(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
15 October 2020 (15.10.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/208442 A1

(51) International Patent Classification:
A01C 5/06 (2006.01) *A01C 23/02* (2006.01)
A01C 7/06 (2006.01)

(21) International Application Number:
PCT/IB2020/052424

(22) International Filing Date:
17 March 2020 (17.03.2020)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/831,338 09 April 2019 (09.04.2019) US
62/967,293 29 January 2020 (29.01.2020) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*
— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

(54) **Title:** TRENCH CLOSING ASSEMBLY

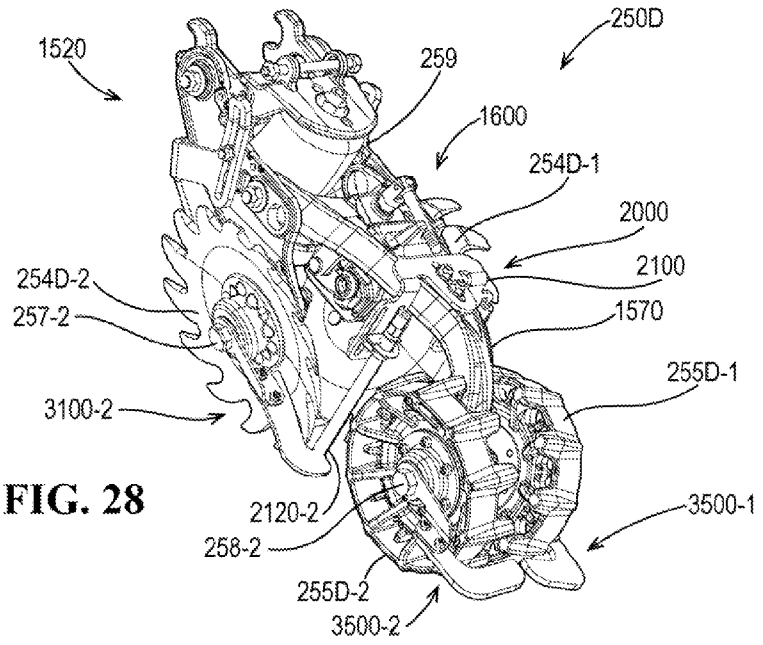


FIG. 28

(57) **Abstract:** A trench closing assembly (250D, 250) including at least one soil deflector (3100, 3500) and/or a fluid applicator (2000).

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TRENCH CLOSING ASSEMBLY

BACKGROUND

[0001] It is well known that good seed-to-soil contact within the seed trench is a critical factor in uniform seed emergence and high yields. To obtain good seed-to-soil contact, once seeds are planted in a seed trench, the seed trench needs to be closed so that soil surrounds the seed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] FIG. 1 is a side elevation view of an embodiment of a row unit of an agricultural planter.

[0003] FIG. 2 is a diagram of a system for implementing operational control of the closing wheel assembly based on signals generated by the trench closing sensor.

[0004] FIG. 3 is a left side perspective view of an embodiment of a trench closing assembly.

[0005] FIG. 4 is a top plan view of the trench closing assembly of FIG. 3.

[0006] FIG. 5 is a bottom plan view of the trench closing assembly of FIG. 3.

[0007] FIG. 6 is a top perspective view of the trench closing assembly of FIG. 3 with some parts removed.

[0008] FIG. 7 is a bottom perspective view of the trench closing assembly of FIG. 6.

[0009] FIG. 8 is a bottom perspective view of the trench closing assembly of FIG.7 with some parts removed.

[0010] FIG. 9 is a bottom perspective view of the trench closing assembly of FIG.8 with some parts removed.

[0011] FIG. 10 is a top perspective view of the trench closing assembly of FIG. 9.

[0012] FIG. 11 is a top perspective view of the frame of the trench closing assembly of FIG. 3.

[0013] FIG. 12 is a bottom perspective view of the frame of FIG. 11.

[0014] FIG. 13 is bottom plan view of the frame of FIG. 11.

[0015] FIG. 14 is top perspective view of the frame of the trench closing assembly of FIG. 3.

[0016] FIG. 15 is a bottom perspective view of the frame of FIG. 14.

[0017] FIG. 16 is a top perspective view of the connection bracket of the frame of FIG. 14.

[0018] FIG. 17 is a bottom perspective view of the connection bracket of FIG. 16.

[0019] FIG. 18 is a top perspective view of the attachment bracket of the frame of FIG. 14.

[0020] FIG. 19 is a bottom perspective view of the attachment bracket of FIG. 15.

[0021] FIG. 20 is top perspective view of the mounting arm of the trench closing assembly of FIG. 3.

[0022] FIG. 21 is a bottom perspective view of the mounting arm of FIG. 20.

[0023] FIG. 22 is a front elevation view of the handle assembly of the trench closing assembly of FIG. 3.

[0024] FIG. 23 is a left side elevation view of the handle assembly of FIG. 22.

[0025] FIG. 24 is a perspective view of the shank of the handle assembly of FIG. 22.

[0026] FIG. 25 is a bottom perspective view of the pressure sensor of the handle assembly of FIG. 22.

[0027] FIG. 26 is a top perspective view of the pressure sensor of FIG. 25.

[0028] FIG. 27 is a perspective view of the handle assembly and mounting arm of the trench closing assembly of FIG. 3.

[0029] FIG. 28 is a perspective view of the trench closing assembly of FIG.3 further including soil deflectors and a fluid applicator according to an embodiment.

[0030] FIG. 29 is a left side elevation view of the trench closing assembly of FIG. 28.

[0031] FIG. 30 is a top plan view of the trench closing assembly of FIG. 28.

[0032] FIG. 31 is a left side elevation view of the closing wheel soil deflector of FIG. 28.

[0033] FIG. 32 is a left side elevation view of the press wheel soil deflector of FIG. 28.

[0034] FIG. 33 is a perspective view of the closing wheel soil deflector of FIG. 31.

[0035] FIG. 34 is a perspective view of the press wheel soil deflector of FIG. 32.

[0036] FIG. 35 is a top plan view of the closing wheel soil deflector of FIG. 31.

[0037] FIG. 36 is a top plan view of the press wheel soil deflector of FIG. 32.

[0038] FIG. 37 is a perspective view of the fluid applicator according to an embodiment.

[0039] FIG. 38 is a right side elevation view of the fluid applicator of FIG. 37.

[0040] FIG. 39 is a top plan view of the fluid applicator of FIG. 37.

[0041] FIG. 40 is a rear elevation view of the fluid applicator of FIG. 37.

[0042] FIG. 41 is a top plan view of a fluid applicator according to an embodiment.

[0043] FIG. 42 is a left side elevation view of the closing wheel soil deflector of FIG. 31 and including a nozzle.

[0044] FIG. 43 is a left side elevation view of the closing wheel soil deflector of FIG. 32 and including a nozzle.

[0045] FIG. 44A is a perspective view of the trench closing assembly of FIG.3 with a modified guard and further including a scraper with an optional fluid applicator according to an embodiment.

[0046] FIG. 44B is a top plan view of the trench closing assembly of FIG. 44A.

[0047] FIG. 44C is a bottom plan view of the trench closing assembly of FIG. 44A.

[0048] FIG. 44D is a left side elevation view of the trench closing assembly of FIG. 44A.

[0049] FIG. 44E is a right side elevation view of the trench closing assembly of FIG. 44A.

[0050] FIG. 45A is a top plan view of left and right scrapers of FIG. 44A.

[0051] FIG. 45B is a bottom plan view of left and right scrapers of FIG. 45A.

[0052] FIG. 45C is a front elevation view of left and right scrapers of FIG. 45A.

[0053] FIG. 45D is a rear elevation view of left and right scrapers of FIG. 45A.

[0054] FIG. 46A is a right side elevation view of a right scraper of FIG. 45A.

[0055] FIG. 46A is a left side elevation view of a right scraper of FIG. 45A.

[0056] FIG. 47A is a left side elevation view of a left scraper of FIG. 45A.

[0057] FIG. 47B is a right side elevation view of a left scraper of FIG. 45A.

[0058] FIG. 48A is a partial perspective view of the trench closing assembly of FIG. 44A with parts removed for viewing.

[0059] FIG. 48B is a bottom plan view of the trench closing assembly of FIG. 48A.

[0060] FIG. 48C is a right side elevation view of the trench closing assembly of FIG. 48A.

[0061] FIG. 48D is a left side elevation view of the trench closing assembly of FIG. 48A.

[0062] FIG. 49A is a perspective view of the guard of FIG. 44A.

[0063] FIG. 49B is a top plan view of the guard of FIG. 49A.

[0064] FIG. 49C is a bottom plan view of the guard of FIG. 49A.

[0065] FIG. 49D is a front elevation view of the guard of FIG. 49A.

[0066] FIG. 49E is a rear elevation view of the guard of FIG. 49A.

[0067] FIG. 49F. is right side elevation view of the guard of FIG. 49A.

[0068] FIG. 49G. is left side elevation view of the guard of FIG. 49A.

[0069] FIG. 49H is a front elevation view of the guard of FIG. 49D with the adjustable plate removed.

DESCRIPTION

[0070] All references cited herein are hereby incorporated by reference in their entireties. In the event of a conflict in a definition in the present disclosure and that of a cited reference, the present disclosure controls.

[0071] Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, FIG. 1 illustrates an embodiment of an agricultural planter row unit 200. The row unit 200 is comprised of a frame 204 pivotally connected to a toolbar 202 by a parallel linkage 206 enabling each row unit 200 to move vertically independently of the toolbar 202. The frame 204 operably supports one or more hoppers 208, a seed meter 210, a seed delivery mechanism 212, a downforce control system 214, a seed trench opening assembly 220, a trench closing assembly 250, an optional packer wheel assembly 260, and an optional row cleaner assembly 270. It should be understood that the row unit 200 shown in FIG. 1 may be for a conventional planter or the row unit 200 may be a central fill planter, in which case the hoppers 208 may be replaced with one or more mini-hoppers and the frame 204 modified accordingly as would be recognized by those of skill in the art.

[0072] The optional downforce control system 214 is disposed to apply lift and/or downforce on the row unit 200 such as disclosed in U.S. Publication No. US2014/0090585. The downforce applied by downforce control system 214 can be determined by methods disclosed in U.S. Patent No. 9173339.

[0073] The seed trench opening assembly 220 includes a pair of opening discs 222 rotatably supported by a downwardly extending shank member 205 of the frame 204. The opening discs 222 are arranged to diverge outwardly and rearwardly so as to open a v-shaped trench 10 in the soil 11 as the planter traverses the field. The seed delivery mechanism 212, such as a seed tube or seed conveyor, is positioned between the opening discs 222 to deliver seed from the seed meter 210 into the opened seed trench 10. The depth of the seed trench 10 is controlled by a pair of gauge wheels 224 positioned adjacent to the opening discs 222. The gauge wheels 224 are rotatably supported by gauge wheel arms 226 which are pivotally secured at one end to the frame 204 about pivot pin 228. A rocker arm 230 is pivotally supported on the frame 204 by a pivot pin 232. It should be appreciated that rotation of the rocker arm 230 about the pivot pin 232 sets the depth of the trench 10 by limiting the upward travel of the gauge wheel arms 226 (and thus the gauge wheels) relative to the opening discs 222. The rocker arm 230 may be adjustably

positioned via a linear actuator 234 mounted to the row unit frame 204 and pivotally coupled to an upper end of the rocker arm 230. The linear actuator 234 may be controlled remotely or automatically actuated as disclosed, for example, in International Publication No. WO2014/186810.

[0074] An optional downforce sensor 238 is configured to generate a signal related to the amount of force imposed by the gauge wheels 224 on the soil. In some embodiments the pivot pin 232 for the rocker arm 230 may comprise the downforce sensor 238, such as the instrumented pins disclosed in U.S. Patent No. 8561472.

[0075] An optional seed meter 210 may be any commercially available seed meter, such as a finger-type meter or a vacuum seed meter. One exemplary vacuum seed meter is the VSet® meter, available from Precision Planting LLC, 23207 Townline Rd, Tremont, IL 61568.

[0076] An optional packer wheel assembly 260 comprises an arm 262 pivotally attached to the row unit fame 204 and extends rearward of the closing wheel assembly 250 and in alignment therewith. The arm 262 rotatably supports a packer wheel 264. An actuator 266 is pivotally attached at one end to the arm 262 and at its other end to the row unit frame 204 to vary the amount of downforce exerted by the packer wheel 264 to pack the soil over the seed trench 10.

[0077] An optional row cleaner assembly 270 may be the CleanSweep® system available from Precision Planting LLC, 23207 Townline Rd, Tremont, IL 61568. The row cleaner assembly 270 includes an arm 272 pivotally attached to the forward end of the row unit frame 204 and aligned with the trench opening assembly 220. A pair of row cleaner wheels 274 are rotatably attached to the forward end of the arm 272. An actuator 276 is pivotally attached at one end to the arm 272 and at its other end to the row unit frame 204 to adjust the downforce on the arm to vary the aggressiveness of the action of the row cleaning wheels 274 depending on the amount of crop residue and soil conditions.

[0078] Referring to FIG. 2, a monitor 300 is visible to an operator within the cab of a tractor pulling the planter. The monitor 300 may be in signal communication with a GPS unit 310, the trench closing assembly actuator 256 and the optional packer wheel assembly actuator 266 to enable operational control of the trench closing assembly 250 and the optional packer wheel assembly 260 based on the signals generated by trench closing sensors 1000, which are described in International Publication No. WO2017/197274. Also as discussed later, the monitor 300 may be programmed to display operational recommendations based on the signals generated by the

trench closing sensors 1000. The monitor 300 may also be in signal communication with the row cleaner actuator 276, the downforce control system 214, the depth adjustment actuator 234 to enable operational control of row cleaner assembly 270, the downforce control system 214 and the trench opening assembly 230, respectively.

Trench Closing Assembly

[0079] Examples of Trench Closing Assemblies can be found in U.S. Patent Application Nos. 62/637372, filed 1 March 2018, 62/644201, filed 16 March 2018, 62/731813, filed 14 September 2018, 62/791203, filed on 11 January 2019, and in International Application No. PCT/US2019/020452, filed on 2 March 2019. Also, an example of a trench closing assembly is the FurrowForce™ trench closing assembly available from Precision Planting, LLC.

[0080] FIGs. 3-27 illustrate a trench closing assembly 250D according to an embodiment. In this embodiment, trench closing assembly 250D has a main frame 251D that is connected to row unit 200. Trench closing assembly 250D has a frame 1520, an actuator 259, a pair of closing wheels 254D-1, 254D-2, and optionally, a press wheel 255D.

[0081] Turning to FIGs. 14-19, frame 251D has a connection bracket 1540 and an attachment bracket 1550. Connection bracket 1540 can have one or more bolts 1209D extending through apertures 1207D in connection bracket 1540 for mounting the frame 251D to the row unit 200. Connection bracket 1540 (as with connection brackets 1200 and 1201A) can be varied to mate attachment to different styles of row units. Connection bracket 1540 has a first side 1542-1, a second side 1542-2, and a plate 1543 disposed between first side 1542-1 and second side 1542-2. First side 1542-1 and second side 1542-2 each have a post 1541-1 and 1541-2, respectively, protruding perpendicularly outward.

[0082] Attachment bracket 1550 connects to connection bracket 1540. Attachment bracket 1550 provides a common structure for mounting other parts while connection bracket 1540 has a varied structure to mate with different styles of row units. Attachment bracket has a first side 1552-1, a second side 1552-2, a crossbar 1557 disposed between first side 1552-1and second side 1552-2, and plate 1553 disposed between first side 1552-1and second side 1552-2, and plate 1553. First side 1552-1 and second side 1552-2 each have a u-shaped opening 1555-1 and 1555-2, respectively, for connection to posts 1541-1 and 1541-2, respectively. First side 1552-1 and second side 1552-2 have openings 1558-1 and 1558-2, respectively, for accepting pivots 1529-1 and 1529-2, respectively. Attachment bracket 1550 can be secured to connection bracket

with fastener 1549. Optionally, attachment bracket 1550 can also have an opening 1501 disposed in first side 1552-1 or second side 1552-2 for accepting a pin. While connection bracket 1540 is illustrated with separate parts it may be fabricated as a unitary part.

[0083] Optionally, as illustrated in FIGs. 5 and 7, a guard 1590 can be disposed on frame 1520 ahead of closing wheels 254D-1, 254D-2. Guard 1590 can prevent rocks, rootballs, or other trash from approaching closing wheels 254D-1, 254D-2. The height of guard 1590 can be adjusted by changing the placement of arms 1591-1 and 1591-2 on frame 1520.

[0084] Turning to FIGs. 20-21, mounting arm 1570 has a first side 1571-1, a second side 1571-2, a plate 1574 disposed between first side 1571-1 and second side 1571-2, a hole 1573 through plate 1574 for passage of sleeve 1603, axle hubs 1575-1 and 1575-2 for mounting press wheels 255D-1 and 255D-2, respectively, and, optionally, a handle cradle 1579.

[0085] Turing to FIGs. 6-13, frame 1520 is pivotally connected to frame 251D through pivots 1529-1 and 1529-2. Frame 1520 has a first side 1526-1 and a second side 1526-2, a plate 1525 connecting first side 1526-1 and second side 1526-2, a connection arm 1527 extending rearwardly along the direction of travel from plate 1525, a cross-brace 1528-1 connecting connection arm 1527 to first arm 1526-1, a cross-brace 1528-2 connecting connection arm 1527 to second arm 1526-2. First side 1526-1 and second side 1526-2 have openings 1521-1 and 1521-2 for disposing about pivots 1529-1 and 1529-2, respectively. Mounting arm 1570 can attach to frame 1520 at connections 1522-1a and 1522-2a or to 1522-1b and 1522-2b. The plurality of connections allows the distance between closing wheels 254D-1, 254D-2, and press wheel 255D (255D-1, 255D-2) to be changed. There can be one connection 1522 or a plurality of connections 1522. As the mounting arm 1570 position is changed, there are also corresponding connections 1523-a and 1523-b (matching in number to connection 1522) for connecting handle assembly 1600 to frame 1520. Frame 1520 also has connections 1524 (1524-1a, 1524-1b, 1524-2a, and 1524-2b) for mounting closing wheels 254D-1, 254D-2. While there can be one set of connections 1524, the plurality of connections 1524 allow for forward and back placement of the closing wheels 254D-1, 254D-2 on frame 1520, or closing wheels 254D-1, 254D-2 can be offset from each other with one closing wheels 254D-1, 254D-2 being mounted to a forward location (the “a” position) or to a rear location (the “b” position). As illustrated, closing wheels 254D-1, 254D-2 are offset from each other. Optionally, frame 1520 can have an opening 1502 in either the first side 1526-1 or second side 1526-2 (shown in 1526-2) for

accepting a pin. Frame 1520 can be raised to allow opening 1501 and opening 1502 to align for accepting a pin (not shown). This allows trench closing assembly 250D to be raised for transport or when closing is not needed. While illustrated on one side, openings 1501 and 1502 can be disposed on both sides.

[0086] Actuator 259 is disposed between plate 1525 and plate 1553 to apply a force to plate 1553 to cause frame 1520 to pivot and apply pressure to closing wheels 254D-1 and 254D-2.

[0087] Turning to FIGs. 22-27, handle assembly 1600 is illustrated. Handle assembly 1600 has a sleeve 1603 having a first diameter 1620 and a second diameter 1621. Second diameter 1621 is small enough to be disposed through load sensor 1610, and first diameter 1620 is large enough so that it cannot pass through load sensor 1610. Sleeve 1603 has a bracket 1622 (u-shaped bracket as illustrated or any other shape) for accepting handle 1609. Disposed on sleeve 1603 below bracket 1622 are bevel washers 1601 and 1602. Bevel washer 1601 and bevel washer 1602 are disposed with their concave surfaces facing each other. This allows bevel washers 1601 and 1602 to flex to absorb shocks experienced by trench closing assembly 250D to prevent overloading of load sensor 1610. Before bevel washers 1601 and 1602 reach maximum flex, first diameter 1620 will contact plate 1604 to limit the travel. Load sensor 1610 is a pancake load sensor. Load sensor 1610 has a hole 1612 for passage of sleeve 1603. Disposed on the underside of load sensor 1610 are a plurality of feet 1611 to allow load sensor 1610 to flex and measure force. Load sensor 1610 can be disposed on mounting arm 1570 directly, or as shown, a plate 1604 can be disposed between load sensor 1610 and mounting arm 1570. Optionally, a washer 1607 can be disposed about sleeve 1603 under mounting arm 1570. Handle assembly 1600 is connected to frame 1520 at connection 1523-a or 1523-b with a bracket 1606 (u-shaped bracket) and a bolt 1605 connecting bracket 1606 with sleeve 1603. In the horizontal position, handle 1609 locks handle assembly 1600 in place against mounting arm 1570. In the vertical position, handle 1609 releases handle assembly from engagement with mounting arm 1570. Bolt 1605 can be adjusted to set a vertical placement of mounting arm 1570 relative to frame 1520.

