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(71) Applicant: **NO SCREW LTD.** [IL/IL]; 34 Hahofer Street, P.O.B. 1978, 5885807 Holon (IL).

(72) Inventor: **HARIF, Gershon**; 21 Tarpab Street, 5250396 Ramat Gan (IL).

(74) Agent: **ROZHENKO, Joseph**; Reinhold Cohn and Partners, P.O. Box 13239, 6113102 Tel Aviv (IL).

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(54) Title: MOUNTING MECHANISM FOR A CUTTING INSERT, A CUTTING INSERT THEREFOR AND A CUTTING TOOL USING SAID INSERT

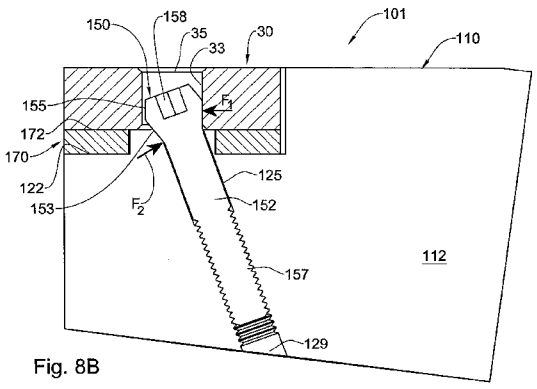

Fig. 8B

(57) Abstract: A cutting tool holder adapted for mounting thereon a cutting insert having a top face, a bottom face and an insert bore extending between the top face and the bottom face, and having an inner surface. The holder comprises a seat defined by a base surface and at least one side wall angled to the base surface, a seat bore extending along a bore axis, and having an open end at the base surface. The holder also comprises a securing arrangement having a securing member extending between a proximal end and a distal end, the securing member having a head portion at the proximal end and having its distal end received within the seat bore. The securing arrangement also has a displacement arrangement adapted to displace the securing member along the bore axis of the seat bore between a mounting position in which the head portion protrudes from within the seat bore through the base surface into the seat to a first extent, defining a first gap distance between the head portion and the at least one side wall allowing the cutting insert to be placed within the seat and/or being fully removed from the seat, and a securing position in which the head portion protrudes from within the seat bore through the base surface into the seat to a second extent, smaller than the first extent, defining a second gap distance between the head portion and the at least one side wall smaller than the first gap distance, so as to engage the inner surface of the insert bore, thereby securing

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the insert between the head portion and the at least one side wall. The insert seat is further formed with a support surface configured for engaging and providing support to the head portion of the securing member at least in the securing position.

MOUNTING MECHANISM FOR A CUTTING INSERT, A CUTTING INSERT THEREFOR AND A CUTTING TOOL USING SAID INSERT

TECHNOLOGICAL FIELD

The subject matter of the present application is in the field of cutting tools, in particular, in the field of mounting and securing mechanisms of cutting inserts onto cutting tool holders.

BACKGROUND

A cutting tool is generally formed with at least one cutting edge, and is adapted for the removal of material from a workpiece by bringing the cutting edge into contact with the workpiece and displacing the cutting edge with respect to the workpiece either by displacing the cutting tool with respect to the workpiece or vise versa.

The cutting edges of cutting tools wear rapidly when used for cutting operations, particularly when cutting hard materials such as metal, and therefore they must be frequently replaced or re-sharpened. In many types of cutting tools, such as tools adapted for milling/drilling/turning machines, the cutting tool may comprise a plurality of cutting inserts, each being formed with at least one cutting edge, the inserts being fixed within seats of a cutting tool holder to form the cutting tool.

In a conventional cutting tool, the cutting insert is attached within the seat of the cutting tool by a fastener passing through a bore in the cutting insert into the bottom of the seat of the cutting tool. Indexing (or completely replacing) the cutting insert to enable the use of another cutting edge (or another insert altogether) requires the removal of the fastener, the reorientation or removal of the cutting insert, and the reattachment of the cutting insert within the seat of the cutting tool by the fastener. Each of these operations involves time and labor, and since cutting tools generally include a plurality of such cutting inserts, the time and labor costs involved in indexing the cutting inserts in a cutting tool are considerable.

In order to overcome technical problems, among which is the one presented above, alternative methods of mounting the cutting inserts onto the cutting tool holder have been devised as disclosed in WO2008/149371 to the applicant.

Other methods of fastening cutting inserts onto cutting tool holders include the use of clamps and lever mechanisms which are usually in the form of a mechanic assembly comprising at least one moving part configured for displacing so as to come into contact with a designated surface of the cutting insert and applying pressure thereto for the purpose of securing it. Examples of such arrangement are disclosed in US3027623A, US3138846A and others.

Additional examples include EP0037554, US 3,341,919, US 3,805,351, US 3,913,197, US 3,946,473 and US 5,199,828, disclosing arrangements in which the fastening screw remains engaged with the tool holder during mounting/dismounting of the cutting insert.

Acknowledgement of the above references herein is not to be inferred as meaning that these are in any way relevant to the patentability of the presently disclosed subject matter.

GENERAL DESCRIPTION

According to one aspect of the subject matter of the present application there is provided a cutting tool holder adapted for mounting thereon a cutting insert having a top face, a bottom face and an insert bore extending between said top face and said bottom face, and having an inner surface; said holder comprising a seat defined by a base surface and at least one side wall angled to said base surface, a seat bore extending along a bore axis, and having an open end at said base surface; a securing arrangement comprising a securing member extending between a proximal end and a distal end, the securing member having a head portion at said proximal end and having its distal end received within said seat bore, and a displacement arrangement adapted to displace the securing member along the bore axis of said seat bore between a mounting position in which said head portion protrudes from within the seat bore through said base surface into said seat to a first extent, defining a first gap distance between said head portion and said at least one side wall allowing said cutting insert to be placed within the seat and/or being fully removed from the seat, and a securing position in which said head portion protrudes from within the seat bore through said base surface into said seat to a

second extent, smaller than said first extent, defining a second gap distance between said head portion and said at least one side wall smaller than said first gap distance, so as to engage the inner surface of said insert bore, thereby securing said insert between the head portion and the at least one side wall, and wherein said insert seat is further formed with a support surface configured for engaging and providing support to the head portion of said securing member at least in said securing position.

According to different example, the support surface can be constituted by:

- a portion of the base surface itself, adjacent the open end of said seat bore;
- a surface extending from the base surface into the seat bore, forming a part of an inner surface thereof, and oriented at an angle to said base surface; and
- a surface of a support structure extending from the base surface into said seat.

In accordance with the above example, said support surface can be at least one of the following, respectively:

- disposed above said base surface;
- disposed at said base surface; and
- disposed below said base surface.

It should be noted that the seat can comprise more that one support surface according to the above examples, and/or one extensive support surface having a first portion extending below the base surface and a second portion extending above the base surface.

Under the above arrangement, the head portion of the securing member is supported in at least two different locations – the inner surface of the insert bore of the cutting insert and the support surface. According to a particular design, the inner surface of the insert bore and the support surface can be counter opposed, so that the head portion constitutes a wedge interposed therebetween.

Specifically, in a cross section of the cutting tool taken along a plane of the bore axis at least in the securing position, the arrangement of elements is as follows: the at least one side wall of the seat, a portion of the cutting insert firmly pressed against the side wall by the head portion, the head portion of the securing member, the support surface firmly pressed against the head portion, and the opposite portion of the cutting insert (that portion of the insert farthest from the side wall).

In accordance with the third example above, the support structure can extend into the insert bore. In that case, there would extend a slight gap between the support structure and the inner surface of the insert bore at the opposite portion of the cutting insert.

The presence of the support surface provides back support for the head portion of the fastening member on a side opposite that of the portion of the cutting insert closer to the side wall. One of the benefits of such a support surface is in preventing bending and deformation of the securing member when inserted into the seat bore.

Specifically, when the securing member is moved deeper into the seat bore, the head portion applies pressure to the portion of the cutting insert adjacent the side wall. When that portion of the cutting insert is pressed against the side wall, further attempt to insert the securing member deeper into the seat bore can result in bending and deformation of the head portion with respect to the axis of the securing member, in a direction away from the side wall. This, in turn, causes an irreversible damage to the securing member as well as weakening the fastening strength on the cutting insert.

The bore axis can be angled to the at least one side wall at a positive angle so that the open end of the seat bore is the farthest portion of the seat bore from the side wall, so that when the securing member is gradually removed from the seat bore (but not all the way), the head portion moves away from the side wall of the seat.

The head portion of the securing member can comprise a conical surface. Specifically, the conical surface can have a tapering angle which is such that at least a segment thereof is parallel to the at least one side wall, in a cross section along a longitudinal axis of the fastening member.

According to a specific example, the head portion can comprise a first conical portion with an outwardly diverging tapering angle and a second conical portion with an inwardly converging conical portion, the first conical portion being configured for coming into contact with the inner surface of the cutting insert and with the support surface, and the second conical portion being configured for allowing removal of the cutting insert without obstructing it.

It is appreciated that the shape of the head portion is designed in a manner complimentary with the insert bore, so that it does not obstruct the cutting insert when attempting to pull it over the head portion.

The tapering angle of the second conical portion can be half the angle between the base surface and the side wall. In addition, at least a segment of said second conical portion can be parallel to the inner surface of the cutting insert, in a cross section along a longitudinal axis of the fastening member. Furthermore, the tapering angles can be such that at least a segment of said second conical portion is parallel to a segment of the first conical portion, in a cross section along a longitudinal axis of the fastening member.

In operation, in transition between the mounting position and the securing position, the conical portion can perform lateral displacement of towards the at least one side wall, due to the angled axis of the bore, and vise versa.

According to a particular example, the screw can have an inscribing cylinder which is not greater in diameter than the insert bore. As a result, in the mounting position of the securing member, a cutting insert can be placed into the seat by slipping its insert bore over the head portion.

The securing member can be a fastening screw, and the head portion can comprise a port for a designated tool such as a screw-driver to be received therein. Alternatively, or in addition, the distal end of the securing member can comprise a secondary port allowing an operator to access the securing member therefrom.

The fastening screw can comprise a shank portion and a threaded portion, and said seat bore can have corresponding non-threaded and threaded portions respectively, configured for properly accommodating the screw.

According to one example, said non-threaded portion can be of a larger diameter than said shank portion. Alternatively, according to another example, said non-threaded portion can be of a diameter corresponding to the diameter of the shank portion.

The side wall can comprise a support portion and a cut-out portion disposed between the base surface and the support portion, wherein said support portion is configured for engaging an external surface of the cutting insert and said cut-out is configured for remaining out of contact with the external surface.

Under this arrangement, pressing the cutting insert towards the at least one side wall entails application of pressure on the top portion of the external surface, due to its contact with the support portion, while a bottom portion of the external surface is free of contact. Thus, there is applied a combined force of the cutting insert by which the

portion of the cutting insert remote from the side wall is pressed down onto the base surface, thereby preventing lifting of the cutting insert during a cutting operation.

According to one example, the seat can comprise a first and a second side wall, angled to one another to form a corner, and the seat bore can be angled to the base surface and towards said corner.

According to a specific design embodiment, the fastening screw is not threadingly engaged with the seat bore, but rather said cutting tool holder further comprises a thread element received within a channel intersecting said seat bore, and comprises an inner thread configured for engaging the clamping screw.

The thread element can be configured for performing at least one of the following:

- revolving about an axis of the channel; and
- axially displacing along the channel.

According to another aspect of the subject matter of the present application, there is provided a method for mounting a cutting insert onto a seat of a cutting tool holder according to the previous aspect in order to form a cutting tool, said method including the steps of:

a) displacing the fastening member into the mounting position, while a distal end thereof is still received within the seat bore;
b) placing the cutting insert onto the seat, slipping the insert bore over the head portion of the fastening member; and
c) displacing the fastening member into the securing position.

The insert bore of the cutting insert configured for being mounted onto the cutting tool holder can comprise a first inner surface configured for coming in contact with the securing member of the cutting tool holder, and a second inner surface configured for providing sufficient space for mounting/removing the cutting insert from the cutting tool holder.

According to a particular example, the first inner surface can be conical and tapering at an angle complimentary to that of the securing member, and the second inner surface can be cylindrical. The first and second inner surfaces can merge at the base of the cone, so that the diameter of the cylindrical portion is equivalent to the diameter of the base of the conical portion.

The cutting insert can be reversible.

In accordance with one example, the inner surface of the insert bore of the cutting insert can comprise a plurality of first contact surfaces associated with the top face of the cutting insert and a plurality of second contact surfaces associates with the bottom face of the cutting insert. The first and second contact surfaces are configured for coming into contact with the head portion of the securing member. The first contact surfaces and the second contact surfaces can be arranged alternately along the inner surface of the insert bore.

In addition, the cutting insert can comprise a plurality of first passage cut-outs associated with the bottom face of the cutting insert and a plurality of second passage cut-outs associates with the top face of the cutting insert, and configured for allowing the shank of the securing member to pass into the seat bore.

According to another design embodiment, the inner surface of the insert bore can comprise a plurality of projection, each having a contact surface configured for coming into contact with the head portion of the securing member. This cutting insert can be configured for mounting onto a support structure projecting into the seat and configured for being received within the insert bore.

The arrangement is such that the support structure has a an inscribing circle of a diameter corresponding to that of the insert bore, while the projections have an inscribing circle which is of smaller diameter.

Under the above arrangement, on the one hand, attempting to mount a cutting insert with a regular cylindrical bore of a diameter corresponding to that of the support structure, without projections, will prevent the head portion of the securing member from properly coming in contact with the inner surface of the cutting insert, thereby preventing proper securing thereof. On the other hand, attempting to mount a cutting insert with a regular cylindrical bore of a diameter corresponding to that of the smaller inscribing circle of the projections will prevent the support structure from being properly received therein, thereby, again, preventing proper securing of the cutting insert within the seat. Therefore, only the above described type of insert (or similar) can be used with such a cutting tool holder.

According to yet another example, the side wall of the seat can be angled to the base surface at an acute angle, and the head portion can have a first and second tapering portions, thereby yielding a 'dove-tail' securing of the cutting insert. In particular, the distance between the base of the conical portion and a first point on the side wall is

smaller than the distance between any other point on the cone and a second point on the side wall, closer to the base surface.

According to yet another aspect of the subject matter of the present application, there is provided a cutting tool comprising a cutting tool holder and a cutting insert according to the previous aspects of the present application.

According to yet another aspect of the subject matter of the present application there is provided a cutting tool holder adapted for mounting thereon a cutting insert having a top face, a bottom face and formed with an insert bore having an inner surface extending between said top and said bottom face; said holder comprising a seat defined by a bottom surface and at least one side wall angled to said bottom surface, a seat bore with a bore axis angled to said at least one side wall and having an open end at the bottom surface of said seat, and a clamping screw for securing said cutting insert in said seat, said screw having a head portion, and is configure for displacing between at least a first, mounting position in which said head protrudes from within the seat bore through said bottom surface into said seat to a first extent, defining a first gap distance between said head portion and said at least one side wall allowing said cutting insert to be placed within the seat, having its bottom face aligned against said bottom surface as well as being fully removed therefrom, and a second, securing position in which said head portion protrudes from within the seat bore through said bottom surface into said seat to a second extent, smaller than said first extent, defining a second gap distance between said head portion and said at least one side wall smaller than said first gap distance, so as to engage the inner surface of said insert bore, thereby securing said insert between the head portion and the at least one side wall, wherein said clamping screw is not threadingly engaged with the seat bore, and wherein said cutting tool holder further comprises a thread element received within a channel intersecting said seat bore, and comprises an inner thread configured for engaging the clamping screw.

According to still another aspect of the subject matter of the present application there is provided a cutting tool holder adapted for mounting thereon a cutting insert having a top face, a bottom face and an insert bore extending between said top face and said bottom face, and having an inner surface; said holder comprising a seat defined by a base surface and at least one side wall angled to said base surface, a seat bore extending along a bore axis, and having an open end at said base surface; a securing arrangement comprising a securing member extending between a proximal end and a

distal end, the securing member having a head portion at said proximal end and having its distal end received within said seat bore, and a displacement arrangement adapted to displace the securing member along the bore axis of said seat bore between a mounting position in which said head portion protrudes from within the seat bore through said base surface into said seat to a first extent, defining a first gap distance between said head portion and said at least one side wall allowing said cutting insert to be placed within the seat and/or being fully removed from the seat, and a securing position in which said head portion protrudes from within the seat bore through said base surface into said seat to a second extent, smaller than said first extent, defining a second gap distance between said head portion and said at least one side wall smaller than said first gap distance, so as to engage the inner surface of said insert bore, thereby securing said insert between the head portion and the at least one side wall, and wherein the seat bore is angled to the base surface said base surface and the head portion of the screw comprises a contact portion which is so angled with respect to the axis of the screw that, at least in said securing position, the contact portion is configured for engaging the base surface of the seat for providing support to the head portion.

BRIEF DESCRIPTION OF THE DRAWINGS

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

Fig. 1 is a schematic exploded isometric view of a turning tool according to the subject matter of the present application;

Fig. 2A is a schematic section view of the turning tool shown in Fig. 1;

Figs. 2B and **2C** are schematic enlarged section and isometric views of the turning tool shown in Fig. 2A, in an open position of a securing mechanism thereof;

Figs. 2D and **2E** are schematic enlarged section and isometric views of the turning tool shown in Fig. 2A, in a closed position of a securing mechanism thereof;

Figs. 3A to **3E** are schematic section views demonstrating consecutive steps of removing a cutting insert from the turning tool holder shown in Figs. 2A to 2C;

Figs. 4A and **4B** are schematic section views of a turning tool according to another example of the subject matter of the present application, shown in respective open and closed positions of the securing mechanism thereof;

Figs. 5A and **5B** are schematic isometric and exploded isometric view of a turning tool according to yet another example of the subject matter of the present application;

Fig. 6A is a schematic section view of the turning tool sown in Figs. 5A and 5B, in an open position of the securing mechanism thereof;

Fig. 6B is a schematic enlarged view of the securing mechanism shown in Fig. 6A;

Fig. 6C is a schematic section view of the turning tool sown in Figs. 5A and 5B, in a closed position of the securing mechanism thereof;

Fig. 6D is a schematic enlarged view of the securing mechanism shown in Fig. 6C;

Figs. 7A and **7B** are schematic section views of a turning tool according to another example of the subject matter of the present application, shown in respective open and closed positions of the securing mechanism thereof;

Figs. 8A and **8B** are schematic section views of a turning tool according to another example of the subject matter of the present application, shown in respective open and closed positions of the securing mechanism thereof;

Fig. 8C is a schematic isometric view of the turning tool shown in Fig. 8B;

Figs. 9A and **9B** are schematic section views of a turning tool according to another example of the subject matter of the present application, shown in respective open and closed positions of the securing mechanism thereof;

Fig. 9C is a schematic isometric view of a turning tool holder used in the turning tool shown in Figs. 9A and 9B;

Fig. 9D is a schematic isometric view of a turning tool holder shown in Fig. 9C, when fitted with a securing bolt;

Figs. 10A and **10B** are schematic isometric and section views of a reversible cutting insert which can be used in the turning tool shown in Figs. 9A to 9D;

Fig. 11A is a schematic exploded isometric view of a turning tool according to another example of the subject matter of the present application;

Figs. 11B and **11C** are schematic section and isometric views of the turning tool shown in Fig. 11A, in a closed position thereof;

Figs. 11D and **11E** are schematic section and isometric views of the turning tool shown in Fig. 11A, in an open position thereof;

Fig. 12 is a schematic isometric view of a cutting insert used in the turning tool shown in Figs. 11A to 11E;

Fig. 13A is a schematic exploded isometric view of a mold used for the manufacture of the cutting insert shown in Fig. 12;

Figs. 13B and **13C** are schematic isometric views of respective members of the mold shown in Fig. 13A;

Fig. 14A is a schematic isometric view of a milling tool according to another example of the subject matter of the present application;

Fig. 14B is a schematic enlarged isometric view of a seat portion of the milling tool shown in Fig. 14A;

Figs. 15A and **15B** are schematic isometric and section views of the milling tool shown in Figs. 14A and 14B, shown in a closed position of the securing mechanism thereof;

Fig. 15C is a schematic section view of the milling tool shown in Figs. 14A and 14B in an open position thereof;

Fig. 16 is a schematic isometric view of the seat portion shown in Fig. 14B, when fitted with a securing bolt;

Figs. 17A and **17B** are schematic isometric and top views of a cutting insert used in the milling tool shown in Figs. 14A and 14B;

Fig. 18A is a schematic isometric view of a milling tool according to another example of the subject matter of the present application;

Fig. 18B is a schematic enlarged isometric view of a portion of the milling tool shown in Fig. 18A;

Figs. 19A and **19B** are schematic isometric and section views of the milling tool shown in Figs. 18A and 18B, shown in a closed position of the securing mechanism thereof;

Figs. 19C and **19D** are schematic isometric and section views of the milling tool shown in Figs. 18A and 18B, shown in an open position of the securing mechanism thereof;

Figs. 20A and **20B** are schematic isometric and top views of a cutting insert used in the milling tool shown in Figs. 18A and 18B;

Fig. 21 is a schematic isometric view of a mold member used for the manufacture of the cutting insert shown in Figs. 20A and 20B;

Fig. 22 is a schematic isometric view of a milling tool according to another example of the subject matter of the present application;

Figs. 23A and **23B** are schematic isometric and section views of the milling tool shown in Fig. 22, shown in a closed position of the securing mechanism thereof;

Fig. 24 is a schematic isometric view of a cutting insert used in the milling tool shown in Fig. 22;

Fig. 25 is a schematic isometric view of a mold member used for the manufacture of the cutting insert shown in Fig. 24;

Fig. 26 is a schematic isometric view of a milling tool according to another example of the subject matter of the present application;

Figs. 27A and **27B** are schematic section views of the milling tool shown in Fig. 26, shown in respective closed and open positions of the securing mechanism thereof;

Fig. 28 is a schematic isometric section view of a cutting insert used in the milling tool shown in Fig. 26;

Fig. 29 is a schematic isometric view of a mold member used for the manufacture of the cutting insert shown in Fig. 26;

Figs. 30A and **30B** are schematic cross-section views of a turning tool according to another example of the present application, shown in open and closed positions respectively;

Fig. 30C is a schematic isometric view of the turning tool shown in Figs. 30A and 30B;

Fig. 30D is a schematic cross-section view of the turning tool shown in Figs. 30A to 30C;

Figs. 31A and **31B** are schematic cross-section views of a turning tool according to another example of the present application, shown in open and closed positions respectively;

Fig. 31C is a schematic isometric view of the turning tool shown in Figs. 31A and 31B;

Figs. 32A and **32B** are schematic cross-section views of a turning tool according to another example of the present application, shown in open and closed positions respectively;

Fig. 32C is a schematic cross-section view of the turning tool shown in Figs. 32A and 32B, with a different fastening screw being used therein;

Figs. 33A and **33B** are schematic cross-section views of a turning tool according to another example of the present application, shown in open and closed positions respectively;

Figs. 34A and **34B** are schematic cross-section views of a turning tool according to another example of the present application, shown in open and closed positions respectively;

Fig. 34C is a schematic isometric view of a cutting insert used in the turning tool shown in Figs. 34A and 34B;

Fig. 35A is a schematic isometric view of a turning tool according to another example of the present application, show with a cutting insert thereof being sectioned;

Figs. 35B and **35C** are schematic cross-section views of the turning tool shown in Fig. 35A, illustrated in open and closed positions respectively;

Figs. 36A and **36B** are schematic cross-section views of a turning tool according to another example of the present application, shown in open and closed positions respectively;

Fig. 36C is a schematic isometric cross-section view of the turning tool shown in Figs. 36A and 36B;

Fig. 37A is a schematic isometric view of a turning tool according to another example of the present application, show with a cutting insert thereof being sectioned;

Figs. 37B and **37C** are schematic cross-section views of the turning tool shown in Fig. 37A, illustrated in open and closed positions respectively;

Figs. 38A and **38B** are schematic isometric cross-section views of a turning tool according to another example of the present application, shown in open and closed positions respectively;

Fig. 38C is a schematic isometric view of a fastening screw used in the turning tool shown in Figs. 38A and 38B;

Fig. 39A is a schematic isometric cross-section view of a turning tool according to another example of the present application;

Fig. 39B is a schematic isometric cross-section view of a turning insert used in the turning tool shown in Fig. 39A;

Figs. 40A and **40B** are schematic cross-section views of a turning tool according to another example of the present application, shown in open and closed positions respectively;

Figs. 41A and **41B** are schematic cross-section views of a turning tool according to another example of the present application, shown in open and closed positions respectively;

Figs. 42A and **42B** are schematic cross-section views of a turning tool according to another example of the present application, shown in open and closed positions respectively;

Fig. 43A is a schematic isometric view of a turning tool according to still another example of the present application;

Fig. 43B is a schematic cross-section view of the turning tool shown in Fig. 43A;

Fig. 43C is a schematic isometric view of a restraining mechanism used in the turning tool shown in Figs. 43A and 43B;

Fig. 44A is a schematic isometric view of a milling tool according to another example of the present application;

Fig. 44B is a schematic cross-section view of a portion of the milling tool shown in Fig. 44A;

Fig. 45A is a schematic isometric view of a milling tool according to another example of the present application;

Figs. 45B and **45C** are schematic cross-section views of a portion of the milling tool shown in Fig. 45A, shown in open and closed positions respectively;

Fig. 46A is a schematic isometric view of a drill according to the present application;

Fig. 46B is a schematic enlarged view of a head portion of a holder of the drill shown in Fig. 46A;

Figs. 46C and **46D** are schematic cross-section views of a portion of the drill shown in Figs. 46A and 46B, shown in open and closed positions respectively;

Fig. 47A is a schematic isometric view of a drill according to the present application;

Fig. 47B is a schematic enlarged view of a head portion of a holder of the drill shown in Fig. 47A;

Figs. 47C and **47D** are schematic cross-section views of a portion of the drill shown in Figs. 47A and 47B, shown in open and closed positions respectively; and

Figs. 48A and **48B** are schematic cross-section views of a portion of a drill according to another example of the present application, shown in open and closed positions respectively.

