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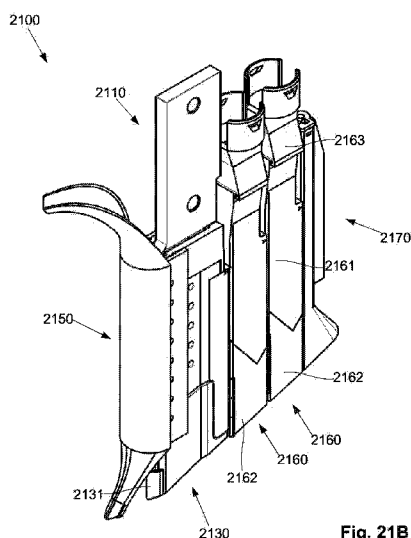


Fig. 21B

(57) Abstract: Apparatus for delivering material to below ground level in use, the apparatus including: a tine shank including a tine shank body; a heel including a heel body mounted to the tine shank in use; a point mounted to a leading edge of the heel in use; a material delivery member adjustably mounted to a trailing edge of the heel, the material delivery member including a material delivery member body defining a delivery path extending from a material inlet to a material outlet configured to supply material received via the delivery path to below ground level in use, the material delivery member being adjustable so as to allow a depth of material delivery relative to the heel to be adjusted.



DELIVERY APPARATUS

Background of the Invention

[0001] The present invention relates to an apparatus for delivering material, and in particular to an apparatus for planting seeds and/or supplying other materials, such as fertiliser or the like, to below ground level.

Description of the Prior Art

[0002] The reference in this specification to any prior publication (or information derived from it), or to any matter which is known, is not, and should not be taken as an acknowledgment or admission or any form of suggestion that the prior publication (or information derived from it) or known matter forms part of the common general knowledge in the field of endeavour to which this specification relates.

[0003] AU2010100138 describes an inter-row tine with J knife point and integrated gas fertilizer delivery system, which is designed to cut a furrow in the soil and to deliver fertiliser into the furrow at the optimal depth and relative distance from adjacent planted seed. The gas fertiliser delivery system is integrated into the tine shank, and enclosed by the J knife point, ensuring optimal fertiliser delivery and longevity of the equipment. The J knife point is slim lined and low profile to minimise soil shatter and balling or build-up of mud and stubble as the sowing point and tine shank pass through the soil. The depth of the fertiliser point can be accurately and easily adjusted to a calibrated depth and the assembly can be fixed against its hard stop for easy stowage during transportation or when not required for operational use.

[0004] WO2010/091469 describes an agricultural assembly including a plurality of components or assemblies able to be alternatively attached to an agricultural toolbar to form an assembly or series of assemblies able to meet the agricultural or cultivation requirements at the optimal level of performance. In one example, a seed delivery boot and gas delivery system is described which can be easily installed and remains precisely located and at the correct depth to match the calibrated depth of the seed boot bottom and so the gas delivery system remains undamaged when drawn through the soil. The slim line tine shank is

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designed to cut a furrow in the soil and to deliver seeds and fertiliser into the furrow at the optimal depth and relative distances. The device is able to accept a multitude of tine types, including those required for simultaneous gas fertiliser delivery. The gas fertiliser delivery system is integrated into the slim line tine shank, sowing boot and sowing point, ensuring optimal fertiliser delivery and longevity of the equipment. The tine shank and seed boot are slim lined and low profile to minimise soil shatter and balling or build-up of mud and stubble as the sowing point and tine shank pass through the soil. The gas fertiliser delivery system is integrated into the seed boot ensuring optimal fertiliser delivery and longevity of the equipment. The seed boot, seed boot bottom, discs, bearings, hubs, double stub axle, and seed boot guard are all able to be separately removed and replaced in the field by a single operator.

[0005] However, the arrangement suffers a number of drawbacks. For example, the sowing point is fastened to the shank using a fastener that extends through apertures in the sowing point. This introduces discontinuities, which in turn significantly weakens the sowing point, as well as making the sowing point difficult to replace. Additionally, the arrangement only allows limited configurations to be provided, limiting their versatility, meaning farmers often require multiple different pieces of equipment to perform broadly similar tasks.

Summary of the Present Invention

[0006] In one broad form an aspect of the present invention seeks to provide an apparatus for delivering material to below ground level in use, the apparatus including: a tine shank including a tine shank body; a heel including a heel body mounted to the tine shank in use; a point mounted to a leading edge of the heel in use; a tip mounted to a leading edge of the point; and, a material delivery member adjustably mounted to a trailing edge of the heel, the material delivery member including a material delivery member body defining a delivery path extending from a material inlet to a material outlet configured to supply material received via the delivery path to below ground level in use, the material delivery member being adjustable so as to allow a depth of material delivery relative to the heel to be adjusted.

[0007] In one embodiment the heel includes a heel slot defined by spaced apart heel spines extending at least part way along a trailing edge of the heel, and wherein the material

delivery member is slidably mounted in the heel slot allowing a depth of the material outlet relative to the heel to be adjusted.

[0008] In one embodiment the material delivery member includes a tongue extending at least part way along a leading edge, the tongue having a dovetail shape to engage the heel spines.

[0009] In one embodiment the tongue includes a number of lateral tongue openings extending along the tongue, and the heel spines include heel spine apertures allowing a fastener to be inserted through the heel spine apertures and tongue openings to thereby secure the delivery member at a respective depth relative to the heel.

[0010] In one embodiment the apparatus includes a plurality of material delivery members each including a material delivery member slot defined by spaced apart material delivery member spines extending at least part way along a trailing edge of the material delivery member and a material delivery member tongue extending at least part way along a leading edge, and wherein a second material delivery member is slidably mounted in a first material delivery member slot allowing a depth of the second material outlet relative to the material delivery member to be adjusted.

[0011] In one embodiment the material delivery member includes a material delivery member body coupled to a material outlet body defining the material outlet.

[0012] In one embodiment the material delivery member body and material outlet body include interlocking V-shaped side walls and interlocking spines on a trailing edge, to define a material delivery member slot extending across at least part of the material delivery member body and material outlet body.

[0013] In one embodiment the material outlet body includes at least one of: a ramp for directed solid material from a trailing edge of the delivery member; an opening on an underside for delivering solid material from the underside; one or more fluid outlets on an underside for delivering fluids from the underside; one or more laterally extending wings, each wing including a wing opening for delivering solid material laterally from the delivery

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member; and, one or more laterally extending wings, each wing including one or more fluid outlets for delivering one or more fluids laterally from the delivery member.

[0014] In one embodiment the apparatus includes multiple material delivery members mounted in sequence rearwardly of the heel, and wherein the material delivery members include respective material outlet bodies to deliver respective materials in a defined sequence.

[0015] In one embodiment the apparatus includes multiple material delivery outlets to deliver at least one: nitrate and stabiliser; fluid material, seeds and then fluid material; seed under or overcoated with liquid; and dual rows of laterally spaced seeds overcoated with fluids.

[0016] In one embodiment the material inlet includes a connector for coupling to a supply tube that provides material from a material supply in use.

[0017] In one embodiment the apparatus includes one or more delivery tubes extending along the delivery path from a material inlet to a material outlet.

[0018] In one embodiment at least one material delivery member includes one or more delivery tubes extending from respective inlets to respective outlets.

[0019] In one embodiment the heel is removably mounted to the tine shank.

[0020] In one embodiment the heel is removably coupled to the tine shank via a fastener extending through respective apertures in the tine shank and heel bodies.

[0021] In one embodiment an upper end of the heel includes a channel extending from a leading edge of the heel, the channel receiving a lower end of the tine shank in use.

[0022] In one embodiment a lower end of the tine shank and a surface of the channel include complimentary V-shapes to assist aligning the tine shank within the channel.

[0023] In one embodiment side walls of the recess including grooves that in use receive an angled ridge extending downwardly from a leading edge of the tine shank to thereby lock the tine shank into engagement with the heel.

[0024] In one embodiment a leading edge of the heel includes a recess that in use receives a tube defining a liquid material delivery path extending to a material outlet in an underside of the point.

[0025] In one embodiment the point includes a substantially U-shaped point body having point side walls extending rearwardly from a leading edge of the point.

[0026] In one embodiment the heel includes point channels extending rearwardly along faces of heel body side walls from a leading edge of the heel body, the point including ridges adapted to be received within the point channels allowing the point to be coupled to the heel.

[0027] In one embodiment the point includes a tip mounting, the apparatus including a tip coupled to the tip mounting in use.

[0028] In one embodiment the apparatus includes a shin guard coupled to the heel proximate the point.

[0029] In one embodiment the shin guard includes a substantially U-shaped shin guard body having shin guard side walls extending rearwardly from a leading shin guard edge.

[0030] In one embodiment the shin guard body includes a V-shaped leading edge defining a working edge facing away from the tine shank.

[0031] In one embodiment the shin guard engages the point to thereby secure the point to the heel.

[0032] In one embodiment an upper edge of each point side wall includes a ridge that engages a recessed corner of each shin guard side wall.

[0033] In one embodiment the heel includes an L-shaped shin guard channel extending rearwardly and then downwardly along faces of heel body side walls from a leading edge of the heel body, the shin guard including pegs adapted to engage the shin guard channels allowing the shin guard to be coupled to the heel.

[0034] In one embodiment the shin guard rear edges include recesses that align with a shin guard securing aperture extending laterally through the heel body allowing a fastener to be inserted therethrough, to thereby secure the shin guard to the heel.

[0035] In one embodiment the apparatus includes a stubble guard coupled to the heel to thereby secure the shin guard to the heel.

[0036] In one embodiment the stubble guard includes a substantially U-shaped stubble guard body having stubble guard side walls extending rearwardly from a leading stubble guard edge.

[0037] In one embodiment the stubble guard includes an upper tip extending forwardly and laterally from the leading edge of the heel to thereby urge material laterally around the heel and tine shank.

[0038] In one embodiment the stubble guard body includes a rounded leading edge defining a working edge facing away from the tine shank.

[0039] In one embodiment the heel includes a T-shaped stubble guard channel extending rearwardly and along faces of heel body side walls from a leading edge of the heel body, the stubble guard including pegs adapted to engage the stubble guard channels allowing the stubble guard to be coupled to the heel.

[0040] In one embodiment the stubble guard channels allow the stubble guard to be lifted allowing the shin guard to be selectively coupled to the heel and lowered to secure the shin guard to the heel.

[0041] In one embodiment the stubble guard channels allow the stubble guard to be positioned at different heights relative to the heel.

[0042] In one embodiment the stubble guard includes a plurality of longitudinally spaced openings, wherein one of the openings aligns with a stubble guard securing aperture extending laterally through the heel body depending on the relative position of the stubble

guard, allowing a fastener to be inserted therethrough, to thereby secure the stubble guard to the heel at a desired relative height.

[0043] In one embodiment the stubble guard includes a lower tip extending forwardly of the stubble guard.

[0044] In one embodiment the apparatus includes a fluid delivery system adjustably mounted to a trailing edge of a material delivery member, the fluid delivery system including one or more nozzles adapted to direct fluid at least partially rearwardly from one or more depths along a trailing edge of the apparatus.

[0045] In one embodiment the fluid delivery system includes a skirt at least partially surrounding at least one of the nozzles.

[0046] In one embodiment the heel includes a guide member extending substantially parallel to a trailing edge of the heel, and wherein the material delivery member is slidably mounted to the guide member allowing a depth of the material outlet relative to the heel to be adjusted.

[0047] In one embodiment the delivery member includes a mounting having a slot laterally spaced from and extending substantially parallel to a leading edge of the delivery member, and wherein a fastener engages the slot and the heel to thereby secure the delivery member to the heel.

[0048] In one embodiment the heel includes a plurality of delivery member mountings spaced along a trailing edge of the heel, and wherein the material delivery member includes a toe that is selectively mounted to one of the delivery member mountings allowing a depth of the material outlet relative to the heel to be adjusted.

[0049] In one embodiment the heel includes a delivery member securing tab extending rearwardly from and along a trailing edge of the heel, and wherein the material delivery member includes a heel securing tab extending forwardly from and along a leading edge of the delivery member, and wherein in use the tabs include apertures extending therethrough, the apertures being spaced along the length of the respective tab and wherein a fastener

extends through selected apertures in the tabs to thereby secure the delivery member at a fixed height relative to the heel.

[0050] In one embodiment the apparatus includes at least one second material delivery member including a second material delivery member body defining a second delivery path extending from a second material inlet to a second material outlet configured to supply second material received via the second delivery path to below ground level in use, the second material delivery member being adjustably mounted to the material delivery member to allow a depth of second material delivery relative to the material delivery member to be adjusted.

[0051] In one embodiment the material delivery member includes a guide member extending substantially parallel to a trailing edge of the material delivery member, and wherein the second material delivery member is slidably mounted to the guide member allowing the depth of a second material outlet relative to the material delivery member to be adjusted.

[0052] In one embodiment the second delivery member includes a mounting having a slot laterally spaced from and extending substantially parallel to a leading edge of the second delivery member, and wherein a fastener engages the slot and the material delivery member to thereby secure the second material delivery member to the material delivery member.

[0053] In one embodiment the first delivery member includes a plurality of delivery member mountings spaced along a trailing edge of the first delivery member, and wherein the second material delivery member includes a toe that is selectively mounted to one of the delivery member mountings allowing a depth of the second material outlet relative to the first delivery member to be adjusted.

[0054] In one embodiment the first delivery member includes a delivery member securing tab extending rearwardly from and along a trailing edge of the first delivery member, and wherein the second material delivery member includes a first delivery member securing tab extending forwardly from and along a leading edge of the delivery member, and wherein in use the tabs include apertures extending therethrough, the apertures being spaced along the length of the respective tab and wherein a fastener extends through selected apertures in the

tabs to thereby secure the second delivery member at a fixed height relative to the first delivery member.

[0055] In one embodiment the material outlet includes a ramp for directed solid material from a trailing edge of the delivery member.

[0056] In one embodiment the material outlet includes a sleeve selectively mounted within the material outlet, the sleeve defining a narrowing of the material outlet to thereby increase a flow rate of material through the material outlet.

[0057] In one embodiment the sleeve defines a shroud extending rearwardly from a trailing edge of the delivery member, and wherein a liquid delivery tube extends along the trailing edge of the delivery member, the liquid delivery tube terminating in a nozzle positioned within the shroud.

[0058] In one broad form an aspect of the present invention seeks to provide an apparatus for delivering material to below ground level in use, the apparatus including: a tine shank including a tine shank body defining a tine shank cavity that extends along a length of the tine shank; a heel mounted to the tine shank in use, the heel including a heel body having spaced apart side walls defining a heel cavity that extends at least partially along a length of the heel and a heel opening extending along a trailing edge of the heel body; a boot mounted to the tine shank and heel in use; a tip coupled to the boot; at least one delivery path extending through at least part of the tine shank cavity and at least part of the heel cavity; and, at least one material outlet member providing a material outlet configured to supply material received via the delivery path to below ground level in use, the at least one material outlet member being adjustably mounted within the heel opening to allow a depth of material delivery relative to the heel to be adjusted.

[0059] In one embodiment the apparatus includes a plurality of members positioned within the heel opening, the plurality of members including at least one of: a wing material outlet member; a material outlet member; a securing member; and, a spacer member.

[0060] In one embodiment the plurality of members are interchangeable allowing a depth of material outlet members to be adjusted.

[0061] In one embodiment the apparatus includes at least one side wall securing member mounted in the heel opening in use to thereby secure the side walls with a fixed spacer.

[0062] In one embodiment the heel opening includes tongues extending inwardly from the side walls and a chamfered outer edge corner, and wherein the at least one side wall securing member includes first and second bodies that clamp on the tongues when urged together by a fastener, the first body including shoulders that engage the chamfered outer edge corner to thereby secure the side walls with the fixed spaced arrangement.

[0063] In one embodiment the heel opening includes tongues extending inwardly from the side walls, the material outlet member including grooved opposing edges that receive the tongues of the opening, allowing the material outlet member to be slidably mounted within the opening.

[0064] In one embodiment the apparatus includes at least one mounting securing member that includes first and second bodies that clamp the tongues when urged together by a fastener, at least one of the first and second bodies including sloped edges that engage at least one member and urge the at least one member towards at least one of: a closed end of the heel opening; and, another member.

[0065] In one embodiment the apparatus includes a root cutter having: a substantially U-shaped root cutter body mounted to a leading edge of the heel body and extending rearwardly towards the trailing edge of the heel body; and, cutting wings extending outwardly from the heel body.

[0066] In one embodiment a trailing edge of the wings include a recess defining at least part of a root cutter delivery path for delivery of material to one or more root cutter outlets allowing material to be delivered from the root cutter.

[0067] In one embodiment a rear portion of the root cutter body receives a root cutter mounting member for mounting the root cutter body to the heel opening.

[0068] In one embodiment the root cutter mounting member includes a mounting body having an opening, the root cutter delivery path extending through the opening.

[0069] In one embodiment the boot includes a boot body defining a boot body opening extending along a trailing edge of the boot body and wherein the heel includes a number of boot connectors on a leading face, the boot connectors engaging the boot body opening to thereby secure the boot to the heel.

[0070] In one embodiment the boot connectors are spaced apart along a leading edge of the heel body, and wherein a root cutter is mounted within at least one gap between adjacent boot connectors in use.

[0071] In one embodiment the boot body opening includes tongues extending inwardly from side walls of the boot body, the connectors having laterally extending ridges that engage the tongues of the boot body opening in use.

[0072] In one embodiment the boot body defines a boot cavity that extends at least partially along a length of the boot, and wherein at least one boot delivery path extends through at least part of the tine shank cavity and at least part of the boot cavity to at least one material outlet member provided in the boot body opening.

[0073] In one embodiment the boot body includes a sleeve extending rearwardly from an upper portion of the boot body, the sleeve being mounted around the tine shank in use and secured thereto with a fastener extending through the sleeve.

[0074] In one embodiment the boot is adjustably mounted to the tine shank to allow a relative separation between the tip and at least one outlet to be adjusted.

[0075] In one embodiment the boot body includes a tip mounting, the apparatus including a tip coupled to the tip mounting in use.

[0076] In one embodiment the tip including apertures configured to receive a mounting pin for coupling the tip to the mounting.

[0077] In one embodiment the apparatus includes: a shin guard coupled to the boot adjacent the tip; and, a stubble guard coupled to the boot spaced from the tip.

[0078] In one embodiment the boot body includes T-shaped guard channels extending rearwardly along faces of the side walls from a leading edge of the boot body, the shin guard including pegs adapted to engage the guard channels allowing the shin guard to be coupled to the boot body, and wherein the guard channels allow the shin guard to be lifted allowing the tip to be selectively coupled to the tip mounting and lowered to secure the tip to the tip mounting.

[0079] In one embodiment the stubble guard includes a substantially U-shaped stubble guard body having stubble guard side walls extending rearwardly from a leading stubble guard edge.

[0080] In one embodiment the shin guard includes a substantially U-shaped shin guard body having shin guard side walls extending rearwardly from a leading shin guard edge.

[0081] In one embodiment the shin guard body includes a V-shaped leading edge defining a working edge facing away from the tine shank.

[0082] In one embodiment at least part of the shin guard is positioned between at least part of the stubble guard and the tine shank, thereby securing the shin guard to the tine shank.

[0083] In one embodiment the boot body includes a recess extending along a leading edge to an opening passing through the boot body rearwardly of a tip mounting, and wherein the recess and opening define a tip delivery path for delivering material to a delivery outlet on an underside of the boot.

[0084] In one embodiment the material outlet includes at least one of: a seed outlet configured to supply seed to be planted; and, a liquid outlet configured to supply liquid material.

[0085] In one embodiment the delivery path includes at least one of: a channel; and, a pipe.

[0086] It will be appreciated that the broad forms of the invention and their respective features can be used in conjunction, interchangeably and/or independently, and reference to separate broad forms is not intended to be limiting.

Brief Description of the Drawings

[0087] An example of the present invention will now be described with reference to the accompanying drawings, in which: -

[0088] Figure 1A is a schematic side view of an example of an apparatus for delivering material to below ground level;

[0089] Figure 1B is a schematic perspective rear side view of the apparatus of Figure 1A;

[0090] Figure 1C is a schematic underside view of the apparatus of Figure 1A;

[0091] Figure 1D is a schematic cutaway side view of the apparatus of Figure 1A;

[0092] Figure 2A is a schematic perspective front side view of an example of a tine shank;

[0093] Figure 2B is a schematic rear side perspective view of the tine shank of Figure 2A;

[0094] Figure 3A is a schematic perspective rear side view of an example of a heel;

[0095] Figure 3B is a schematic front side perspective view of the heel of Figure 3A;

[0096] Figure 3C is a schematic rear side perspective side view of the heel of Figure 3A including a number of delivery outlet members;

[0097] Figure 3D is a schematic underside cut away view of the heel and an outlet member;

[0098] Figure 4A is a schematic front side perspective view of an example of a root cutter;

[0099] Figure 4B is a schematic rear side perspective view of the root cutter of Figure 4A;

[0100] Figure 4C is a schematic front side perspective partially transparent view of the root cutter of Figure 4A including a root cutter mounting member;

[0101] Figure 4D is a schematic front side perspective view of the root cutter of Figure 4A mounted to the heel of Figure 3A;

[0102] Figure 5A is a schematic front side perspective view of an example of a boot;

[0103] Figure 5B is a schematic rear side perspective view of the boot of Figure 5A;

[0104] Figure 5C is a schematic underside cutaway view of the boot of Figure 5A coupled to the heel of Figure 3A;

[0105] Figure 6A is a schematic perspective view of an example of a heel, tine shank and boot with a tip fitted;

[0106] Figure 6B is a schematic perspective view of the apparatus of Figure 6A with a shin guard and stubble guard fitted;

[0107] Figure 7A is a schematic side view of a second example of apparatus for delivering material;

[0108] Figure 7B is a schematic perspective front view of the apparatus of Figure 7A;

[0109] Figure 7C is a schematic perspective rear underside view of the apparatus of Figure 7A;

[0110] Figure 7D is a schematic side cutaway view of the apparatus of Figure 7A;

[0111] Figure 8 is a schematic perspective view of an example of a tine shank for the apparatus of Figure 7A;

[0112] Figure 9A is a schematic perspective front view of an example of a heel for the apparatus of Figure 7A;

[0113] Figure 9B is a schematic rear perspective view of the heel of Figure 9A;

[0114] Figure 9C is a schematic side cutaway view of the heel of Figure 9A attached to the tine shank of Figure 8;

[0115] Figure 10A is a schematic perspective front view of an example of a point for the apparatus of Figure 7A;

[0116] Figure 10B is a schematic perspective rear view of the point of Figure 10A;

[0117] Figure 10C is a schematic perspective front view of the point of Figure 10A attached to the heel of Figure 9A;

[0118] Figure 11A is a schematic perspective rear view of an example of a shin guard for the apparatus of Figure 7A;

[0119] Figure 11B is a schematic perspective front view of the shin guard of Figure 11A;

[0120] Figure 11C is a schematic perspective front view of the shin guard of Figure 11A attached to the heel and point of Figure 10C;

[0121] Figure 12A is a schematic perspective front view of an example of a stubble guard for the apparatus of Figure 7A;

[0122] Figure 12B is a schematic perspective rear view of the stubble guard of Figure 12A;

[0123] Figure 12C is schematic perspective front view of the stubble guard of Figure 12A attached to the shin guard, heel and point of Figure 11C;

[0124] Figure 13A is a schematic perspective front view of an example of a material delivery member for the apparatus of Figure 7A;

[0125] Figure 13B is a schematic perspective side view of the material delivery member of Figure 13A;

[0126] Figure 13C is a schematic side cutaway view of the material delivery member of Figure 10A coupled to the heel of Figure 9A;

[0127] Figure 14A is a schematic perspective front view of a third example of apparatus for delivering material;

[0128] Figure 14B is a schematic perspective rear view of the apparatus of Figure 14A;

[0129] Figure 14C is a schematic perspective rear view of the apparatus of Figure 14A with a relative height of delivery members adjusted;

[0130] Figure 14D is a schematic side cutaway view of the apparatus of Figure 14A;

[0131] Figure 15A is a schematic perspective front view of an example of a tine shank for the apparatus of Figure 14A;

[0132] Figure 15B is a schematic perspective rear view of the tine shank of Figure 15A;

[0133] Figure 16A is a schematic perspective rear view of an example of a heel for the apparatus of Figure 14A;

[0134] Figure 16B is a schematic front perspective view of the heel of Figure 16A;

[0135] Figure 16C is a schematic front cutaway view of the heel of Figure 16A attached to the tine shank of Figure 15A;

[0136] Figure 16D is a schematic perspective view of the heel of Figure 16A attached to the tine shank of Figure 15A;

[0137] Figure 17A is a schematic perspective front view of an example of a first material delivery member for the apparatus of Figure 14A;

[0138] Figure 17B is a schematic perspective rear view of the material delivery member of 17A;

[0139] Figure 17C is a schematic side cutaway view of the material delivery member of Figure 17A;

[0140] Figure 18A is a schematic perspective front view of an example of a second material delivery member for the apparatus of Figure 14A;

[0141] Figure 18B is a schematic perspective rear view of the material delivery member of 18A;

[0142] Figure 18C is a schematic side cutaway view of the material delivery member of Figure 18A;

[0143] Figure 19 is a schematic plan view of an example of a liquid delivery tube mounting;

[0144] Figure 20A is a schematic side cutaway view of an example of a delivery member including an internal sleeve;

[0145] Figure 20B is a schematic rear view of the delivery member and internal sleeve of Figure 20A;

[0146] Figure 21A is a schematic side view of a further example of apparatus for delivering material;

[0147] Figure 21B is a schematic perspective front view of the apparatus of Figure 21A;

[0148] Figure 21C is a schematic perspective rear underside view of the apparatus of Figure 21A;

[0149] Figure 21D is a schematic side cutaway view of the apparatus of Figure 21A;

[0150] Figures 21E to 21G are schematic side views of the apparatus of Figure 21A with material delivery tubes in different positions;

[0151] Figure 22 is a schematic perspective view of an example of a tine shank for the apparatus of Figure 21A;

[0152] Figure 23A is a schematic perspective front view of an example of a heel for the apparatus of Figure 21A;

[0153] Figure 23B is a schematic rear perspective view of the heel of Figure 23A;

[0154] Figure 23C is a schematic side cutaway view of the heel of Figure 23A attached to the tine shank of Figure 22;

[0155] Figure 24A is a schematic perspective front view of an example of a point for the apparatus of Figure 21A;

[0156] Figure 24B is a schematic perspective rear view of the point of Figure 24A;

[0157] Figure 25A is a schematic perspective front view of an example of a shin guard for the apparatus of Figure 21A;

[0158] Figure 25B is a schematic perspective rear view of the shin guard of Figure 25A;

[0159] Figure 25C is a schematic perspective front view of the shin guard of Figure 25A attached to the heel and point of Figure 24A;

[0160] Figure 26A is a schematic perspective front view of an example of a stubble guard for the apparatus of Figure 21A;

[0161] Figure 26B is a schematic perspective rear view of the stubble guard of Figure 26A;

[0162] Figure 26C is schematic perspective front view of the stubble guard of Figure 26A attached to the shin guard, heel and point of Figure 25C;

[0163] Figure 27A is a schematic perspective rear view of an example of a material delivery member for the apparatus of Figure 21A;

[0164] Figure 27B is a schematic perspective side view of the material delivery member of 27A;

[0165] Figure 27C is a schematic side view of the material delivery member of Figure 26A coupled to the heel of Figure 25A;

[0166] Figure 27D is a schematic side cross sectional view along the line C-C' of Figure 27C;

[0167] Figure 27E is a schematic perspective rear view of the material delivery member of Figure 26A coupled to the heel of Figure 25A;

[0168] Figure 28A is a schematic perspective front view of a further example of apparatus for delivering material;

[0169] Figure 28B is a schematic perspective rear view of the apparatus of Figure 28A;

[0170] Figure 28C is a schematic side cutaway view of the apparatus of Figure 28A; and,

[0171] Figure 28D is a schematic perspective rear underside view of the apparatus of Figure 21A.

Detailed Description of the Preferred Embodiments

[0172] An example of apparatus for delivering material will now be described with reference to Figures 1A to 1D and with additional reference to a specific arrangement further described in Figures 2A and 2B, 3A to 3D, 4A to 4D, 5A to 5C and 6A and 6B. For the purpose of illustration, relative terms, such as upper, lower, forward, rearward, leading and trailing are

used relative to the intended orientation of the apparatus in use, but are otherwise not intended to be limiting.

[0173] In this example, the apparatus 100 includes a tine shank 110 including a tine shank body 111 defining a tine shank cavity 214 that extends along a length of the tine shank 110. A heel 120 is mounted to the tine shank 110 in use, the heel 120 including a heel body 121 having spaced apart sidewalls 122 defining a heel cavity 124 that extends at least partially along the length of the heel, and a heel opening 123 extending along a trailing edge of the heel body 121. A boot 130 is mounted to the tine shank 110 and heel 120 in use, with a tip 140 being coupled to the boot 130.

[0174] At least one delivery path 150 extends through at least part of the tine shank cavity and at least part of the heel cavity, with at least one material outlet member 161, 162 providing a material outlet 160 configured to supply material received via the delivery path 150 to below ground level in use.

[0175] The nature of the material will vary depending on the preferred usage, and can include seeds, fertiliser (solid, liquid or gaseous), nutrients, fungicides, soil modifying materials, such as gypsum, or the like. For example, the apparatus can be configured with one or more solid material outlet members 162 used for planting seed and/or granular nutrients, such as phosphorus, potash or the like, and can include one or more liquid material outlet members 161 for supplying liquid/gaseous materials, such as liquid nitrogen, water or the like. However, the outlet members are typically removably mounted, meaning these can be used interchangeably, so that the delivery apparatus 100 could be used for any suitable purpose and combination of materials. For ease, the remainder of the description will focus on the delivery of both seeds and other material, but it will be appreciated that this is not intended to be limiting.

[0176] In use, the apparatus 100 may be attached to a vehicle, via a mounting system 170, or the like, and then positioned with the tip 140 and at least the material outlets 160 below ground level. A coulter disc 180 can also be mounted forwardly of the delivery apparatus 100 to perform trash cutting, whilst an optional root cutter 190 can be mounted to the

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delivery apparatus 100, to assist in cutting roots and laterally delivering material, as will be described in more detail below.

[0177] In any event, the tip 140 is provided on a leading edge of the delivery apparatus 100, and in particular the boot, with the material outlets provided on a trailing edge of the heel 120 (and optionally the boot 130), so that as the apparatus 100 is urged through ground, the tip 140 cuts through the soil, with seed and optionally other materials being deposited behind the apparatus 100. It will be appreciated that in this arrangement, the tip acts as a sowing point, as will be appreciated by persons skilled in the art.

[0178] In the above arrangement, the material outlet member(s) are adjustably mounted within the heel opening, to allow a depth of material delivery relative to both the heel 120 and the tip 140 to be adjusted. Additionally, as shown for example in Figure 1C, multiple delivery outlets can be provided, allowing multiple different types of material, such as seed, fertiliser, gypsum or the like, to be delivered at multiple depths in a single pass of the delivery apparatus. This can be used to ensure different materials are provided into carefully controlled relative locations, thereby maximising the effectiveness of the planting operation. Furthermore, in one example the boot can be adjustably mounted to the tine shank and heel, allowing the depth of the tip to be altered, for example to allow the ground to be broken below the depth of planting, further increasing the flexibility and variation in dispersal of material that can be performed.

[0179] A number of additional or alternative features will now be described with reference to Figures 2A and 2B, 3A to 3D, 4A to 4D, 5A and 5B and 6A and 6B.

[0180] An example of the tine shank will now be described with reference to Figures 1B, 2A and 2B.

[0181] In this example, the tine shank 110 includes a tine shank body 211 having rearwardly extending spaced side walls 212 and a closed trailing edge 213 defining the tine shank cavity 214. In this example, the tine shank cavity includes a laterally extending web 214.1 dividing the tine shank cavity 214 into front and rear cavity portions, which in use communicate with a heel cavity and boot cavity of the heel 120 and boot 130 respectively, as will be described

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in more detail below. A mount of the tine shank cavity 214 can receive inlets 214.2 that connect to delivery paths within the tine shank cavity 214, allowing material to be supplied to the respective material outlets 160.

[0182] The nature of the delivery paths 150 will vary depending on the nature of the material to be delivered. For example, the delivery paths could include tubes extending from the inlets 214.2 to the material outlets, with these being optionally insulated allowing cold fertilisers such liquid nitrogen based fertilisers to be supplied without risking damage either to seeds, equipment, or other fertilisers supplied. In particular, this can help prevent moisture condensing on the apparatus 100, which can in turn lead to the apparatus becoming clogged in use. However, alternatively, the delivery path can be a chute or other channel, defined by one or more dividing members 151, allowing solid material to pass through the cavity and exit via a ramp 162.2 forming part of a seed outlet 162.

[0183] The trailing edge 213 includes a number of spaced recesses 215, which in use engage a toothed wheel 172 supported by a vehicle mounting arm 171 of the mounting system 170, and which acts as a drive allowing the tine shank to be raised and lowered relative to the mounting arm 171. Locking apertures 216 are provided aligned with the web 214.1, allowing fasteners such as bolts or locking pins to be inserted through the locking apertures 216, and corresponding apertures in the mounting arm, thereby locking the tine shank 110 into engagement with the mounting arm 171.

[0184] The tine shank 110 further includes a heel mounting tab 217 extending downwardly from the trailing edge 213 allowing the heel 120 to be coupled thereto.

[0185] An example of the heel will now be described in more detail with reference to Figures 3A to 3D.

[0186] In this example, the heel 120 includes a heel body 121 and two substantially parallel spaced side walls 122 extending rearwardly from the heel body 121 so as to define a heel cavity 124, which in this example extends along the entire length of the heel 120.

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[0187] The heel body 121 includes a number of T-shaped boot connectors 321, each including a spine 321.1 and laterally extending ridges 321.2 spaced along a leading edge of the heel 120. The boot connectors 321 allow the heel to be coupled to the boot 130, and are separated by recesses 321.3 allowing the root cutter 190 to be mounted therein, as will be described in more detail below. The heel 120 further includes a connector opening 323, for receiving a connector, such as a bolt and supporting pin (not shown), that secures the heel 120 to the heel mounting tab 217 of the tine shank 110.

[0188] The heel body 121 is open along the trailing edge, allowing a plurality of members to be positioned within the heel opening 123, the plurality of members can include wing material members (not shown), material outlet members 161, 162 and optionally one or more other members, such as securing members (not shown) and spacer members 363. In use, this allows multiple different material outlets 160 to be positioned in the heel opening 123, with these being held in place by securing members and spaced apart by spacer members. It will be appreciated that this allows different combinations of material outlets to be provided with different spacings, enabling highly customised configurations to be created simply through selection of appropriate members.

[0189] As shown in Figure 3D, the heel opening 123 typically includes tongues 322.1 extending inwardly from the sidewalls 122 and a chamfered outer corner edge 322.2. The material outlet members 161, 162 and spacer members 163 can include grooved opposing edges, defined by inner and outer lips 361, 362 that receive the tongues 322.1 of the opening 123, allowing the members to be slidably mounted within the opening 123. The outer lip 361 can include a shoulder 361.1 that engages the chamfered outer edge 322.2 of the tongue to help retain the respective member within the opening.

[0190] In general, a number of different securing members can be provided to help retain the material outlet members 161, 162 and spacer members 163 in position, and these can include sidewall securing members used to secure the sidewalls in a fixed spaced apart arrangement and mounting securing members that operate to secure other members in place within the opening 123.

[0191] In this regard, the sidewall securing members (not shown) can include first and second bodies that are positioned on either side of the tongue, so as to clamp onto the tongue 322.1 when urged together by a fastener. In this instance, a shoulder similar to the shoulder 361.1 of the material outlet members 161, 162 can engage the chamfered outer edge corner to thereby secure the sidewalls in fixed spaced configuration. This prevents deformation of the side walls occurring through loading during use, which could in turn result in outlet members disengaging with the opening.

[0192] Additionally, a mounting securing member can be provided that similarly includes inner and outer bodies that clamp the tongues 322.1 when urged together by a fastener, at least one of the inner and outer bodies including sloped edges that engage at least one member and urge the at least one member towards a closed end of the heel opening and/or another member, thereby urging the outlet and spacer members against each other to prevent unwanted movement of the members within the opening.

[0193] Thus, multiple members can be held within the opening using the mounting securing member, whilst the walls are held in a fixed spaced arrangement using the sidewall securing member. This combination can be used to ensure the material outlets 160 are held in a desired configuration in use, whilst also allowing the configuration to be easily adjusted as required.

[0194] In the above example, the outlet members define outlets including pipes 161 and seed ramps 162, allowing liquids or solids to be delivered via different outlets. This can be used for example to allow the seed to be planted together with water, starter fertiliser or nutrients, thereby increasing the likelihood of successful seed germination. In this instance, the relative position of the liquid and solid outlets 161, 162 may be configured depending on the nature of the seed and/or fertiliser or other material, to ensure optimum separation is achieved. Thus, providing the material outlets 160 at respective distances along the heel, allows seeds and other materials to be buried at different depths, for example to provide for stratification of material and seed delivery. This allows separation to be maintained between, for example, fertilisers and seed, which can be important for ensuring correct delivery of fertiliser, as well

as preventing seed damage in the event that chilled fertilisers, such as liquid nitrogen fertilisers, are used.

[0195] It will be appreciated from this that a variety of different material inlets, outlets and tubes can be provided, and that the above examples are for the purpose of illustration only. Additionally, mechanisms may be incorporated into the inlet, outlet or tubes, for treating material prior to or during delivery. For example, a spraying system can be incorporated into a seed tube allowing the seeds to be coated prior to or immediately upon delivery, for example with a fungicide, or the like.

[0196] The root cutter will now be described in more detail with reference to Figures 4A to 4D.

[0197] In this example, the root cutter 190 includes a substantially U-shaped root cutter body 491, including respective connectors, having a spine 491.1 and lateral ridges 491.2 mounted to a leading edge of the root cutter body. It will be appreciated that these are similar in form to and fit between the boot connectors 321 of the heel, allowing the boot connectors 321 and root connectors to form a continuous connector body. In this regard, blanks may be inserted into empty gaps between the boot connectors 321 where no root cutter is present, preventing ingress of soil or other material.

[0198] The root cutter body 491 extends rearwardly towards the trailing edge of the heel body and includes cutting wings 492 extending laterally outwardly from the heel 120. A rear portion of the root cutter body 491 receives a root cutter mounting member 493 for mounting the root cutter body 391 to the heel opening 123, in a manner similar to that described above with respect to the material outlet and spacer members. Thus, the root cutter mounting member 493 acts as one of the members described above.

[0199] In one example, the root cutter mounting member 493 includes an opening 493.1 to allow a root cutter delivery path, such as a delivery tube, to extend therethrough. In one specific example, this is achieved by forming the root cutter mounting member 493 from two complementary halves, allowing each half to be attached in turn, with the delivery tube being mounted therebetween, before the second half is attached.

[0200] A trailing edge of the wings 492 include a recess 492.1 defining at least part of a root cutter delivery path for delivery of material to one or more root cutter outlets allowing material to be delivered from the root cutter. Typically this is achieved by passing a delivery tube through the tine shank and heel cavities 214, 124, and the opening 493.1 of the root cutter mounting member 493, with this extending along the recess 492.1 and including one or more holes along the length of the tube so that liquid is dispensed from the tube. However, other suitable arrangements could be used.

[0201] An example of a boot will now be described with reference to the Figures 5A to 5C.

[0202] The boot 130 includes a boot body 531, which has a generally triangular shape, with two spaced apart side walls 532 extending rearwardly therefrom to define a boot body opening 533 extending along a trailing edge of the boot 530. In use, the boot connectors 321 engage the boot body opening to thereby secure the boot 130 to the heel 120. In particular, the boot opening 533 includes tongues 533.1 extending inwardly from the side walls 532 which engage the ridges 321.2 of the boot connectors 321, thereby securing the boot 130 to the heel 120 as the boot is urged rearwardly when coupled to the tine shank 110.

