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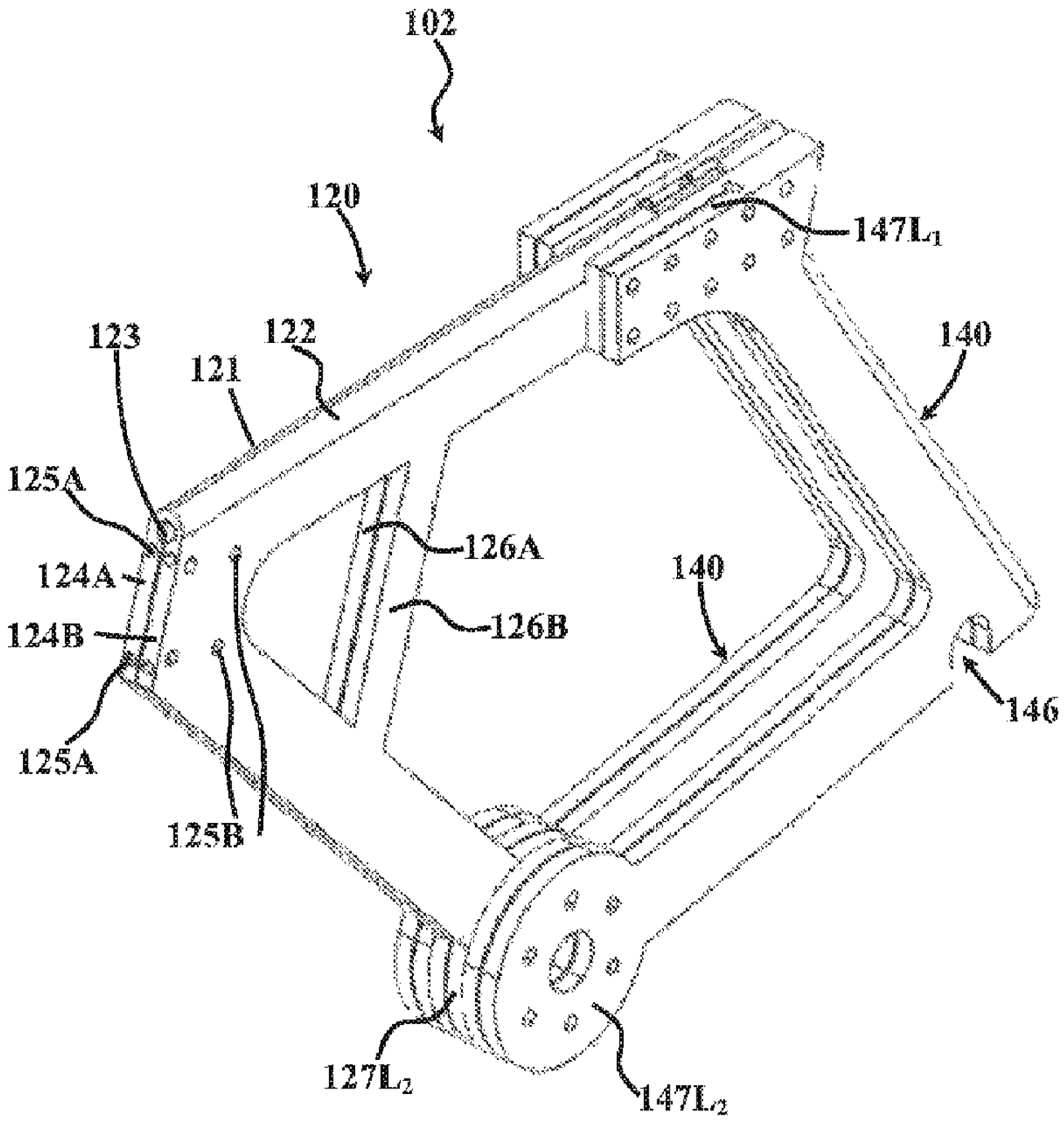
(54) Title: CARDBOARD-BASED STRUCTURE



(57) Abrégé/Abstract:
The invention provides cardboard-based structures comprising two or more, generally elongated elements angled with respect to one another and being cut out of a multi-layered cardboard-based piece that comprises at least two layers of a single cardboard sheet folded about a longitudinal reinforcing member. The invention further provides frames, preferably human-powered vehicle frames, constructed from structures of the invention, as well as methods for producing structures of the invention.

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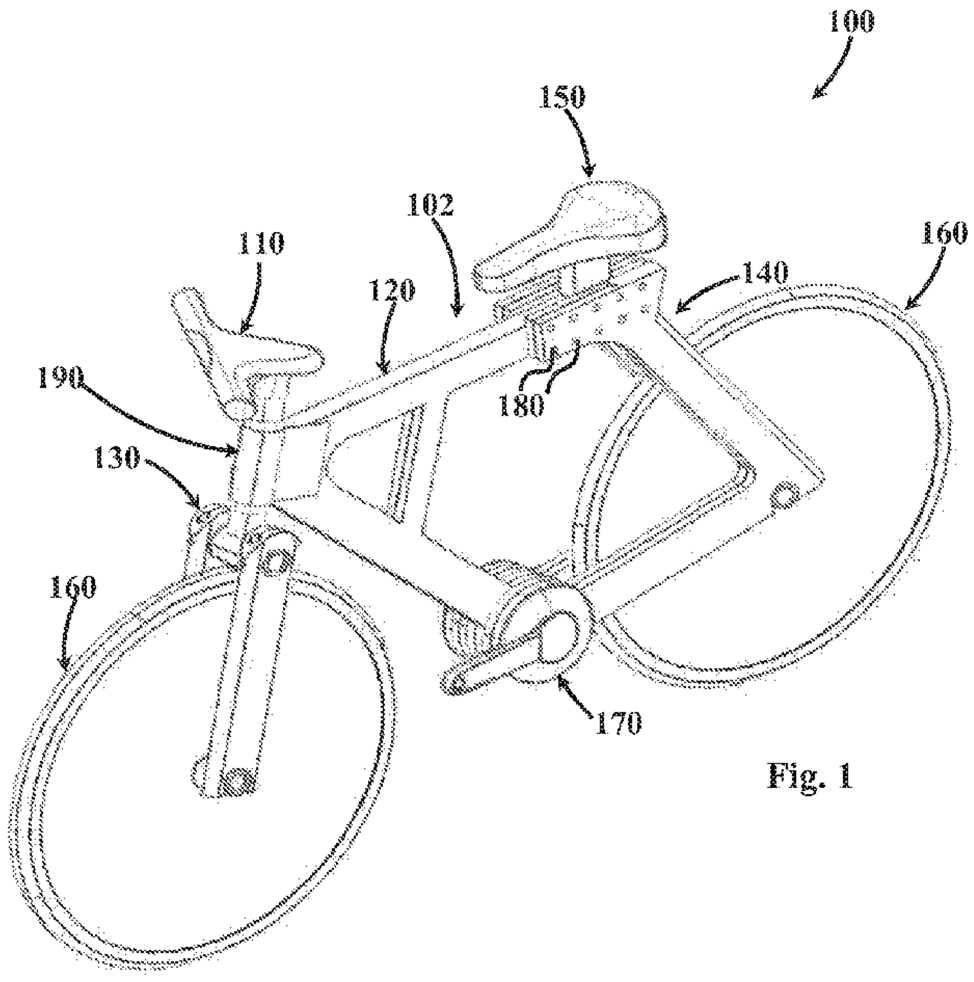

Fig. 1

(57) Abstract: The invention provides cardboard-based structures comprising two or more, generally elongated elements angled with respect to one another and being cut out of a multi- layered cardboard-based piece that comprises at least two layers of a single cardboard sheet folded about a longitudinal reinforcing member. The invention further provides frames, preferably human-powered vehicle frames, constructed from structures of the invention, as well as methods for producing structures of the invention.

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CARDBOARD-BASED STRUCTURE

TECHNOLOGICAL FIELD AND BACKGROUND

The present invention relates to a structure made of or comprising cardboard that may, for example, be a component in a frame, e.g. a frame of a human-powered vehicle such as a bicycle.

WO11067742 discloses a human-powered land vehicle sufficiently rigid so as to transport a human rider. The vehicle is constructed from pulpably recyclable and shreddably recyclable materials.

GENERAL DESCRIPTION

The present invention provides a structure made of or comprising cardboard. Typically, the structure provided by the present invention comprises cardboard as a major component. At times, the structure may also comprise some reinforcing members or elements made of material other than cardboard, e.g. wood, or may comprise cardboard-based elements that are articulated to one another by connecting elements made of material other than cardboard, e.g. wood, metal, etc.

Provided by one aspect of the invention is a structure comprising two or more generally elongated elements, i.e. at least a first and a second elongated elements, angled with respect to one another that are cut out of a multi-layered cardboard-based piece. The term "*generally elongated*" should be understood to mean that the element has a length dimension that is significantly more prominent than other dimensions of the element. The generally elongated element may have an overall shape resembling a rod, a beam, etc.

The cardboard-based piece comprises at least two layers of a single cardboard sheet that is folded about a longitudinal reinforcing member to thereby define a two-layered structure with longitudinal fold region at its end, said region comprising the

reinforcing member embraced by portions of the cardboard sheet. At least a first of said elongated elements extends along and comprises at least a portion of the fold region.

The cardboard sheet may be of a kind comprising (i) at least one low-density layer made of paper, heavy duty paper or cardboard (for ease of reference the term *"paper"*, will be used hereinafter to refer collectively to paper, heavy duty paper or cardboard) arranged to define a plurality of cells or voids, e.g., formed by corrugated, fluted or otherwise loosely packed paper sheets or strips that define a plurality of voids therebetween, and comprising (ii) one or more liner cardboard sheets lined at one side or both sides of the low-density layers (namely sandwiching the low-density layer between them). Examples of such cardboard panels are such known as "*corrugated cardboard*", which consists of a fluted or corrugated paper panel(s) or strip and one or two flat linerboards at one or both (i.e. sandwiching) sides of the fluted or corrugated paper; and may also be such referred to as "*honeycomb cardboard*". The corrugated or honeycomb cardboard sheets may be single-walled or multi-walled cardboard sheets. These terms are also meant to encompass heavy-duty cardboard of various strengths, ranging from a simple arrangement of a single thick panel of paper to complex configurations featuring multiple corrugated, honeycomb and other layers.

According to one embodiment, the at least two elongated elements are integral with one another and are cut as a single integral structure out of said cardboard piece.

By another aspect, the present invention provides a method for manufacturing a structure made of or comprising cardboard. The method comprises folding a cardboard sheet about a longitudinal member to thereby form a generally planar two-layer cardboard-based piece with a longitudinal fold region at its edge. The structure is then cutout from the planar two-layer cardboard-based piece, the structure comprises at least two integral elongated elements angled with respect to one another, at least one of which two elements extends along said fold region.