[0088] Load sensor 1610 can be connected to a network directly through a plug (not shown) having a CAN processor to allow direct communication over a CAN network. The CAN processor can communicate pressure readings and provide control signals over the CAN network. Alternatively, load sensor 1610 can be connected to a control module (either an on-row

module, or a module controlling a plurality of row) to communicate pressure readings that are then processed by the control module.

Soil deflector

[0089] FIGs. 28-30 illustrate soil deflectors (3100, 3500) and fluid applicator (2000) disposed on closing assembly 250D. Soil deflector 3100 is illustrated on the left, and the right (not shown) is the mirror image of the left. Soil deflectors 3100 and soil deflectors 3500 are illustrated as two parts, but they can be made unitary parts. Soil deflectors 3100 and 3500 can keep dirt/mud from spraying or "rooster tailing" as the trench closing system 250D traverses the field. Also, soil deflectors 3100 and 3500 can scrape closing wheels 254D and/or press wheels 255D, respectively, by being adjusted to contact closing wheels 254D and/or press wheels 255D.

[0090] Soil deflector 3100-2 is connected to axle 257-2 and extends rearward opposite the direction of travel adjacent to closing wheel 254D-2. Depending on the shape of closing wheel 254D, soil deflector 3100 can be shaped to follow the contour of closing wheel 254D or contact closing wheel 254D. Soil deflector 3100-2 can be made of two parts, bracket 3101-2 and deflector 3102-2. When connected to axle 257-2, optionally a spacer (not shown), such as washer or bushing, can be disposed on axle 257-2 to vary the spacing between soil deflector 3100-2 and closing wheel 254D-2. Optionally, a connection orientation between bracket 3102-2 and deflector 3102-2 can be changed to change the orientation of deflector 3102-2 with closing wheel 254D-2. In one embodiment, soil deflector 3100 extends beyond the circumference of closing wheel 254D, and optionally, extends behind closing wheel 254D toward frame 1520. Deflector 3102-2 can be made from a flexible material. A flexible material is a material that will deflect when impacted by soil when trench closing assembly 250D is operated at typical planting speeds (e.g., up to 20 mph (32 kph) or up to 10 mph (16 kph)). In one embodiment, deflector 3102-2 is polyurethane.

[0091] Optionally, soil deflector 3500 (3500-1, 3500-2) can be included for press wheels 255D (255D-1, 255D-2). While illustrated with two press wheels 255D (255D-1, 255D-2), there can be just one press wheel 255D. Soil deflector 3500 (3500-1, 3500-2) is connected to axle 258 (258-1, 258-2) and extends rearward opposite the direction of travel adjacent to press wheel 255D (255D-1, 255D-2). Depending on the shape of press wheel 255D, soil deflector 3500 can be shaped to follow the contour of press wheel 255D 254D or press wheel 255D. Soil deflector 3500-2 can be made of two parts, bracket 3501-2 and deflector 3502-2. When connected to axle

258-2, optionally a spacer (not shown), such as washer or bushing, can be disposed on axle 258-2 to vary the spacing between soil deflector 3500-2 and closing wheel 2545-2. Optionally, a connection orientation between bracket 3502-2 and deflector 3502-2 can be changed to change the orientation of deflector 3502-2 with press wheel 255D-2. In one embodiment, soil deflector 3500 extend beyond the circumference of press wheel 255D, and optionally, extend behind press wheel 255D. Deflector 3502-2 can be made from a flexible material as defined above.

Fluid Applicator

[0092] Fluid applicator 2000 is illustrated in FIGs. 37-40 according to one embodiment. Fluid applicator 2000 has a frame 2100 for connection to mounting arm 1570. An optional slot 2101 can be disposed in frame 2100 to allow for adjustment front to back along the direction of travel. While illustrated with two arms 2104 (2104-1, 2104-2), fluid applicator 2000 can have just one arm 2014. Arms 2104 (2104-1, 2104-2) are disposed on either side of mounting arm 1570. Nozzles 2120 (2120-1, 2120-2) are attached to arms 2104 (2104, 1, 2014-2), respectively. Optionally, arms 2104 (2104-1, 2104-2) can have slots 2105 (2105-1-a, 2105-1-b, 2105-2-a, 2105-2-b) to allows nozzles 2120 (2120-1, 2120-2) to be adjusted vertically. For adjustable connection, U-bolts 2110 (2110-1, 2110-2) can connect nozzle 2120 (2120-1, 2120-2) to arms 2104 (2104-1, 2104-2) through slots 2105 (2105-1-a, 2105-1-b, 2105-2-a, 2105-2-b). Optionally, slots 2105 (2105-1-a, 2105-1-b, 2105-2-a, 2105-2-b) can be sized larger than U-bolts 2110 (2110-1, 2110-2) to allow nozzles 2120 (2120-1, 2120-2) to rotate in a direction transverse to the direction of travel so that nozzles 2120 (2120-1, 2120-2) can deposit fluid closer to or further away from the trench. Optionally, frames 2111 (2111-1, 2111-2) can be included to ensure fit of nozzles 2120 (2120-1, 2120-2) to arms 2104 (2104-1, 2104-2), for example when nozzles 2120 (2120-1, 2120-2) are round. Nozzles 2120 (2120-1, 2120-2) are connected to a fluid source (not shown) for applying fluid to the soil surface. Optionally, frame 2100 can be disposed on mounting arm 1570 rotated 180° from the orientation illustrated.

[0093] In an alternative embodiment, fluid applicator 2000' is illustrated in FIG. 41. While illustrated on the right side, fluid applicator 2000' can also be installed as a mirror image on the left side. An arm 2200-1 is connected to an axle 257-1 between frame 1520 and closing wheel 254D-1 and extends in a rearward direction away from the direction of travel. A nozzle 2220-1 is attached to arm 2200-1 via a bracket 2210-1. Optionally, a slot 2205-1 can be disposed in arm

2200-1 to permit adjustment of nozzle 2220-1 front to back along the direction of travel. Nozzle 2220-1 is connected to a fluid source (not shown) for applying fluid to the soil surface.

[0094] In an alternative embodiment as illustrated in FIG. 42 or FIG. 43, a nozzle 2300 (2300-2) can be connected to one or both soil deflectors 3100, 3500. Nozzle 2300 is connected to a fluid source (not shown). While illustrated with nozzle 2300 depositing fluid rearward of soil deflector 3100 or 3500 opposite the direction of travel, nozzle 2300 can be positioned to apply fluid towards the trench, or nozzle 2300 can be positioned to deposit fluid away from the trench.

[0095] FIGs. 44A-44E illustrate trench closing assembly 250E, which is similar to trench closing assembly 250D except that guard 1590 is replaced with guard 1590A, and press wheel 255D (255D-1, 255D-2) is shown with press wheel 1300' (1300'-1, 1300'-2) from US Provisional Patent Application No. 62/843,037.

[0096] Scraper 4000 (4000-1, 4000-2) is illustrated in FIGs. 45A to 47B. Scraper 4000 (4000-1, 4000-2) connects to axel 257 (257-1, 257-2, respectively) and is shaped to extend towards closing wheel 254D (254D-1, 254D-2, respectively) and follows the contour of closing wheel 254D rearward opposite the direction of travel of closing system 250E and can terminate at an edge of closing wheel 254D or extend beyond the outer radius of closing wheel 254D. Optionally, a nozzle 4010 (4010-1, 4010-2) can be connected to scraper 4000 to apply fluid from a source (not shown). Scraper 4000 (4000-1, 4000-2) can be a unitary piece, or it can be fabricated from different pieces. Scraper 4000 (4000-1, 4000-2) can have different sections. Hub section 4001 (4001-1, 4001-2) is for connecting to axle 257 (257-1, 257-2, respectively). Section 4002 (4002-1, 4002-2) transitions from hub section 4001 (4001-1, 4001-2) to scraping section 4003 (4003-1, 4003-2, respectively). Scraping section 4003 (4003-1, 4003-2) follow the contour of closing wheel 254D (254D-1, 254D-2, respectively). Scraping section 4003 (4003-1, 4003-2) terminates at end 4004 (4004-1, 4004-2, respectively). Optional nozzle 4010 (4010-1, 4010-2) is connected to end 4004 (4004-1, 4004-2, respectively). While illustrated with this embodiment, scraper 4000 can be adapted to work with any closing wheel 254 (such as 254, 254D).

[0097] Guard 1590A is illustrated in FIGs. 48A to 49H. Guard 1590 is generally U-shaped having a front plate 1593 and arms 1591-1 and 1591-2 extending rearwardly opposite the direction of travel. Front plate 1593 and arms 1591-1, 1591-2 can be a unitary part or fabricated from individual parts. Front plate 1593 can be perpendicular to the direction of travel of closing

system 250, or front plate 1593 can be disposed at an angle with respect to the direction of travel. Front plate 1593 has a slot 1594 for accepting a fastener (such as a bolt or screw) to adjustably attach adjustable plate 1595. Slot 1594 can be continuous (not shown) or can be a series of holes for specific positions for accepting the fastener. While shown with adjustable plate 1595, guard 1590 can replace the front plate 1593 with slot 1594 with plate 1595 in place of front plate 1593 for a fixed configuration (not shown). Arm 1591-1 can have one hole 1597-1 or a plurality of holes 1597-1 (1597-1a, 1597-1b, 1597-1c). One hole 1597-1 (such as 1597-1b) can be used for attaching guard 1590A to frame 1520 and closing wheel 254D-1. Closing wheel 254D-1 could optionally be attached at hole 1597-1a or 1597-1c for different configurations. Arm 1591-2 can have one hole 1597-2 or a plurality of holes 1597-2 (1597-2b, 1597-2c) and/or 1598. One hole 1597-2 (such as 1597-2b) can be used for attaching guard 1590A to frame 1520 and closing wheel 254D-2. Closing wheel 254D-2 could optionally be attached at hole 1597-2c or at hole 1598. Attaching closing wheel 254D-2 at hole 1598 allows for an offset of closing wheels 254D-1, 254D-2. In this configuration, the angle crated by front plate 1593 is such that the side of 1593 closest to closing wheel 254D-2 is disposed forward of the side of 1593 closest to closing wheel 254D-1. Arms 1592-1 and 1592-2 extend from arms 1591-1 and 1591-2, respectively, to connect guard 1590A to frame 1520 at connections 1596-1 and 1596-2, respectively. Arms 1591-1, 1591-2, 1592-1, 1592-2 can be designed to follow the contour of frame 1520. While illustrated as a separate part, guard 1590A could be formed as part of frame 1520.

[0098] Various embodiments of the invention have been described above for purposes of illustrating the details thereof and to enable one of ordinary skill in the art to make and use the invention. The details and features of the disclosed embodiments are not intended to be limiting, as many variations and modifications will be readily apparent to those of skill in the art.

CLAIMS

1. A trench closing system for a row unit of an agricultural planter, the row unit having a row unit frame supporting an opener disk for opening a seed trench in a soil surface as the row unit travels in a forward direction of travel, the trench closing system comprising:

a main frame supported by and extending rearwardly from the row unit frame;

a frame member pivotally supported from the main frame;

a pair of closing wheels each rotatably supported by the frame member with a first one of the pair of closing wheels disposed on a first side of the seed trench and a second one of the pair of closing wheels disposed on a second side of the seed trench, the pair of closing wheels cooperating with one another to close the opened seed trench with soil as the row unit travels in the forward direction of travel;

a first closing wheel soil deflector connected to an axle of the first closing wheel and extending opposite to the forward direction of travel beside the first closing wheel.

2. The trench closing system of claim 1, wherein the first closing wheel soil deflector extends a distance beyond a diameter of the first closing wheel and extends toward the frame member behind the first closing wheel.

3. The trench closing system of claim 1 or claim 2 further comprising a second closing wheel soil deflector connected to an axle of the second closing wheel and extending opposite to the forward direction of travel beside the second closing wheel.

4. The trench closing system of claim 3, wherein the second closing wheel soil deflector extends a distance beyond a diameter of the second closing wheel and extends toward the frame member behind the second closing wheel.

5. The trench closing system of any of claims 1 to 4, wherein the first closing wheel soil deflector comprises a first bracket and a first deflector, and wherein the first deflector is a flexible material.

6. The trench closing system of any of claims 3 to 5, wherein the second closing wheel soil deflector comprises a second bracket and a second deflector, and wherein the second deflector is a flexible material.

7. The trench closing system of any of claims 1 to 5 further including a mounting arm pivotally mounted to the frame member, the mounting arm supporting at least one press wheel rearward of the closing wheels, and a first press wheel soil deflector connected to an axle of the at least one press wheel and extending opposite to the forward direction of travel beside the at least one press wheel.

8. The trench closing system of claim 7, wherein the first press wheel soil deflector extends toward a centerline of the trench closing system behind the at least one press wheel.

9. The trench closing system of claim 7 or 8, wherein the first press wheel soil deflector comprises a first bracket and a first deflector, and wherein the first deflector is a flexible material.

10. The trench closing system of any of claims 7 to 9, wherein the at least one press wheel comprises a first press wheel and a second press wheel with the first press wheel soil deflector connected to an axle of the first press wheel and further including a second press wheel soil deflector connected to an axle of the second press wheel.

11. The trench closing system of claim 10, wherein the second press wheel soil deflector comprises a first bracket and a first deflector, and wherein the first deflector is a flexible material.

12. The trench closing system of any of claims 7 to 11, further comprising a fluid applicator disposed on the mounting arm to apply fluid to the soil surface.

13. The trench closing system of claim 12, wherein the fluid applicator comprises a frame that is disposed over the mounting arm and having a first arm on the first side of the seed trench and a second arm on the second side of the seed trench, wherein a first nozzle is attached to the first arm and a second nozzle is attached to the second arm.

14. The trench closing system of claim 13, wherein the fluid applicator has a slot for adjusting a position of the fluid applicator front to back along the direction of travel.

15. The trench closing system of claim 13 or 14, wherein the first arm has a slot for adjusting a vertical position of the first nozzle and the second arm has a slot for adjusting a vertical position of the second nozzle.

16. The trench closing system of any of claims 13 to 15, wherein the nozzle is adjustable transverse to the direction of travel.

17. The trench closing system of any of claims 1 to 11 further comprising a first arm connected to the axle of the first closing wheel and disposed between the closing wheel and the frame member, the first arm extending opposite to the forward direction of travel and having a first nozzle for applying a fluid to the soil surface.

18. The trench closing system of claim 17, wherein the first arm has a slot for adjusting a position of the first nozzle front to back along the direction of travel.

19. The trench closing system of any of claims 1 to 11, wherein the first closing wheel soil deflector further comprise a nozzle.

20. The trench closing system of any of claims 7 to 11 or 19, wherein the first press wheel soil deflector further comprises a nozzle.

21. A trench closing system for a row unit of an agricultural planter, the row unit having a row unit frame supporting an opener disk for opening a seed trench in a soil surface as the row unit travels in a forward direction of travel, the trench closing system comprising:

a main frame supported by and extending rearwardly from the row unit frame;

a frame member pivotally supported from the main frame;

a pair of closing wheels each rotatably supported by the frame member with a first one of the pair of closing wheels disposed on a first side of the seed trench and a second one of the pair of closing wheels disposed on a second side of the seed trench, the pair of closing wheels cooperating with one another to close the opened seed trench with soil as the row unit travels in the forward direction of travel;

a mounting arm pivotally mounted to the frame member, the mounting arm supporting a press wheel rearward of the closing wheels; and

a fluid applicator disposed on the mounting arm to apply fluid to the soil surface.

22. The trench closing system of claim 21, wherein the fluid applicator comprises a frame that is disposed over the mounting arm and having a first arm on the first side of the seed trench and a second arm on the second side of the seed trench, wherein a first nozzle is attached to the first arm and a second nozzle is attached to the second arm.

23. The trench closing system of claim 22, wherein the fluid applicator has a slot for adjusting a position of the fluid applicator front to back along the direction of travel.

24. The trench closing system of claim 22 or 23, wherein the first arm has a slot for adjusting a vertical position of the first nozzle and the second arm has a slot for adjusting a vertical position of the second nozzle.

25. The trench closing system of any of claims 22 to 24, wherein the first nozzle and the second nozzle are adjustable transverse to the direction of travel.

26. A trench closing system for a row unit of an agricultural planter, the row unit having a row unit frame supporting an opener disk for opening a seed trench in a soil surface as the row unit travels in a forward direction of travel, the trench closing system comprising:

a main frame supported by and extending rearwardly from the row unit frame;

a frame member pivotally supported from the main frame;

a pair of closing wheels each rotatably supported by the frame member with a first one of the pair of closing wheels disposed on a first side of the seed trench and a second one of the pair of closing wheels disposed on a second side of the seed trench, the pair of closing wheels cooperating with one another to close the opened seed trench with soil as the row unit travels in the forward direction of travel; and

a first arm connected to the axle of the first closing wheel and disposed between the closing wheel and the frame member, the first arm extending opposite to the forward direction of travel and having a first nozzle for applying a fluid to the soil surface.

27. The trench closing system of claim 26, wherein the first arm has a slot for adjusting a position of the first nozzle front to back along the direction of travel.

28. A trench closing system for a row unit of an agricultural planter, the row unit having a row unit frame supporting an opener disk for opening a seed trench in a soil surface as the row unit travels in a forward direction of travel, the trench closing system comprising:

a main frame supported by and extending rearwardly from the row unit frame;

a frame member pivotally supported from the main frame;

a pair of closing wheels each rotatably supported by the frame member with a first one of the pair of closing wheels disposed on a first side of the seed trench and a second one of the pair of closing wheels disposed on a second side of the seed trench, the pair of closing wheels

cooperating with one another to close the opened seed trench with soil as the row unit travels in the forward direction of travel;

a first closing wheel scraper connected at a first end to an axle of the first closing wheel extending towards said first closing wheel, following a contour of said first closing wheel, and extending opposite to the forward direction of travel at a second end.