[0203] The boot body 531 also defines a boot cavity 534 that extends at least partially along a length of the boot 130. In use, the boot cavity 534 aligns with, and opens into, the tine shank cavity 214, so that at least one boot delivery path can extend through at least part of the tine shank cavity 214 and at least part of the boot cavity 534 to at least one material outlet member (not shown) provided in the boot body opening 533. This allows material to be delivered from the rear surface of the boot, which depending on the relative configuration of the boot and heel, allows material to be delivered beneath the heel 120. It will be appreciated that material outlet members can be mounted in the boot opening 533 in a manner similar to that described above with respect to the heel opening, and this will not therefore be described in further detail.

[0204] The boot body 531 includes a sleeve 535 extending rearwardly from an upper portion of the boot body 531, the sleeve 535 being mounted around the tine shank 110 in use and secured thereto with one or more fasteners extending through openings 535.1 in a rearward

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face of the sleeve 535. In use, the boot 130 is slide along the boot connectors 321 of the heel 120 and over the tine shank 110, allowing the boot 130 to be positioned so as to define a relative vertical separation between the tip 140 and heel. A set position can be denoted by positional markings provided on the tine shank 120, which align with a window 535.2 in the sleeve, allowing an operator to position the boot 130 relative to the tine shank 110 and heel 120 before securing the boot in position.

[0205] In this regard, securing of the boot is achieved using the fasteners extending through the sleeve apertures 535.1 and into corresponding openings/recesses in the tine shank, as well as by securing the heel 120 to the tine shank 130, with this causing the boot connectors 321 to engage the tongues 532.1 of the boot opening 533, as previously described. The use of dual securing mechanisms can ensure the boot is locked in position and prevent unwanted movement of the boot relative to the heel and/or tine shank 110.

[0206] The boot body 130 further includes a tip mounting configured to receive a tip 641 in use, as shown in Figure 6A.

[0207] In this regard, the tip mounting typically includes a shaped cut-out 536.1 in the boot body 531 that conforms to an internal surface of the tip 641, and an aperture 536.2 extending through the boot body 531, allowing a locking pin or other fastener to be inserted through the aperture 536.2 and a corresponding opening in the tip 641, thereby locking the tip 641 to the boot body 531. The tip is typically triangularly shaped, defining working edges tapering to a point.

[0208] A shin guard 642 is then coupled to the boot 130 adjacent the tip 641, the shin guard including a V-shaped body defining a working edge facing away from the tine shank. The configuration provides a low resistance entry angle, thereby acting to protect the tine shank 110 and boot 120 as the apparatus 100 is urged through the ground.

[0209] The shin guard 180 is typically removable so that it can be easily replaced as it wears. Mounting of the shin guard is achieved using T-shaped guard channels 536.3 extending rearwardly along outer faces of the boot body 531 from a leading edge of the boot body. The shin guard 642 then includes pegs adapted to engage the guard channels 536.3 allowing the

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shin guard to be coupled to the boot body 531, in particular by sliding this rearwardly from the leading edge. The guard channels also allow the shin guard 642 to be lifted, allowing the tip 641 to be selectively coupled to the tip mounting, before the shin guard is lowered to secure the tip 641 to the tip mounting.

[0210] Once the shin guard is fitted, a stubble guard 643 can be attached to the boot 130 using a fastener, such as a bolt, inserted into a stubble guard opening 536.4 extending laterally through the leading edge of the boot body 531. The stubble guard 643 includes a generally semi-cylindrical body that at least partially wraps around the boot 130, with an inner surface facing the boot 130, and thereby protecting the boot.

[0211] The stubble guard 643 is mounted outwardly of the shin guard 642, so that at least an end of the shin guard 642 is positioned between the stubble guard 643 and the boot 130. This helps retain the shin guard 642 in position, whilst allowing it to be easily replaced through removal of the stubble guard 643. In use, the stubble guard 643 is designed to be provided at ground level, so that any stubble in the ground impinges on the stubble guard 643 in use, thereby helping protect the tine shank 110 from wear. In this regard, the stubble guard 643 includes a rounded profile for easy stubble run-off, thereby deflecting stubble and preventing this becoming entrained in the tine shank 110, which can in turn damage the tine shank 110.

[0212] The tips, shin guard and stubble guard are typically made of a casting of hardened steel, white iron, or other hard wearing material, with the working edge(s) being made of Tungsten Carbide.

[0213] Additionally, the boot body includes a recess 537.1 that extends along a leading edge of the boot body 531 to an opening 537.2 passing through the boot body and exiting rearwardly of the tip mounting 536.1 so as to define a tip delivery path for delivering material to a delivery outlet on an underside of the boot 130, further allowing for delivery of liquid materials.

[0214] Accordingly, the above described arrangement provides an apparatus including a tine shank, a heel mounted to the tine shank which includes a number of material outlets, and a boot mounted to the tine shank and heel, which includes a tip for breaking the ground. In

use, the heel material outlets are connected via connecting tubes or chutes to inlets mounted on the tine shank, allowing material, fertiliser, nutrients, gypsum, or the like to be delivered via the material outlets. The outlets can be moved relative to the heel, allowing them to be provided at different discrete depths within the ground, providing flexibility for material delivery, depending on the nature of the material being delivered.

[0215] Additionally, as mentioned above, the relative position of the heel 120 and boot 130 can be adjusted, allowing the relative depth of the tip 140 and heel material outlets to be altered. Additionally, the boot 130 can also include one or more boot material outlets, allowing material to be delivered to a region immediately behind the tip 140. In this regard, the boot material outlets can be provided at different positions and/or be adjustable, allowing material to be delivered at different depths when the boot is lowered relative to the heel.

[0216] It will also be appreciated that the heel and boot material outlets can be coupled to corresponding material inlets via chutes and/or connecting tubes, allowing a combination of materials including seeds, fertilisers or the like to be delivered to different depths relative to the tip 140. The nature of the inlets, outlet and connecting tubes will vary depending on the preferred implementation, and will not be described in detail, but could include tubes that might be insulated or non-insulated, pressurised or unpressurised, as well as chutes or openings, allowing solid material to be dispensed via ramps or the like.

[0217] It will be appreciated that in the above described example, the tip can be provided at a significant depth below the heel, as shown for example in Figure 1D. This can be useful in certain scenarios, for example to break up soil beneath the seeds, and optionally deliver fertiliser or other nutrients thereto meaning that the region below the seed is more accommodating to root growth. The material can also include gypsum which in one example acts as a ground-softening agent to thereby further enhance plant growth, reduce equipment fuel usage etc.

[0218] A number of further variations are also possible. For example, the tine shank and heel cavities can accommodate either insulated liquid or granular fertiliser options, which can be for single or multiple product types, and which can include multiple discharge outlets

provided at different locations along the trailing edge of the heel 120. The boot also has a cavity 534, to allow for either liquid or granular fertilisers/nutrients to be placed at various levels below the bottom of the heel 120. This can be used to accommodate singular or multiple types of products at different depths.

[0219] The boot 130 can also be interchanged so as to accommodate different fertiliser/nutrient distribution options including supplying fertiliser at different depths and widths, as well as different boot styles for varying applications or soil conditions.

[0220] Accordingly, the above described arrangement provides a highly adjustable arrangement that can be used to easily adjust a soil fracturing depth up to 500mm. Material, including liquid and/or solids can be discharge at up to 500mm deep, with a liquid outlet being provided directly behind the tip for maximum depth placement.

[0221] The arrangement can use long life wear parts, such as Tungsten Carbide, providing enhanced wear capabilities.

[0222] The material outlets 160 can include a large dual or single wing, adapted to delivery material such as nitrogen laterally of other material, which can allow for banding of delivered material, which is desirable in some circumstances. Additionally, the wing can be insulated to allow for delivery of liquid nitrogen, or adapted for solid nitrogen delivery at up to 75mm or more on either side of the tines. The dual wing can also be used to allow for delivery of humic acid or other stabilisers over liquid nitrogen, to assist in locking nitrogen into the soil. A smaller dual wing could additionally or alternatively be provided for lateral delivery of liquid and/or solid material a distance of up to 100mm or more from the tine.

[0223] The relative position of the delivery outlets 160 can be adjusted through appropriate selection of delivery outlets and spacer members, allowing each member to be adjusted in 25mm increments, providing a depth range from 50mm to 400mm.

[0224] The apparatus can include a removable root cutter, which in one example is up to 600mm, and can be adjustably mounted in 25mm increments. The root cutter allows for liquid discharge out either wing.

[0225] The above described features provide an agronomic arrangement that can allow for vertical banding of liquids and/or solids, enabling users to place fertilisers/nutrients at correct depths for optimum plant access, as well as allowing for lateral liquid dispersion.

[0226] This enables seeding and conditioning to be performed using fewer passes over land, resulting in reduced moisture loss, reduced equipment wear & tear, significant fuel savings, reduced soil compaction and a lower carbon footprint. Additionally, the equipment can be retrofitted to existing toolbars and be easily reconfigured to suit changing requirements and conditions.

[0227] A further example of apparatus for delivering material to below ground level will now be described with reference to Figures 7A to 7D and with additional reference to a specific arrangement further described in Figures 8, 9A to 9C, 10A to 10C, 11A to 11C, 12A to 12C and 13A to 13C. For the purpose of illustration, relative terms, such as upper, lower, forward, rearward, leading and trailing are used relative to the intended orientation of the apparatus in use, but are otherwise not intended to be limiting.

[0228] In this example, the apparatus 700 includes a tine shank 710 including a tine shank body, a heel 720 including a heel body mounted to a lower end of the tine shank 710, a point 730 mounted to a leading edge of the heel, a tip 731 mounted to a leading edge of the point 730, and a material delivery member 760 adjustably mounted to a trailing edge of the heel 720. The material delivery member 760 includes a material delivery member body 761 defining a delivery path extending from a material inlet 763 to a material outlet 762 configured to supply material received via the delivery path to below ground level in use.

[0229] In this example, two material delivery members 760 are provided, with a second material delivery member being mounted to a rear edge of the material delivery member. This allows different material to be delivered to different depths as will be described in more detail below. However, this configuration is not essential and any arrangement of one or more material delivery members can be used.

[0230] An optional shin guard 740 can be provided coupled to the heel proximate the point, with a stubble guard 750 mounted to a leading edge of the heel 720 may also be provided, depending on the intended usage, as will be described in more detail below.

[0231] Accordingly, it will be appreciated that in the above described arrangement, the apparatus 700 again utilises a material delivery member having a material outlet 762 whose height relative to a heel 720 can be adjusted, so that a depth of material delivery relative to the heel can be adjusted.

[0232] The nature of the material will again vary depending on the preferred usage, although in this example, the material delivery members are typically adapted for delivering solid materials, such as seeds, granular nutrients, or the like. The material delivery members are typically removably mounted, meaning these can be used interchangeably, so that the delivery apparatus 700 could be used for any suitable purpose and combination of materials. For ease, the remainder of the description will focus on the delivery of both seeds and other material, but it will be appreciated that this is not intended to be limiting.

[0233] In use, the apparatus 700 may be attached to a vehicle, or the like, and then positioned with tip 731 and material outlets 762 below ground level. The tip 731 is provided on a leading edge of the delivery apparatus 700 so that as the apparatus 700 is urged through ground, the tip 731 cuts through the soil, with seed and optionally other materials being deposited behind the apparatus 700. It will be appreciated that in this arrangement, the tip acts as a sowing point, as will be appreciated by persons skilled in the art.

[0234] In contrast to the previous arrangement, the above described arrangement utilises a point coupled to the heel instead of an adjustable boot. As a consequence, the tip is typically at a fixed height relative to the heel and hence provides a reduced degree of adjustability, but nevertheless, still allows for material to be delivered at a different depth to the tip.

[0235] As will be described in further detail below, the above described arrangement can be particularly beneficial as it allows multiple separate material delivery members to be provided in abutment, with each being adapted to deliver material via separate outlets to different depths. This allows multiple different types of material, such as seed, fertiliser,

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gypsum or the like, to be delivered at multiple depths in a single pass of the delivery apparatus. This can be used to ensure different materials are provided into carefully controlled relative locations, thereby maximising the effectiveness of the planting operation.

[0236] Additionally, this arrangement can use material delivery members that are physically distinct to the tine shank, allowing these to be larger in cross sectional area, making these more suited for use in delivering solid material and in particular seed to different depths to a sowing point defined by the tip.

[0237] Furthermore, the above arrangement also allows the apparatus to be used with tine shanks that do not include a cavity, allowing the tine shank to be stronger, as well as allowing the apparatus to be used with multi-use tine shanks, as will be described in more detail below.

[0238] A number of further features will now be described with reference to specific examples of the tine shank, heel, point, shin guard, stubble guard and material delivery member.

[0239] An example tine shank is shown in Figure 8.

[0240] In this example, the tine shank 710 typically includes a solid tine shank body 810, having a generally elongate shape with a rectangular cross section extending from leading to trailing edges. The tine shank body 810 can include mounting holes 812 extending laterally therethrough, spaced apart along a length of the tine shank body 810, allowing fasteners to be provided therein for coupling the tine shank to a vehicle, via a mounting system, or the like (not shown).

[0241] A heel mounting 811 is provided at a lower end of the tine shank body 810, with the heel mounting 811 including a rebate 811.1 in a lower forward corner of the tine shank body 810 and a fastener opening 811.2 extending rearwardly from the rebate 811.1 to a fastener recess 811.3 in the trailing edge of the tine shank body 810.

[0242] An example heel 720 is shown in more detail in Figures 9A and 9B.

[0243] In this example, the heel 720 includes a heel body 920, which is generally a trapezoidal shaped solid body, including substantially parallel spaced apart side walls and trailing and leading edges that taper towards a lower end of the heel body 920. A recess 922 is provided along the leading edge of the heel, for accommodating a liquid material delivery tube extending between the heel 720 and the point 730, shin guard 740 and stubble guard 750.

[0244] The heel 720 includes a tine shank mounting 921 provided at an upper end of the heel body 920, the tine shank mounting 921 including a tine shank channel 921.1 extending forward from the trailing edge of the heel body 920, allowing the lower end of the tine shank 710 to be accommodated therein, with the leading edge of the heel body 920 contained within the rebate 811.1. A tine shank fastener aperture 921.2 extends through a leading edge of the heel body 920, so as to align with the fastener opening 811.2, allowing a fastener such as a bolt, to be inserted therethrough to couple the heel to the tine shank 710. In particular, the bolt can be inserted through the fastener opening 811.2 and tine shank fastener aperture 921.2, with a nut being retained in the recess 811.3, allowing the heel 720 and associated components to be rapidly decoupled from the tine shank 710. This allows equipment mounted on the tine shank to be easily interchanged, without requiring the tine shank to be removed from the vehicle mounting system, whilst also allowing re-use of the tine shank, thereby reducing overall equipment costs.

[0245] The heel 720 includes a point mounting 923 for receiving the point 730, an example of which is shown in Figures 10A to 10C.

[0246] In this example, the point 730 includes a generally U-shaped body 1030, including side walls 1031 extending rearwardly from a leading edge. In this example, the side walls are trapezoidally shaped, although this is not essential and other configurations could be used. The point mounting 923 includes a cut-out section 923.2, having a complementary shape to the point, allowing the point 730 to be accommodated therein to ensure the point 730 is correctly positioned.

[0247] The point mounting 923 includes point channels 923.1 provided in faces of the heel body side walls. Four point channels are included in this example, with two longitudinally spaced point channels being provided on either side of the heel. The point channels 923.1 extend rearwardly from a leading edge of the heel body 910. The point 730 includes ridges 1032 extending forwardly along internal faces of the side walls 1031 from proximate the trailing edge, which in use sit within the point channels 923.1 to allow the point to be mounted to the heel.

[0248] In use, the leading edge of the point defines a tip mounting for receiving a tip 1033.1, and a tip extension 1033.2 providing a working edge to the point.

[0249] Additionally, a recess 1030.1 can be provided along on a rear side of the leading edge of the point 730, which cooperates with the recess 922 on the leading edge of the heel to accommodate a liquid material delivery tube, allowing liquid to be supplied from an opening (not shown) on an underside of the point 730.

[0250] Upper edges of the side walls 1031 further include ridges 1031.1 used to secure the point 730 to the heel 720 using the shin guard 740, as will now be described.

[0251] In this regard, the heel 720 includes a shin guard mounting 924 for receiving the shin guard 740, an example of which is shown in Figures 11A to 11C.

[0252] In this example, the shin guard 740 includes a generally U-shaped shin guard body 1140 having shin guard side walls 1141 extending rearwardly from a leading edge, which is typically V-shaped to define a working edge facing away from the tine shank to thereby break ground in front of the apparatus. The side walls 1141 are typically rectangular, and extend longitudinally along the heel when mounted thereon. The shin guard mounting 924 includes a cut-out section 924.3, having a complementary shape to the shin guard, allowing the shin guard 740 to be accommodated therein to ensure the shin guard 740 is correctly positioned.

[0253] The shin guard mounting 924 includes L-shaped shin guard channels 924.1 extending rearwardly and downwardly along faces of heel body side walls, from a leading edge of the

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heel body 810, allowing the shin guard to be mounted thereto. Shin guard pegs 1142 are mounted on each internal face of the shin guard side walls 1041, allowing these to engage shin guard channels 924.1 so that the shin guard can be attached to the heel and dropped into abutment with the point 730 to thereby secure the point 730 to the heel 720. In particular, the shin guard 740 can include rebated lower trailing edge corners 1143, which engage the point ridges 1031.1 to thereby secure the point 730 to the heel 720.

[0254] The shin guard is then locked into position using a fastener 1120, which is inserted through a fastener aperture 924.2 extending laterally through the heel body 920 rearwardly of the shin guard channels 924.1, and which engages fastener recesses 1141.1 in trailing edges of the shin guard side walls 1141. This prevents upward movement of the shin guard 740, thereby securing the shin guard pegs 1142 within the shin guard channels 924.1 so as to secure the shin guard 740 to the heel 720, and hence the point 730 to the heel 720.

[0255] The heel 720 also includes a stubble guard mounting 925 for receiving a stubble guard 750, an example of which is shown in Figures 12A to 12C.

[0256] In this example, the stubble guard 730 includes a generally U-shaped stubble guard body 1250 and spaced apart side walls 1251 extending rearwardly from a leading edge, which is typically rounded to define a working edge facing away from the tine shank to thereby break and deflect debris on the ground surface in front of the apparatus. The side walls are typically rectangular, and extend longitudinally along the heel when mounted thereon, to protect the heel 720. The stubble guard 1250 also generally includes a stubble guard tip 1253 extending forwardly of the stubble guard. In general, this is aligned with ground level to assist clearance of debris, and accordingly, in one example the stubble guard is adjustably mounted to the heel 720 allowing the stubble guard to be correctly positioned irrespective of the depth of the point tip 731.

[0257] The stubble guard mounting includes a T-shaped stubble guard channel 925.1 extending rearwardly and along faces of the heel body side wall from a leading edge of the heel body and/or the cut-out portion 924.3. The stubble guard 750 includes stubble guard pegs 1252 extending inwardly from internal faces of the side walls 1251, which in use engage

the stubble guard channels 925.1 in the heel 720 allowing the stubble guard 750 to be attached to the heel 720 and moved longitudinally along the heel 720.

[0258] A stubble guard fastener aperture 925.2 extends laterally through the heel body rearwardly of and below the stubble guard channel 925.1, with fastener apertures 1251.1 being spaced along the stubble guard side walls 1251, allowing the stubble guard to be fastened to the heel at a desired height by inserting a fastener (not shown) through the fastener apertures 925.2 in the heel.

[0259] With the above described configuration, the stubble guard 750 sits over the shin guard 740, thereby helping to retain the shin guard 740 in position.

[0260] The point, tips, shin guard and stubble guard are typically made of a casting of hardened steel, white iron, or other hard wearing material, with the working edge(s) being made of Tungsten Carbide.

[0261] The heel 720 also includes a delivery mounting, allowing a material delivery member to be attached to the heel 720, an example of which will now be described with reference to Figures 13A to 13B.

[0262] The material delivery member includes a main body 1361 which is in the form of a rectangular cross section hollow elongate tube. The body 1361 is coupled to an outlet body 1362 defining an outlet 1362.6, such as a ramp, for delivery of solid material, and an inlet body 1363 defining an inlet 1363.1 for receiving material from a supply.

[0263] In one example, the delivery mounting 926 includes a guide member, such as an elongate shaft 926.1 extending substantially parallel to a trailing edge of the heel 720, with the material delivery member being slidably mounted thereon allowing the depth of the material outlet relative to the heel to be adjusted. In particular, in one example this is achieved using a toe 1362.1 having an aperture 1362.2 therein which extends forwardly from the outlet body 1362, allowing the shaft 926.1 of the heel 720 to be received therein.

[0264] The guide member 926.1 is typically supported by a mounting 926.2, which extends rearwardly from the lower trailing edge corner of the heel body 920. The mounting 926.2 can also include an aperture (not shown) extending therethrough, allowing an end of the toe to be received therein to thereby assist coupling with the delivery device member.

[0265] The outlet body 1362 further includes a lug 1362.3 extending from a leading face, which aligns with a corresponding lug 1361.1 of the main body 1361, allowing the main and outlet bodies 1361, 1362 to be connected using a fastener 1364 extending through the lugs. This allows the outlet body 1362 to be removed and replaced, for example to provide for different outlet configurations.

[0266] The main body 1361 further includes a fastener mounting 1361.2 coupled to the lug, which has a slot 1361.3 laterally spaced from and extending substantially parallel to a leading edge of the delivery member 760. The slot 1361.3 extends to a wider opening 1361.4, so as to define a keyway for receiving a bolt 1320. In use, the fastener mounting 1361.2 abuts against a plate 926.3 on the trailing edge of the heel 920, with the bolt being inserted through an opening 926.4, allowing a nut to be coupled to the bolt and accommodated within a recess 926.5 on a leading edge of the heel 720. This arrangement secures the material delivery member 926 to the heel 720, whilst allowing the bolt to be moved along the length of the slot 1361.3 so as to adjust the height of the material delivery member 760 relative to the heel. Additionally, the engagement between the fastener mounting 1361.2 and the plate 926.3 is typically configured to apply a torque to the material delivery member 760, thereby urging the toe 1362.1 into engagement with shaft 926.1, thereby helping retain the material delivery device securely in position.

[0267] The main body 1361 further includes a lug 1361.5 extending from a leading face, which aligns with a corresponding lug 1363.2 of the inlet body 1363, allowing the main and inlet bodies 1362, 1363 to be connected using a fastener extending through the lugs. This allows the inlet body 1363 to be removed and replaced, for example to provide for different inlet configurations. In this regard, in the current example, the inlet body 1363 defines a connector that can be connected to a supply tube, for delivery of solid materials, although other suitable connectors could be used.

[0268] Additionally, the outlet body includes a guide member, such as an elongate shaft 1326.5 extending substantially parallel to a trailing edge of the material delivery member 760, for example by supporting this on a mounting 1362.4. A lug 1361.6 is further provided on an upper end of the main body 1361, allowing a second material delivery member to be mounted to the rear of the delivery member 760, in a manner similar to that described above with respect to connection of the material delivery member 760 to the heel 720.

[0269] It will be appreciated that this allows a number of different material delivery members 760 to be attached to each other, allowing different materials to be supplied at different depths depending on the particular usage requirements.

[0270] Thus, the above described arrangement provides a material delivery system that is less complex than the previous example, but which still provides significant flexibility in terms of material delivery.

[0271] A further example of apparatus for delivering material to below ground level will now be described with reference to Figures 14A to 14D and with additional reference to a specific arrangement further described in Figures 15A and 15B, 16A to 16D, 17A to 17C, 18A to 18C, 19 and 20A and 20B. For the purpose of illustration, relative terms, such as upper, lower, forward, rearward, leading and trailing are used relative to the intended orientation of the apparatus in use, but are otherwise not intended to be limiting.

[0272] In this example, the apparatus 1400 includes a tine shank 1410 including a tine shank body, a heel 1420 including a heel body mounted to a lower end of the tine shank 1410, a point 1430 mounted to a leading edge of the heel, a tip 1431 mounted to a leading edge of the point 1430, and a material delivery member 1460 adjustably mounted to a trailing edge of the heel 1420. The material delivery member 1460 includes a material delivery member body 1461 defining a delivery path extending from a material inlet 1463 to a material outlet 1462 configured to supply material received via the delivery path to below ground level in use.

[0273] In this example, two material delivery members 1460.1, 1460.2 are provided, with a second material delivery member 1460.2 being mounted to a rear edge of the material delivery member 1460.1. The height of each material delivery member is adjustable, as

shown in Figures 14B and 14C, allowing different material to be delivered to different depths as will be described in more detail below. However, this configuration is not essential and any arrangement of one or more material delivery members can be used.

[0274] An optional shin guard 1440 can be provided coupled to the heel proximate the point, with a stubble guard (not shown) also being optionally mounted to a leading edge of the heel 1420 in a manner similar to that described above with respect to the example of Figures 7A to 7D.

[0275] Accordingly, it will be appreciated that in the above described arrangement, the apparatus 1400 again utilises a material delivery member having a material outlet 1462 whose height relative to a heel 1420 can be adjusted, so that a depth of material delivery relative to the heel can be adjusted.

[0276] The nature of the material will again vary depending on the preferred usage, although in this example, the material delivery members are typically adapted for delivering solid materials, such as seeds, granular nutrients, or the like. The material delivery members are typically removably mounted, meaning these can be used interchangeably, so that the delivery apparatus 1400 could be used for any suitable purpose and combination of materials. For ease, the remainder of the description will focus on the delivery of both seeds and other material, but it will be appreciated that this is not intended to be limiting.

[0277] In use, the apparatus 1400 may be attached to a vehicle, or the like, and then positioned with tip 1431 and material outlets 1462 below ground level. The tip 1431 is provided on a leading edge of the delivery apparatus 1400 so that as the apparatus 1400 is urged through ground, the tip 1431 cuts through the soil, with seed and optionally other materials being deposited behind the apparatus 1400. It will be appreciated that in this arrangement, the tip acts as a sowing point, as will be appreciated by persons skilled in the art.

[0278] It will therefore be appreciated that the apparatus 1400 is broadly similar to the apparatus 700 described above with respect to Figures 7A to 7D, and therefore provides

many of the same advantages. These will not therefore be described in further detail and the following description will focus on distinctions between the two arrangements.

[0279] An example tine shank is shown in Figures 15A and 15B.

[0280] In this example, the tine shank 1410 typically includes a solid tine shank body 1510, having a generally elongate shape with a rectangular cross section extending from leading to trailing edges. The tine shank body 1510 can include mounting holes 1512 extending laterally therethrough, spaced apart along a length of the tine shank body 1510, allowing fasteners to be provided therein for coupling the tine shank to a vehicle, via a mounting system, or the like (not shown).

[0281] A heel mounting 1511 is provided at a lower end of the tine shank body 1510, with the heel mounting 1511 including a rebate 1511.1 in a lower trailing corner of the tine shank body 1510 and a fastener opening 1511.2 extending forwardly from the rebate 1511.1 to a leading edge of the tine shank body 1510, with the opening being elongated along an axial direction of elongation of the tine shank body to accommodate vertical movement of a fastener therein. Angled ridges 1511.4 extend along outer side walls from the rebate 1511.1 to the leading edge of the tine shank body 1510, with the ridges raising from the rebate to the leading edge. Furthermore, the lower end of the tine shank terminates in a V-shaped end 1511.5.

[0282] An example heel 1420 is shown in more detail in Figures 16A and 16B.

[0283] In this example, the heel 1420 includes a heel body 1620, which is generally a trapezoidal shaped solid body, including substantially parallel spaced apart side walls and trailing and leading edges that taper towards a lower end of the heel body 1620. A recess 1622 is provided along the leading edge of the heel, for accommodating a liquid material delivery tube extending between the heel 1420 and the point 1430, shin guard 1440 and stubble guard (not shown).

[0284] The heel 1420 includes a tine shank mounting 1621 provided at an upper end of the heel body 1620, the tine shank mounting 1621 including a tine shank channel 1621.1

extending rearwardly from a trailing edge of the heel body 1620, allowing the lower end of the tine shank 1410 to be accommodated therein, with the trailing edge of the heel body 1620 contained within the rebate 1511.1. The channel 1621.1 has a V-shaped lower surface, having a complementary profile to the end 1511.5 of the tine shank, to help align the tine shank with the centre of the channel 1621.1. Additionally, grooves are provided on inner wall surfaces of the channel 1621.1, allowing the ridges 1511.4 to be received therein, so that as the tine shank is pushed into the channel 1621.1, it is urged downwardly into engagement with the lower surface, to thereby align and hold the tine shank 1410 and heel 1420 in position. A tine shank fastener aperture 1621.2 extends through a trailing edge of the heel body 1620, so as to align with the fastener opening 1511.2, allowing a fastener such as a bolt, to be inserted therethrough to secure the heel to the tine shank 1410. In this regard, the elongation of the fastener opening 1511.2 accommodates relative vertical movement of the tine shank 1410 and heel 1420 as the ridges 1511.4 slide within the grooves in the channel.

[0285] This allows equipment mounted on the tine shank to be easily interchanged, without requiring the tine shank to be removed from the vehicle mounting system, whilst also allowing re-use of the tine shank, thereby reducing overall equipment costs. Additionally, in contrast to the previous arrangement, the heel is mounted from the trailing edge of the tine shank, allowing this to be mounted with delivery members already coupled to the heel, thereby making the mounting process easier. Furthermore, the above described arrangement provides the complimentary V-shaped tine shank end 1511.5 and channel lower surface, as well as the ridges 1511.4 and corresponding grooves, to thereby securely lock the tine shank and heel into engagement and prevent relative movement of the tine shank and heel in use.

[0286] The heel 1420 includes a point mounting 1623, a shin guard mounting 1624 and stubble guard mounting 1625, for receiving a point 1430, shin guard 1440 and stubble guard respectively. These are generally identical to the corresponding point mounting 923, shin guard mounting 924 and stubble guard mounting 925 of the previous example and will not therefore be described in further detail.

[0287] The heel 1420 also includes a delivery mounting, allowing a material delivery member to be attached to the heel 1420. An example of a first delivery member 1460.1 will now be described with reference to Figures 17A to 17B.

[0288] The material delivery member includes a main body 1761 which is in the form of a rectangular cross section hollow elongate tube. The body 1761 is coupled to an outlet body 1762 defining an outlet 1762.6, which in this example includes liquid outlets mounted in an underside of the outlet body, but could alternatively include a ramp, for delivery of solid material. Additionally, an inlet body (not shown) can be coupled to the main body 1761 to provide an inlet for receiving material from a supply.

[0289] The delivery mounting 1626 includes a plurality of delivery member mountings 1626.1, spaced along the trailing edge of the heel, the material delivery member includes a toe 1762.2, that is selectively mounted to one of the delivery member mountings, allowing a depth of the material outlet relative to the heel to be adjusted. In one example, delivery member mountings 1626.1 are in the form of U-shaped loops projecting rearwardly from the trailing edge of the heel 1420, with the toe 1762.2 including a downwardly extending peg 1762.1 that is inserted into one of the loops 1626.1, to thereby couple the toe to the delivery member mounting 1626.1, although other suitable arrangements could be used. For example, although a single toe is shown, alternatively three toes could be provided spaced along the delivery member, to increase the degree of coupling between the delivery member and the heel, which can assist with accommodating lateral loads in use, as shown in the example second delivery member below.

[0290] Additionally, the heel includes a delivery member securing tab 1626.3 extending rearwardly from and along a trailing edge of the heel 1420, and wherein the material delivery member 1460.1 includes a heel securing tab 1761.1 extending forwardly from and along a leading edge of the delivery member 1460.1. The tabs include respective apertures 1626.4, 1761.2 extending therethrough and spaced along a length of the tabs, and wherein in use a fastener extends through selected ones of the apertures to secure the delivery member at a fixed height relative to the heel.

[0291] The outlet body 1762 further includes a lug 1762.3 extending from a leading face, which aligns with a corresponding lug 1761.1 of the main body 1761, allowing the main and outlet bodies 1761, 1762 to be connected using a fastener (not shown) extending through the lugs. This allows the outlet body 1762 to be removed and replaced, for example to provide for different outlet configurations.

[0292] The main body 1761 further includes a lug 1761.5 extending from a leading face, which aligns with a corresponding lug of the inlet body (not shown), allowing the main and inlet bodies 1762, to be connected using a fastener extending through the lugs. This allows the inlet body 1763 to be removed and replaced, for example to provide for different inlet configurations in a manner similar to that described above with respect to the previous example.

[0293] In this example, the delivery member further includes parallel spaced apart working edges 1765 provided along outer corners of the leading edge of the delivery member to assist in breaking the soil as the apparatus is moved through the ground.

[0294] Additionally, the outlet body includes a plurality of delivery member mountings 1762.3 spaced along the trailing edge of the delivery member and a delivery member securing tab 1761.3 having spaced apertures 1761.4 therein, the tab extending rearwardly from and along a trailing edge of the delivery member. It will be appreciated that this arrangement allows a further delivery member 1460.2 to be secured to the trailing edge of the delivery member 1460.1, in a manner similar to that described above with respect to connection of the first material delivery member 1460.1 to the heel 1420.

[0295] An example of a second delivery member 1460.2 is shown in Figures 18A to 18B.

[0296] This largely includes similar features to those of the first delivery member 1460.1 with reference numerals increased by 100, and these will not therefore be described in detail. However, it should be noted that differences are for illustrative purposes only and that in practice features of the first and second delivery members, and the delivery members themselves can be used interchangeably. Reference to specific features in specific examples are not intended to be limiting.

[0297] In this example, the outlet includes a ramp 1862.5, allowing seeds or other particulate material to be delivered from the trailing edge.

[0298] In this example, the material delivery member 1460.2 includes three toes 1862.2 spaced along a leading edge of the delivery member 1460.2, which are selectively mounted to respective ones of the delivery member mountings 1762.3 of the first delivery member 1460.1, allowing a depth of the material outlet relative to the heel to be adjusted.

[0299] Additionally, in the example of Figure 18C, a liquid delivery tube 1867 is shown extending along the trailing edge of the delivery member, supported by a tube clamp provided on a mounting tab 1861.6, extending rearwardly from an upper trailing edge of the main body 1861, and through the loops of the delivery member mountings 1862.3. The liquid delivery tube 1867 is for delivering liquid fertiliser, fungicide, or inoculant or other liquid substantially coincident with and even directly onto the seed, during sowing. This allows seeds to be delivered uncoated and coated in situ, or delivered coincident with liquid material, which reduces clogging of seed outlets.

[0300] In the example of Figure 18C, a single liquid delivery tube is shown, although this is not essential and alternatively multiple spaced tubes can be mounted, for example using a mounting similar to that shown in Figure 19.

[0301] In this example, the mounting 1970, includes a body 1971, including openings 1972.1, 1972.2 for receiving respective delivery tubes 1867.1, 1867.2. The body 1971 includes pairs of parallel spaced apart arms 1971.1 that can be urged together using fasteners, thereby partially closing the openings 1972.1, 1972.2 allowing the delivery tubes 1867.1, 1867.2 to be secured therein. Additionally, a gap between the arms 1971.2 can be used to receive a mounting tab 1861.6, provided on an upper trailing edge of the delivery member body 1861 of the second delivery member 1460.2, thereby allowing the body 1971 to extend rearwardly from the delivery member, to thereby secure the delivery tubes thereto.

[0302] An example of an outlet sleeve incorporated in the outlet of the second material delivery member 1460.2 will now be described with reference to Figures 20A and 20B.

[0303] In this example, the delivery member can also include a sleeve 2080 selectively mounted within the material outlet 1862, the sleeve defining a narrowing of the material outlet to thereby increase a flow rate of material through the material outlet. In one example this is achieved using parallel spaced apart sleeve sidewalls 1861 that abut against inner side walls of the delivery member outlet 1862, to thereby narrow the outlet width. In this regard the sleeve sidewalls can be tapered to progressively narrow the outlet, which avoids discontinuities which can cause blockages, whilst also allowing sufficient narrowing to be achieved to ensure a noticeable increase in flow rate, ensuring blocking of the outlet is prevented. This can also help constrain lateral spread of material during delivery.

[0304] An upper end of the sleeve is typically shaped to define a recess that allows the sleeve to pivotally attach to a lower end of the trailing edge of the delivery member, with cut outs 2083 in the side walls receiving the delivery ramp 1862.5, and a lower edge of the sleeve being attached to the delivery member using a fastener 2084, such as a nut and bolt.

[0305] The sleeve can also be configured to further adapt the delivery member outlet. For example, the sidewalls can be extended beyond the trailing edge of the delivery member so as to define a shroud extending rearwardly from a trailing edge of the delivery member. The liquid delivery tube extending along the trailing edge of the delivery member can terminate in a nozzle positioned within the shroud, so as to protect the nozzle from soil, preventing the nozzle becoming blocked. Similarly, the sleeve can be adapted to extend a length of the seed ramp, for example to increase separation between materials supplied via different outlets.

[0306] A further example arrangement will now be described with reference to Figures 21 to 27.

[0307] In this example, the apparatus 2100 includes a tine shank 2110 including a tine shank body, a heel 2120 including a heel body mounted to a lower end of the tine shank 2110, a point 2130 mounted to a leading edge of the heel, a tip 2131 mounted to a leading edge of the point 2130, and a material delivery member 2160 adjustably mounted to a trailing edge of the heel 2120. The material delivery member 2160 includes a material delivery member body

2161 defining a delivery path extending from a material inlet 2163 to a material outlet 2162 configured to supply material received via the delivery path to below ground level in use.

[0308] In this example, two material delivery members 2160 are provided, with a second material delivery member being mounted to a rear edge of the material delivery member. This allows different material to be delivered to different depths as will be described in more detail below. However, this configuration is not essential and any arrangement of one or more material delivery members can be used.

[0309] An optional 2140 can be provided coupled to the heel proximate the point, with a stubble guard 2150 mounted to a leading edge of the heel 2120 may also be provided, depending on the intended usage, as will be described in more detail below.

[0310] Accordingly, it will be appreciated that in the above described arrangement, the apparatus 2100 again utilises a material delivery member having a material outlet whose height relative to a heel 2120 can be adjusted, so that a depth of material delivery relative to the heel can be adjusted. The current example broadly functions in a manner similar to that of the example of Figures 7 to 13, and broad features will not therefore be described in any further detail.

[0311] A number of further features will now be described with reference to specific examples of the tine shank, heel, point, shin guard, stubble guard and material delivery member.

[0312] An example tine shank is shown in Figure 22.

[0313] In this example, the tine shank 2110 typically includes a solid tine shank body 2210, having a generally elongate shape with a rectangular cross section extending from leading to trailing edges. The tine shank body 2210 can include mounting holes 2212 extending laterally therethrough, spaced apart along a length of the tine shank body 2210, allowing fasteners to be provided therein for coupling the tine shank to a vehicle, via a mounting system, or the like (not shown).

[0314] A heel mounting 2211 is provided at a lower end of the tine shank body 2210, with the heel mounting 2211 including a rebate 2211.1 in a lower forward corner of the tine shank body 2210 and a fastener opening 2211.2 extending rearwardly from the rebate 2211.1 to the trailing edge of the tine shank body 810. Ridges 2211.4 are provided on either side of the heel mounting 2211 extending rearwardly from the leading edge, to facilitate attachment to the heel.

[0315] An example heel 2120 is shown in more detail in Figures 23A and 23B.

[0316] In this example, the heel 2120 includes a heel body 2320, which is generally a rectangular shaped solid body, including substantially parallel spaced apart side walls and trailing and leading edges that taper at a lower end of the heel body 2320. A recess 2322 is provided along the leading edge of the heel, for accommodating a liquid material delivery tube extending between the heel 2120 and the point 2130, shin guard 2140 and stubble guard 2150.

[0317] The heel 2120 includes a tine shank mounting 2321 provided at an upper end of the heel body 2320, the tine shank mounting 2321 including a tine shank channel 2321.1 extending forward from the trailing edge of the heel body 2320, allowing the lower end of the tine shank 2110 to be accommodated therein, with the leading edge of the heel body 2320 contained within the rebate 2211.1. A lower edge of the tine shank heel mounting 2211 includes a "V" shape 2211.5, with the tine shank mounting 2321 including a complementary profile, to assist in centralising the tine shank 2110 within and guiding insertion of the tine shank 2110 into the tine shank channel 2321.1.