The reinforcing member has typically a substantially rounded cross-section, e.g. circular, ellipsoid or oval cross-section. The reinforcing member is typically, though not exclusively, made of cardboard or wood. Other materials, such as plastic, metal, etc. are also possible.

The first elongated element may be made to comprise substantially all or only a portion of said fold region. By some embodiments, a single cardboard piece may be

used to produce two or a plurality of identical or different structures of the kind provided by the invention.

The reinforcing element that is embedded within the fold region typically extends the length of the first elongated element. By some embodiments of the invention, the structure also comprises a support element that extends between the first and the second elongated elements, typically angled with respect to both and providing additional reinforcement to the structure. The reinforcement element may also be made of cardboard and may typically also be cut out of said cardboard piece, *a priori* integral with the two elongated elements. However, it is also possible to construct a support element separately and connect it subsequently in a proper way to the two elongated elements.

The at least two elongated elements, even if integrally formed, may have free ends typically designed for connection to other structures or structural elements, e.g. by the use of appropriate connectors or connecting members, e.g. such that are formed or embedded within said structure.

By some embodiments of the invention, the first elongated element has a load-bearing or bend-resistance property significantly larger (e.g. at least about 5, 10, 15, and even at least about 20 times more) than that of the longitudinal reinforcing member. The structure of the invention is typically capable of supporting a load in a direction perpendicular to said first elongated element (when said first element is supported at its two ends), which is at least about 10, 15, 20 and even at least about 25 times the weight of such structure.

The structure in its entirety or its elements may comprise an external coating which may be one or more of a fire-resistant coating, liquid-resistant coating, scratch-resistant coating, and other environmental-resistant coatings.

By one embodiment, the structure as defined above is a part of a frame of a human-powered vehicle. According to one specific embodiment, the structure is configured as a part of a frame of a human-powered vehicle, e.g. a bicycle. Such frame may comprise two or more parts, one or both of which are structures as provided by the invention, which may be the same or different. For example, two elements being mirror images of one another constituting the rear frame part of a bicycle frame and a third structure constituting the front part of a bicycle frame.

By one embodiment of the invention, at least one of the elongated elements is configured for articulation to a pedal crank.

Reference is also made to the concurrently filed and co-owned PCT application publication no. WO 2014/061012, claiming priority from US provisional applications, Serial Nos. 61/715,359 and 61/787,229, both entitled "Structural Element Comprising Cardboard" (hereinafter: "the co-owned application"). This co-owned application describes a structural element similar in its properties and manufacture to said first elongated element, *mutatis mutandis*.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to better understand the subject matter that is disclosed herein and to exemplify how it may be carried out in practice, embodiments will now be described, by way of non-limiting examples only, with reference to the accompanying drawings, in which:

Fig. 1 is a schematic isometric view of a bicycle with a frame according an embodiment of the invention;

Fig. 2 is a schematic isometric view of the frame shown in Fig. 1;

Fig. 3A is a schematic isometric view of a front frame component of the frame shown in Fig. 2;

Fig. 3B is a schematic enlarged view of a detail A shown in Fig. 3A;

Fig. 3C is a schematic enlarged view of detail B shown in Fig. 3A;

Fig. 3D is a schematic rear view of detail B shown in Fig. 3C;

Fig. 3E is a schematic enlarged perspective view of detail C shown in Fig. 3A;

Figs. 3F to **3H** are schematic section views taken along lines A-A, B-B and C-C shown in Fig. 3A;

Figs. 4A and **4B** are schematic respective front and isometric views of two stages of producing the front frame shown in Figs. 3A to 3E;

Fig. 5A is a schematic isometric view of a rear frame component of the frame shown in Fig. 2;

Fig. 5B is a schematic enlarged view of a detail D shown in Fig. 5A;

Fig. 5C is a schematic enlarged view of detail E shown in Fig. 5A;

Figs. 5D to **5E** show schematic cross-sections taken along lines D-D and E-E, respectively, of Fig. 5A.

DETAILED DESCRIPTION OF EMBODIMENTS

In the following description, although at times particular mention of a specific figure will be made, reference is mostly to the figures in their entirety.

Reference is first made in particular to Figs. 1 and 2 showing a bicycle **100** having a steering arrangement **110,** a frame **102,** a front wheel fork **130**, a seat **150,** wheels **160** and a crank assembly **170.**

The frame **102** comprises a front frame part **120** and two rear frame parts **140,** the two being mirror images of one another. Each of the frame parts is made substantially of cardboard, as will also be further explained below.

As best seen in Figs. 3A to 3E, the front frame part **120** comprises two integral elongated elements **L1** and **L2** and a support element **126,** which is also integrally formed with the two elongated elements **L1, L2.**

End portions **127L1** and **127L2** of the longitudinal elements **L1** and **L2,** respectively, serve as the site for association with corresponding elements **147L1'** and **147L2'** of the rear frame part **140,** the bicycle seat **150** and the crank assembly **170.** As can be seen, the end portion **127L2** that couples with the crank assembly has a circular shape.

Figs. 4A and 4B are a schematic illustration of the manner of manufacture of the front frame part **120.** As can be seen in these figures, the entire front frame part **120** is made of a single sheet of cardboard **124** that is folded about a reinforcing member that is constituted by rod **123,** extending along a fold region **121** of the cardboard sheet **124** to form an elongated core-envelop member **122** that is integral with the frame part **120.** The reinforcing member is typically made of cardboard but may also be made of wood, plastic and other materials. The cardboard sheet is typically a two-walled corrugated, a multi-walled corrugated or honeycombed cardboard sheet.

Once the sheet **124** has been folded, a left and a right portion thereof **124A, 124B** are affixed to one another (e.g. by adhesive **AD**, sewing, stapling etc.) such that portions thereof firmly embrace and close around the reinforcing rod **123** and form at least a double-layer pre-production cardboard-based piece **128.** The pre-production structure shown in Fig. 4B can then be cut to the required shape, shown in this example (by dotted lines) to be the shape of the front frame part **120.**

Consequently, the elongated member **L1** has the reinforcing rod **123** passing along the full length thereof and includes the fold region **121,** whereas the elongated

element **L2,** as well as the supporting element **126,** is formed of a double-layer cardboard without a reinforcing rod passing therethrough.

In this connection, Figs. 3F to 3H show schematic cross-sections taken along lines **A-A, B-B** and **C-C** (Fig. 3A). As can be seen, each of the elements **L1, L2** and **126** comprises two layers of cardboard (**126A, 126B**), while elongated element **L1** also includes the reinforcing rod **123** that may be made of cardboard but may also be made of wood and other materials. The reinforcing member in this specific embodiment has a circular cross-section. It should, however, be noted that it may have oval or other rounded cross-sectional shapes. Generally, the elongated element **L1** has features of the structural element of the co-owned application.

The front and rear frame parts **120** and **140** are assembled together in the manner shown in Fig. 2, through use of a plurality of pins **180** (seen in Fig. 1 and which may be made of cardboard, wood or other materials) that fit into designated through-bores **125A, 125B, 125C** in frame parts **120, 140.** Frame parts **120, 140** have overlapping portions and tight association may be ensured by applying adhesive **AD** on juxtaposed surfaces at these portions.

In particular, as shown in Fig. 3B, the front portion of the frame part **120** comprises four longitudinally-oriented blind holes **125A** in cardboard portion **124A** and **124B** and four bores **125B** normal to holes **125A** and the side surface of part **120.** This set of holes and bores serves for articulation to the front frame part **120** of the steering arrangement **110** through the use of pins (not shown) that protrude from the stem of the steering arrangement and flaps **190** extending from the steering arrangement and attached to the side surfaces of part **120.**

End portion **127L1** is formed with eight through-bores **125C** also perpendicular to and passing through both portions **124A, 124B,** and configured for attachment to a corresponding end portion **147L1** of the rear frame part **140.**

Rounded end portion **127L2** is provided with six through-bores perpendicular to and passing through both portions **127A, 127B,** arranged circumferentially about the central bore **129**. The rounded end portion **127L2** is configured for attachment to a corresponding end portions **147L2'** of two rear frame parts **140,** to jointly form a crank assembly seat for crank **170.**

Rear frame part **140** is shown, in isolation, in Figs 5A-5C. While differently configured, like frame part **120** it is constructed out of a single, two-layered cardboard piece. Frame part **140** is then cut out from that piece such that the fold region **141** with a reinforcing member embraced by cardboard sheet portions eventually forms the elongated element **L1,** similarly as the fold region **121** forms the elongated element **L1** of part **120.** For this reason, equivalent elements between the parts will be designated by similar reference numerals upped by 20, i.e. cardboard portion **124A** of the front frame **120** is equivalent to cardboard portion **144A** of rear frame part **140.**

The rear frame part **140** also comprises two longitudinal members **L1'** and **L2'** with, respective, end portions **147L1'**, **147L2'** configured for attachment to the respective end portions **127L1, 127L2** of the front frame part **120.**

As previously explained with respect to Figs. 4A and 4B, the entire rear frame part **140** is also made of a single sheet of cardboard folded about a reinforcing rod **143,** extending along a fold region **141** of the cardboard sheet.

Once the sheet **144** has been folded and the portions thereof **144A, 144B** are affixed to one another it can then be cut to the required shape of the rear frame part **140.** A rear triangular piece is the attached to the cut-out structure to constitute triangular projection **149.**

Elongated member **L1'** has, thus, the reinforcing rod **143** passing along the full length thereof and includes the fold region **141,** whereas the elongated member **L2'** is formed of a double-layer cardboard without a reinforcing rod passing therethrough. This can be seen, in particular, in Figs. 5D and 5E.

The rear frame part **140** is also formed with an axle-port **146** configured for receiving therein a rear axle of the bicycle **100** of rear wheel **160.**

The front and rear frame parts **120** and **140** are assembled together in the manner shown in Fig. 2, through use of a plurality of pins **180** (some of which are seen in Fig. 1 and which may be made of cardboard, wood, plastic and other materials) that fit into designated bores **125A**, **125B**, **125C**, **128, 145, 148** in the different frame parts **120, 140.** The different frame parts **120, 140** have overlapping portions and tight association may be ensured by passing the pins **180** through the bores and by applying adhesive **AD** on juxtaposed surfaces at these portions; and also through other means.

As previously mentioned, the rear frame comprises two mirror image frame parts **140,** being attached to opposite sides of the front frame part **120.** Among others,

this provides for a robust stable construction of the frame reinforcing the front frame part **120** on both sides and (the gap between the mirror image frame parts **140** receives therebetween the rear wheel **160**).