29. The trench closing system of claim 28, wherein the first closing wheel scraper further includes a nozzle.

30. The trench closing system of claim 29, wherein the nozzle is disposed the second end.

31. The trench closing system of any of claims 28 to 30, wherein the second end extends beyond the first closing wheel.

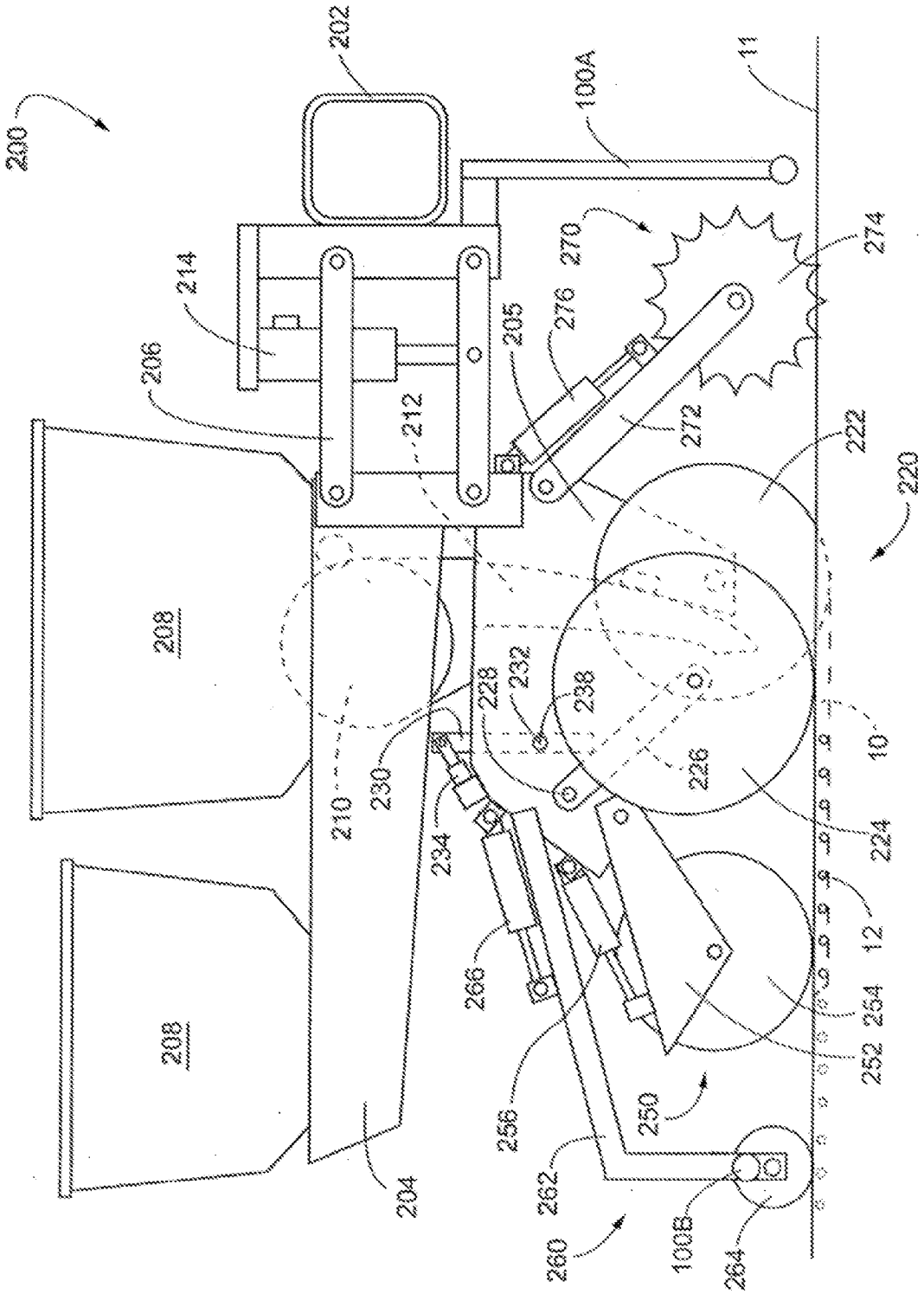

200
202
100A
11
214
206
212
205
276
270
274
272
222
220
208
208
228
232
238
210
230
226
10
234
224
12
266
254
252
256
250
262
204
260
100B
264

FIG. 1

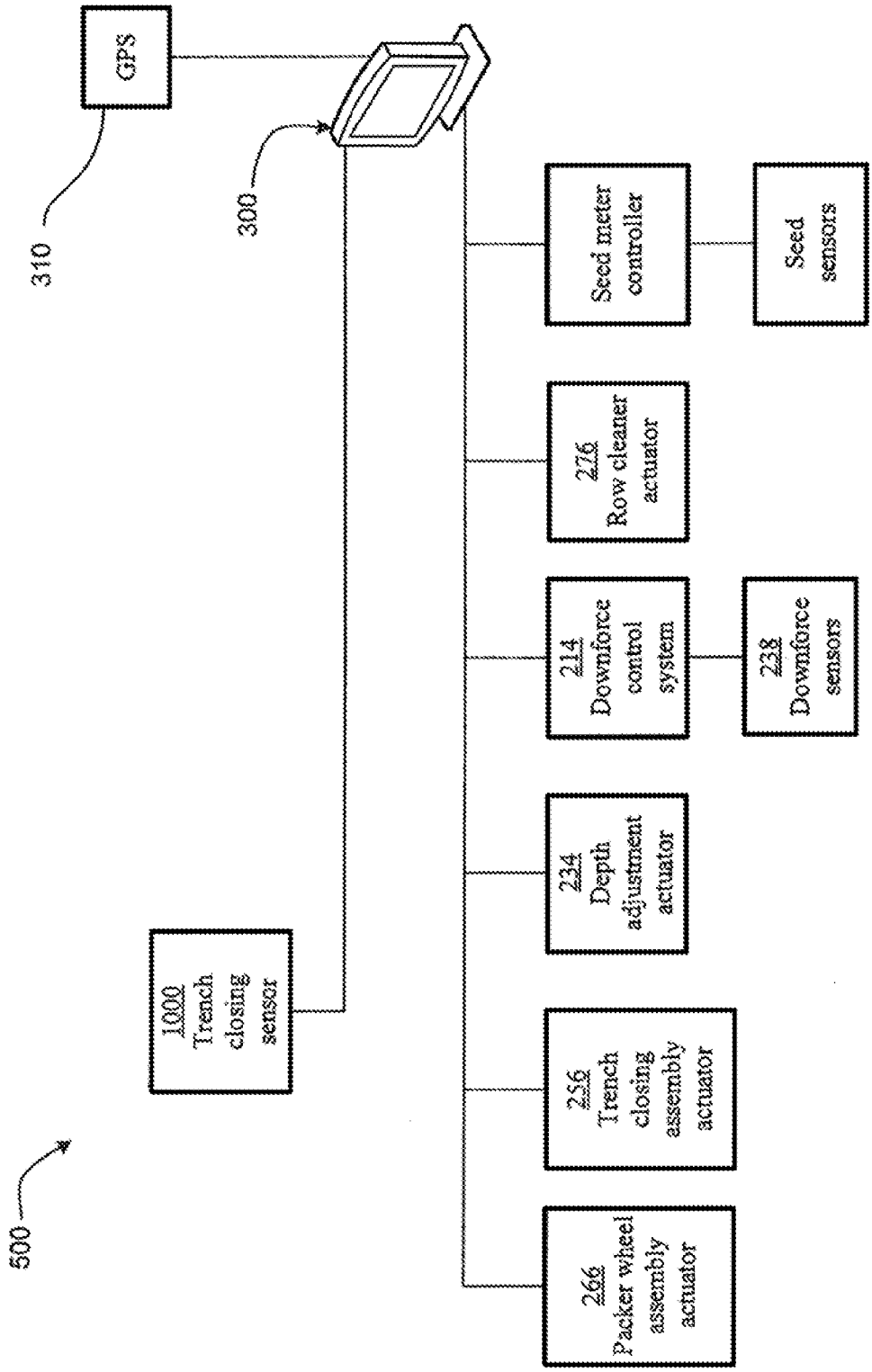

GPS
310
300
Seed meter controller
Seed sensors
276 Row cleaner actuator
214 Downforce control system
238 Downforce sensors
234 Depth adjustment actuator
1000 Trench closing sensor
256 Trench closing assembly actuator
266 Packer wheel assembly actuator
500

FIG. 2

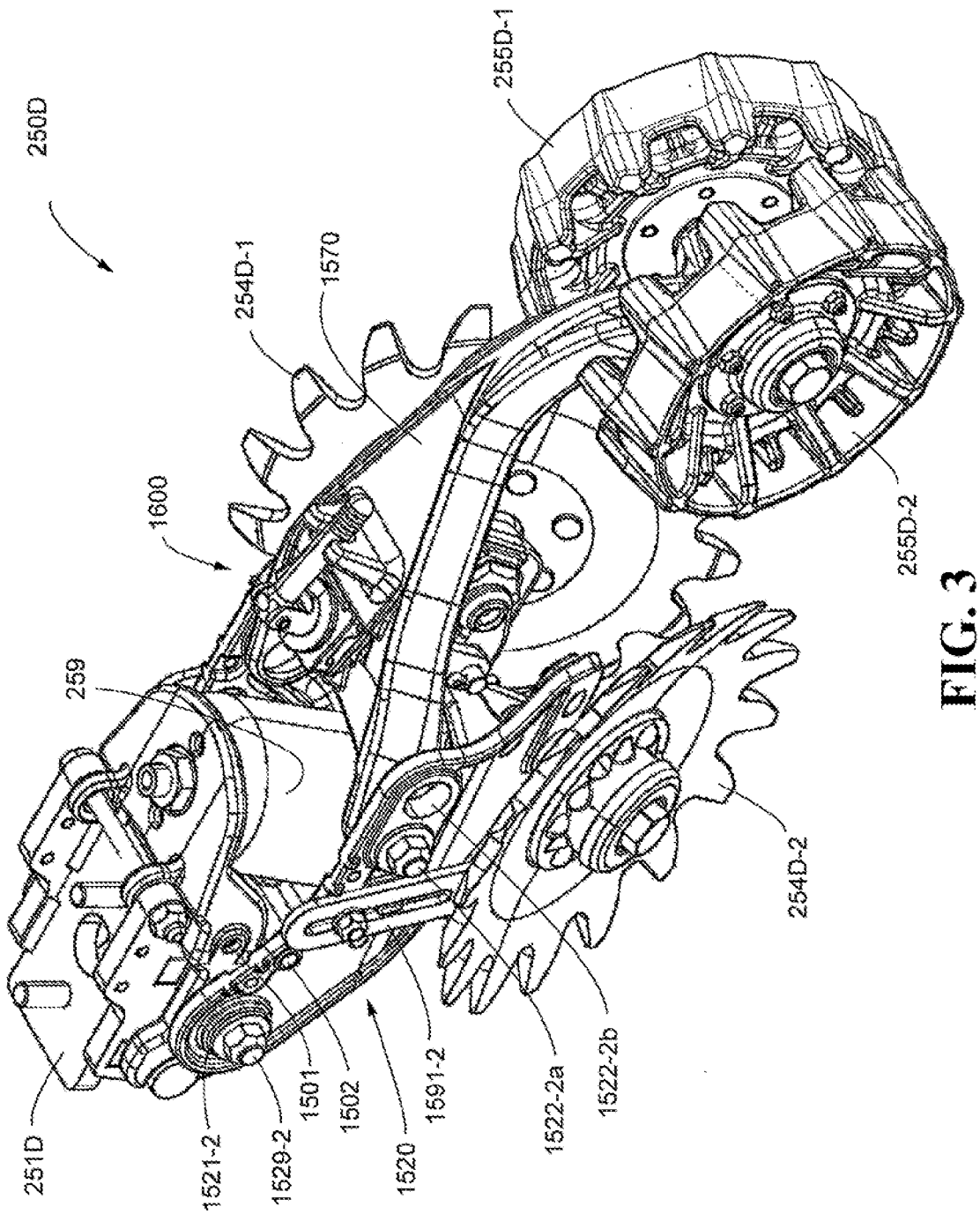

250D
255D-1
254D-1
1570
1600
259
255D-2
254D-2
251D
1521-2
1529-2
1501
1502
1520
1591-2
1522-2a
1522-2b

FIG. 3

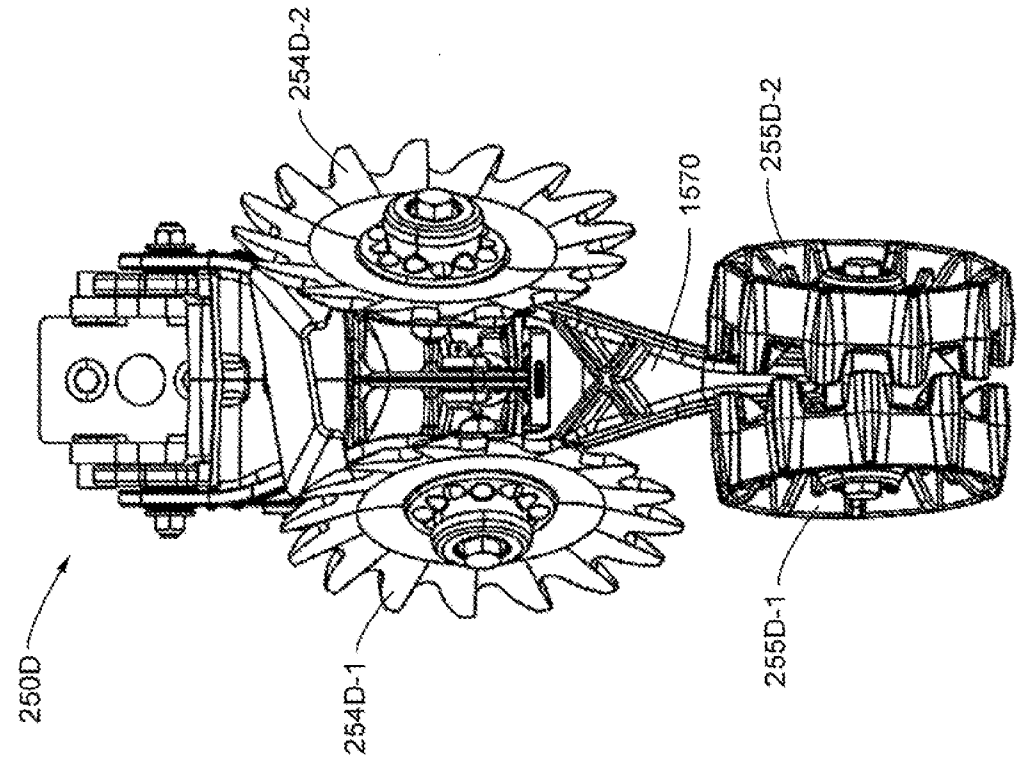

254D-2
1570
255D-2
250D
254D-1
255D-1

FIG. 5

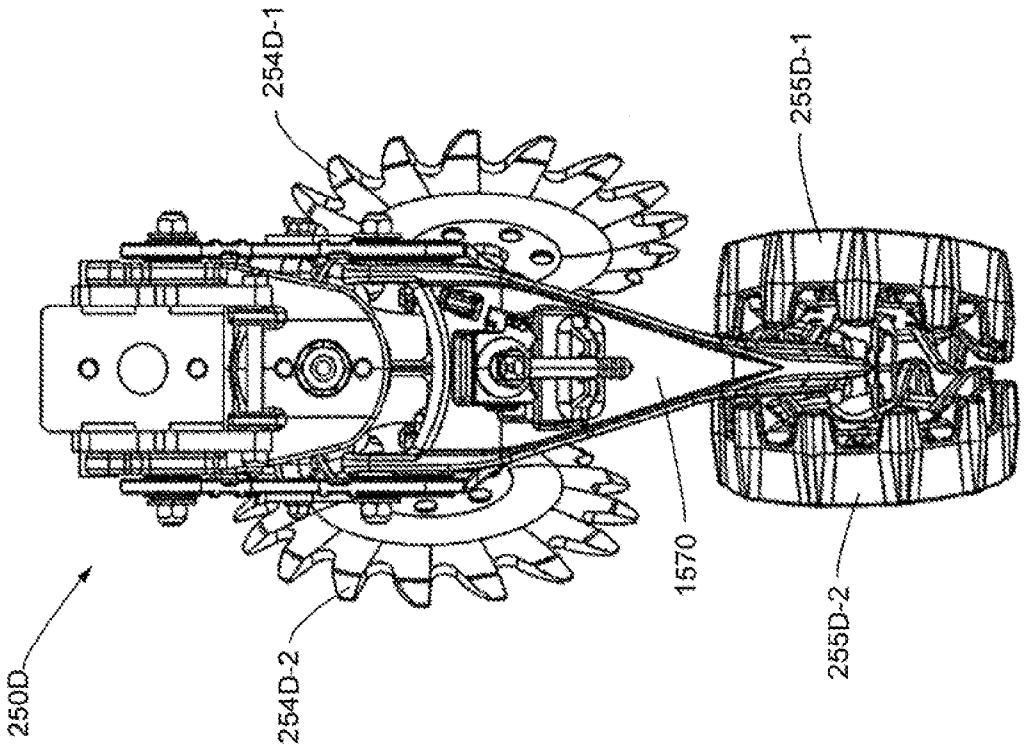

254D-1
255D-1
250D
254D-2
1570
255D-2

FIG. 4

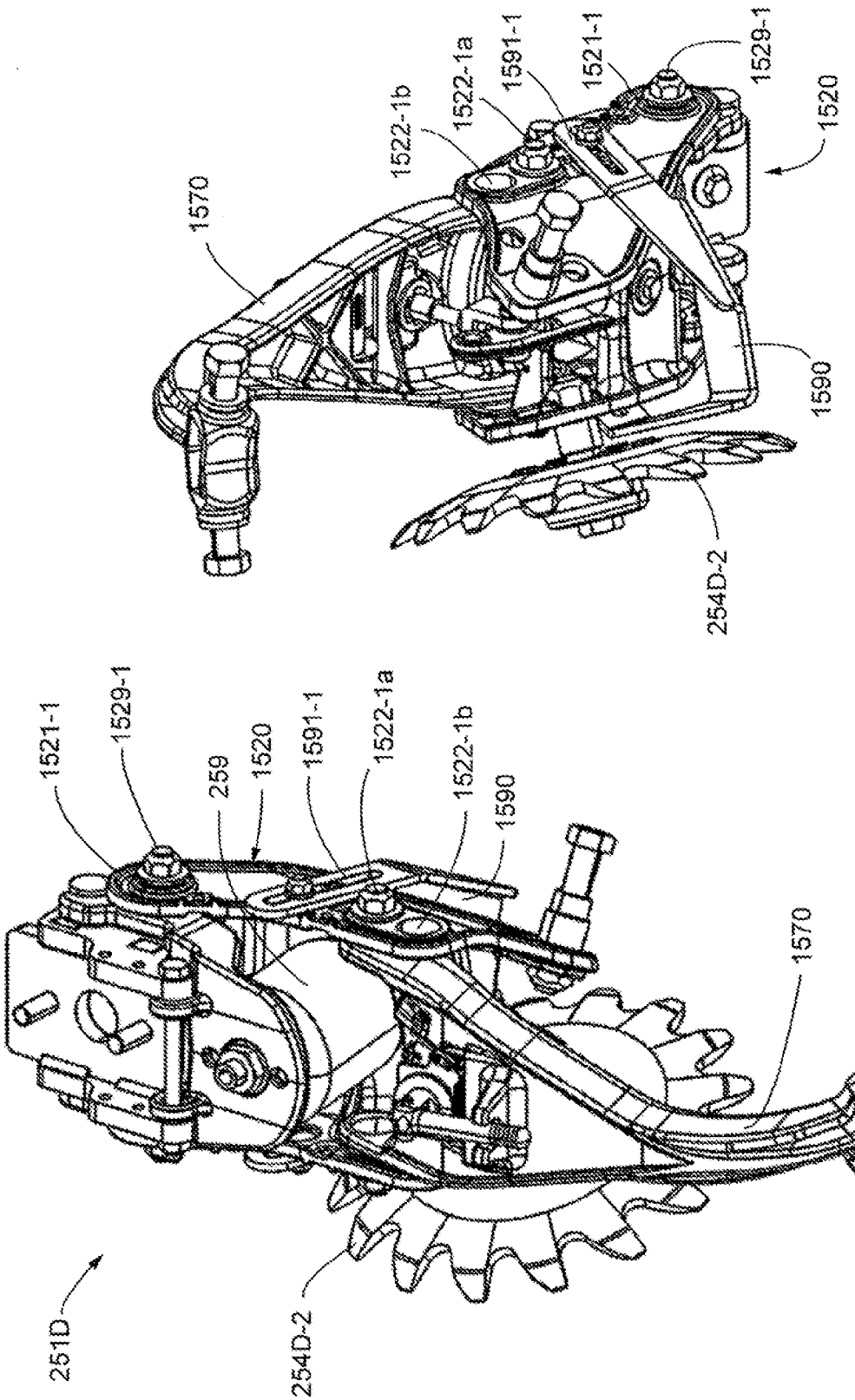

1570
1522-1b
1522-1a
1591-1
1521-1
1529-1
1520
1590
254D-2

FIG. 7

1521-1
1529-1
259
1520
1591-1
1522-1a
1522-1b
1590
1570
251D
254D-2

FIG. 6

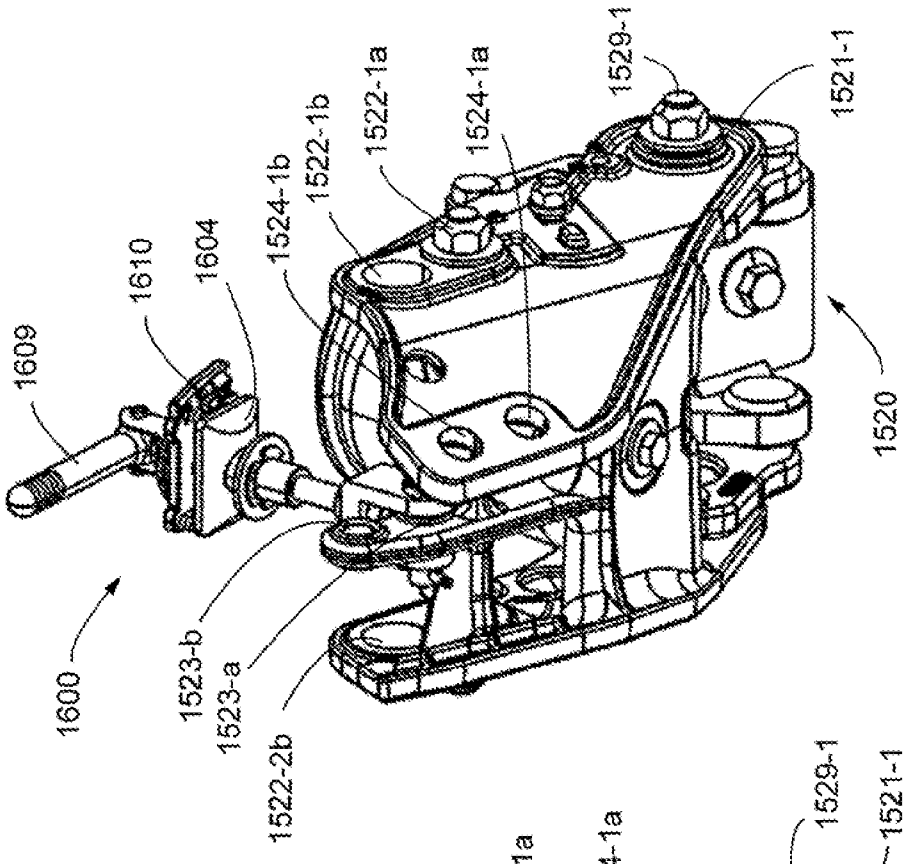

1609
1610
1604
1524-1b
1522-1b
1522-1a
1524-1a
1529-1
1521-1
1520
1600
1523-b
1523-a
1522-2b