[0318] A tine shank fastener aperture 2321.2 is provided in a trailing edge of the heel body 2320, so as to align with the fastener opening 2211.2, allowing a fastener such as a bolt, to be inserted therethrough to couple the heel to the tine shank 2110. In particular, the bolt can be inserted through the fastener opening 2211.2 and tine shank fastener aperture 2321.2, with a nut being retained in the fastener aperture 2321.2, allowing the heel 2120 and associated components to be rapidly decoupled from the tine shank 2110. The heel ridges 2211.4 are received in corresponding slots 2321.3 extending along inner surfaces of the tine shank

mounting 2321, guiding the heel into the mounting. Furthermore, as the fastener is tightened, this will bias the heel ridges 2211.4 against the slots 2321.3 to thereby securely physically interconnected the heel and tine shank. This allows equipment mounted on the tine shank to be easily interchanged, without requiring the tine shank to be removed from the vehicle mounting system, whilst also allowing re-use of the tine shank, thereby reducing overall equipment costs.

[0319] The heel 2120 includes a point mounting 2223 for receiving the point 2130, an example of which is shown in Figures 24A and 24B.

[0320] In this example, the point 2130 includes a generally U-shaped body 2430, including side walls 1031 extending rearwardly from a leading edge. In this example, the side walls are rectangularly shaped, although this is not essential and other configurations could be used. The point mounting 2323 includes a cut-out section 2323.2, having a complementary shape to the point, allowing the point 2130 to be accommodated therein to ensure the point 2130 is correctly positioned.

[0321] The point mounting 2323 includes point channels 2323.1 provided in faces of the heel body side walls. Three point channels are included in this example on either side of the heel. The point channels 2323.1 extend rearwardly from a leading edge of the heel body 2310. The point 2130 includes ridges 2432 extending forwardly along internal faces of the side walls 2431 from proximate the trailing edge, which in use sit within the point channels 2323.1 to allow the point to be mounted to the heel.

[0322] In use, the leading edge of the point defines a tip mounting for receiving a tip 2433.1, and a shin guard extension 2533.2 providing a working edge to the point.

[0323] Additionally, a recess 2430.1 can be provided along on a rear side of the leading edge of the point 2130, which cooperates with the recess 2322 on the leading edge of the heel to accommodate a liquid material delivery tube, allowing liquid to be supplied from an opening (not shown) on an underside of the point 2130.

[0324] Upper edges of the side walls 2431 further include shoulders 2431.1 used to secure the point 2130 to the heel 2120 using the shin guard 2140, as will now be described.

[0325] In this regard, the heel 2120 includes a shin guard mounting 2324 for receiving the shin guard 2140, an example of which is shown in Figures 25A to 25C.

[0326] In this example, the shin guard 2140 includes a generally U-shaped shin guard body 2540 having shin guard side walls 2541 extending rearwardly from a leading edge, which is typically V-shaped to define a working edge facing away from the tine shank to thereby break ground in front of the apparatus. The side walls 2541 are typically rectangular, and extend longitudinally along the heel when mounted thereon. The shin guard mounting 2324 includes a cut-out section 2324.3, having a complementary shape to the shin guard, allowing the shin guard 2140 to be accommodated therein to ensure the shin guard 2140 is correctly positioned.

[0327] The shin guard mounting 2324 includes L-shaped shin guard channels 2324.1 extending rearwardly and downwardly along faces of heel body side walls, from a leading edge of the heel body 2210, allowing the shin guard to be mounted thereto. Shin guard pegs 2542 are mounted on each internal face of the shin guard side walls 2541, allowing these to engage shin guard channels 2324.1 so that the shin guard can be attached to the heel and dropped into abutment with the point 2130 to thereby secure the point 2130 to the heel 2120. In particular, the shin guard 2140 can include lower trailing edge corners 2343, which engage the shoulders 2431.1 to thereby secure the point 2130 to the heel 2120. The shin guard further includes a shin guard working edge 2553, extending along the leading edge of the shin guard, and extending downwardly along a front edge of the point to assist in retaining the point in position, as shown in Figure 25C.

[0328] The shin guard is then locked into position using a fastener (not shown), which is inserted through a fastener aperture 2324.2 extending laterally through the heel body 2320 and through fastener recesses 2544 in the shin guard side walls. This prevents upward movement of the shin guard 2140, thereby securing the shin guard pegs 2542 within the shin

guard channels 2324.1 so as to secure the shin guard 2140 to the heel 2120, and hence the point 2130 to the heel 2120.

[0329] An example of a stubble guard is shown in Figures 26A to 26C.

[0330] In this example, the stubble guard 2150 includes a generally U-shaped stubble guard body 2650 and spaced apart side walls 2651 extending rearwardly from a leading edge, which is typically rounded to define a working edge facing away from the tine shank to thereby break and deflect debris on the ground surface in front of the apparatus. The stubble guard typically includes an upper tip 2654 extending upwardly, forwardly and laterally from the leading edge of the heel to thereby urge material laterally around the heel and tine shank. The stubble guard typically also includes a lower tip 2653 extending downwardly and forwardly from the leading edge of the heel to assist in lifting stubble and other trash clear of the ground, and urging this towards the upper tip, so that it is then deflected around the tine shank. This prevents the build-up of trash, which in turn can place an undue load on the apparatus. The side walls 2651 include a number of spaced apertures 2651.1 extending along the stubble guard, allowing the stubble guard to be mounted to a fastener which is inserted into corresponding apertures in the heel, to thereby secure the stubble guard to the heel, thereby allowing the relative depth of the stubble guard to be adjusted.

[0331] With the above described configuration, the stubble guard 2150 sits over the shin guard 2140, to help protect the shin guard 2140 in position.

[0332] The point, tips, shin guard and stubble guard are typically made of a casting of hardened steel, white iron, or other hard wearing material, with the working edge(s) being made of Tungsten Carbide.

[0333] The heel 2120 also includes a delivery mounting, allowing a material delivery member to be attached to the heel 2120, an example of which will now be described with reference to Figures 27A to 27B.

[0334] The material delivery member includes a main body 2761 which is in the form of a rectangular cross section hollow elongate tube. The body 2761 is coupled to an outlet body

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2762 defining an outlet 2762.6, such as a ramp, for delivery of solid material, and an inlet body 2763 defining an inlet 2763.1 for receiving material from a supply. The inlet can include a rubber connector sleeve (not shown) that fits within the inlet 2763.1. The connector sleeve typically includes ridges that align with openings 2763.2 extending along a length of the inlet 2763.1, with tabs that sit within side openings 2763.3 to thereby lock the sleeve in position using an interference fit. The rubber sleeve provides a connector, allowing for a connection to seed tubes or the like, with these being held in place using a friction or interference fit, and enabling this to be achieved in a minimal footprint, which is important in ensuring a number of delivery members can be interconnected as shown.

[0335] In one example, the heel delivery member mounting 2326 includes a heel slot defined by spaced apart heel spines 2326.1 extending at least part way along a trailing edge of the heel, and wherein the material delivery member is slidably mounted in the heel slot allowing a depth of the material outlet relative to the heel to be adjusted. In particular, in one example this is achieved using a tongue 2761.3, extending at least part way along a leading edge of the delivery member body 2761, and optionally the outlet body 2762, as shown at 2762.3. The tongue has a dovetail shape to engage the heel spines 2326.1 and thereby slidably attach the delivery member to the heel.

[0336] The tongue 2761.3 includes a number of lateral tongue openings 2761.4 extending along the tongue, and the heel spines include heel spine apertures 2327.1 allowing a fastener to be inserted through the heel spine apertures and tongue openings to thereby secure the delivery member at a respective depth relative to the heel. The tongues 2761.3, 2762.3 can also include lateral apertures that are aligned when the delivery member and outlet bodies 2761, 2762 are connected, allowing a fastener to be used to secure the outlet body 2762 to the delivery member body 2761.

[0337] It will be appreciated that the delivery member further includes spines 2761.1, 2761.2, 2762.1, 2762.2 extending along the trailing edge of the delivery member body 2761 and outlet body 2762, to define a slot for receiving a further delivery member body, thereby allowing a second material delivery member to be slidably mounted in a first material delivery member slot allowing a depth of the second material outlet relative to the material

delivery member to be adjusted. Openings 2761.5 are provided in the spine 2761.2 allowing the further delivery member to be secured at a desired depth relative to the delivery member body, as shown for example in Figures 21E to 21G.

[0338] The material delivery member body 2761 and material outlet body 2762 include interlocking V-shaped side walls 2761.6, 2762.4 which assists in positioning the outlet body relative to the delivery member body 2761 and holding the bodies in position. Additionally, the spines on the trailing edge of the delivery member body 2761 and material outlet body 2762 interlock with cooperating shoulders 2761.7, 2762.5. This allows a continuous slot to extend across at least part of the material delivery member body and material outlet body, allowing further delivery members to be coupled thereto. This also ensures forces on the material outlet body 2762, as the body is pushed through the ground, are transmitted into the spines 2761.1, 2762.2 on the material member body 2762, which provide additional strength, allowing these forces to be accommodated by the delivery member body.

[0339] The spine 2762.2 also includes a lateral opening 2761.8 at an upper end, which cooperates with a corresponding opening 2763.2 on the inlet body 2763 allowing a fastener to be used to secure the inlet body to the main body 2761. This allows the inlet body 2763 to be removed and replaced, for example to provide for different inlet configurations. In this regard, the inlet 2763.1 can be connected to one or more delivery tubes extending along the delivery path from a material inlet to a material outlet. In one example, the three delivery tubes are provided extending through the delivery member body 2761, with these being connected, via respective rubber connectors, to respective inlets to respective outlets in the inlet and outlet bodies 2763, 2762. Given the rectangular cross sectional shape of the delivery member body 2761, this typically requires at least one of the delivery tubes is rectangular.

[0340] It will be appreciated that the above described arrangement allows a range of different inlet and outlet bodies to be used, thereby providing a range of different material delivery options.

[0341] A number of examples are shown in Figures 28A to 28D.

[0342] In this example, the apparatus again includes a tine shank 2810 including a tine shank body, a heel 2820 including a heel body mounted to a lower end of the tine shank 2810, a point 2830 mounted to a leading edge of the heel, a tip 2831 mounted to a leading edge of the point 2830, and three material delivery members 2860 adjustably mounted sequentially to the heel 2820.

[0343] In this example, the first delivery member includes an outlet body 2862 similar to those described above, whereas the second and third delivery members include respective outlet bodies 2865, 2866, each of which includes laterally extending wings, which contain respective material outlets.

[0344] In this example, the second outlet body 2865 includes tapered wings, adapted to cut through the ground. The wings include openings 2865.5 within the wings to allow laterally spaced delivery of solid material, and in one example seeds. In the case of the third outlet body 2866, the wings are adapted to fit behind the wings of the second outlet body, and include lateral outlets 2866.52 for fluid delivery into a space beneath the wings as well as liquid outlets 2866.51 for delivery of liquid beneath the outlet body.

[0345] It will be appreciated from this that a wide range of different outlets can be provided, including but not limited to ramps for directed solid material from a trailing edge of the delivery member, an opening on an underside for delivering solid material from the underside, one or more fluid outlets on an underside for delivering fluids from the underside, one or more laterally extending wings, each wing including a wing opening for delivering solid material laterally from the delivery member and one or more laterally extending wings, each wing including one or more fluid outlets for delivering one or more fluids laterally from the delivery member.

[0346] By providing multiple material delivery members mounted in sequence rearwardly of the heel, with the material delivery members including respective material outlet bodies, this allows respective materials to be delivered in a defined sequence.

[0347] For example, this can be used to deliver nitrate and stabiliser from dual outlets, fluid material, seeds and then further fluid material, in one example, allowing seed to be under or

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under and over coated with liquid, and in the arrangement of Figures 28A to 28D, to allow dual rows of laterally spaced seeds overcoated with fluids. Specifically, this can be achieved using combinations of outlets or spray nozzles for liquid delivery from an underside, rear or laterally from wings of the apparatus. For example, this can include straight tubes or spray nozzles direct on seed through flared section at the bottom of the point 2830, delivery members 2860, wings 2866, or rearwardly from a height adjustable spray system 2170. In this latter case, incremental apertures along a rear face of the delivery members allows for tubes or nozzles at varying depths, both below & above ground, to be used to delivery liquids.

[0348] Thus, the above described arrangement provides a material delivery system that is less complex than the previous example, but which still provides significant flexibility in terms of material delivery.

[0349] It will be appreciated that features from the different described examples could be used interchangeably and reference to use of certain features in particular examples is not intended to be limiting.

[0350] Throughout this specification and claims which follow, unless the context requires otherwise, the word “comprise”, and variations such as “comprises” or “comprising”, will be understood to imply the inclusion of a stated integer or group of integers or steps but not the exclusion of any other integer or group of integers.

[0351] Persons skilled in the art will appreciate that numerous variations and modifications will become apparent. All such variations and modifications which become apparent to persons skilled in the art, should be considered to fall within the spirit and scope that the invention broadly appearing before described.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

- 1) Apparatus for delivering material to below ground level in use, the apparatus including:
 - a) a tine shank including a tine shank body;
 - b) a heel including a heel body mounted to the tine shank in use;
 - c) a point mounted to a leading edge of the heel in use;
 - d) a tip mounted to a leading edge of the point; and,
 - e) a material delivery member adjustably mounted to a trailing edge of the heel, the material delivery member including a material delivery member body defining a delivery path extending from a material inlet to a material outlet configured to supply material received via the delivery path to below ground level in use, the material delivery member being adjustable so as to allow a depth of material delivery relative to the heel to be adjusted.
- 2) Apparatus according to claim 1, wherein the heel includes a heel slot defined by spaced apart heel spines extending at least part way along a trailing edge of the heel, and wherein the material delivery member is slidably mounted in the heel slot allowing a depth of the material outlet relative to the heel to be adjusted.
- 3) Apparatus according to claim 2, wherein the material delivery member includes a tongue extending at least part way along a leading edge, the tongue having a dovetail shape to engage the heel spines.
- 4) Apparatus according to claim 3, wherein the tongue includes a number of lateral tongue openings extending along the tongue, and the heel spines include heel spine apertures allowing a fastener to be inserted through the heel spine apertures and tongue openings to thereby secure the delivery member at a respective depth relative to the heel.
- 5) Apparatus according to any one of the claims 1 to 4, wherein the apparatus includes a plurality of material delivery members each including a material delivery member slot defined by spaced apart material delivery member spines extending at least part way along a trailing edge of the material delivery member and a material delivery member tongue extending at least part way along a leading edge, and wherein a second material delivery member is slidably mounted in a first material delivery member slot allowing a depth of the second material outlet relative to the material delivery member to be adjusted.

- 6) Apparatus according to any one of the claims 1 to 5, wherein the material delivery member includes a material delivery member body coupled to a material outlet body defining the material outlet.
- 7) Apparatus according to claim 6, wherein the material delivery member body and material outlet body include interlocking V-shaped side walls and interlocking spines on a trailing edge, to define a material delivery member slot extending across at least part of the material delivery member body and material outlet body.
- 8) Apparatus according to 6 or claim 7, wherein the material outlet body includes at least one of:
 - a) a ramp for directed solid material from a trailing edge of the delivery member;
 - b) an opening on an underside for delivering solid material from the underside;
 - c) one or more fluid outlets on an underside for delivering fluids from the underside;
 - d) one or more laterally extending wings, each wing including a wing opening for delivering solid material laterally from the delivery member; and,
 - e) one or more laterally extending wings, each wing including one or more fluid outlets for delivering one or more fluids laterally from the delivery member.
- 9) Apparatus according to any one of the claims 6 to 8, wherein the apparatus includes multiple material delivery members mounted in sequence rearwardly of the heel, and wherein the material delivery members include respective material outlet bodies to deliver respective materials in a defined sequence.
- 10) Apparatus according to any one of the claims 1 to 9, wherein the apparatus includes multiple material delivery outlets to deliver at least one:
 - a) nitrate and stabiliser;
 - b) fluid material, seeds and then fluid material;
 - c) seed under or overcoated with liquid; and,
 - d) dual rows of laterally spaced seeds overcoated with fluids.
- 11) Apparatus according to any one of the claims 1 to 10, wherein the material inlet includes a connector for coupling to a supply tube that provides material from a material supply in use.

- 12) Apparatus according to any one of the claims 1 to 11, wherein the apparatus includes one or more delivery tubes extending along the delivery path from a material inlet to a material outlet.
- 13) Apparatus according to claim 12, wherein at least one material delivery member includes one or more delivery tubes extending from respective inlets to respective outlets.
- 14) Apparatus according to any one of the claims 1 to 13, wherein the heel is removably mounted to the tine shank.
- 15) Apparatus according to claim 14, wherein the heel is removably coupled to the tine shank via a fastener extending through respective apertures in the tine shank and heel bodies.
- 16) Apparatus according to any one of the claims 1 to 15, wherein an upper end of the heel includes a channel extending from a leading edge of the heel, the channel receiving a lower end of the tine shank in use.
- 17) Apparatus according to claim 16, wherein a lower end of the tine shank and a surface of the channel include complimentary V-shapes to assist aligning the tine shank within the channel.
- 18) Apparatus according to claim 16 or claim 17, wherein side walls of the recess including grooves that in use receive an angled ridge extending downwardly from a leading edge of the tine shank to thereby lock the tine shank into engagement with the heel.
- 19) Apparatus according to any one of the claims 1 to 18, wherein a leading edge of the heel includes a recess that in use receives a tube defining a liquid material delivery path extending to a material outlet in an underside of the point.
- 20) Apparatus according to any one of the claims 1 to 19, wherein the point includes a substantially U-shaped point body having point side walls extending rearwardly from a leading edge of the point.
- 21) Apparatus according to any one of the claims 1 to 20, wherein the heel includes point channels extending rearwardly along faces of heel body side walls from a leading edge of the heel body, the point including ridges adapted to be received within the point channels allowing the point to be coupled to the heel.
- 22) Apparatus according to any one of the claims 1 to 21, wherein the point includes a tip mounting, the apparatus including a tip coupled to the tip mounting in use.

- 23) Apparatus according to any one of the claims 1 to 22, wherein the apparatus includes a shin guard coupled to the heel proximate the point.
- 24) Apparatus according to claim 23, wherein the shin guard includes a substantially U-shaped shin guard body having shin guard side walls extending rearwardly from a leading shin guard edge.
- 25) Apparatus according to claim 24, wherein the shin guard body includes a V-shaped leading edge defining a working edge facing away from the tine shank.
- 26) Apparatus according to any one of the claims 23 to 25, wherein the shin guard engages the point to thereby secure the point to the heel.
- 27) Apparatus according to claim 26, wherein an upper edge of each point side wall includes a ridge that engages a recessed corner of each shin guard side wall.
- 28) Apparatus according to any one of the claims 23 to 27, wherein the heel includes an L-shaped shin guard channel extending rearwardly and then downwardly along faces of heel body side walls from a leading edge of the heel body, the shin guard including pegs adapted to engage the shin guard channels allowing the shin guard to be coupled to the heel.
- 29) Apparatus according to any one of the claims 23 to 28, wherein the shin guard rear edges include recesses that align with a shin guard securing aperture extending laterally through the heel body allowing a fastener to be inserted therethrough, to thereby secure the shin guard to the heel.
- 30) Apparatus according to any one of the claims 23 to 29, wherein the apparatus includes a stubble guard coupled to the heel to thereby secure the shin guard to the heel.
- 31) Apparatus according to claim 30, wherein the stubble guard includes a substantially U-shaped stubble guard body having stubble guard side walls extending rearwardly from a leading stubble guard edge.
- 32) Apparatus according to claim 30 or claim 31, wherein the stubble guard includes an upper tip extending forwardly and laterally from the leading edge of the heel to thereby urge material laterally around the heel and tine shank.
- 33) Apparatus according to any one of the claims 30 to 32, wherein the stubble guard body includes a rounded leading edge defining a working edge facing away from the tine shank.

- 34) Apparatus according to any one of the claims 30 to 33, wherein the heel includes a T-shaped stubble guard channel extending rearwardly and along faces of heel body side walls from a leading edge of the heel body, the stubble guard including pegs adapted to engage the stubble guard channels allowing the stubble guard to be coupled to the heel.
- 35) Apparatus according to claim 34, wherein the stubble guard channels allow the stubble guard to be lifted allowing the shin guard to be selectively coupled to the heel and lowered to secure the shin guard to the heel.
- 36) Apparatus according to claim 34 or claim 35, wherein the stubble guard channels allow the stubble guard to be positioned at different heights relative to the heel.
- 37) Apparatus according to any one of the claims 30 to 36, wherein the stubble guard includes a plurality of longitudinally spaced openings, wherein one of the openings aligns with a stubble guard securing aperture extending laterally through the heel body depending on the relative position of the stubble guard, allowing a fastener to be inserted therethrough, to thereby secure the stubble guard to the heel at a desired relative height.
- 38) Apparatus according to any one of the claims 30 to 37, wherein the stubble guard includes a lower tip extending forwardly of the stubble guard.
- 39) Apparatus according to any one of the claims 1 to 38, wherein the apparatus includes a fluid delivery system adjustably mounted to a trailing edge of a material delivery member, the fluid delivery system including one or more nozzles adapted to direct fluid at least partially rearwardly from one or more depths along a trailing edge of the apparatus.
- 40) Apparatus according to claim 39, wherein the fluid delivery system includes a skirt at least partially surrounding at least one of the nozzles.
- 41) Apparatus according to any one of the claims 1 to 40, wherein the heel includes a guide member extending substantially parallel to a trailing edge of the heel, and wherein the material delivery member is slidably mounted to the guide member allowing a depth of the material outlet relative to the heel to be adjusted.
- 42) Apparatus according to claim 41, wherein the delivery member includes a mounting having a slot laterally spaced from and extending substantially parallel to a leading edge of the delivery member, and wherein a fastener engages the slot and the heel to thereby secure the delivery member to the heel.

- 43) Apparatus according to claim 41, wherein the heel includes a plurality of delivery member mountings spaced along a trailing edge of the heel, and wherein the material delivery member includes a toe that is selectively mounted to one of the delivery member mountings allowing a depth of the material outlet relative to the heel to be adjusted.
- 44) Apparatus according to claim 43, wherein the heel includes a delivery member securing tab extending rearwardly from and along a trailing edge of the heel, and wherein the material delivery member includes a heel securing tab extending forwardly from and along a leading edge of the delivery member, and wherein in use the tabs include apertures extending therethrough, the apertures being spaced along the length of the respective tab and wherein a fastener extends through selected apertures in the tabs to thereby secure the delivery member at a fixed height relative to the heel.
- 45) Apparatus according to any one of the claims 1 to 44, wherein the apparatus includes at least one second material delivery member including a second material delivery member body defining a second delivery path extending from a second material inlet to a second material outlet configured to supply second material received via the second delivery path to below ground level in use, the second material delivery member being adjustably mounted to the material delivery member to allow a depth of second material delivery relative to the material delivery member to be adjusted.
- 46) Apparatus according to claim 45, wherein the material delivery member includes a guide member extending substantially parallel to a trailing edge of the material delivery member, and wherein the second material delivery member is slidably mounted to the guide member allowing the depth of a second material outlet relative to the material delivery member to be adjusted.
- 47) Apparatus according to claim 45 or claim 46, wherein the second delivery member includes a mounting having a slot laterally spaced from and extending substantially parallel to a leading edge of the second delivery member, and wherein a fastener engages the slot and the material delivery member to thereby secure the second material delivery member to the material delivery member.
- 48) Apparatus according to claim 47, wherein the first delivery member includes a plurality of delivery member mountings spaced along a trailing edge of the first delivery member, and wherein the second material delivery member includes a toe that is selectively

mounted to one of the delivery member mountings allowing a depth of the second material outlet relative to the first delivery member to be adjusted.

- 49) Apparatus according to claim 48, wherein the first delivery member includes a delivery member securing tab extending rearwardly from and along a trailing edge of the first delivery member, and wherein the second material delivery member includes a first delivery member securing tab extending forwardly from and along a leading edge of the delivery member, and wherein in use the tabs include apertures extending therethrough, the apertures being spaced along the length of the respective tab and wherein a fastener extends through selected apertures in the tabs to thereby secure the second delivery member at a fixed height relative to the first delivery member.
- 50) Apparatus according to any one of the claims 1 to 49, wherein the material outlet includes a ramp for directed solid material from a trailing edge of the delivery member.
- 51) Apparatus according to any one of the claims 1 to 50, wherein the material outlet includes a sleeve selectively mounted within the material outlet, the sleeve defining a narrowing of the material outlet to thereby increase a flow rate of material through the material outlet.
- 52) Apparatus according to claim 51, wherein the sleeve defines a shroud extending rearwardly from a trailing edge of the delivery member, and wherein a liquid delivery tube extends along the trailing edge of the delivery member, the liquid delivery tube terminating in a nozzle positioned within the shroud.
- 53) Apparatus for delivering material to below ground level in use, the apparatus including:
- a) a tine shank including a tine shank body defining a tine shank cavity that extends along a length of the tine shank;
 - b) a heel mounted to the tine shank in use, the heel including a heel body having spaced apart side walls defining a heel cavity that extends at least partially along a length of the heel and a heel opening extending along a trailing edge of the heel body;
 - c) a boot mounted to the tine shank and heel in use;
 - d) a tip coupled to the boot;
 - e) at least one delivery path extending through at least part of the tine shank cavity and at least part of the heel cavity; and,
 - f) at least one material outlet member providing a material outlet configured to supply material received via the delivery path to below ground level in use, the at least one

material outlet member being adjustably mounted within the heel opening to allow a depth of material delivery relative to the heel to be adjusted.

- 54) Apparatus according to claim 53, wherein the apparatus includes a plurality of members positioned within the heel opening, the plurality of members including at least one of:
- a) a wing material outlet member;
 - b) a material outlet member;
 - c) a securing member; and,
 - d) a spacer member.
- 55) Apparatus according to claim 54, wherein the plurality of members are interchangeable allowing a depth of material outlet members to be adjusted.
- 56) Apparatus according to claim 54 or claim 55, wherein the apparatus includes at least one side wall securing member mounted in the heel opening in use to thereby secure the side walls with a fixed spacer.
- 57) Apparatus according to claim 56, wherein the heel opening includes tongues extending inwardly from the side walls and a chamfered outer edge corner, and wherein the at least one side wall securing member includes first and second bodies that clamp on the tongues when urged together by a fastener, the first body including shoulders that engage the chamfered outer edge corner to thereby secure the side walls with the fixed spaced arrangement.
- 58) Apparatus according to any one of the claims 54 to 57, wherein the heel opening includes tongues extending inwardly from the side walls, the material outlet member including grooved opposing edges that receive the tongues of the opening, allowing the material outlet member to be slidably mounted within the opening.
- 59) Apparatus according to any one of the claims 54 to 58 wherein the apparatus includes at least one mounting securing member that includes first and second bodies that clamp the tongues when urged together by a fastener, at least one of the first and second bodies including sloped edges that engage at least one member and urge the at least one member towards at least one of:
- a) a closed end of the heel opening; and,
 - b) another member.

- 60) Apparatus according to any one of the claims 54 to 59, wherein the apparatus includes a root cutter having:
- a) a substantially U-shaped root cutter body mounted to a leading edge of the heel body and extending rearwardly towards the trailing edge of the heel body; and,
 - b) cutting wings extending outwardly from the heel body.
- 61) Apparatus according to claim 60, wherein a trailing edge of the wings include a recess defining at least part of a root cutter delivery path for delivery of material to one or more root cutter outlets allowing material to be delivered from the root cutter.
- 62) Apparatus according to claim 60 or claim 61, wherein a rear portion of the root cutter body receives a root cutter mounting member for mounting the root cutter body to the heel opening.
- 63) Apparatus according to claim 62, wherein the root cutter mounting member includes a mounting body having an opening, the root cutter delivery path extending through the opening.
- 64) Apparatus according to any one of the claims 53 to 63, wherein the boot includes a boot body defining a boot body opening extending along a trailing edge of the boot body and wherein the heel includes a number of boot connectors on a leading face, the boot connectors engaging the boot body opening to thereby secure the boot to the heel.
- 65) Apparatus according to claim 64, wherein the boot connectors are spaced apart along a leading edge of the heel body, and wherein a root cutter is mounted within at least one gap between adjacent boot connectors in use.
- 66) Apparatus according to claim 64 or claim 65, wherein the boot body opening includes tongues extending inwardly from side walls of the boot body, the connectors having laterally extending ridges that engage the tongues of the boot body opening in use.
- 67) Apparatus according to any one of the claims 64 to 66, wherein the boot body defines a boot cavity that extends at least partially along a length of the boot, and wherein at least one boot delivery path extends through at least part of the tine shank cavity and at least part of the boot cavity to at least one material outlet member provided in the boot body opening.
- 68) Apparatus according to any one of the claims 64 to 67, wherein the boot body includes a sleeve extending rearwardly from an upper portion of the boot body, the sleeve being

mounted around the tine shank in use and secured thereto with a fastener extending through the sleeve.

- 69) Apparatus according to any one of the claims 64 to 68, wherein the boot is adjustably mounted to the tine shank to allow a relative separation between the tip and at least one outlet to be adjusted.
- 70) Apparatus according to any one of the claims 64 to 69, wherein the boot body includes a tip mounting, the apparatus including a tip coupled to the tip mounting in use.
- 71) Apparatus according to claim 70, wherein the tip including apertures configured to receive a mounting pin for coupling the tip to the mounting.
- 72) Apparatus according to claim 70 or claim 71, wherein the apparatus includes:
- a) a shin guard coupled to the boot adjacent the tip; and,
 - b) a stubble guard coupled to the boot spaced from the tip.
- 73) Apparatus according to claim 72, wherein the boot body includes T-shaped guard channels extending rearwardly along faces of the side walls from a leading edge of the boot body, the shin guard including pegs adapted to engage the guard channels allowing the shin guard to be coupled to the boot body, and wherein the guard channels allow the shin guard to be lifted allowing the tip to be selectively coupled to the tip mounting and lowered to secure the tip to the tip mounting.
- 74) Apparatus according to claim 72 or claim 73, wherein the stubble guard includes a substantially U-shaped stubble guard body having stubble guard side walls extending rearwardly from a leading stubble guard edge.
- 75) Apparatus according to any one of the claims 72 to 74, wherein the shin guard includes a substantially U-shaped shin guard body having shin guard side walls extending rearwardly from a leading shin guard edge.
- 76) Apparatus according to claim 75, wherein the shin guard body includes a V-shaped leading edge defining a working edge facing away from the tine shank.
- 77) Apparatus according to any one of the claims 72 to 76, wherein at least part of the shin guard is positioned between at least part of the stubble guard and the tine shank, thereby securing the shin guard to the tine shank.
- 78) Apparatus according to any one of the claims 64 to 77, wherein the boot body includes a recess extending along a leading edge to an opening passing through the boot body

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rearwardly of a tip mounting, and wherein the recess and opening define a tip delivery path for delivering material to a delivery outlet on an underside of the boot.

79) Apparatus according to any one of the claims 53 to 78, wherein the material outlet includes at least one of:

- a) a seed outlet configured to supply seed to be planted; and,
- b) a liquid outlet configured to supply liquid material.

80) Apparatus according to any one of the claims 53 to 79, wherein the delivery path includes at least one of:

- a) a channel; and,
- b) a pipe.

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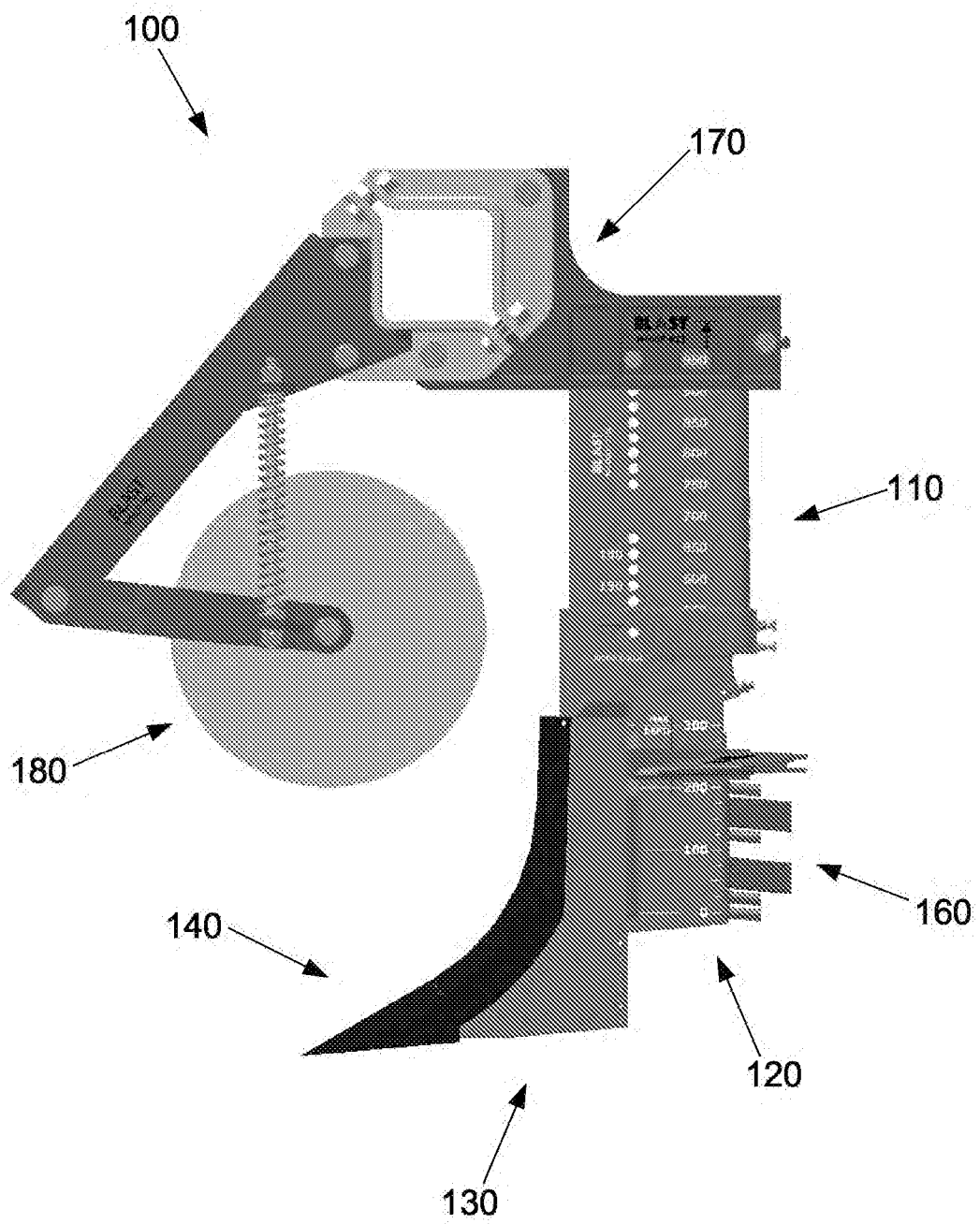


Fig. 1A

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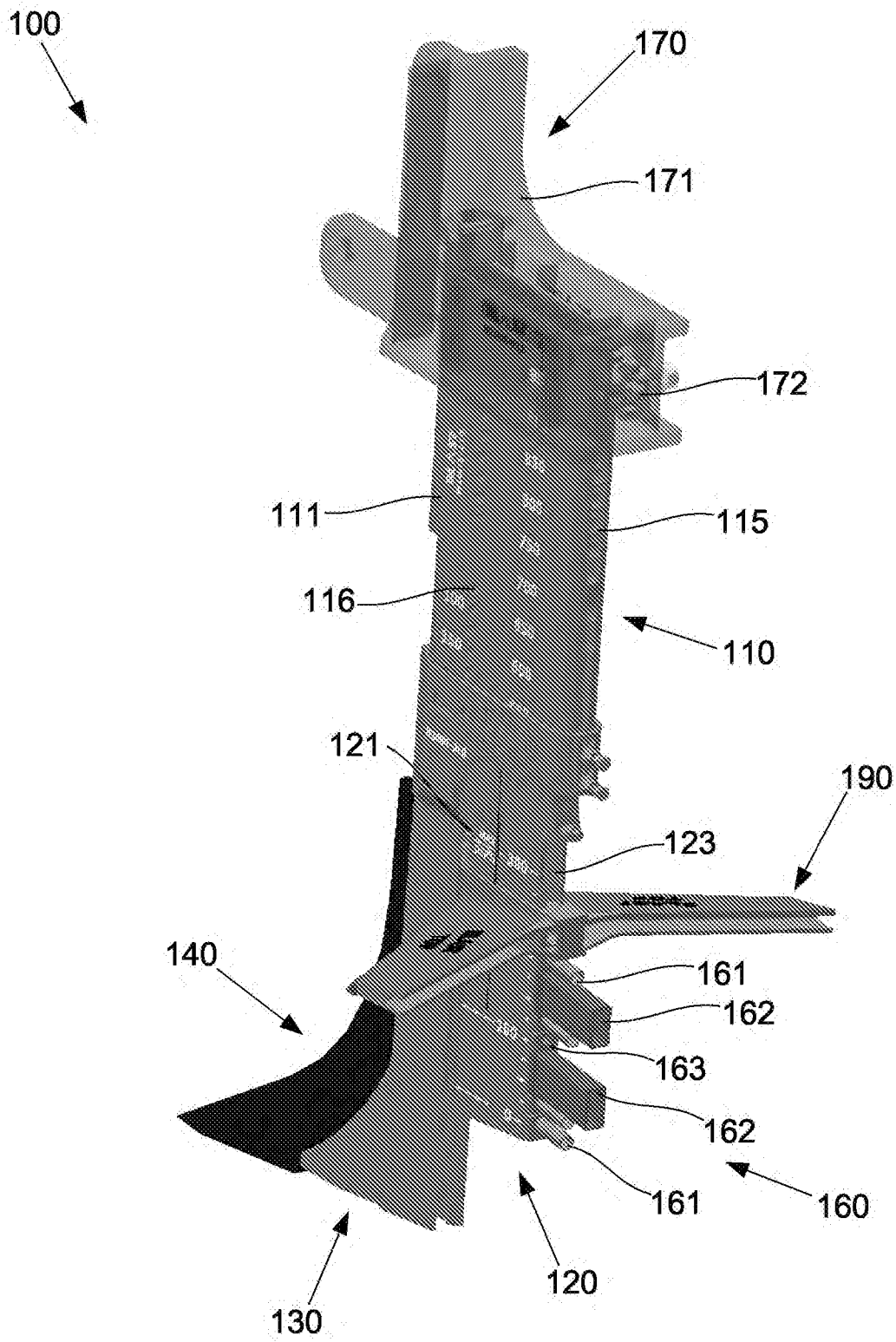