The assembled frame **102** comprising the two frame parts **120, 140** forms together a closed-contour structure, (including the two reinforcing members **123, 143**), providing for a robust construction configured for supporting considerable loads. In particular, the frame **102** can support the weight of at least two adult males (about 200Kg) and/or properly transferring this weight to the wheels **160** of the bicycle **100.**

CLAIMS:

1. A frame part comprising

two or more, generally elongated elements angled with respect to one another and being cut out of a planar multi-layered cardboard-based piece that comprises at least two layers of a single cardboard sheet folded about a longitudinal reinforcing member, to thereby define a longitudinal fold region comprising said member embraced by portions of the cardboard sheet, such that at least two of said elongated elements being integral with one another and are cut as a single integral structure out of said planar multi-layered cardboard-based piece; and

at least a first element of said elongated elements comprises at least a portion of the fold region, said at least a portion of the fold region extends the length of said first of said elongated elements.

2. The frame part of claim 1, wherein said reinforcing member has a rounded cross-section.

3. The frame part of claim 1 or 2, wherein said reinforcing member is made of cardboard or wood.

4. The frame part of any one of claims 1 to 3, wherein said first element comprises substantially the entire fold region.

5. The frame part of claim 4, wherein said reinforcing member extends the length of said first element.

6. The frame part of any one of claims 1 to 5, further comprising a support element extending between said first element and at least one other of the elongated elements.

7. The frame part of claim 6, wherein the support element is made of cardboard.

8. The frame part according to any one of claims 1 to 7, wherein one or more of said elongated elements has free ends connectable to other structures or other structural elements.

9. The frame part of any one of claims 1 to 8, wherein at least the first element has a load-bearing or bend-resistance property that is larger than a load-bearing or bend-resistance property of the longitudinal reinforcing member.

10. The frame part of any one of claims 1 to 9 being capable of supporting a load in a direction perpendicular to said first element, which is at least 10 times the weight of said frame part.

11. The frame part of any one of claims 1 to 10, comprising an external coating.

12. The frame part of claim 11, wherein the external coating comprises at least one of a fire-resistant coating, a liquid-resistant coating, and a scratch-resistant coating.

13. The frame part of any one of claims 1 to 12, being a component of a frame of a human-powered vehicle.

14. The frame part of claim 12, wherein at least one end of at least one of the elongated elements is configured for articulation to a pedal crank.

15. A human-powered vehicle, comprising two or more frame parts, each of the parts being according to anyone of claims 1 to 14.

16. The human-powered vehicle of claim 15, sized and shaped for a human rider.

17. A method for manufacturing a frame part, comprising:

forming a generally planar two-layer cardboard-based piece with a longitudinal fold region at its edge, said forming comprises folding a single cardboard sheet about a longitudinal reinforcing member; and

cutting out a structure from the planar piece, the structure comprising at least two elongated elements, a first of the at least two elongated elements extends along said fold region and is integral with at least one other of said elements and angled thereto, such that the at least two elongated elements are cut from the planar piece as a single integral structure.