DETAILED DESCRIPTION OF EMBODIMENTS

Attention is first drawn to Fig. 1 in which a turning tool is shown, generally designated as **1** and comprising a holder **10** formed with a seat (also referred herein as 'a pocket'), a cutting insert **30** configured for being placed within the pocket **20** and a securing mechanism in the form of a fastening screw **50** configured for securing the cutting insert **30** within the pocket **20**. The cutting insert **30** is formed with at least two cutting edges **32** defined at the intersection between respective rake and relief surfaces **34**, **36**.

Turning now to Figs. 2A to 2E, respective open and closed positions of the securing mechanism **50**, i.e. positions in which the cutting insert **30** is free and secured to the pocket **10** respectively.

With particular reference being made to Fig. 2A, the seat **20** comprises a bottom base **22** and two side walls **24**a, **24**b (shown Fig. 1) and configured for receiving thereon the cutting insert **30** such that the bottom face **31**B of the cutting insert **30** is flush against the base surface **22**.

The holder **10** comprises a body **12** formed with a seat bore **25** having a threaded portion **27** and a bottom access bore **29**, the seat bore **25** being configured for receiving therein the fastening screw **50**.

The fastening screw **50**, in turn, has a body **52** and a head portion **51** at a proximal end thereof, the head portion **51** being formed with opposite cone-geometry having a first conical portion **53** and a second conical portion **55**, of opposite tapering angles. The arrangement is such that when the fastening screw is received within the seat bore **25**, first conical portion **53** extends parallel to the side wall **24**a of the seat **20**, owing the angle α between the axis of the seat bore **25** and the side wall **24**a.

Specifically, the first conical portion **53** has as tapering angle of **5°** with respect to the central axis of the fastening screw **50**, and the second conical portion **55** has an opposite tapering angle of **5°**.

One of the advantages of such a slight angle of the conical portion is that a reasonably small number of turns of the screw **50** in order to fasten the cutting insert **30**. Specifically, 2-3 revolutions of the screw **50** are sufficient for bringing it into the first, open position.

Furthermore, the small tapering angle of the conical portion **53** allows for the use of a generally small diameter of the screw **50** with respect to the bore **35** of the cutting insert. In the specific example, the insert bore **35** is of a diameter of 6mm while the screw **50** has a diameter of 5mm.

In addition, the above arrangement orients the first conical portion **53** directly along the insert bore **35** of the cutting insert **30**, allowing appropriate contact between the head portion **51** and the insert **30** during the secured position thereof.

With particular reference being made to Figs. 2B and 2C, the fastening screw **50** is shown in a first, open position thereof, in which the screw **50** is received within the seat bore **25** so that the head portion **31** projects into the seat **20** to a first extent H**1,** and is spaced from the side wall a first gap distance L**1.** There also extends a gap **g** between the cutting insert **30** and the wall **24**a, and a slight gap **ε** between the conical portion **53** and the inner surface of the cutting insert **30**.

In the above position, the cutting insert **30** can be placed onto the seat **20** so that the insert bore **35** is passed over the entire head portion **31**, and can also be removed therefrom as will be described with respect to Figs. 3A to 3E.

Once the cutting insert **30** is in position, the fastening screw **50** can be further threaded, reaching the position shown in Figs. 2D and 2E. As will be observed, in this second, closed position, the fastening screw **50** projects into the seat **20** to a first extent H**2** < H**1,** and is spaced from the side wall a first gap distance L**1** < L**2.**

In effect, during the transition from the first position to the second position, the surface of the first conical portion **53** displaces laterally towards the side wall **24**a, thereby fastening the corresponding portion of the cutting insert **10** between the conical portion **53** and the side wall **24**a.

It is observed that during the above transition, the fastening screw **50** also displaces downwards, thereby applying some downward pressure on the cutting insert

30, so that it presses the cutting insert **30** not only towards the side wall **24**a, but also towards the base surface **22**.

It is further observed that the first portion of the seat bore **25** is not threaded and has a slightly larger diameter than that of the shank **52** of the fastening screw **50** (see distance **s**). This arrangement allows for certain elastic deformation of the screw **50** in the closed position despite further threading (i.e. if it is further threaded after the cutting insert **30** is already secured). Furthermore, it is noted that the threaded portion **27** is of limited length, acting as a stop, preventing over-threading of the screw **50** beyond a certain point to subsequently prevent plastic deformation thereof.

Attention is now drawn to Figs. 3A to 3E, demonstrating various stages of releasing the cutting insert **30** from the holder **10** when the screw **50** is in the second, open position.

As noted, when the screw **50** is threaded out (but still engaged with the seat **20** via the bore **25**), the cutting insert **30** can be slipped off the head portion **51** allowing both placement and replacement of the cutting insert **30** while the screw **51** is engaged with the seat **20**.

In particular, it is noted that the second conical portion **55**, tapering at an opposite angle to the first conical portion **53** serves a double purpose in the above operation.

First of all, it allows removing the cutting insert **30** without coming in contact with the inner surface of the insert bore **35** (had it not been there, the inner surface would encounter the first conical portion), without reducing the depth of the screw port **58**. Secondly, the second conical portion **55** serves as a guide for the cutting insert **30** during its placing in the pocket **20**, aligning the inner surface of the bore **35** with the conical portion **55**.

In addition, it is noted that when the screw **50** is threaded out towards the open position, the more it is threaded, the more the cutting insert **30** is pushed away from the pocket **20** by virtue of the contact between the inner surface of the bore **35** and the second conical portion **55**.

Finally, it is noted that the angle of the seat bore **25** does not have to be oriented directly against the opposite corner of the working corner of the cutting insert **30** (i.e. towards the intersection between walls **24**a and **24**b), and can also be such that the screw applies more pressure towards one of the sidewalls than towards the other.

Attention is now drawn to Figs. 4A and 4B illustrating another example of a turning tool, generally designated as **1'**, and also comprising a holder **10'**, a seat **20'**, a cutting insert **30** (can be similar to that previously described) and a screw **50'**.

The difference between the present example and the previously described turning tool lies in the fact that the diameter of the bore **25'** of the seat **20'** is matched to the diameter of the screw **50'**, whereby support is provided to the shank **52** of the screw **50'**, in the closed position (Fig. 4B) from two directions – see forces F**1** and F**2.**

Turning now to Figs. 5A to 6D, another example of a turning tool is shown, generally designated **1"**. Similar elements have been designated with similar reference numbers with the addition of ("). The turning tool **1"** includes a holder **10"**, a pocket **20"**, a cutting insert **30** (can be similar to that previously described) and a screw **50"**.

Several differences can be clearly noted from the above mentioned figures. First of all, the screw port **58"** is now located at the bottom of the screw **50"** (at its distal end) whereby the head portion **51"** is of full material and is not likely to collapse during transition to the closed position (by deforming the screw port). In addition, this position of the port **58"** also allows easier access to the cutting insert **30** during placement and replacement thereof since the tool used to unscrew the screw **50** (hexa-screw driver) is located below the holder **10"**.

In addition, such access from below allows for the use of a large diameter of the threaded portion **57"** of the screw **50"**. Furthermore, it is observed that the head portion **51"** of the screw **50"** is formed as a stub due to it diameter being smaller than that of the threaded portion **57"**, allowing for a more robust design of the screw **50"**.

Attention is now drawn to Figs. 7A and 7B, in which another example of the turning too is shown, generally designate as **1'"**. Similar elements have been designated with similar reference numbers with the addition of ('"). The turning tool **1'"** includes a holder **10'"**, a pocket **20'"**, a cutting insert **30** (can be similar to that previously described) and a screw **50'"**.

The turning tool **1'"** is essentially similar to that described with respect to Figs. 4A and 4B, with the difference being that the conical portion **53'"** of the screw **50'"** now comes in contact with the inner surface of the bore **35** of the insert **30** along the entire length thereof, providing better support.

Turning now to Figs. 8A to 8C, still another example of a turning tool is shown, generally designated as **101.** Similar elements have been designated with similar

reference numbers with the addition of **100.** The turning tool **101** includes a holder **110,** a pocket **120,** a cutting insert **130** (can be similar to that previously described) and a screw **150.**

Two main additions are provided in the turning tool **101** with respect to previously described tools **1, 1', 1"** and **1'"**:

- the addition of a support plate **170** positioned between the cutting insert **130** and the base surface **122** of the pocket **120;** and
- a support structure **128** formed in the base surface **122** of the pocket **120** configured for additional support of the shank **152** of the screw **150.**

In particular, the support plate **170** can be made of a hard steel alloy as known *per se* and be provided with a shaped cut-out for receiving therein the support structure **128** and the fastening screw **150.**

Under the above arrangement, the head portion of the screw 150 is supported in at least two different locations – the inner surface 133 of the insert bore of the cutting insert and the support surface of the support structure 128. It is noted that the inner surface of the insert bore and the support surface are counter opposed, so that the head portion constitutes a wedge interposed therebetween.

Specifically, in the cross section shown, the arrangement of elements is as follows: the side wall 124a of the seat 120, a portion of the cutting insert 30 firmly pressed against the side wall by the head portion of the screw 150, the head portion of the screw 150, the support surface of the support structure 128 firmly pressed against the head portion, and the opposite portion of the cutting insert (that portion of the insert farthest from the side wall).

Turning now to Figs. 9A to 9D, another example of a turning tool is shown, generally designated **101'**. Similar elements have been designated with similar reference numbers with the addition of (') . The turning tool **101'** includes a holder **110'**, a pocket **120'**, a cutting insert **130** (can be similar to that previously described) and a screw **150'**.

This turning tool **101'** demonstrates a smaller support structure **128'**, but such that is easier to manufacture as part of the pocket **120'**. It is noted that the support structure **128'** has a contact surface **S** at a **10°** which comes in contact with the conical portion **153'** of the screw **150'**, and applies greater pressure to the cutting insert, preventing release of the screw **150'**.

In addition, it is observed that the inner surface **133** of the insert bore **135** is constituted by a first, straight inner portion **133a** and a second, conical inner portion **133b**. This arrangement is complementary to the tapering angle of the conical portion **153'**, and allows applying more downward pressure on the cutting insert **150'**.

In operation, as the screw **150'** is threaded into the bore **125'**, the cutting insert **130'** is pushed further towards the side walls **124a'**, **124b'** of the pocket **120'**.

When removing the cutting insert **150'**, some angular displacement thereof maybe required (and not simply axial displacement as in previous examples).

With reference being made to Figs. 10A and 10B, a reversible cutting insert **130'** is shown, in which the inner surface **133'** has been arranged to have several alternating portions, each being formed with a first, straight portion **133a'** and a second conical portion **133b'**, allowing reversing the cutting insert **130'** and utilizing four cutting corners thereof.

It is noted that under the above arrangement, the diameter of the first portion at the top surface **131T'** of the cutting insert **130'** is smaller than the diameter of the second portion at the top surface **131T'**, while, simultaneously, the diameter of the first portion at the bottom surface **131B'** of the cutting insert **130'** is greater than the diameter of the second portion at the bottom surface **131B'**.

Attention is now drawn to Figs. 11A to 11E, in which yet another example of a turning tool is shown, generally designated as **130"**. Similar elements have been designated with similar reference numbers with the addition of ("). The turning tool **101"** includes a holder **110"**, a pocket **120"**, a support plate **170"**, a cutting insert **130"** and a screw **150"**.

In the present example, the screw **150"** is designed such that the tapering angle of the conical portion is **45°**, so that one segment of the conical portion **153"** is parallel to the base surface **122"** while the other is parallel to the inner surface **133"** of the cutting insert **130"**.

As can be seen from Fig. 11B, in the closed position, the screw **150"** is supported on the one hand by the base surface **122"** (resting flat against it) and on the other hand by the straight inner surface **133"** of the insert bore **135"**.

In addition, it is noted that the head portion **151"** of the fastening screw **150"** does not fill the bore **135"**, and that there extends a considerable gap G between the second conical portion **155"** and the inner surface **133b"** of the cutting insert **130"**.

However, this is not a necessity and the arrangement can be modified to conform the size of the bore **135"** with that of the head portion **151"**.

In addition, it is observed that cutting insert **130"** is formed with a second set of inner surfaces **133a"** configured for receiving, or at least allowing the screw **150"** to pass into the bore **125"**.

As in previous examples, and as shown in Fig. 12, the cutting insert **130"** is fully reversible and comprises eight cutting corners, each having a cutting edge **132"**, its inner surface is formed with alternative sets of straight and conical inner surfaces **133b"** and **133a"** respectively.

With reference to Figs. 13A to 13C, the cutting insert **130"** is manufactured in a sintering -pressing process between two mold members **210** and **250** of a mold **201.** The first mold member **210** comprises a base surface **212** and a cavity **216** defined by sidewalls **216** and a bottom **218.**

In the middle of the cavity there projects a main stub **220** and a platform **230** having an octagonal configuration similar to that of the cutting insert **130"**. The platform **230** comprises a top surface **232** and side surface of two kinds – planar **234** and shaped **236.**

The platform **230** is merged to the surface **218** by a transition surface **240** constituted by an array of alternative surfaces **244, 246** corresponding to surfaces **234, 236** of the platform **230.**

The second mold member **250** has an almost identical design with the only difference being in the fact that it has a main cavity **260** instead of the main stub **220.** Therefore, the elements of the mold member **250** which are similar to those of mold member **210** have been give the same reference numeral but upped by **40** (element **210** is similar to element **250** etc.).

Turning now to Figs. 14A and 14B, a milling tool is shown generally designated as **301,** and comprising a holder **310** formed with a plurality of seats **320** receiving therein a plurality of cutting insert **330** fastened by screws **350.** Similar elements have been designated with similar reference numbers with the addition of **300** (seat **320** is similar to seat **20** etc.).

As in a previously described example, the seat **320** is provided with a support structure **328** with a support surface **S** configured for extending the length at which the screw **350** is supported.

Attention is now turned to Figs. 15A to 16, in which open and closed positions of the screw **350** are shown, with respective positions of the cutting insert **330.** It is observed that the entire head portion **351** is supported by the support structure **328.**

With reference to Figs. 17A and 17B, it is observed that the cutting insert **330** comprises an inner surface **333a** and two inner members, each having an inner surface **333a** configured for engaging the respective portion of the head portion **351** of the screw **350.** This insert **330** is not reversible, making it manufacture very simple.

Attention is now drawn to Figs. 18A to 19D, in which another example of a milling tool is shown, generally designated **301'**. Similar elements have been designated with similar reference numbers with the addition of ('). The tool **301'** comprises a holder **310'** formed with a plurality of seats **320'** receiving therein a plurality of cutting insert **330'** fastened by screws **350'**.

It is first noted that the seat **320'** is not formed with a support structure **328'** but simply with a support surface **S** extending below the level of the base surface **322'**. Thus, in this example, the screw **350'** has a greater cone angle (**30°** instead of **20°**), and the angle of the bore **325'** is greater with respect to the wall **324a'**, allowing the head portion **351'** of the screw **350'** to 'sink' into the seat **320'**. Under the above arrangement, the seat **320'** is of a more robust configuration.

Turning to Figs. 20A and 20B, the cutting insert **330'** is now a reversibly cutting insert, having four working cutting corners, each with its own cutting edge **332'**. Similarly to previously described reversible cutting inserts, this also comprises alternative surfaces **333a'** and **333b'**. In addition, the inner surfaces **333a'** are formed as portions of a cylinder, providing additional support to the screw **350'**.

With respect to Fig. 21, a mold member **410** is shown, used in the manufacture of the cutting insert **330'**. Two such members **410,** angularly displaced with respect to one another at **90°**, allow a full interlocking between the structures **420, 430, 440** of each one in the cavity **414** of the other.

Attention is now drawn to Fig. 22, another example of a milling tool is shown, generally designated **501.** Similar elements have been designated with similar reference numbers to that of tool **301** with the addition of **200** (seat **520** is similar to seat **320** etc.). The milling tool comprises a holder **510** formed with a plurality of seats **520** receiving therein a plurality of cutting insert **530** fastened by screws **550.**

Turning to Figs. 23A to 23D, closed and opened positions of the fastening screw **550** and the cutting insert **530** are shown. Contrary to the previously described milling tool **301,** in the present example the surface **533a** and **533b** are both of cylindrical/conical configuration which is complementary to the geometry of the head portion **551** of the screw **550,** so that there is provided full surface contact between the screw **550** and the insert **530.**

With reference to Fig. 24, the cutting insert **530** is a fully reversible insert having eight cutting corners, each with a cutting edge **532** of its own. As in previous examples, the inner surface portions **533a**, **533b** alternate in order to allow reversibility. This cutting insert **530** is particularly suitable for surface milling.

Fig. 25 illustrates a mold member **410'** used in the manufacture of the cutting insert **530,** so that two similar mold members **410'** can be matched (angularly displaced at **90°** with respect to each other) to form the geometry of the cutting insert **530.**

Some advantages of the above milling tool **501** include a stronger hold of the screw **550** and less wear of the screw **550.**

Turning now to Fig. 26, another milling tool is shown, generally designated **501'**. Similar elements have been designated with similar reference numbers to that of tool **301** with the addition of ('). The milling tool **501'** comprises a holder **510'** formed with a plurality of seats **520'** receiving therein a plurality of cutting insert **530'** fastened by screws **550'**.

As in previously described example of the turning tool **101"**, in this example as well the screw **550'** has a conical angle of **45°** so that one segment thereof is aligned with the inner surface **533a'** of the insert **530'** and another segment thereof is aligned with the base surface **522'**, as can be seen in Figs. 27A and 27B.

The cutting insert **530'** is reversible and has four cutting corners, each with a cutting edge **532'** of its own, as shown in Fig. **28**. It also has the same alternative arrangement of surfaces **533a'** and **533b'**.

Fig. **29** illustrates a mold member **410"** used in the manufacture of the cutting insert **530'**, so that two similar mold members **410"** can be matched (angularly displaced at **90°** with respect to each other) to form the geometry of the cutting insert **530'**.

In all of the above described example of turning tools **1, 1', 1", 1'", 101, 101', 101", 301, 301', 501** and **501'**, the cutting inserts can be fully removed and fully placed

onto their respective seat portions over the head portions of the cutting tools, while the screws are engaged with the holders.

In other words, in order to remove the cutting insert and to replace it (or another insert) back onto the seat, the screw does not have to be removed from the seat bore (just slightly unscrews).

Attention is now drawn to Figs. 30A to 30D illustrating another example of a turning tool, generally designated as **601**, and also comprising a holder **610**, a seat **620**, a cutting insert **630** (can be similar to that previously described) and a screw **650**. In this example, it is observed that the turning tool further comprises a base plate 670, fastened to the base surface 622 with an auxiliary screw.

Under the present example, it is observed that the side wall of the pocket of the tool holder 610 is constituted by two surfaces: 624a, 624b. It is further noted that the surfaces are not flush with one another and that surface 624b constitutes part of a nook in the cutting tool holder 610.

In particular, when the cutting insert 630 is securely mounted, a top portion of its side wall Pa abuts the surface 624a while the bottom portion of the side wall thereof, Pb, is spaced from surface 624b.

With particular reference being made to Fig. 30D, due to the above design, when the fastening screw 650 applies pressure to the cutting insert 630 against the sidewall 624, it results in an attempt to pivot the entire insert 630 about a pivot point P.

As a result, the cutting end of the cutting insert 630 is pressed in a downward direction (arrow F2), thereby fastening to cutting end to the base surface 622 and preventing disengagement of the cutting insert 630 therefrom.

Attention is now drawn to Figs. 31A to 31C illustrating another example of a turning tool, generally designated as **601'**, and also comprising a holder **610'**, a seat **620'**, a cutting insert **630'** (can be similar to that previously described) and a screw **650'**.

One difference between the turning tool 601' and the previous turning tool 601, lies in the design of the cutting insert 630' and matching head 658' of the fastening screw 650'. In particular, the cutting insert 630 comprises a faceted inner surface of the insert bore thereof, so that, in fastening, the screw head 653' also presses down on the cutting insert 630', and doesn't jest press it against the side wall as in some of the previous example.

Another difference lies in the fact that the turning tool holder is formed with a static support 628' having a continuous support surface (non-threaded) with three consecutive portions – 628a', 628b' and 628c'. It is observed that the surface portion 628a' lies above the base surface and above the surface of the support plate 670' (belongs to a portion of the support which is received within the bore of the cutting insert 630' itself), the surface portion 628b' which extends above the base surface 622' but below the surface of the support plate 670' (belongs to a portion of the support received within a bore of the support plate 670' and the surface portion 628c' extends below the base surface 622'.

It should be noted that the entire support surface 628' is configured for supporting the fastening screw 650', either the non-threaded portion 651' thereof or a portion of the screw head 653'.

Attention is now drawn to Figs. 32A to 32B illustrating another example of a turning tool, generally designated as **601"**, and also comprising a holder **610"**, a seat **620"**, a cutting insert **630"** (can be similar to that previously described) and a screw **650"**.

In the present example, another variation is shown in which the cutting insert 630" is provided with chamfered areas 635" at the top and bottom ends of the insert bore thereof 633", and the fastening screw 650" is formed with an extended rim portion 653b" having an increased diameter, and configured for engaging with the chamfered portion 635" to thereby apply downward pressure on the turning insert 630".