Fig. 1B

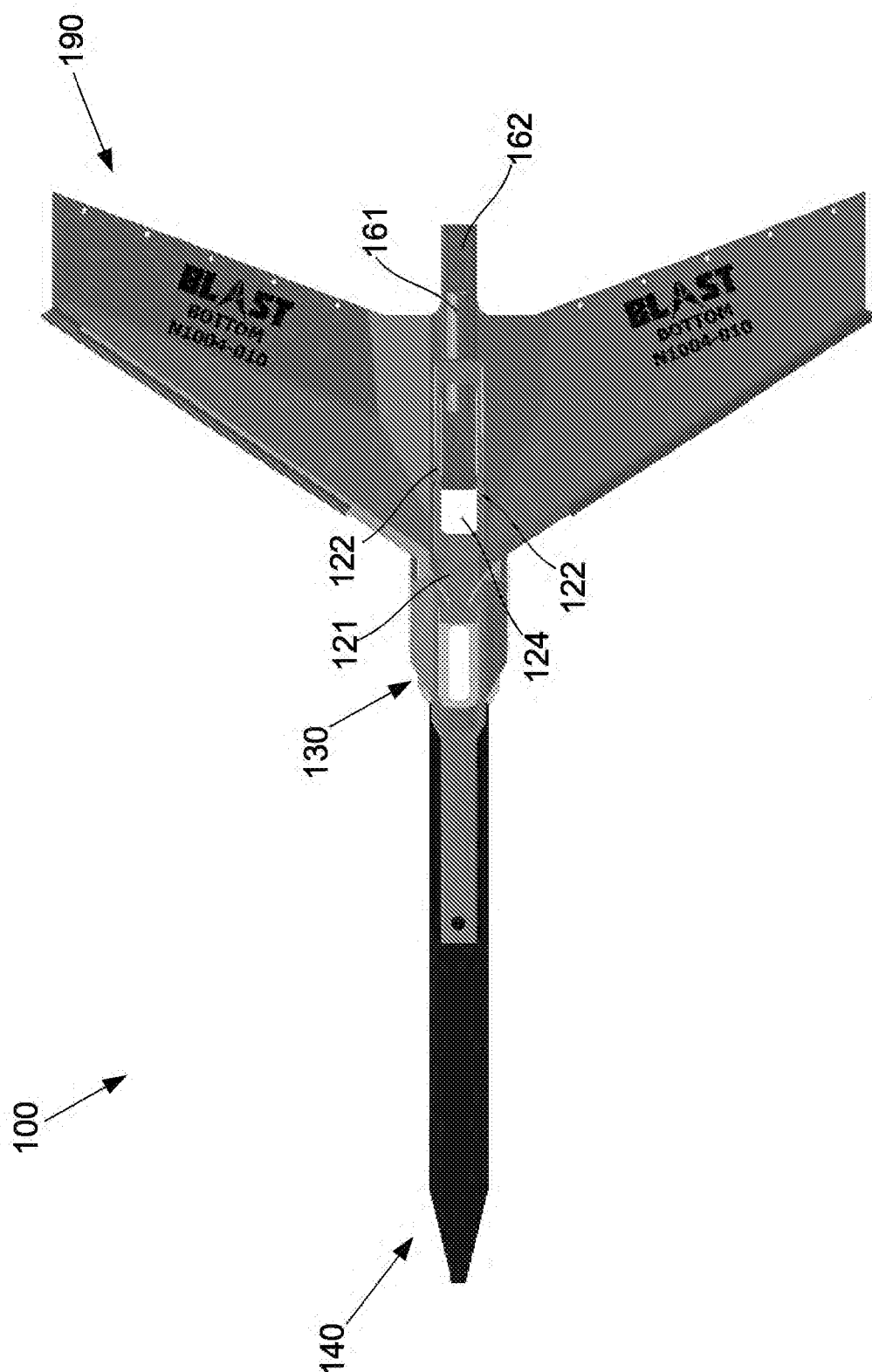


Fig. 1C

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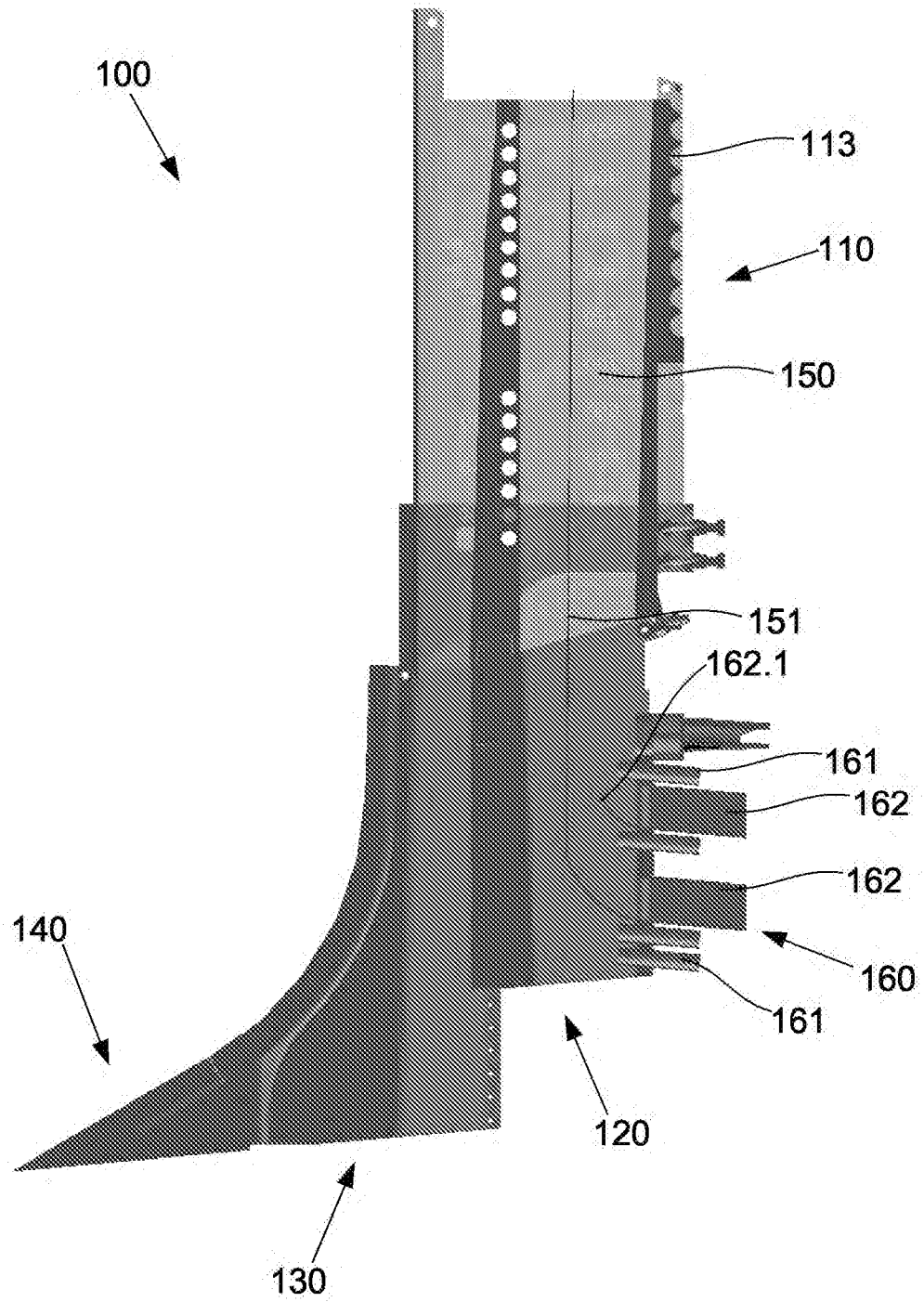


Fig. 1D

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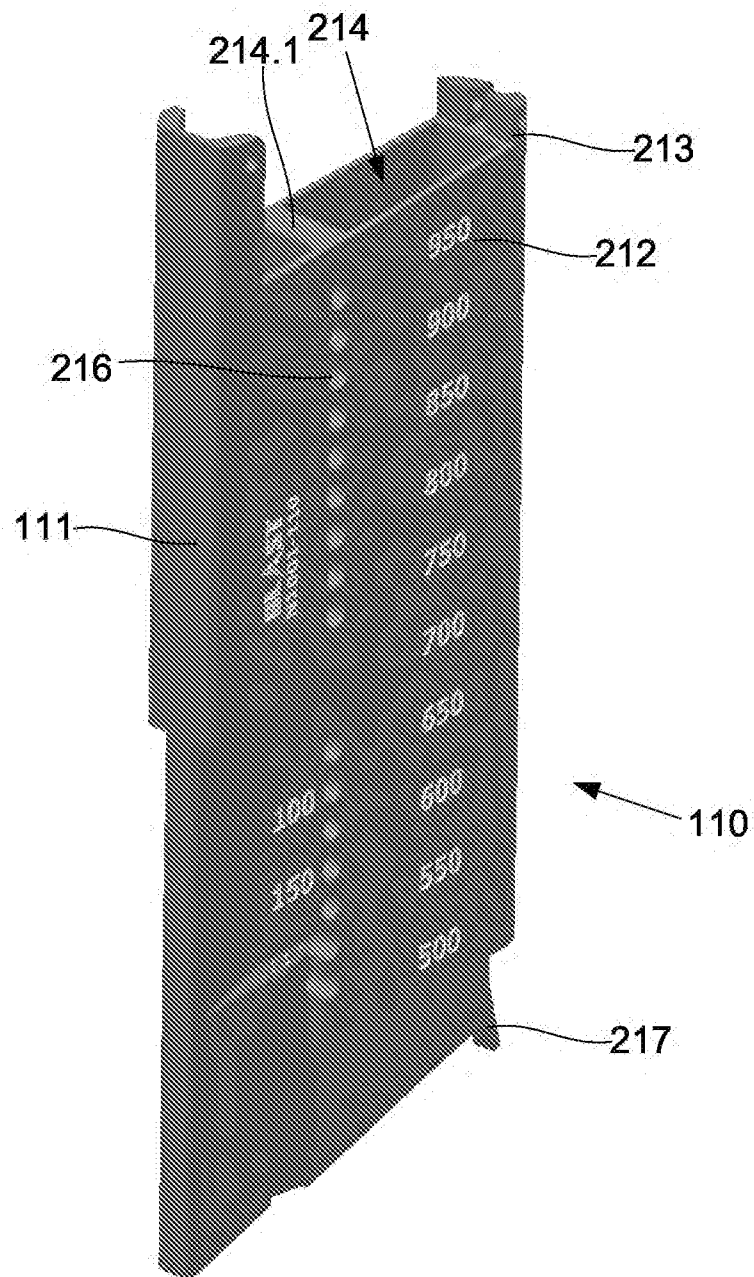


Fig. 2A

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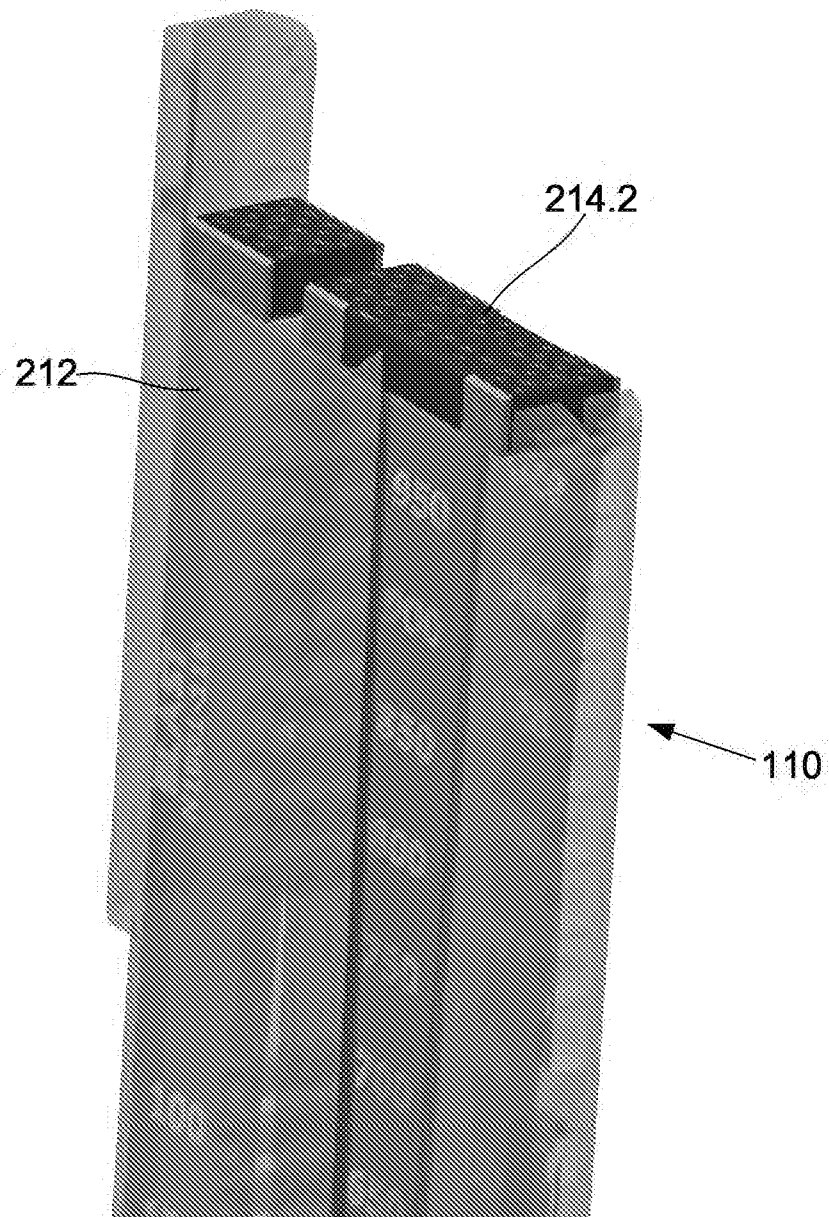


Fig. 2B

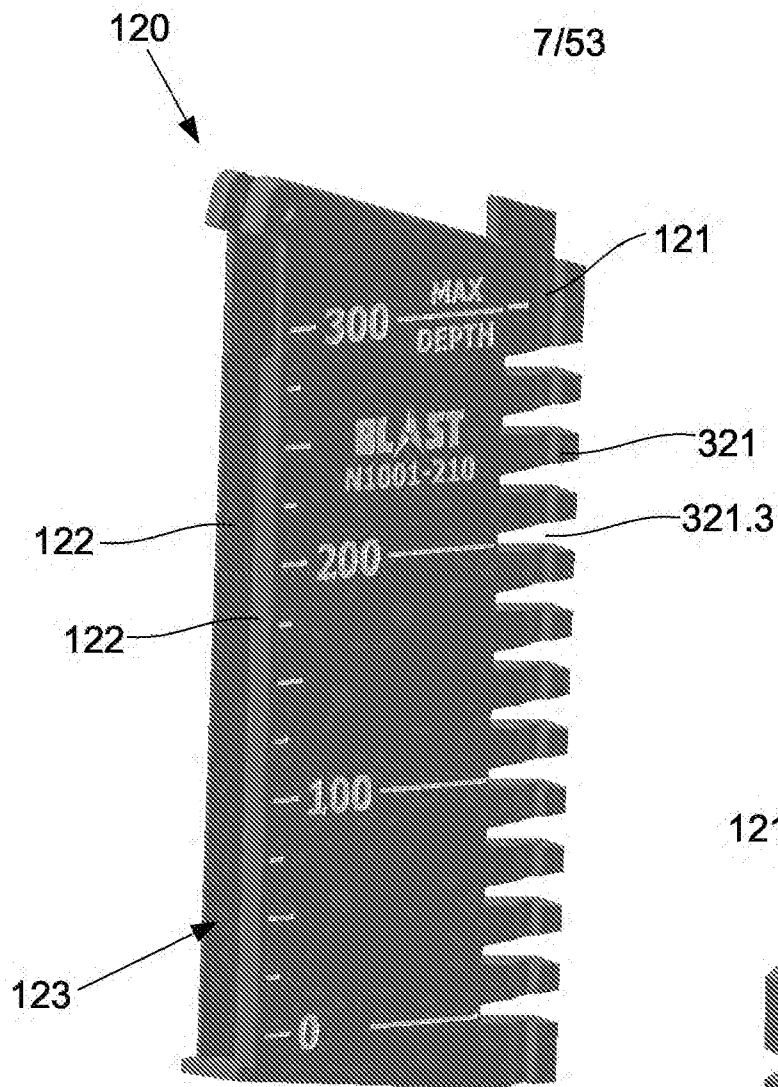


Fig. 3A

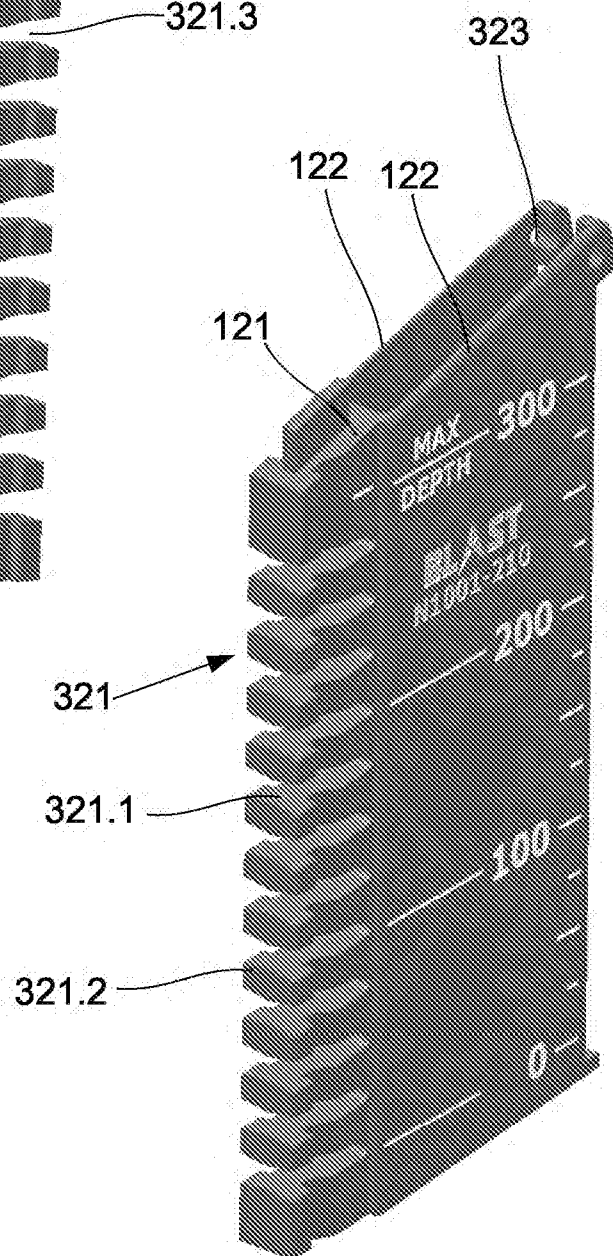


Fig. 3B

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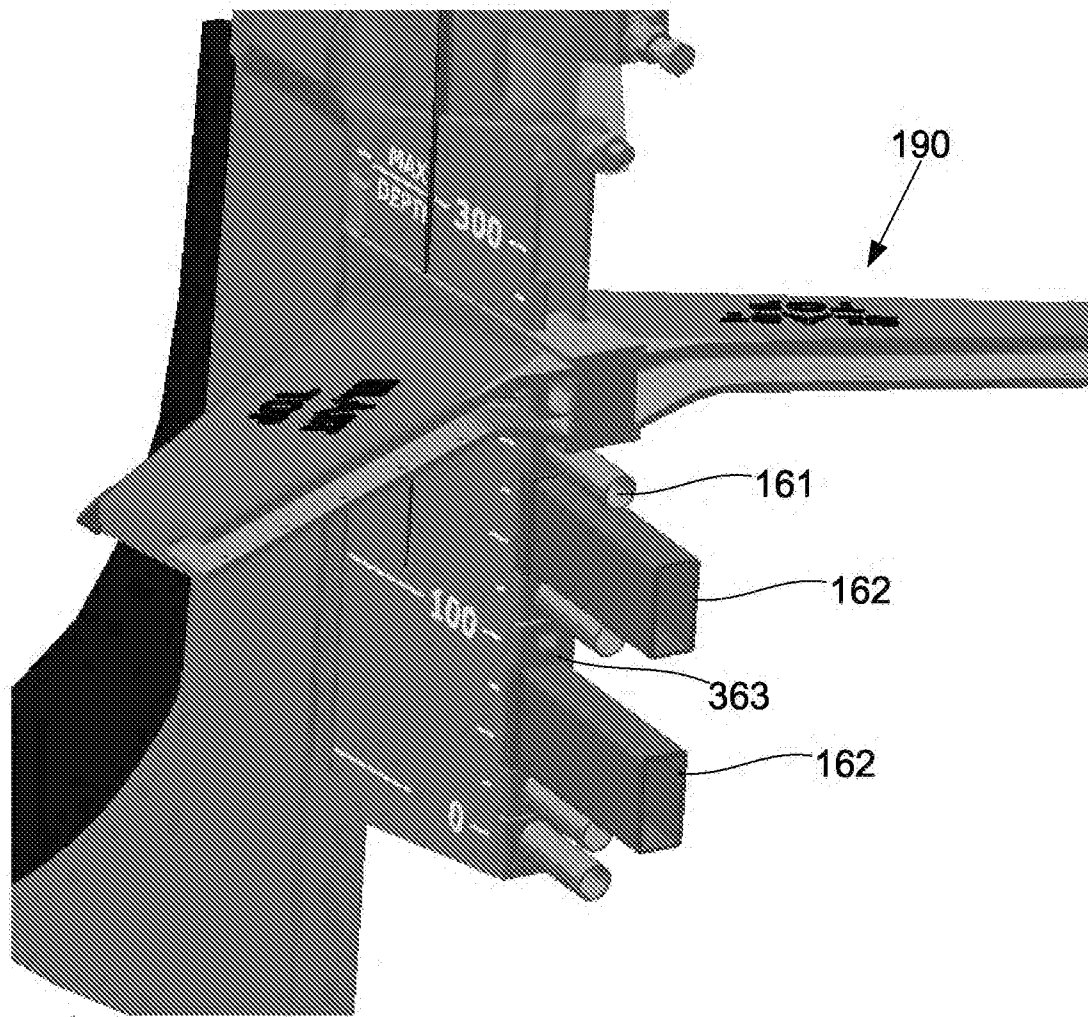


Fig. 3C

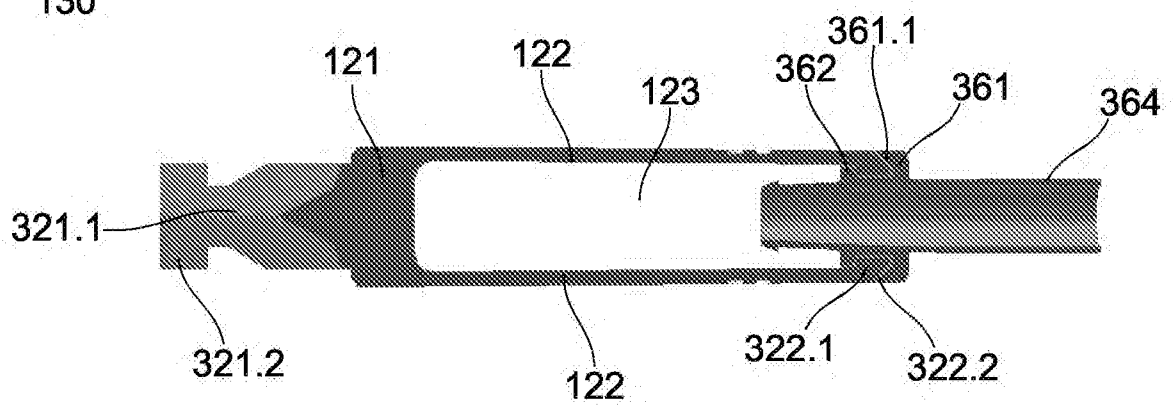


Fig. 3D

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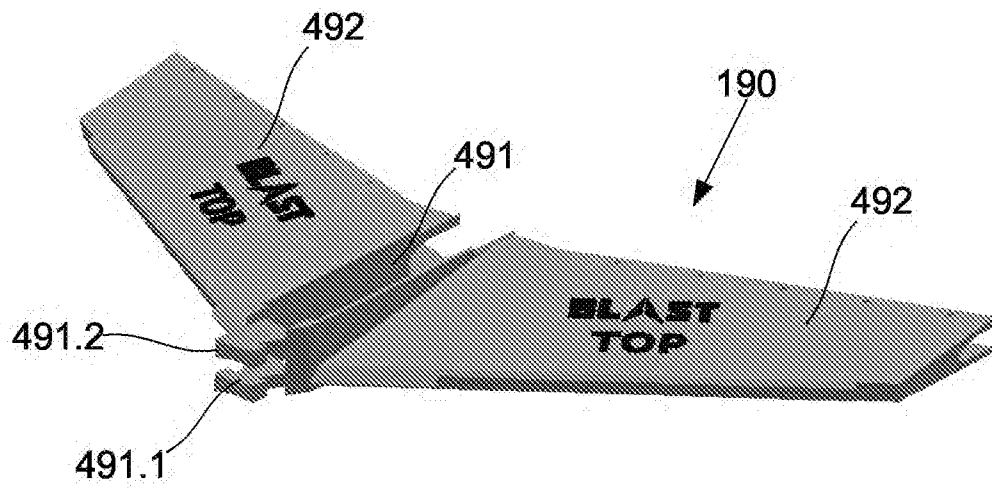


Fig. 4A

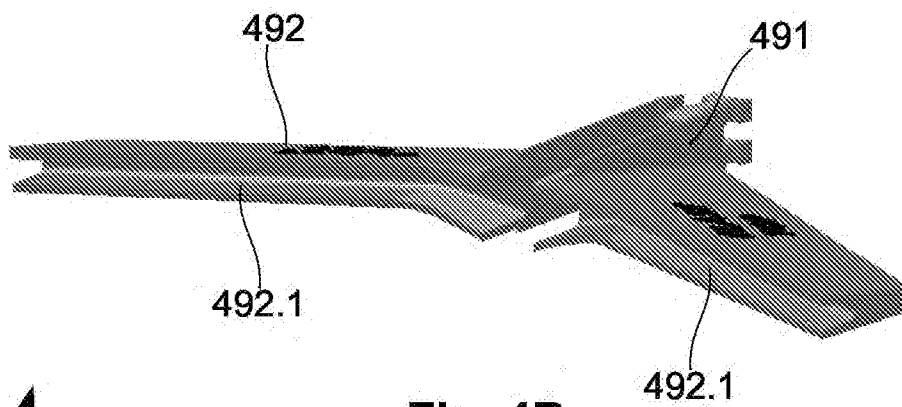


Fig. 4B

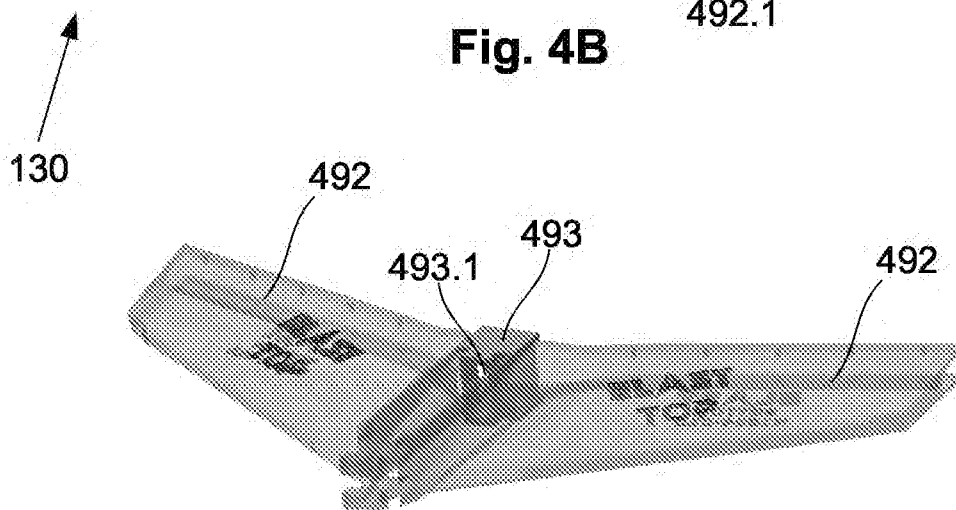


Fig. 4C

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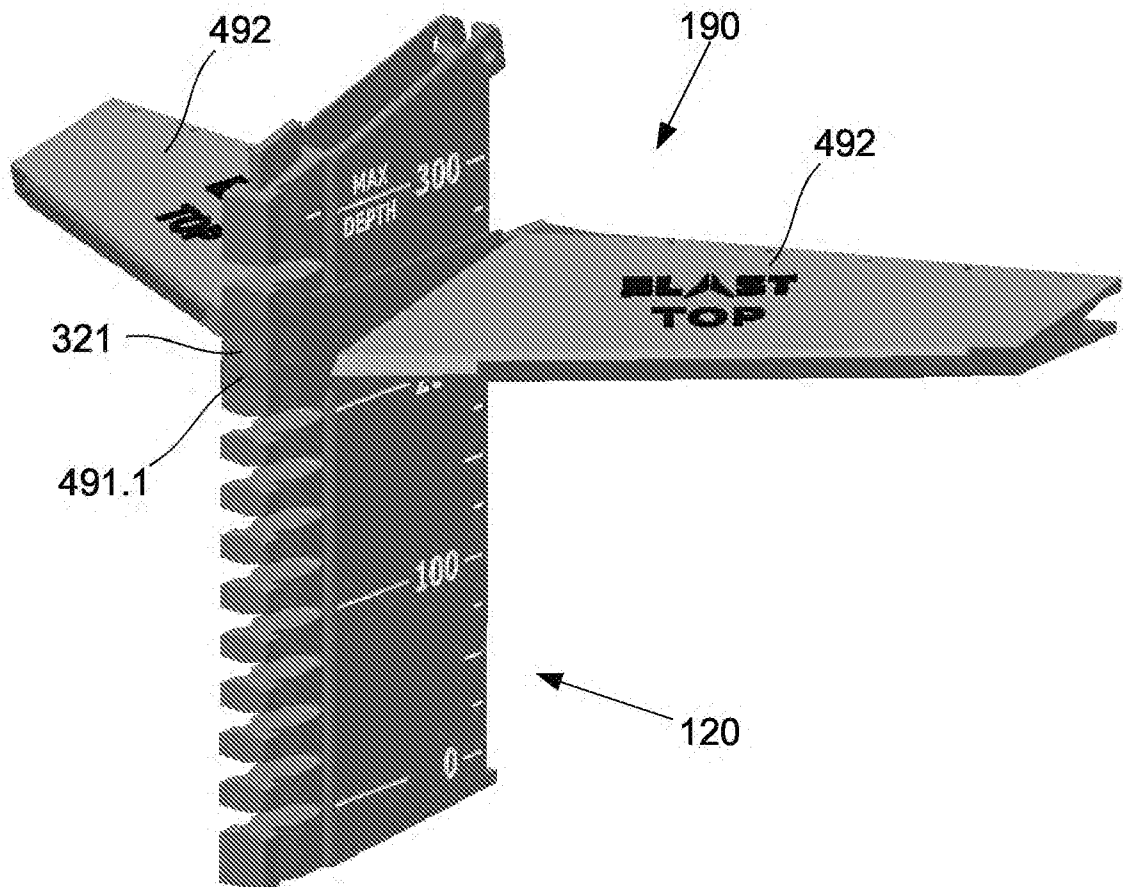


Fig. 4D

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Fig. 5A

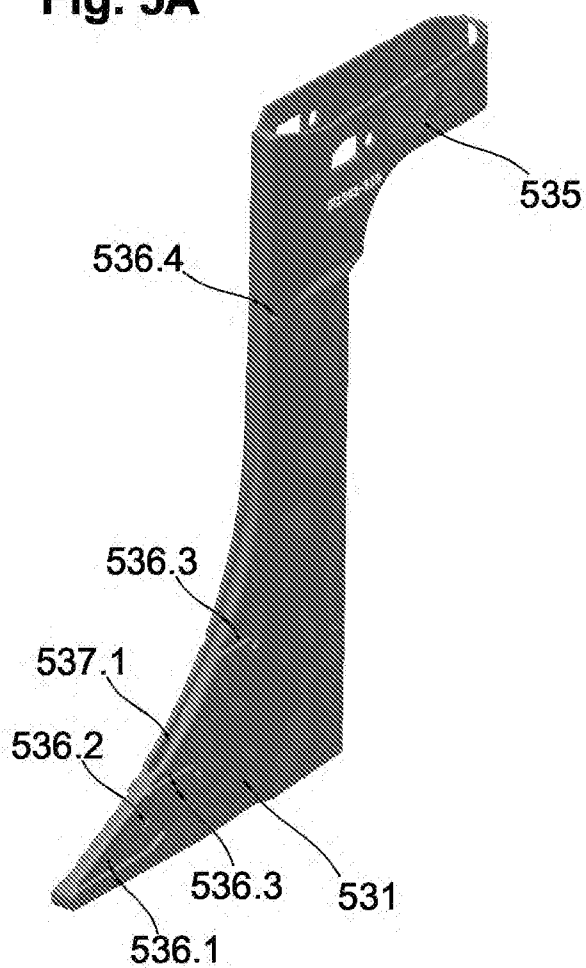


Fig. 5B

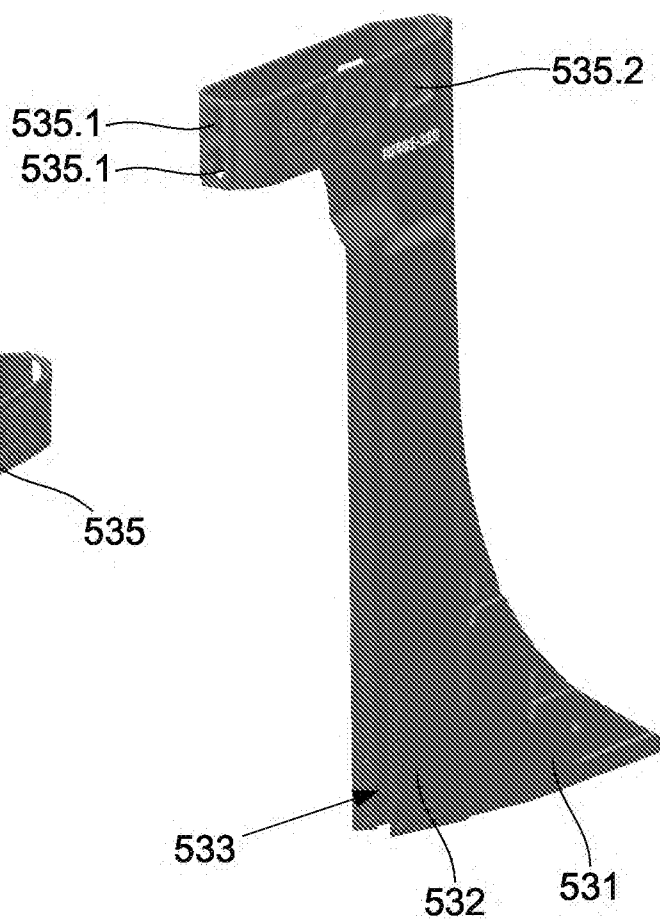
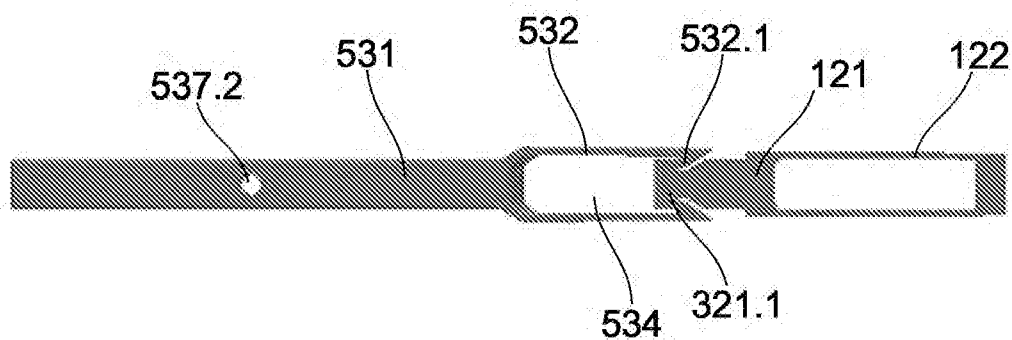


Fig. 5C



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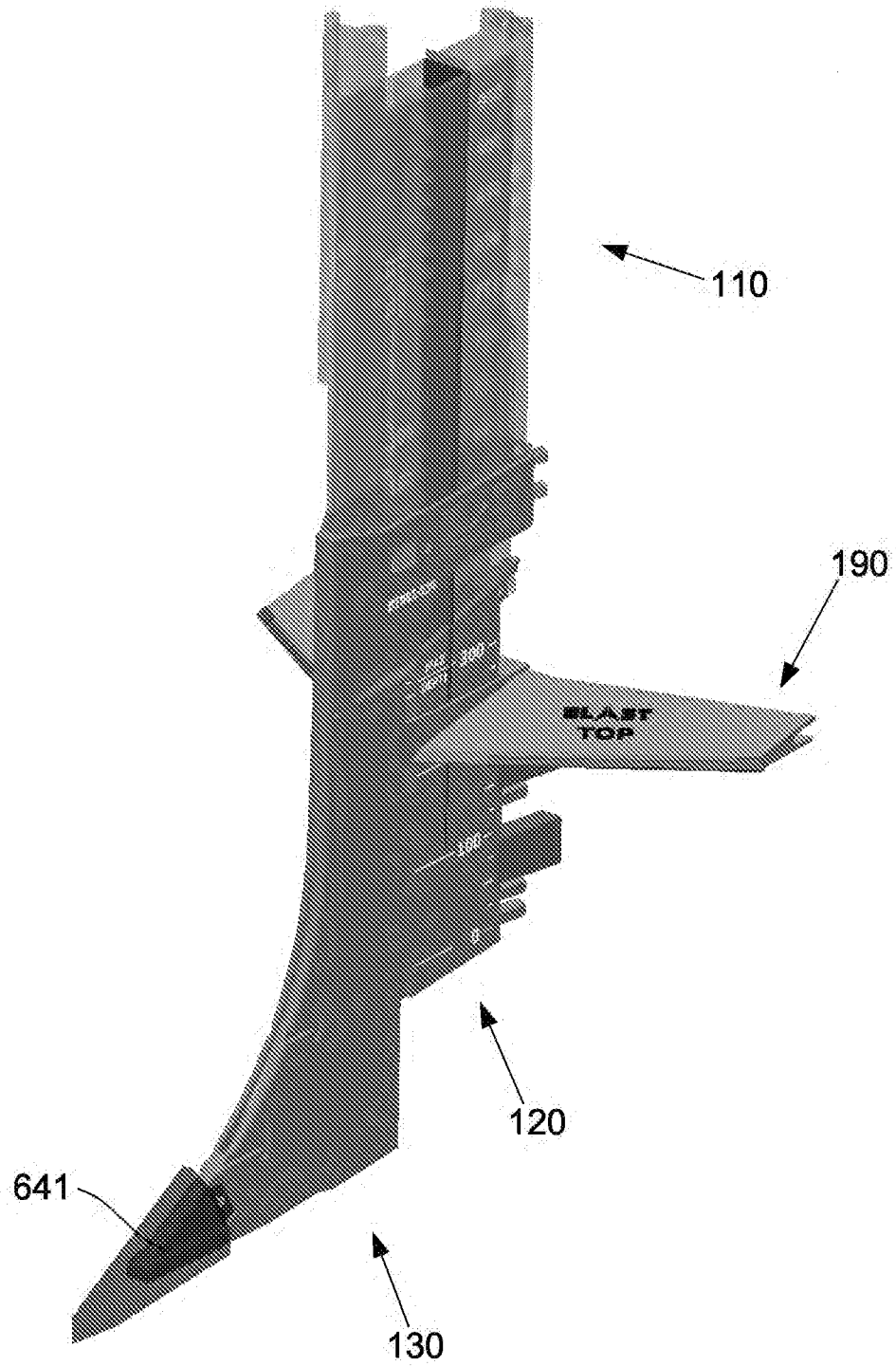


Fig. 6A

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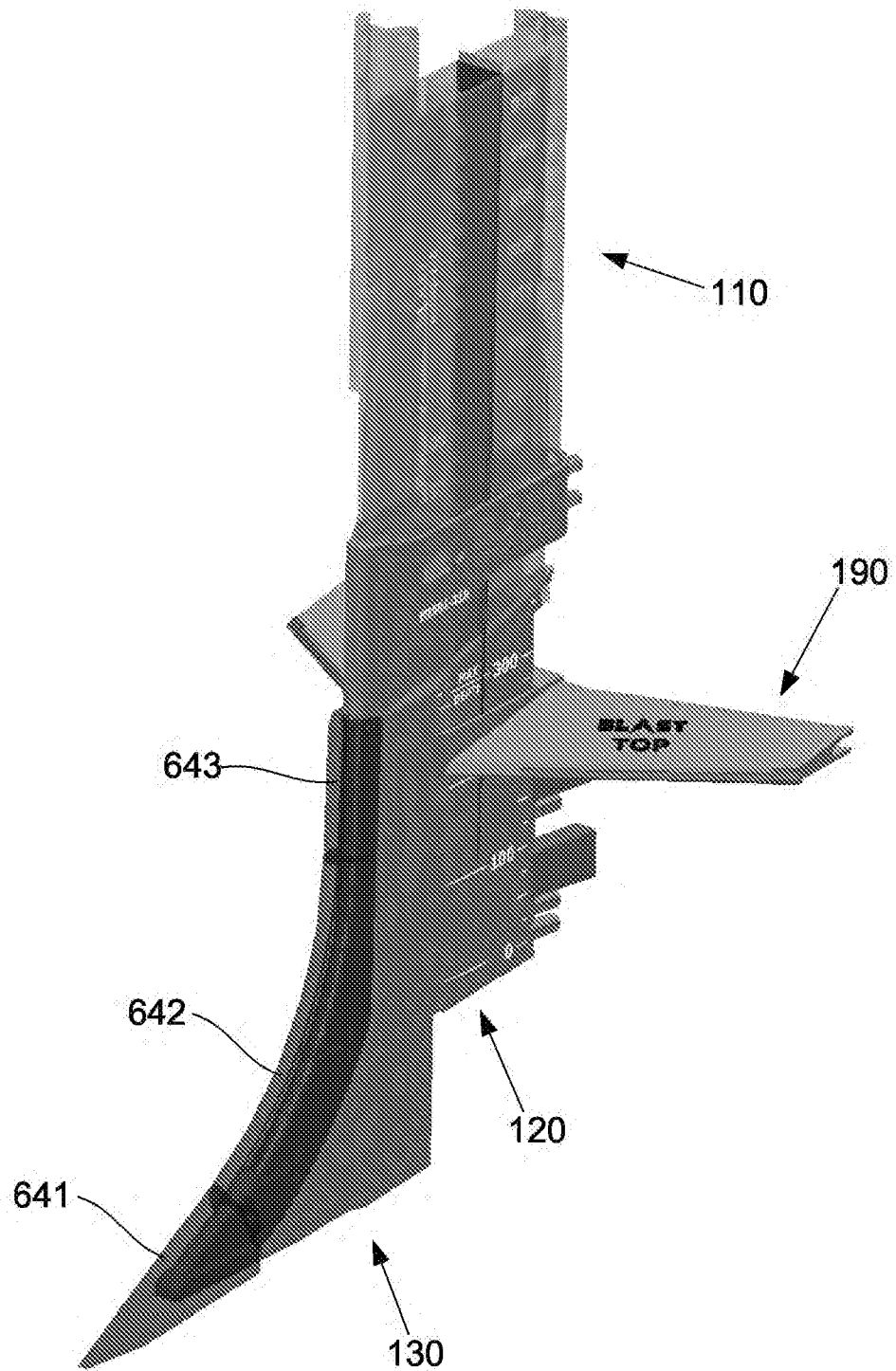