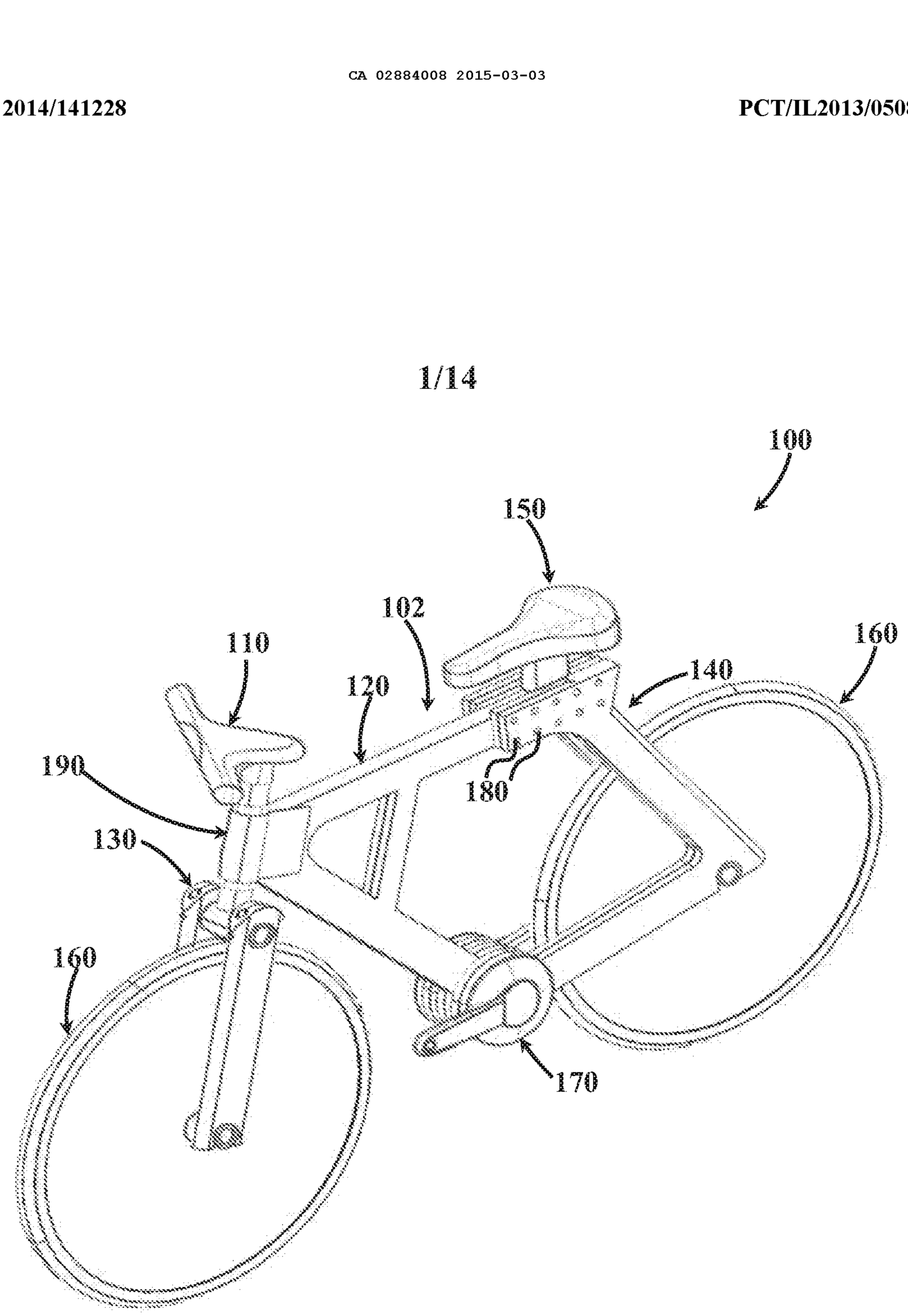


Fig. 1

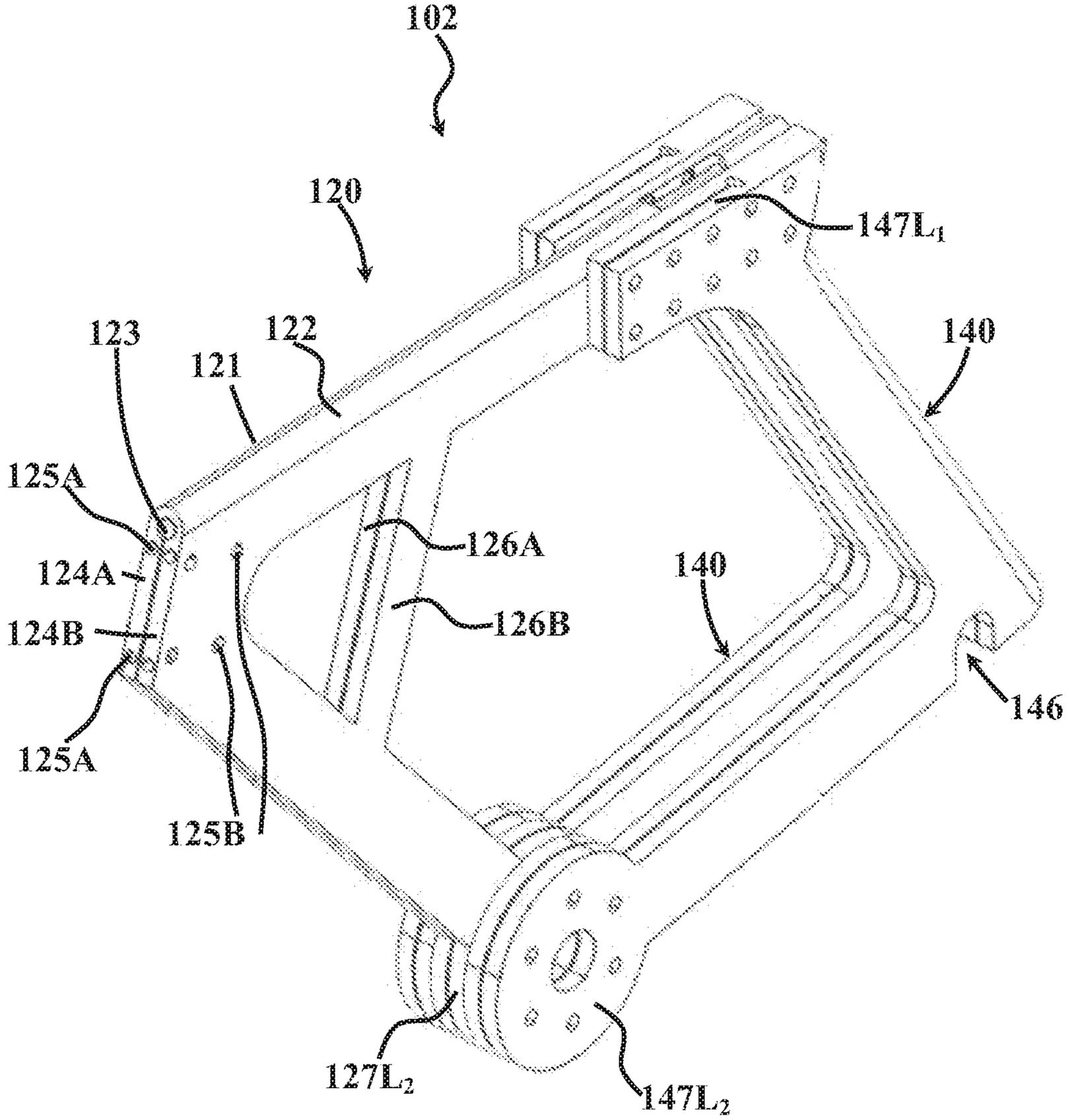

102
120
147L1
123
121
122
140
125A
126A
124A
140
124B
126B
125A
146
125B
127L2
147L2

Fig. 2

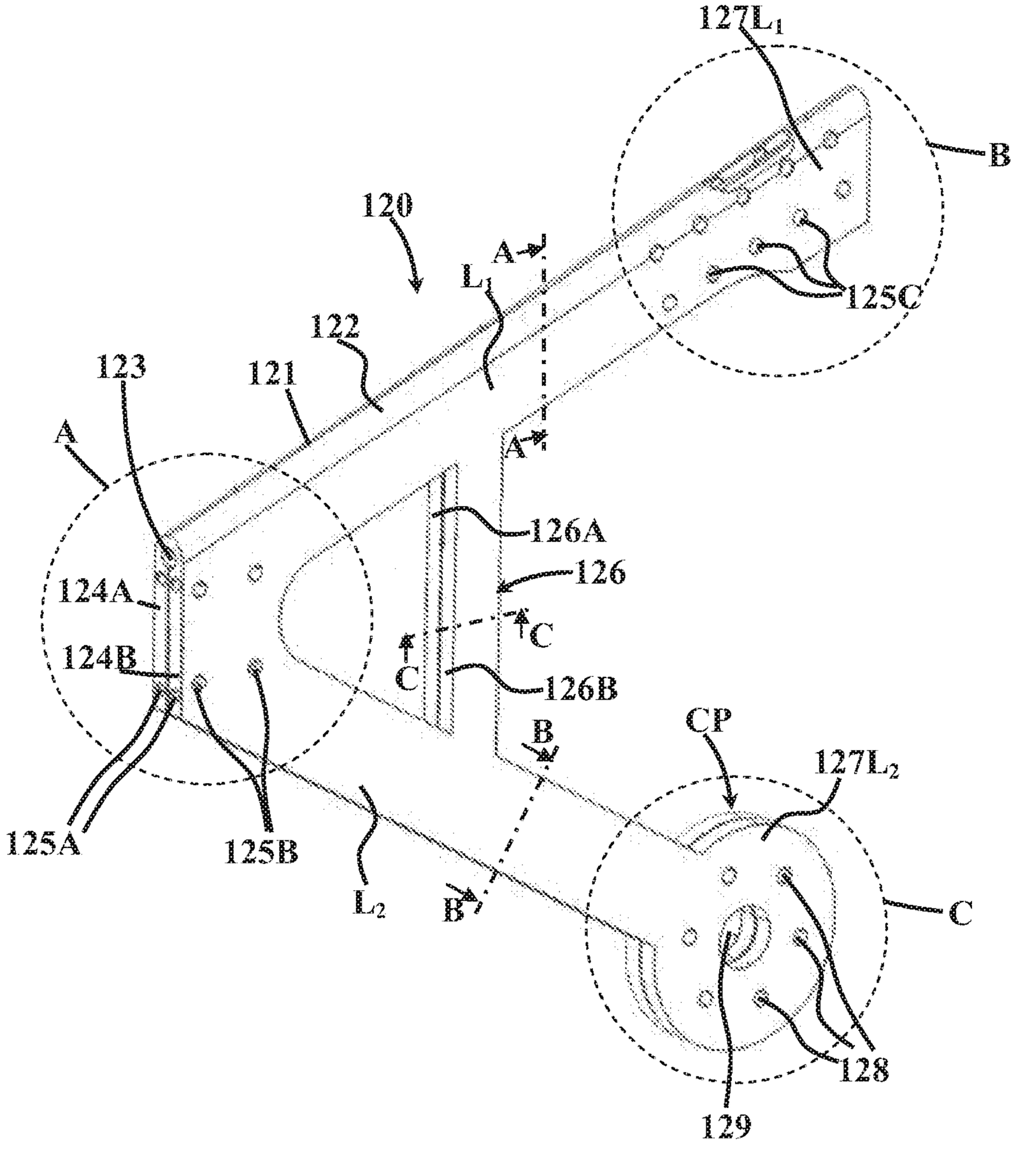

127L1
B
120
A
L1
125C
122
123
121
A
A
126A
126
124A
C
124B
C
126B
B
CP