Under the above arrangement, the fastening screw 650" is configured not only for pressing the cutting insert towards the side walls of the pocket of the cutting tool holder 610 but also press the cutting insert against the base surface 622" of the holder 610" and/or (in case of an existence of a support plate 670") the surface of the support plate.

With particular reference being made to Fig. 32C, a similar turning tool 601"' is shown, now comprising a different fastening screw 650"' and a slightly different configuration of the pocket. In particular, the fastening screw 650"' comprises a narrow neck portion 652b"' and the bore of the holder 625" which is wider than the stem of the fastening screw. Under this above design, the fastening screw can be allowed to slightly deform in order to increase the fastening capabilities thereof.

Attention is now drawn to Figs. 33A and 33B illustrating another example of a turning tool, generally designated as **701**, and also comprising a holder **710**, a seat **720**, a cutting insert **730** (can be similar to that previously described) and a screw **750**.

As in previous examples, in the turning tool 701 there is also a support area 728 which extends both above and below the base surface 722 of the holder 710. Specifically, portion 728a extends above the base surface and below the cutting insert while portion 728b is configured for extending within the cutting insert. Both portion are configured for providing support to the stem and/or head of the fastening screw 750.

In addition, another difference lies in the design of the shape of the head of the screw 750, which has a spherical portion 753 configured for engaging the inner surface of the cutting insert 730.

Attention is now drawn to Figs. 34A and 34B illustrating another example of a turning tool, generally designated as **701'**, and also comprising a holder **710'**, a seat **720'**, a cutting insert **730'** (can be similar to that previously described) and a screw **750'**.

In this particular example, a surface of the head 753a' of the screw 750' is supported by a support surface 725b' which is disposed below the level of the base surface 722'.

In addition, the bore portion 725a' through which the non-threaded portion of the screw 750' is received is also non-threaded and has a slightly larger diameter that than of the stem of the screw 750'. This allows for a certain degree of freedom during the fastening of the screw to the holder.

It is also noted that the turning insert 730' used herein is a positive turning insert, i.e. it tapers outwardly and therefore does not require considerably tilting thereof to get the cutting angle to the appropriate degree.

In this example, as in several previous examples, the side wall of the pocket of the holder 710' comprises two spaced apart support surfaces 724a, 724b, such that the upper surface 724b abuts the cutting insert 730' while the bottom surface 724b' does not, yielding a pivoting effect about a pivot point P, thereby pressing the working portion of the cutting insert downwards.

Attention is now drawn to Figs. 35A to 35C illustrating another example of a turning tool, generally designated as **701''**, and also comprising a holder **710''**, a seat **720''**, a cutting insert **730''** (can be similar to that previously described) and a screw **750''**.

The turning tool 701" of the above example defers from previous turning tools in that the fastening screw is angled with respect to the base surface such that it is not tilted directly towards the corner of the pocket of the turning tool holder 710" but rather tilting more towards one of the side walls.

Under the above design, the pressure applied to the cutting insert in direction R1 is greater than the pressure applied to the cutting insert 730" in direction R2. This can be particularly useful for side cutting operations in which the turning tool is configured for displacement in a direction opposite R1.

However, it is appreciated that a similar example could have been suggested, specifically beneficial for front cutting operation, in which the fastening screw is tilted to a greater extent towards the other side wall of the pocket.

In addition, in these example, it is observed that the support element 728" has a surface extending above the base surface 722" and configured for engaging and supporting the screw head in the closed position thereof.

Attention is now drawn to Figs. 36A to 36C illustrating another example of a turning tool, generally designated as **701'''**, and also comprising a holder **710'''**, a seat **720'''**, a cutting insert **730'''** (can be similar to that previously described) and a screw **750'''**.

In this particular example, the head of the screw 750''' has three surfaces 753a''', 753b''' and 753c''', all angled to one another. The arrangement is such that the bottom surface 753c" is configured for engaging with the support 728''', the middle surface 753b''' is configured for engaging with the inner surface of the cutting insert and the top surface 753a''' is configured for guiding the cutting insert during its mounting onto the fastening screw 750'''.

It is also noted that compared to the previous examples in which there were only two surfaces, the support 728" is now more robust (more material). In particular, the dotted line DL denotes the support of previous examples, showing it to be of thickness T1, whereas in the present example the thickness is increased to T2.

In addition, it is observed that the bore of the tool holder 710''' is configured for supporting the stem of the screw 750''' on the side opposite the side walls of the holder 710'''. Specifically, the axis X1 of the screw 750''' and the axis X2 of the bore 725''' are offset one another. This provides another degree of freedom in fixing the fastening screw.

Attention is now drawn to Figs. 37A to 37C illustrating another example of a turning tool, generally designated as **801**, and also comprising a holder **810**, a seat **820**, a cutting insert **830** (can be similar to that previously described) and a screw **850**.

As in the previously disclosed example of turning tool 610', the cutting insert 830 is reversible but is formed with two spherical surfaces 833a which correspond to the spherical surface of the head of the screw 853a. The engagement between spherical surfaces increases the contact area between the head of the screw and the cutting insert, allowing for firmer engagement therebetween.

In addition, it is noted that the turning tool 801 is provided with an indent 818 configured for allowing the user to easily extract the cutting insert 830 from the holder 801 by providing a space for a user's finger.

Turning now to Figs. 38A to 38C, yet another example of a cutting tool is shown, generally designated as 901, and comprising a cutting tool holder 910, a cutting insert 930 and a clamping screw 950.

Contrary to the previous examples, the clamping screw 950 of the cutting tool 901 is provided with an eccentric head portion 953, so that upon revolving the clamping screw 950 about its axis, not only does the head 953 thereof displaces closer to the side wall of the seat 920, but the eccentricity of the head portion facilitates further clamping and better pressure on the cutting insert.

It is noted that, as in previous examples, the seat 920 is formed with a support portion 928a which is configured for engaging a portion of the head 953 of the clamping screw 950. Moreover, it is observed that a part of the support portion 928b is received within the support plate 970, so that the bottom of the cutting insert rests on both the support plate 970 and the support portion 928b.

Attention is now drawn to Figs. 39A and 39B, in which another example of a turning tool is shown, generally and comprising a cutting tool holder 910", a cutting insert 930" and a clamping screw 950".

It is observed that the bore 935' of the cutting insert 930' is provided with inwardly extending support elements 938', equally disposed about the axis of the bore. The elements 938' are configured for engagement with the head portion 953' of the clamping screw, defining a smaller diameter than that of the insert bore 935'. It is noted that the support elements do not extend all the way along the bore of the cutting insert 930'.

It is further observed that the seat is provided with a support structure, similarly to the previous example, which has a support portion 928' configured for being received within the bore of the cutting insert.

Thus, the cutting tool 901' is limited to the use of this specific cutting insert 930'. In particular, should someone use a cutting insert with an insert bore without support elements, the head portion 953' of the clamping screw 950' will not engage the inner surface of the bore and thus will not be able to properly secure the cutting insert. Alternatively, should someone use an insert with an insert bore of a smaller diameter, equivalent to that defined by the support elements 938', the cutting insert would not be able to fit over the support portion 928a'.

Turning now to Figs. 40A and 40B, another example of a cutting tool is shown, generally designated as 901", and comprising a cutting tool holder 910", a cutting insert 930" and a clamping screw 950".

The cutting tool 901" is similar to the previously described cutting tool 901', with the difference being that the support element 938' is radially disposed (and not axially). Similar to the previous example, in this case it would also be difficult to use a different cutting insert and clamping screw with the same cutting tool holder 910".

In addition, the bore of the cutting insert 930" comprises a spherical inner surface which is configured to engage a corresponding spherical surface of the clamping screw, thereby providing an extended contact surface between the latter and the former (this being opposed to a conical configuration in which the contact is along a contact line).

Attention is now drawn to Figs. 41A and 41B, in which yet another example of a cutting tool is shown, generally designated as 901"', and comprising a cutting tool holder 910"', a cutting insert 930"' and a clamping screw 950"'.

In the present example, the cutting insert 930"' is a positive angle cutting insert, meaning that the cutting tool 901"' is not required to be tilted during operation thereof.

With respect to the present example, it is also noted that when the clamping screw 950"' is in its second, secured position, one portion of the surface 953a"' engages the support portion 928a"' and another portion of the same surface 953a"' engages the inner surface 935"' of the bore of the cutting insert 930"'. Thus, in the secured position, the head portion of the clamping screw 950"' is held tight, whereby deformation to the

head portion about the neck of the clamping screw is prevented or at least highly reduced.

Turning now to Figs. 42A and 42B, another example of a turning tool is shown, generally designated as **801'''**, and also comprising a holder **810'''**, a seat **820'''**, a cutting insert **830'''** and a screw **850'''**.

The cutting tool 810''' is similar to the cutting tool 801' previously described, with the difference being that the support elements 838''' of the cutting insert 830''' extend all the way along the bore 835''' thereof and the support structure 828''' is not configured for being received within the insert bore 835'''.

Attention is now drawn to Figs. 43A to 43C, in which still another example of a cutting tool is shown, generally designated as 1001, and comprising a holder **1010**, a seat **1020**, a cutting insert **1030** (can be similar to that previously described) and a screw **1050**.

However, contrary to previously described examples, it is note that the seat bore is completely unthreaded, i.e. it has no inner thread configured for engaging the clamping screw 1050. Instead, the holder 1010 is formed with a lateral channel 1023 intersecting the seat bore 1025, and the cutting tool 1001 further comprises a sliding thread element 1080 received within the channel 1023, and formed with an inner thread 1082 configured for engaging the external thread of the clamping screw 1050.

It is further noted that the bore 1025 is of larger diameter than the diameter of the clamping screw 1050, and that the thread element 1080 is freely revolvable about the axis of the channel 1023 and freely displaceable therealong. As such, a certain degree of freedom is provided in mounting and removing the clamping screw 1050, while the thread element 1080 revolves about the axis and displaces along it to fit any movements of the clamping screw owing to clamping pressure or loads exerted during operation of the cutting tool.

Attention is now drawn to Figs. 44A and 44B, in which a milling tool is shown, generally designated as 1101, and comprising a holder 1110 and a plurality of cutting inserts 1130, each being received within an insert seat 1120 and secured in place by a clamping screw 1150.

With particular reference being drawn to Fig. 44B, it is observed that in the securing position of the clamping screw, the head portion of the screw 1153a and the

side wall of the seat 1124 form a dove-tail geometry, preventing the cutting insert 1130 from being removed from the seat 1120.

Turning now to Figs. 45A to 45C, still another example of a milling tool is shown, which is generally similar to the previous example, and is designated as 1101', and comprising a holder 1110' and a plurality of cutting inserts 1130', each being received within an insert seat 1120' and secured in place by a clamping screw 1150'.

With respect to Figs. 46A to 46D, a drilling tool is shown, generally designated as 1201, and comprising a holder 1210 and a cutting insert 1230 received within an insert seat 1220 and secured in place by a clamping screw 1250.

It is observed that the clamping screws 1250 operate in a manner similar to that of the clamping screws previously described, and that the head portion of both screws is accessible from the front end of the drilling tool 1201.

In addition, contrary to previous examples, it is noted that the seat 1220 does not comprise a support portion extending through the base surface 1222 but rather a support slope 1228 extending below the base surface and configured for engaging the head portion of the clamping screw 1250.

With respect to Figs. 47A to 47D and Figs. 48A and 48B, two additional examples of drilling tools are shown, generally designated 1201' and 1201".

Those skilled in the art to which this invention pertains will readily appreciate that numerous changes, variations, and modification can be made without departing from the scope of the invention, *mutatis mutandis*.

CLAIMS:

1. A cutting tool holder adapted for mounting thereon a cutting insert having a top face, a bottom face and an insert bore extending between said top face and said bottom face, and having an inner surface; said holder comprising a seat defined by a base surface and at least one side wall angled to said base surface, a seat bore extending along a bore axis, and having an open end at said base surface; a securing arrangement comprising a securing member extending between a proximal end and a distal end, the securing member having a head portion at said proximal end and having its distal end received within said seat bore, and a displacement arrangement adapted to displace the securing member along the bore axis of said seat bore between a mounting position in which said head portion protrudes from within the seat bore through said base surface into said seat to a first extent, defining a first gap distance between said head portion and said at least one side wall allowing said cutting insert to be placed within the seat and/or being fully removed from the seat, and a securing position in which said head portion protrudes from within the seat bore through said base surface into said seat to a second extent, smaller than said first extent, defining a second gap distance between said head portion and said at least one side wall smaller than said first gap distance, so as to engage the inner surface of said insert bore, thereby securing said insert between the head portion and the at least one side wall, and wherein said insert seat is further formed with a support surface configured for engaging and providing support to the head portion of said securing member at least in said securing position.

2. A cutting too holder according to Claim 1, wherein the support surface is constituted by at least one of:

- a portion of the base surface itself, adjacent the open end of said seat bore;
- a surface extending from the base surface into the seat bore, forming a part of an inner surface thereof, and oriented at an angle to said base surface; and
- a surface of a support structure extending from the base surface into said seat.

3. A cutting tool holder according to Claim 2, wherein said support surface is at least one of the following:

- disposed above said base surface;
- disposed at said base surface; and

- disposed below said base surface.

4. A cutting tool holder according to Claim 3, wherein the seat comprises more than one support surface.

5. A cutting tool holder according to Claim 3, wherein the seat comprises one extensive support surface having a first portion extending below the base surface and a second portion extending above the base surface.

6. A cutting tool holder according to any one of Claims 1 to 5, wherein the head portion of the securing member is supported in at least two different locations – the inner surface of the insert bore of the cutting insert and the support surface.

7. A cutting tool holder according to Claim 6, wherein the inner surface of the insert bore and the support surface are counter opposed, so that the head portion constitutes a wedge interposed therebetween.

8. A cutting tool holder according to Claim 6 or 7, wherein, in a cross section of the cutting tool taken along a plane of the bore axis at least in the securing position, the arrangement of elements is as follows: the at least one side wall of the seat, a portion of the cutting insert firmly pressed against the side wall by the head portion, the head portion of the securing member, the support surface firmly pressed against the head portion, and the opposite portion of the cutting insert.

9. A cutting tool holder according to any one of Claims 1 to 8, wherein the support structure extends into the insert bore.

10. A cutting tool holder according to Claim 9, wherein there extends a slight gap between the support structure and the inner surface of the insert bore at the portion of the cutting insert remote from the side wall.

11. A cutting tool holder according to any one of Claims 1 to 10, wherein the support surface is configured for providing back support for the head portion of the fastening member on a side opposite that of the portion of the cutting insert closer to the side wall.

12. A cutting tool holder according to any one of Claims 1 to 11, wherein the bore axis is angled to the at least one side wall at a positive angle so that the open end of the seat bore is the farthest portion of the seat bore from the side wall.

13. A cutting tool holder according to any one of Claims 1 to 12, wherein the head portion of the securing member comprises a conical surface.

14. A cutting tool holder according to Claim 13, wherein the conical surface has a tapering angle which is such that at least a segment thereof is parallel to the at least one side wall, in a cross section along a longitudinal axis of the fastening member.

15. A cutting tool holder according to Claim 13 or 14, wherein the head portion comprises a first conical portion with an outwardly diverging tapering angle and a second conical portion with an inwardly converging conical portion.

16. A cutting tool holder according to Claim 15, wherein the first conical portion is configured for coming into contact with the inner surface of the cutting insert and with the support surface, and the second conical portion being configured for allowing removal of the cutting insert without obstructing it.

17. A cutting tool holder according to any one of Claims 1 to 16, wherein the head portion is designed in a manner complimentary with the insert bore, so that it does not obstruct the cutting insert when attempting to pull it over the head portion.

18. A cutting tool holder according to Claim 15 or 16, wherein the tapering angle of the second conical portion is half the angle between the base surface and the side wall.

19. A cutting tool holder according to Claim 18, wherein at least a segment of said second conical portion is parallel to the inner surface of the cutting insert, in a cross section along a longitudinal axis of the fastening member.

20. A cutting tool holder according to Claim 18 or 19, wherein the tapering angles are such that at least a segment of said second conical portion is parallel to a segment of the first conical portion, in a cross section along a longitudinal axis of the fastening member.

21. A cutting tool holder according to any one of Claims 1 to 20, wherein the screw has an inscribing cylinder which is not greater in diameter than the insert bore.

22. A cutting tool holder according to any one of Claims 1 to 21, wherein the securing member is a fastening screw, and the head portion comprises a port for a designated tool such as a screw-driver to be received therein.

23. A cutting tool holder according to Claim 22, wherein the distal end of the securing member can comprise a secondary port allowing an operator to access the securing member therefrom.

24. A cutting tool holder according to any one of Claims 1 to 23, wherein the fastening screw comprises a shank portion and a threaded portion, and said seat bore has

corresponding non-threaded and threaded portions respectively, configured for properly accommodating the screw.

25. A cutting tool holder according to any one of Claims 1 to 24, wherein the side wall comprises a support portion, and a cut-out portion disposed between the base surface and the support portion, wherein said support portion is configured for engaging an external surface of the cutting insert and said cut-out is configured for remaining out of contact with the external surface.

26. A cutting tool holder according to Claim 25, wherein pressing the cutting insert towards the at least one side wall entails application of pressure on the top portion of the external surface, due to its contact with the support portion, while a bottom portion of the external surface is free of contact.

27. A cutting tool holder according to any one of Claims 1 to 26, wherein the seat comprises a first and a second side wall, angled to one another to form a corner, and the seat bore is angled to the base surface and towards said corner.

28. A cutting tool holder according to any one of Claims 1 to 27, wherein the said cutting tool holder further comprises a thread element received within a channel intersecting said seat bore, and comprises an inner thread configured for engaging the securing member.

29. A cutting tool holder according to Claim 28, wherein the thread element is configured for performing at least one of the following:

- revolving about an axis of the channel; and
- axially displacing along the channel.

30. A cutting tool holder according to any one of Claims 1 to 29, wherein the side wall of the seat is angled to the base surface at an acute angle, and the head portion has a first and second tapering portions, thereby yielding a 'dove-tail' securing of the cutting insert.

31. A cutting tool holder according to Claim 30, wherein the distance between the base of the conical portion and a first point on the side wall is smaller than the distance between any other point on the cone and a second point on the side wall, closer to the base surface.

32. A method for mounting a cutting insert onto a seat of a cutting tool holder according to any one of Claims 1 to 31, in order to form a cutting tool, said method including the steps of:

a) displacing the fastening member into the mounting position, while a distal end thereof is still received within the seat bore;

b) placing the cutting insert onto the seat, slipping the insert bore over the head portion of the fastening member; and

c) displacing the fastening member into the securing position.

33. A cutting insert configured for mounting onto the cutting tool holder according to any one of Claims 1 to 32.

34. A cutting insert according to Claim 33, wherein the insert bore comprises a first inner surface configured for coming in contact with the securing member of the cutting tool holder, and a second inner surface configured for providing sufficient space for mounting/removing the cutting insert from the cutting tool holder.

35. A cutting insert according to Claim 34, wherein the first inner surface is conical and tapering at an angle complimentary to that of the securing member, and the second inner surface is cylindrical.

36. A cutting insert according to Claim 35, wherein the first and second inner surfaces merge at the base of the cone, so that the diameter of the cylindrical portion is equivalent to the diameter of the base of the conical portion.

37. A cutting insert according to any one of Claims 33 to 36, wherein the cutting insert is reversible.

38. A cutting insert according to any one of Claims 33 to 37, wherein the inner surface of the insert bore of the cutting insert comprises a plurality of first contact surfaces associated with the top face of the cutting insert and a plurality of second contact surfaces associates with the bottom face of the cutting insert.

39. A cutting insert according to Claim 38, wherein the first contact surfaces are configured for coming into contact with the head portion of the securing member when the top face is mated with the base surface and the second contact surfaces are configured for coming into contact with the head portion of the securing member when the bottom face is mated with the base surface.

40. A cutting insert according to Claim 39, wherein the first contact surfaces and the second contact surfaces are arranged alternately along the inner surface of the insert bore.

41. A cutting insert according to Claim 38, 39 or 40, wherein the cutting insert comprises a plurality of first passage cut-outs associated with the bottom face of the

cutting insert and a plurality of second passage cut-outs associates with the top face of the cutting insert, and configured for allowing the shank of the securing member to pass into the seat bore.

42. A cutting insert according to any one of Claims 33 to 41, wherein the inner surface of the insert bore comprises a plurality of projections, each having a contact surface configured for coming into contact with the head portion of the securing member.

43. A cutting insert according to Claim 42, wherein the support structure has a an inscribing circle of a diameter corresponding to that of the insert bore, while the projections have an inscribing circle which is of smaller diameter.

44. A cutting tool comprising a cutting insert according to any one of Claims 33 to 43 when mounted onto a cutting tool holder according to any one of Claims 1 to 31.

45. A cutting tool holder adapted for mounting thereon a cutting insert having a top face, a bottom face and formed with an insert bore having an inner surface extending between said top and said bottom face; said holder comprising a seat defined by a bottom surface and at least one side wall angled to said bottom surface, a seat bore with a bore axis angled to said at least one side wall and having an open end at the bottom surface of said seat, and a clamping screw for securing said cutting insert in said seat, said screw having a head portion, and is configure for displacing between at least a first, mounting position in which said head protrudes from within the seat bore through said bottom surface into said seat to a first extent, defining a first gap distance between said head portion and said at least one side wall allowing said cutting insert to be placed within the seat, having its bottom face aligned against said bottom surface as well as being fully removed therefrom, and a second, securing position in which said head portion protrudes from within the seat bore through said bottom surface into said seat to a second extent, smaller than said first extent, defining a second gap distance between said head portion and said at least one side wall smaller than said first gap distance, so as to engage the inner surface of said insert bore, thereby securing said insert between the head portion and the at least one side wall, wherein said clamping screw is not threadingly engaged with the seat bore, and wherein said cutting tool holder further comprises a thread element received within a channel intersecting said seat bore, and comprises an inner thread configured for engaging the clamping screw.

46. A cutting tool holder adapted for mounting thereon a cutting insert having a top face, a bottom face and an insert bore extending between said top face and said bottom face, and having an inner surface; said holder comprising a seat defined by a base surface and at least one side wall angled to said base surface, a seat bore extending along a bore axis, and having an open end at said base surface; a securing arrangement comprising a securing member extending between a proximal end and a distal end, the securing member having a head portion at said proximal end and having its distal end received within said seat bore, and a displacement arrangement adapted to displace the securing member along the bore axis of said seat bore between a mounting position in which said head portion protrudes from within the seat bore through said base surface into said seat to a first extent, defining a first gap distance between said head portion and said at least one side wall allowing said cutting insert to be placed within the seat and/or being fully removed from the seat, and a securing position in which said head portion protrudes from within the seat bore through said base surface into said seat to a second extent, smaller than said first extent, defining a second gap distance between said head portion and said at least one side wall smaller than said first gap distance, so as to engage the inner surface of said insert bore, thereby securing said insert between the head portion and the at least one side wall, and wherein the seat bore is angled to the base surface said base surface and the head portion of the screw comprises a contact portion which is so angled with respect to the axis of the screw that, at least in said securing position, the contact portion is configured for engaging the base surface of the seat for providing support to the head portion.