Fig. 6B

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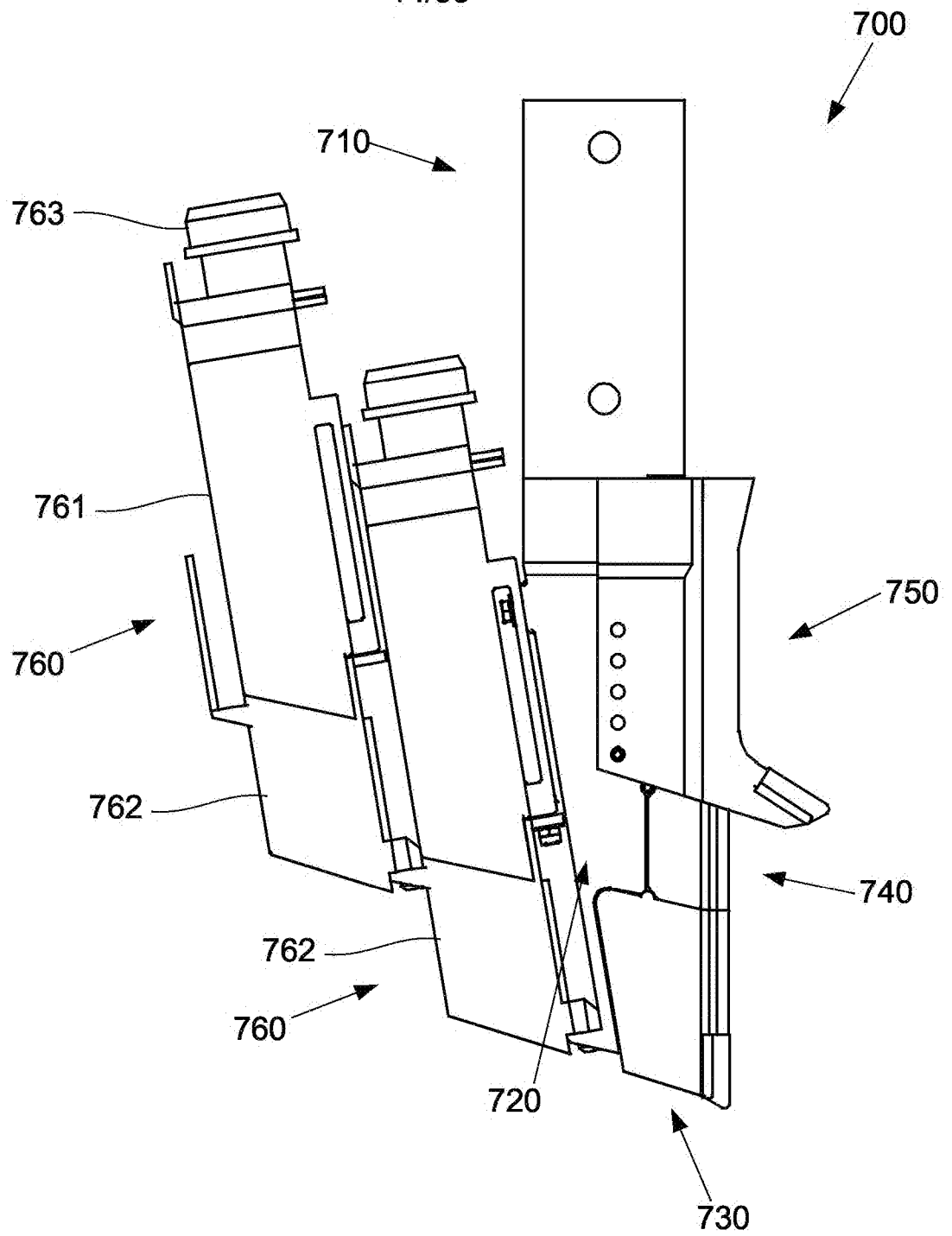


Fig. 7A

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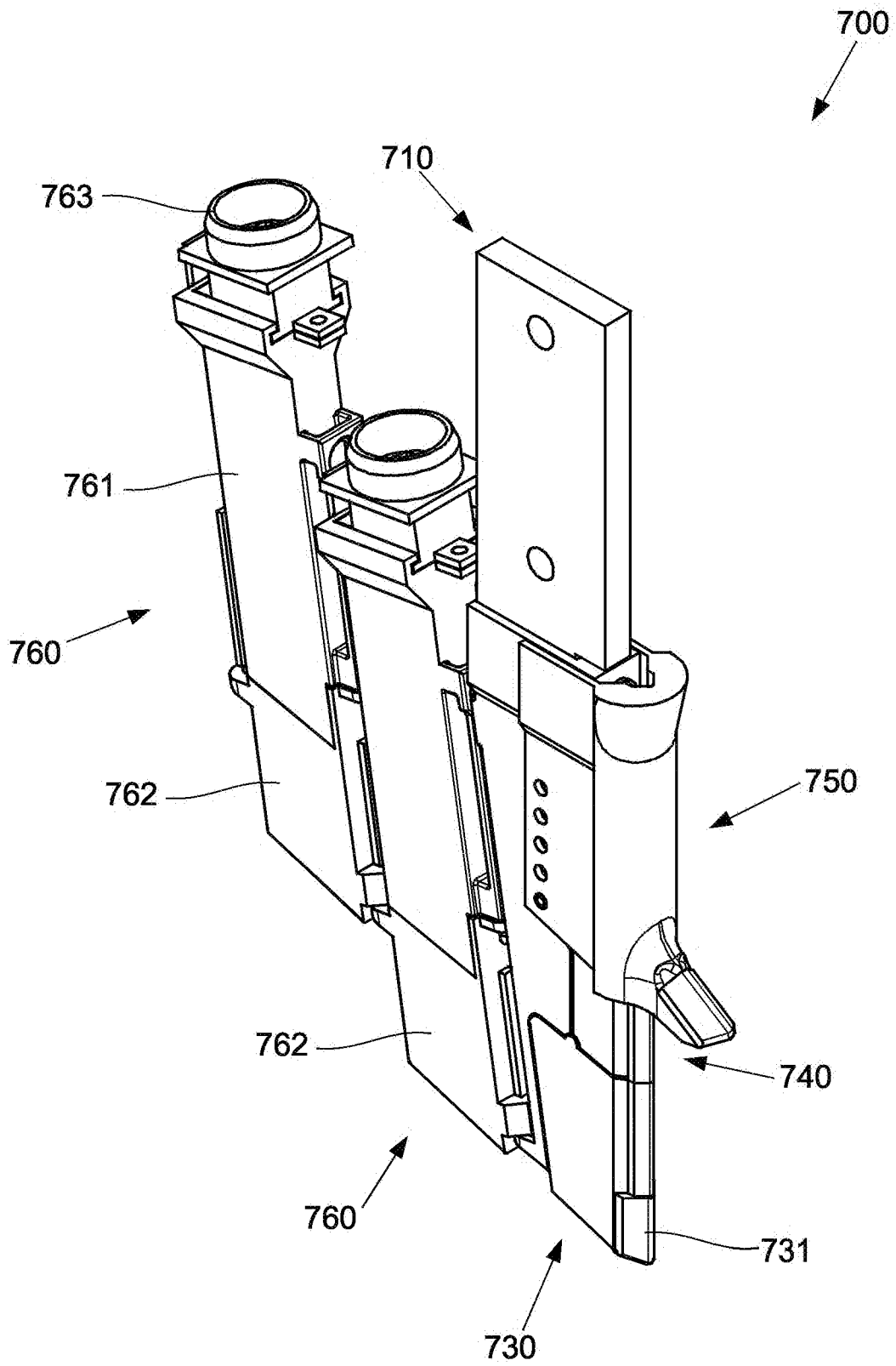


Fig. 7B

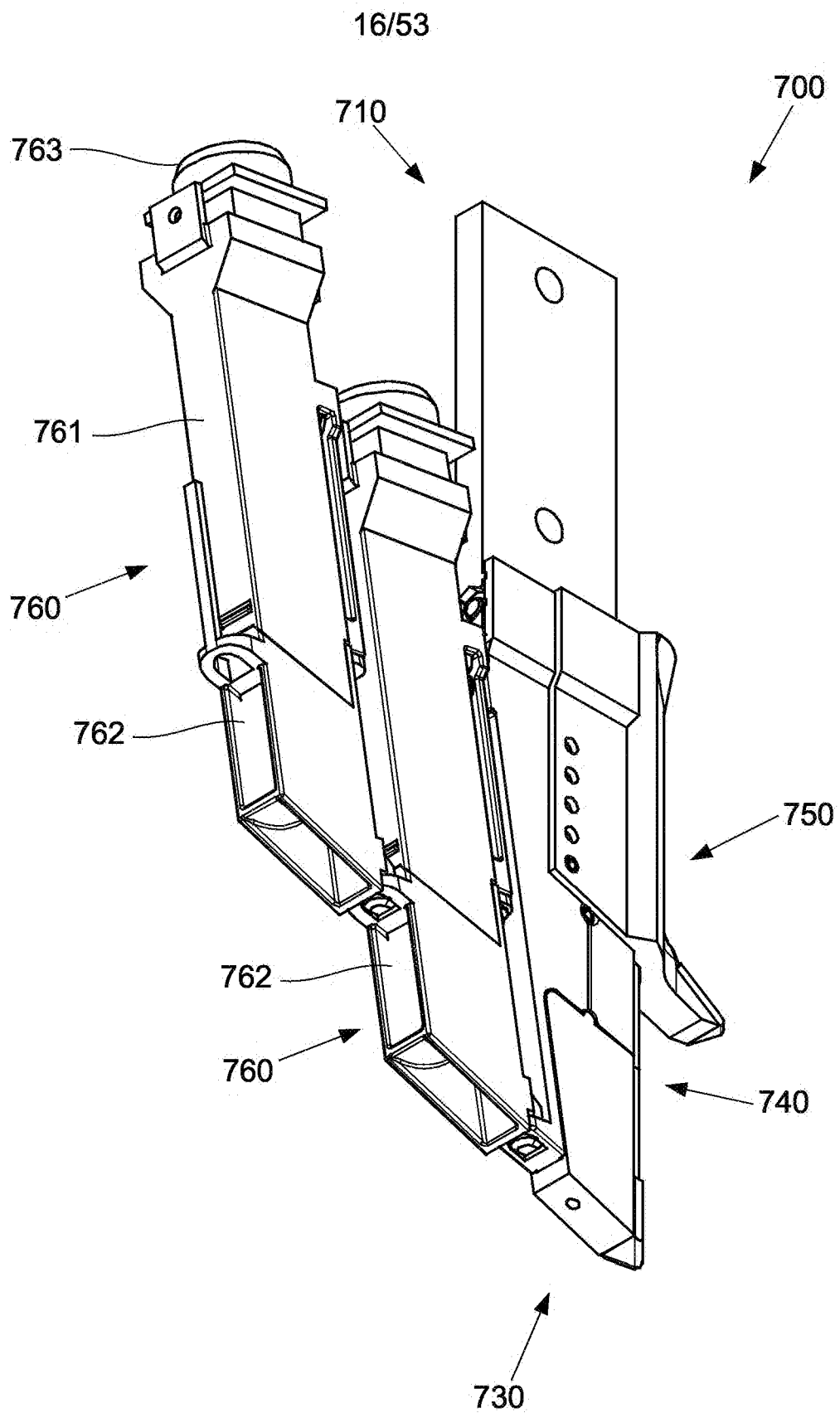


Fig. 7C

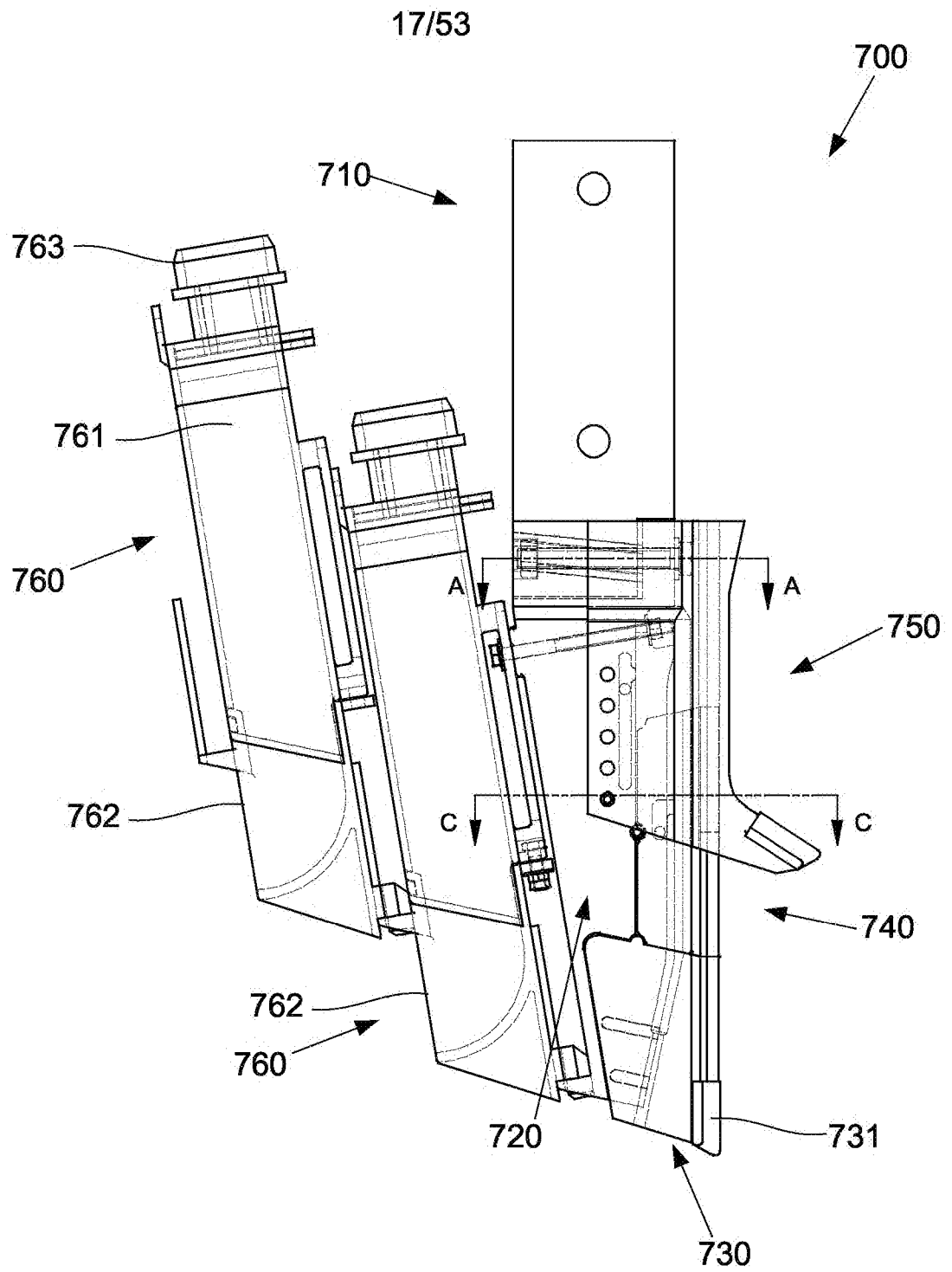


Fig. 7D

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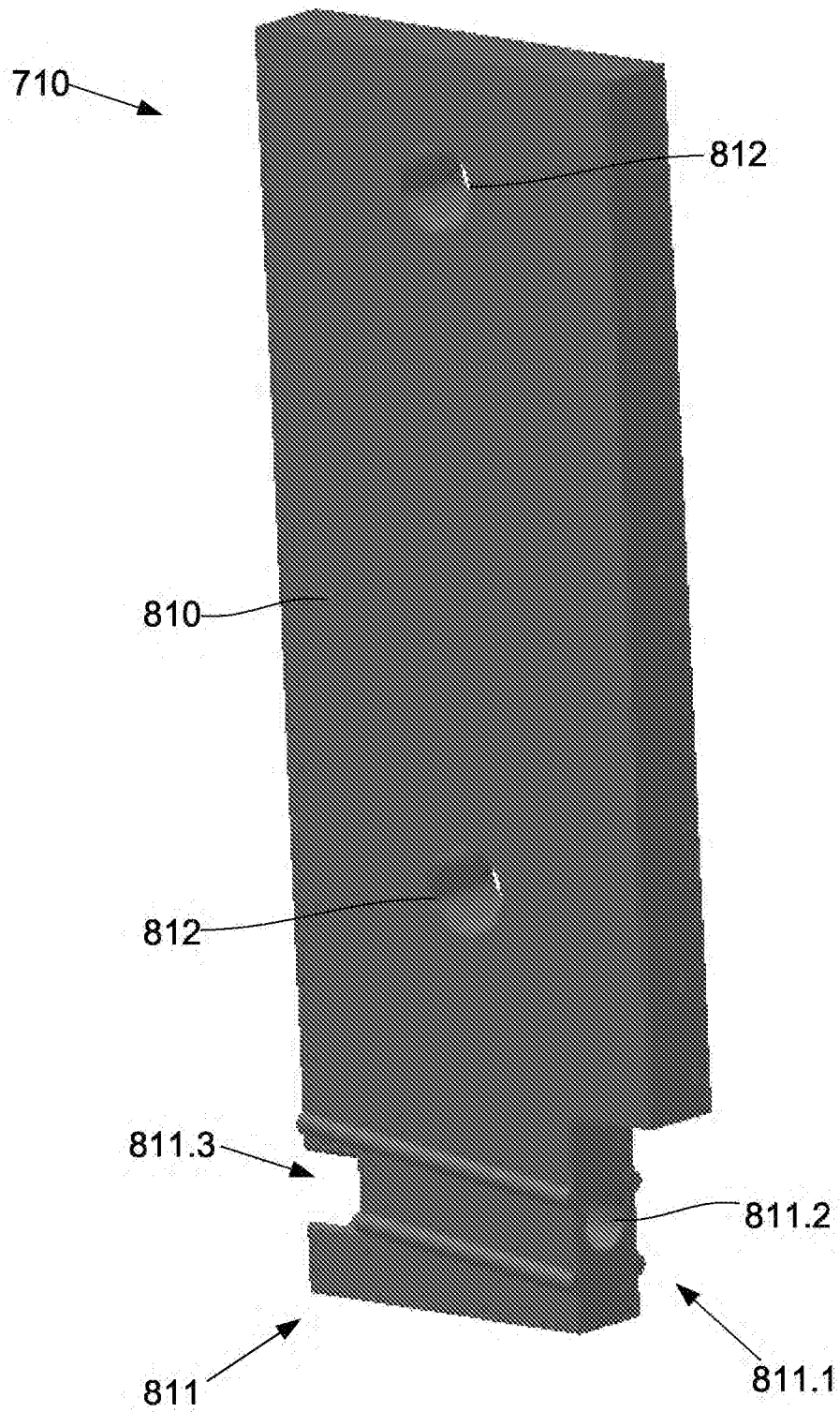


Fig. 8

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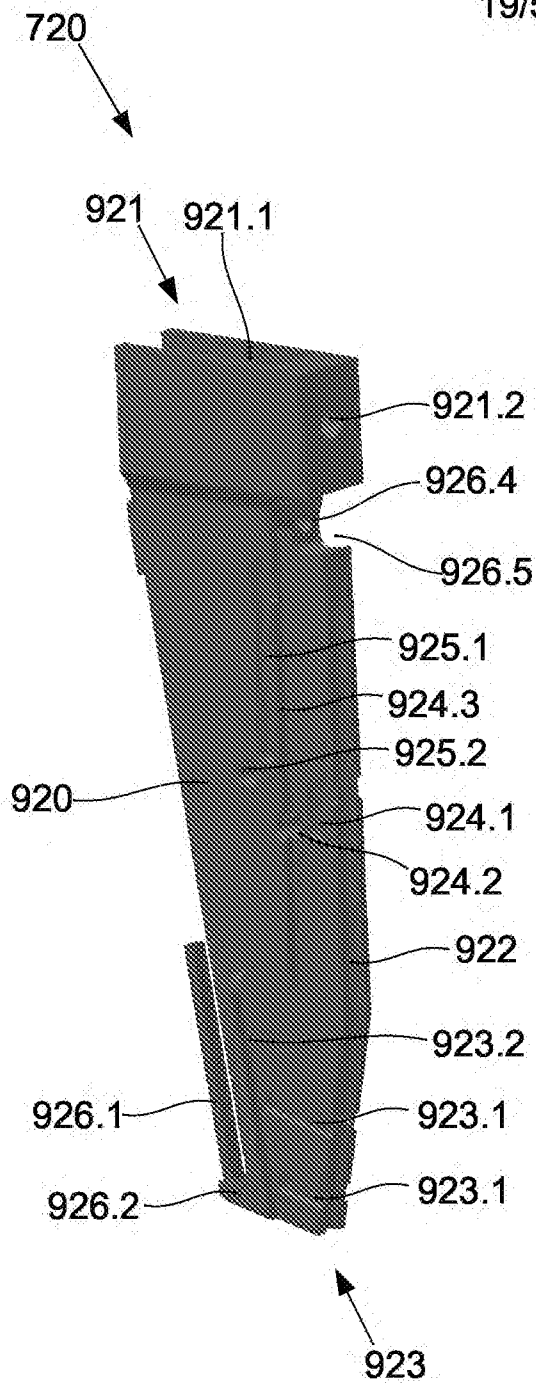


Fig. 9A

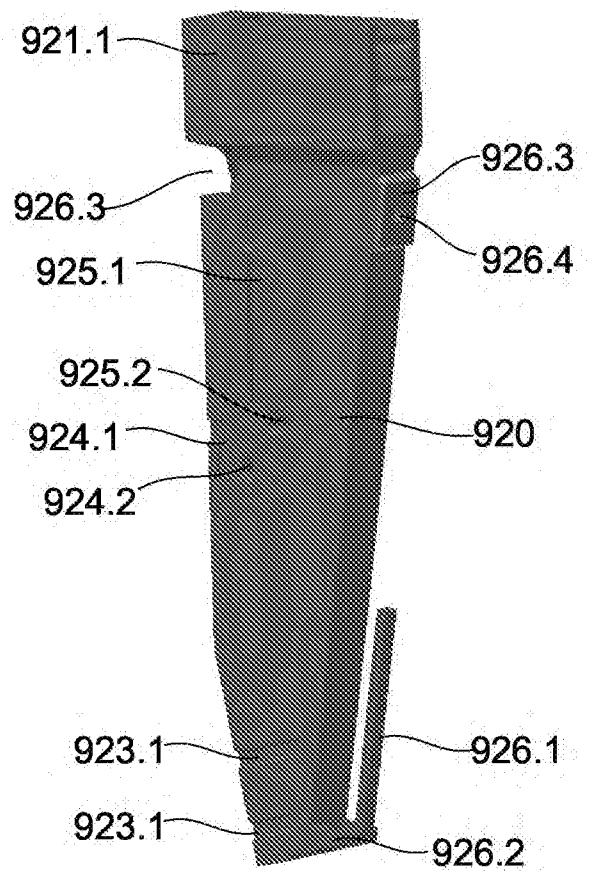


Fig. 9B

20/53

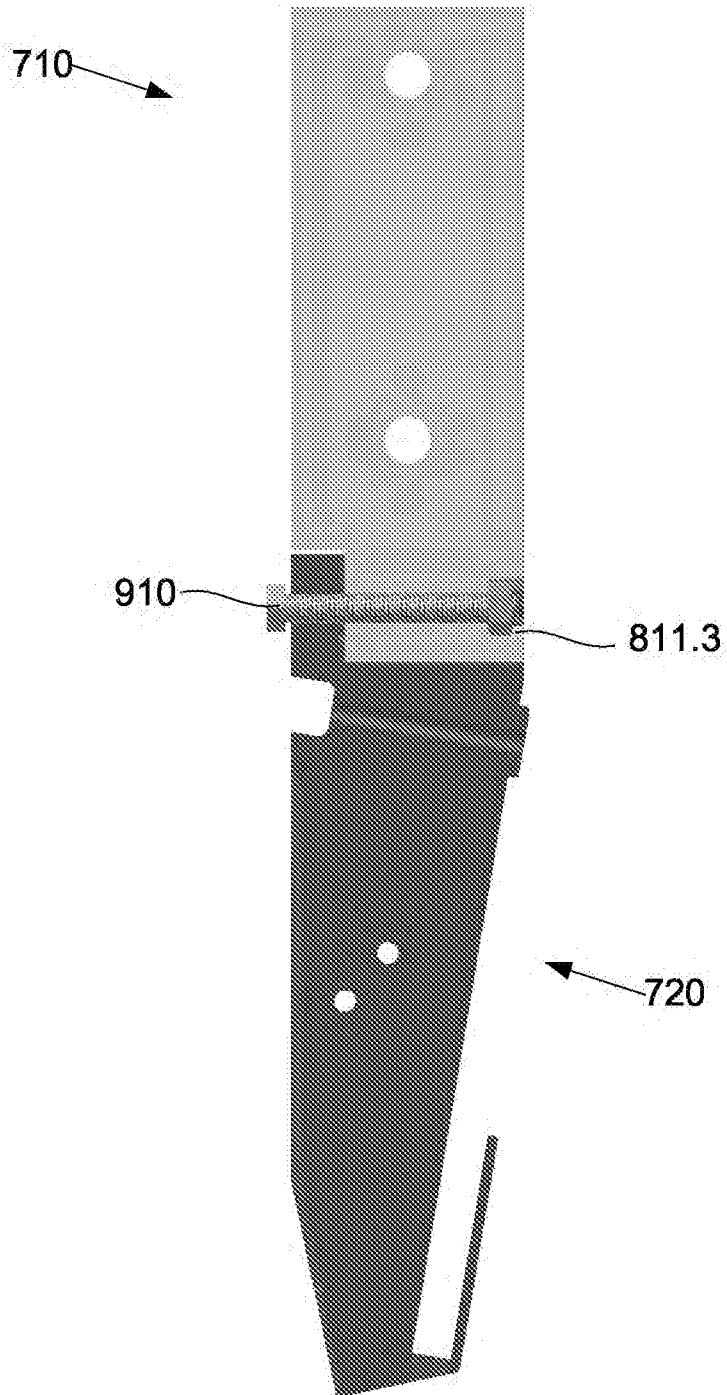


Fig. 9C

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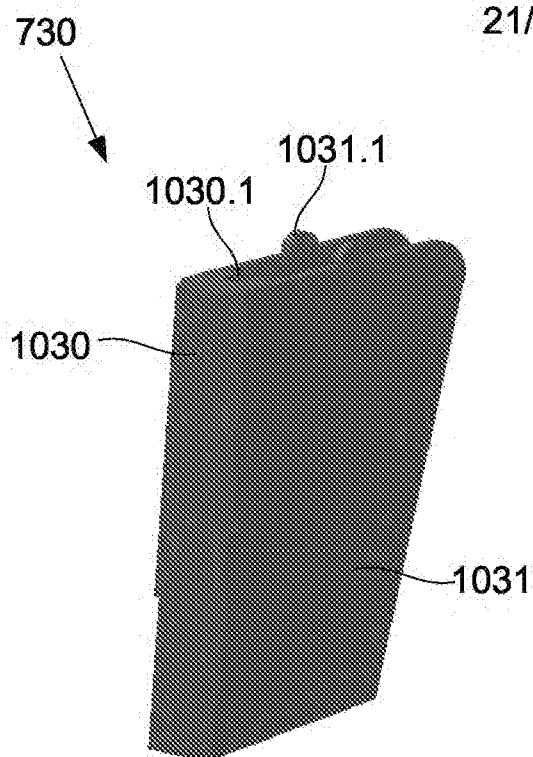


Fig. 10A

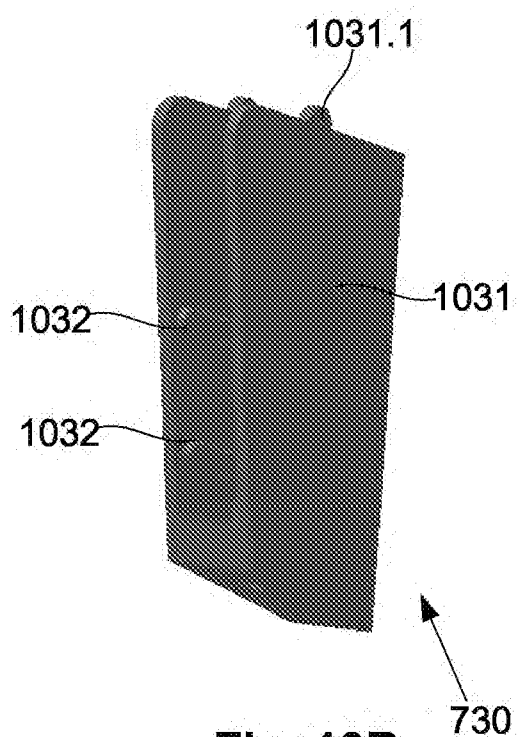


Fig. 10B

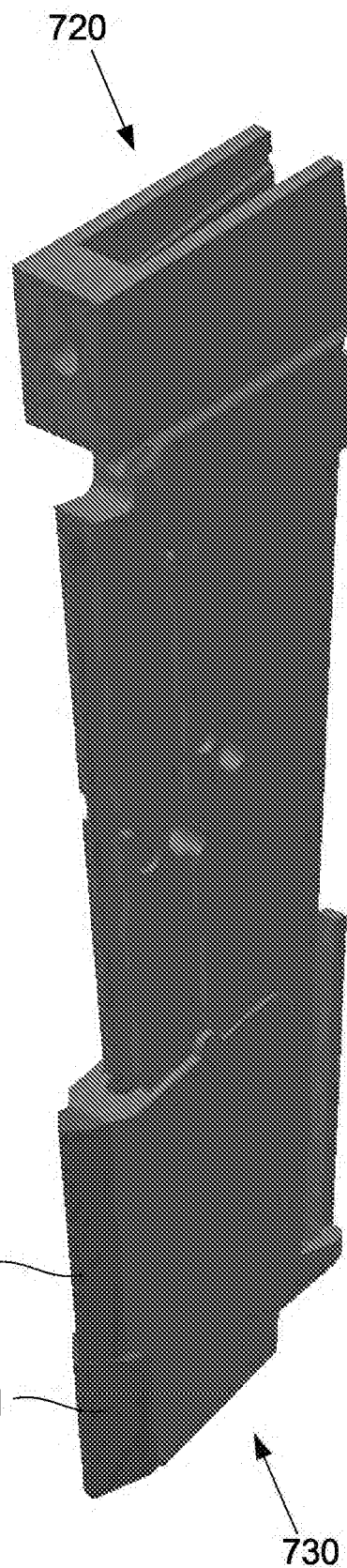


Fig. 10C

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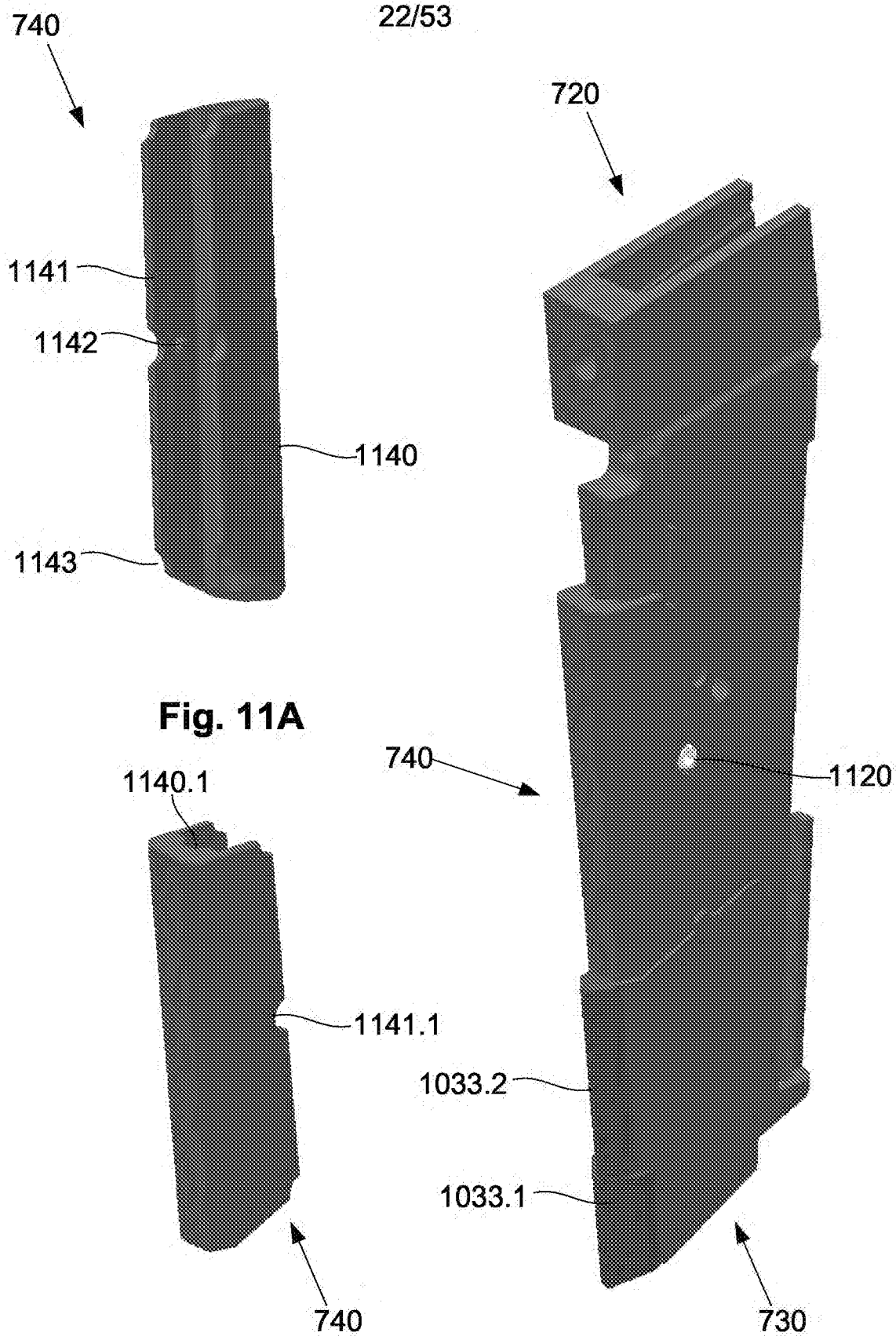


Fig. 11A

Fig. 11B

Fig. 11C

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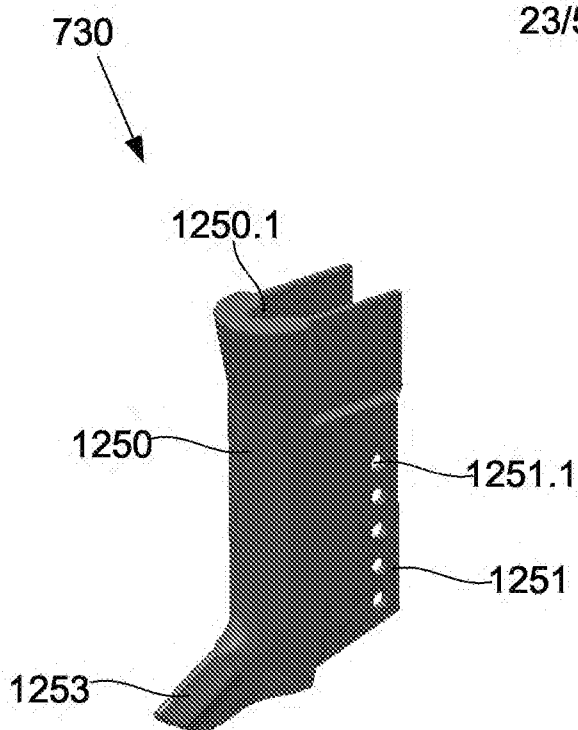


