These apparatuses must meet minimum IEC standards to ensure safe operation during treatment of tissue. A conventional electrosurgical apparatus is an electro-surgical forceps which is a plier-like instrument relying on mechanical action between its jaws to grasp, clamp, and constrict tissue. The jaws are adapted for relative movement, e.g., between open and approximated conditions. The jaws typically pivot at a pivot juncture which incorporates dielectric components, including ceramics, to address insulation concerns and improve wear resistance. Conventional methodologies may include securing the dielectric components relative to the jaw structure with the use of adhesives, brazing or mechanical arrangements. However, these methodologies are highly skill dependent often resulting in rejected units and/or providing a pivot juncture incapable of withstanding repetitive use.

SUMMARY

[0003] Accordingly, the present disclosure is directed an electrosurgical forceps which readily meets dielectric standards and incorporates a manufacturing process capable of securing the components of the forceps in an effective and efficient manner through, e.g., utilization of the insulative polymer coating. The forceps is highly resistance to wear and may be repeatedly reused without concern of degradation of its components.

[0004] In accordance with one exemplary embodiment of the present disclosure, an electrosurgical instrument includes first and second shaft members having respective first and second jaw members. The first and second shaft members are configured for relative movement about a coupling interface to position the first and second jaw members in open and approximated conditions. The first and second jaw members have tissue contacting surfaces configured to communicate electrosurgical energy therebetween. The coupling interface includes at least one insulative member configured to electrically isolate the first and second shaft members. A polymer coating is applied to overlap the at least one insulative member and the coupling interface to secure the at least one insulative member relative to the coupling interface.

[0005] In accordance with another exemplary embodiment, an electrosurgical instrument includes a first shaft member having a first interface segment and a first jaw member with a first tissue contacting surface, a second shaft member having a second interface segment and a second jaw member with a second tissue contacting surface configured to cooperate with the first tissue contacting surface to communicate electrosurgical energy therebetween, a coupling member extending between the first interface segment of the first shaft member and the second interface segment of the second shaft member to couple the first and second shaft members and being configured to permit relative movement of the first and second shaft members to position the first and second jaw members in open and approximated conditions, and first and second insulative shims respectively disposed adjacent the first and second interface segments. The first and second insulative shims are configured to electrically isolate the first and second shaft members. A polymer coating is applied to at least partially overlap the first insulative shim and the first interface segment and to at least partially overlap the second insulative shim and the second interface segment to respectively secure the first and second insulative shims relative to the first and second interface segments.

[0006] In embodiments, each of the first and second insulative shims includes a peripheral groove for accommodating the polymer coating. In some embodiments, the coupling member is a pivot member whereby the first and second shaft members are configured for relative pivotal movement about the pivot member to position the first and second jaw members in the open and the approximated conditions. In certain embodiments, first and second insulative pivot mounts are respectively disposed adjacent the first and second interface segments for reception of the pivot member. The polymer coating at least partially overlaps the first insulative pivot mount and the first interface segment and at least partially overlaps the second insulative pivot mount and the second interface segment to respectively secure the first and second insulative mounts relative to the first and second interface segments. In embodiments, at least one of the first or second insulative pivot mounts includes a peripheral groove for accommodating the polymer coating. In some embodiments, the first and second insulative shims each include an aperture for respective reception of the first and second insulative pivot mounts.

[0007] In another exemplary embodiment, a method for manufacturing an electrosurgical instrument includes providing first and second shaft members having respective first and second jaw members, mounting at least one insulative member adjacent a coupling interface of the first and second shaft members, depositing a polymer coating to overlap the at least one insulative member and the coupling interface to secure the at least one insulative member relative to the coupling interface, and coupling the first and second shaft members at the coupling interface whereby the first and second shaft members are configured for relative movement to position the first and second jaw members in open and approximated conditions.

[0008] In embodiments, mounting the at least one insulative member includes positioning a first insulative shim adjacent a first interface segment of the first shaft member and wherein depositing the polymer coating includes applying the polymer coating to overlap the first insulative shim and the first interface segment. In some embodiments, mounting the at least one insulative member includes positioning a second insulative shim adjacent a second interface segment of the second shaft member and wherein depositing the polymer coating includes applying the polymer coating to overlap the second insulative shim and the second interface segment. In certain embodiments, each of the first and second insulative shims include a peripheral groove and wherein applying the polymer coating includes directing the polymer coating into the peripheral grooves.

[0009] In embodiments, coupling the first and second shaft members includes mounting a pivot member between the first and second shaft members whereby the first and second shaft members are configured for relative pivotal movement to position the first and second jaw members in open and approximated conditions. In some embodiments, mounting the at least one insulative member includes positioning a first insulative pivot mount adjacent the first insulative shim and positioning a second insulative pivot mount adjacent the second insulative shim and wherein mounting the pivot member includes inserting the pivot member through the first and second insulative pivot mounts. In certain embodiments, depositing the polymer coating includes applying the polymer coating to overlap the first insulative pivot mount and the first interface segment, and applying the polymer coating to overlap the second insulative pivot mount and the second interface segment. In embodiments, at least one of the first or second insulative pivot mounts includes a peripheral groove and wherein applying the polymer coating includes directing the polymer coating into the peripheral groove.

[0010] Other features and advantages of the present disclosure will be better appreciated by the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Various aspects and features of the present disclosure are described herein with reference to the drawings wherein corresponding reference characters indicate corresponding parts throughout the drawings, and wherein:

[0012] FIGS. 1A-1B are perspective views of an electrosurgical instrument in accordance with an exemplary embodiment of the present disclosure depicted in the approximated and open conditions, respectively;

[0013] FIG. 2 is an exploded perspective view of the electrosurgical instrument illustrating the first and second shaft members having respective first and second jaw members, the first and second insulative shims and the first and second insulative pivot mounts;

[0014] FIGS. 3A-3B are top and side cross-sectional views of the first insulative shim;

[0015] FIGS. 4A-4B are top and side cross-sectional views of the second insulative shim;

[0016] FIGS. 5A-5B are top and side cross-sectional views of the first insulative pivot mount;

[0017] FIGS. 6A-6B are top and side cross-sectional views of the second insulative pivot mount;

[0018] FIG. 7 is a flow chart illustrating an exemplary method of manufacture of the electrosurgical instrument;

[0019] FIGS. 8A-8B are views illustrating positioning the first and second insulative shims onto the respective first and second shaft members in accordance with the exemplary method of manufacture of the electrosurgical instrument;

[0020] FIGS. 9A-9B are views illustrating positioning the first and second insulative pivot mounts onto the respective first and second shaft members in accordance with the exemplary method of manufacture of the electrosurgical instrument;

[0021] FIGS. 10A-10B are views illustrating the first and second insulative shims secured onto the respective first and second shaft members subsequent to application of the polymer coating in accordance with the exemplary method of manufacture of the electrosurgical instrument;

[0022] FIGS. 11A-11B are views illustrating the first and second insulative pivot mounts secured onto the respective first and second shaft members subsequent to application of the polymer coating in accordance with the exemplary method of manufacture of the electrosurgical instrument; and

[0023] FIG. 12 is a perspective view in cross-section illustrating the second insulative shim and the second pivot mount secured relative to the second shaft member in accordance with the exemplary method of manufacture of the electrosurgical instrument.

DETAILED DESCRIPTION

[0024] In this disclosure, the term "proximal" refers to a portion of a structure closer to an operator, while the term "distal" refers to a portion of the same structure further from the operator. As used herein, the term "subject" refers to a human patient or animal. The term "operator" refers to a doctor (e.g., a surgeon), a nurse, and other clinicians or care providers, and may include support personnel.