FIG. 9

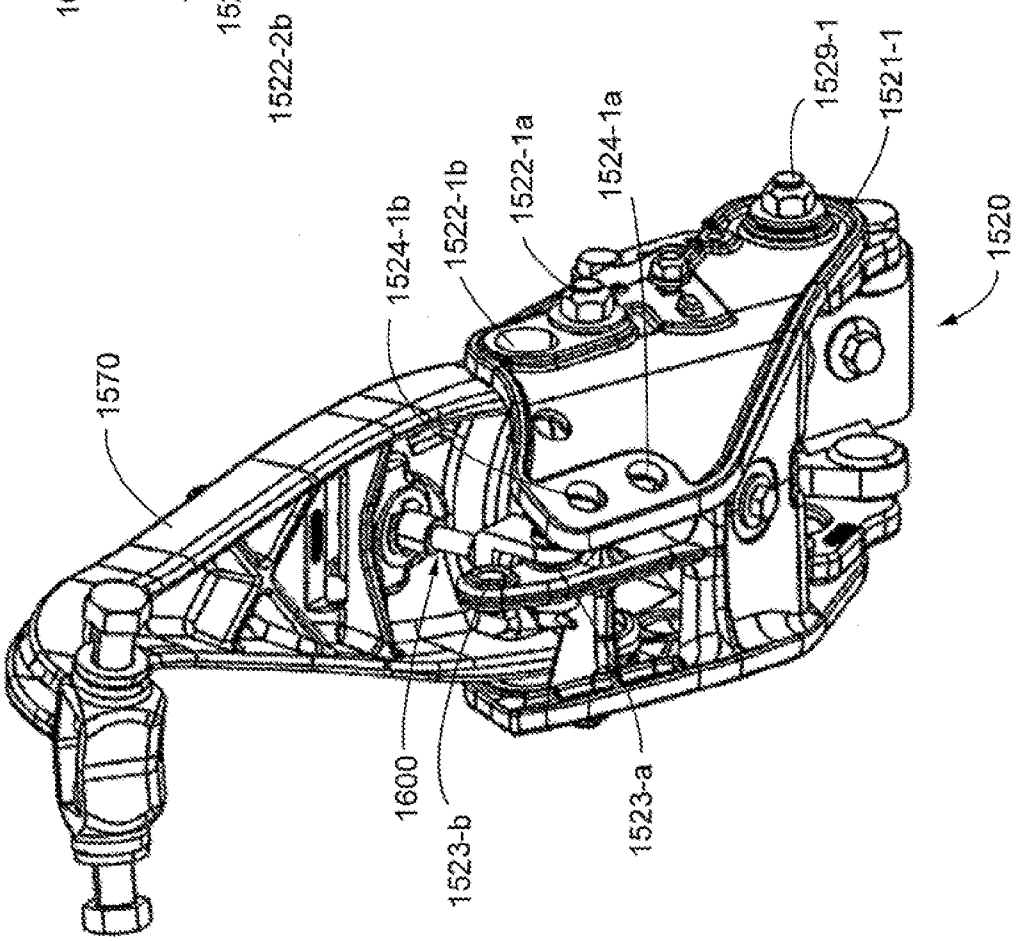

1570
1524-1b
1522-1b
1522-1a
1524-1a
1529-1
1521-1
1520
1600
1523-b
1523-a

FIG. 8

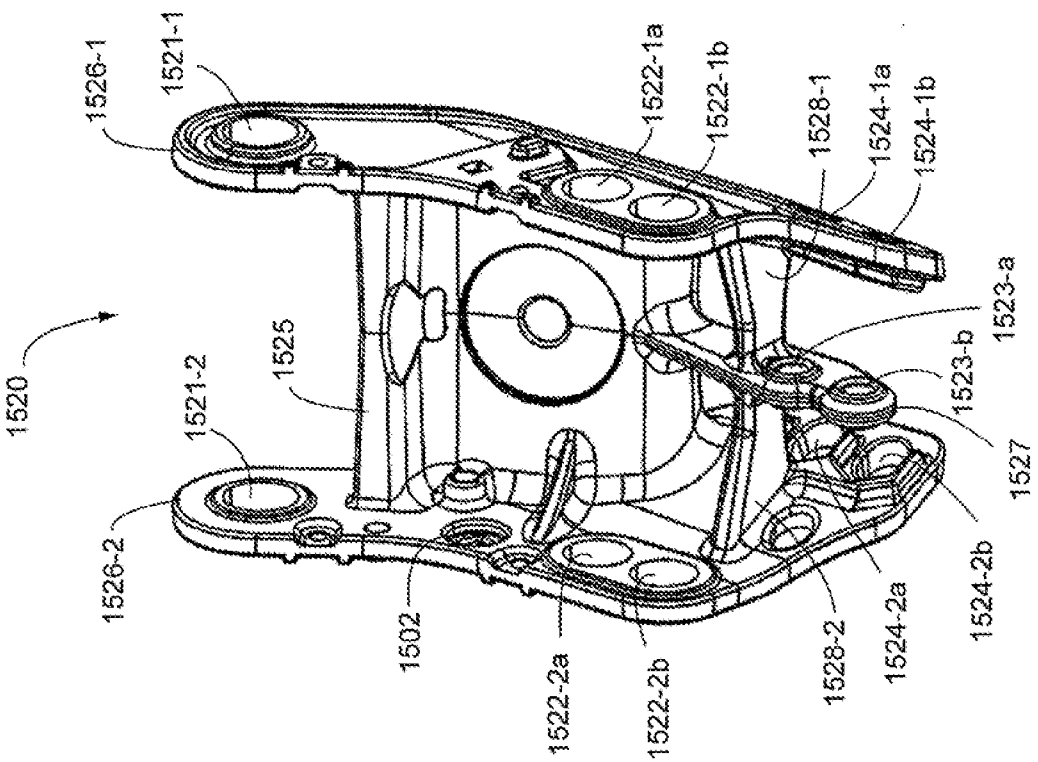

1520
1526-1
1521-1
1522-1a
1522-1b
1528-1
1524-1a
1524-1b
1523-a
1523-b
1527
1524-2b
1524-2a
1528-2
1522-2b
1522-2a
1602
1526-2
1521-2
1525

FIG. 11

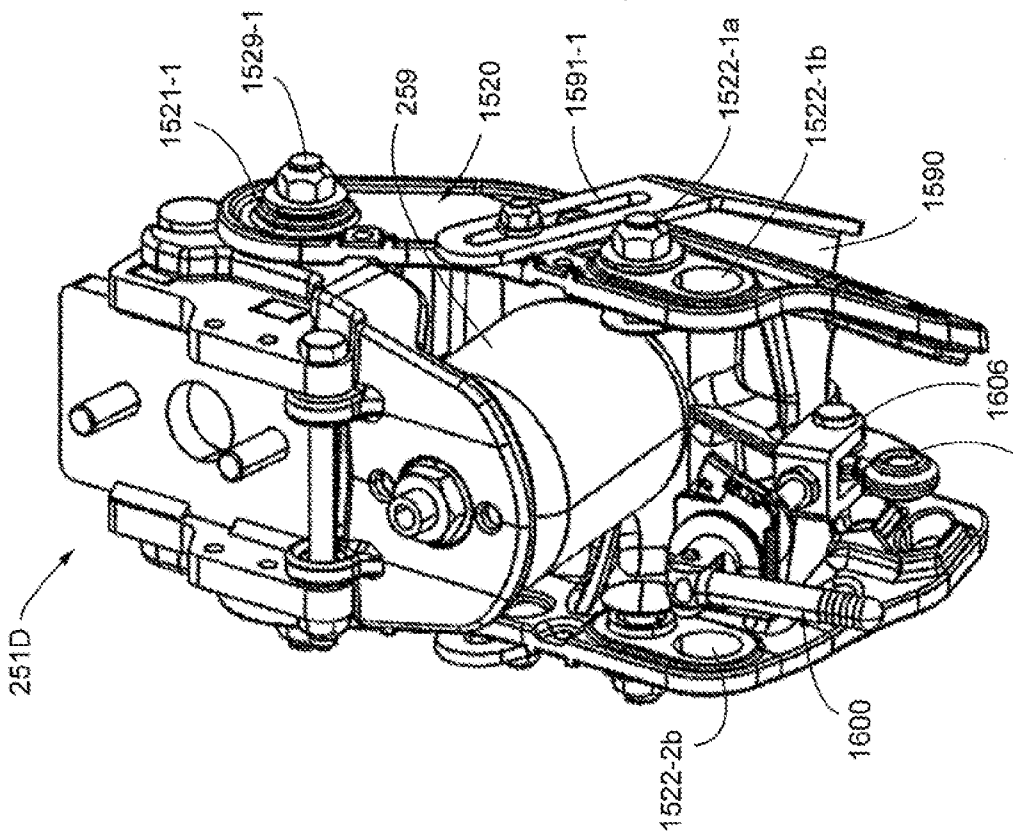

251D
1521-1
1529-1
259
1520
1591-1
1522-1a
1522-1b
1590
1606
1523-b
1600
1522-2b

FIG. 10

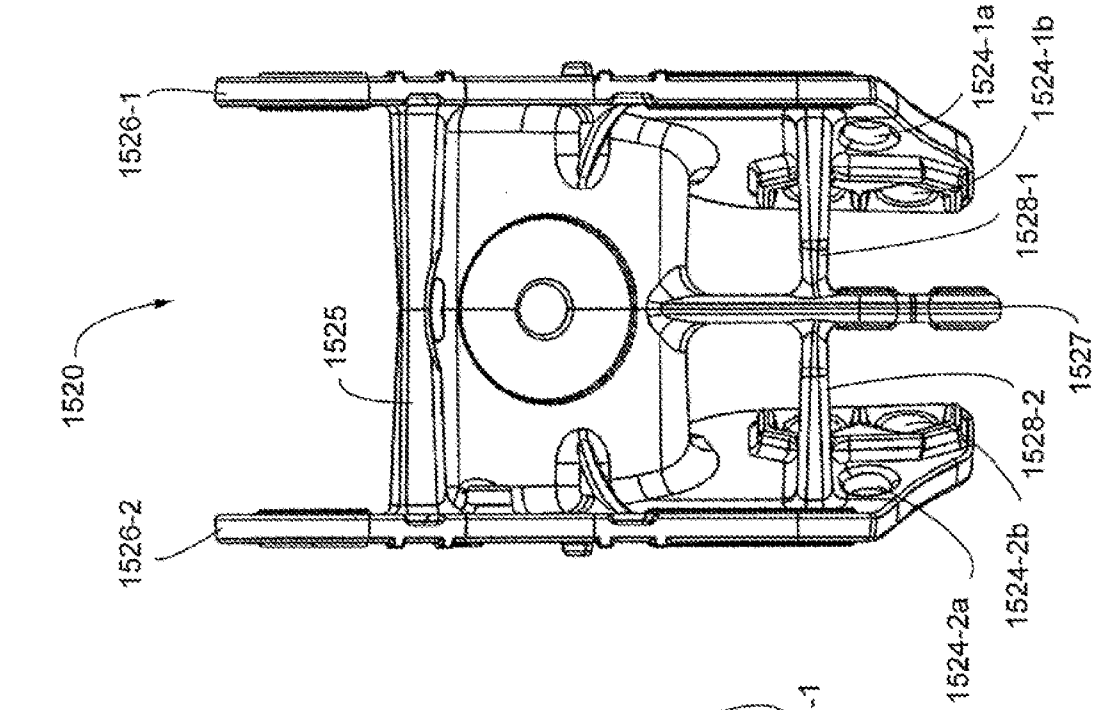

1520
1526-1
1526-2
1525
1524-1a
1524-1b
1528-1
1527
1528-2
1524-2b
1524-2a

FIG. 13

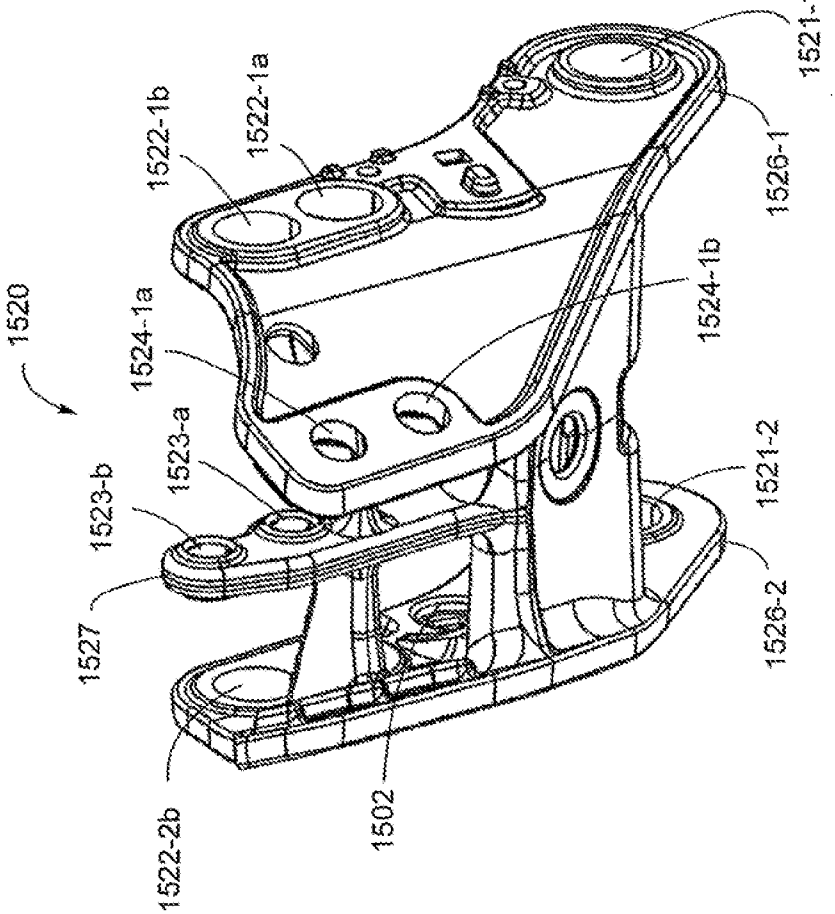

1520
1522-1b
1522-1a
1521-1
1526-1
1524-1a
1524-1b
1523-a
1523-b
1521-2
1527
1526-2
1522-2b
1502