127L2
125A
125B
L2
B
C
128
129

Fig. 3A

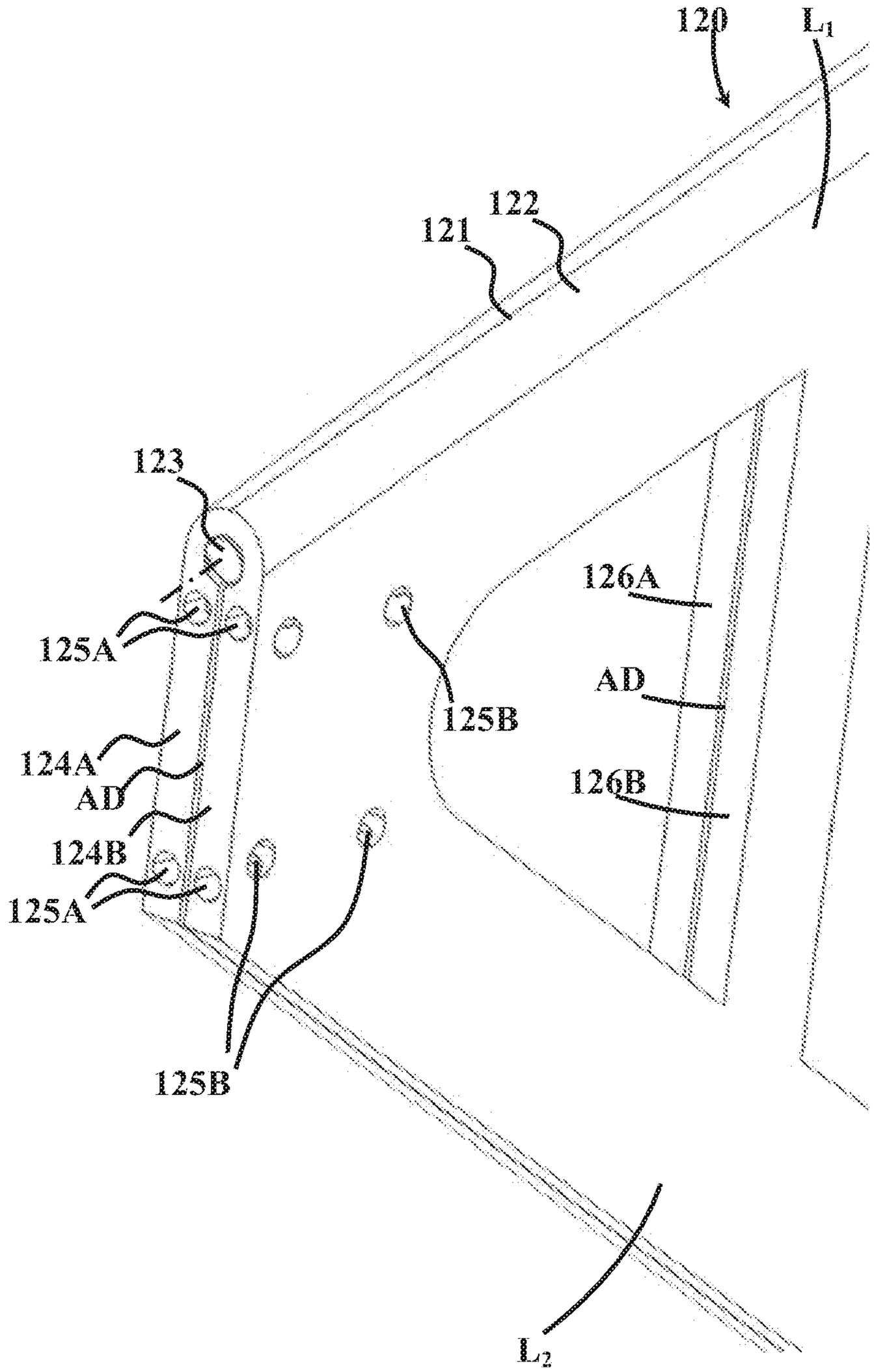

120
L_1
122
121
123
126A
125A
AD
125B
124A
AD
126B
124B
125A
125B
L_2

Fig. 3B

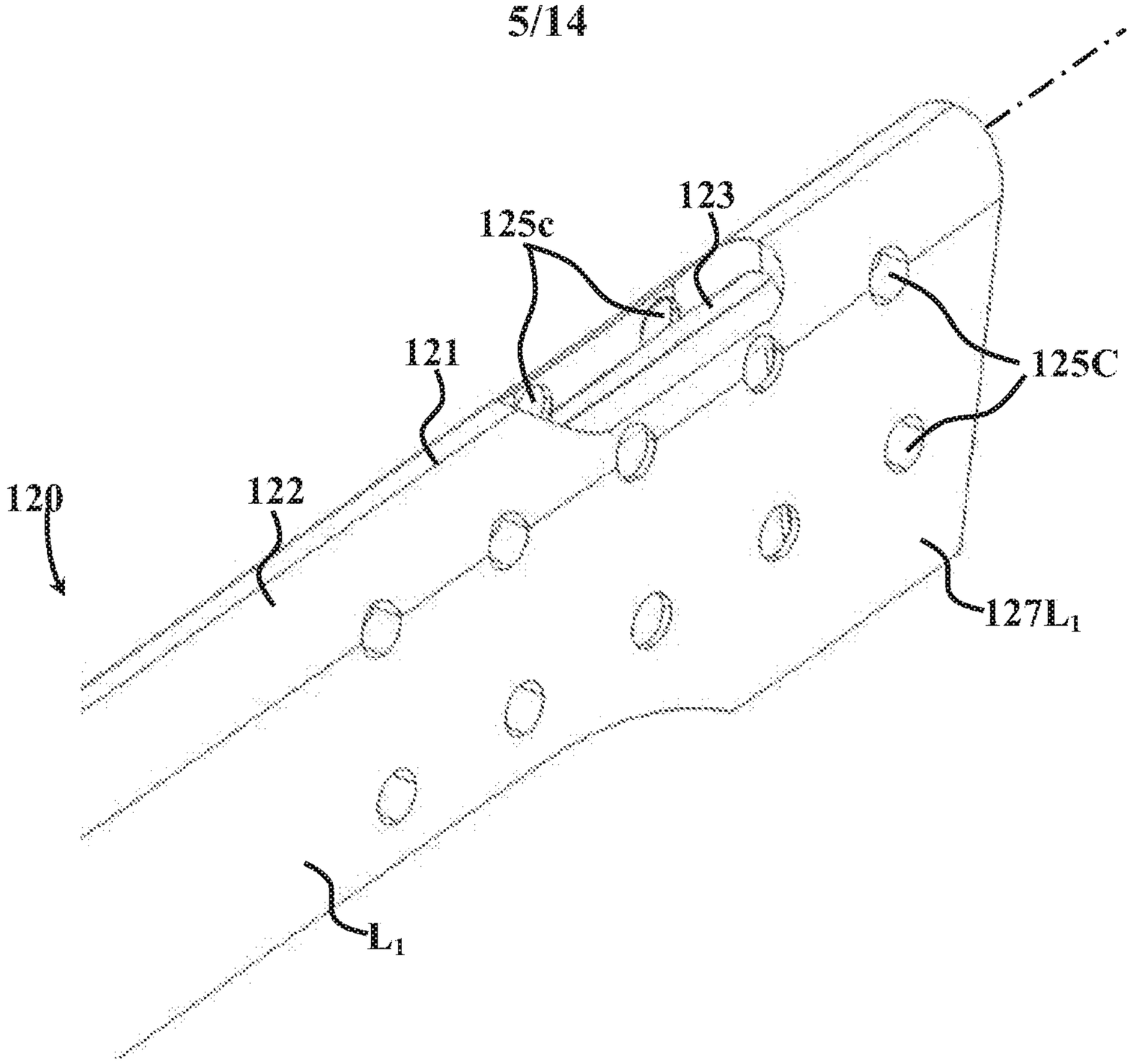


Fig. 3C

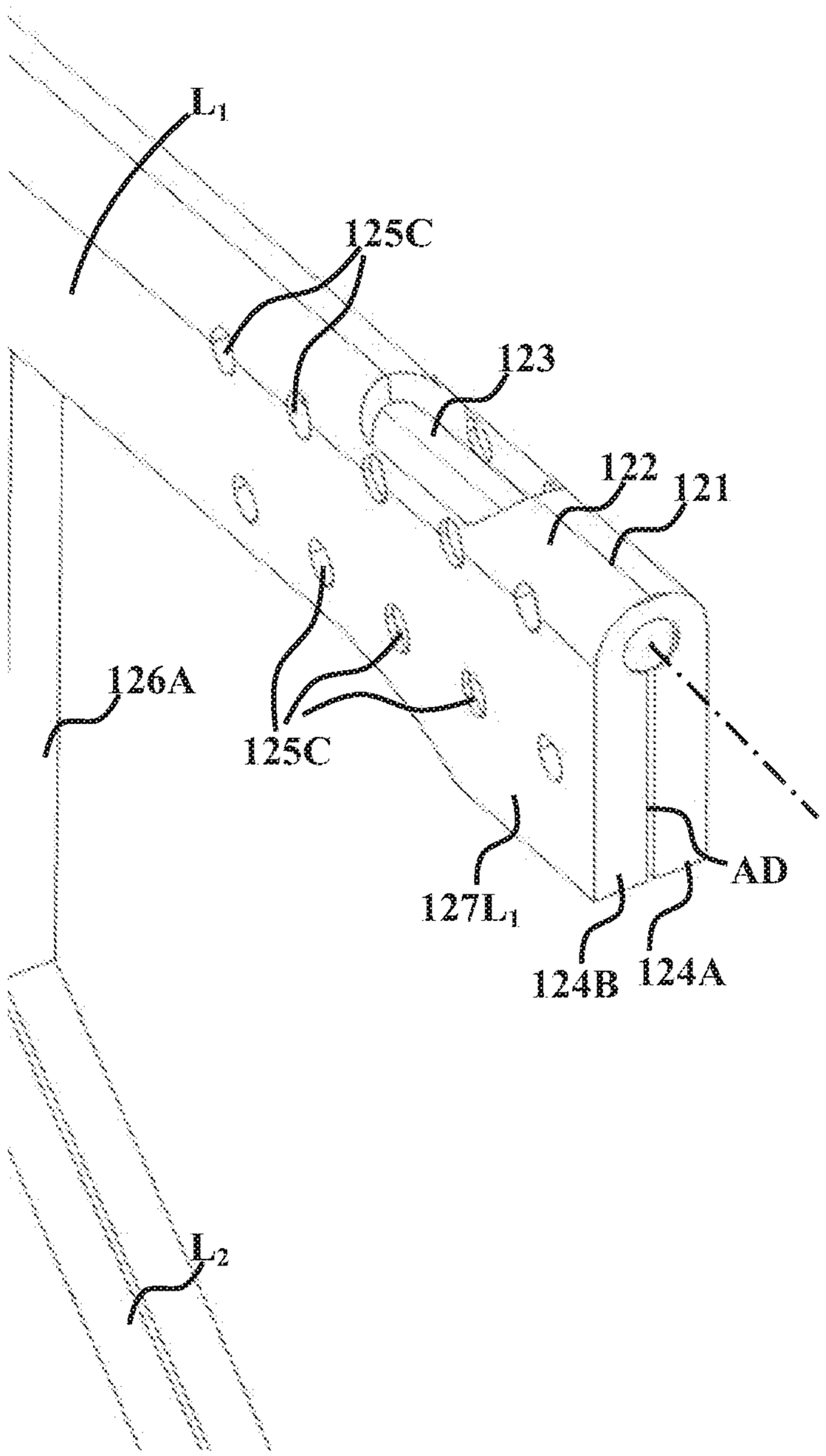


Fig. 3D

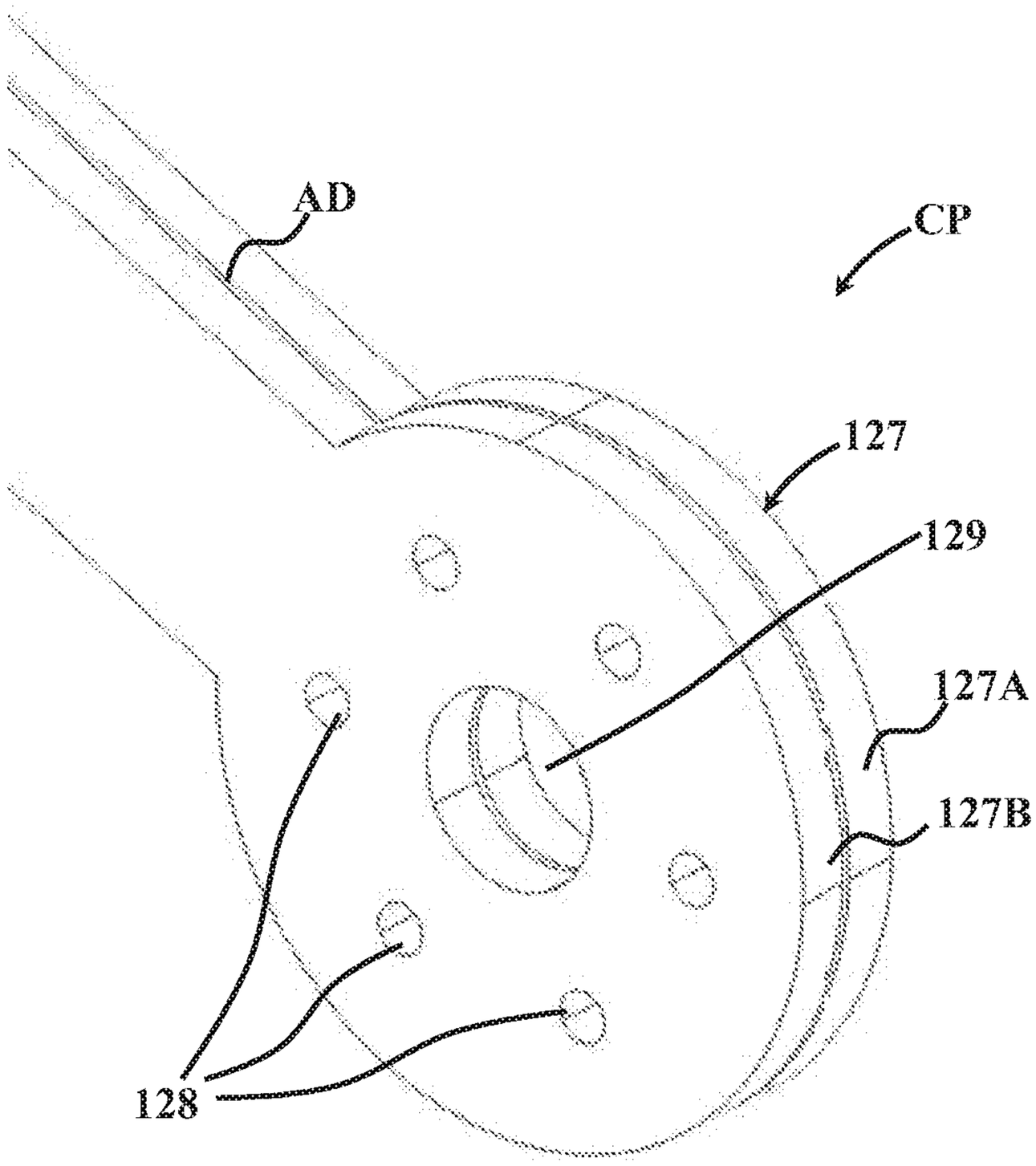