[0025] Referring now to FIG. 1, an electrosurgical system 1 in accordance with an exemplary embodiment of the present disclosure is illustrated. The electrosurgical system 1 may include a surgical instrument such as a grasping instrument or forceps 10 releasably connectable to an electrosurgical energy source 1000. The forceps 10 is adapted for at least one of grasping, electrically sealing, and mechanically dissecting tissue and/or vessels in open and/or laparoscopic surgical procedures. The forceps 10 may be reusable, or alternatively, disposable after a single use. In embodiments, the forceps 10 is reusable and capable of withstanding one or more sterilization processes subsequent to each use.

[0026] With reference to FIGS. 1-2, the forceps 10 includes a first elongated shaft member 100 pivotably coupled to a second elongated shaft member 200. The first shaft member 100 includes proximal and distal end portions 102, 104, respectively, and the second elongated shaft member 200 includes proximal and distal end portions 202, 204, respectively. The proximal end portions 102, 202 of the first and second shaft members 100, 200 include first and second handle members 106, 206, respectively. The first and second handle members 106, 206 are configured to permit an operator to effect movement of one or both of the first and second shaft members 100, 200. The distal end portions 104, 204 of the first and second shaft members 100, 200 cooperate to define an end effector assembly having opposed first and second jaw members 108, 208. Each jaw member 108, 208 has respective tissue contacting surfaces 110, 210 (FIG. 1B) capable of transmitting electrical energy therebetween. FIGS. 1A and 1B illustrate the first and second jaw members 108, 208 in the approximated and open conditions, respectively, as effected through manipulation of the first and second handle members 106, 206.

[0027] The first and second handle members 106, 206 each define a finger hole 112, 212, respectively, for receiving a finger of an operator. In some embodiments, the first and second handle members 106, 206 are each monolithically formed with its respective shaft member 100, 200. Alternatively, the first and second handle members 106, 206 may be separate components secured to its respective shaft member 100, 200 through conventional methodologies including, e.g., via mechanical engagement, welding, molding, adhesion, etc.

[0028] With continued reference to FIGS. 1-2, the first and second shaft members 100, 200 include respective first and second interface segments 114, 214 where the first and second shaft members 100, 200 intersect and are pivotably coupled. The first and second interface segments 114, 214 each defines openings 116, 216 (FIG. 2) respectively therethrough for reception of a pivot pin 118 about which the first and second shaft members 100, 200 pivot.

The first shaft member 100 includes a first insulative shim 120 disposed adjacent the inner surface of the first interface segment 114 and a first insulative pivot mount 122 extending from the outer surface of the first interface segment 114 and through the opening 116 for accommodating the pivot pin 118. In embodiments, the inner surface of the first interface segment 114 may be correspondingly dimensioned to accommodate the first insulative shim 120 and establish an interference fit between the components. Similarly, the second shaft member 200 includes a second insulative shim 220 disposed adjacent the inner surface of the second interface segment 214 and a second insulative pivot mount 222 extending from the outer surface of the second interface segment 214 through the opening 216 for accommodating the pivot pin 118. In embodiments, the inner surface of the second interface 214 may be correspondingly dimensioned to accommodate the second insulative shim 220 and establish an interference fit between the components. A lock washer 124 is disposed adjacent the first insulative pivot mount 122 for coupling with the pivot pin 118 to secure the pivot pin 118 relative to the first and second shaft members 100, 200. The first and second insulative shims 120, 220 and the first and second insulative pivot mounts 122, 222 are formed from an electrically insulative material, such as a ceramic or a plastic, to electrically isolate the first and second jaws 108, 208. The pivot pin 118 and the lock washer 124 may also be fabricated from an insulative material.

[0029] Referring now to FIGS. 3A-3B, the first insulative shim 120 will be discussed. The first insulative shim 120 is substantially plate-like defining inner and outer surfaces 120a, 120b. The inner surface 120a is in opposition to the second insulative shim 220 and is depicted in FIG. 3A. The inner surface 120a of the first insulative shim 120 defines a peripheral groove 126 disposed at least along a peripheral segment of the first insulative shim 120. The peripheral groove 126 accommodates the polymer coating during the assembly process. In embodiments, the peripheral groove 126 may extend along the entire periphery of the first insulative shim 120. The outer surface 120b of the first insulative shim 120 may be substantially planar. An opening 128 extends through the first insulative shim for passage of at least the pivot pin 118.

[0030] Referring now to FIGS. 4A-4B, the second insulative shim 220 also is substantially plate-like defining inner and outer surfaces 220a, 220b. The inner surface 220a is in opposition to the first insulative shim 120 and is depicted in FIG. 4A. The inner surface 220a of the second insulative shim 220 also defines a peripheral groove 226 disposed at least along a peripheral segment of the first insulative shim 120 which accommodates the polymer coating. Alternatively, the peripheral groove 226 may extend along the entire periphery of the second insulative shim 220. The outer surface 220b of the second insulative shim 220 may be substantially planar. An opening 228 extends through the second insulative shim 220 also for passage of at least the pivot pin 118.

[0031] FIGS. 5A-5B illustrate the first insulative pivot mount 122. The first insulative pivot mount 122 includes a flange 130 and a cylindrical segment 132 depending from the flange 130. The cylindrical segment 132 is at least partially received within the opening 116 of the first interface segment 114 and possibly within the opening 128 of the first insulative shim 120. The flange 130 is at least partially accommodated in a correspondingly dimensioned recess 134 (FIG. 2) in the exterior of the first interface segment 114. The flange 130 includes a peripheral groove 136 extending along at least a peripheral segment of the flange

130, e.g., about the entire periphery of the flange 130. The peripheral groove 136 receives polymer coating during assembly.

[0032] FIGS. 6A-6B illustrate the second insulative pivot mount 222. The second insulative pivot mount 222 includes a flange 230 and a first cylindrical segment 232 extending from the flange 230 which is received within the opening 216 of the second interface segment 214 and a second cylindrical segment 234 (having a small diameter than the first cylindrical segment 232) which may be received within the opening 228 of the second insulative shim 220. The flange 230 is devoid of a peripheral groove on its outer surface. In the alternative, the flange 230 may incorporate a peripheral groove similar to the peripheral groove 136 of the first insulative pivot mount 122. The first cylindrical segment 232 defines a curved inner surface 236 which accommodates the head 118a of the pivot pin 118. (FIG. 2).

[0033] FIG. 7 is a flow chart 500 of one exemplary methodology for manufacturing the forceps 10 utilizing the aforedescribed first and second insulative shims 120, 220 and the first and second insulative pivot mounts 122, 222. In STEP 502, the first and second shaft members 100, 200 having respective first and second jaw members 108, 208 are provided. In STEP 504, the first and second insulative shims 120, 220 are respectively positioned on the inner surfaces of the respective first and second interface segments 114, 214. In STEP 506, and with reference to FIGS. 8A-8B, a first shim mask 600 is applied to the first insulative shim 120 and a second shim mask 700 is applied to the second insulative shim 220. The first shim mask 600 is dimensioned to cover the entire first insulative shim 120 with the exception of the peripheral groove 126 which is left unexposed. The second shim mask 700 is dimensioned to also cover the entire second insulative shim 220 with the exception of the peripheral groove 226 also left unexposed.