Fig. 12A

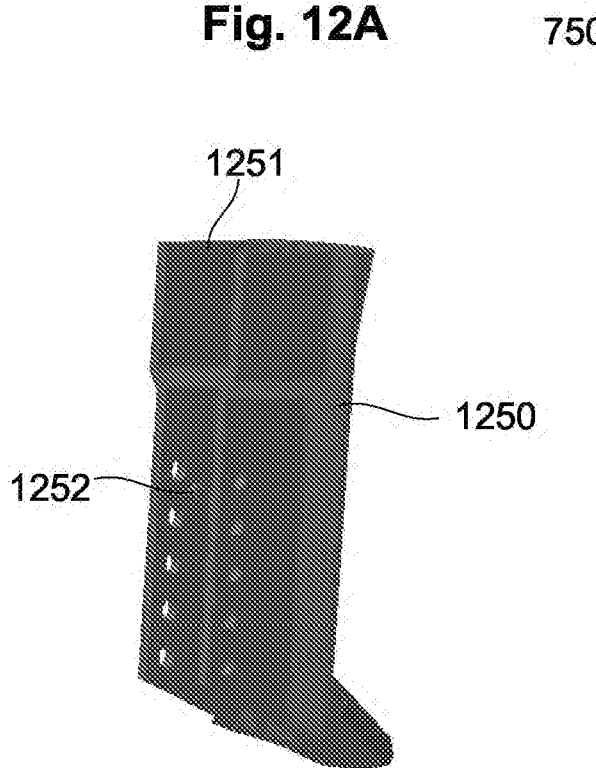


Fig. 12B

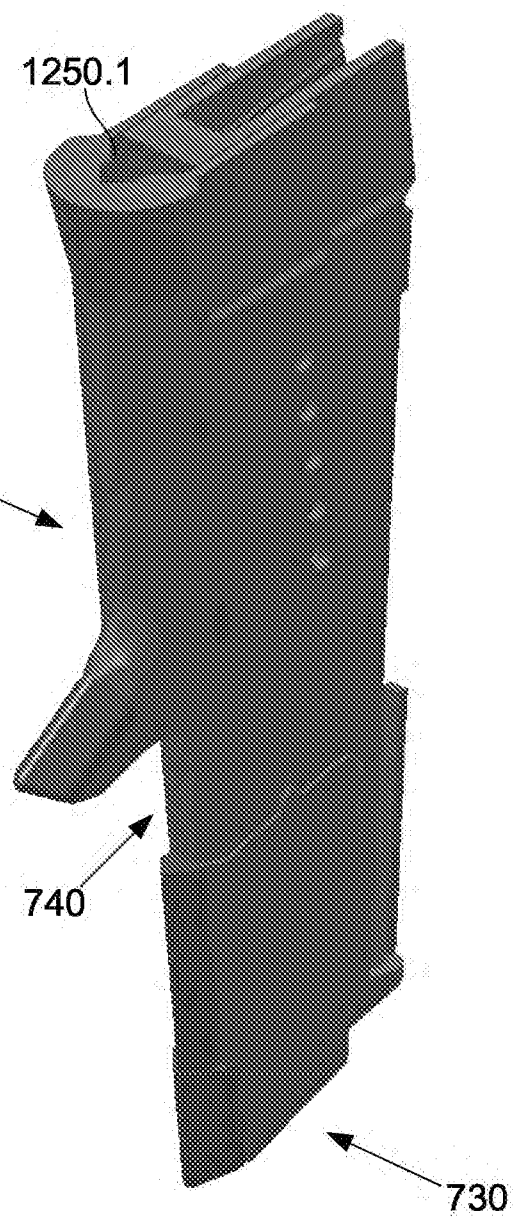


Fig. 12C

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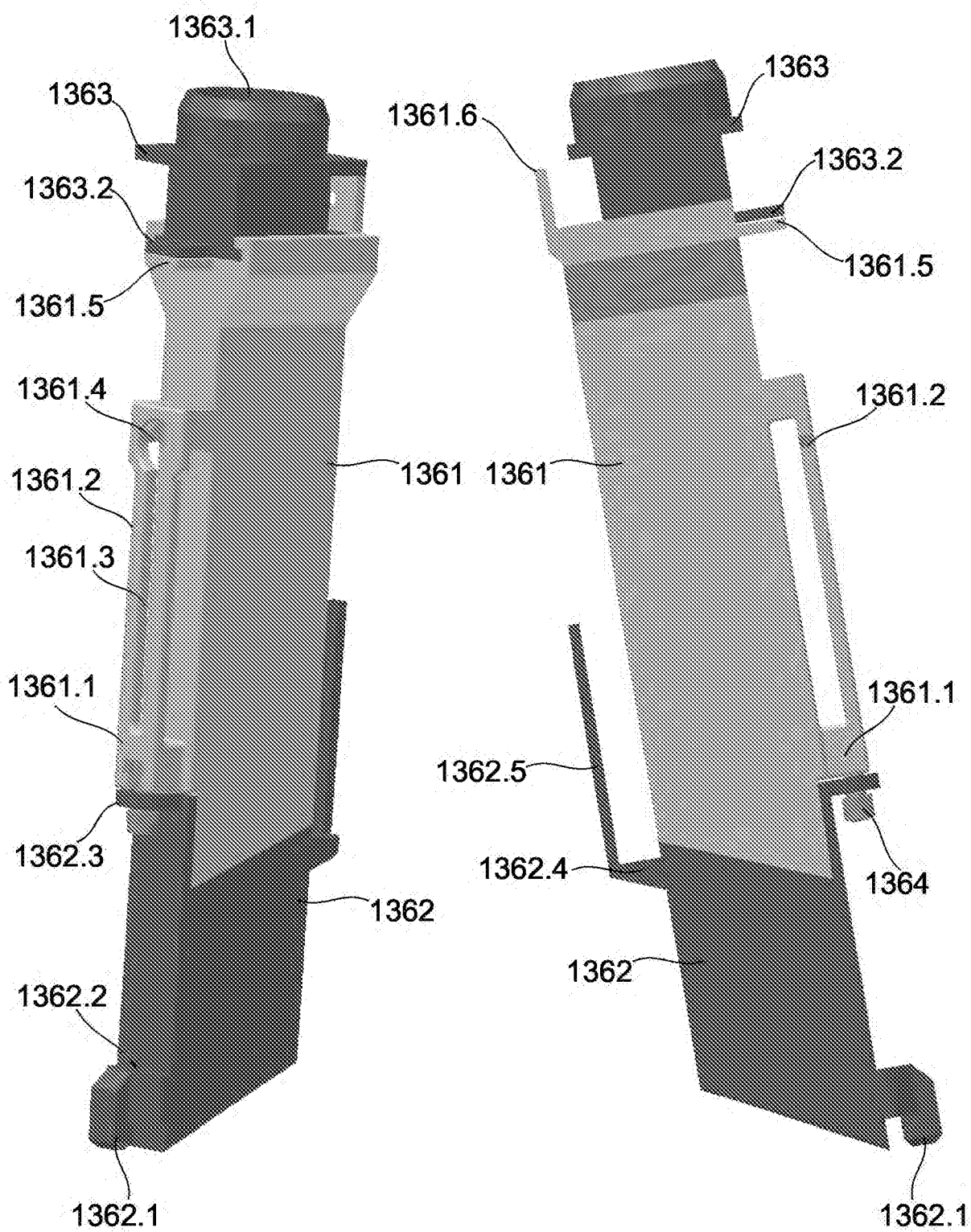


Fig. 13A

Fig. 13B

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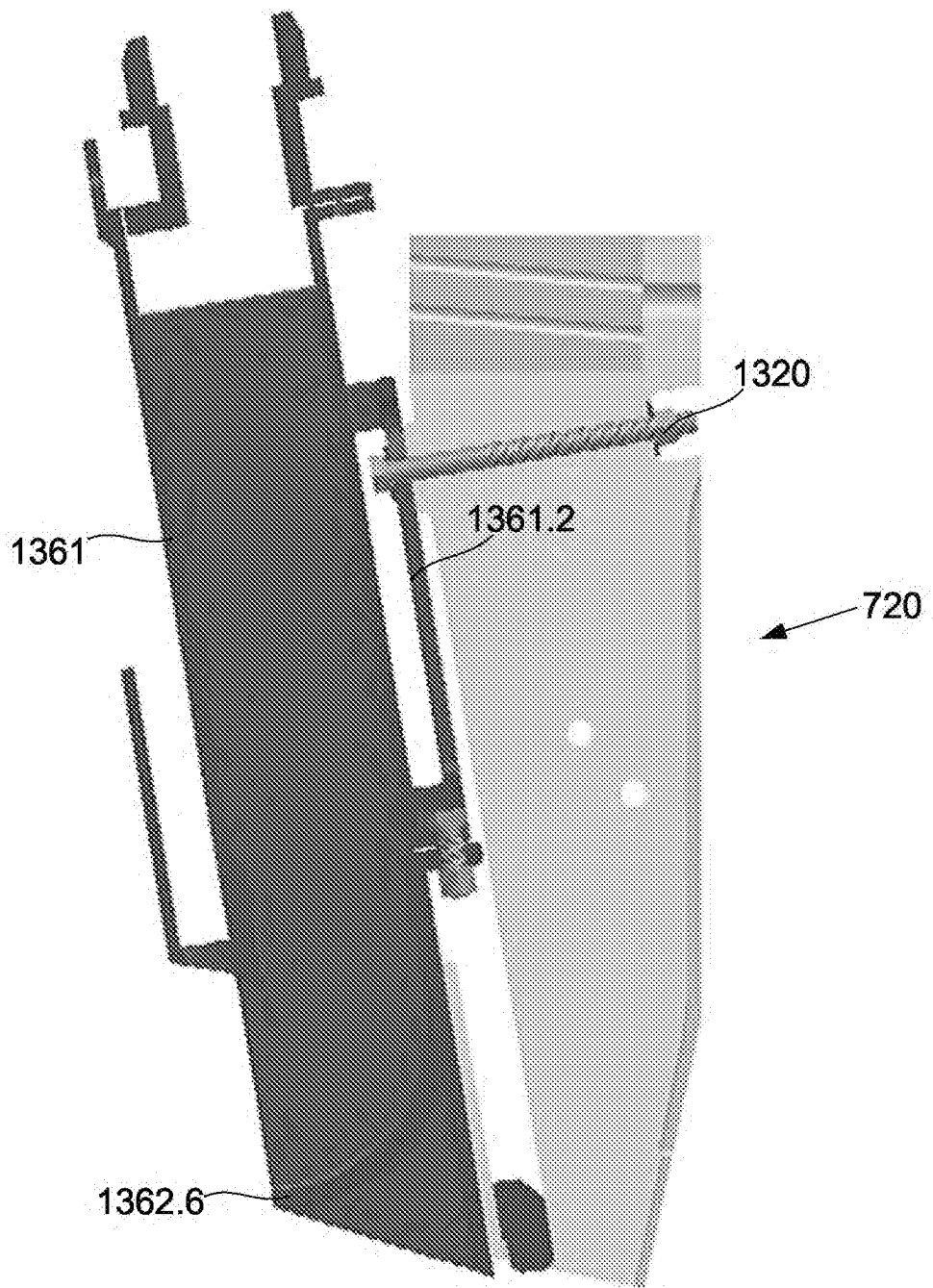


Fig. 13C

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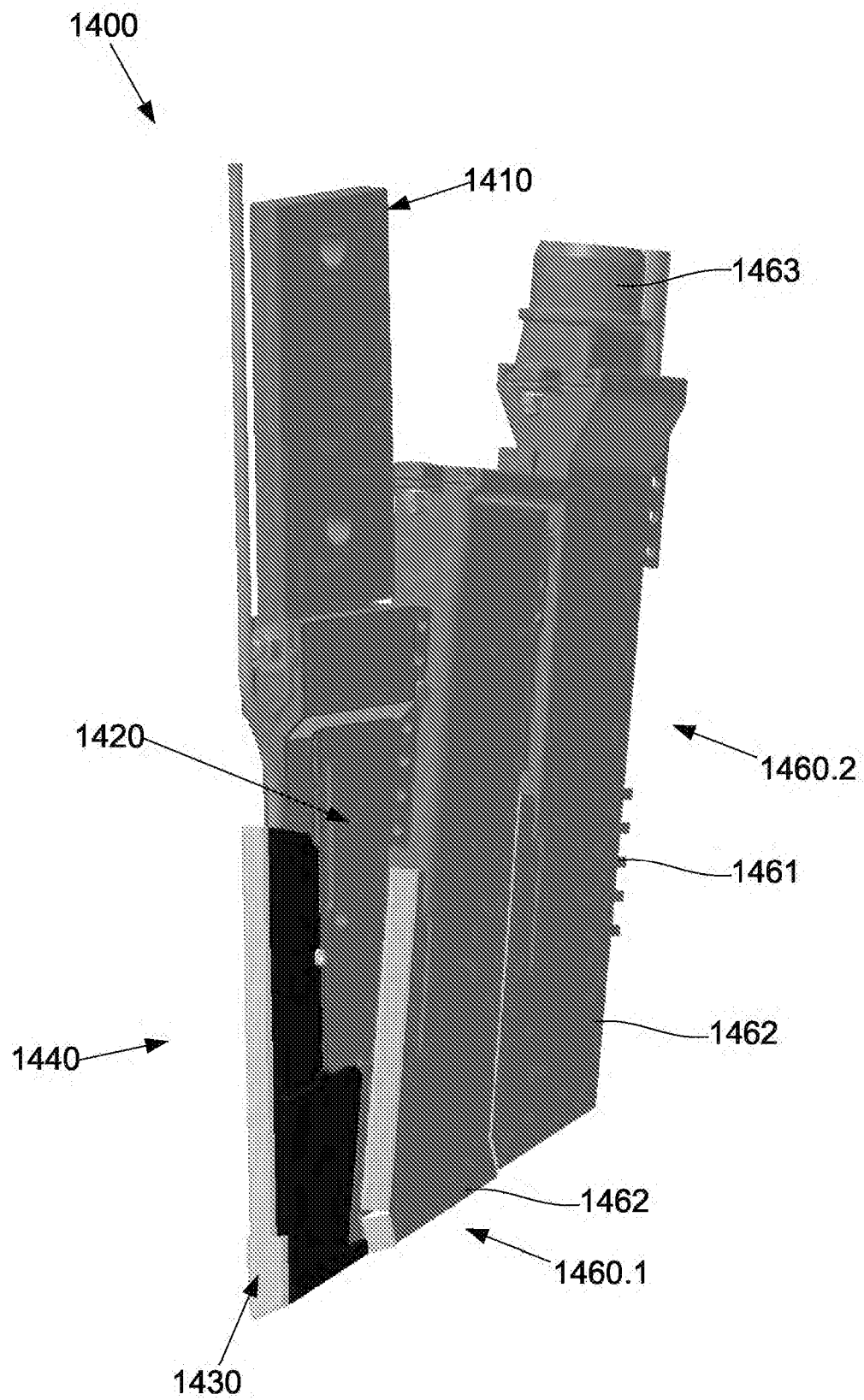


Fig. 14A

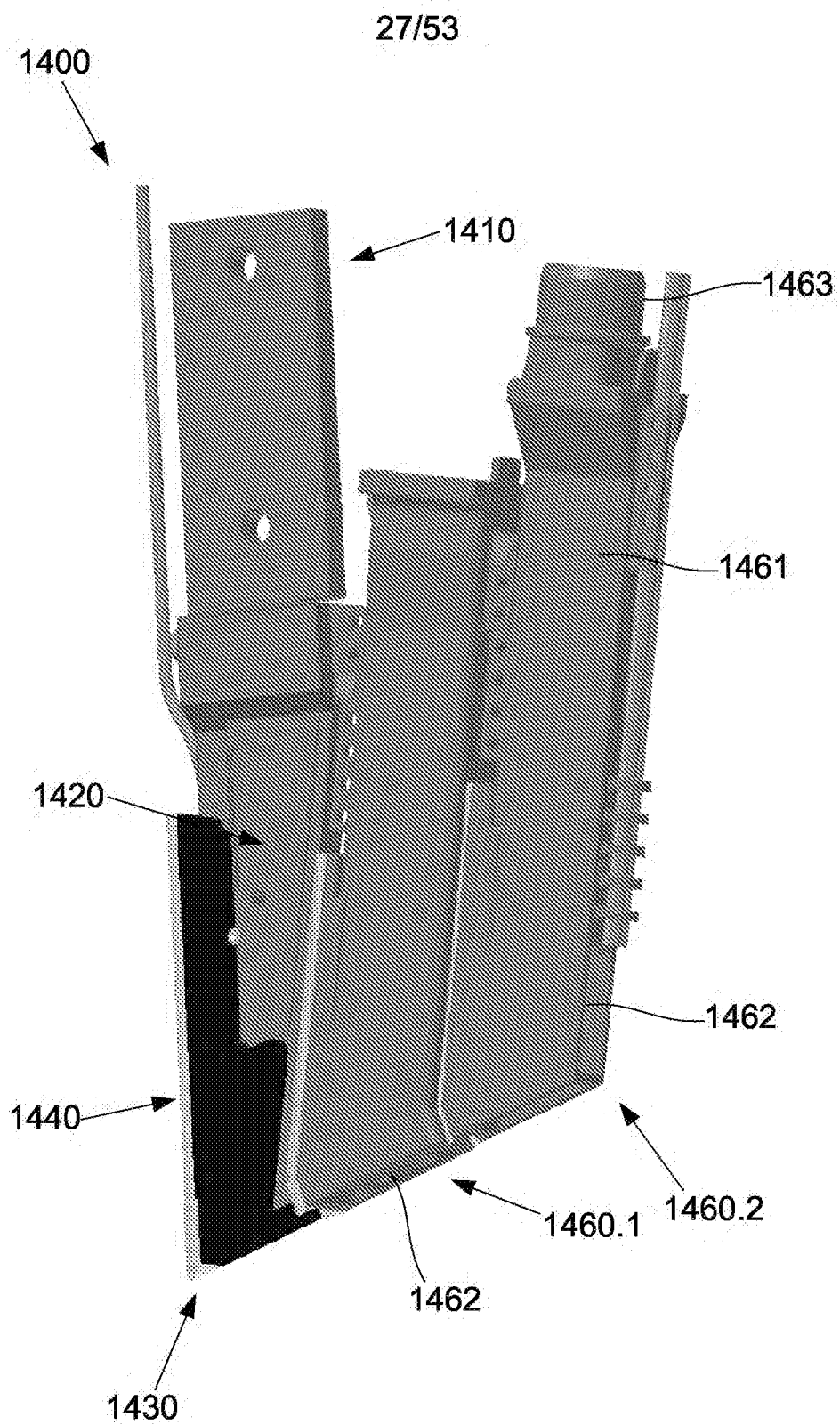


Fig. 14B

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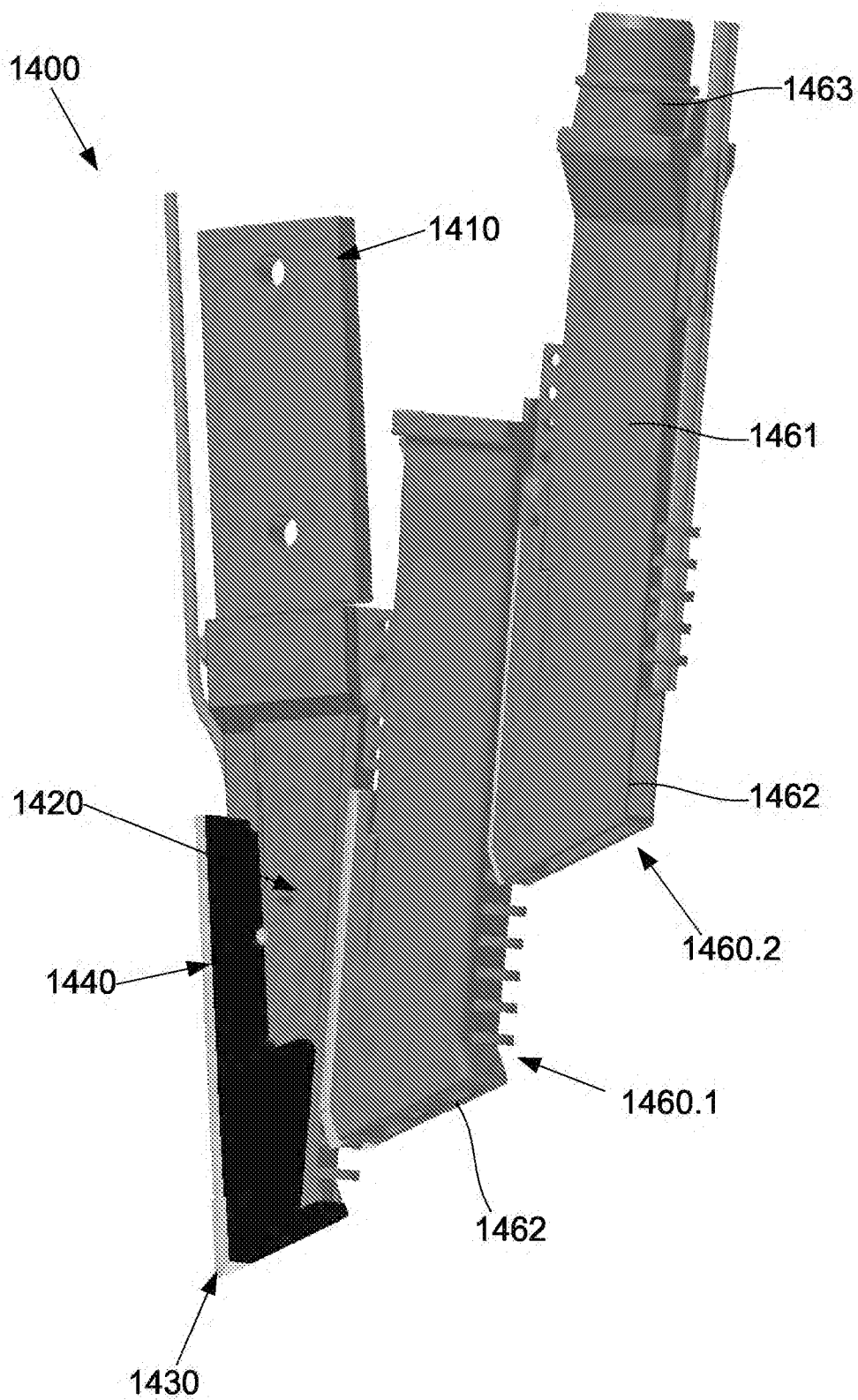


Fig. 14C

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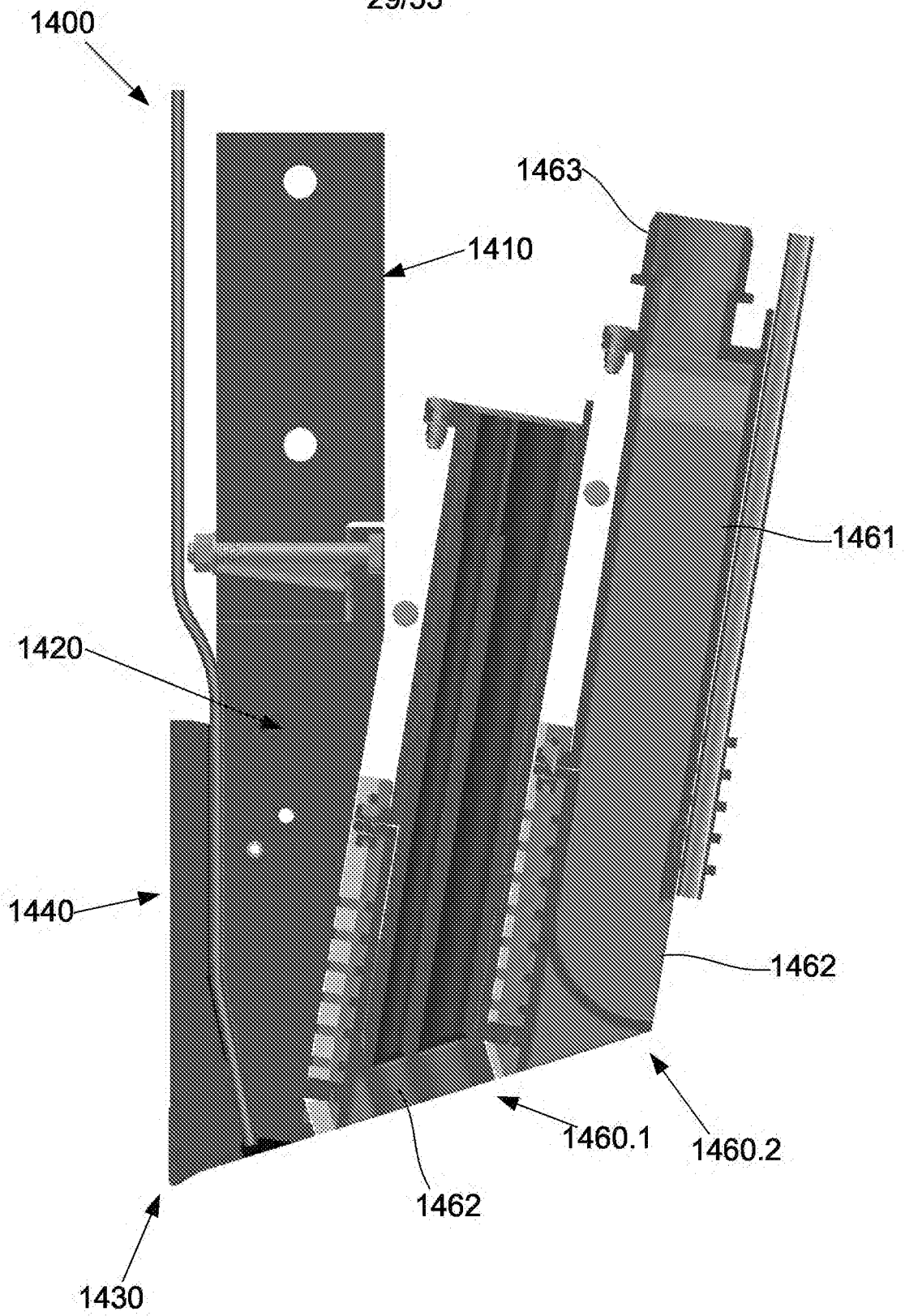


Fig. 14D

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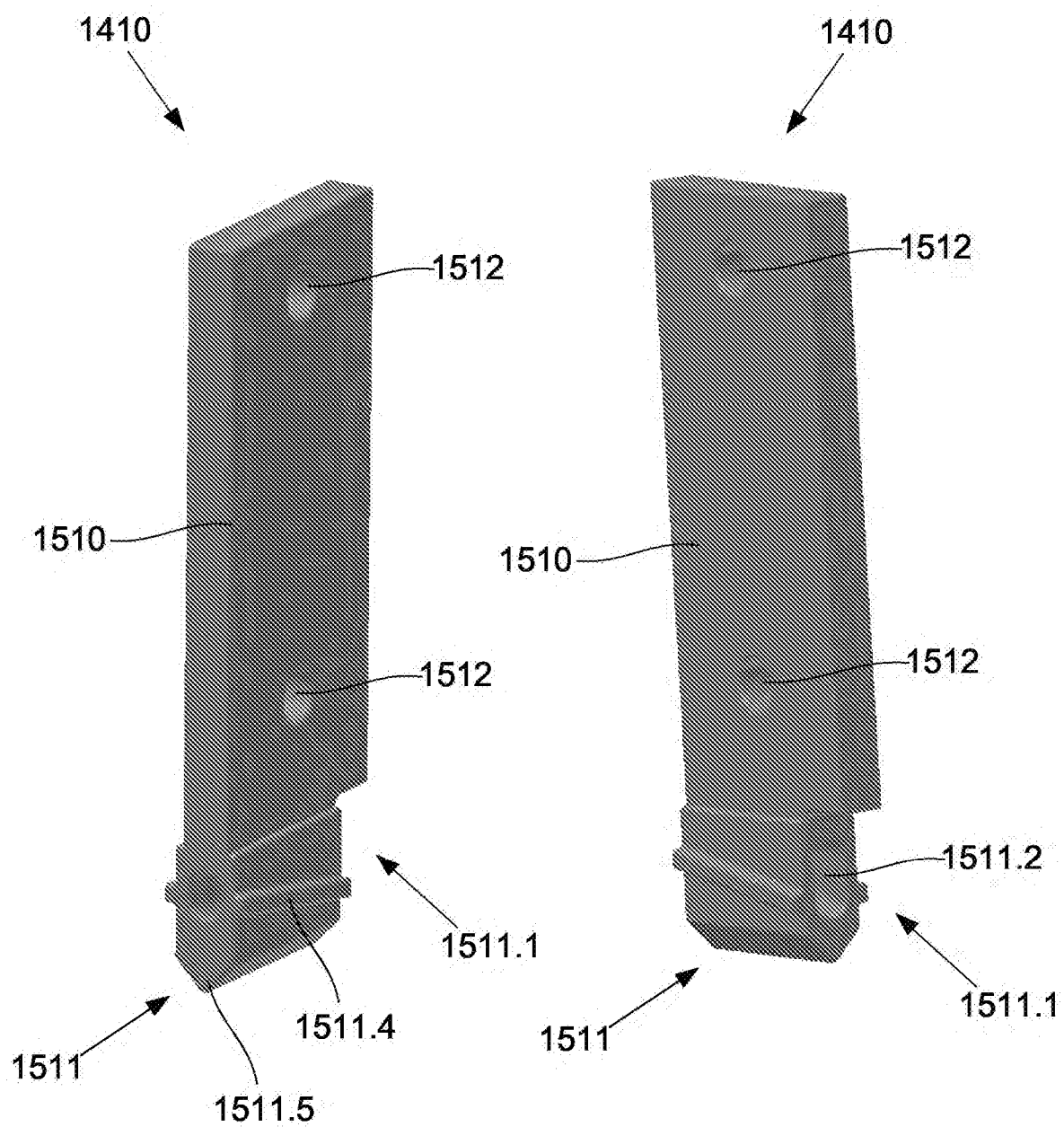


Fig. 15A

Fig. 15B

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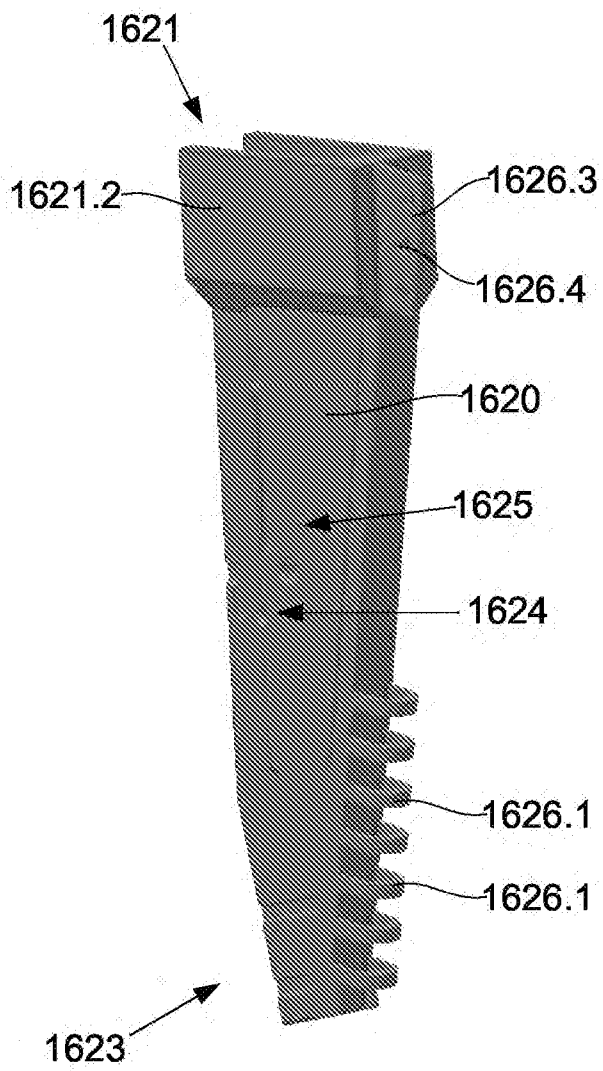


Fig. 16A

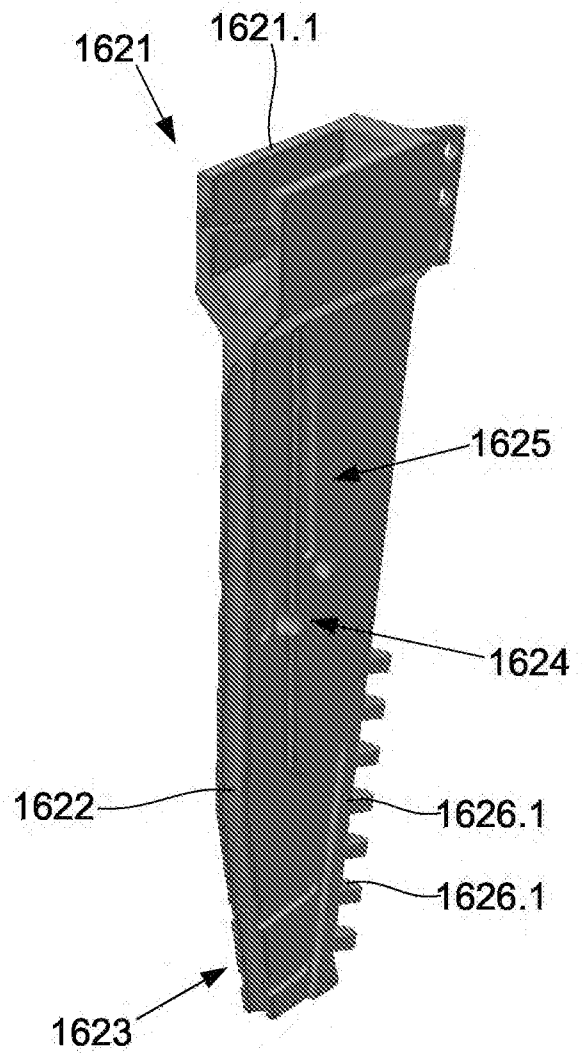


Fig. 16B

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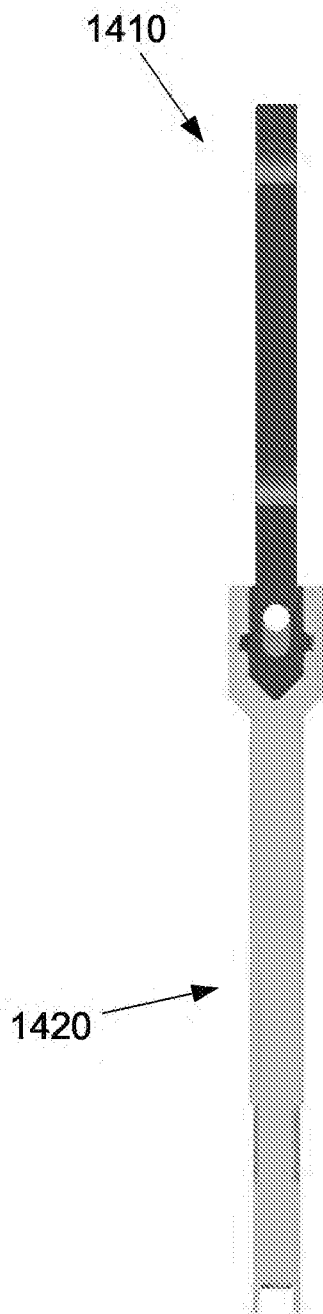


Fig. 16C

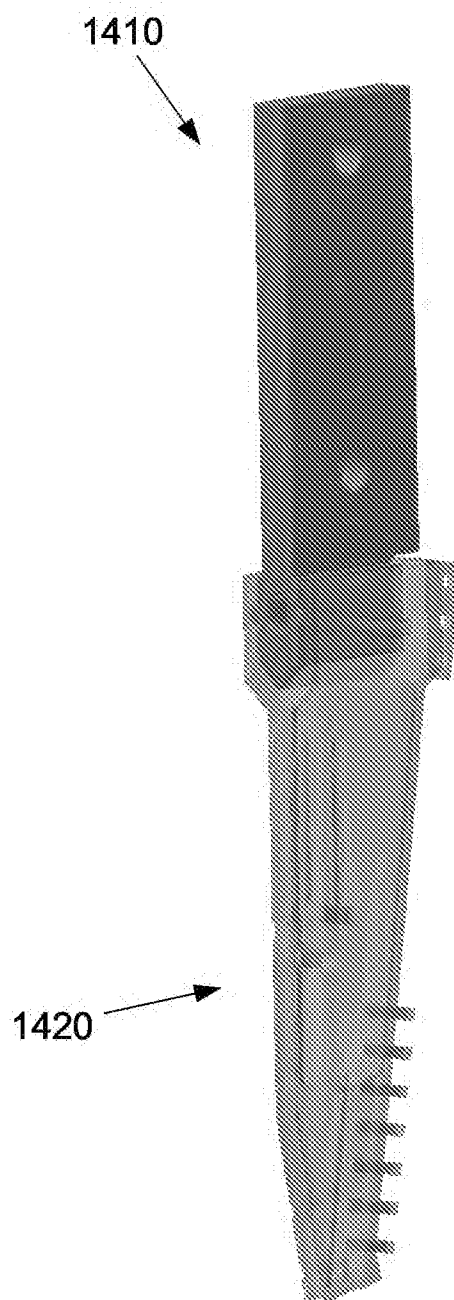


Fig. 16D

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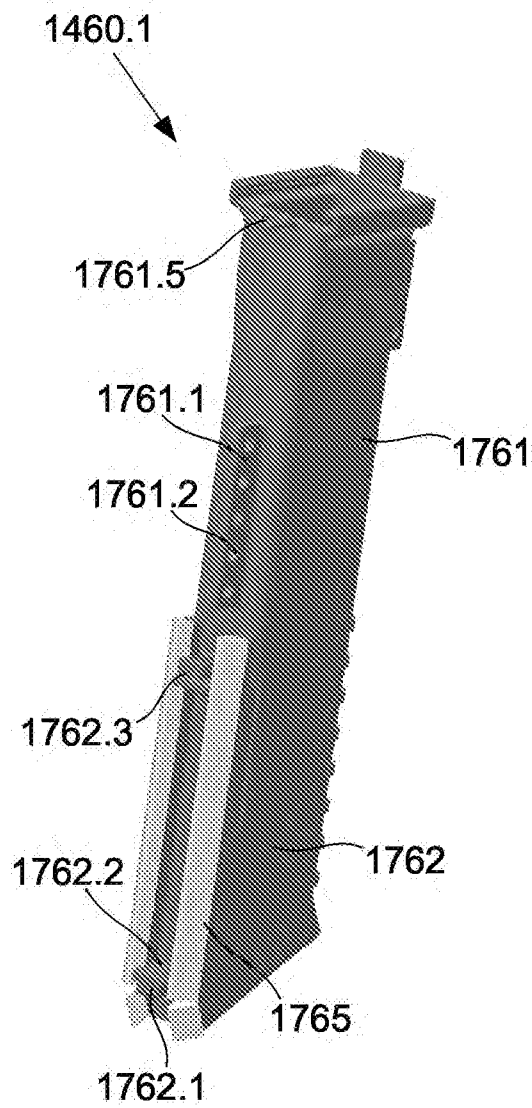


Fig. 17A

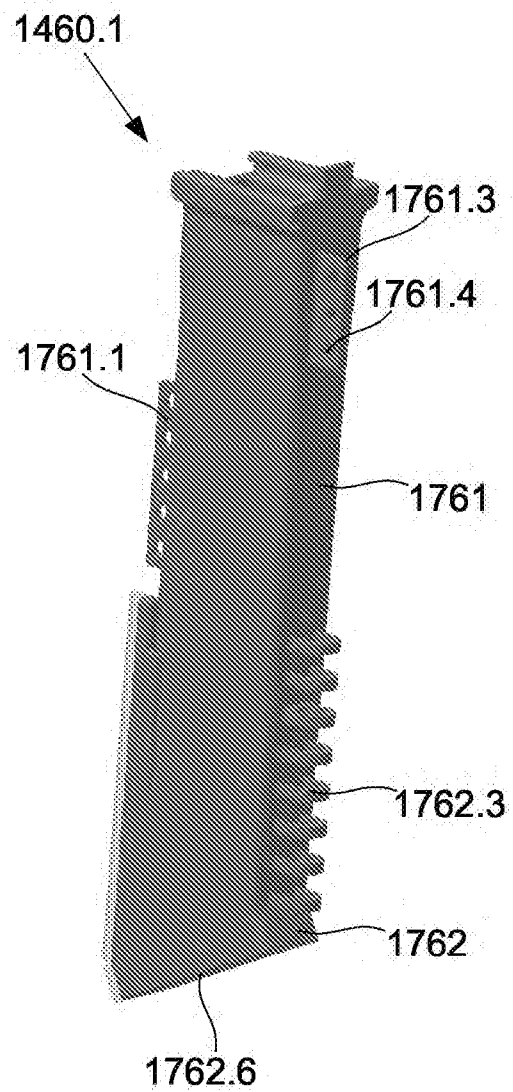


Fig. 17B

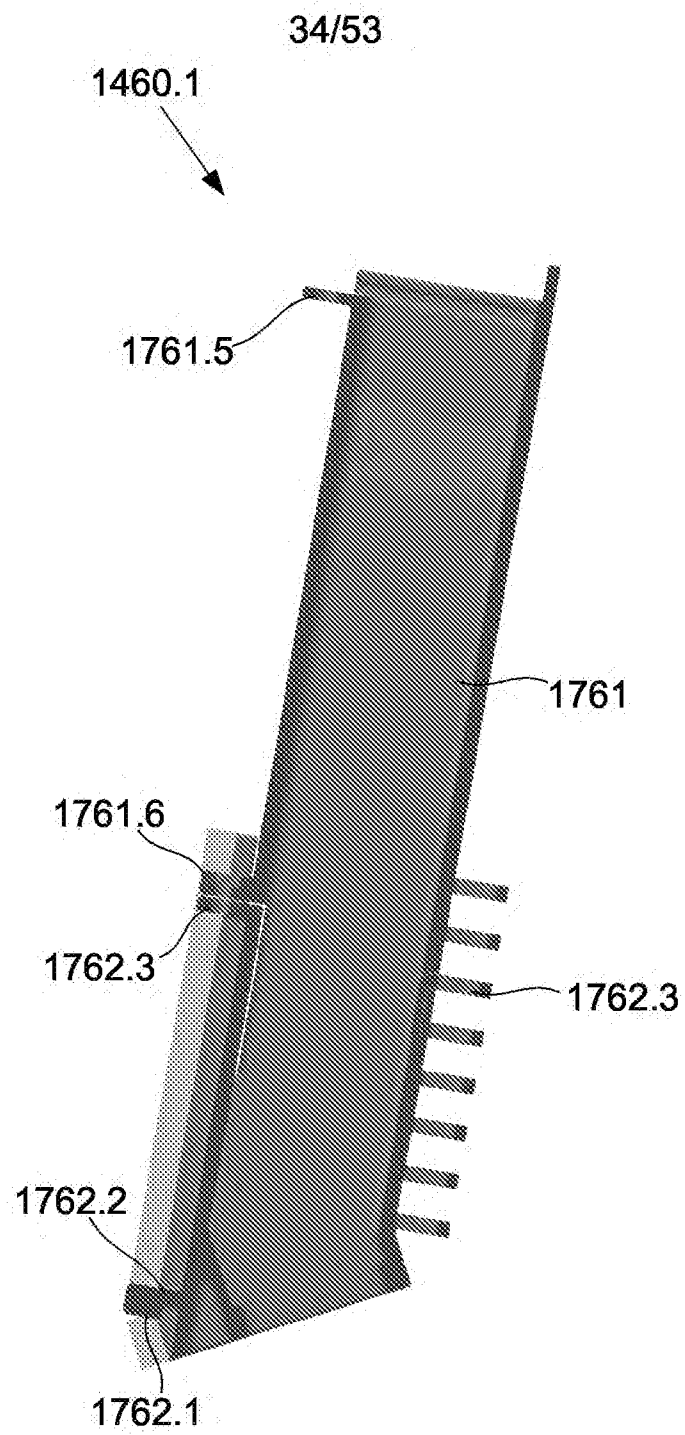


Fig. 17C

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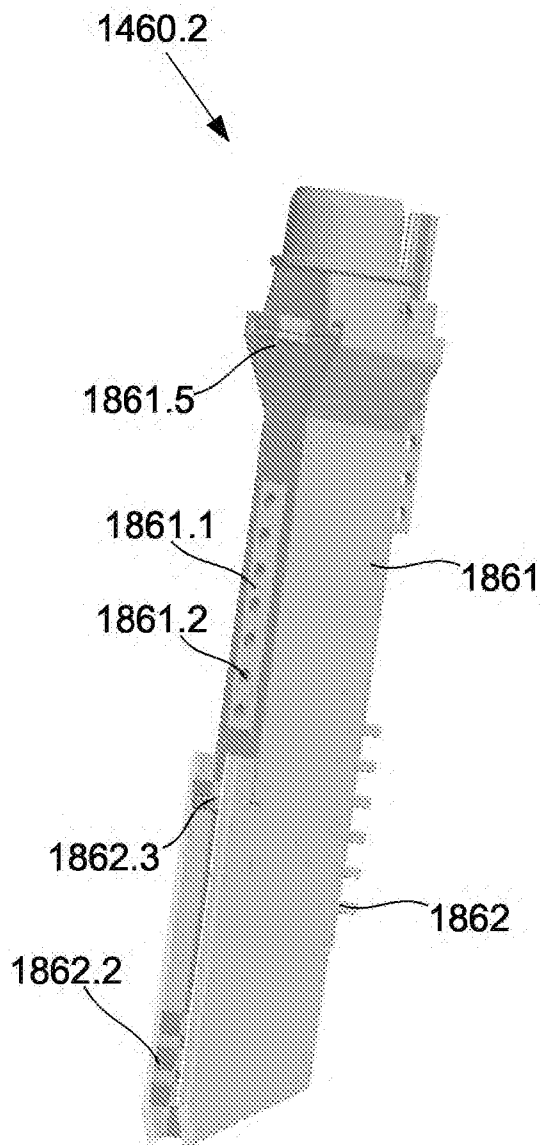