FIG. 12

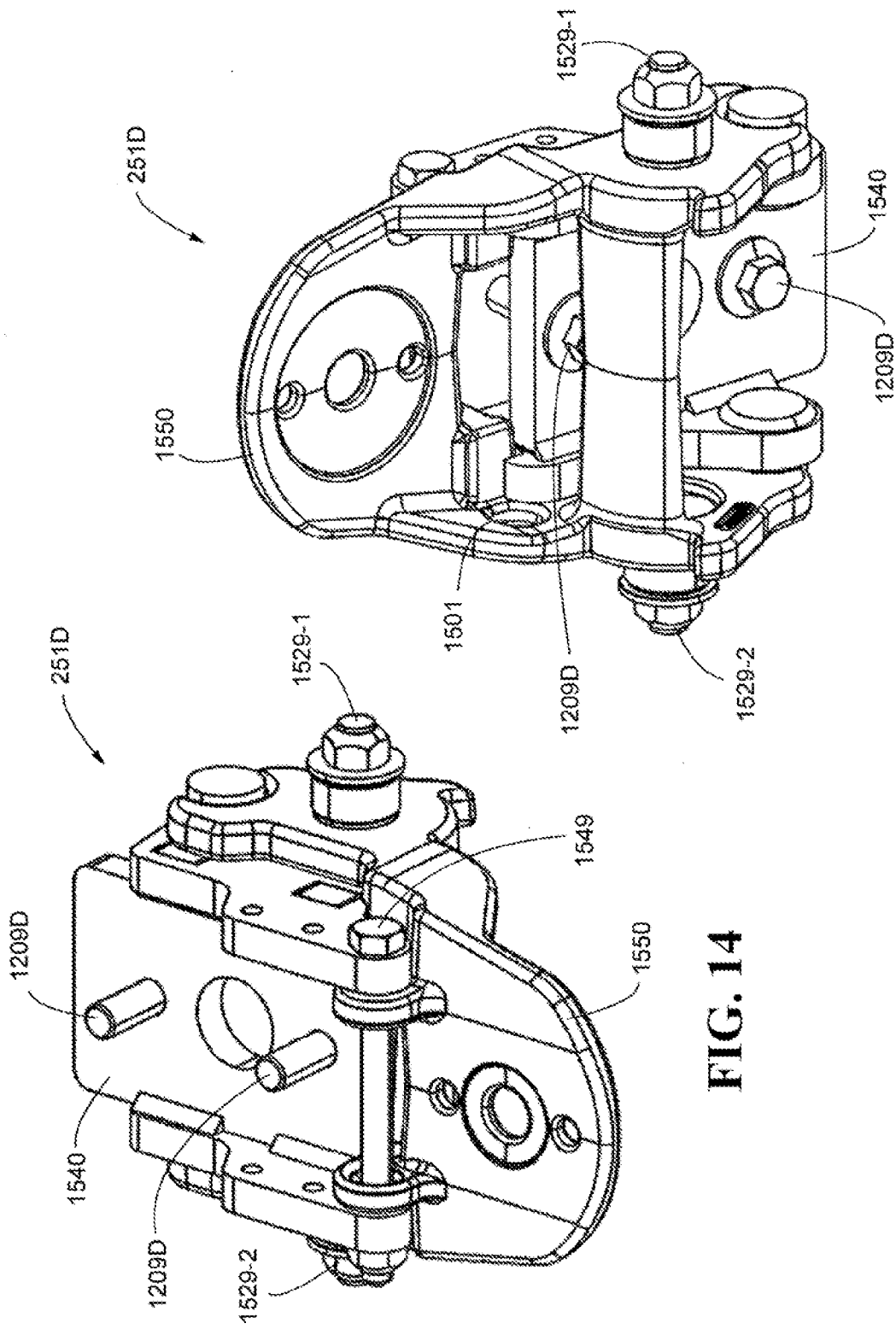

251D
1529-1
1540
1209D
1550
1501
1209D
1529-2
251D
1529-1
1549
1209D
1550
1540
1209D
1529-2

FIG. 15

FIG. 14

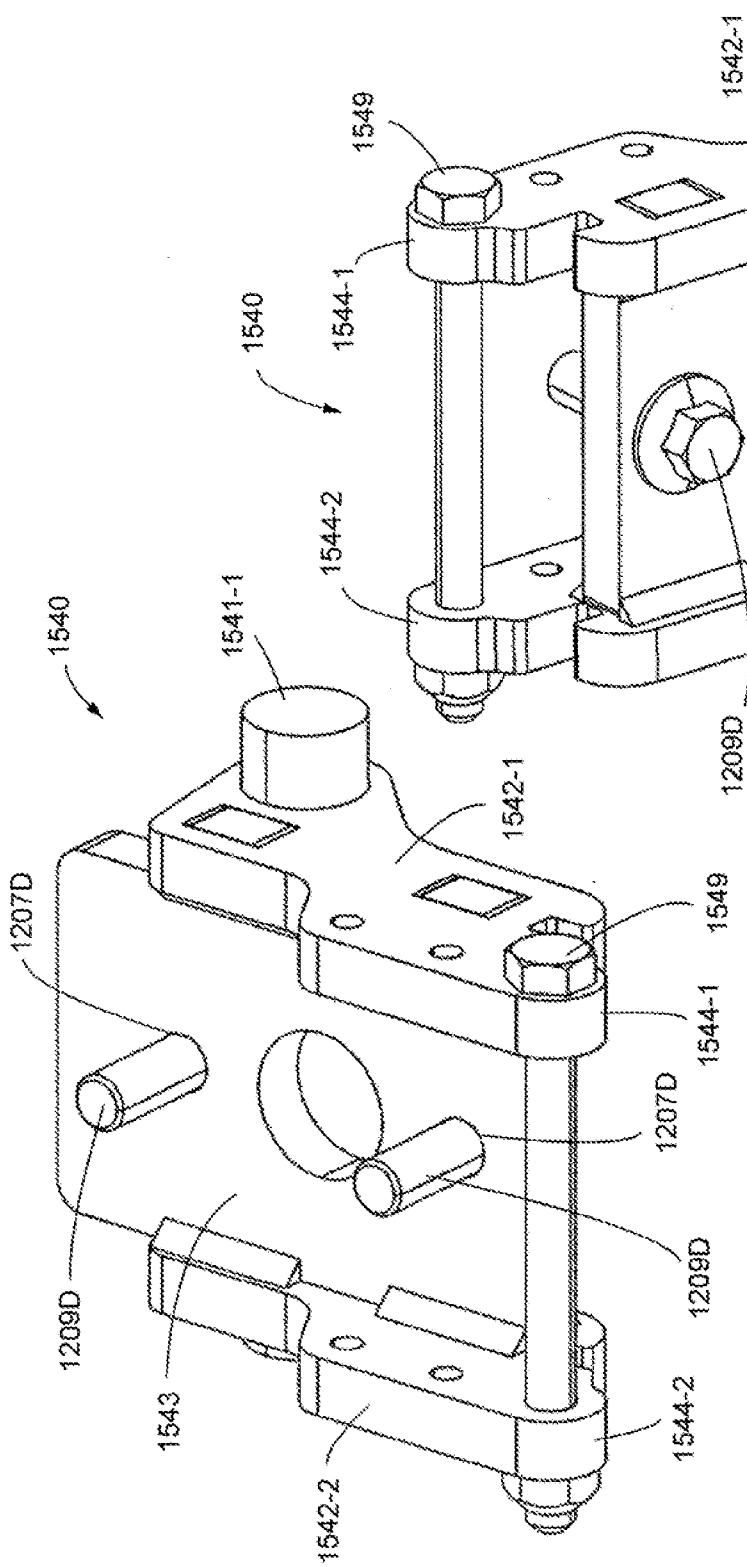

1540
1541-1
1542-1
1549
1544-1
1544-2
1542-2
1543
1207D
1209D

FIG. 16

1540
1549
1544-1
1542-1
1541-1
1209D
1544-2
1542-2
1541-2
1543

FIG. 17

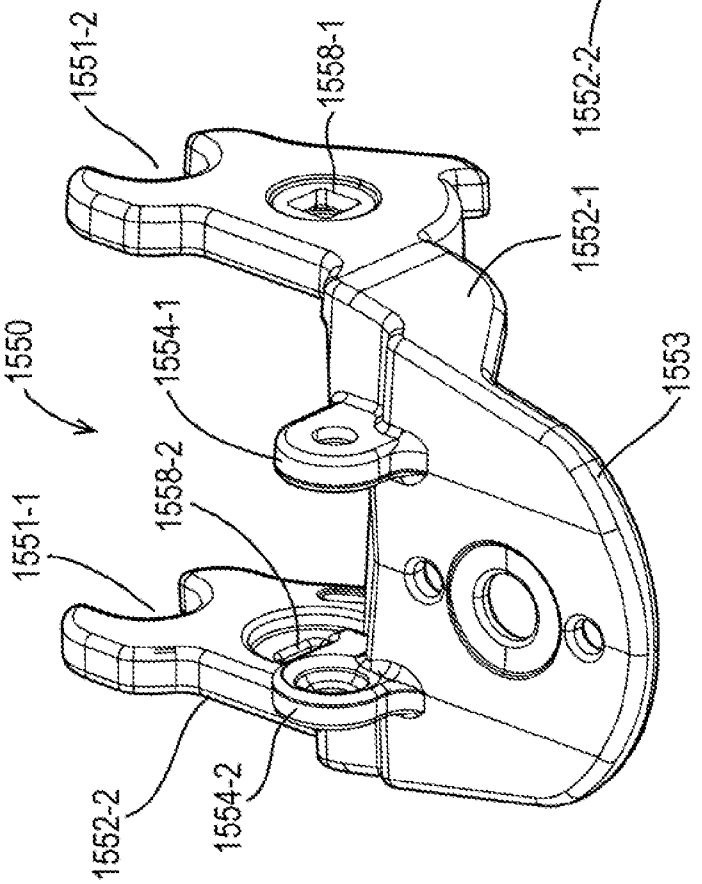

1550
1551-1
1551-2
1552-1
1552-2
1553
1554-1
1554-2
1558-1
1558-2

FIG. 18

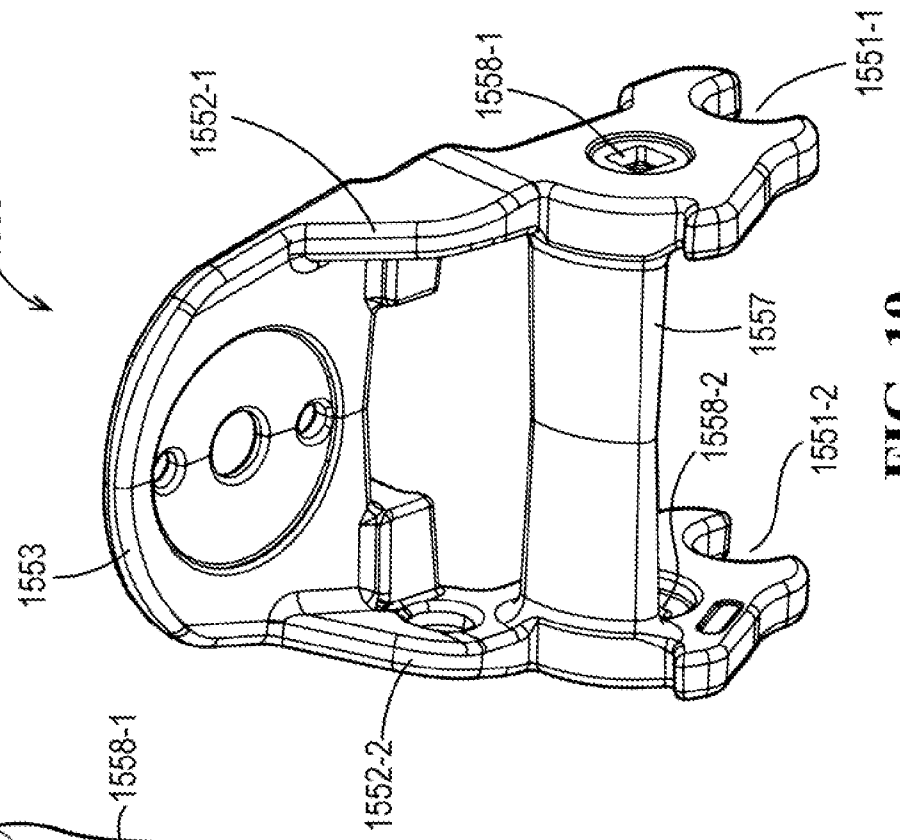

1550
1551-1
1551-2
1552-1
1552-2
1553
1557
1558-1
1558-2

FIG. 19

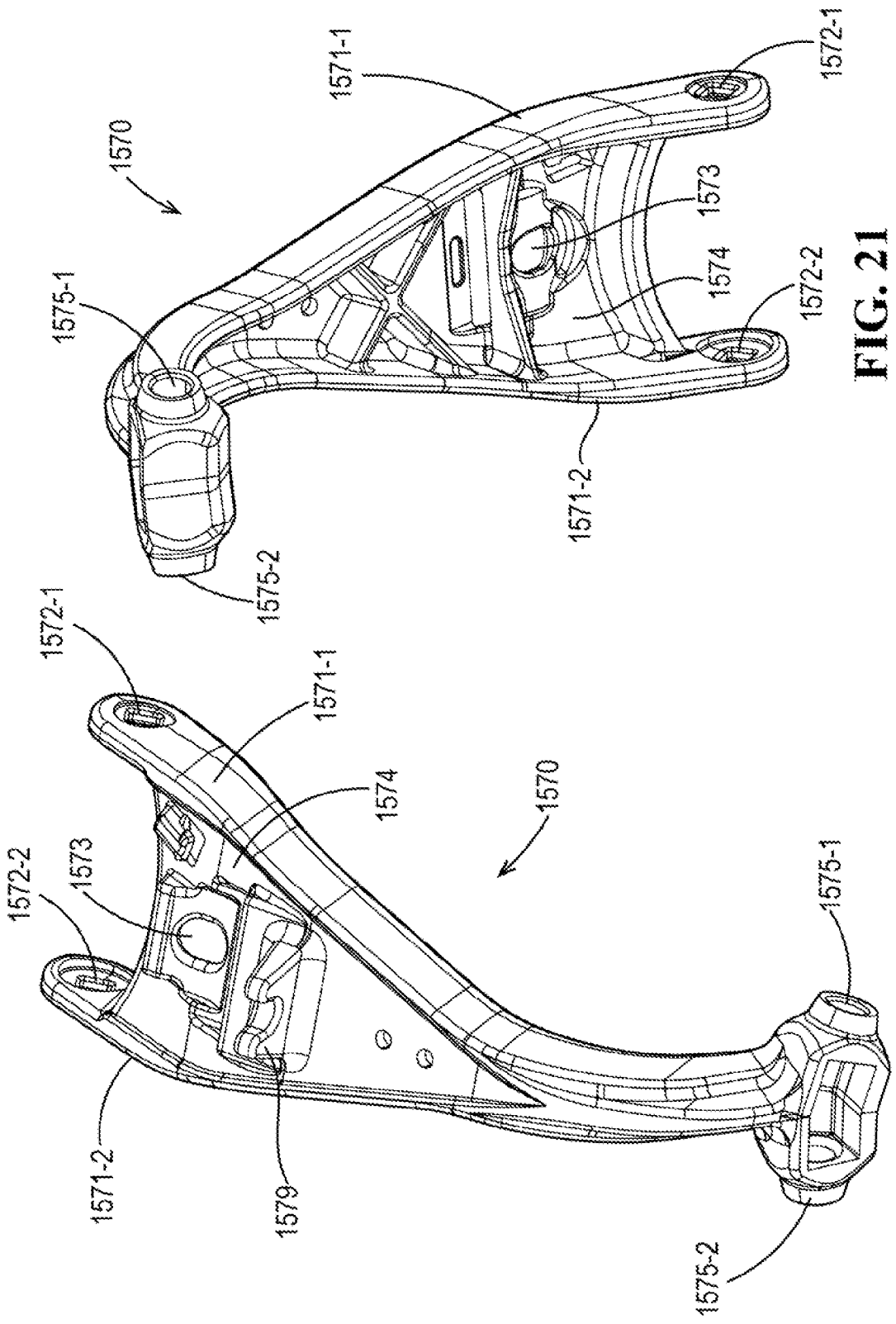

1570
1571-1
1572-1
1573
1574
1572-2
1575-1
1571-2
1575-2
1570
1572-1
1571-1
1574
1572-2
1573
1575-1
1571-2
1579
1575-2