[0034] With reference again to the flow chart of FIG. 7, the process is repeated for each of the first and second insulative pivot mounts 122, 222. In particular, the first and second insulative pivot mounts 122, 222 are positioned relative to the external surfaces of the first and second interface segments 114, 214 and at least partially introduced through the respective openings 116, 216 in the first and second interfaces segments 114, 214. (STEP 508) Thereafter, the first and second pivot masks 800, 900 are positioned on the respective first and second insulative pivot mounts 122, 222 as depicted in FIGS. 9A-9B (STEP 510) The first mask 800 defines a diameter which covers the flange 130 of the first insulative pivot mount 122 with the exception of the peripheral groove 136 which is left exposed. The second mask 900 defines a diameter which is less than the diameter of the flange 230 of the second insulative pivot mount 222 to leave a peripheral or circumferential area 230a of the flange 230 exposed.

[0035] With the first and second shim masks 600, 700 and the first and second pivot masks 800, 900 in position relative to the respective first and second interface segments 114, 214, the components may be optionally secured relative to each other with a fixture or the like. (STEP 512) Thereafter, a polymer coating is deposited onto at least the first and second interface segments 114, 214, including the outer and inner surfaces thereof, such that the polymer coating extends within, e.g., overlaps, the exposed peripheral groove 126 of the first insulative shim 120 and the exposed peripheral groove 226 of the second insulative shim 220 and overlaps the exposed peripheral groove 136 of the first insulative pivot mount 122 and the exposed periphery 230a of the second insulative pivot mount 222. (STEP 514) Upon curing of the polymer coating (STEP 516), the first and second shim masks 600, 700 and the first and second mount masks 800, 900 are removed (STEP 518) leaving the first and second insulative shims 120, 220 secured to the inner surfaces of the first and second interface segments 114, 214 via the polymer coating, and the first and second insulative pivot mounts 122, 222 secured to the outer surfaces of the first and second interface segments 114, 214 via the polymer coating.

[0036] FIGS. 10A-10B illustrate the first and second insulative shims mounted to their respective first and second interface segments 114, 214 via the polymer coating 2000. In FIGS. 10A-10B, the polymer coating 2000 is depicted covering the peripheral grooves 126, 226 of the first and second insulative shims 120, 220 and not overlapping into the respective interface segments 114, 214 for illustrative purposes. However, it is to be appreciated that the polymer coating 2000 encompasses the respective interface segments 114, 214 and, in embodiments, encompasses both the inner and outer surfaces of the first and second interface segments 114, 214. Similarly, FIGS. 11A-11B illustrate the polymer coating 2000 covering only the peripheral groove 136 of the first insulative pivot mount 122 and the peripheral area 230a of the second insulative pivot mount 222. However, the polymer coating 2000 would encompass, e.g., a substantial area of, both the inner and outer surfaces of the first and second interface segments 114, 214.

[0037] In some embodiments, the polymer coating may be initially applied to the first and second interface segments 114, 214 to secure (either temporarily or permanently) the respective first and second insulative shims 120, 220 and the first and second insulative pivot mounts 122, 222 prior to coating the entire forceps 10 (with the exception of the tissue contacting surfaces 110, 210 of the first and second jaw members 108, 208). In other embodiments, the polymer coating is applied in a single step to coat the forceps 10 along with the first and second interface segments 114, 214 thereby simultaneously securing the first and second insulative shims 120, 220 and the first and second insulative pivot mounts 122, 222 during coating of the entire forceps 10. With the polymer coating cured, the first and second shaft members 100, 200 members may be coupled together with the pivot pin 118 and the lock washer 124 thereby providing the assembled forceps.

[0038] FIG. 12 is a perspective view in cross-sectional illustrating the second interface segment 214 of the second shaft member 200 subsequent to securing the second insulative shim 220 and the second insulative pivot mount 222 via the methodology of the present disclosure. As shown, the polymer coating 2000 extends from within the exposed peripheral groove 226 of the second insulative shim 220 to at least partially overlap the second interface segment 214, and also extends to cover the exposed peripheral or circumferential area 230a of the flange 230 of the second insulative pivot mount 222 and also overlap the second interface segment 214. The first insulative shim 120 and the first insulative pivot mount 122 of the first shaft member would be secured to the first interface segment 114 in a similar manner. FIG. 12 also depicts the stainless steel substrate 100a of the first shaft 100.

[0039] While several embodiments of the disclosure have been shown in the drawings and described herein, it is not intended that the disclosure be limited thereto, as it is intended that the disclosure be as broad in scope as the art will allow and that the specification be read likewise. For example, some of the method steps may be combined or performed in a different sequence or order, be optional. Therefore, the above description should not be construed as limiting, but merely as examples of particular embodiments. Those skilled in the art will envision other modifications within the scope and spirit of the claims appended hereto.

WHAT IS CLAIMED IS:

1. An electrosurgical instrument comprising:

first and second shaft members having respective first and second jaw members, the first and second shaft members configured for relative movement about a coupling interface to position the first and second jaw members in open and approximated conditions, the first and second jaw members having tissue contacting surfaces configured to communicate electrosurgical energy therebetween, the coupling interface including at least one insulative member configured to electrically isolate the first and second shaft members; and

a polymer coating overlapping the at least one insulative member and the coupling interface to secure the at least one insulative member relative to the coupling interface.

2. An electrosurgical instrument comprising:

a first shaft member including a first interface segment and a first jaw member having a first tissue contacting surface;

a second shaft member including a second interface segment and a second jaw member having a second tissue contacting surface configured to cooperate with the first tissue contacting surface to communicate electrosurgical energy therebetween;

a coupling member extending between the first interface segment of the first shaft member and the second interface segment of the second shaft member to couple the first and second shaft members and being configured to permit relative movement of the first and second shaft members to position the first and second jaw members in open and approximated conditions;

first and second insulative shims respectively disposed adjacent the first and second interface segments, the first and second insulative shims configured to electrically isolate the first and second shaft members; and

a polymer coating at least partially overlapping the first insulative shim and the first interface segment and at least partially overlapping the second insulative shim and the second interface segment to respectively secure the first and second insulative shims relative to the first and second interface segments.

3. The electrosurgical instrument according to claim 2 wherein each of the first and second insulative shims include a peripheral groove for accommodating the polymer coating.

4. The electrosurgical instrument according to claim 3 wherein the coupling member is a pivot member, the first and second shaft members configured for relative pivotal movement about the pivot member to position the first and second jaw members in the open and the approximated conditions.

5. The electrosurgical instrument according to claim 4 including first and second insulative pivot mounts respectively disposed adjacent the first and second interface segments for reception of the pivot member, and further including a polymer coating at least partially overlapping the first insulative pivot mount and the first interface segment and at least partially overlapping the second insulative pivot mount and the second interface segment to respectively secure the first and second insulative mounts relative to the first and second interface segments.

6. The electrosurgical instrument according to claim 5 wherein at least one of the first or second insulative pivot mounts include a peripheral groove for accommodating the polymer coating.

7. The electrosurgical instrument according to claim 5 wherein the first and second insulative shims each include an aperture for respective reception of the first and second insulative pivot mounts.

8. A method for manufacturing an electrosurgical instrument, comprising:

providing first and second shaft members having respective first and second jaw members;

mounting at least one insulative member adjacent a coupling interface of the first and second shaft members;

depositing a polymer coating to overlap the at least one insulative member and the coupling interface to secure the at least one insulative member relative to the coupling interface;

coupling the first and second shaft members at the coupling interface whereby the first and second shaft members are configured for relative movement to position the first and second jaw members in open and approximated conditions.

9. The method according to claim 8 wherein mounting the at least one insulative member includes positioning a first insulative shim adjacent a first interface segment of the first shaft member and wherein depositing the polymer coating includes applying the polymer coating to overlap the first insulative shim

and the first interface segment.