Fig. 18A

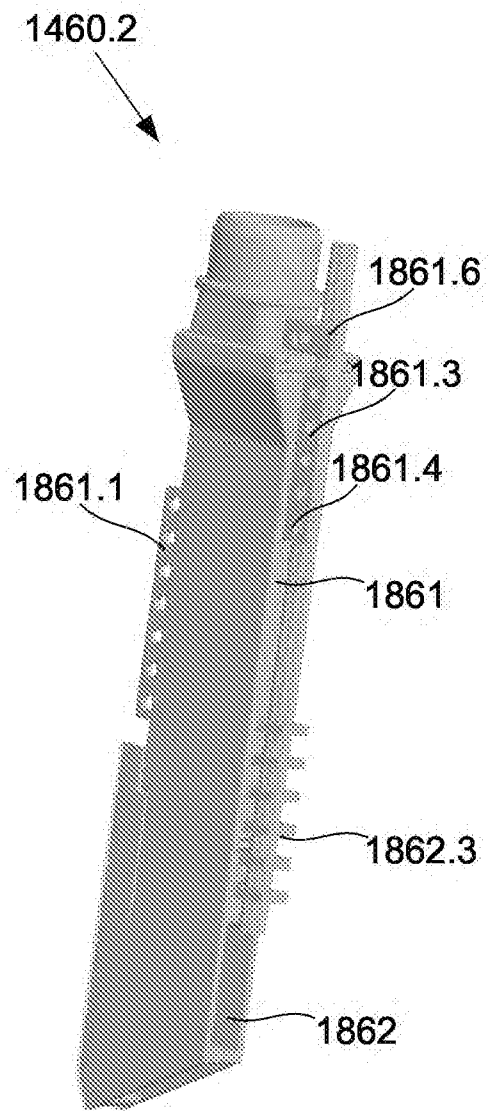
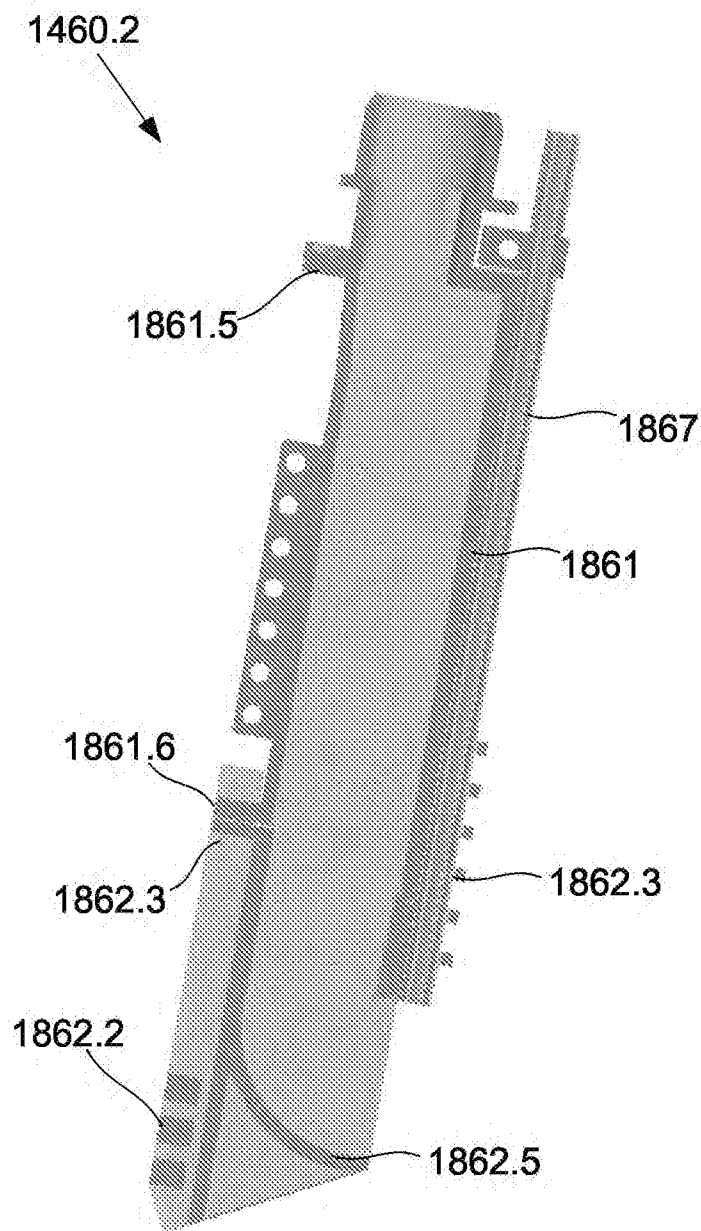


Fig. 18B

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**Fig. 18C**

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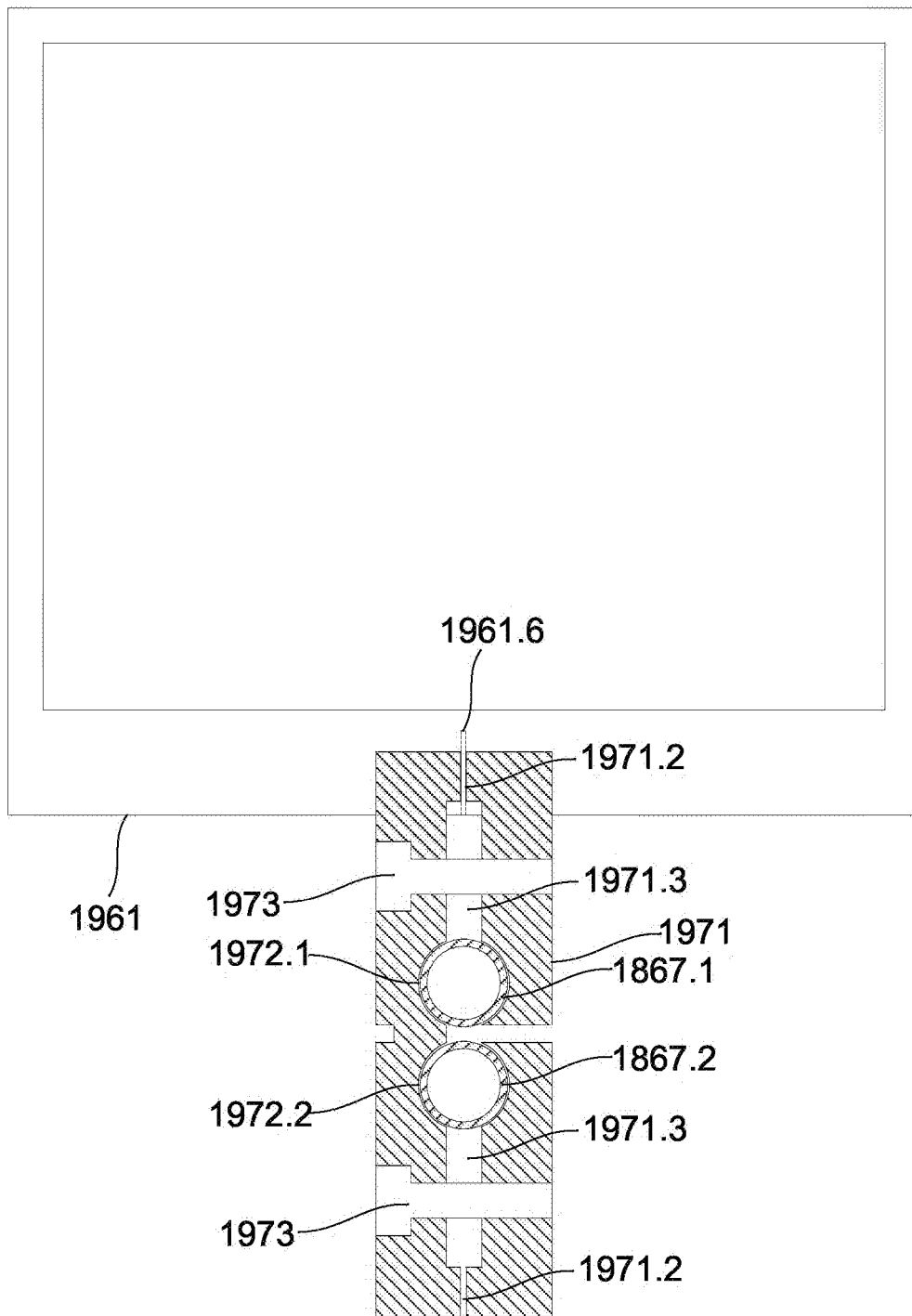


Fig. 19

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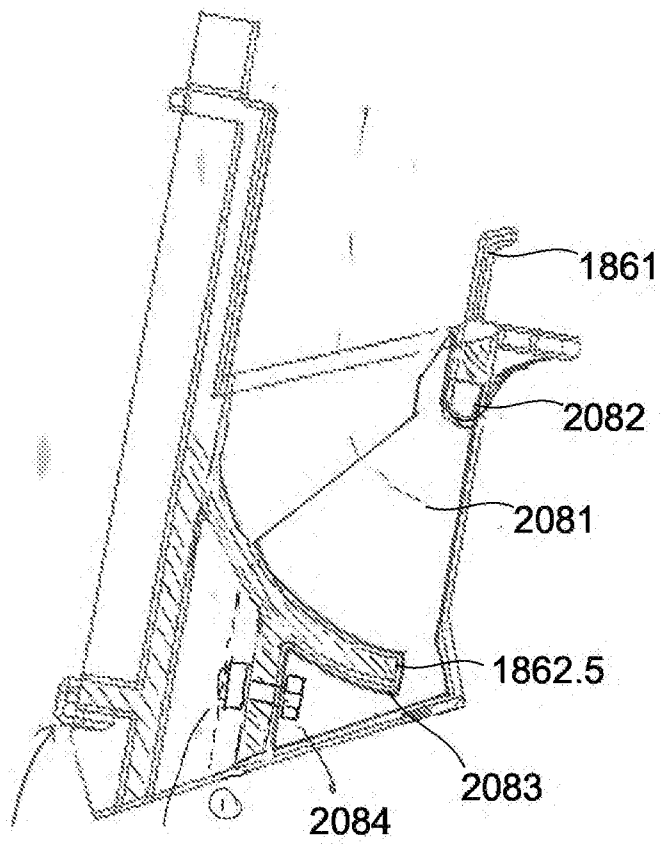


Fig. 20A

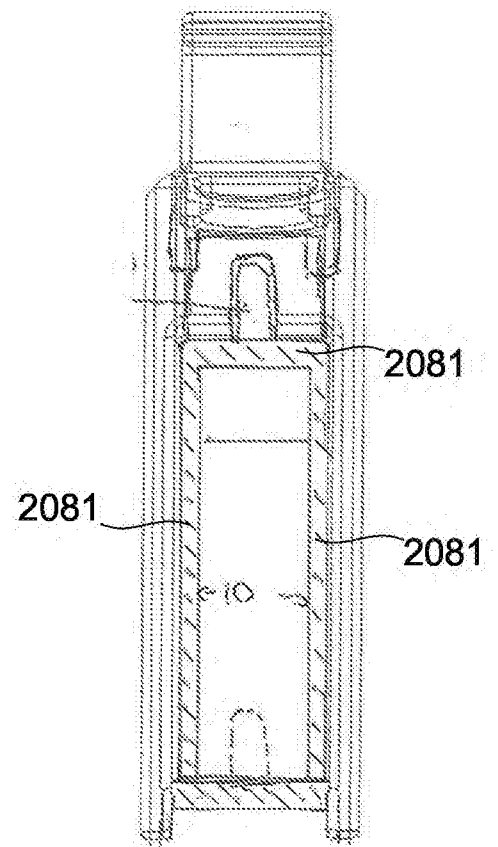


Fig. 20B

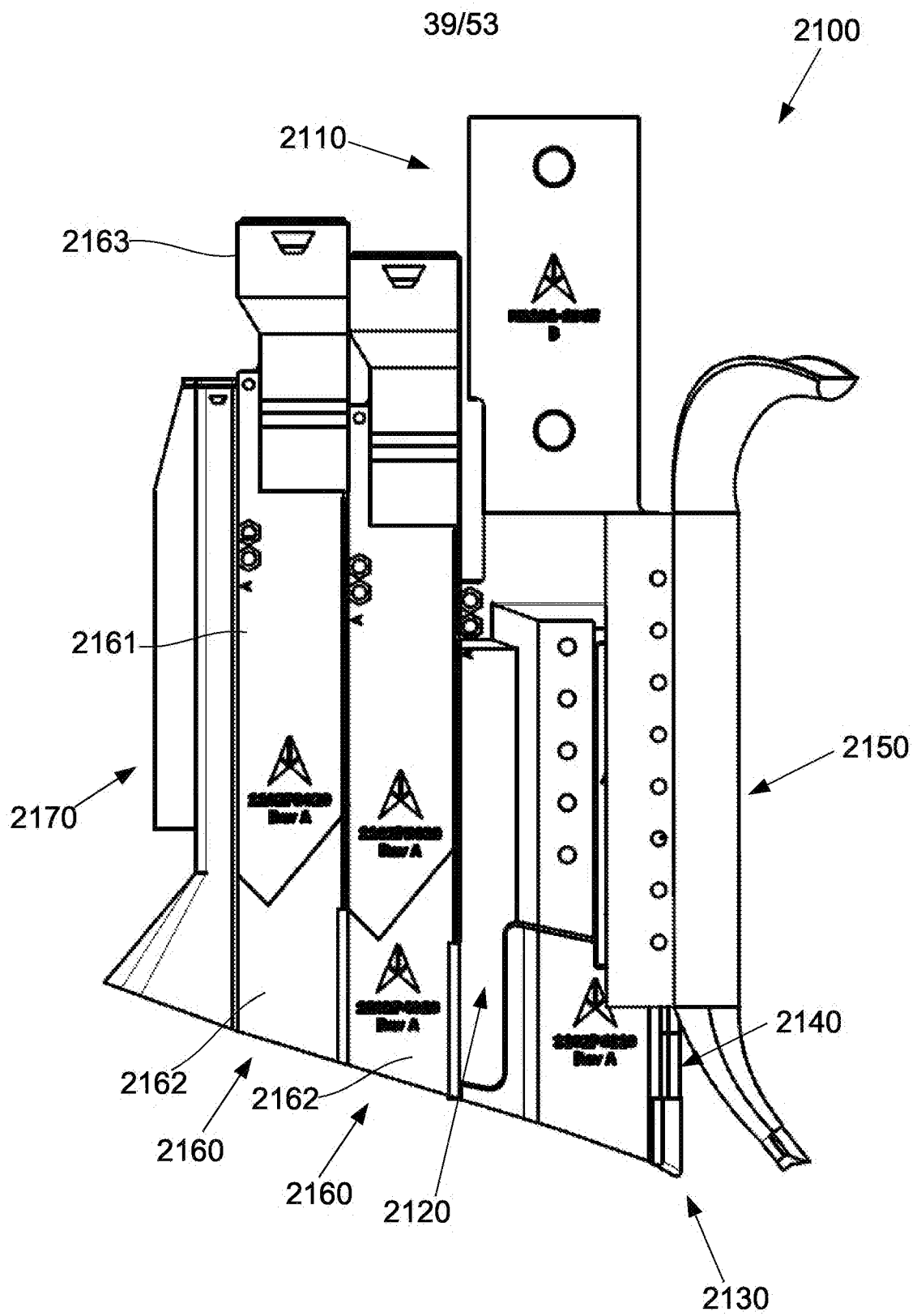


Fig. 21A

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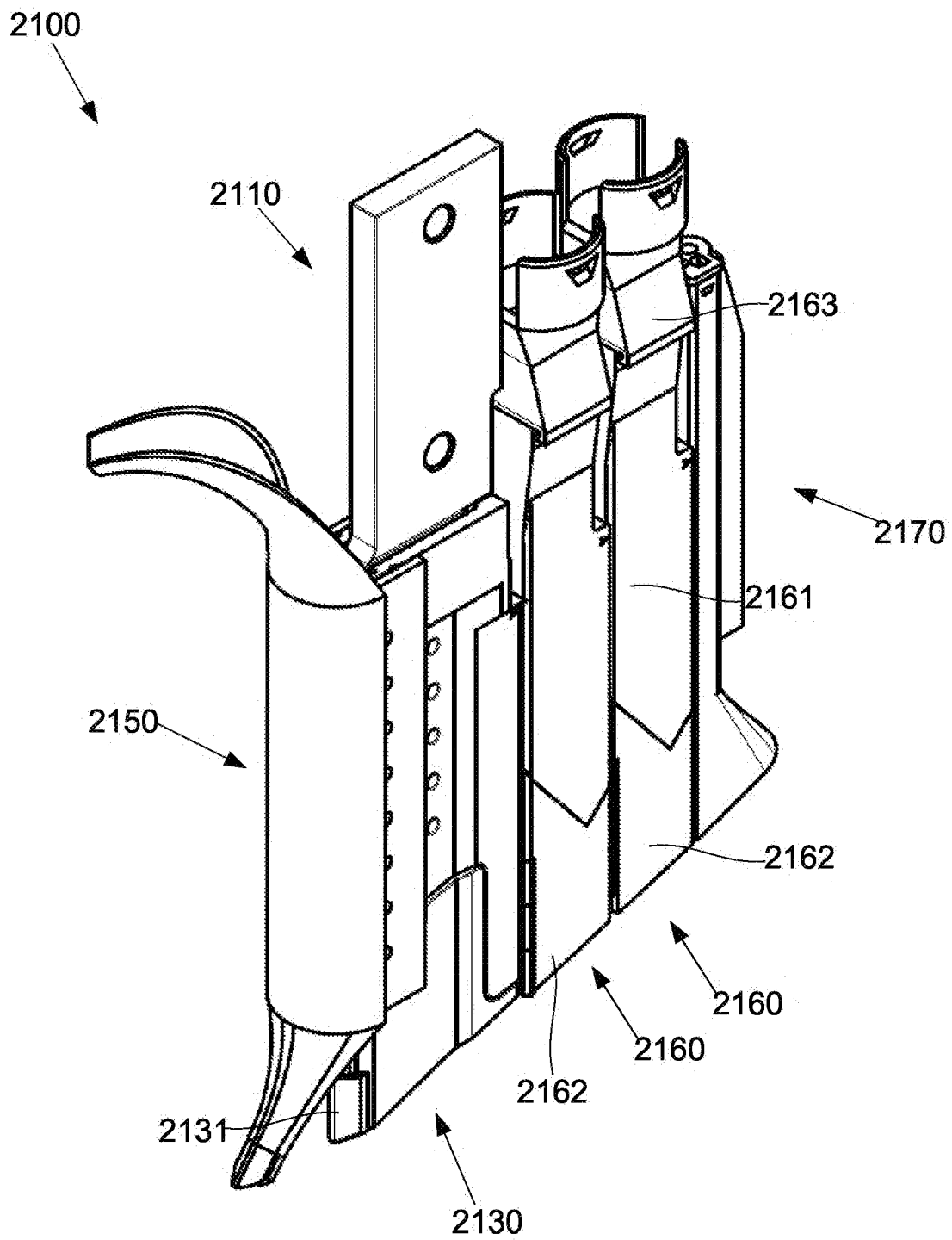


Fig. 21B

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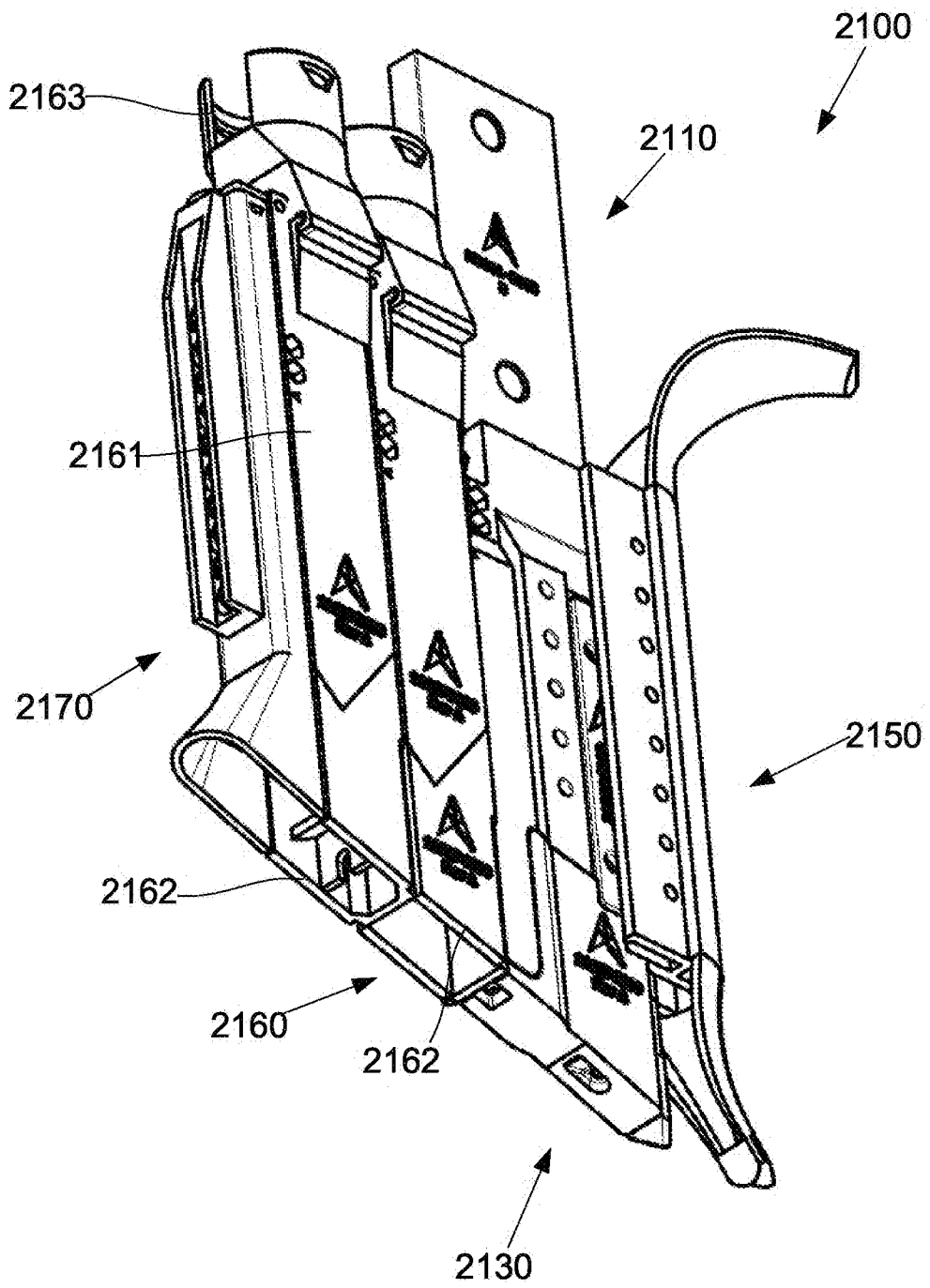


Fig. 21C

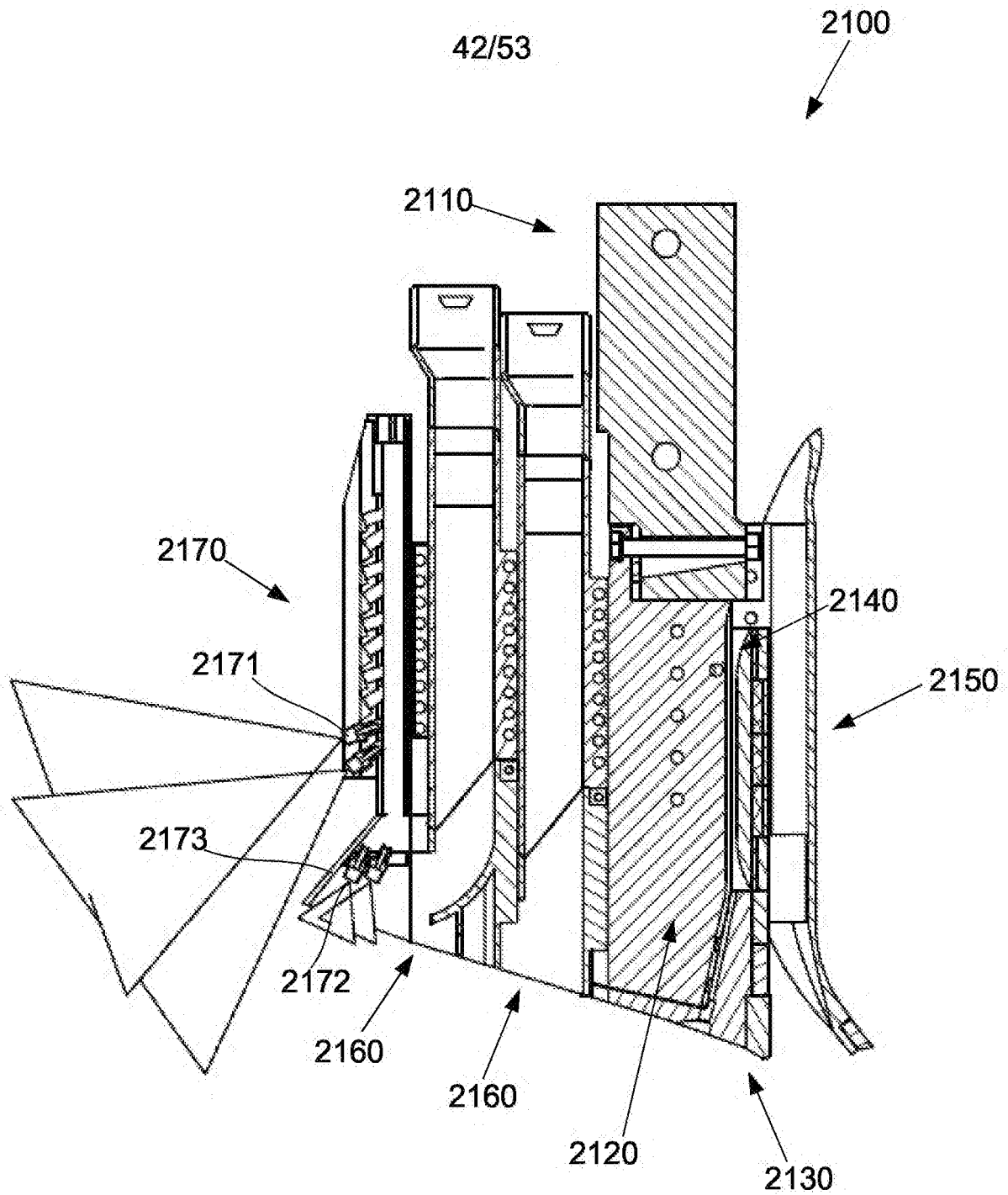
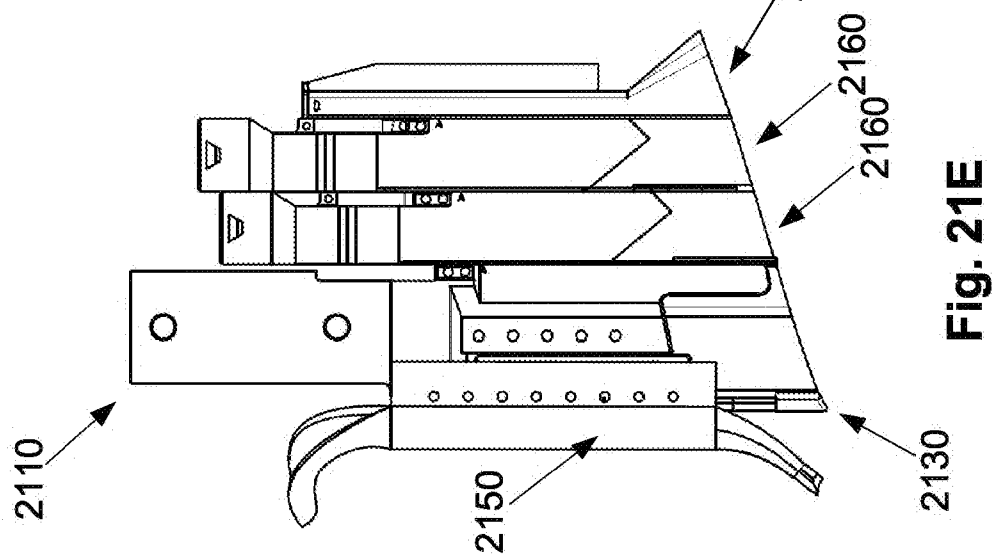
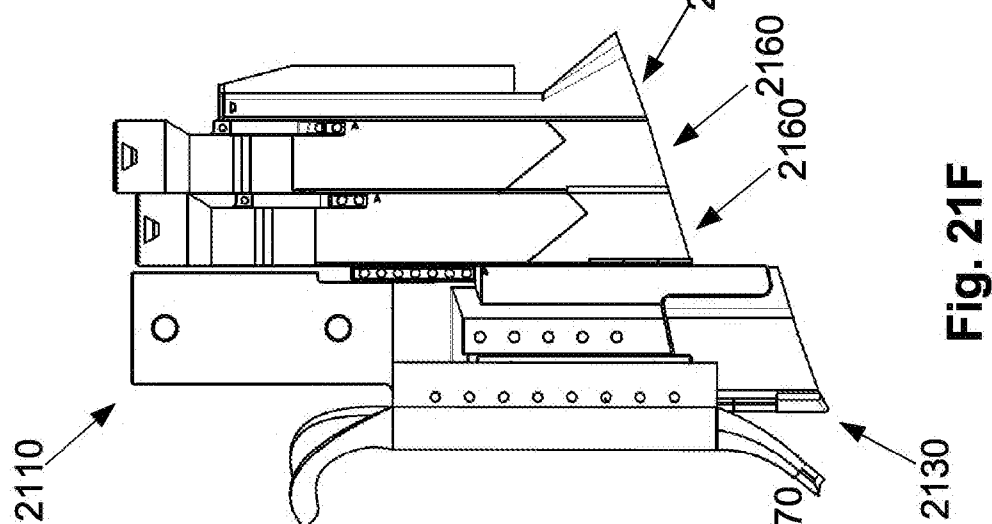
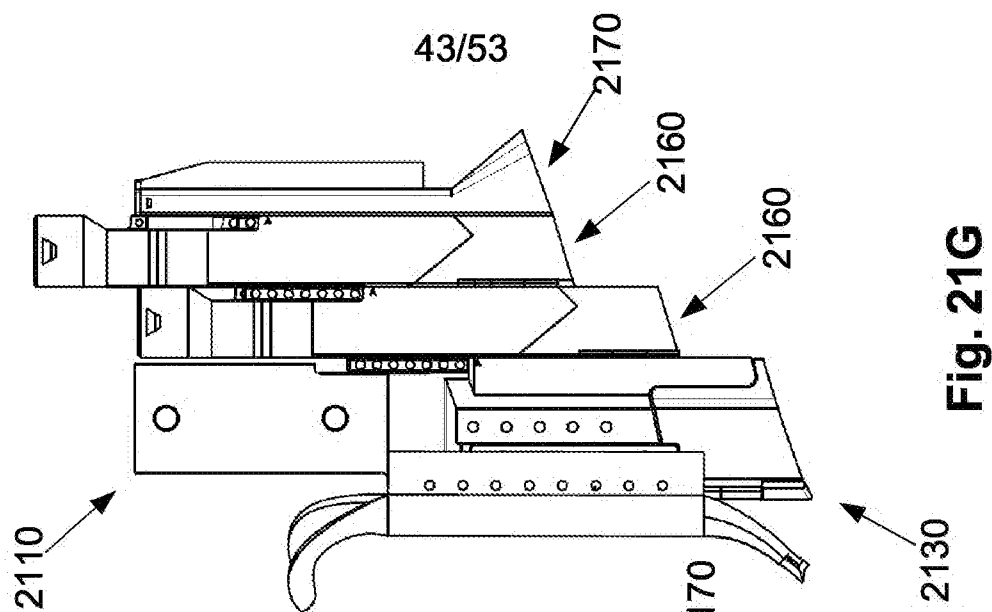
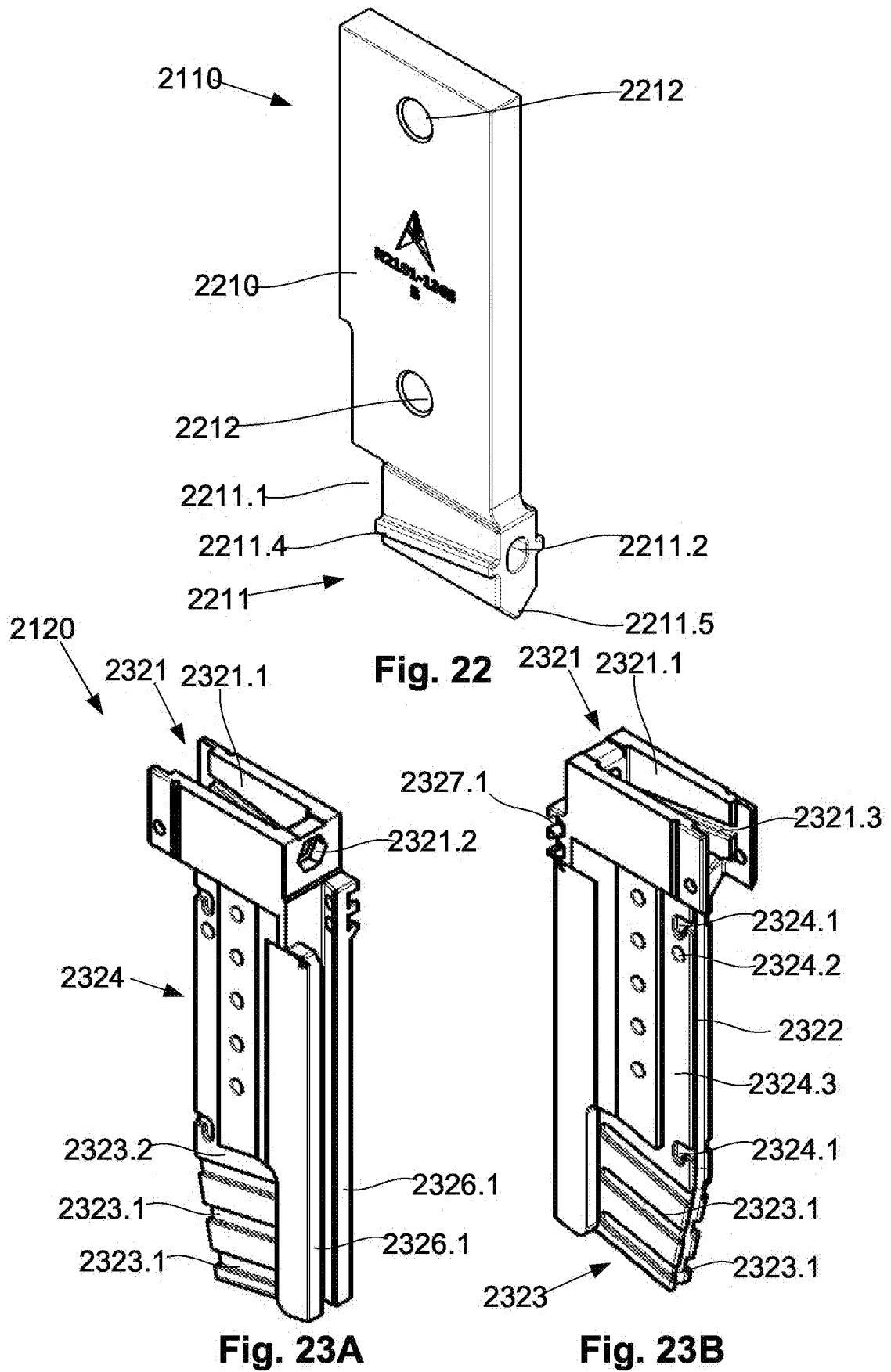