FIG. 21

FIG. 20

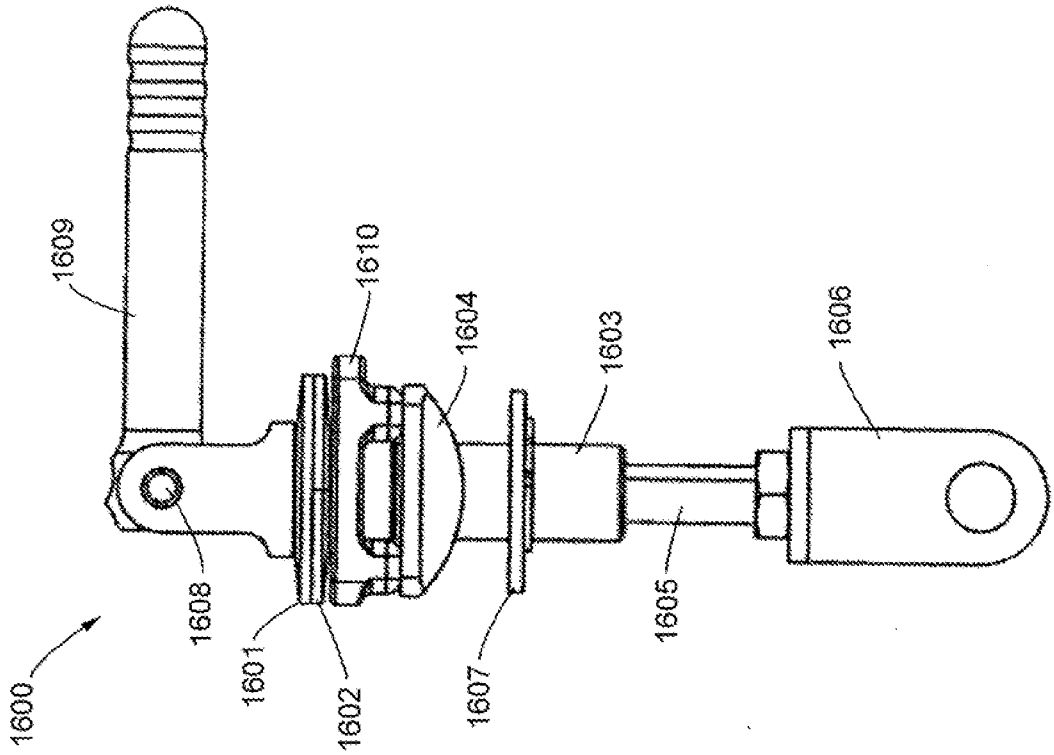

1600
1609
1608
1601
1602
1610
1604
1607
1603
1605
1606

FIG. 23

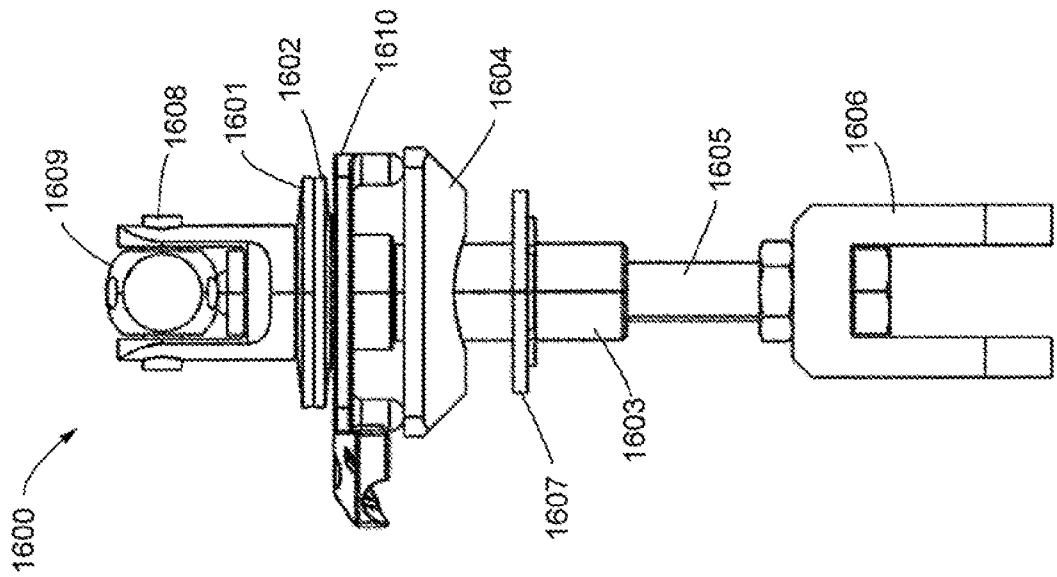

1600
1609
1608
1601
1602
1610
1604
1607
1603
1605
1606

FIG. 22

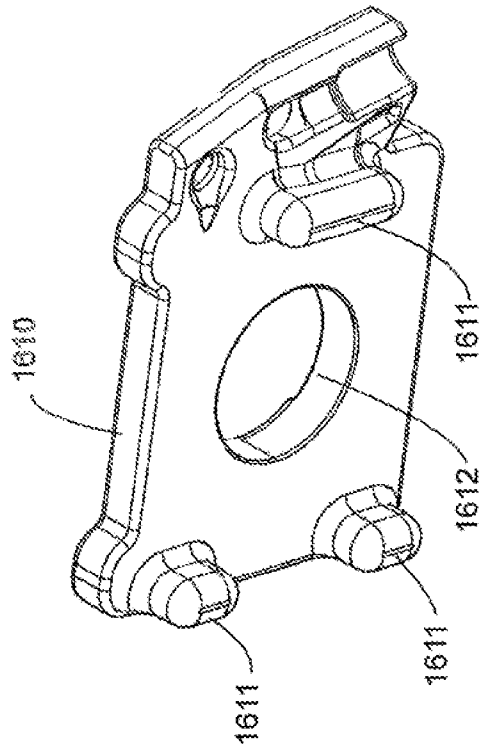


FIG. 26

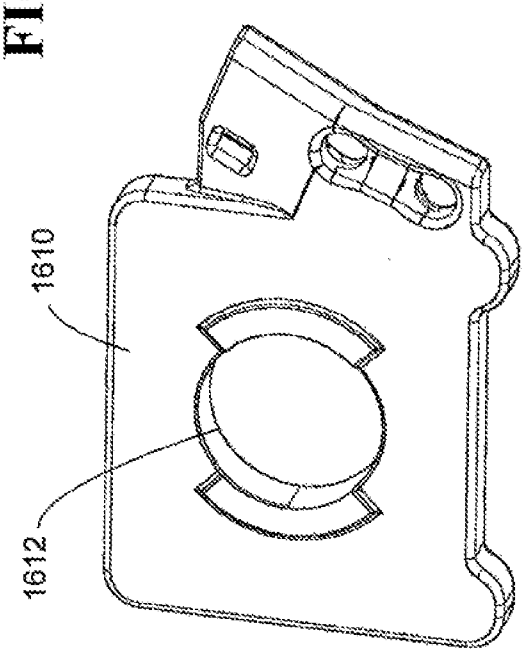


FIG. 25

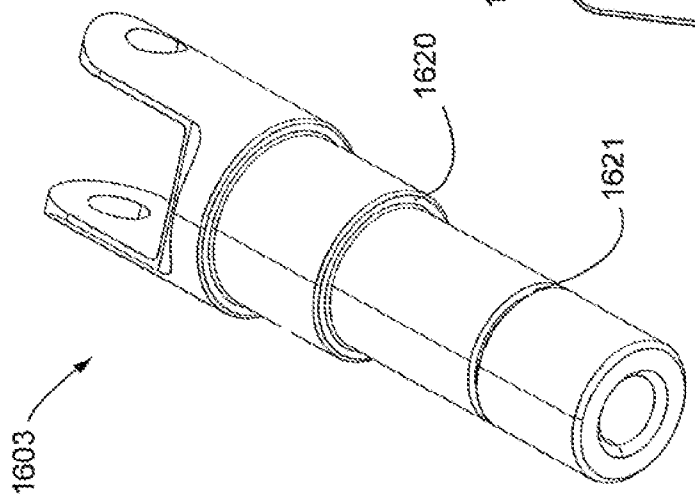


FIG. 24

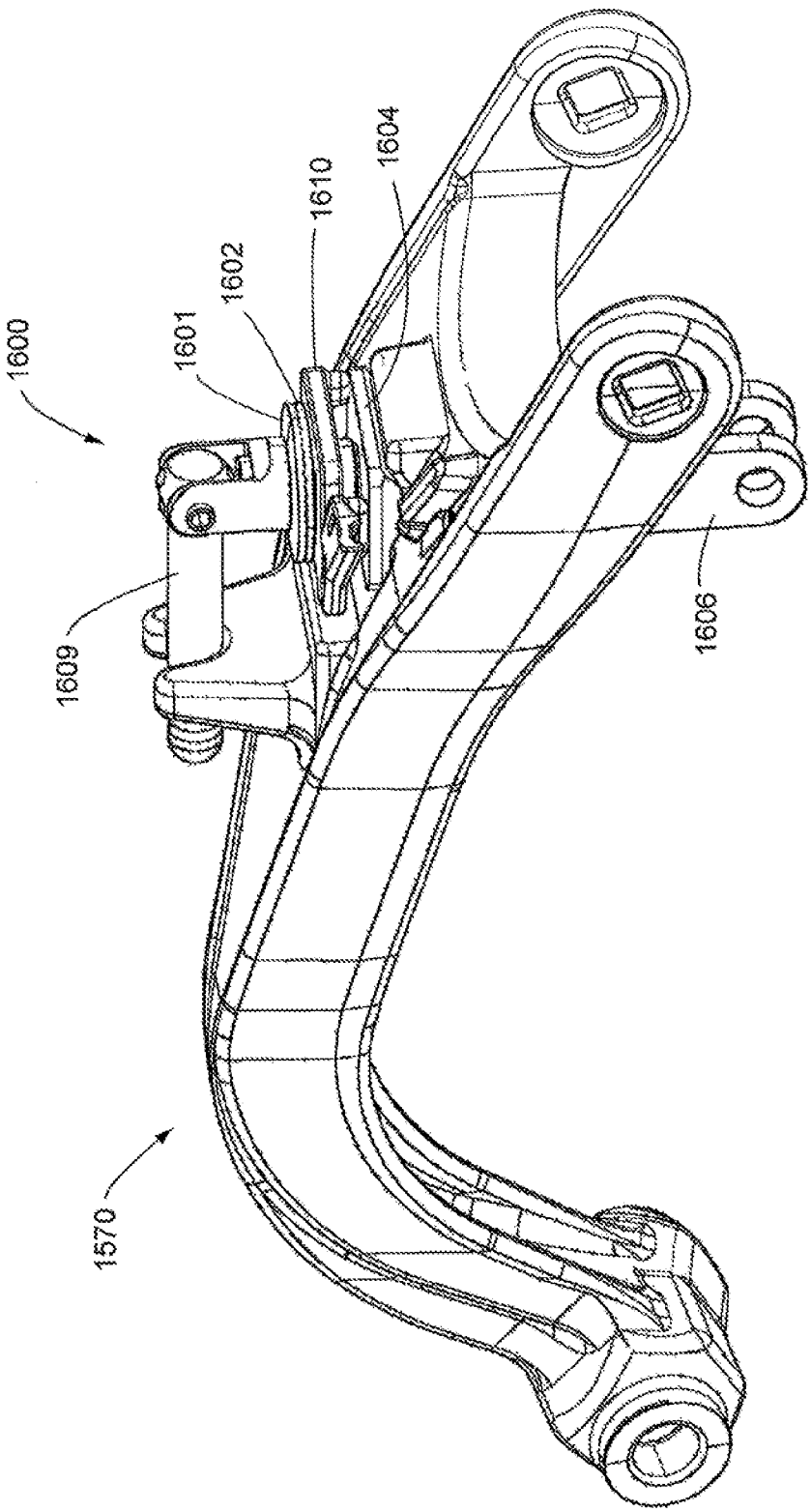


FIG. 27

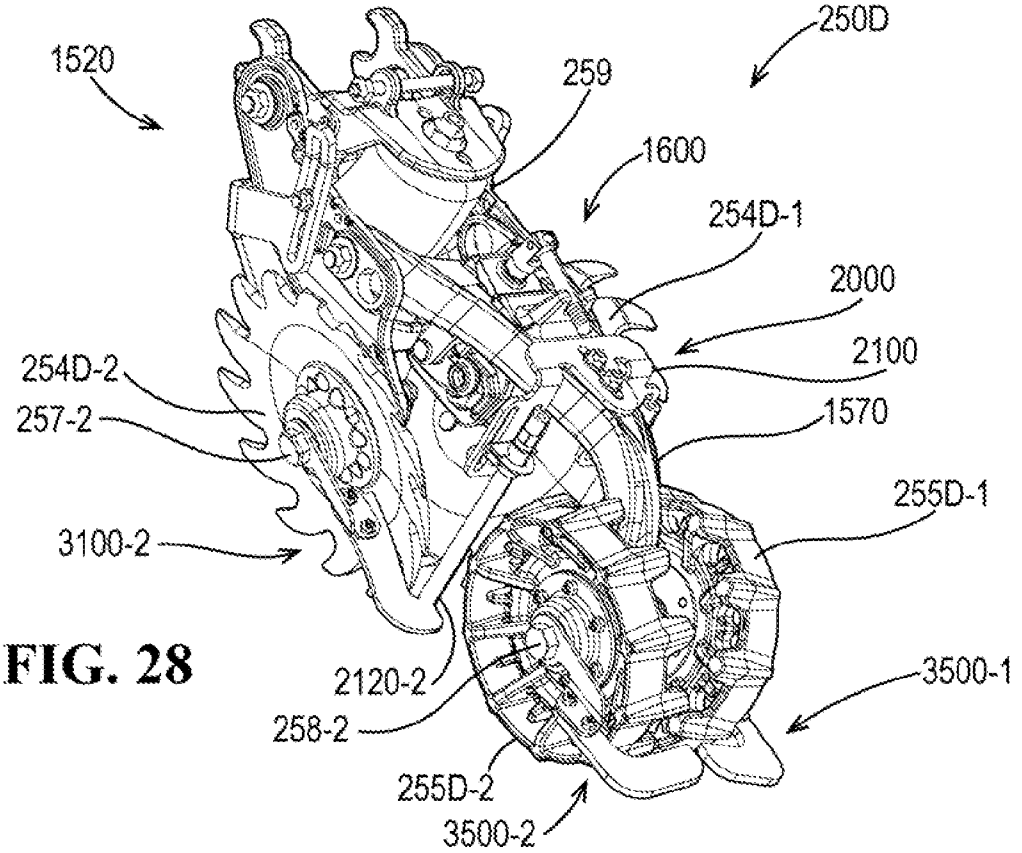

1520
259
250D
1600
254D-1
2000
2100
254D-2
257-2
1570
255D-1
3100-2
2120-2
3500-1
258-2
255D-2
3500-2

FIG. 28

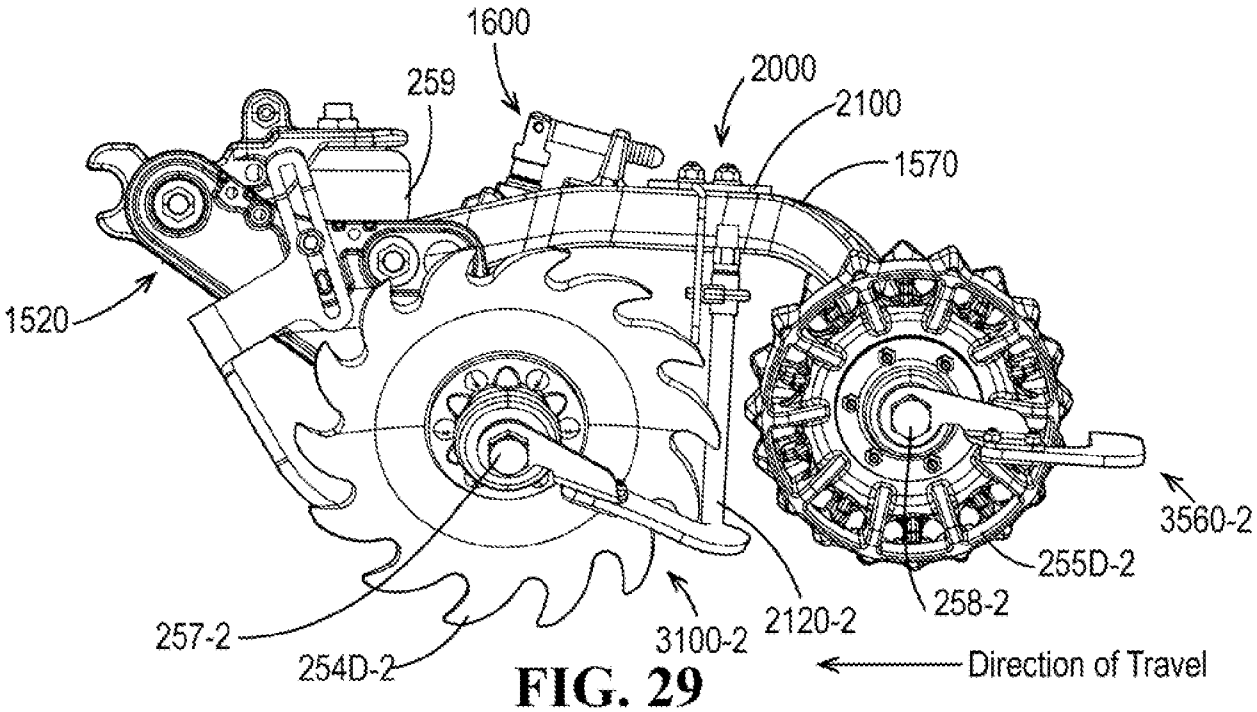

1600
259
2000
2100
1570
1520
3560-2
255D-2
258-2
257-2
254D-2
3100-2
2120-2
Direction of Travel

FIG. 29

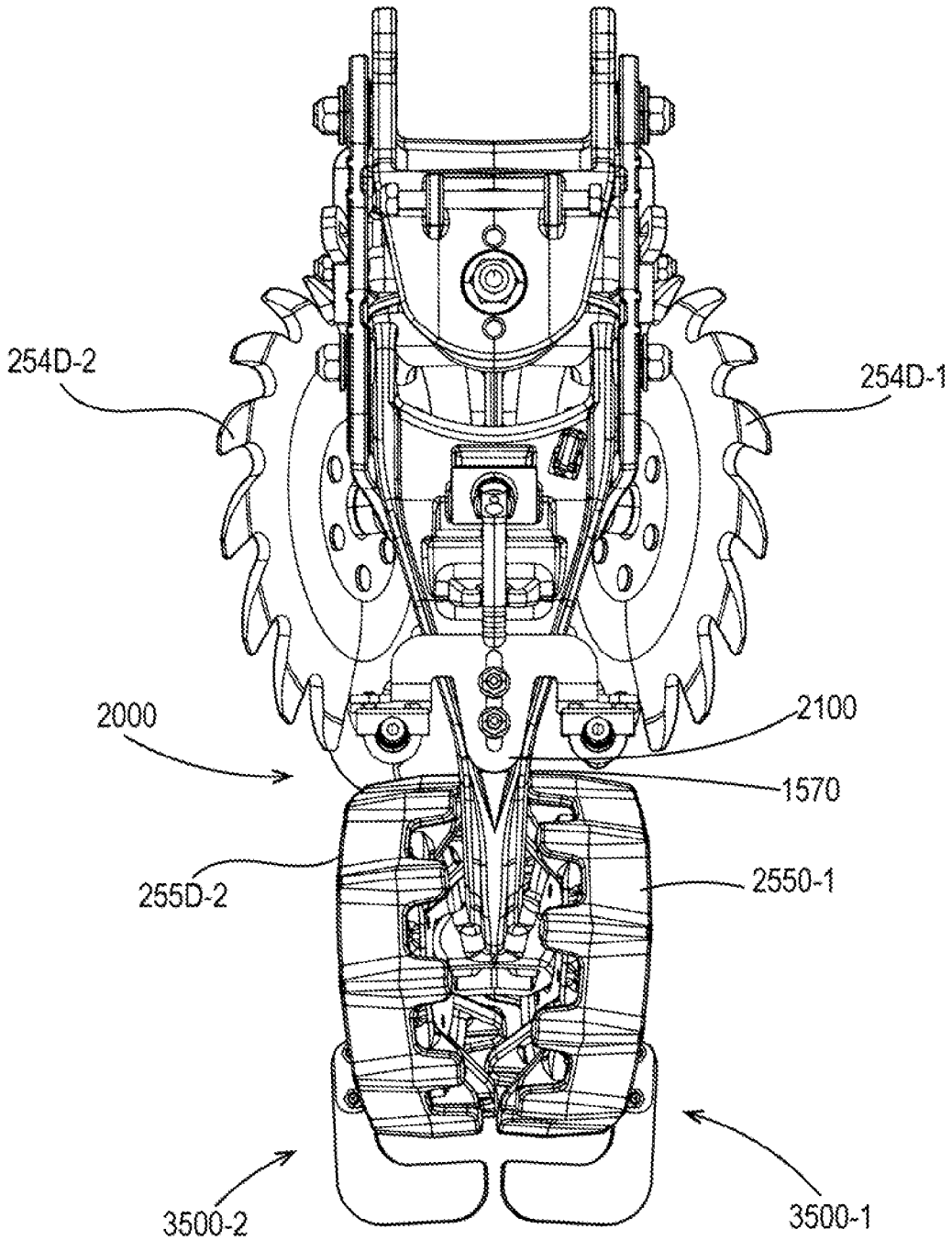


FIG. 30

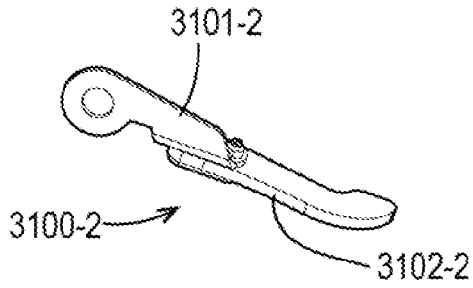


FIG. 31

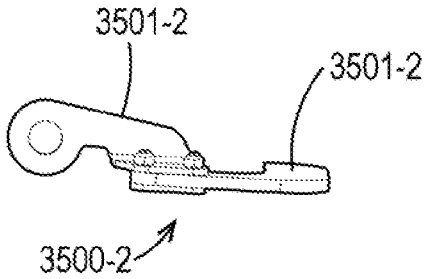


FIG. 32

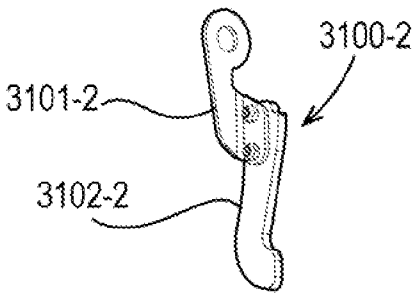


FIG. 33

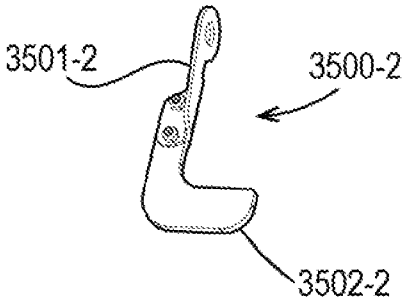


FIG. 34

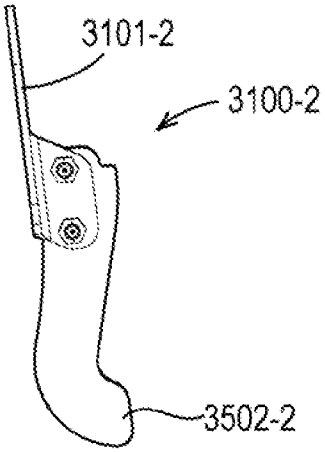


FIG. 35

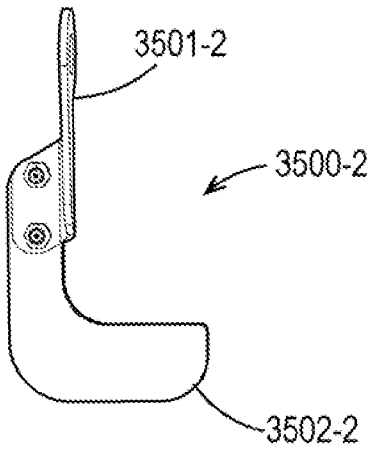


FIG. 36

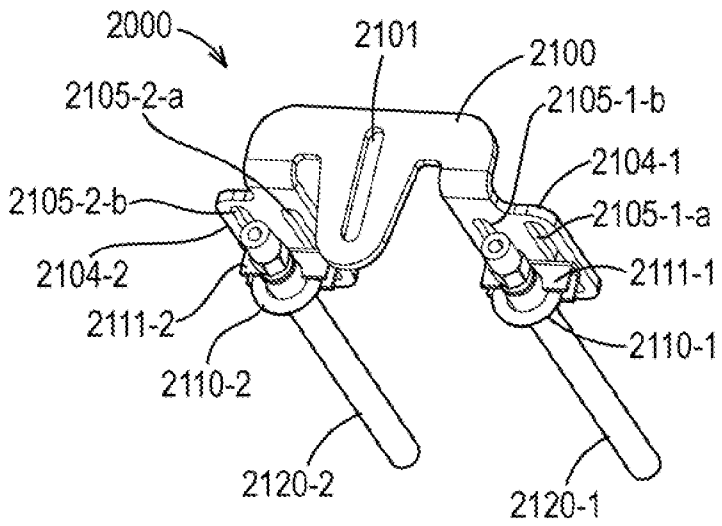


FIG. 37

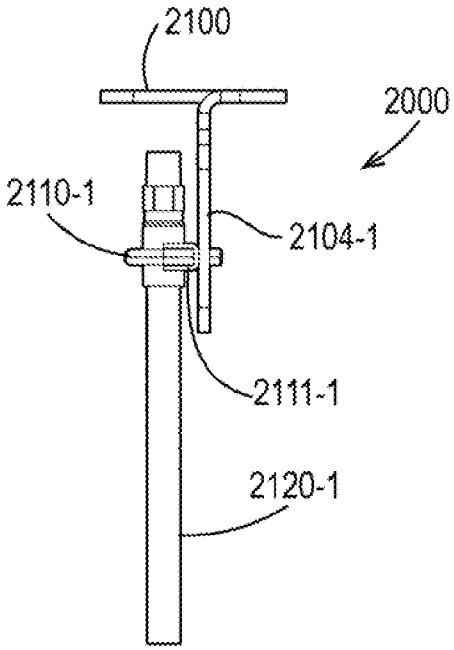


FIG. 38

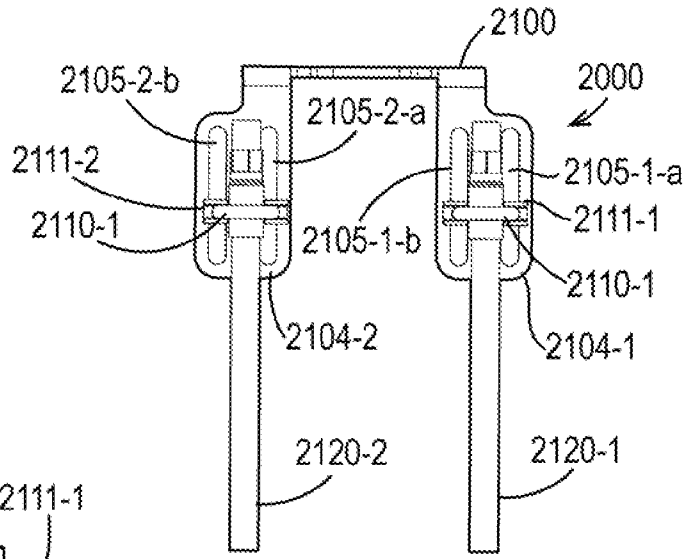


FIG. 40

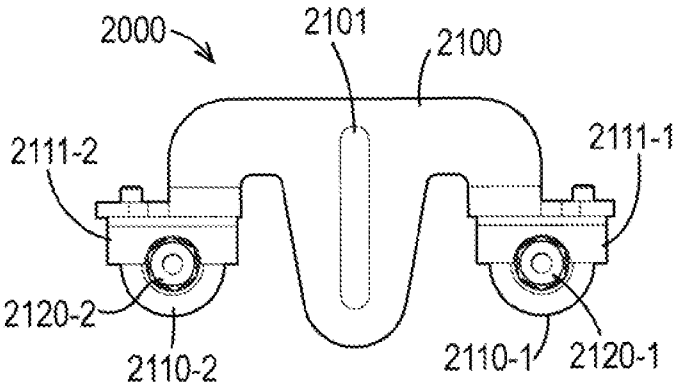


FIG. 39

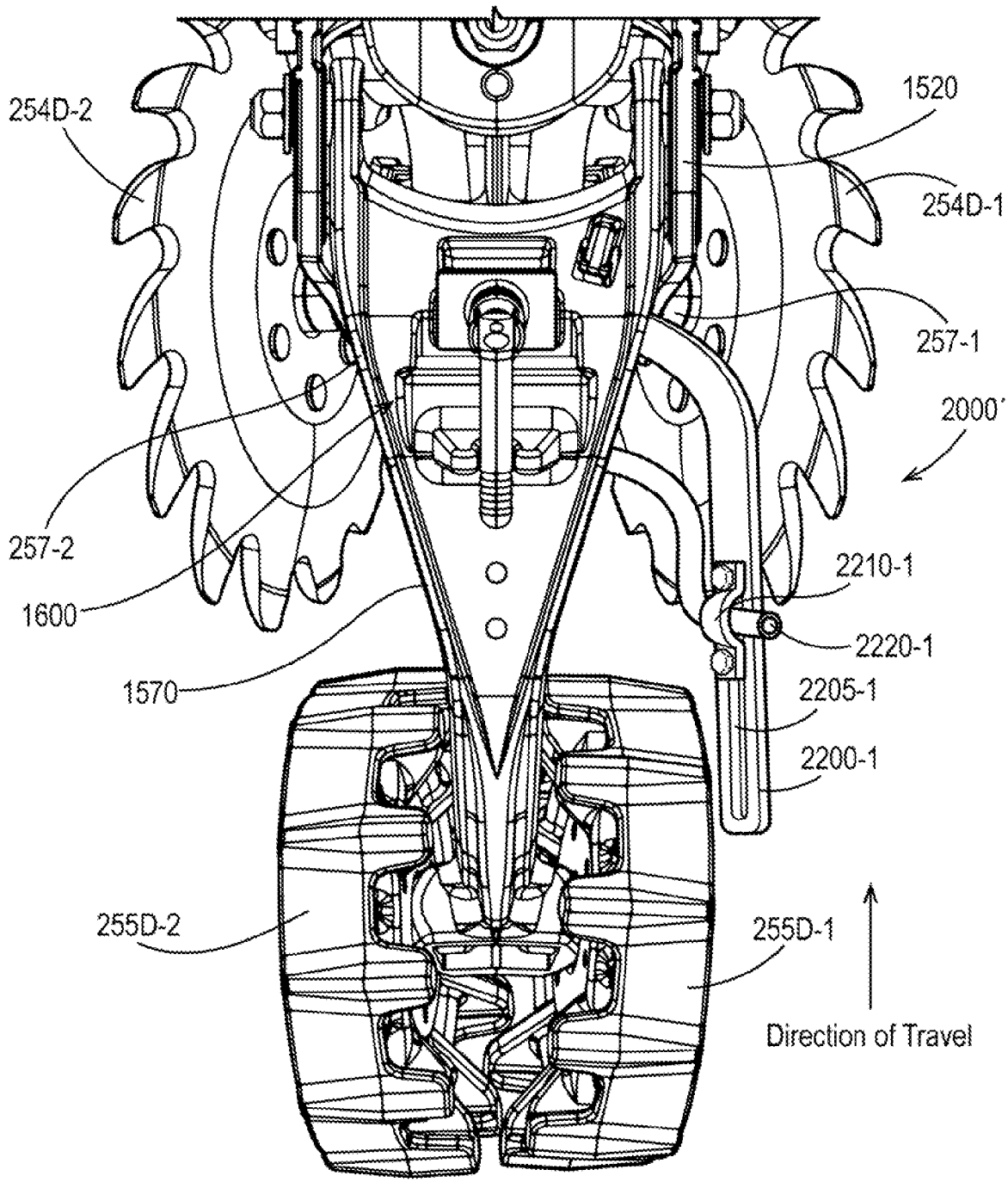

254D-2
1520
254D-1
257-1
2000'
257-2
2210-1
1600
2220-1
1570
2205-1
2200-1
255D-2
255D-1
Direction of Travel