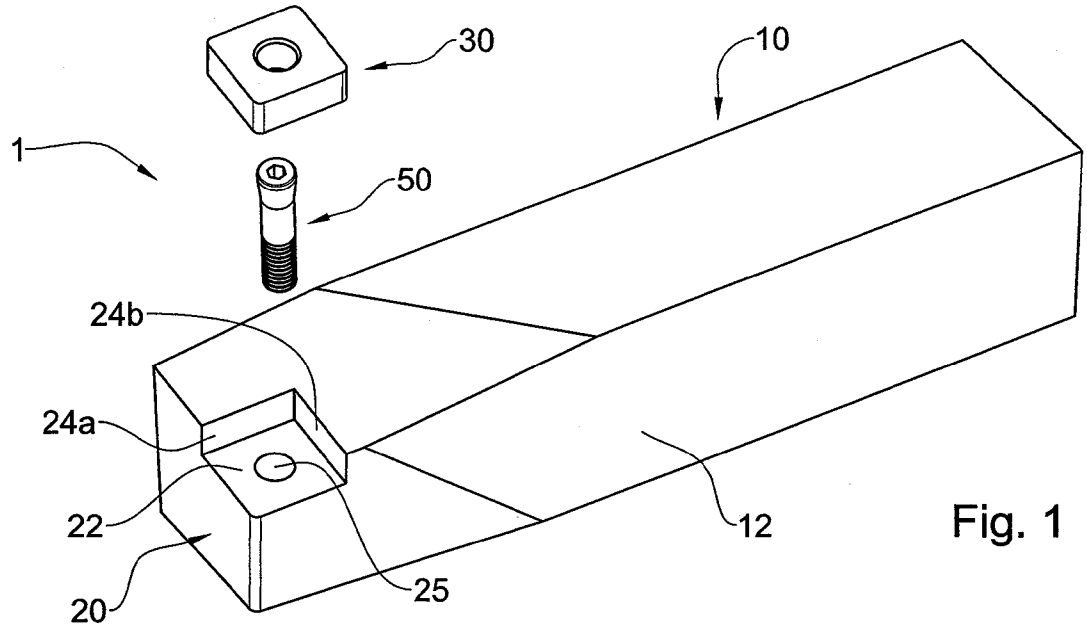
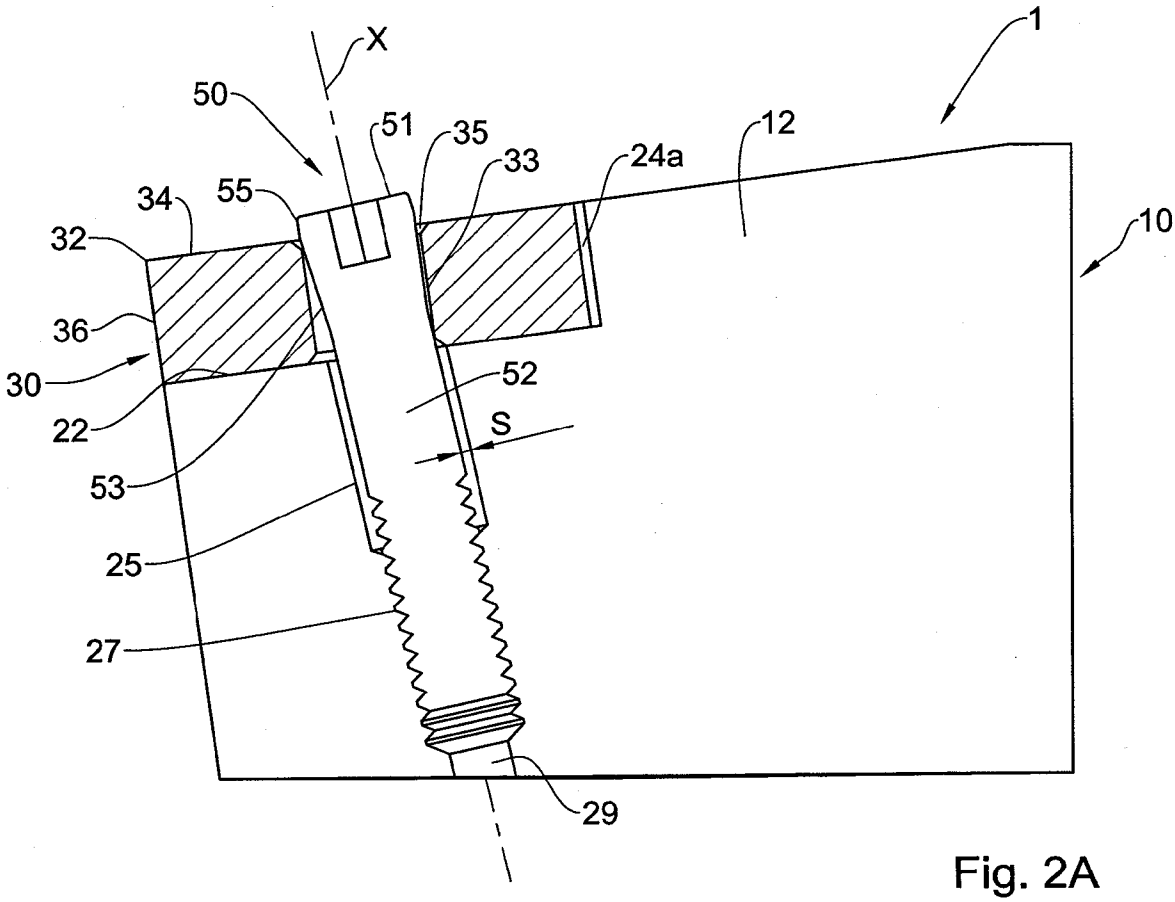

30
10
1
50
24b
24a
22
20
25
12

Fig. 1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1
50
51
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24a
12
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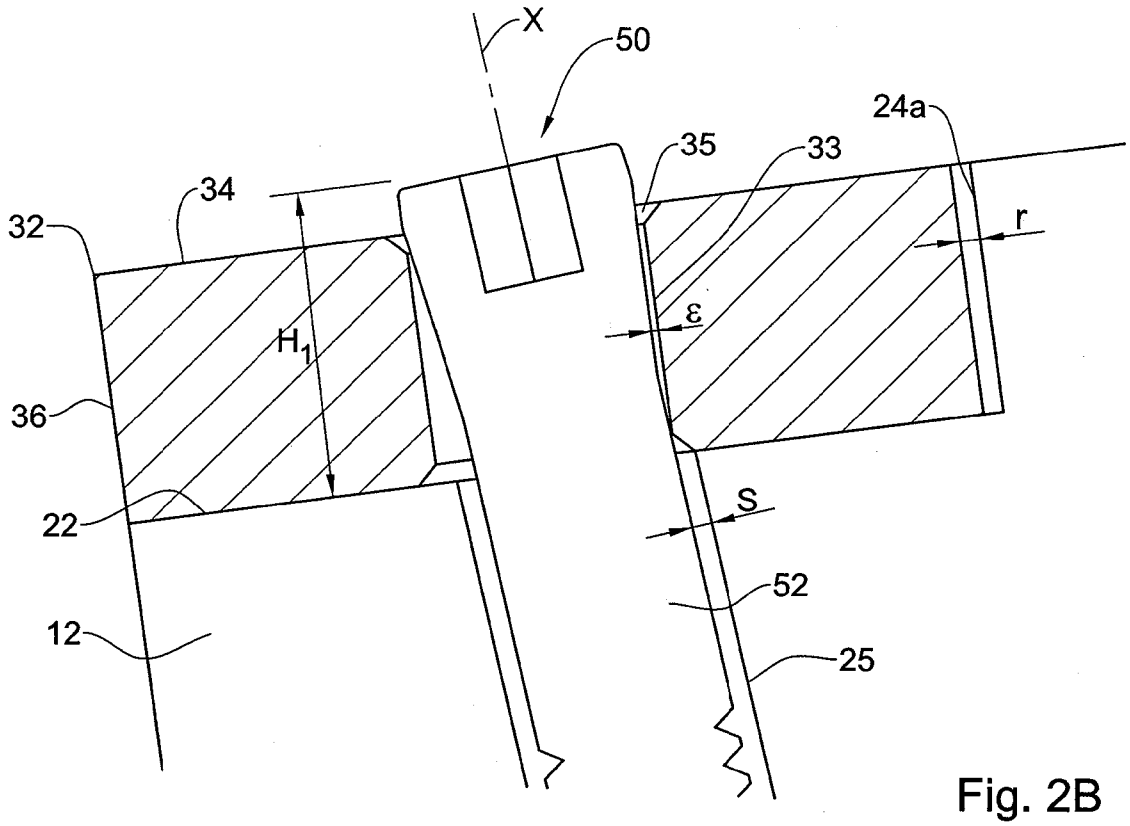
32
10
36
30
52
22
S
53
25
27
29

Fig. 2A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24a
35
33
34
32
r
ε
H_1
36
22
S
52
12
25

Fig. 2B

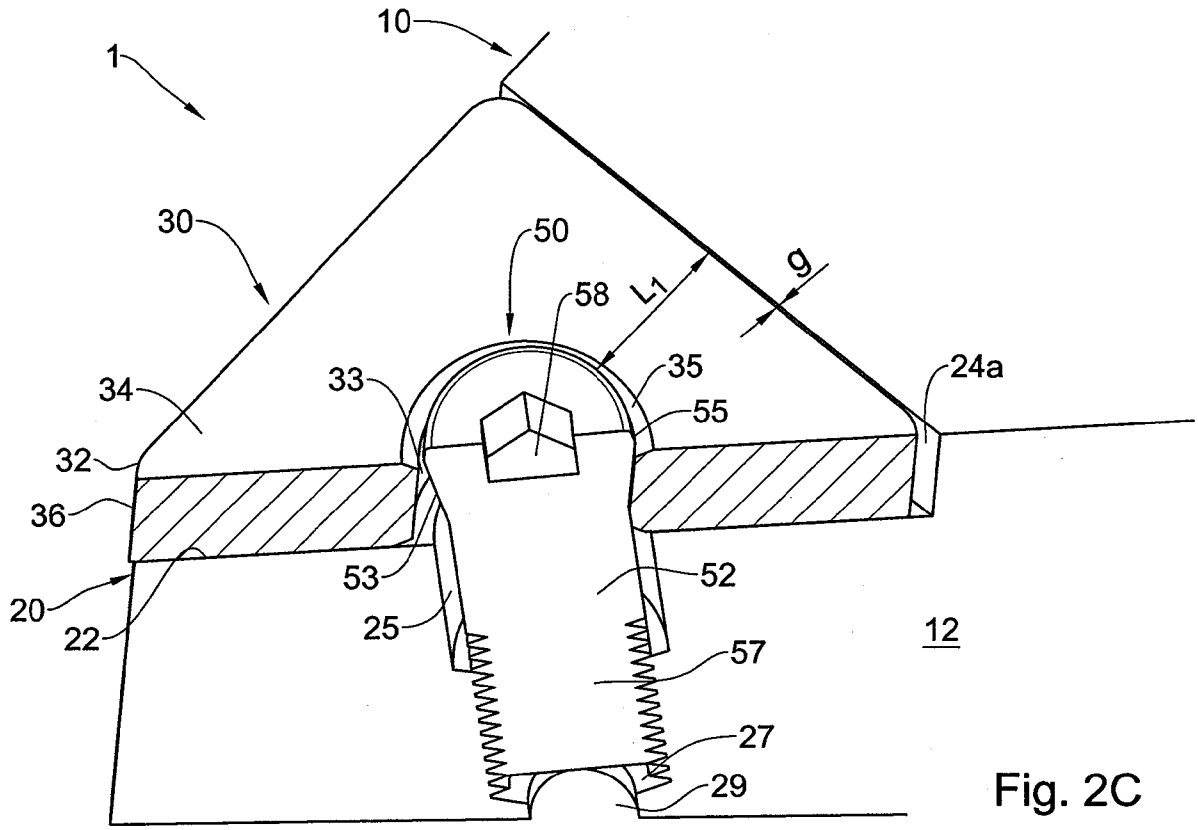
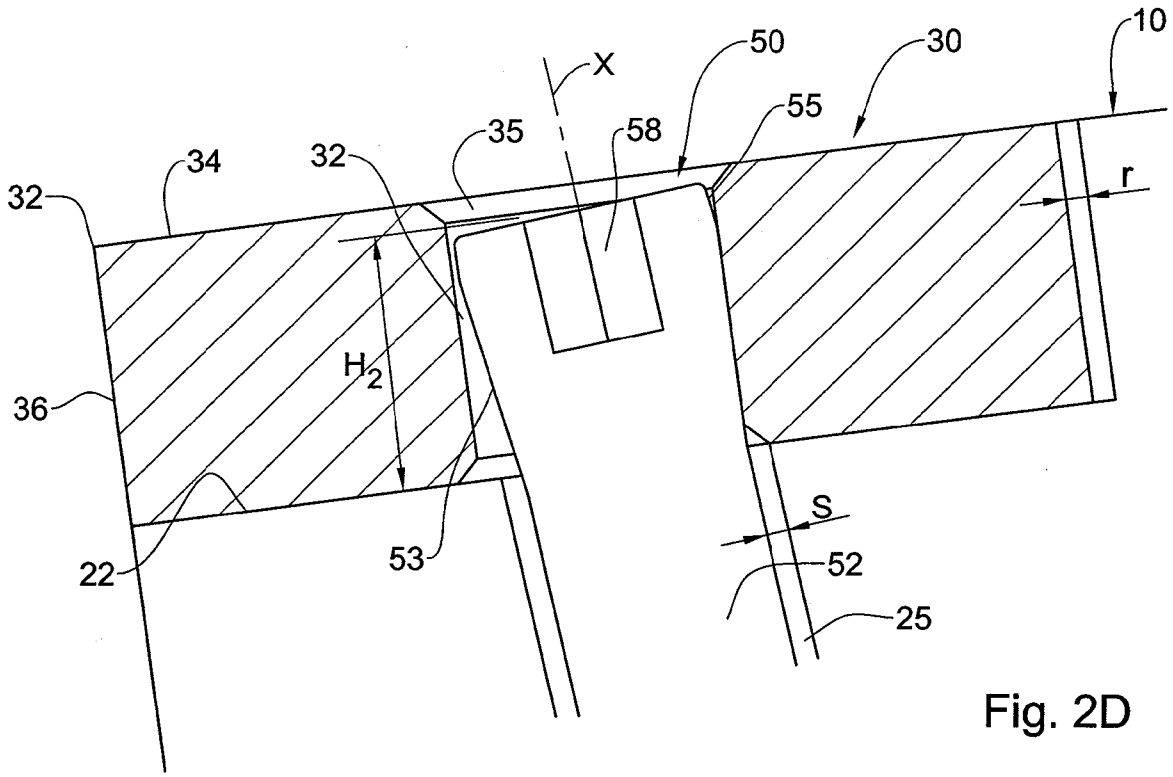

10
1
30
50
58
L_1
g
34
33
35
24a
55
32
36
53
52
20
22
25
12
57
27
29

Fig. 2C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30
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X
55
35
58
34
32
32
r
H_2
36
S
53
52
22
25

Fig. 2D

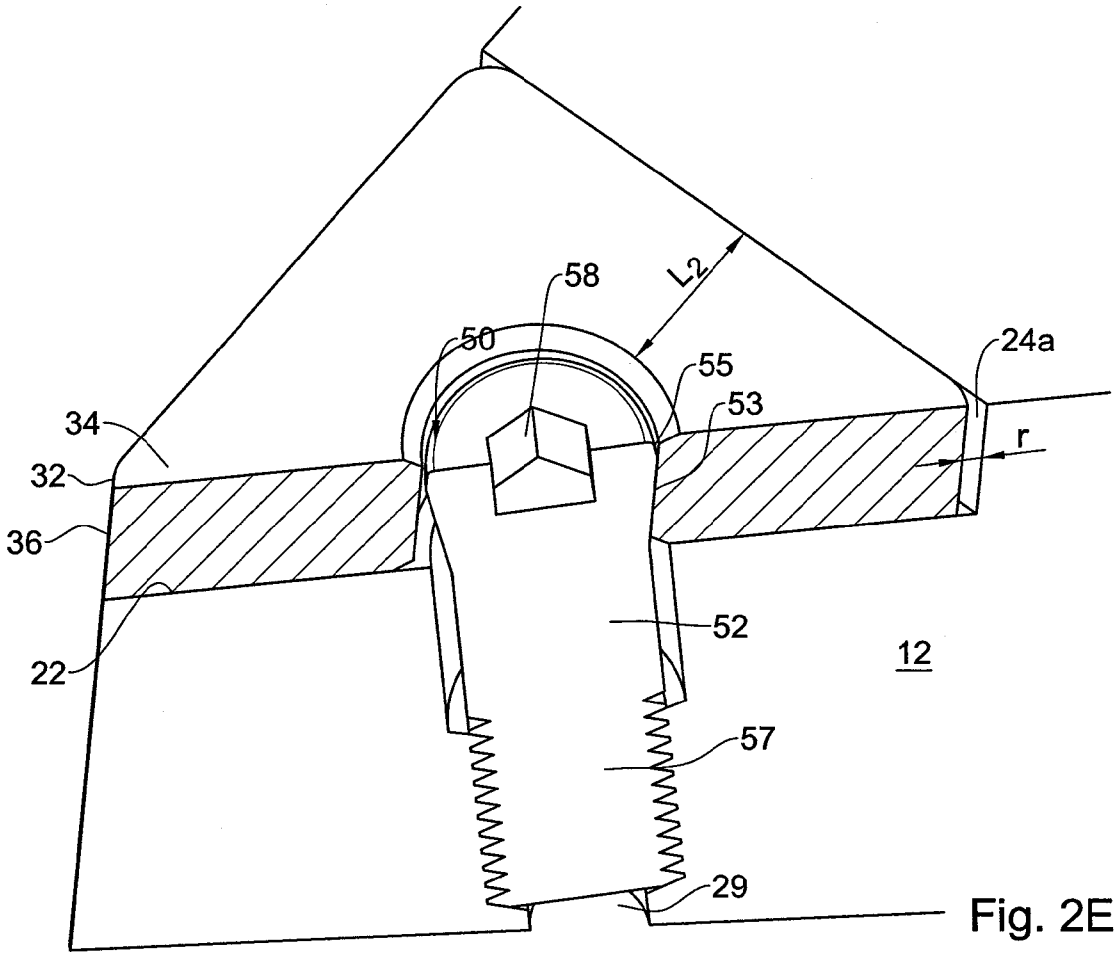

58
L_2
50
24a
55
53
34
r
32
36
52
12
22
57
29

Fig. 2E

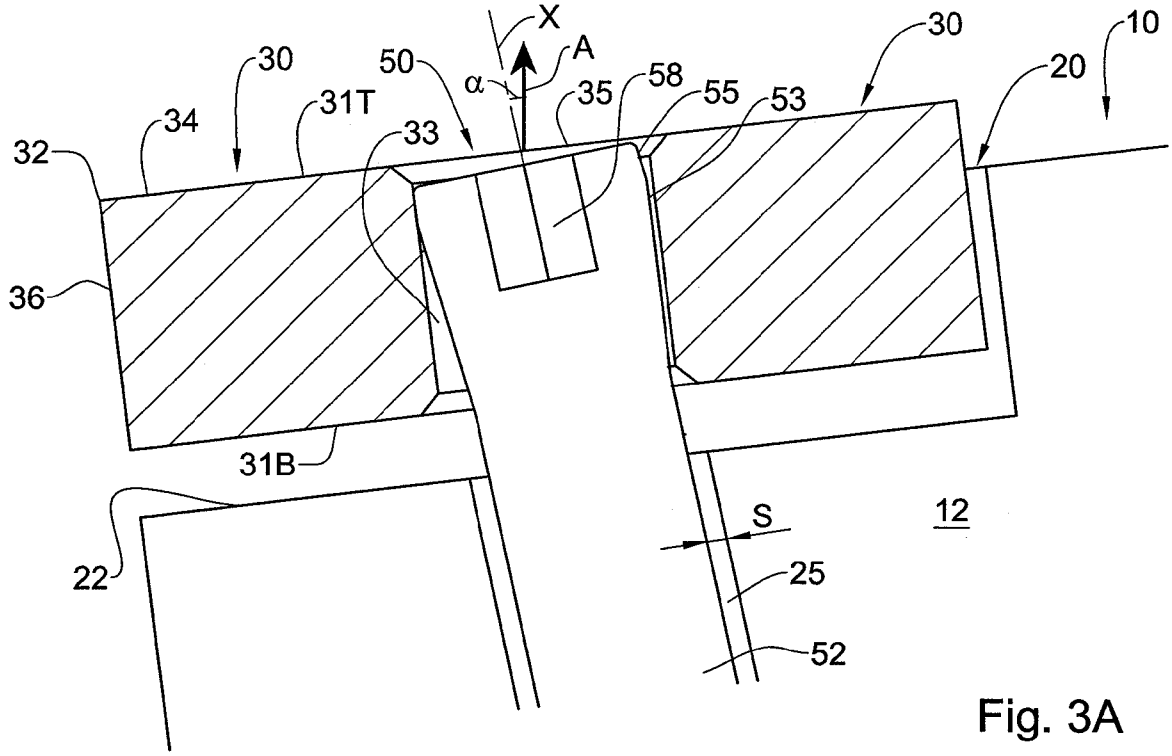
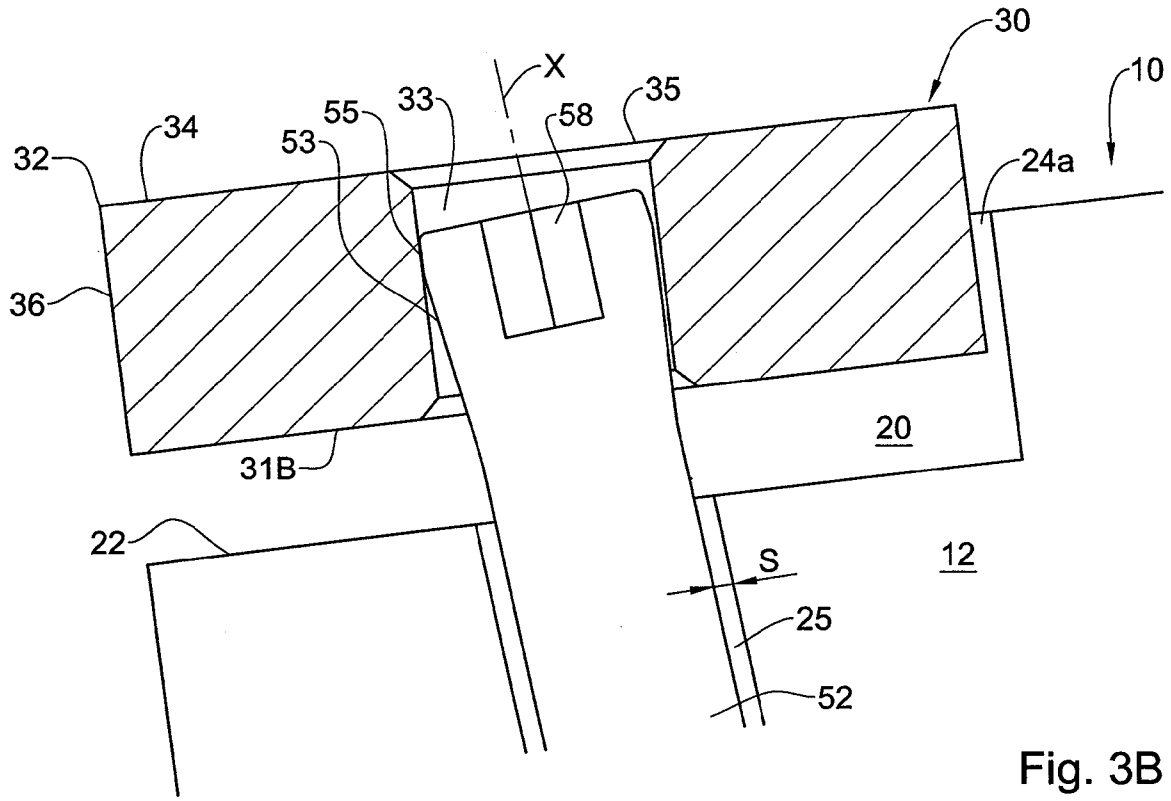