10. The method according to claim 9 wherein mounting the at least one insulative member includes positioning a second insulative shim adjacent a second interface segment of the second shaft member and wherein depositing the polymer coating includes applying the polymer coating to overlap the second insulative shim and the second interface segment.

11. The electrosurgical instrument according to claim 10 wherein each of the first and second insulative shims include a peripheral groove and wherein applying the polymer coating includes directing the polymer coating into the peripheral grooves.

12. The method according to claim 11 wherein coupling the first and second shaft members includes mounting a pivot member between the first and second shaft members whereby the first and second shaft members are configured for relative pivotal movement to position the first and second jaw members in open and approximated conditions.

13. The method according to claim 12 wherein mounting the at least one insulative member includes positioning a first insulative pivot mount adjacent the first insulative shim and positioning a second insulative pivot mount adjacent the second insulative shim and wherein mounting the pivot member includes inserting the pivot member through the first and second insulative pivot mounts.

14. The method according to claim 13 wherein depositing the polymer

coating includes applying the polymer coating to overlap the first insulative pivot mount and the first interface segment, and applying the polymer coating to overlap the second insulative pivot mount and the second interface segment.

15. The electrosurgical instrument according to claim 14 wherein at least one of the first or second insulative pivot mounts include a peripheral groove and wherein applying the polymer coating includes directing the polymer coating into the peripheral groove.

ABSTRACT

An electrosurgical instrument includes first and second shaft members having respective first and second jaw members. The first and second shaft members are configured for relative movement about a coupling interface to position the first and second jaw members in open and approximated conditions. The first and second jaw members have tissue contacting surfaces configured to communicate electrosurgical energy therebetween. The coupling interface includes at least one insulative member configured to electrically isolate the first and second shaft members. A polymer coating overlaps the at least one insulative member and the coupling interface to secure the at least one insulative member relative to the coupling interface.

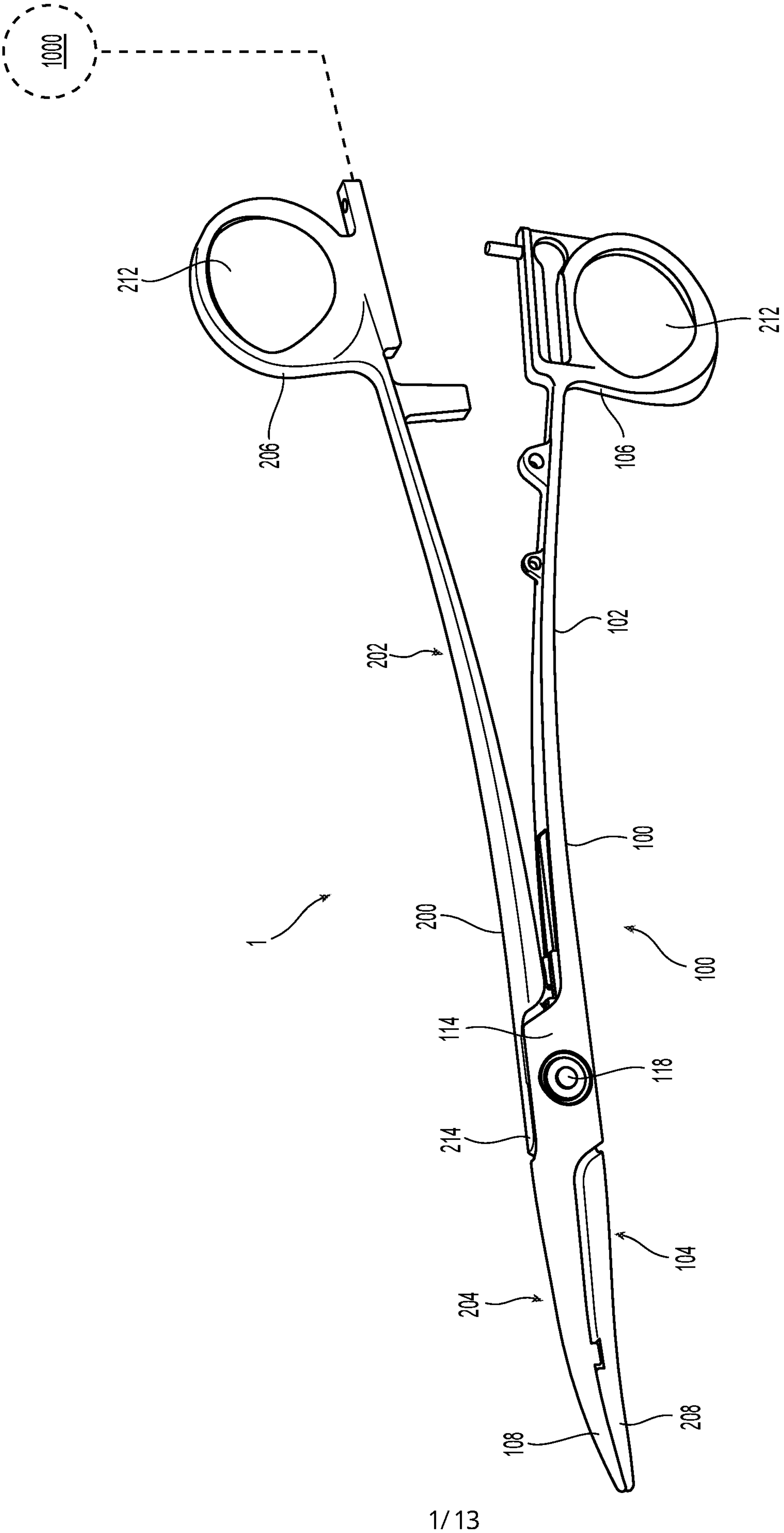
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Fig. 1A