FIG. 41

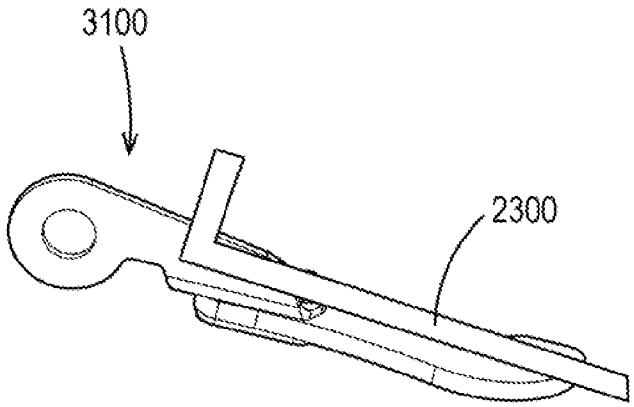


FIG. 42

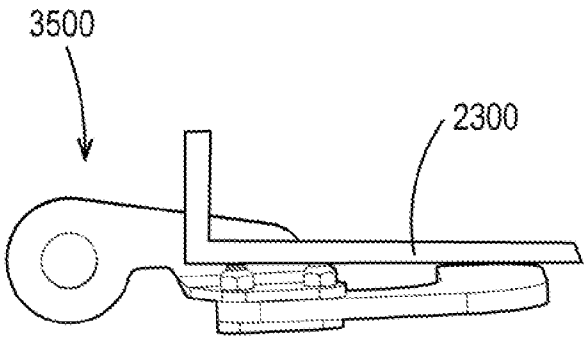


FIG. 43

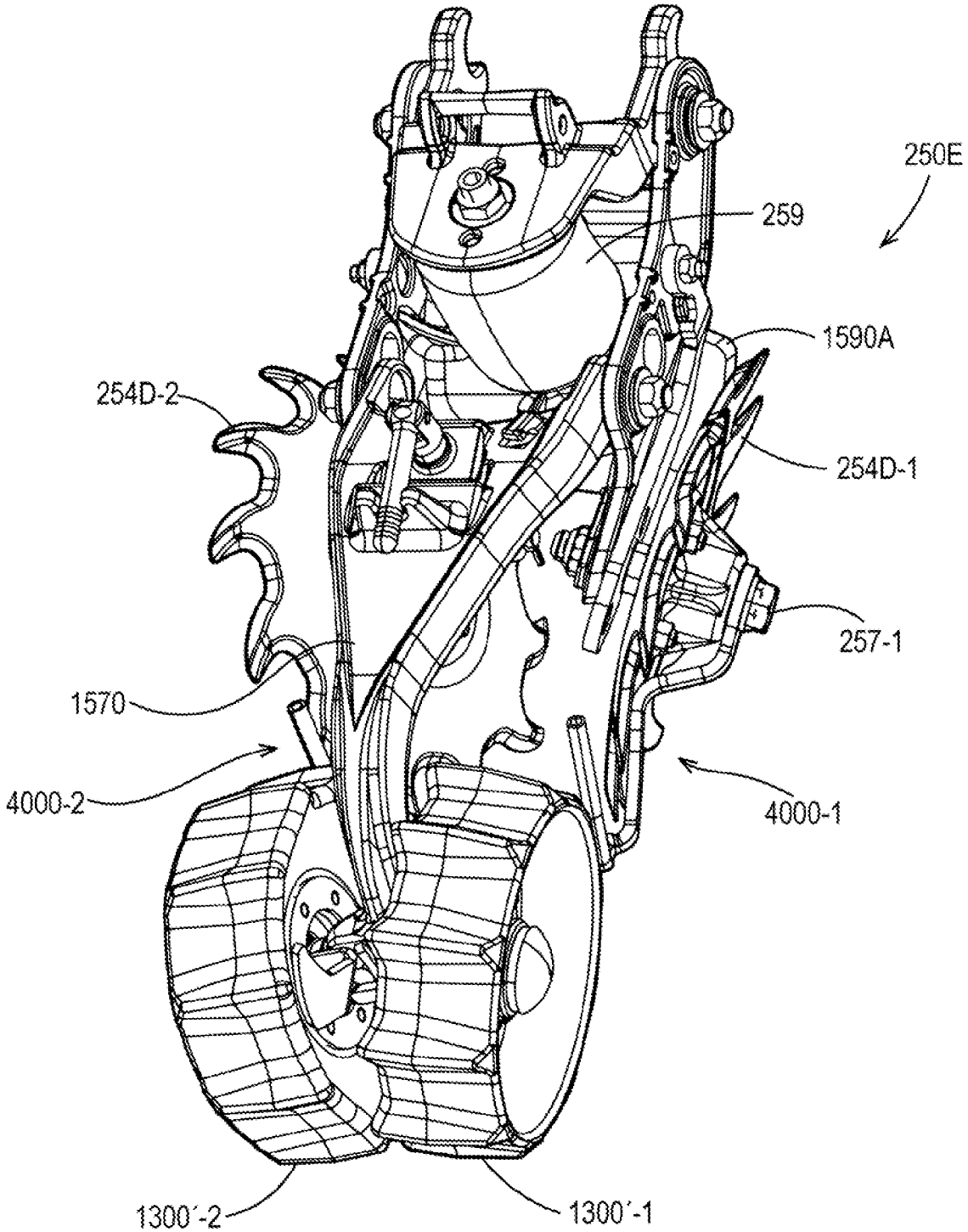

250E
259
1590A
254D-2
254D-1
257-1
1570
4000-2
4000-1
1300´-2
1300´-1

FIG. 44A

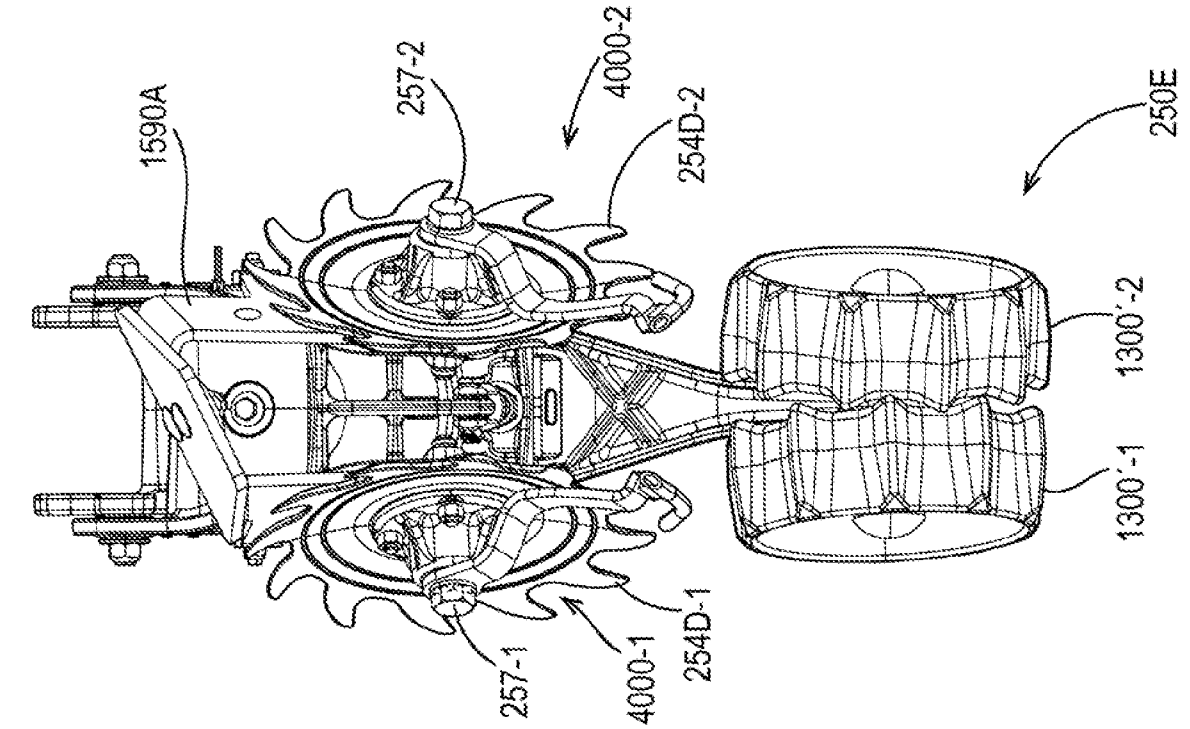


FIG. 44C

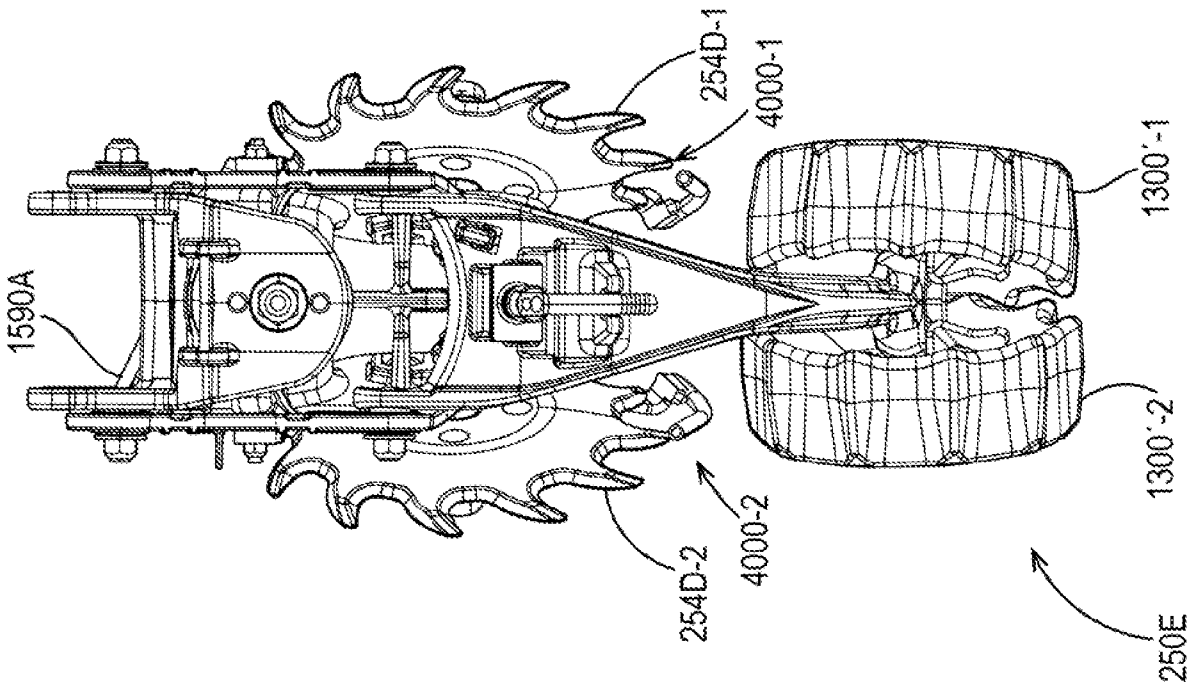


FIG. 44B

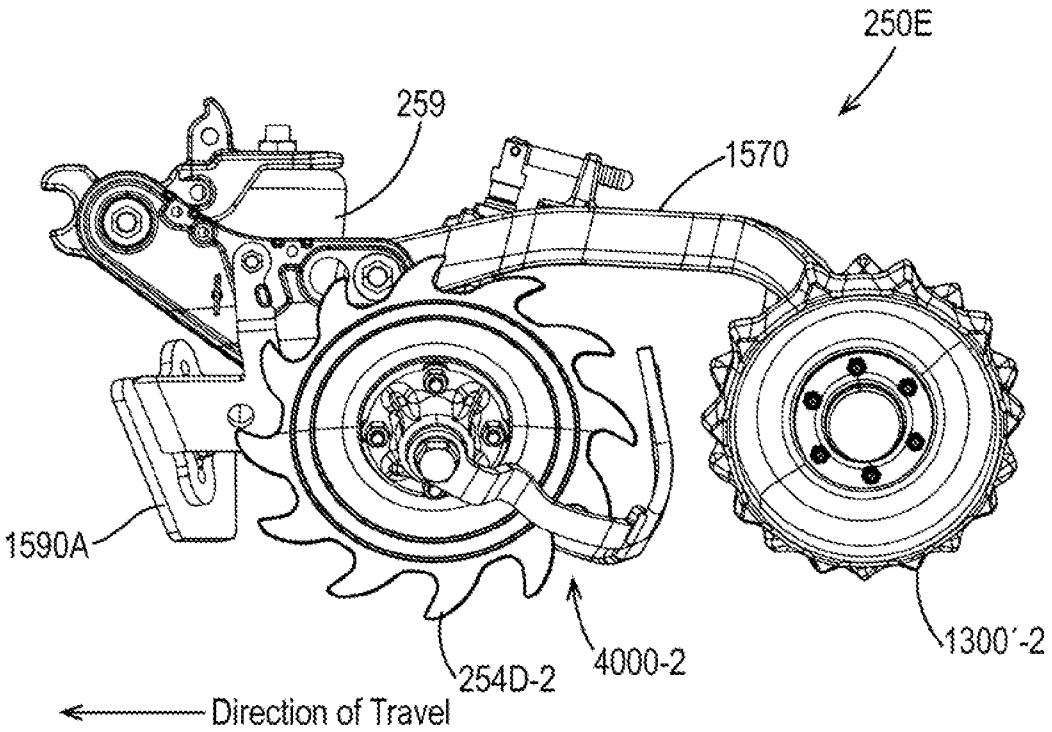


FIG. 44D

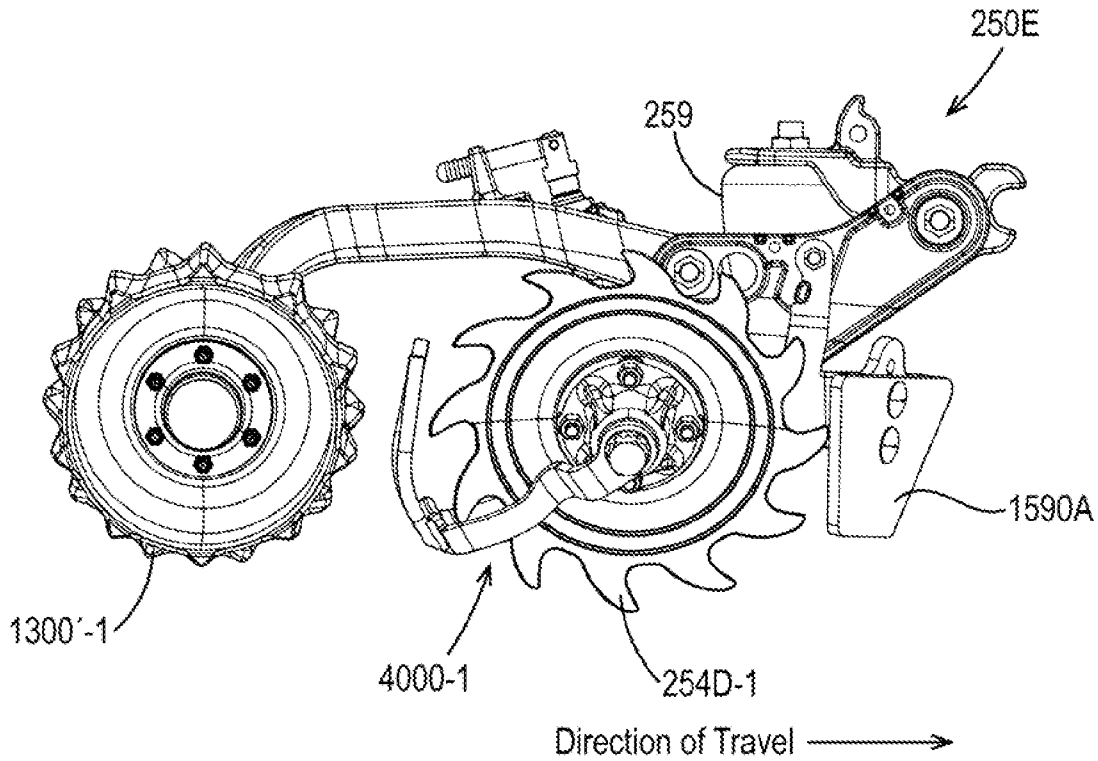


FIG. 44E

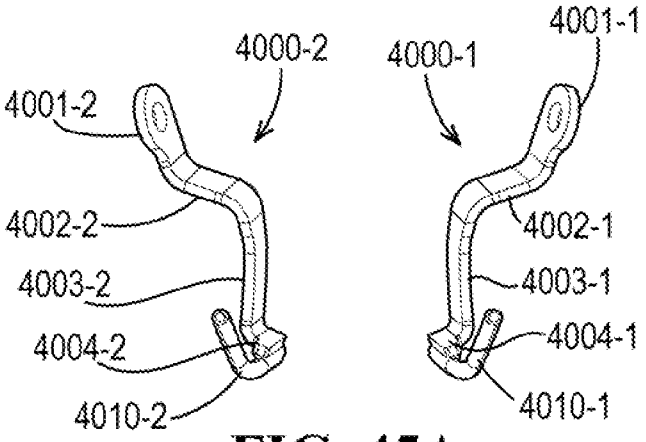


FIG. 45A

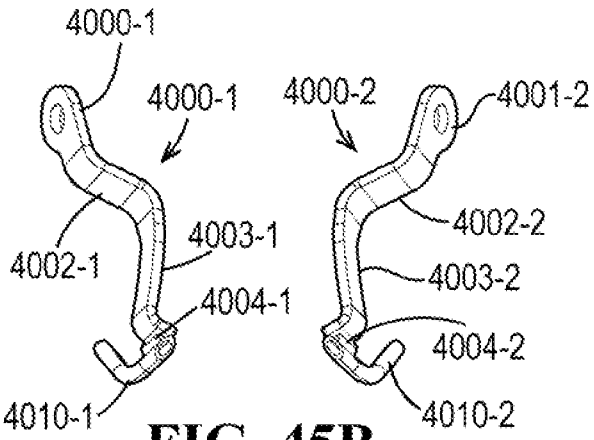


FIG. 45B

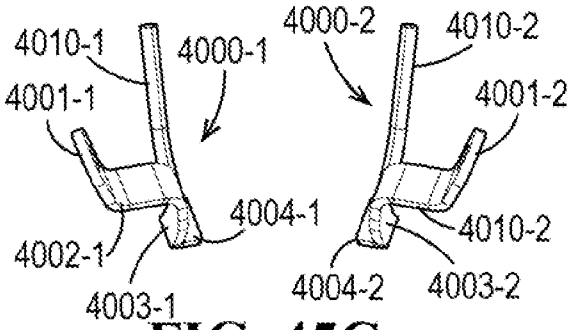


FIG. 45C

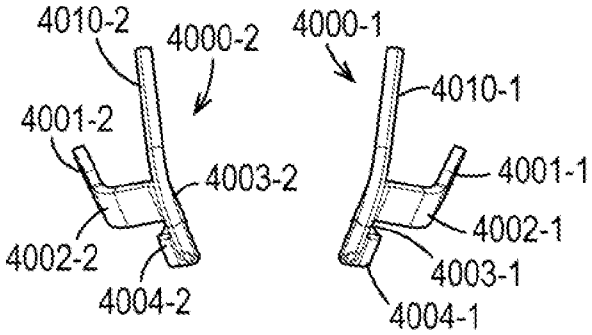


FIG. 45D

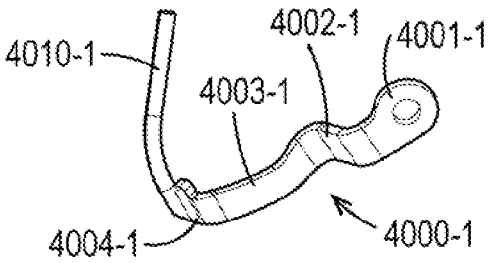


FIG. 46A

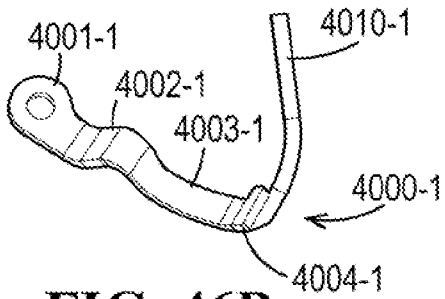


FIG. 46B

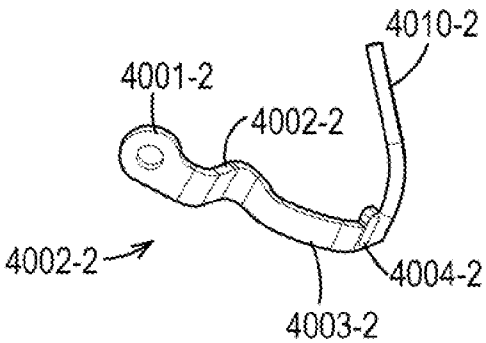


FIG. 47A

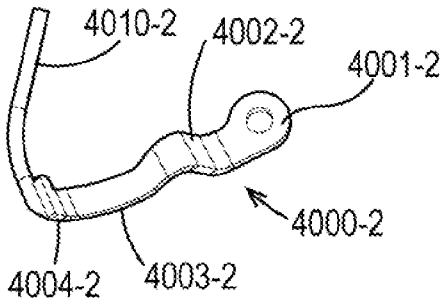


FIG. 47B

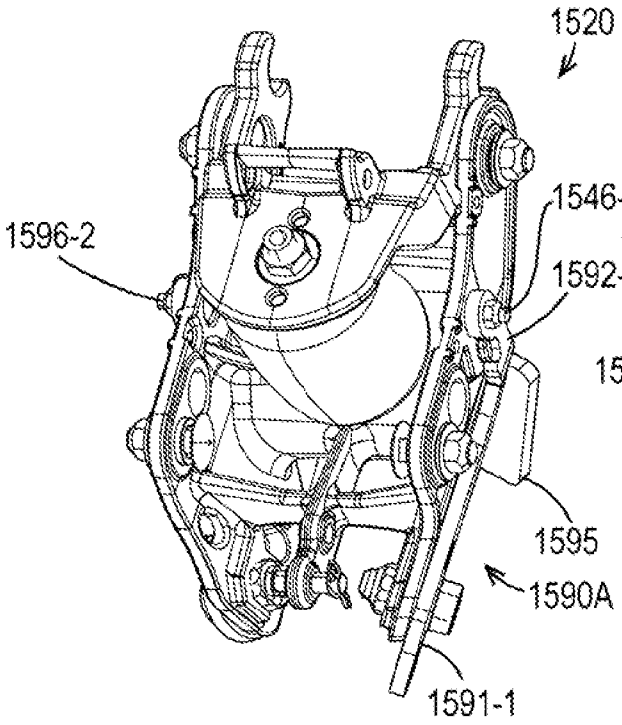


FIG. 48A

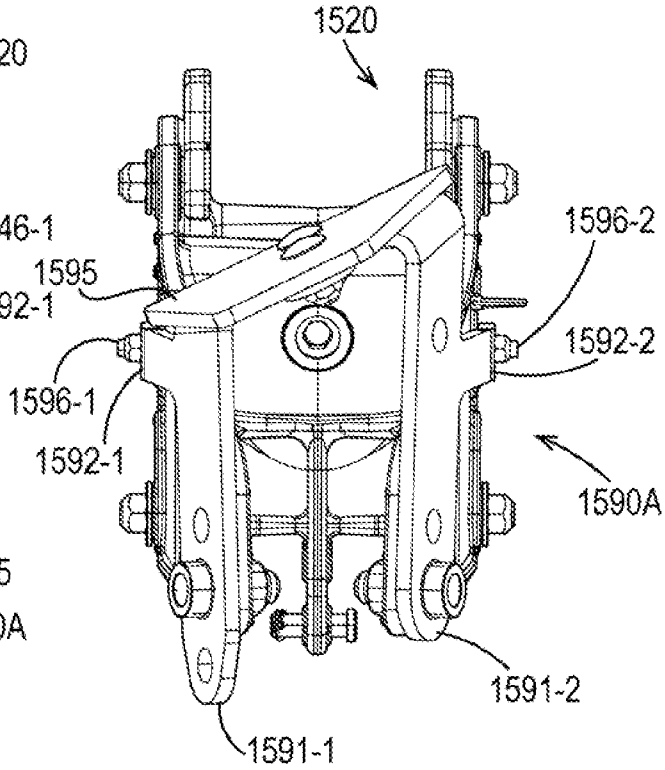


FIG. 48B

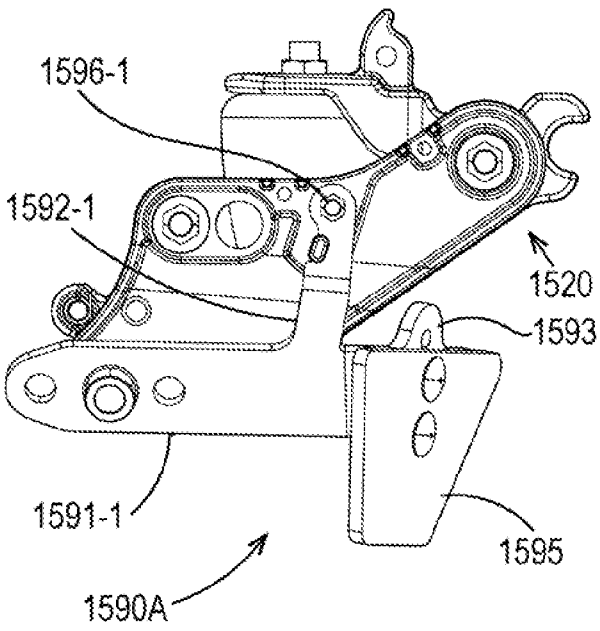


FIG. 48C

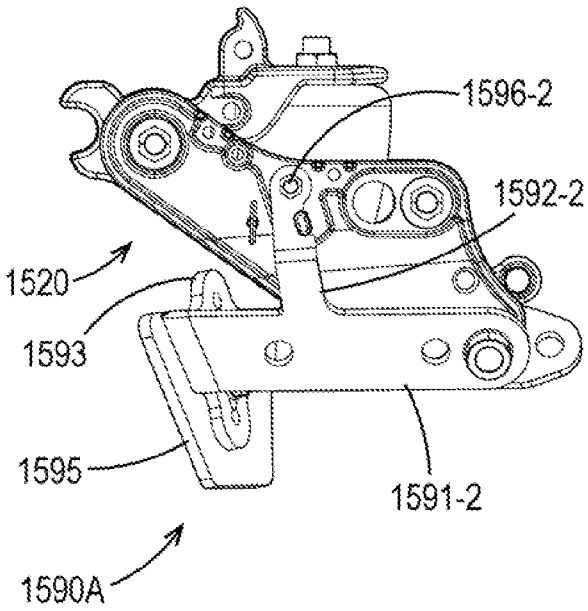


FIG. 48D

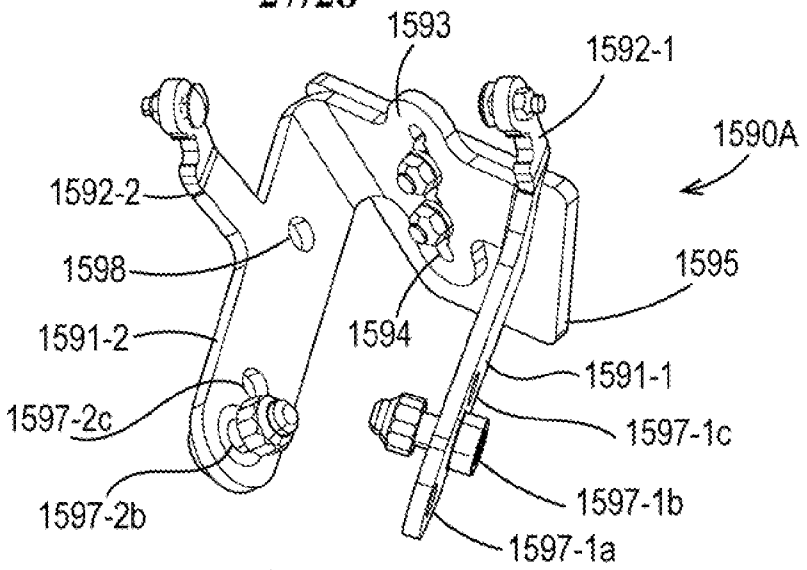


FIG. 49A

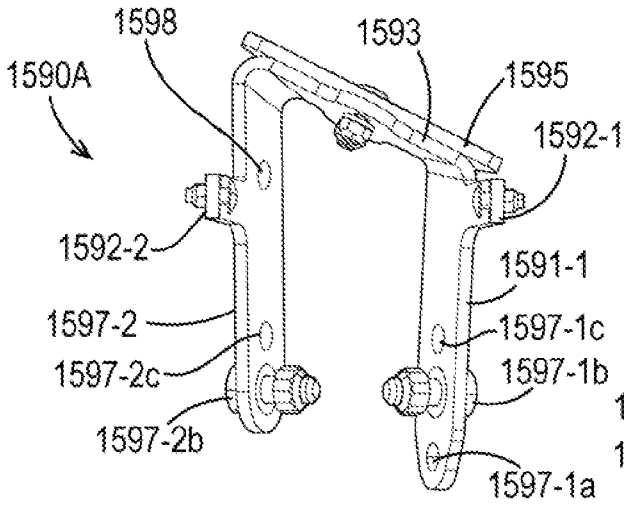


FIG. 49B

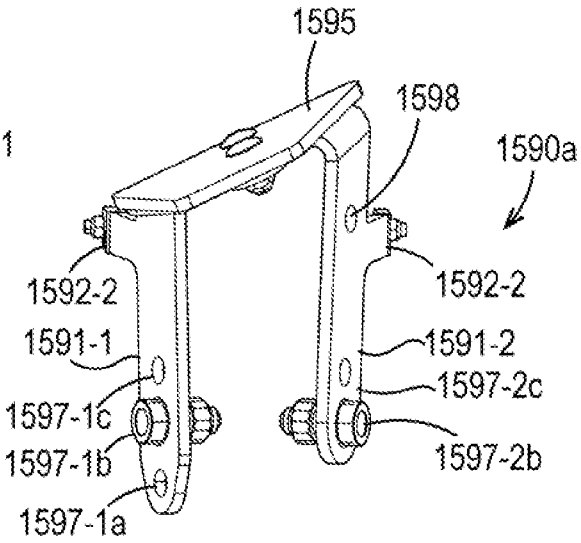


FIG. 49C

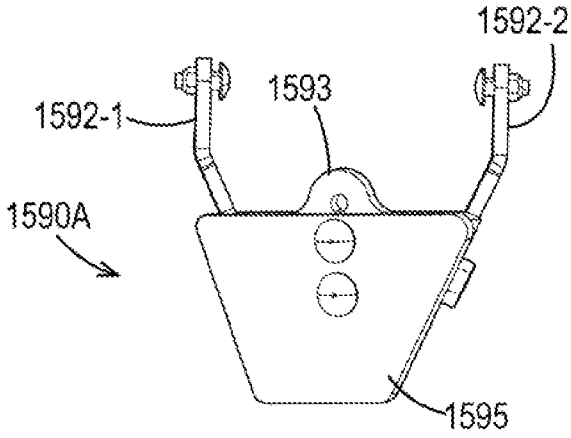


FIG. 49D

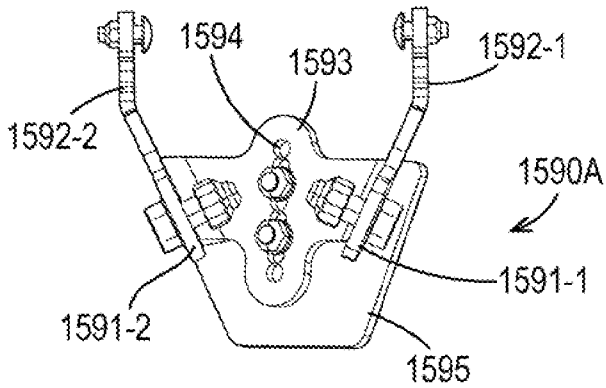


FIG. 49E

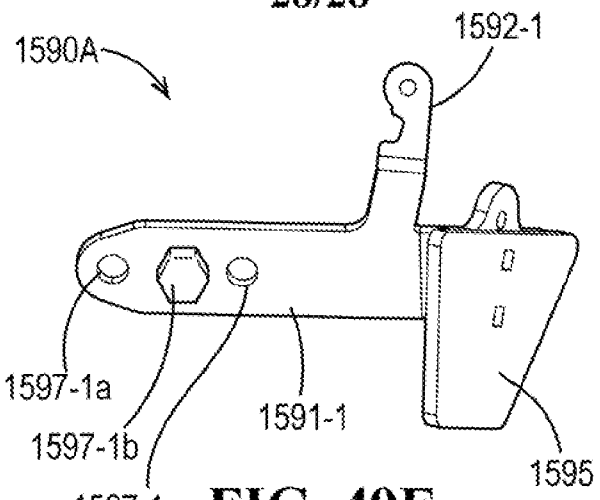


FIG. 49F

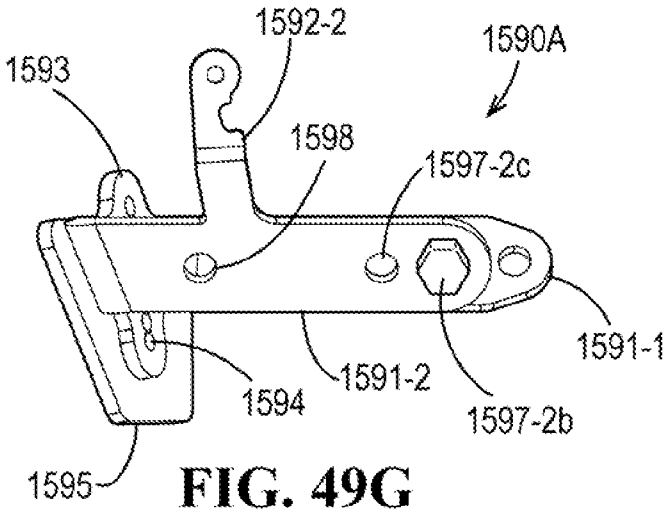


FIG. 49G

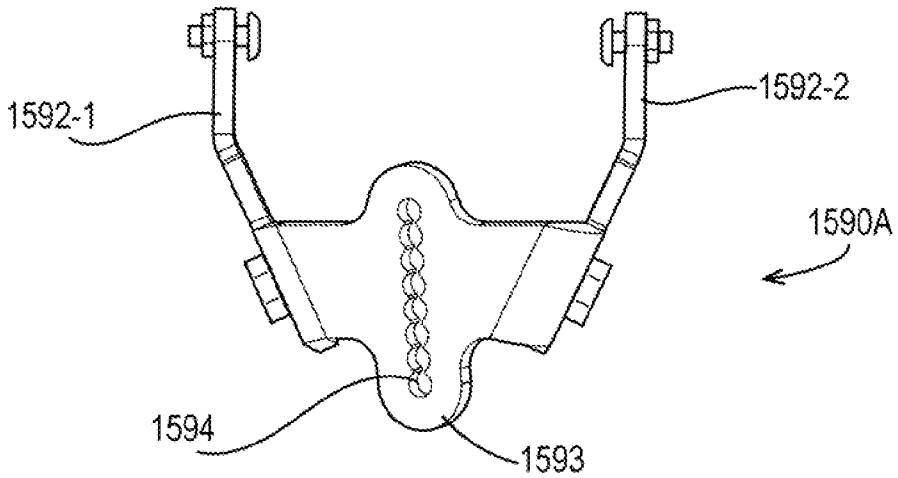


FIG. 49H

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2020/052424

A. CLASSIFICATION OF SUBJECT MATTER
INV. A01C5/06 A01C7/06 A01C23/02
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A01C

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2013/206431 A1 (FREED BRIAN [US]) 15 August 2013 (2013-08-15) abstract; figures 1,2 paragraphs [0051], [0052]	1-12, 17-21, 26-31
Y	US 7 322 302 B1 (REIDHAR JOHN T [US]) 29 January 2008 (2008-01-29) column 5, lines 30-55; figures 1,4,5	1-12, 17-21, 28-31
Y	US 2017/000014 A1 (ANDERSON BRIAN J [US] ET AL) 5 January 2017 (2017-01-05) paragraph [0018]; figure 1	7-12,20