X
A
α
30
50
31T
34
33
35
58
55
53
30
20
10
32
36
31B
22
S
12
25
52

Fig. 3A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53
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24a
36
20
31B
22
S
12
25
52

Fig. 3B

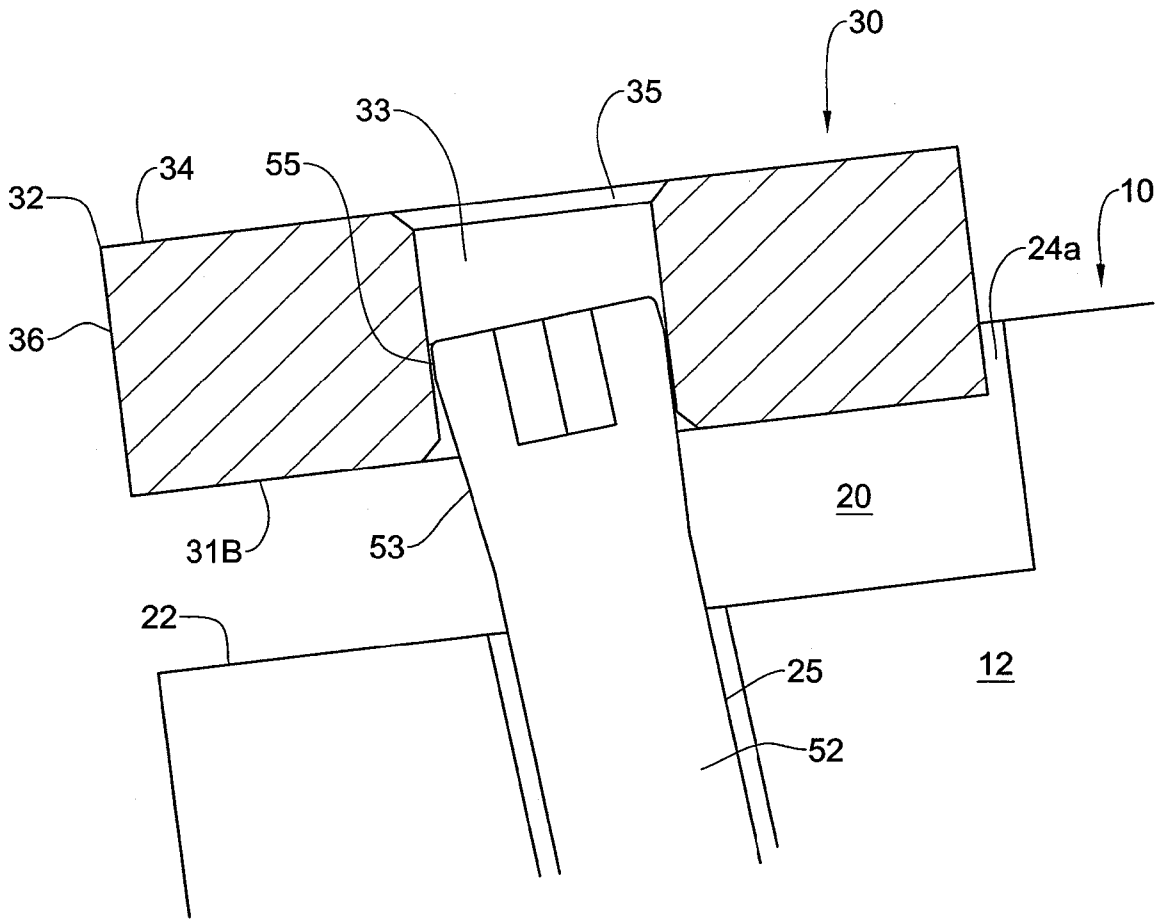

Fig. 3C

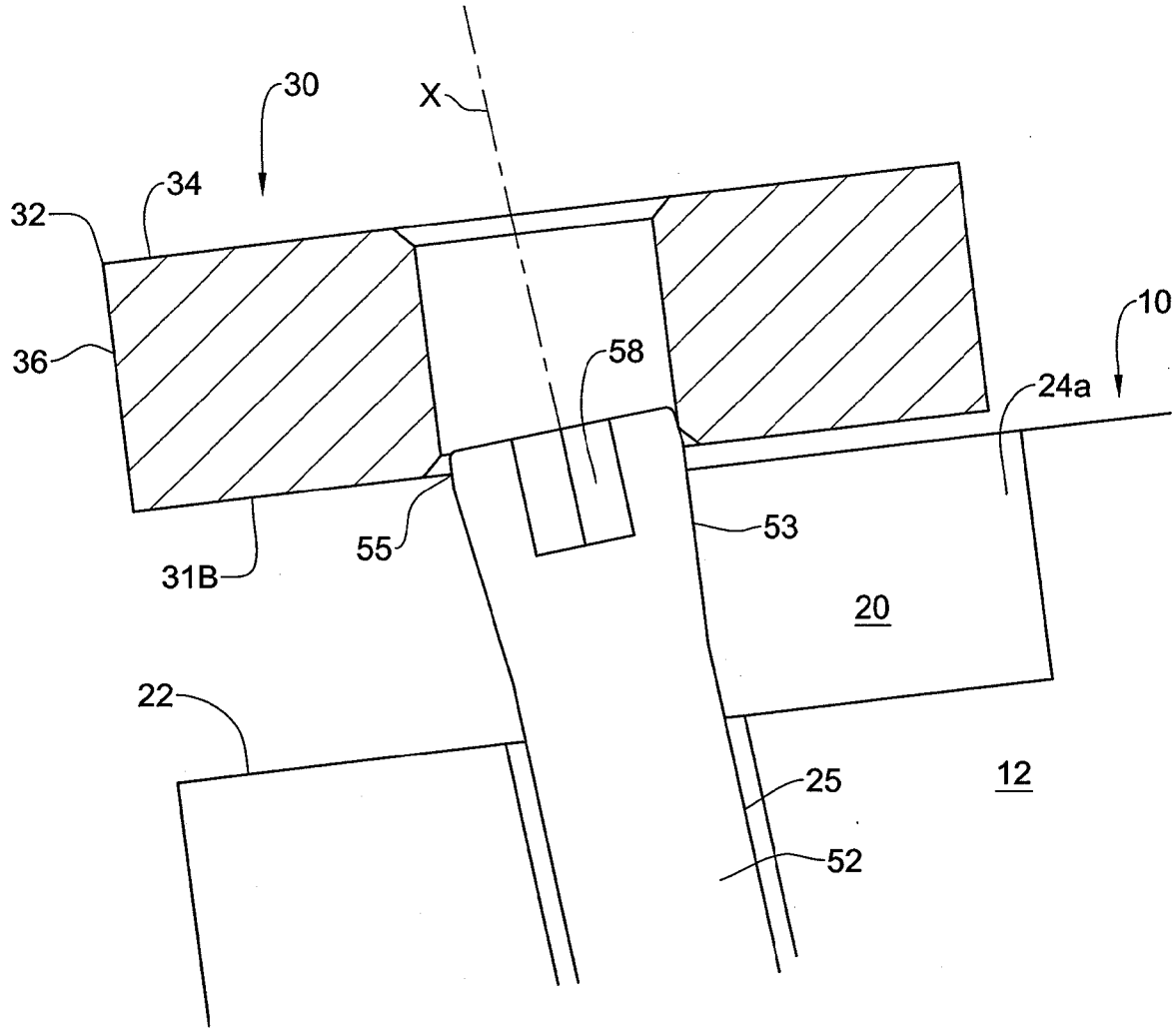

Fig. 3D

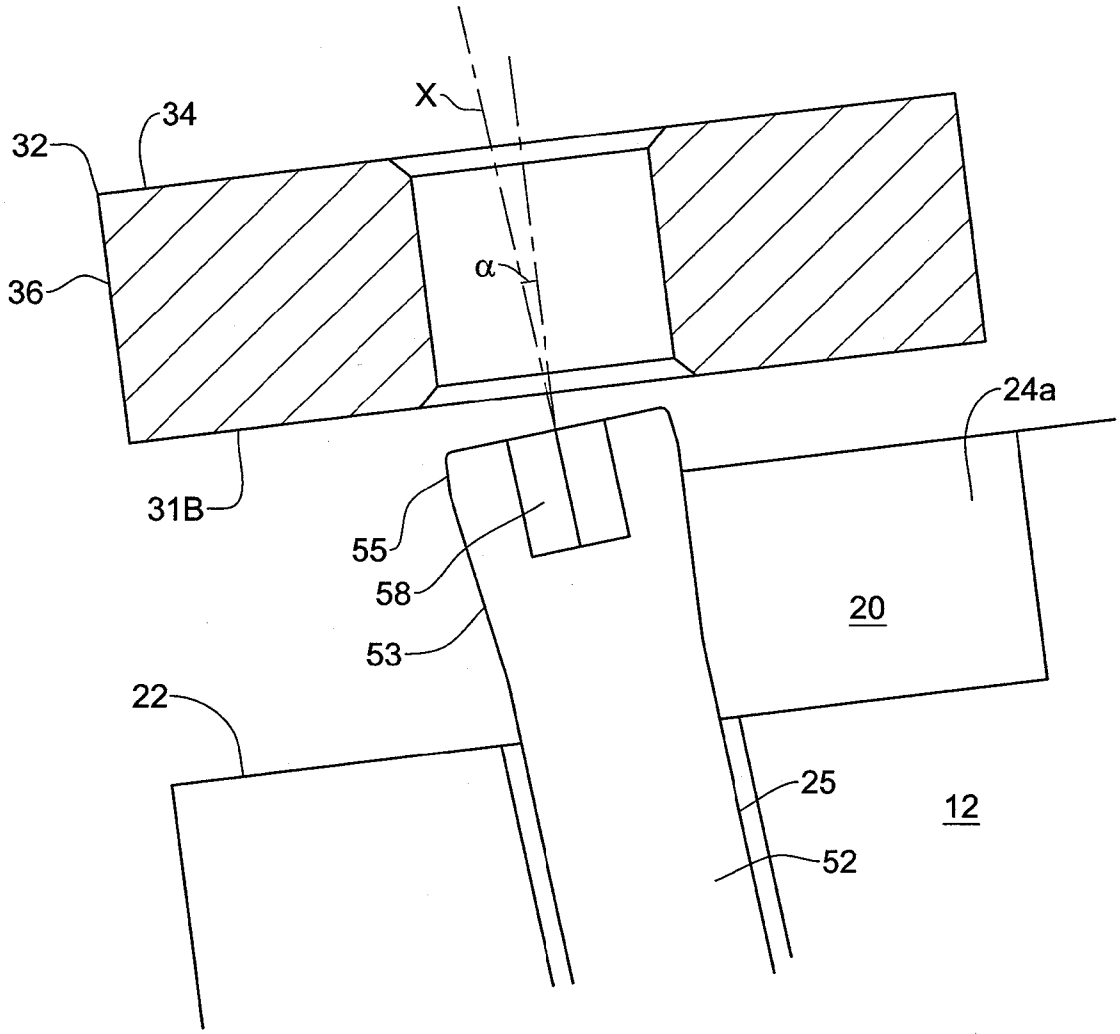

Fig. 3E

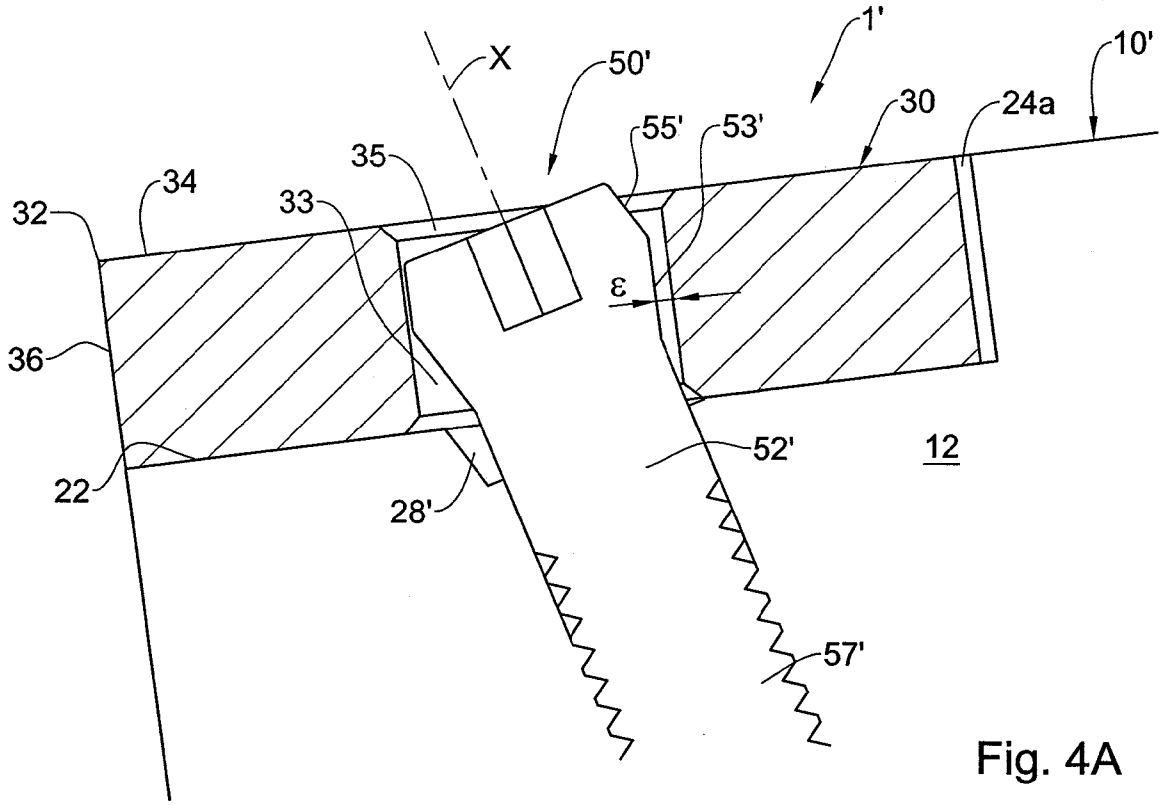
1'
X
50'
10'
30
24a
55'
53'
35
34
33
32
ε
36
52'
12
22
28'
57'

Fig. 4A

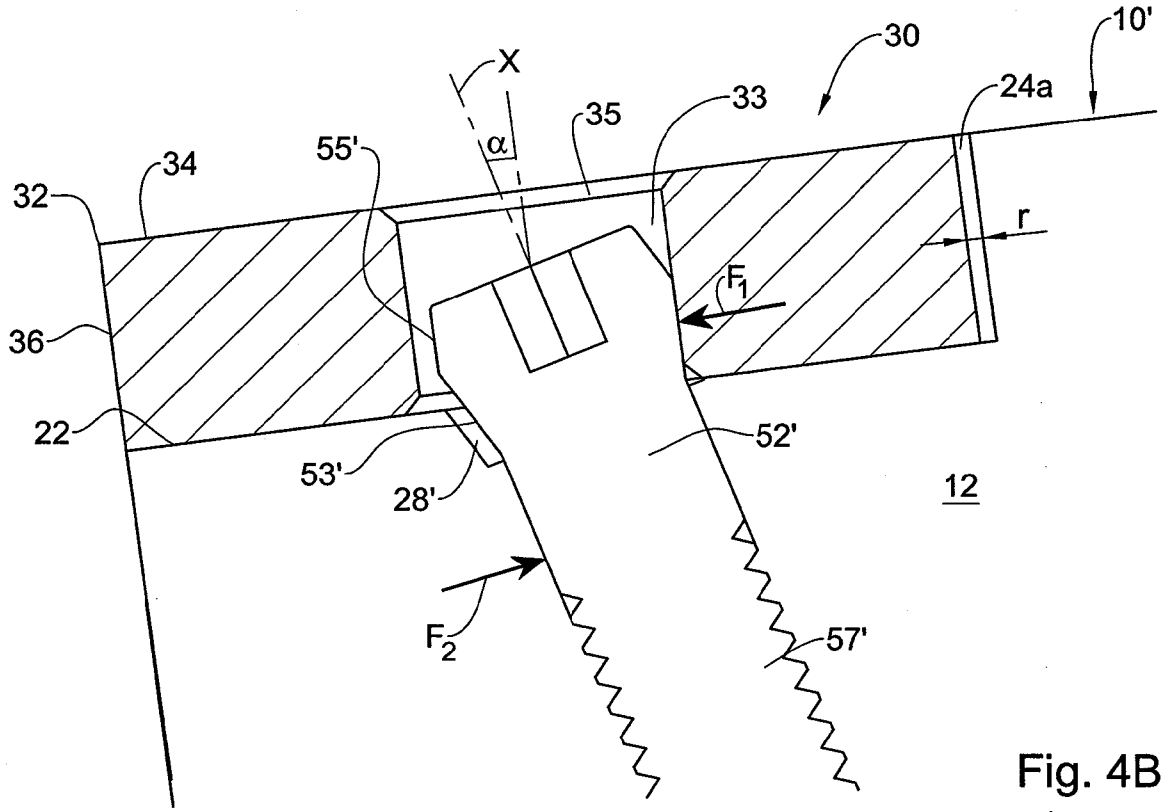
10'
30
X
24a
33
35
α
55'
34
32
r
F1
36
22
52'
53'
28'
12
F2
57'