Fig. 3E

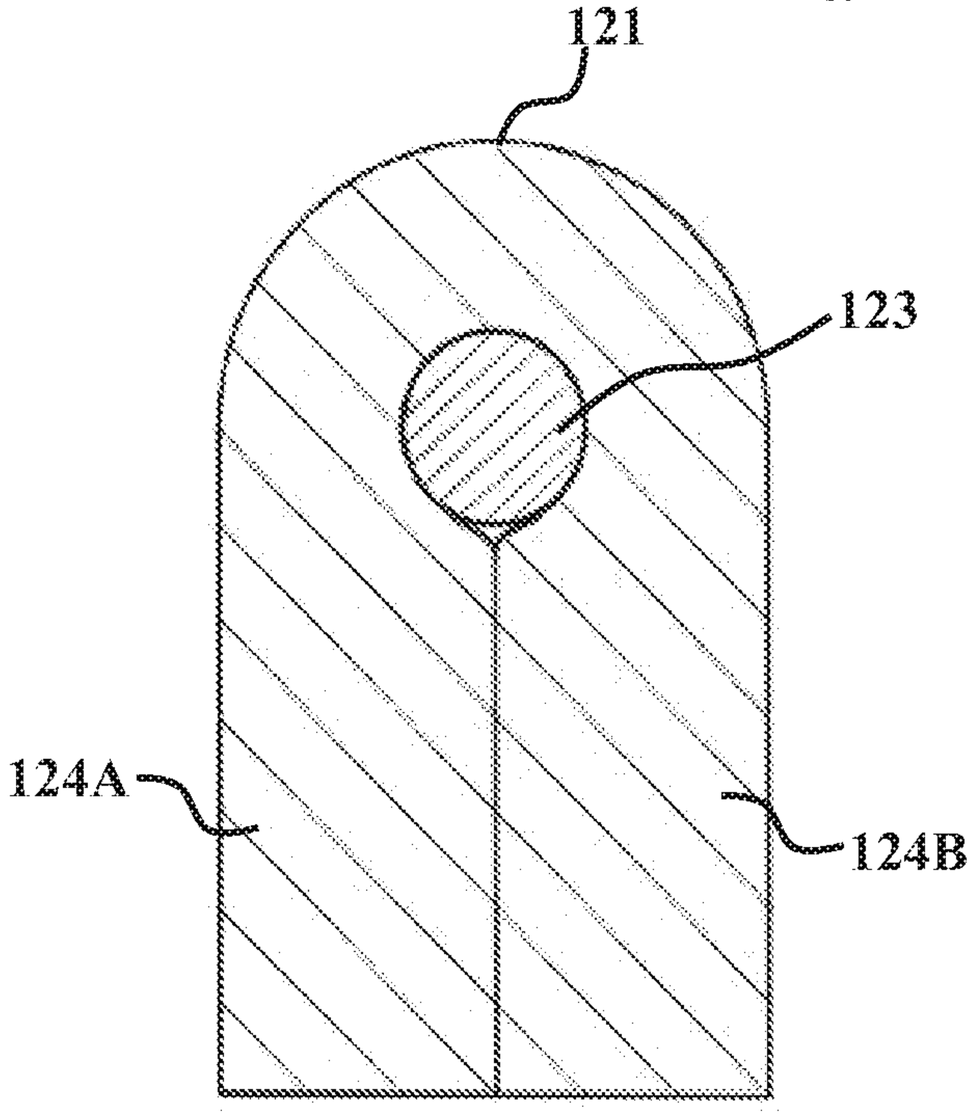


Fig. 3F

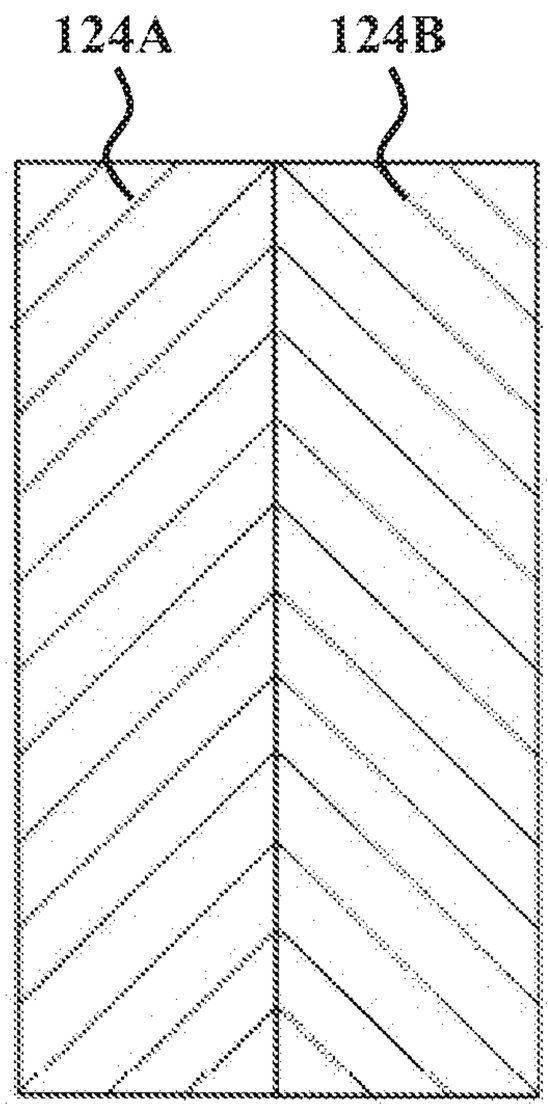


Fig. 3G

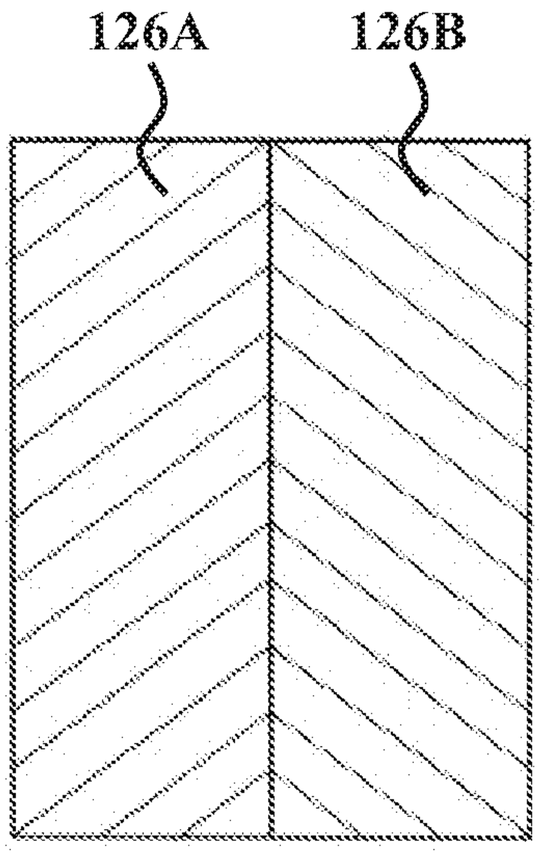


Fig. 3H

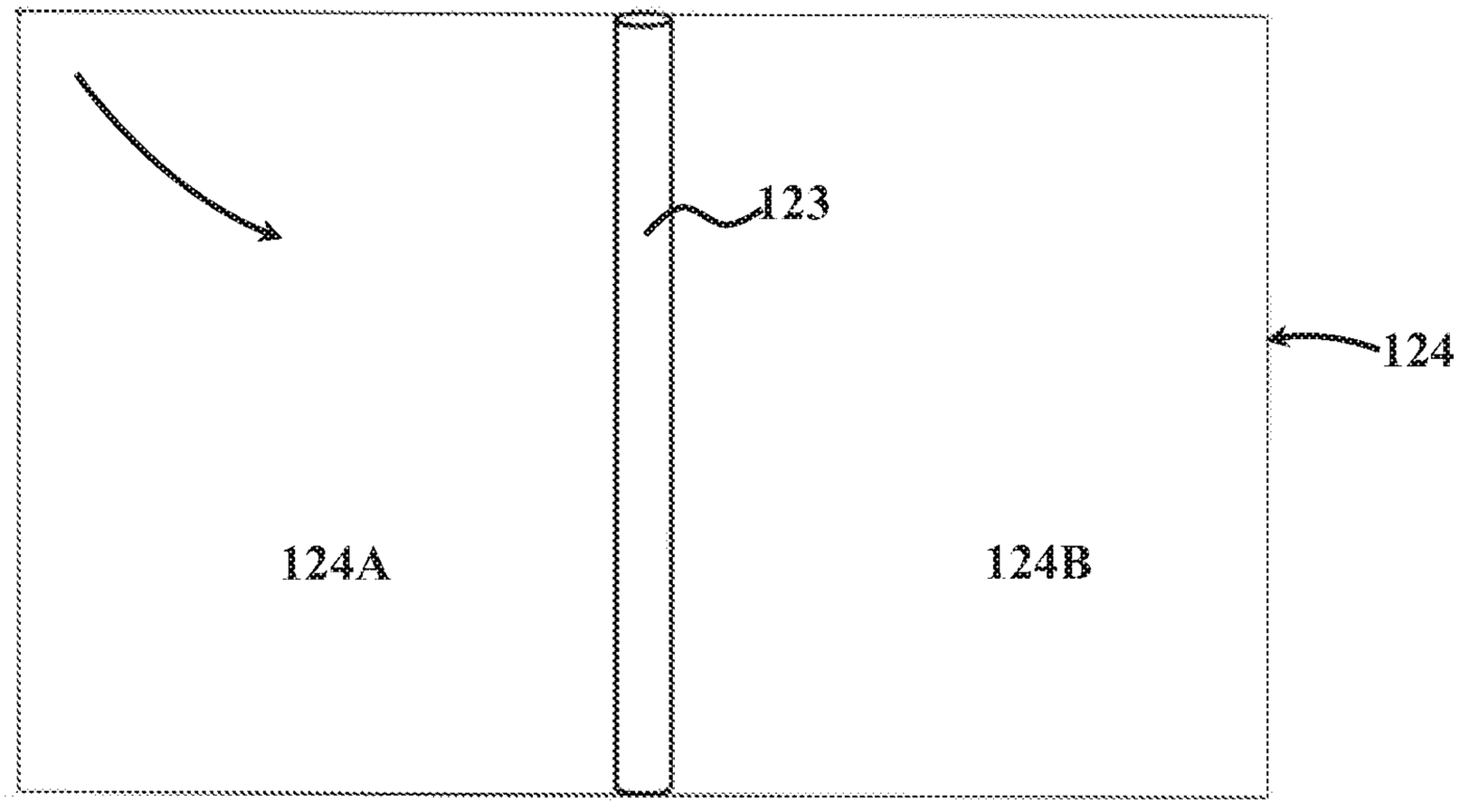


Fig. 4A

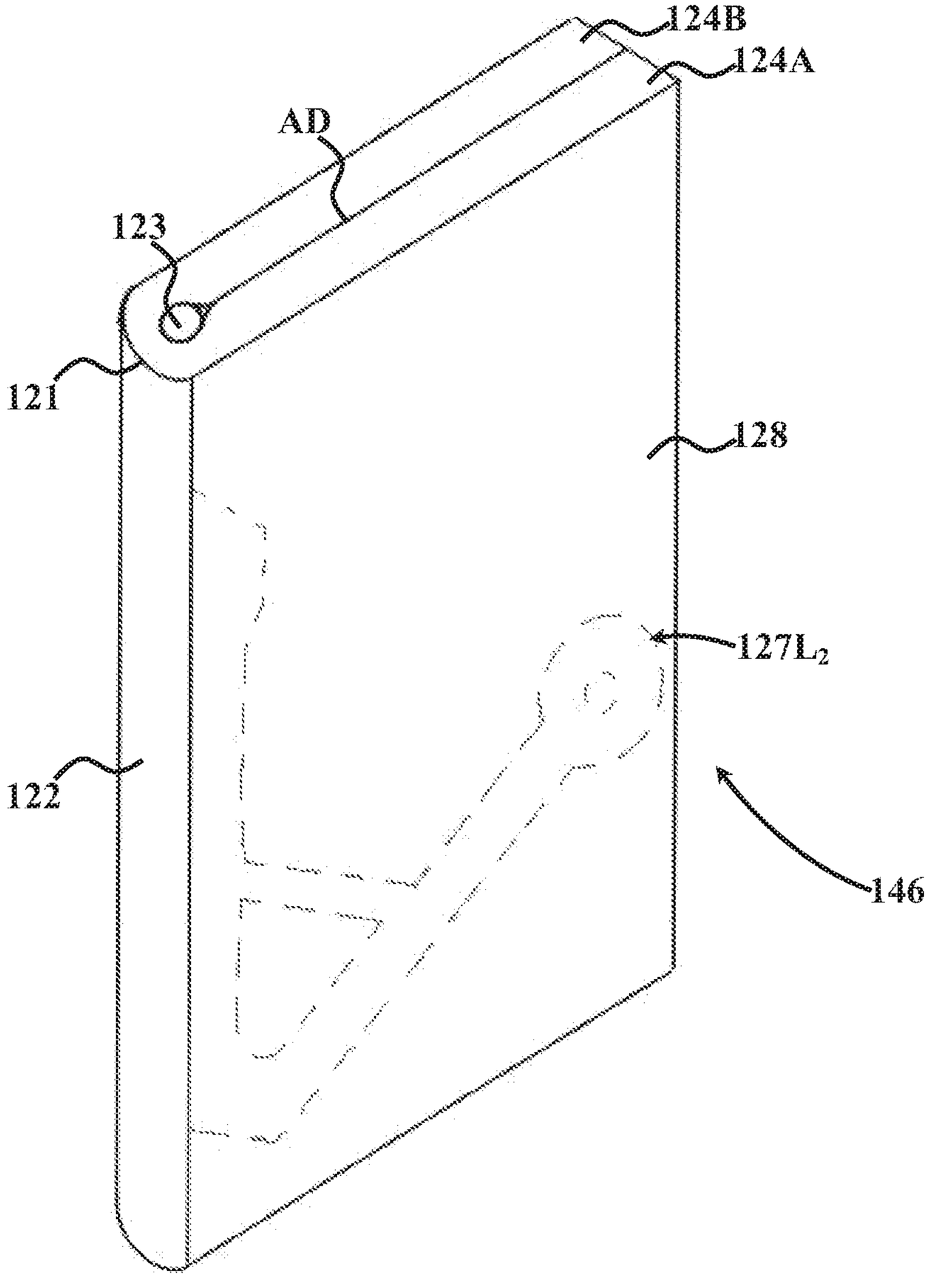


Fig. 4B

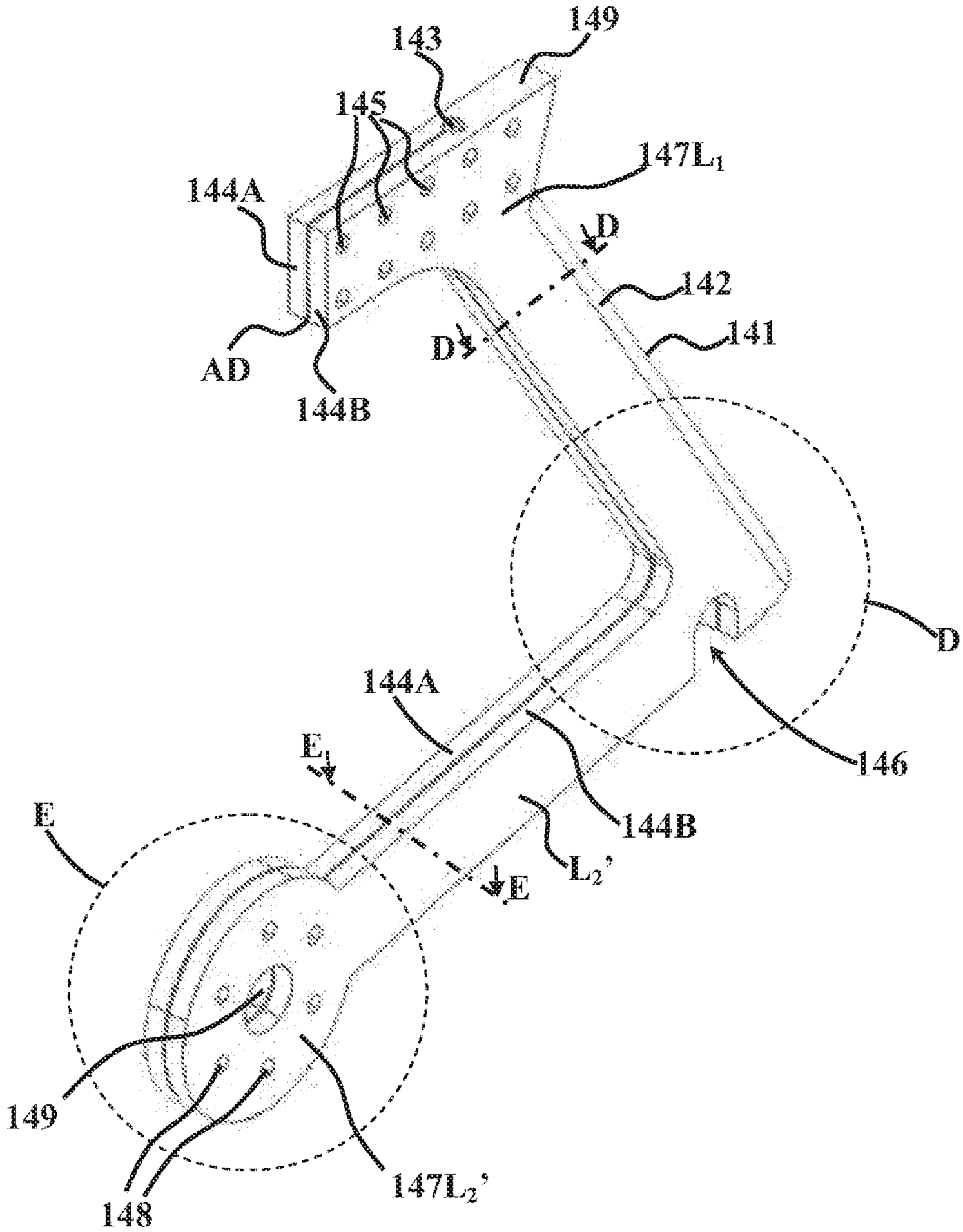