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 May 2020	26/05/2020

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Weinmüller, C

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2020/052424

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 10 2008 027064 A1 (AMAZONEN WERKE DREYER H [DE]) 10 December 2009 (2009-12-10)	12,21
A	paragraphs [0004], [0005]; figures 5,6	13-16, 22-25

Y	WO 2019/040414 A1 (360 YIELD CENTER LLC [US]) 28 February 2019 (2019-02-28)	12, 17-21, 26,27
A	paragraphs [0069], [0072]; figures 1-3	13-16, 22-25

Y	US 2014/230704 A1 (ZIMMERMAN BENJAMIN G [US]) 21 August 2014 (2014-08-21) paragraph [0023]; figure 6	29-31

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2020/052424

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

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

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

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

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

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

This International Searching Authority found multiple inventions in this international application, as follows:

see additional 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 an 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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-31

   Trench closing system

1.1. claims: 1-11, 28(completely); 12-20, 29-31(partially)

   Trench closing system with a soil deflector

1.2. claims: 21-27(completely); 12-20, 29-31(partially)

   Trench closing system with a fluid applicator

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2020/052424

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2013206431 A1	15-08-2013	US 2013206431 A1	15-08-2013
		US 2015107862 A1	23-04-2015
US 7322302 B1	29-01-2008	NONE	
US 2017000014 A1	05-01-2017	CA 2927778 A1	30-12-2016
		US 2017000014 A1	05-01-2017
DE 102008027064 A1	10-12-2009	DE 102008027064 A1	10-12-2009
		WO 2009146780 A1	10-12-2009
WO 2019040414 A1	28-02-2019	CA 3073308 A1	28-02-2019
		WO 2019040414 A1	28-02-2019
US 2014230704 A1	21-08-2014	NONE	