Fig. 4B

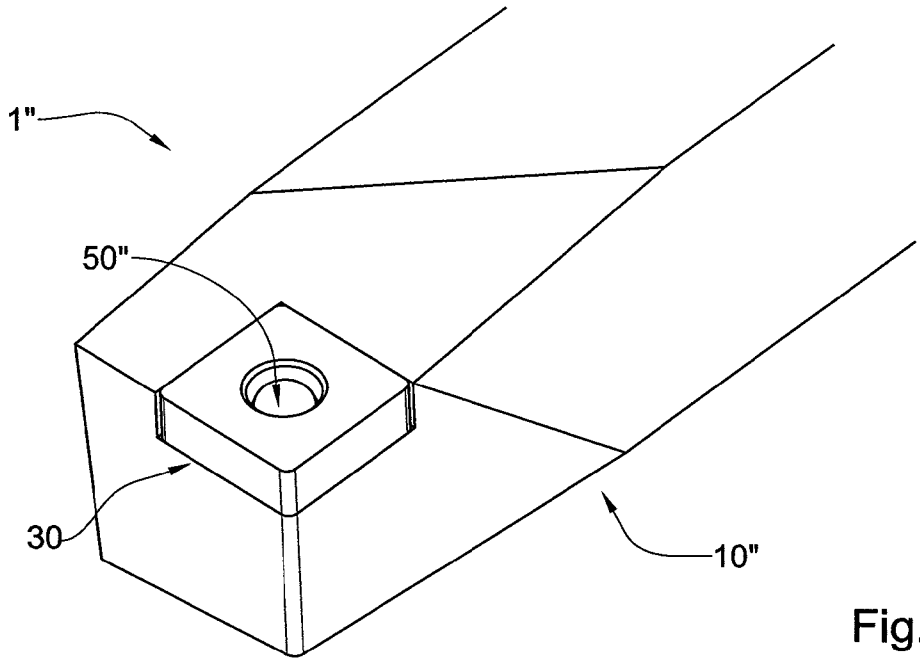

Fig. 5A

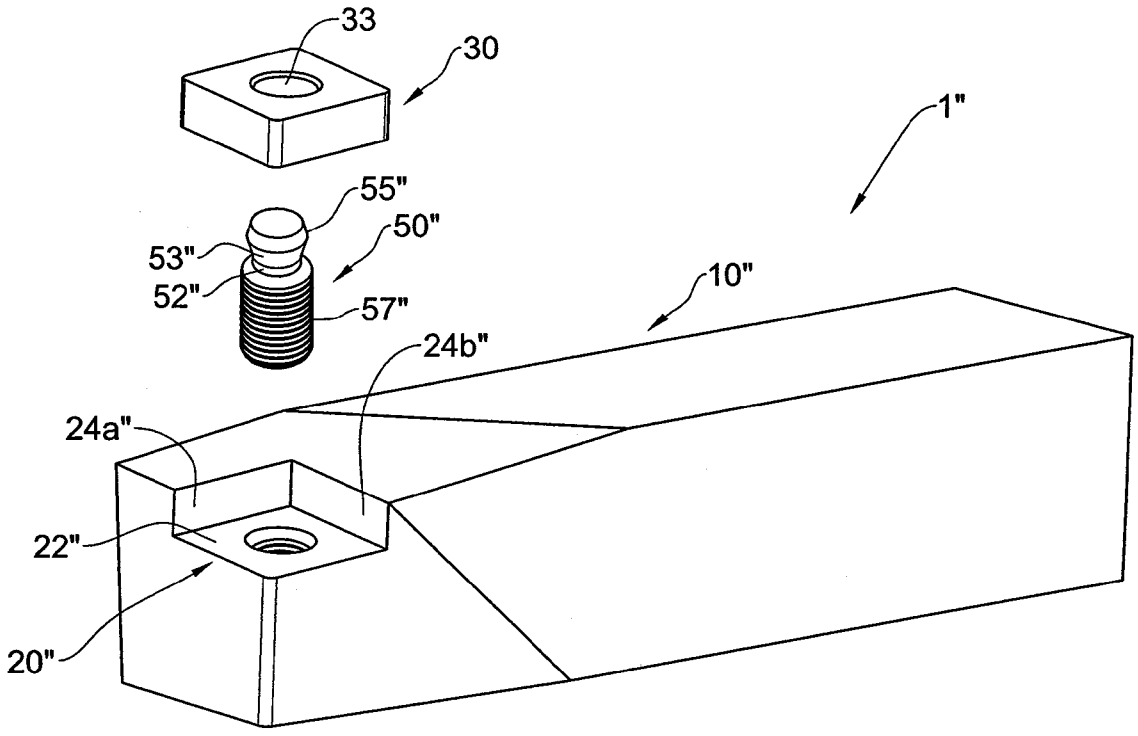

Fig. 5B

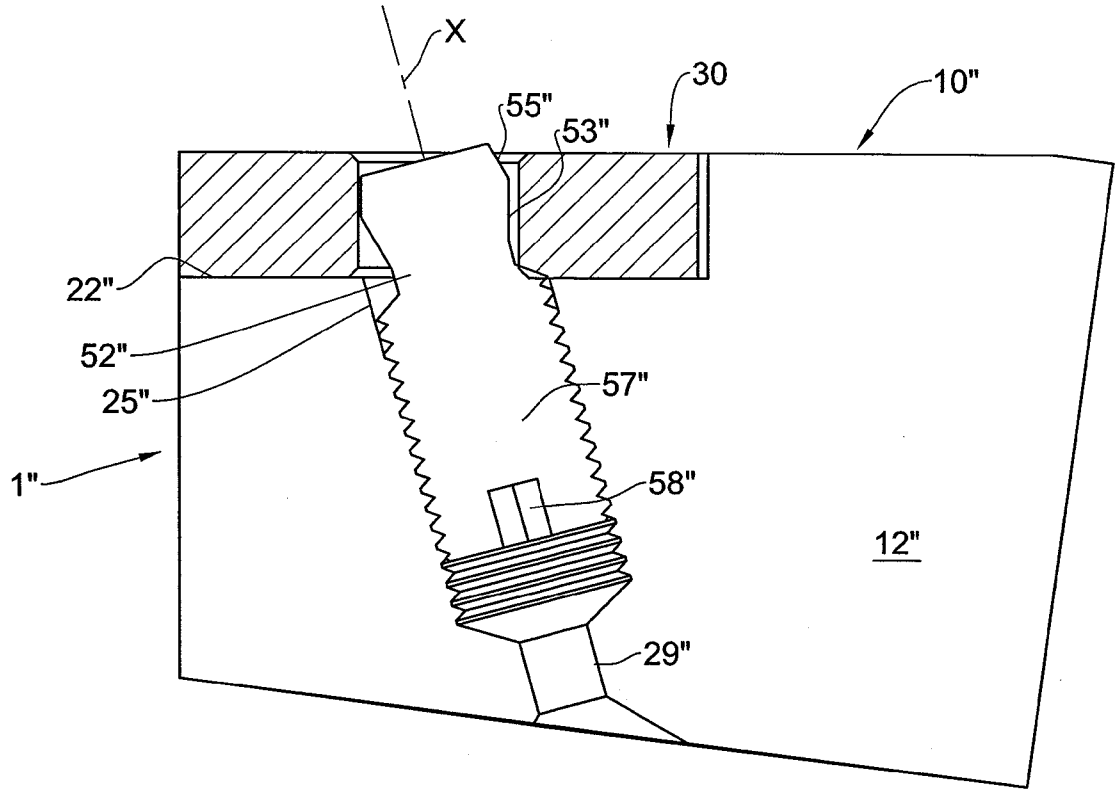

Fig. 6A

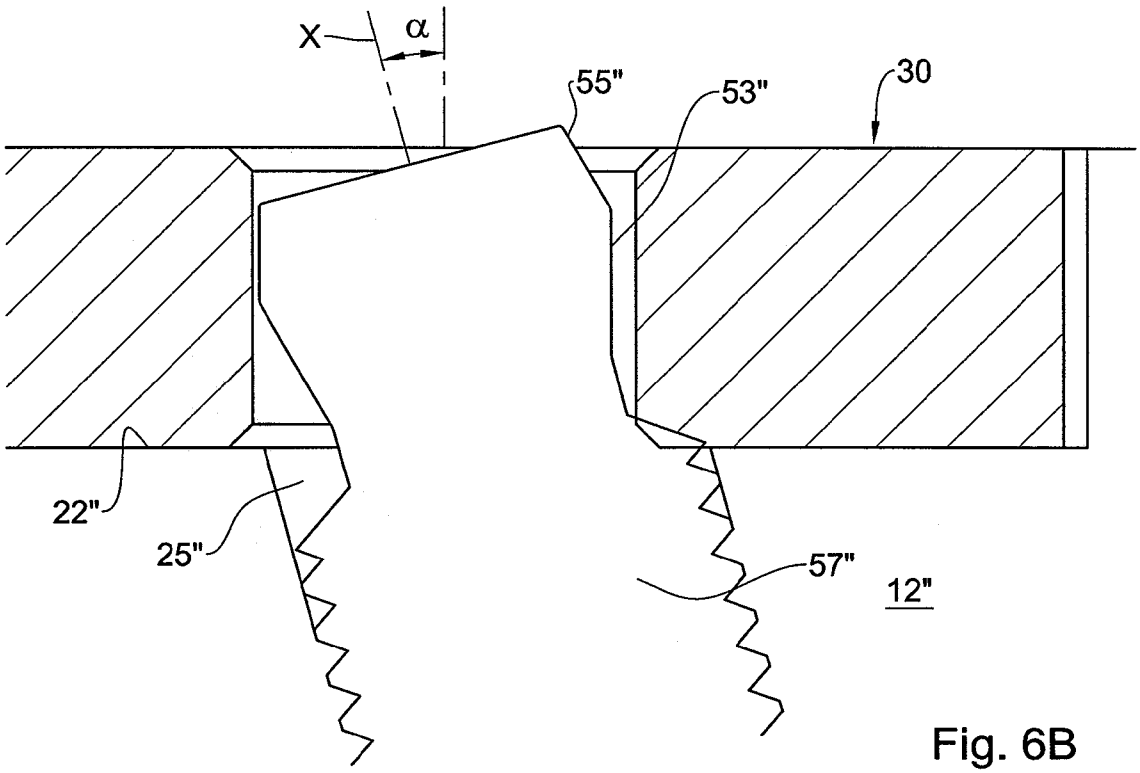

Fig. 6B

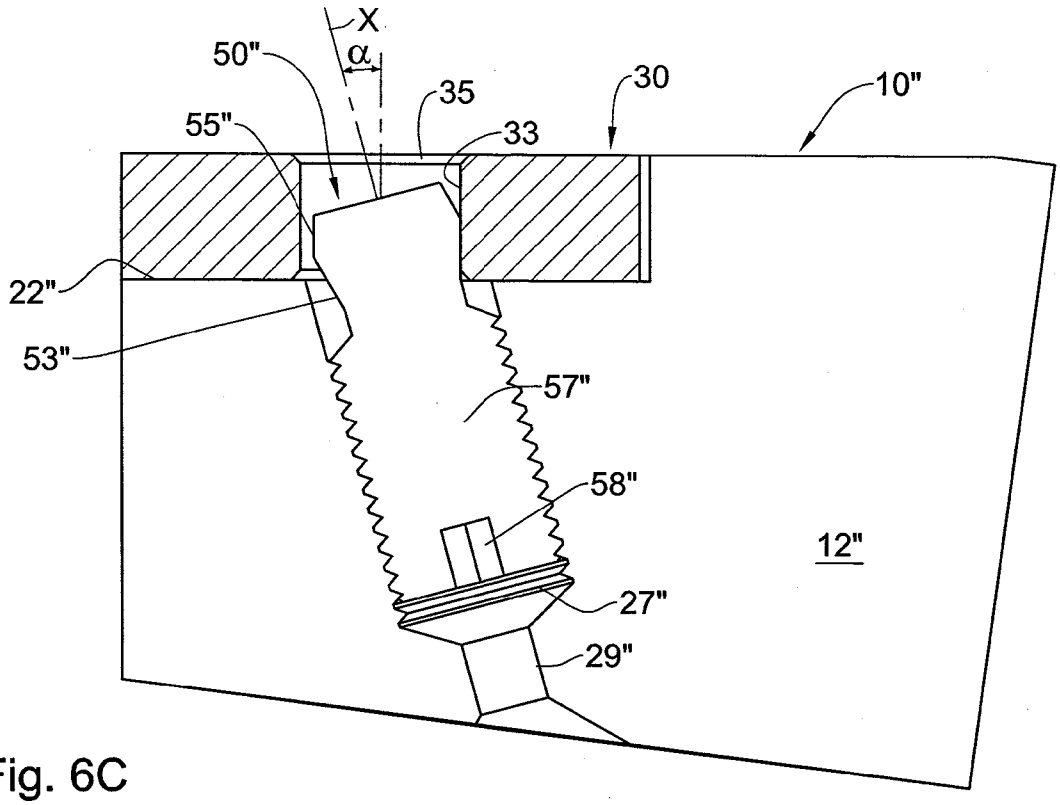
X
α
50"
35
30
10"
55"
33
22"
53"
57"
58"
12"
27"
29"

Fig. 6C

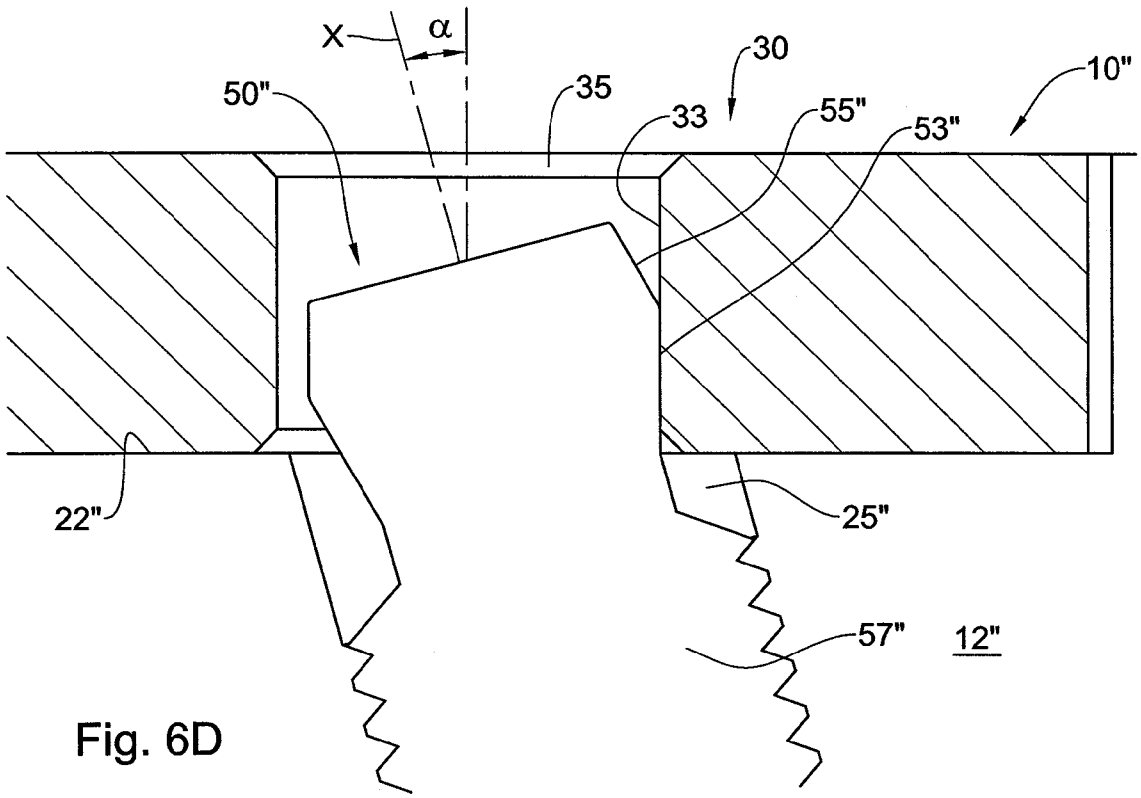
X
α
30
10"
50"
35
33
55"
53"
22"
25"
57"
12"

Fig. 6D

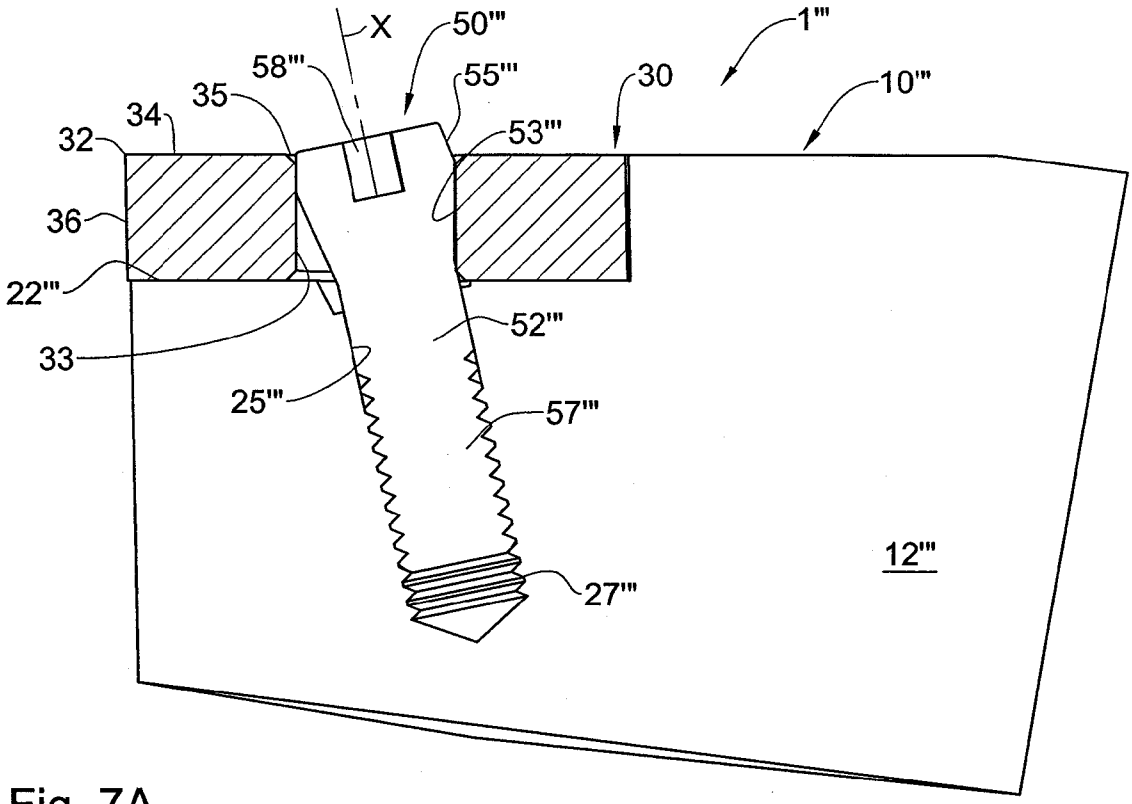
X
50'''
1'''
58'''
55'''
30
10'''
35
34
53'''
32
36
22'''
52'''
33
25'''
57'''
12'''
27'''

Fig. 7A

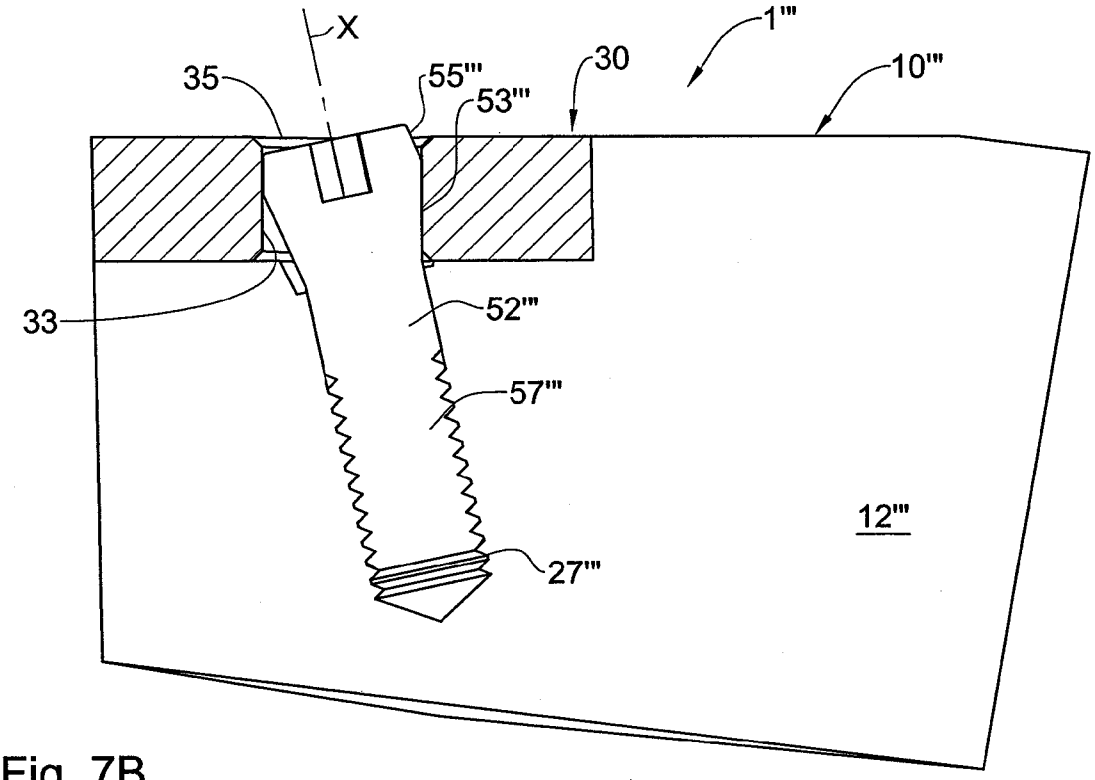
X
1'''
35
55'''
30
10'''
53'''
33
52'''
57'''
12'''
27'''

Fig. 7B

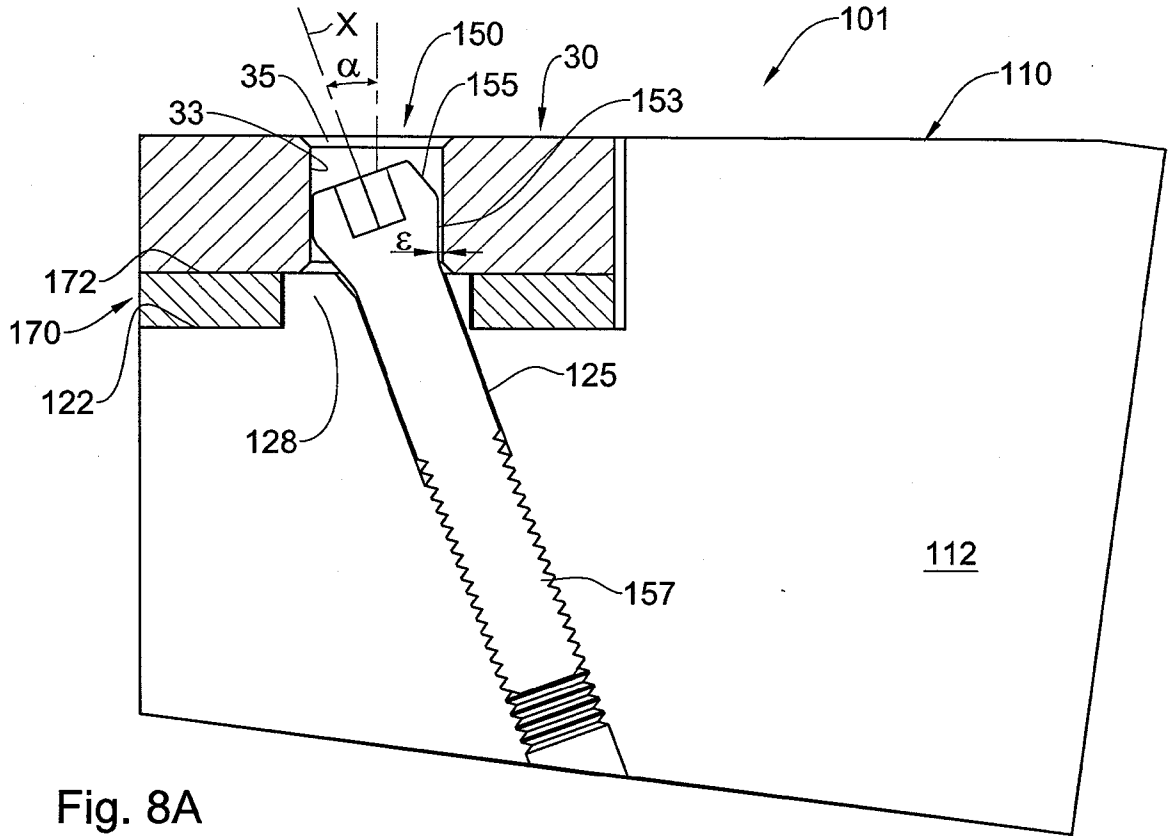
X
α
150
155
30
101
110
35
33
153
ε
172
170
122
125
128
112
157

Fig. 8A

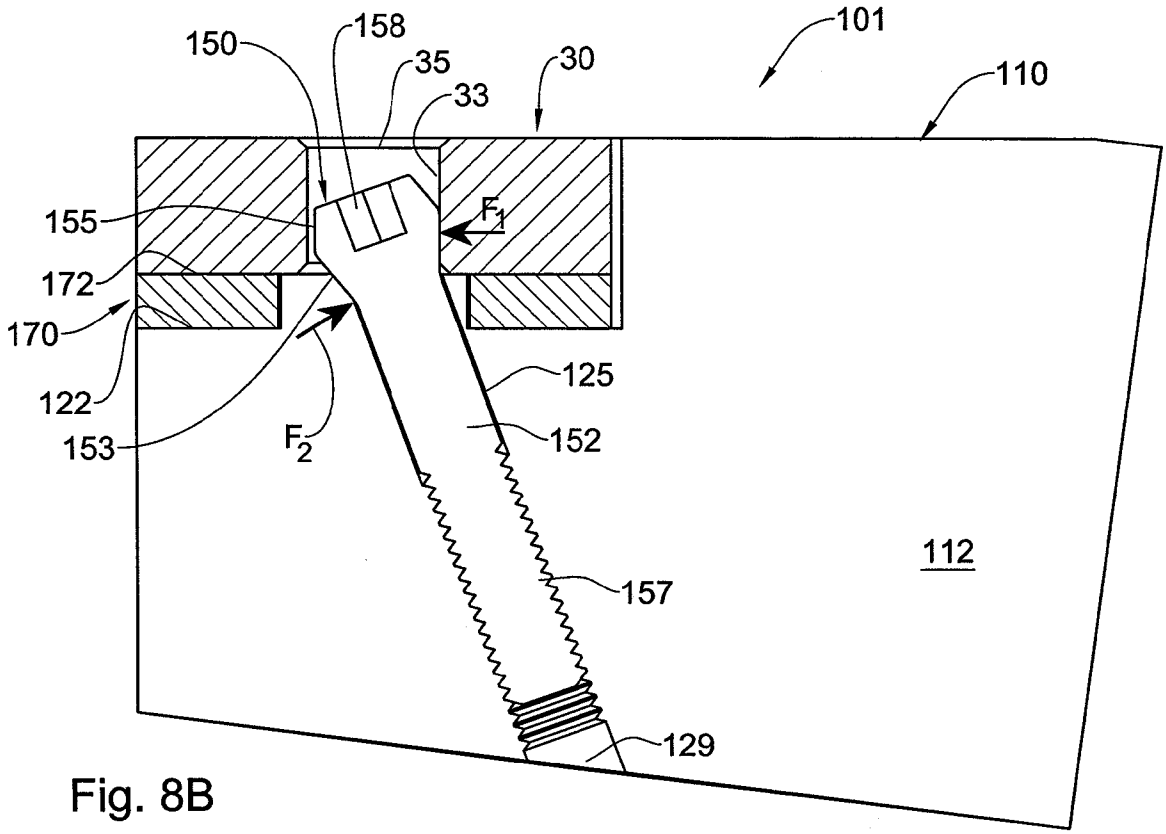
150
158
35
33
30
101
110
155
F1
172
170
122
153
F2
125
152
112
157
129