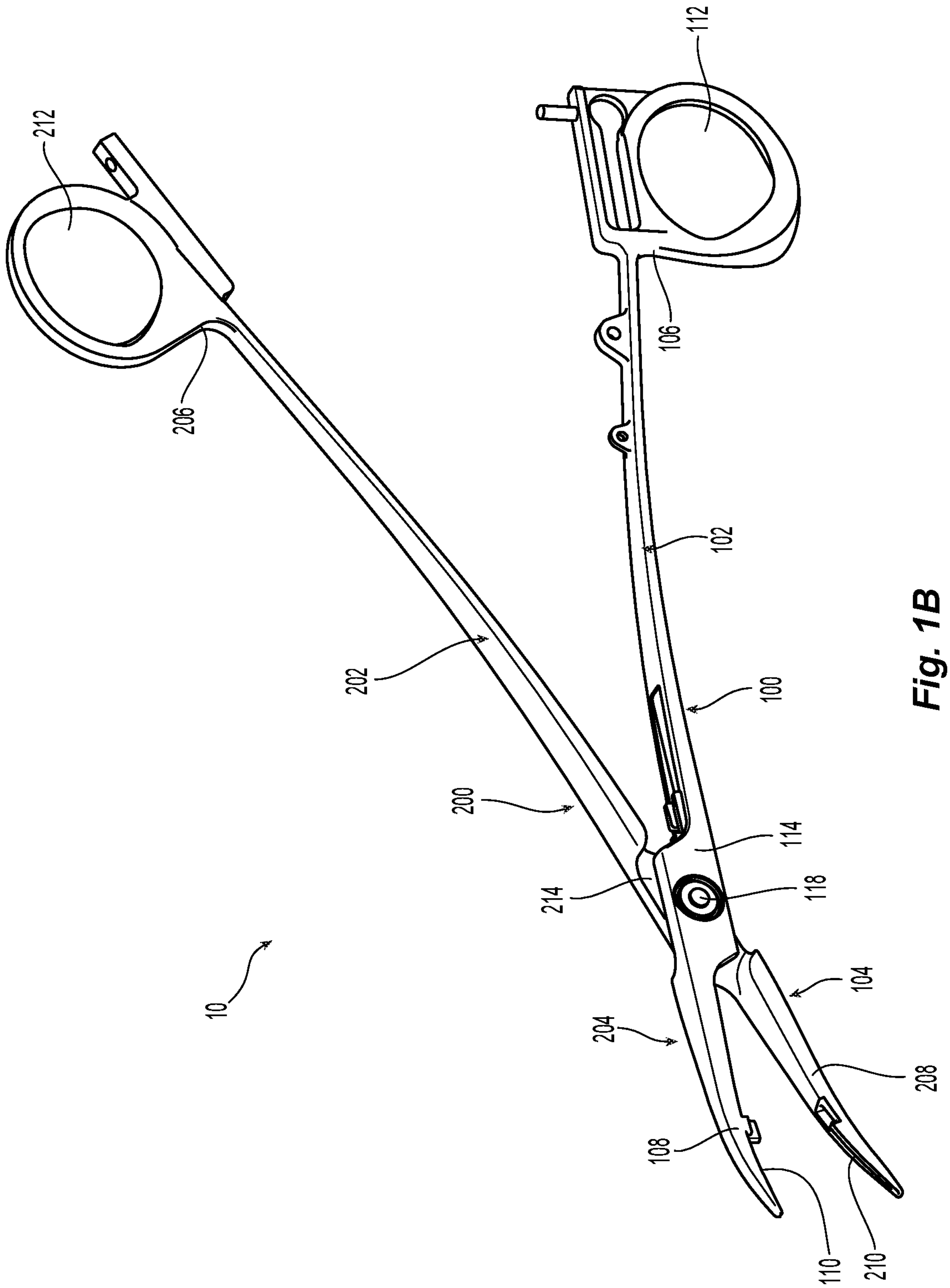
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Fig. 1B

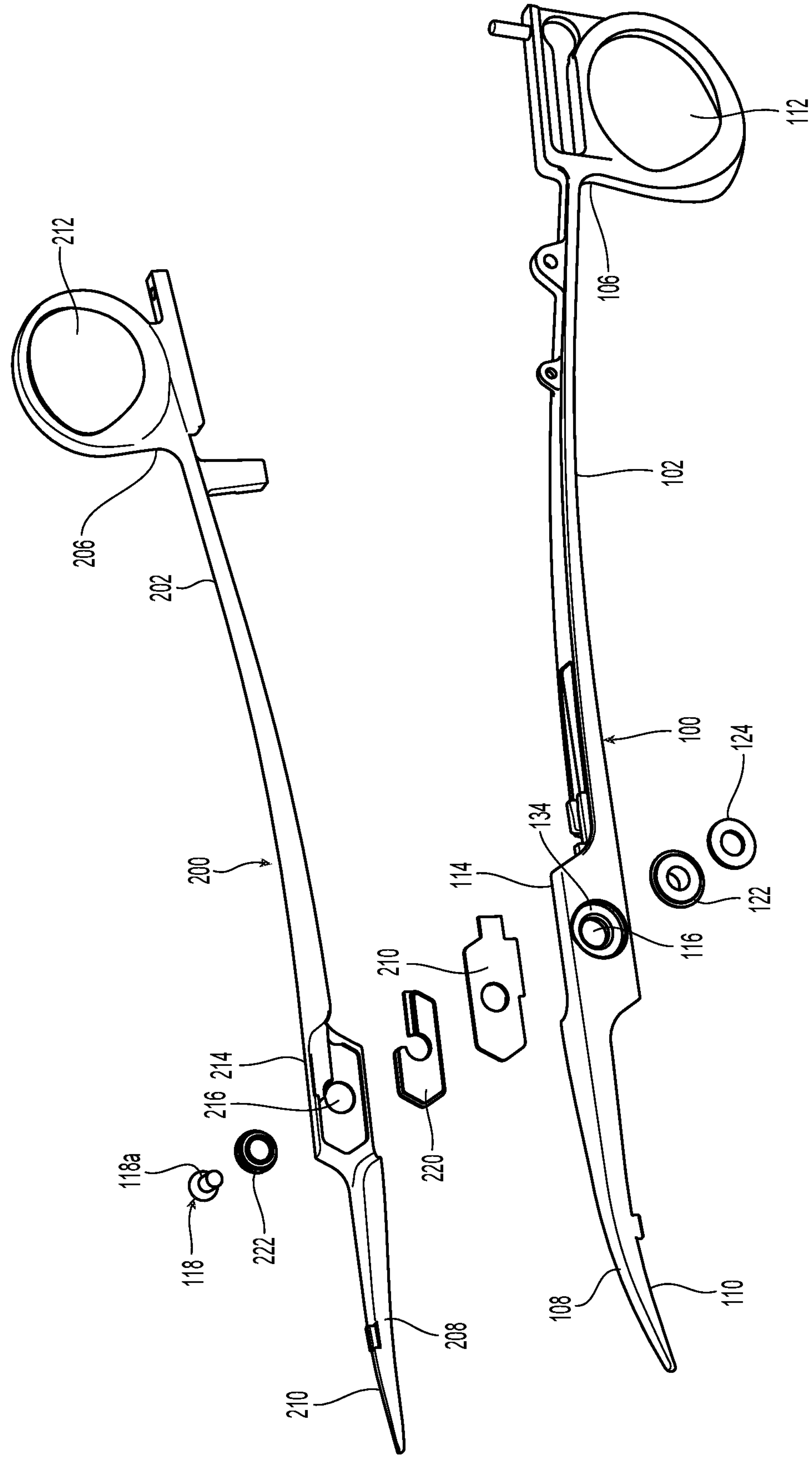
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Fig. 2