143
149
145
147L1
144A
D
142
AD
141
D
144B
144A
146
E
144B
E
L2'
E
149
147L2'
148

Fig. 5A

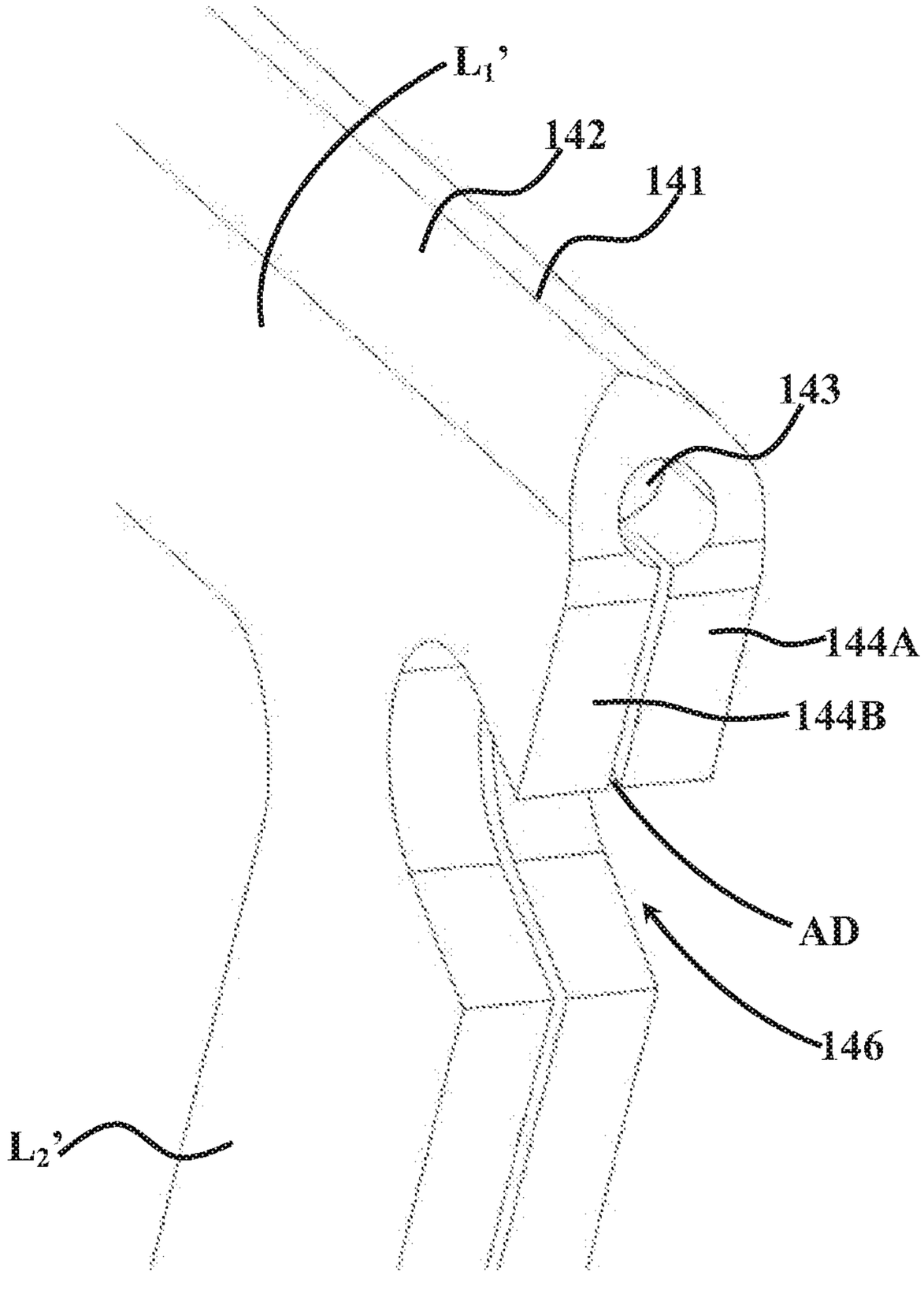


Fig. 5B

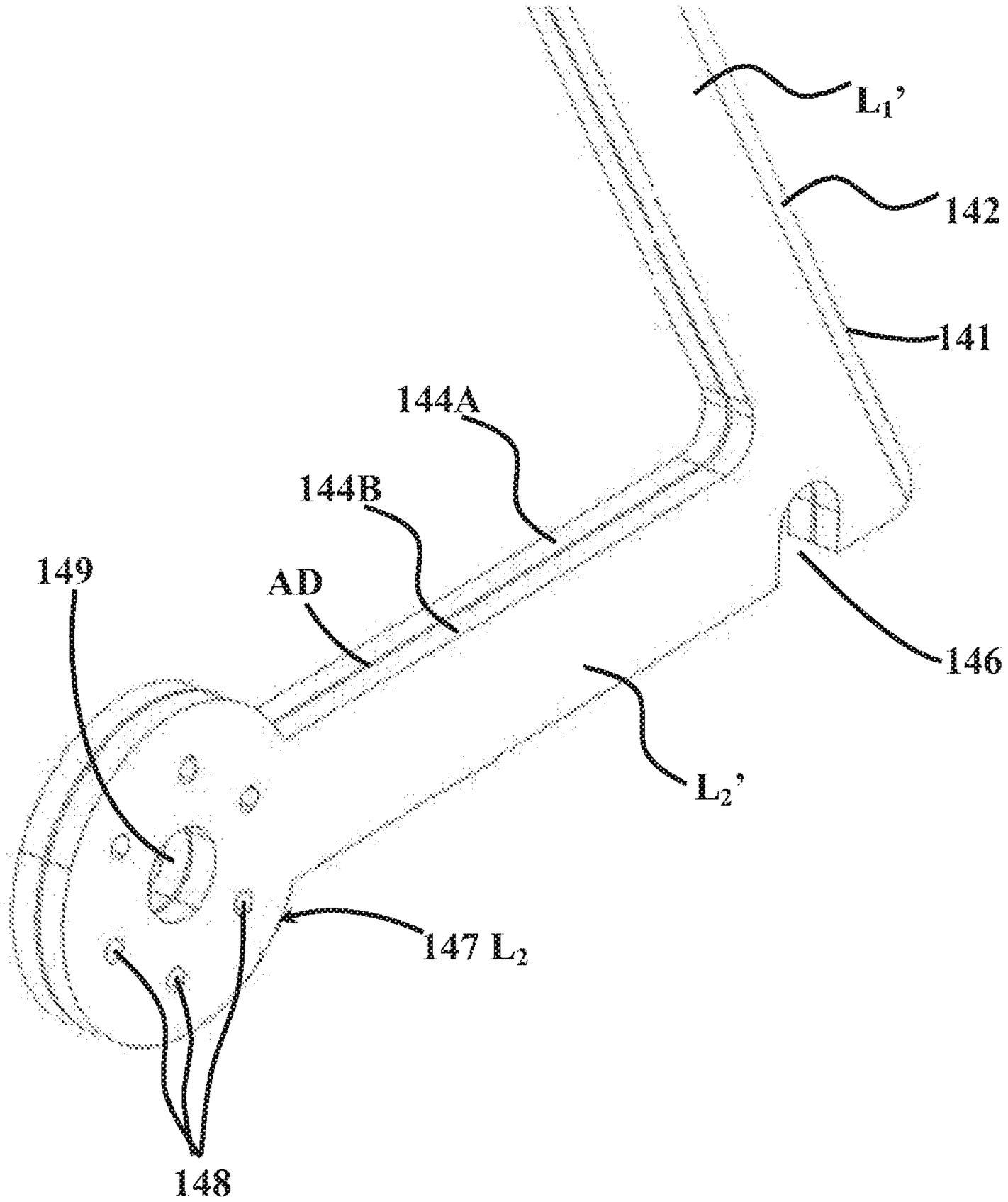


Fig. 5C

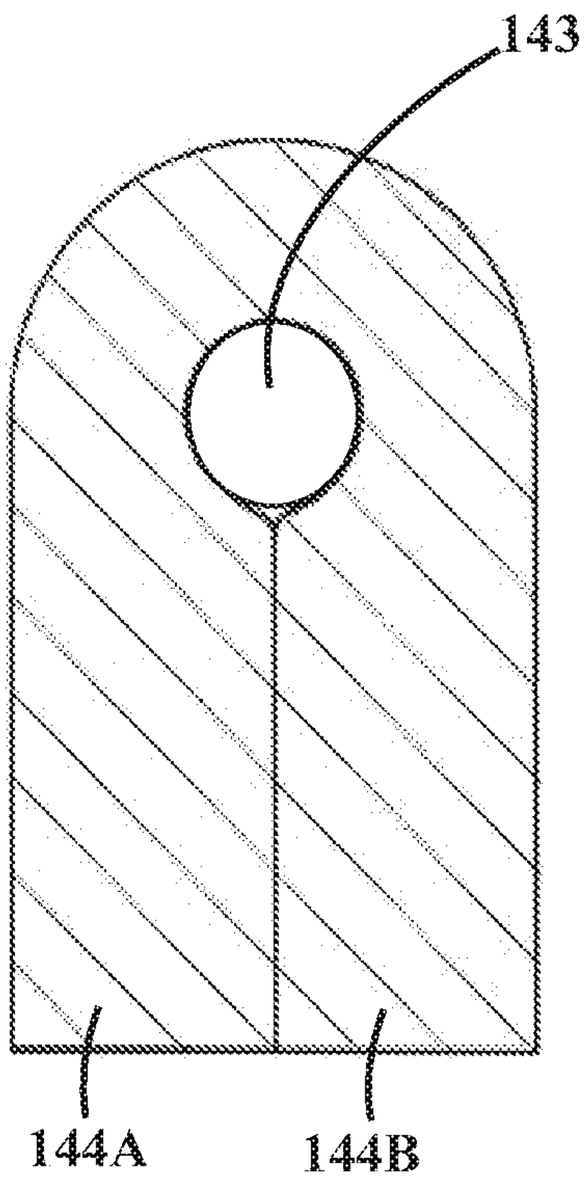


Fig. 5D

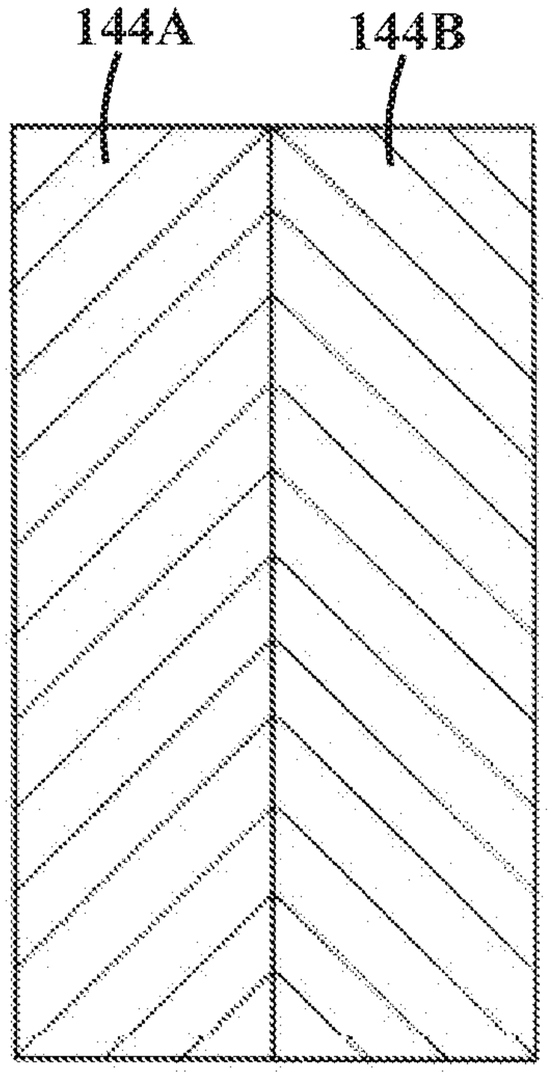