Fig. 8B

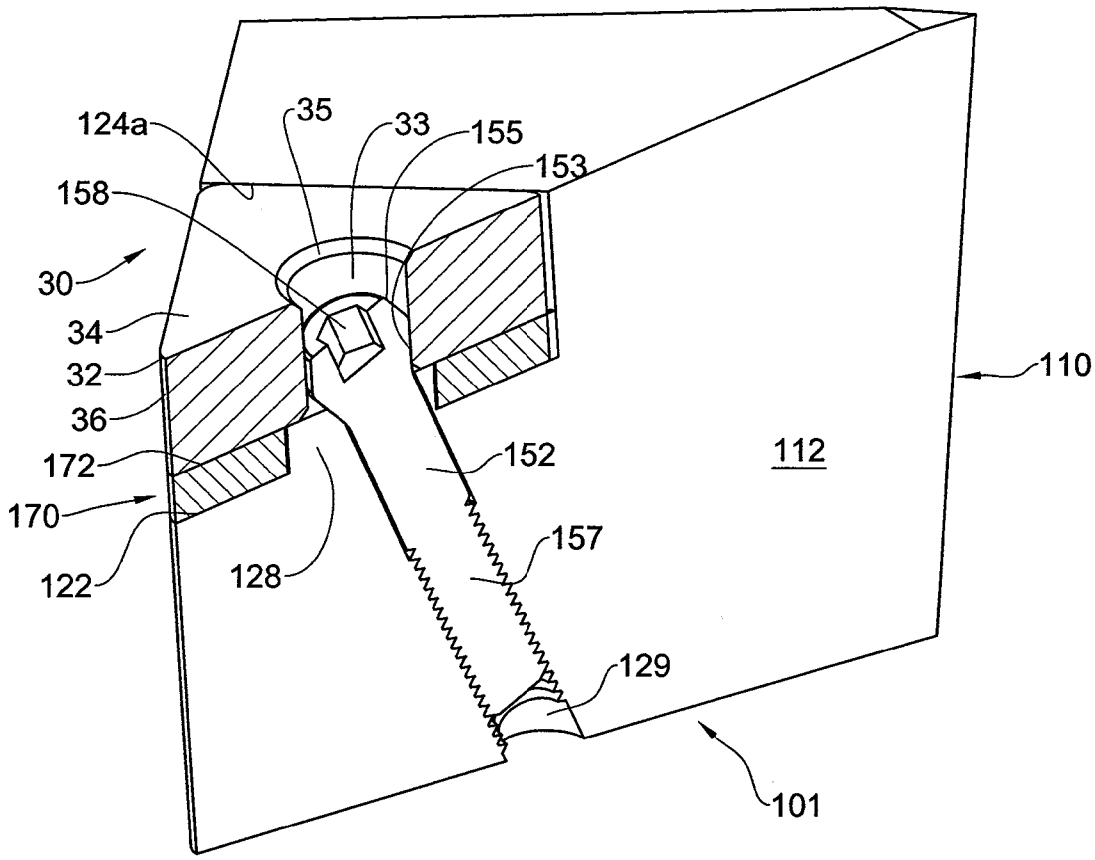
124a
35
33
155
153
158
30
34
32
36
172
170
122
128
152
112
110
157
129
101

Fig. 8C

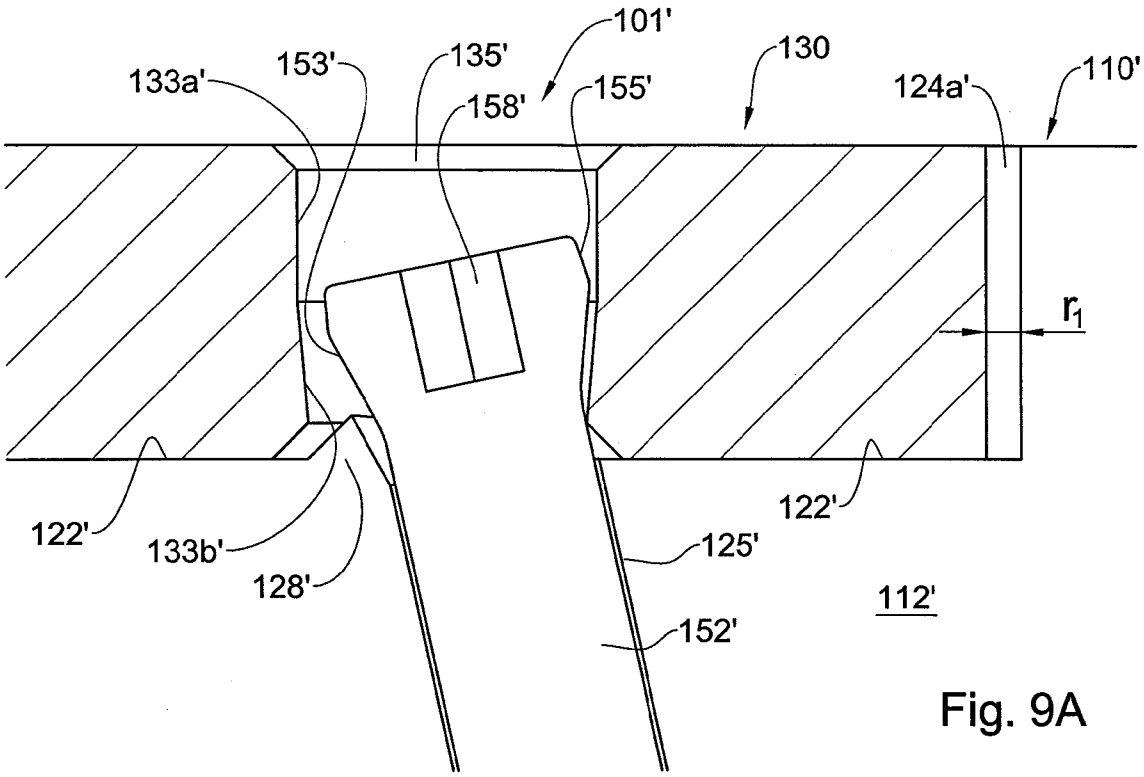
101'
130
110'
133a'
153'
135'
158'
155'
124a'
r_1
122'
133b'
128'
125'
122'
112'
152'

Fig. 9A

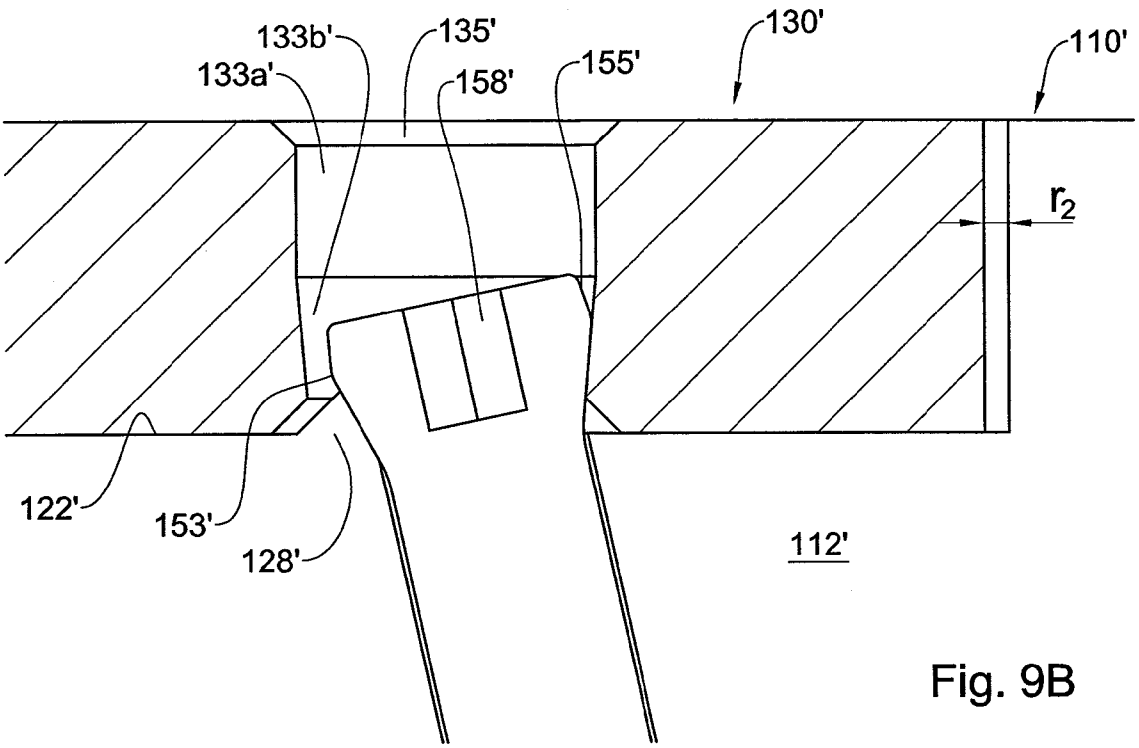
133b'
135'
130'
110'
133a'
158'
155'
r_2
122'
153'
128'
112'