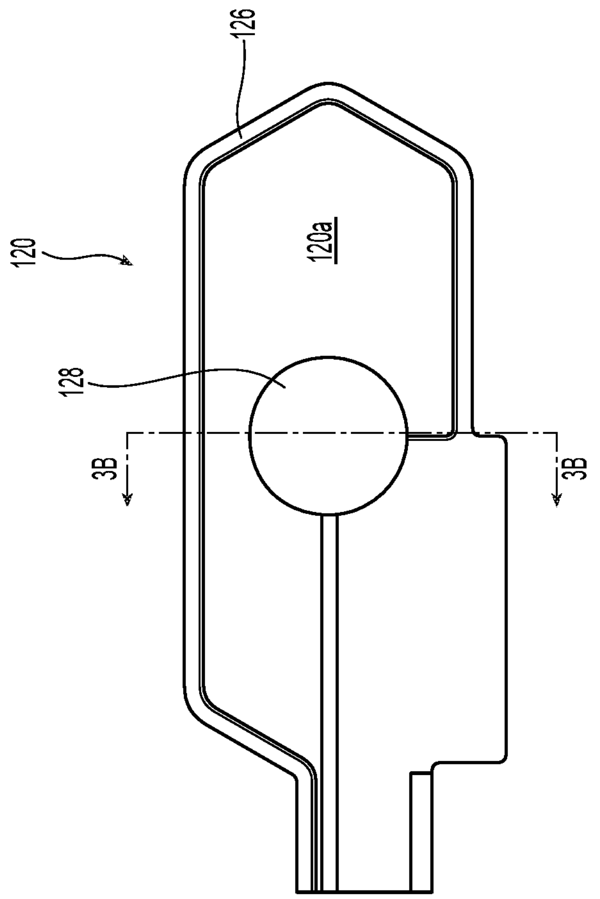

Fig. 3A

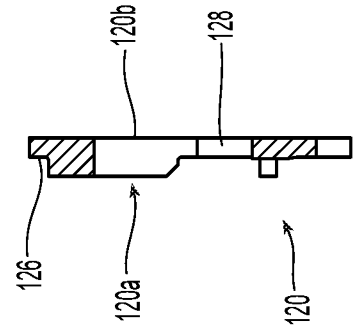

Fig. 3B

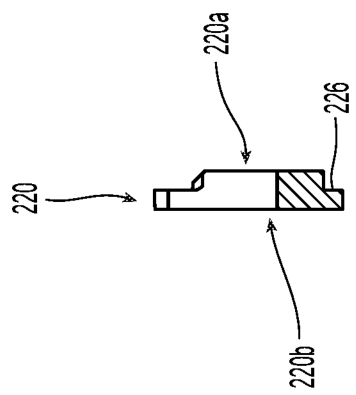

Fig. 4B

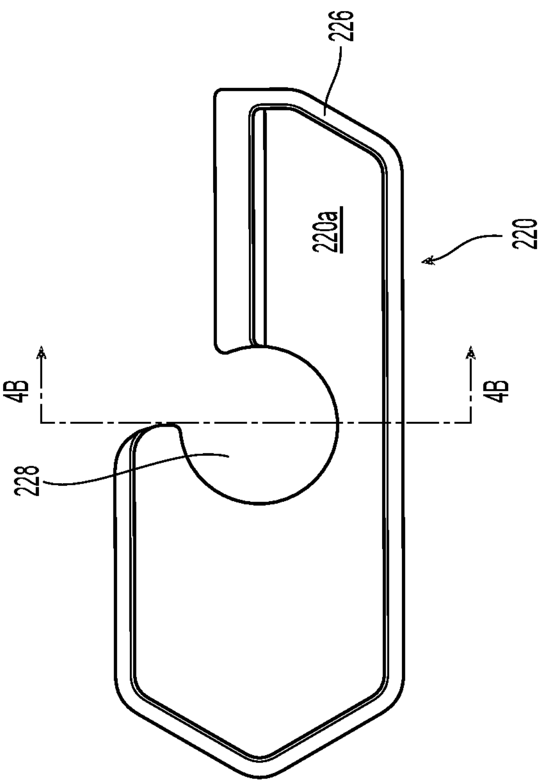

Fig. 4A

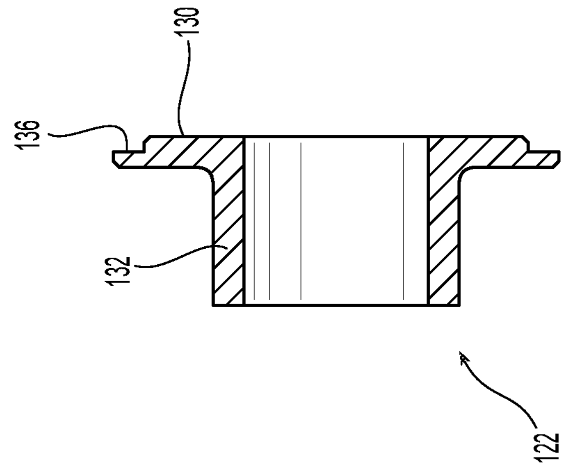

Fig. 5B

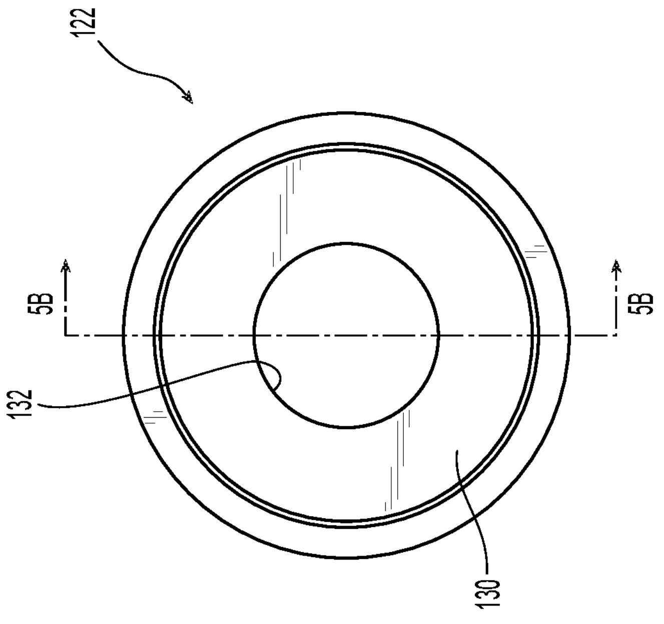

Fig. 5A

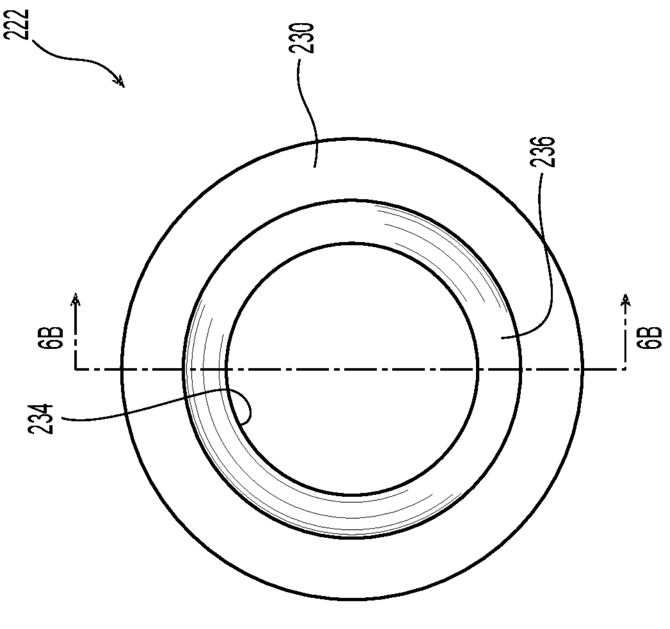

Fig. 6A

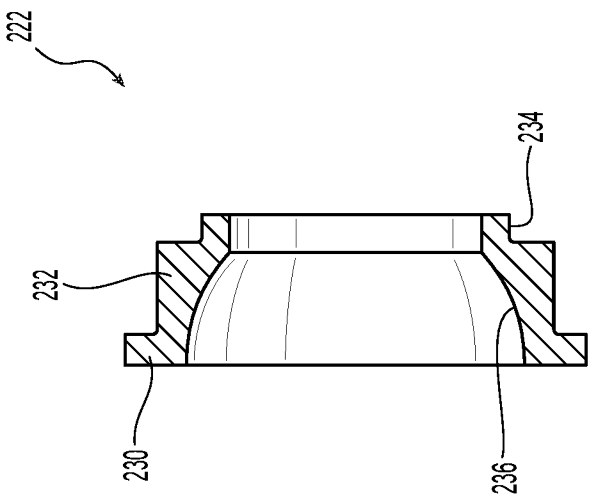

Fig. 6B

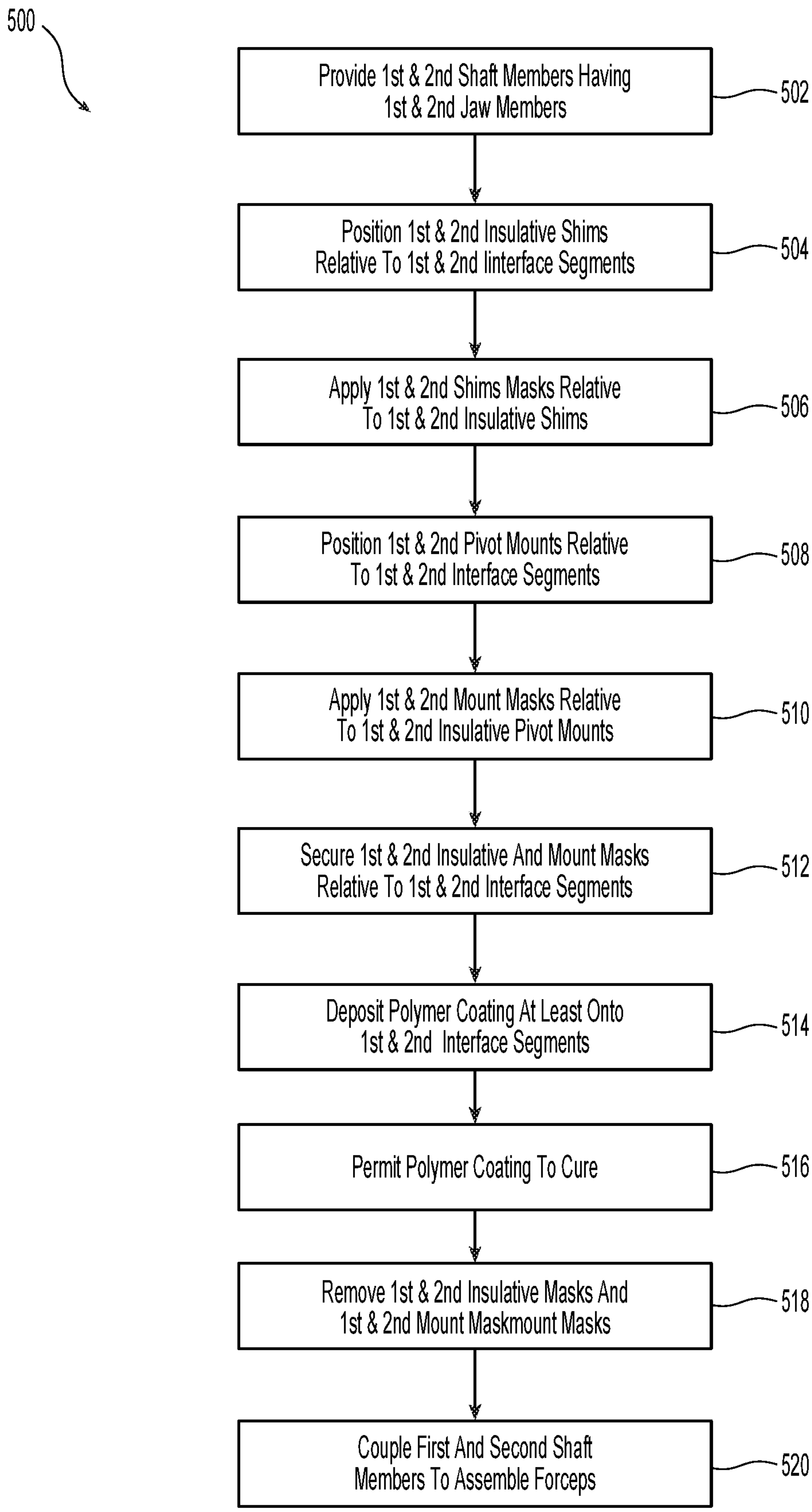
500
Provide 1st & 2nd Shaft Members Having 1st & 2nd Jaw Members
502
Position 1st & 2nd Insulative Shims Relative To 1st & 2nd Iinterface Segments
504
Apply 1st & 2nd Shims Masks Relative To 1st & 2nd Insulative Shims
506
Position 1st & 2nd Pivot Mounts Relative To 1st & 2nd Interface Segments
508
Apply 1st & 2nd Mount Masks Relative To 1st & 2nd Insulative Pivot Mounts
510
Secure 1st & 2nd Insulative And Mount Masks Relative To 1st & 2nd Interface Segments
512
Deposit Polymer Coating At Least Onto 1st & 2nd Interface Segments
514
Permit Polymer Coating To Cure
516
Remove 1st & 2nd Insulative Masks And 1st & 2nd Mount Maskmount Masks
518
Couple First And Second Shaft Members To Assemble Forceps
520