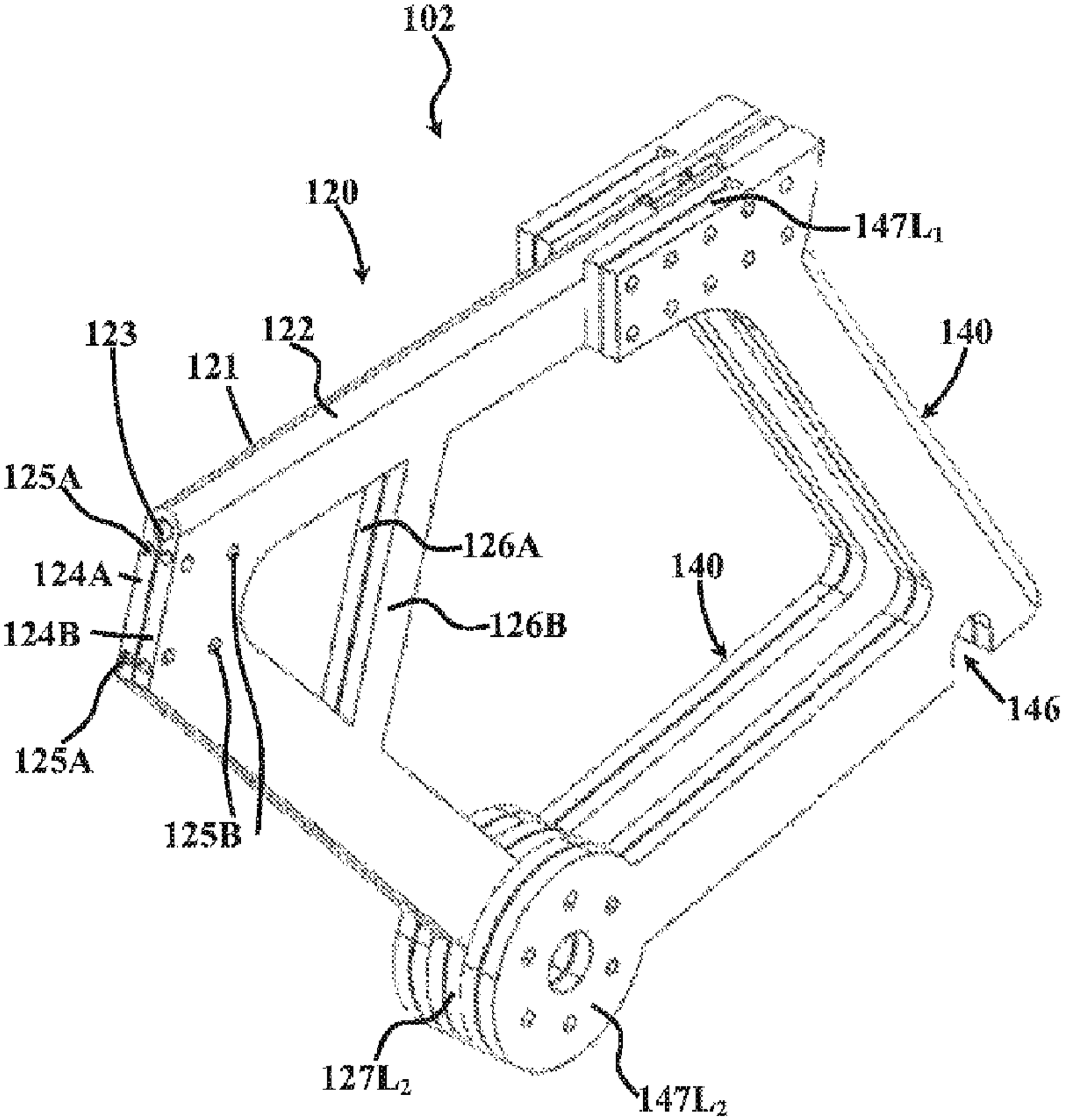


Fig. 5E


102
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147L1
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126B
124B
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125A
125B
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147L2