Fig. 21D



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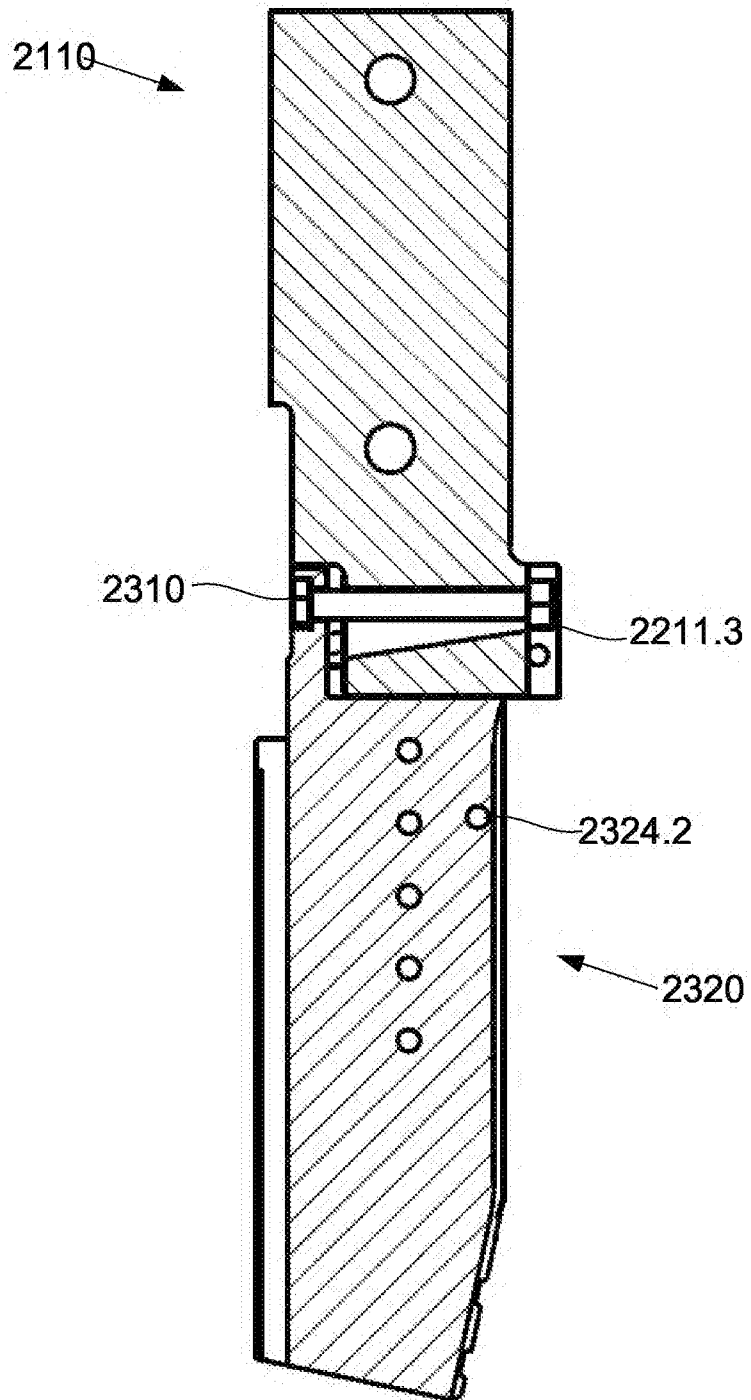


Fig. 23C

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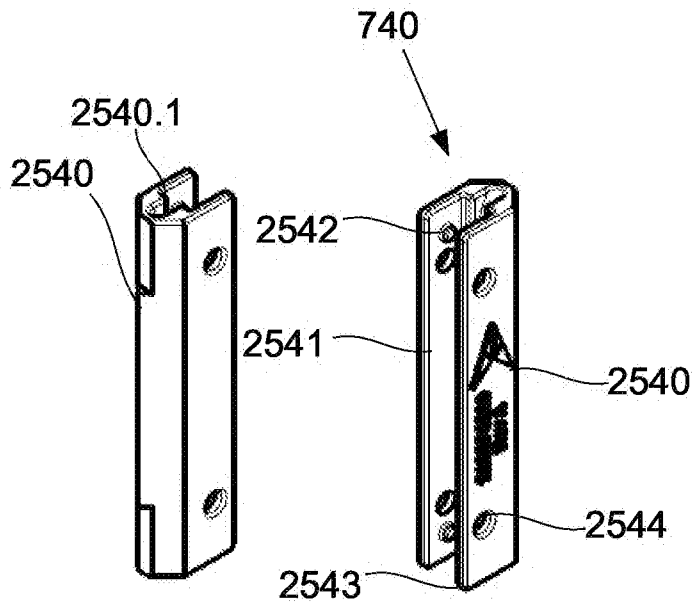


Fig. 25A

Fig. 25B

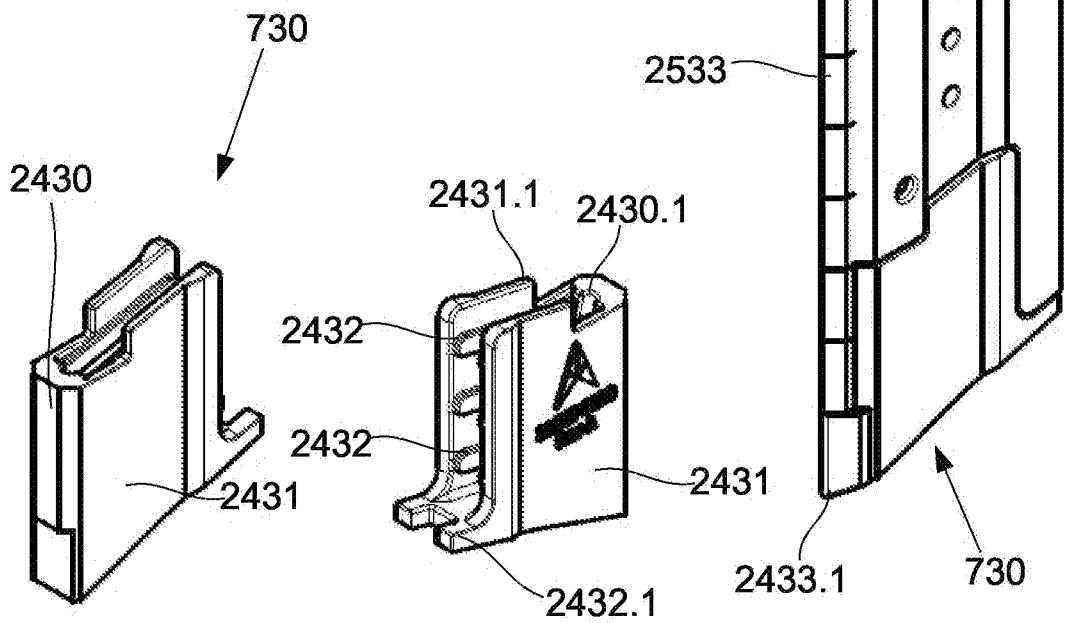


Fig. 24A

Fig. 24B

Fig. 25C

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Fig. 26A

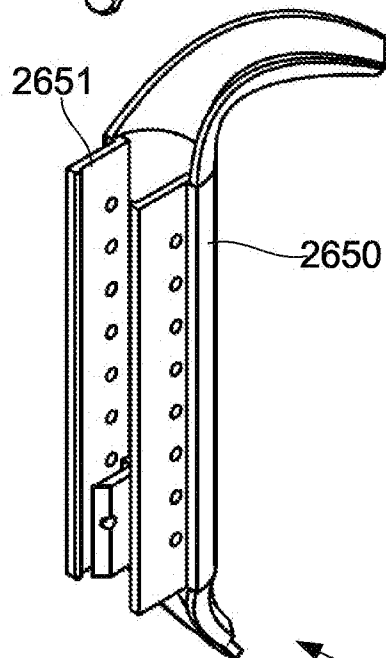
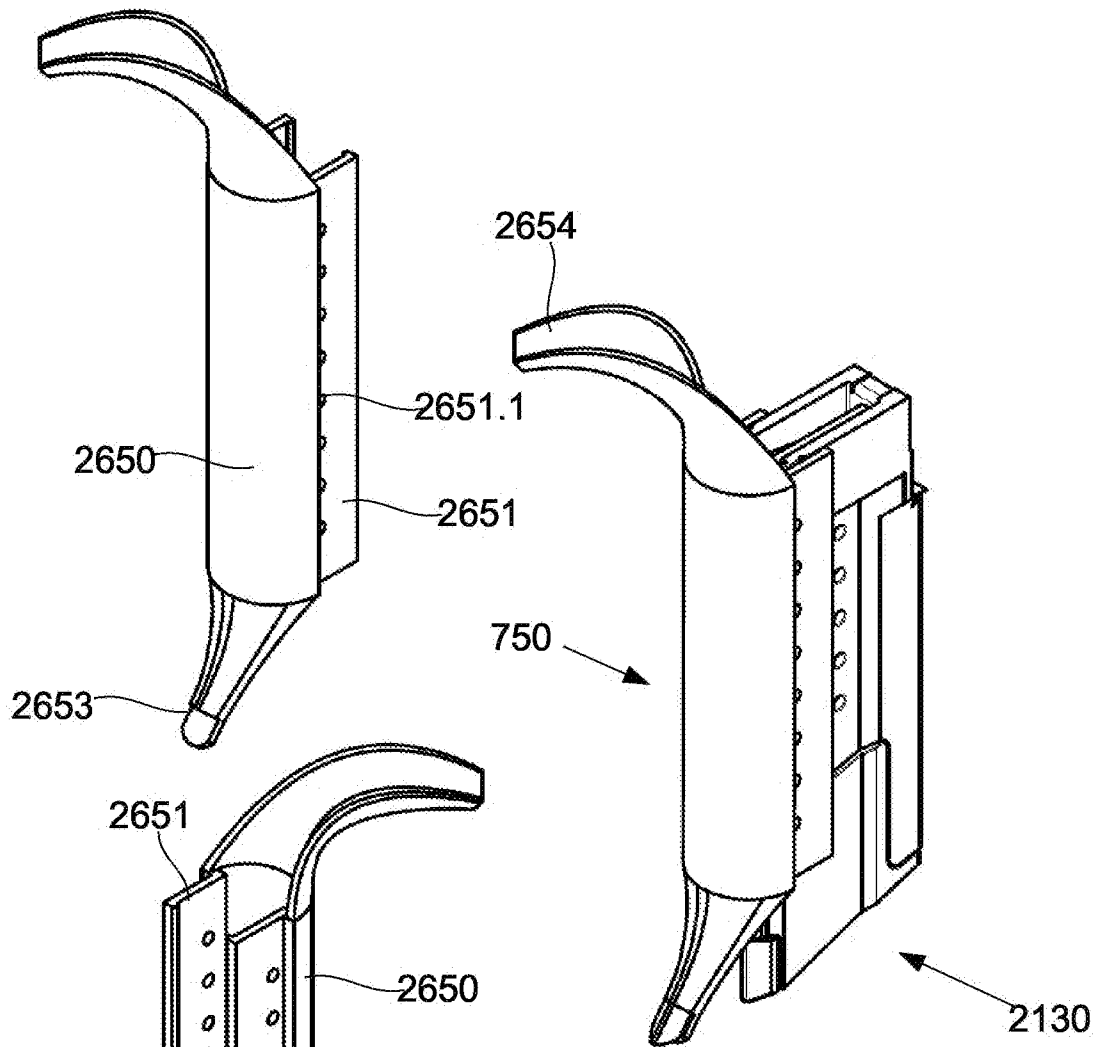
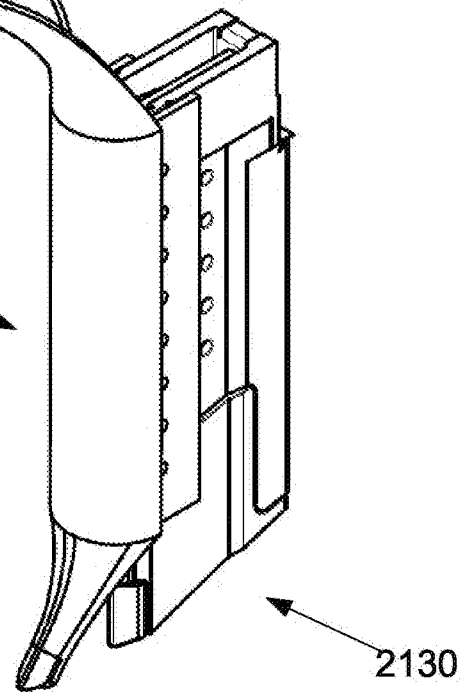


Fig. 26B

Fig. 26C



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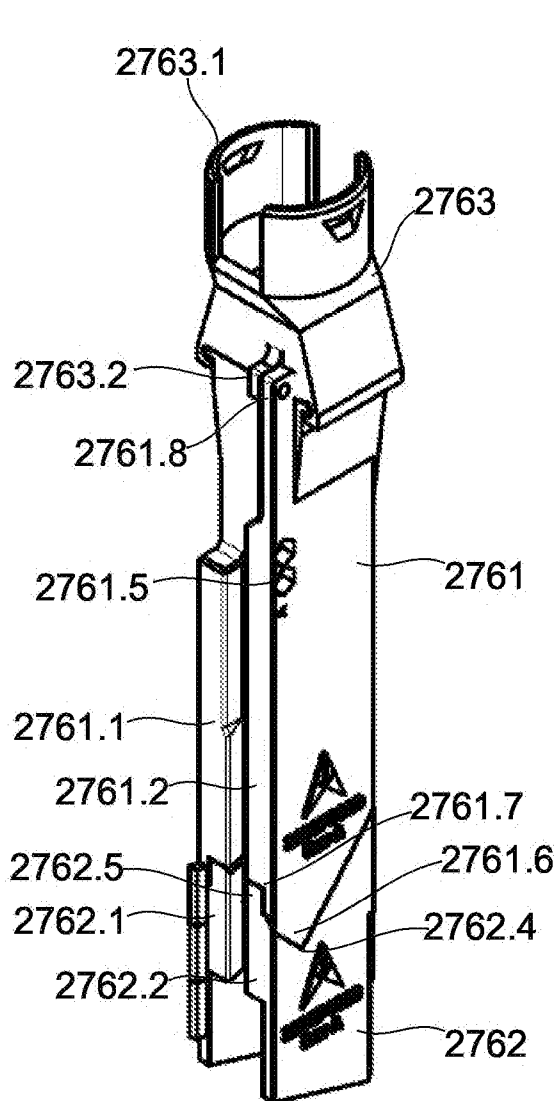


Fig. 27A

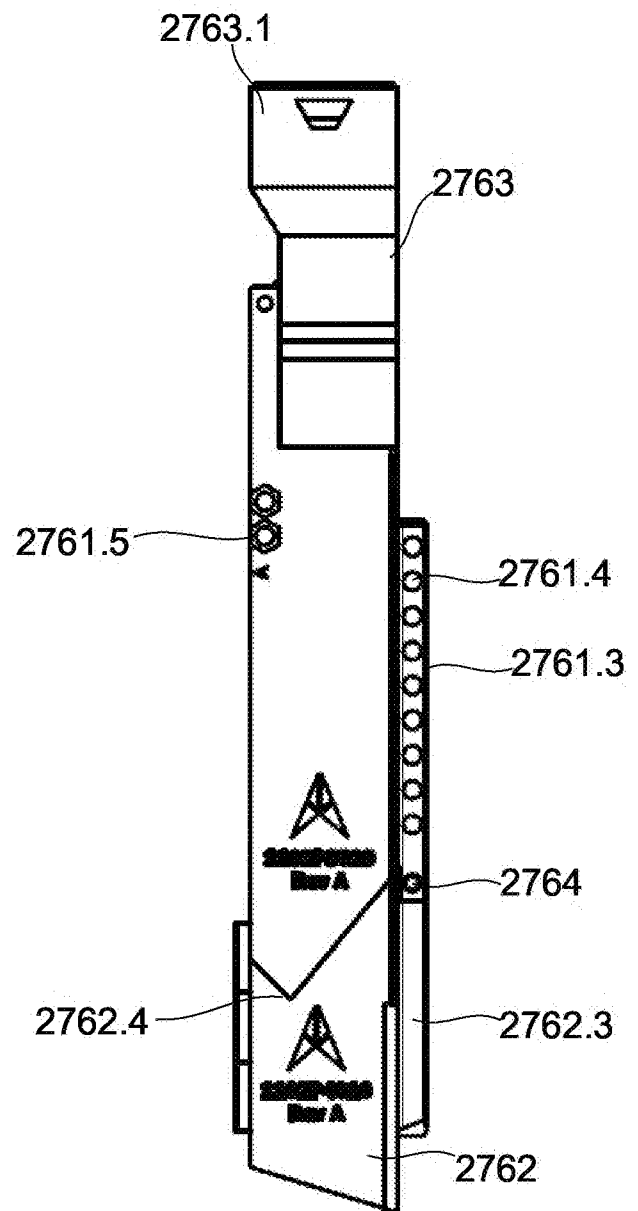
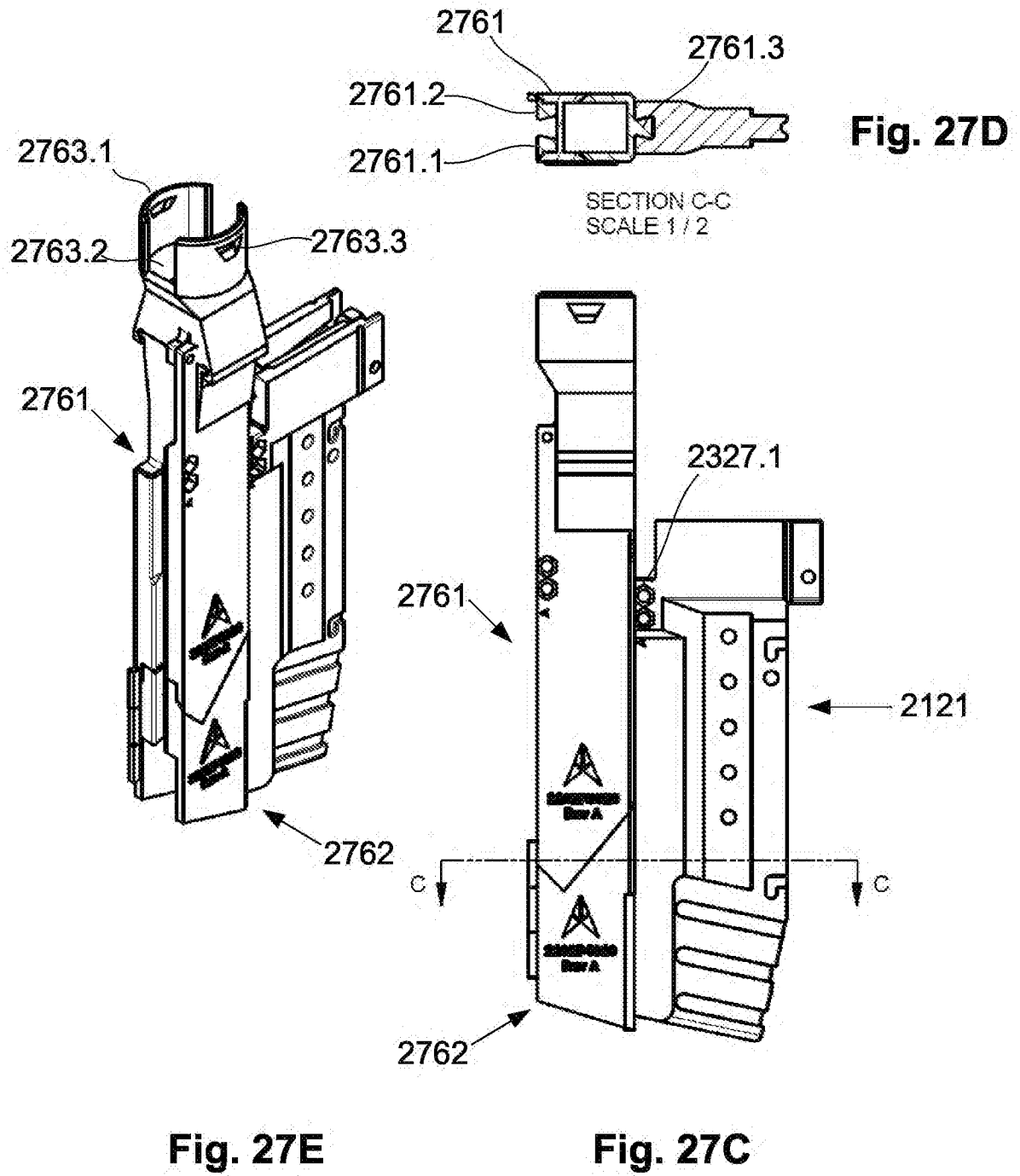


Fig. 27B

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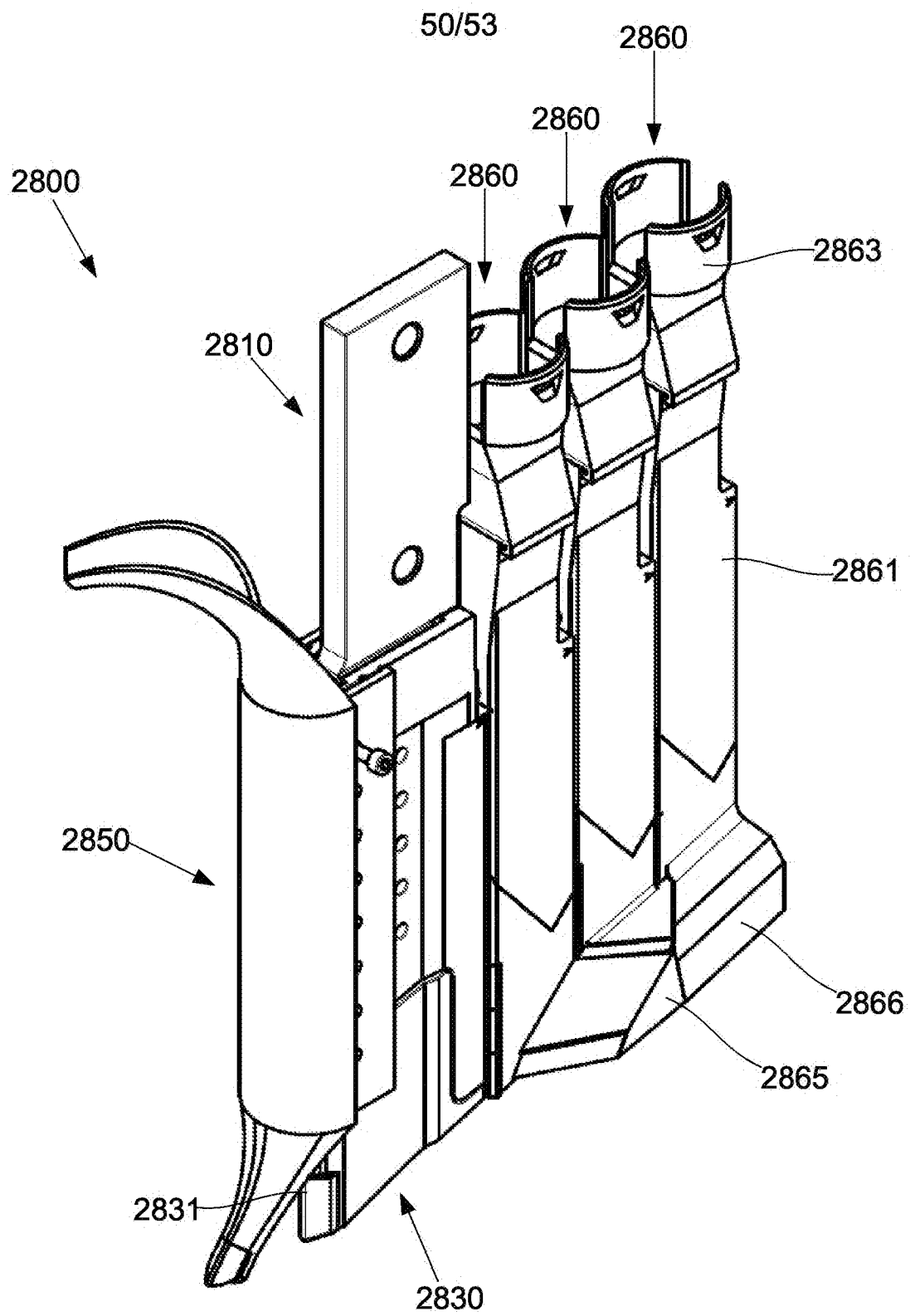


Fig. 28A

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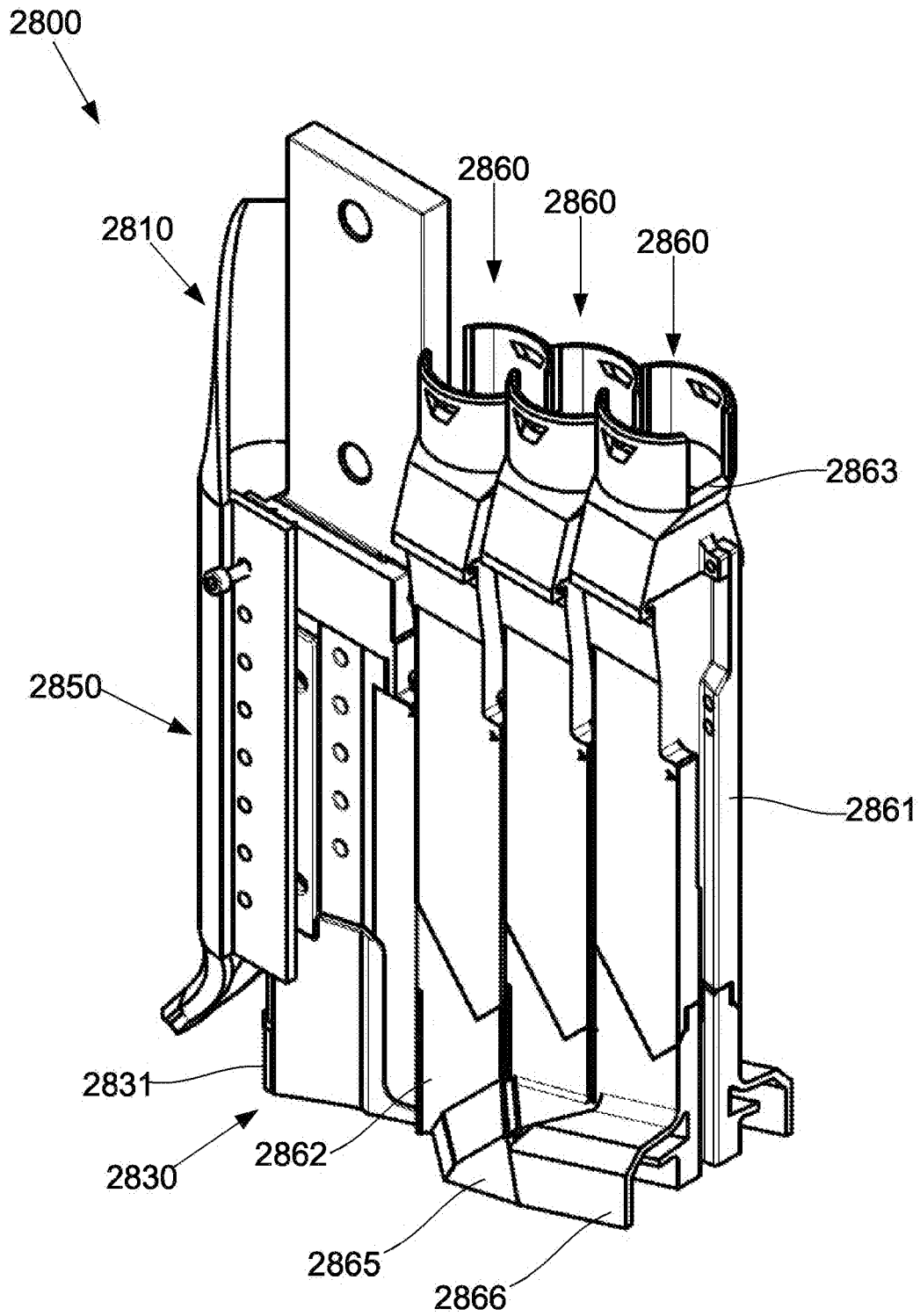


Fig. 28B

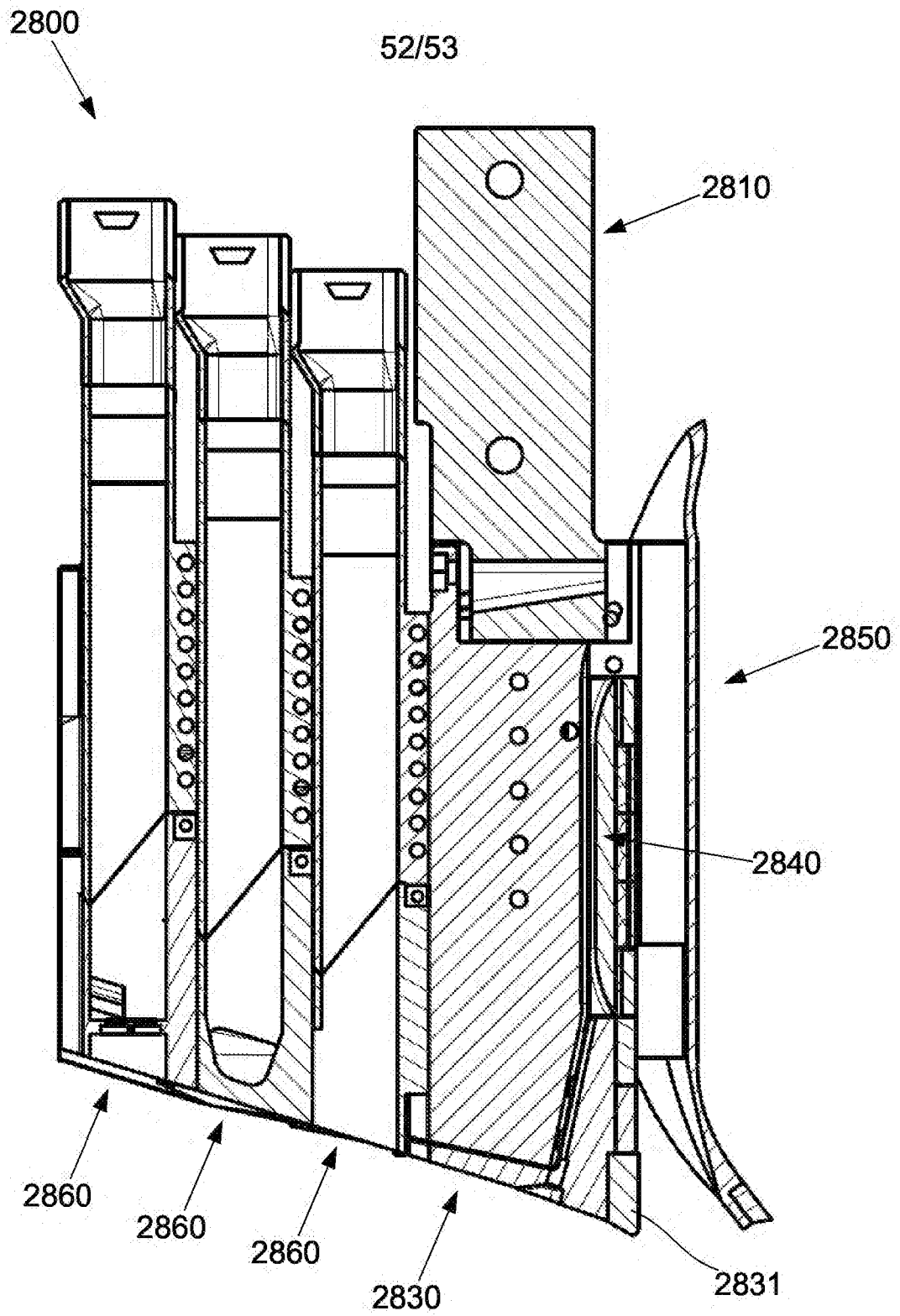


Fig. 28C

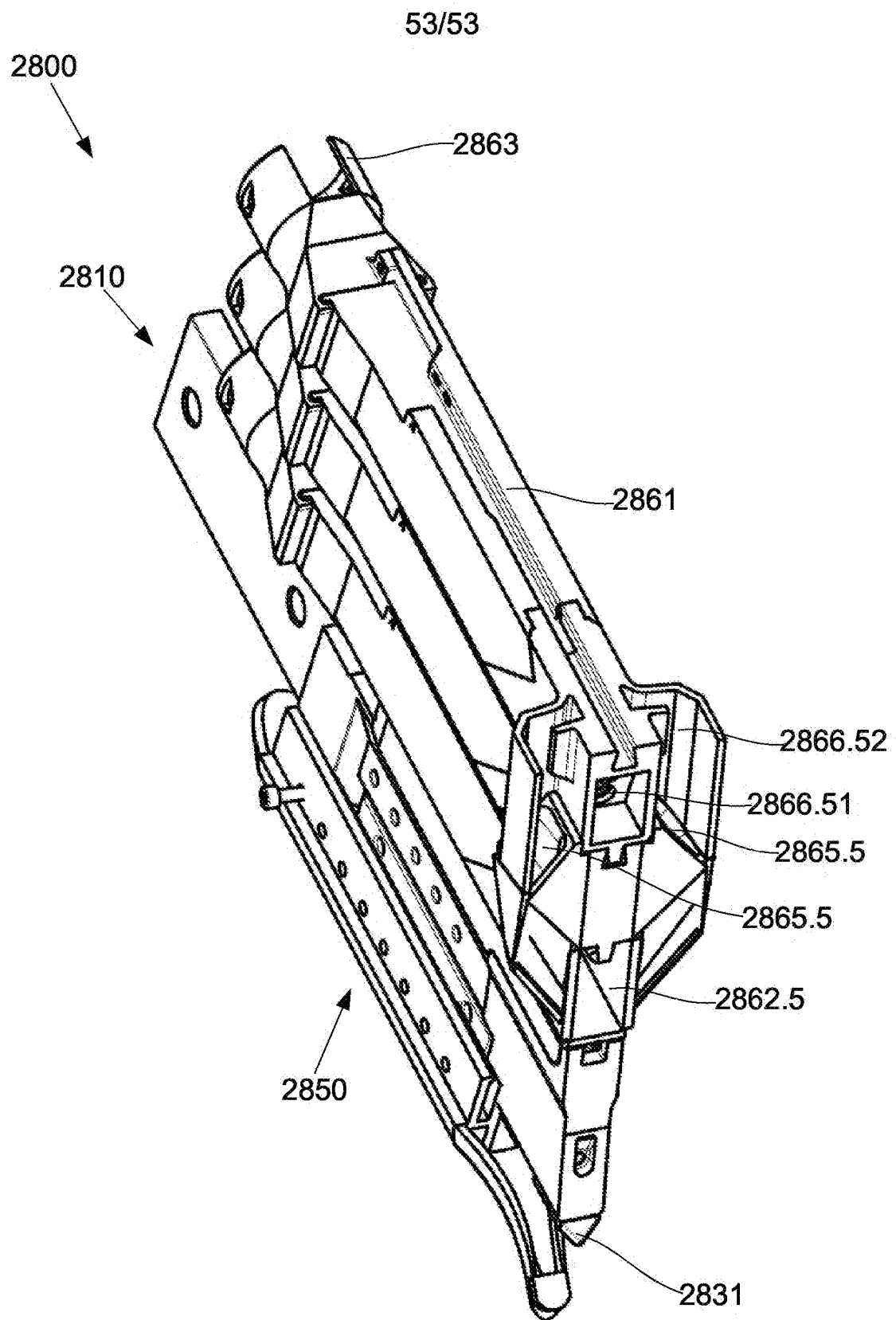


Fig. 28D

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2017/050033

A. CLASSIFICATION OF SUBJECT MATTER

A01C 7/06 (2006.01) A01C 5/06 (2006.01) A01C 23/02 (2006.01)

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)

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

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

Databases: EPODOC & WPIAP – IPC/CPC Symbols: A01C5/06, A01C23/02, A01C7/06, A01B49/06, A01C21/002, A01C7/203, A01B63/008, A01C5/062; Keywords: vary, change, adjust, height, depth, multiple, several, outlet, dispenser, delivery, fertiliser, material, seed, nitrate, slide, linear and like terms

Google Patents – Keywords: fertiliser, material, nitrate, plough, tine, knife, deliver, distribute, adjust, vary, alter, depth, height, slide, translate and like terms

Cited and citing documents of most relevant documents viewed

Applicant name/Inventor name search conducted in Espacenet, AusPat and internal databases provided by IP Australia

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	



Further documents are listed in the continuation of Box C



See patent family annex

* "A"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance	"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
"E"	earlier application or patent but published on or after the international filing date	"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
"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)	"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
"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search
2 May 2017

Date of mailing of the international search report
02 May 2017

Name and mailing address of the ISA/AU

AUSTRALIAN PATENT OFFICE
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Authorised officer

Andrew Spain
AUSTRALIAN PATENT OFFICE
(ISO 9001 Quality Certified Service)
Telephone No. 0262832923

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/AU2017/050033
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2013/033784 A1 (BLAST R & D PTY LTD) 14 March 2013 Figures 1A-2D & 7A-7E, Paragraphs [0103], [0111], [0120]-[0123], [0128], [0130]-[0131], [0142], [0146], [0149], [0153]	1-52
X	US 7866270 B2 (ANKENMAN) 11 January 2011 Figures 2-7, Column 4	1-4, 6-29, 39-52
X	US 4388878 A (DEMZIN) 21 June 1983 Figures 1-2, Column 2	1-4, 6-25, 39-52
X	US 6178900 B1 (DIETRICH, SR.) 30 January 2001 Figures 1-3 & 10, Column 7	1-4, 6-8, 10-25, 39-44, 50-52
X	US 2015/0075826 A1 (AUSPLOW PTY. LTD.) 19 March 2015 Figures 35-37, 42 & 48-50, Paragraph [0155]	1-4, 6-8, 10-25, 39-44, 50-52
A	WO 2014/117210 A1 (PFITZNER) 07 August 2014 The whole document	
A	AU 2009100123 A4 (AUSINCO PTY LTD) 19 March 2009 The whole document	
A	US 4711187 A (SCHULTZ) 08 December 1987 The whole document	

Form PCT/ISA/210 (fifth sheet) (July 2009)

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:
the subject matter listed in Rule 39 on which, under Article 17(2)(a)(i), an international search is not required to be carried out, including
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 Supplemental Box for Details

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-52

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.

Supplemental Box**Continuation of: Box III**

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

This Authority has found that there are different inventions based on the following features that separate the claims into distinct groups:

Claims 1-52 are directed to, inter alia, an apparatus for delivering material to below ground level, the apparatus including: a tine shank including a tine shank body; a heel including a heel body mounted to the tine shank in use; a point mounted to a leading edge of the heel in use; a tip mounted to a leading edge of the point; and, a material delivery member adjustably mounted to a trailing edge of the heel, the material delivery member including a material delivery member body defining a delivery path extending from a material inlet to a material outlet configured to supply material received via the delivery path to below ground level in use, the material delivery member being adjustable so as to allow a depth of material delivery relative to the heel to be adjusted.

The features of a point mounted to a leading edge of the heel, a tip mounted to a leading edge of the point and the material delivery member being adjustably mounted to a trailing edge of the heel are specific to this group of claims.

There are also further, significant features that are also specific to the group defined by **claims 1-52**. Examples of these are:

- The plurality of delivery members defined in **claim 5**
- The multiple material delivery members mounted in sequence rearwardly of the heel defined in **claim 9**
- The specific features of the stubble guard defined in **claims 34-37**

Claim 53-80 are directed to, inter alia, an apparatus for delivering material to below ground level, the apparatus including: a tine shank including a tine shank body defining a tine shank cavity that extends along a length of the tine shank; a heel mounted to the tine shank in use, the heel including a heel body having spaced apart side walls defining a heel cavity that extends at least partially along a length of the heel and a heel opening extending along a trailing edge of the heel body; a boot mounted to the tine shank and heel in use; a tip coupled to the boot; at least one delivery path extending through at least part of the tine shank cavity and at least part of the heel cavity; and, at least one material outlet member providing a material outlet configured to supply material received via the delivery path to below ground level in use, the at least one material outlet member being adjustably mounted within the heel opening to allow a depth of material delivery relative to the heel to be adjusted.

The features of a boot mounted to the tine shank and heel in use and a tip coupled to the boot are specific to this group of claims.

There are also further, significant features that are also specific to the group defined by **claims 53-80**. Examples of these are:

- The apparatus including a plurality of members positioned within the heel opening as defined in **claim 54**
- The root cutter as defined in **claims 60-63 and 65**
- The specific details of the boot (including the boot connectors) as defined in **claims 64-73 and 78**

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

When there is no special technical feature common to all the claimed inventions there is no unity of invention.

In the above groups of claims, the identified features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. The only feature common to all of the claimed inventions and which provides a technical relationship among them is an apparatus for delivering material below ground level including a tine shank having a tine body, a heel mounted to the tine, a tip and a material outlet, the material outlet being adjustable to allow a depth of delivery relative to the heel to be adjusted. However this feature does not make a contribution over the prior art because it is disclosed in:

US 7866270 B2 (Ankenman) 11 January 2011

Form PCT/ISA/210 (Supplemental Box) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2017/050033**Supplemental Box**

Therefore in the light of this document this common feature cannot be a special technical feature. Therefore there is no special technical feature common to all the claimed inventions and the requirements for unity of invention are consequently not satisfied *a posteriori*.

Because no additional search fees were paid, the International Search Report and the Written Opinion of the International Searching Authority was restricted to the invention claimed in **claims 1-52**.

INTERNATIONAL SEARCH REPORT Information on patent family members		International application No. PCT/AU2017/050033	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
Patent Document/s Cited in Search Report		Patent Family Member/s	
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End of Annex			
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001. Form PCT/ISA/210 (Family Annex)(July 2009)			