Fig. 7

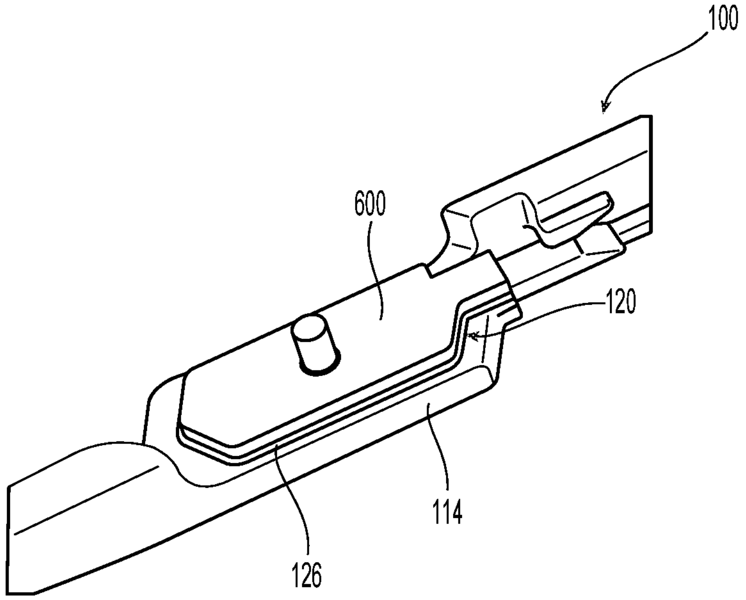

Fig. 8A

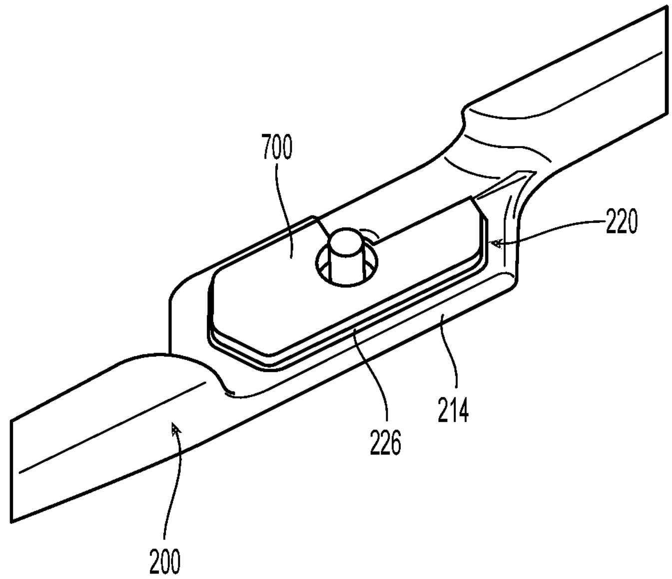

Fig. 8B

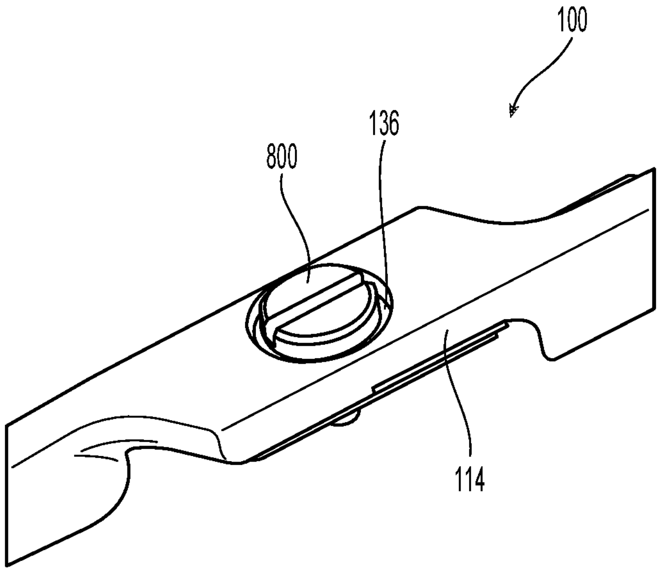

Fig. 9A

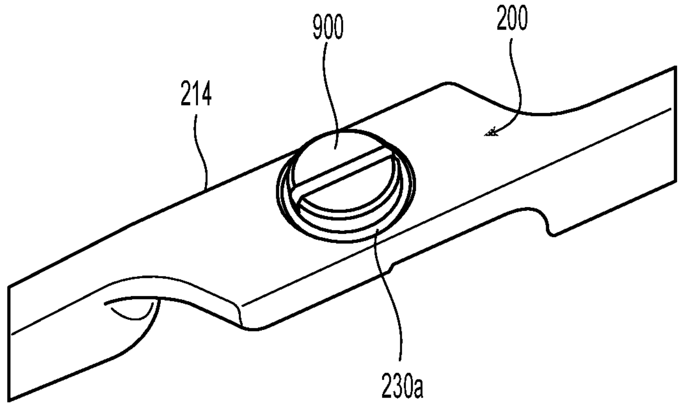

Fig. 9B

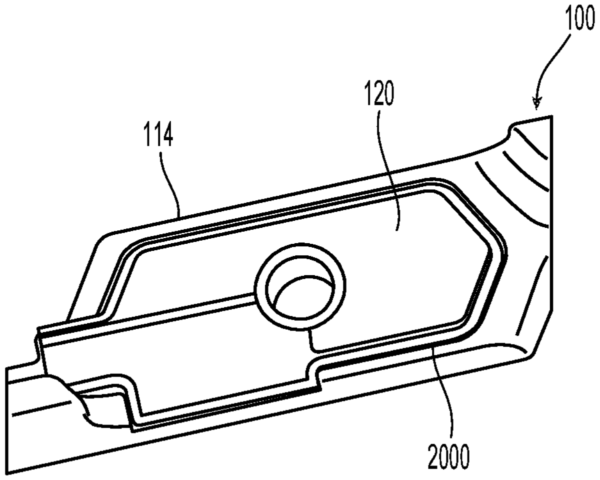

Fig. 10A

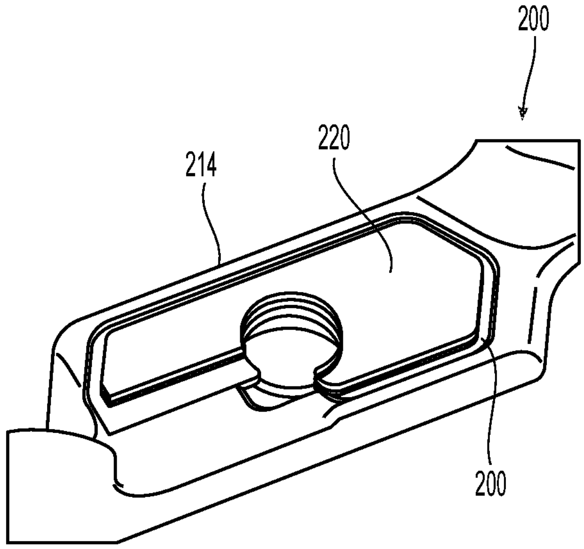

Fig. 10B

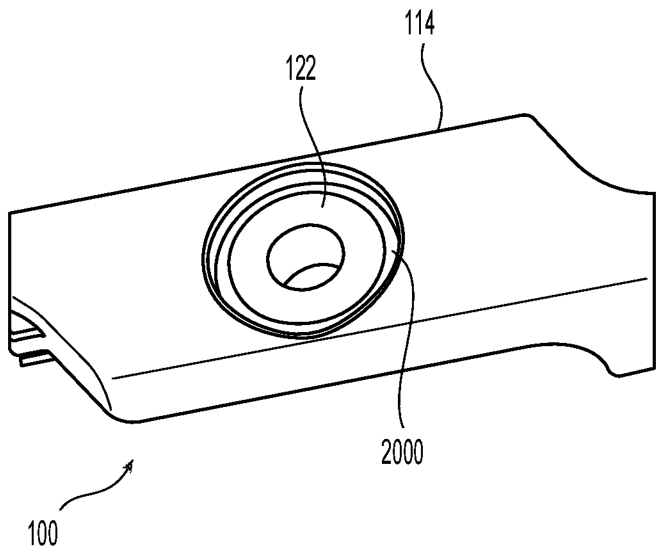

Fig. 11A

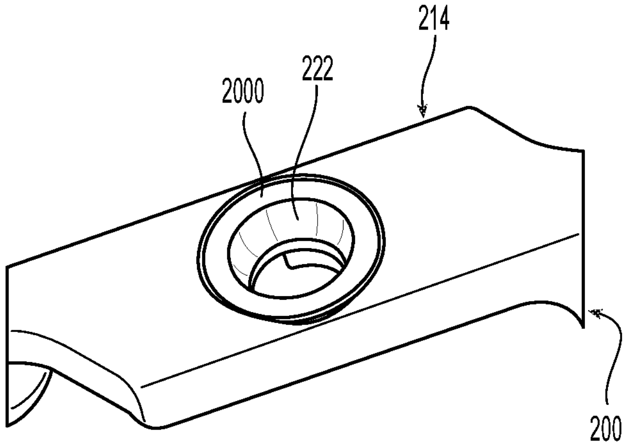

Fig. 11B

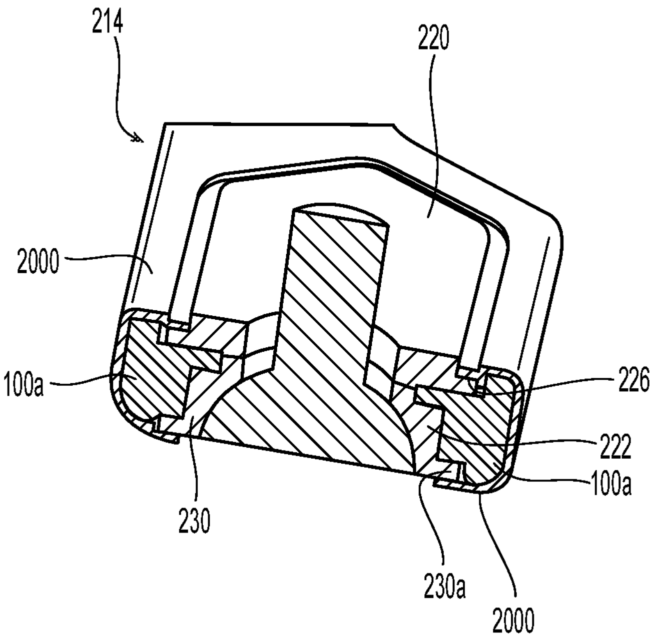

Fig. 12