Fig. 9B

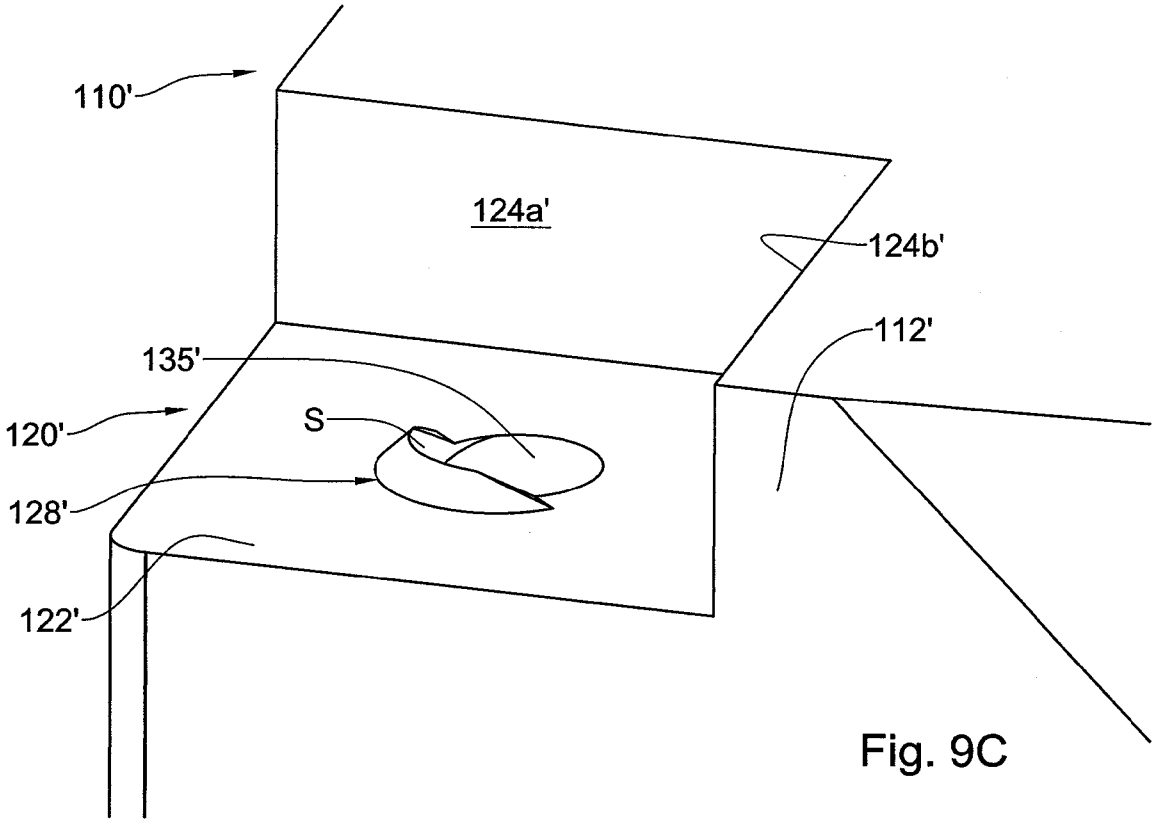

Fig. 9C

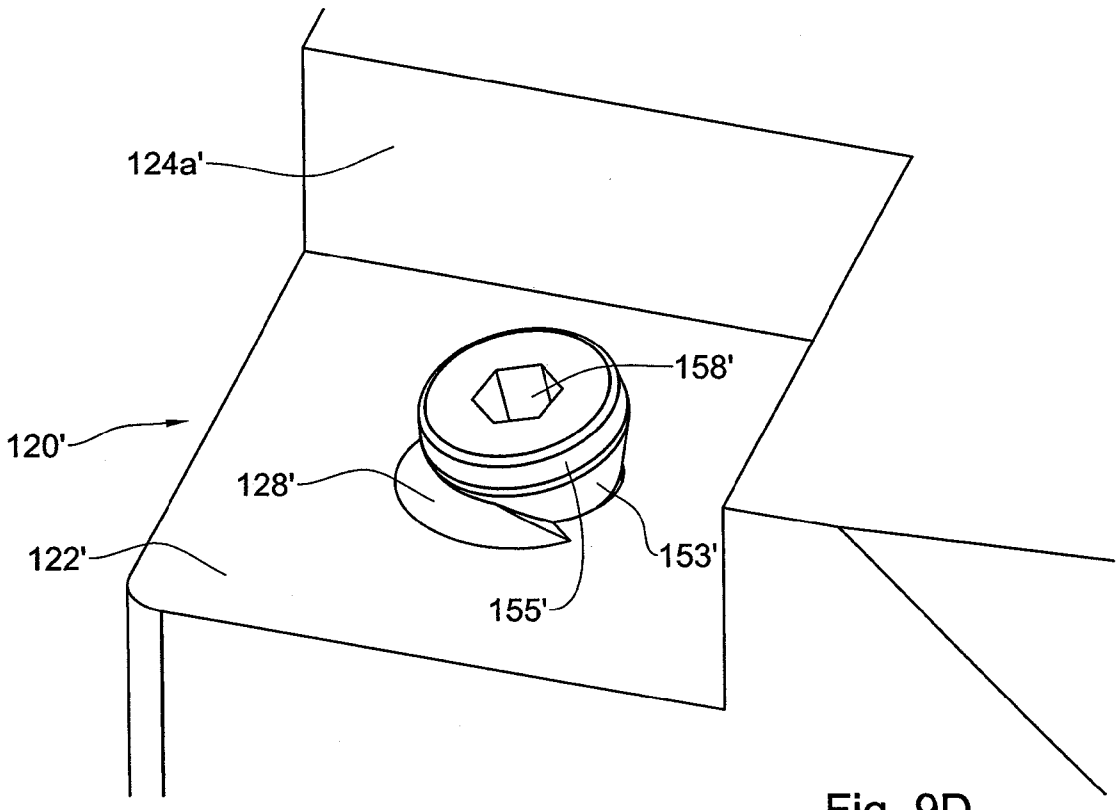

Fig. 9D

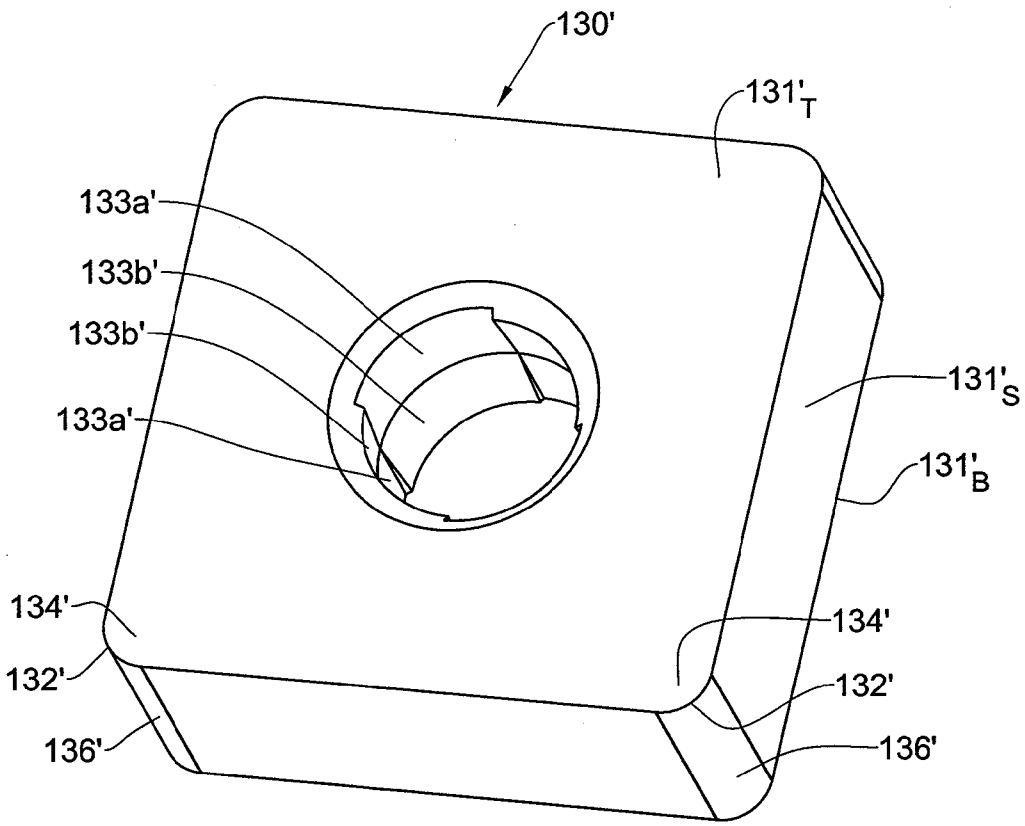

Fig. 10A

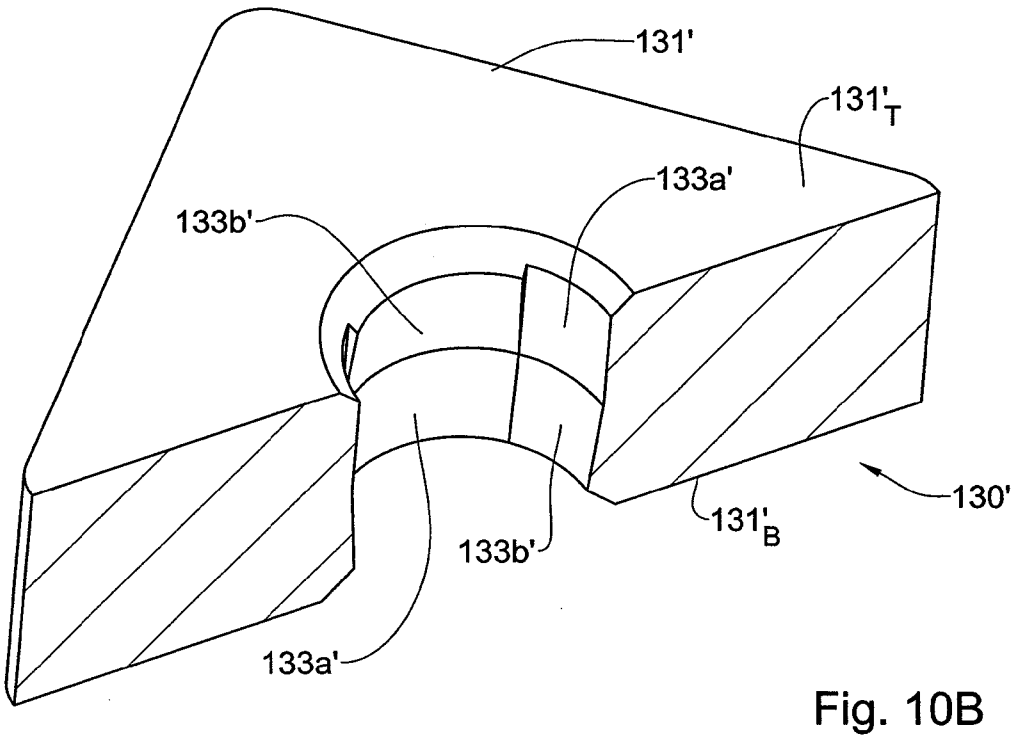

Fig. 10B

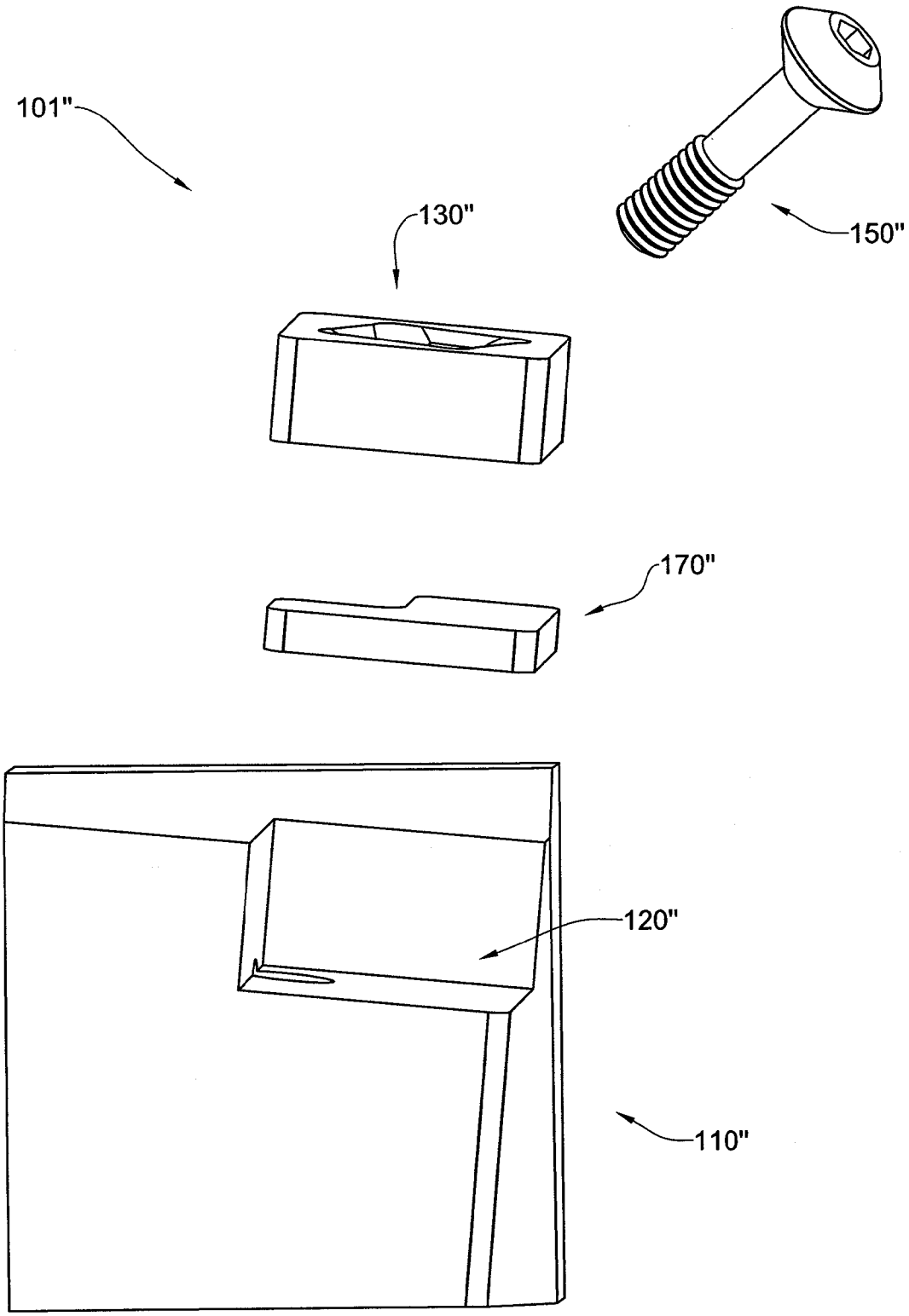

Fig. 11A

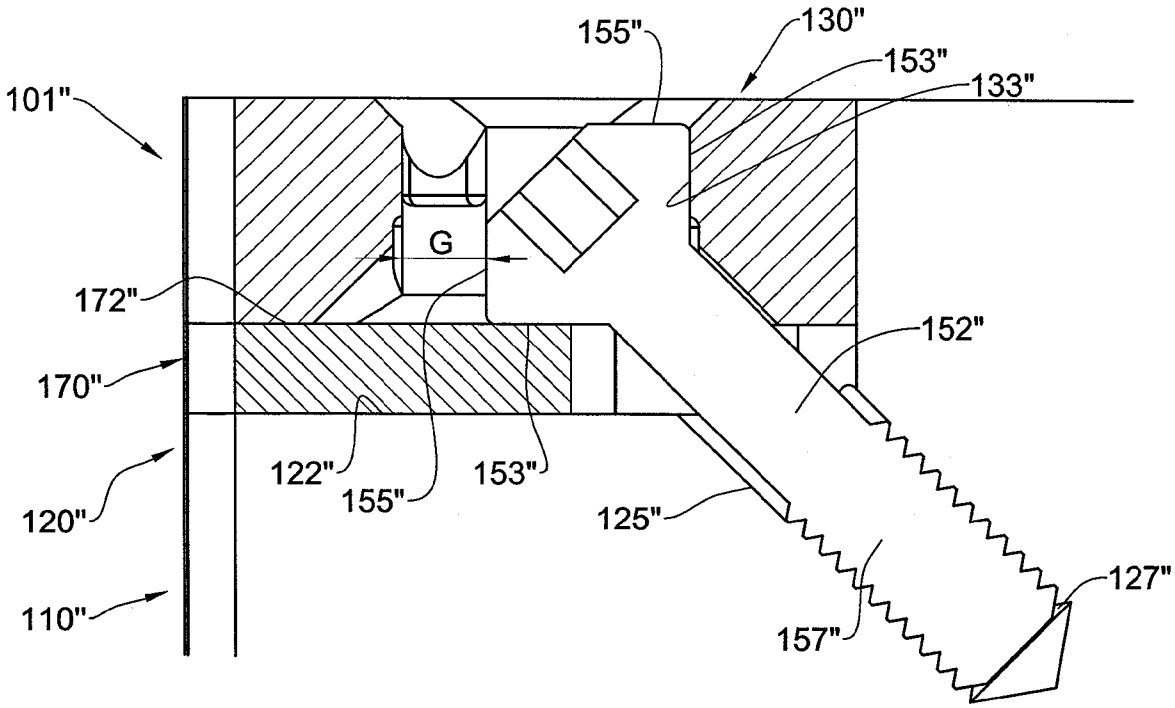

Fig. 11B

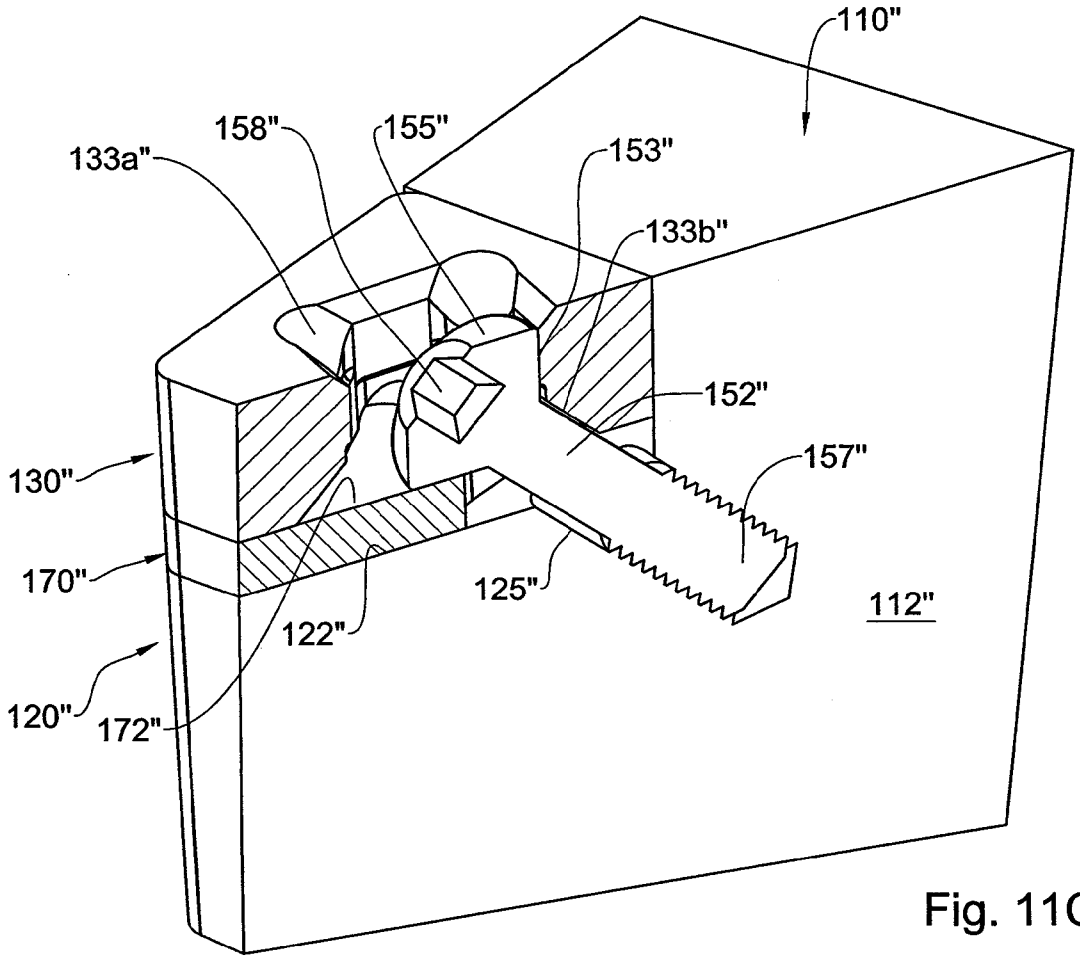

Fig. 11C

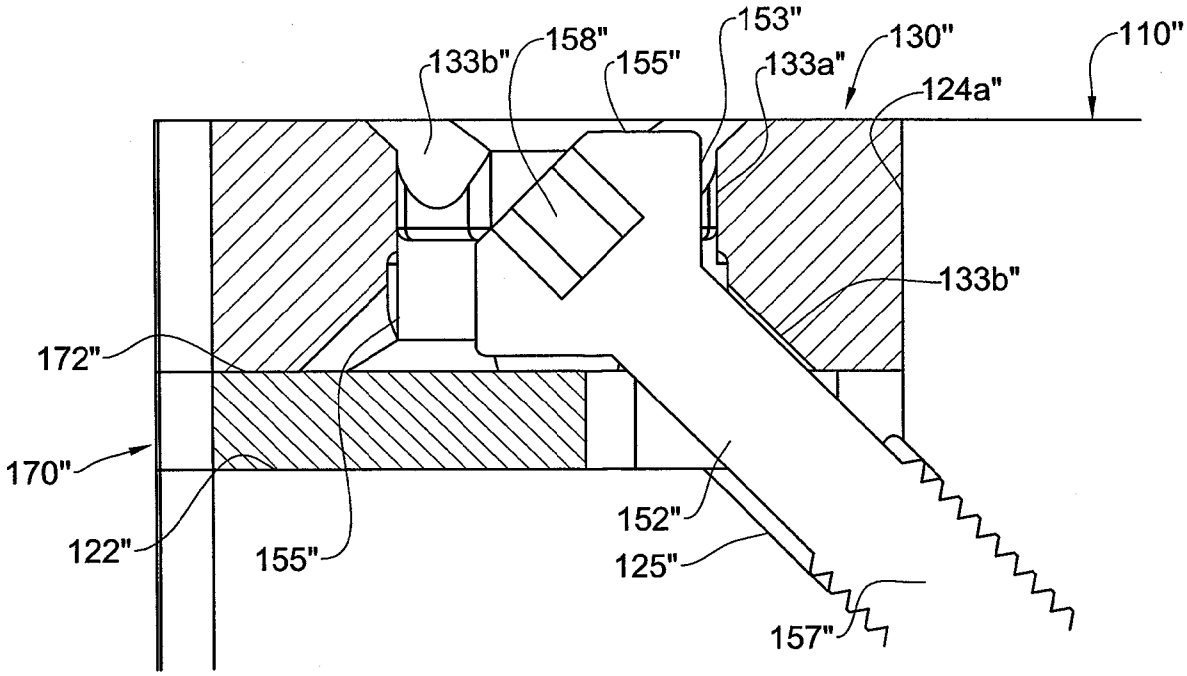

Fig. 11D

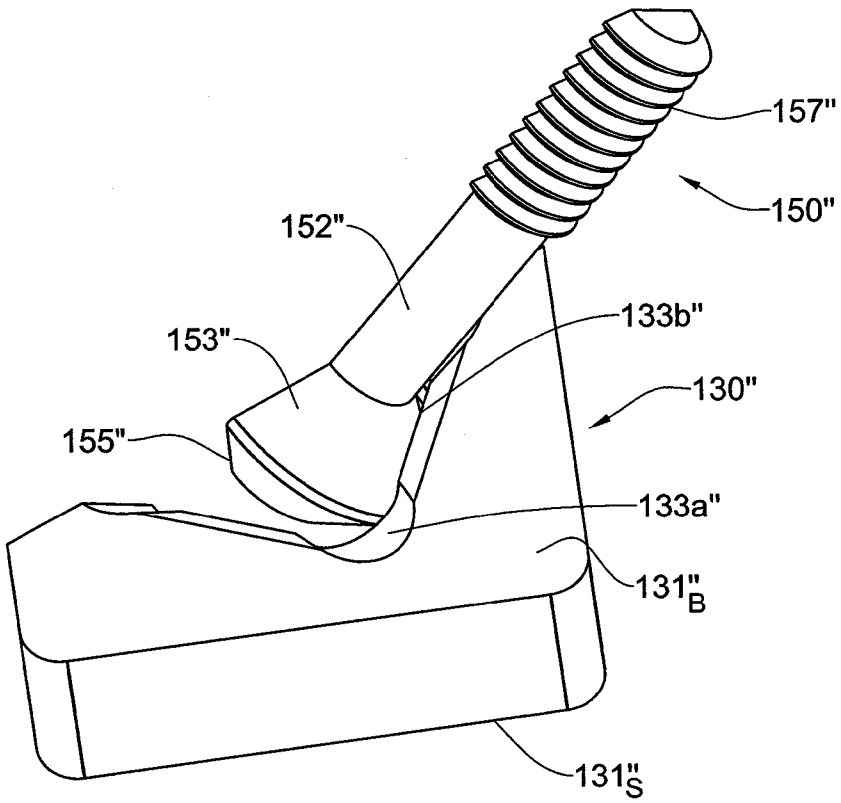

Fig. 11E

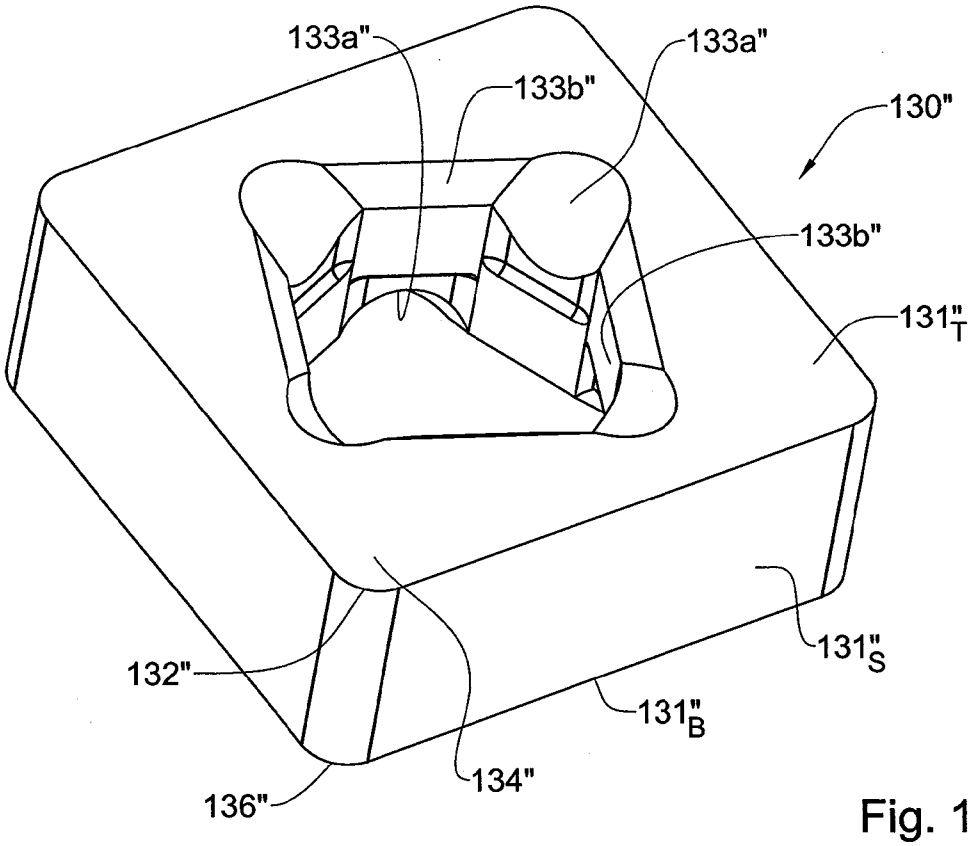

Fig. 12

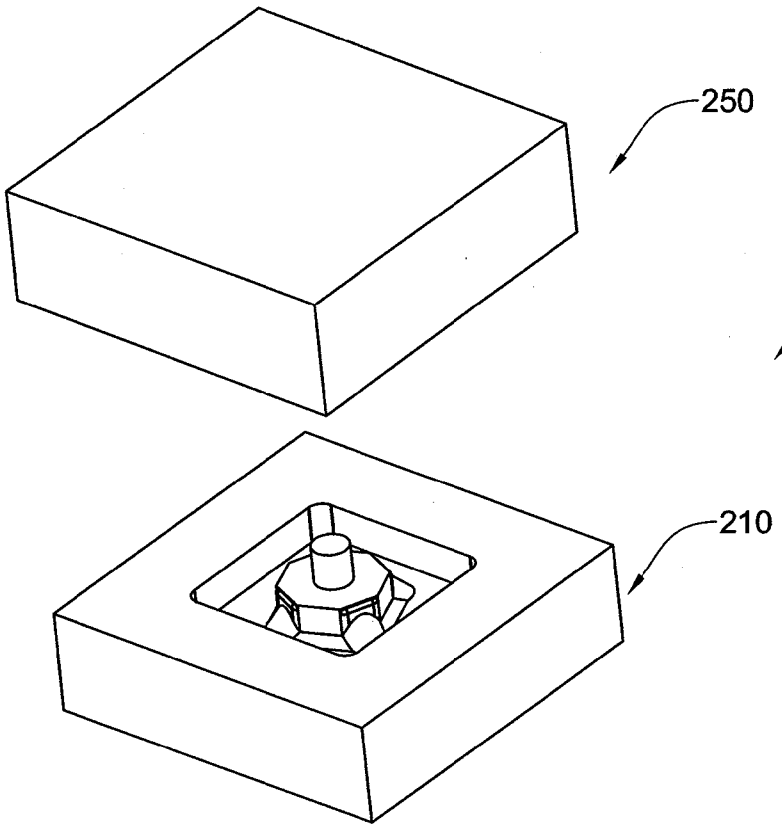

Fig. 13A

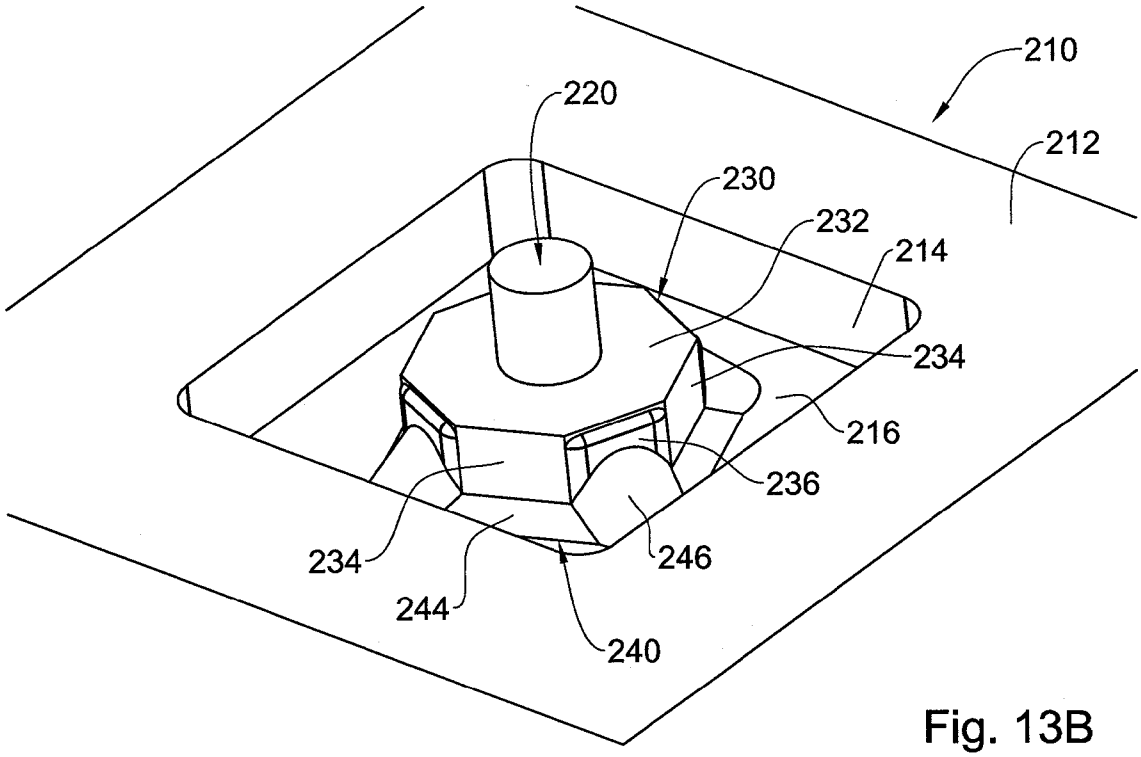

Fig. 13B

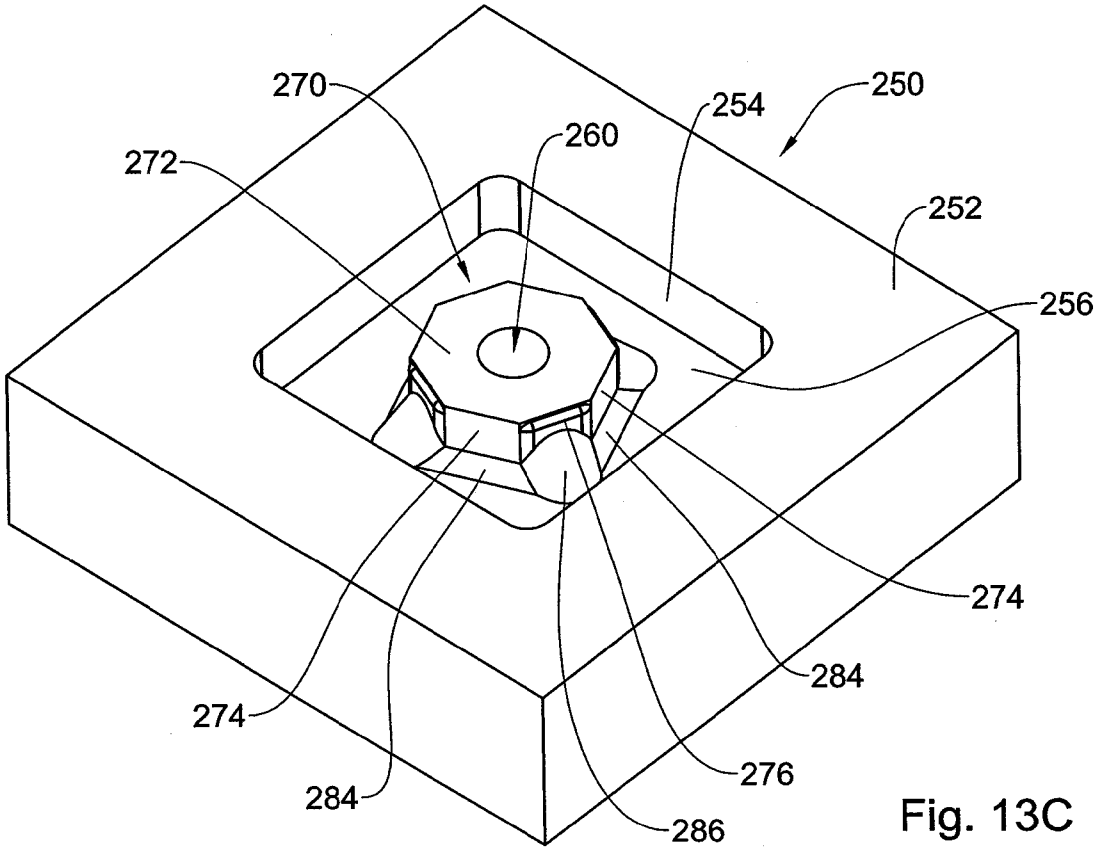

Fig. 13C

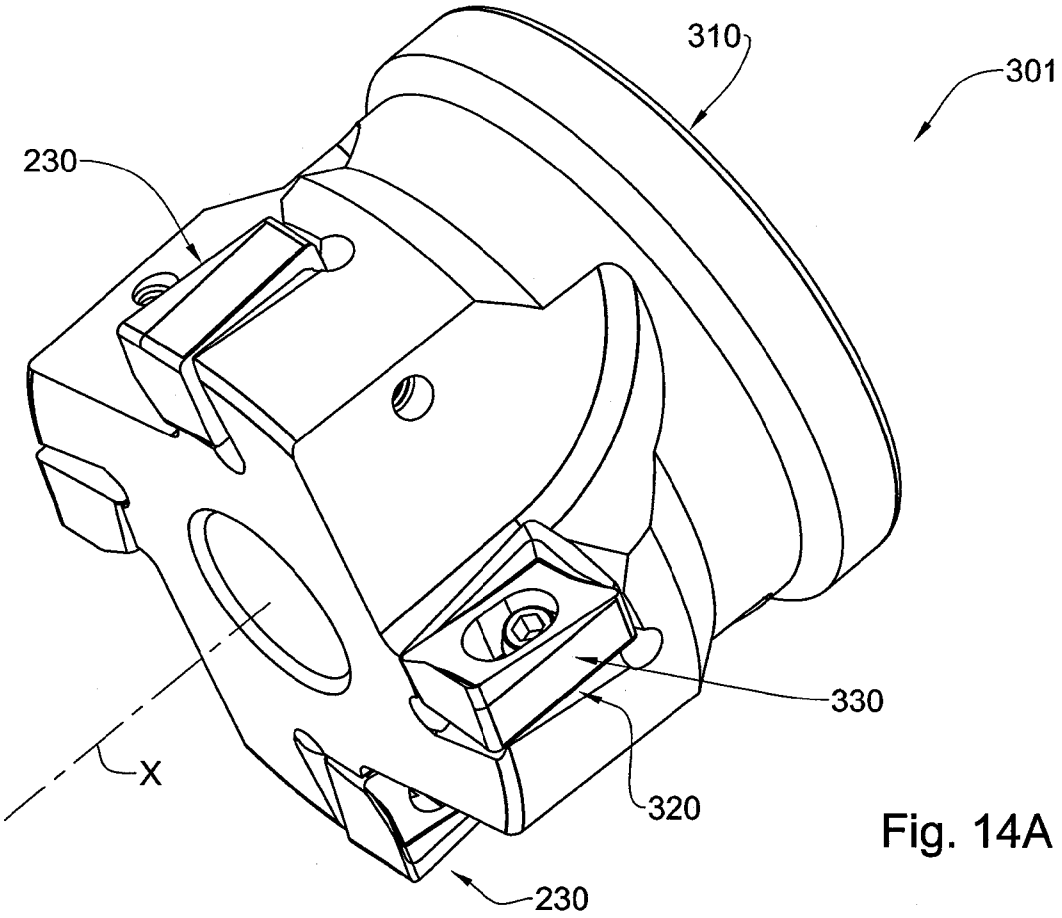

Fig. 14A

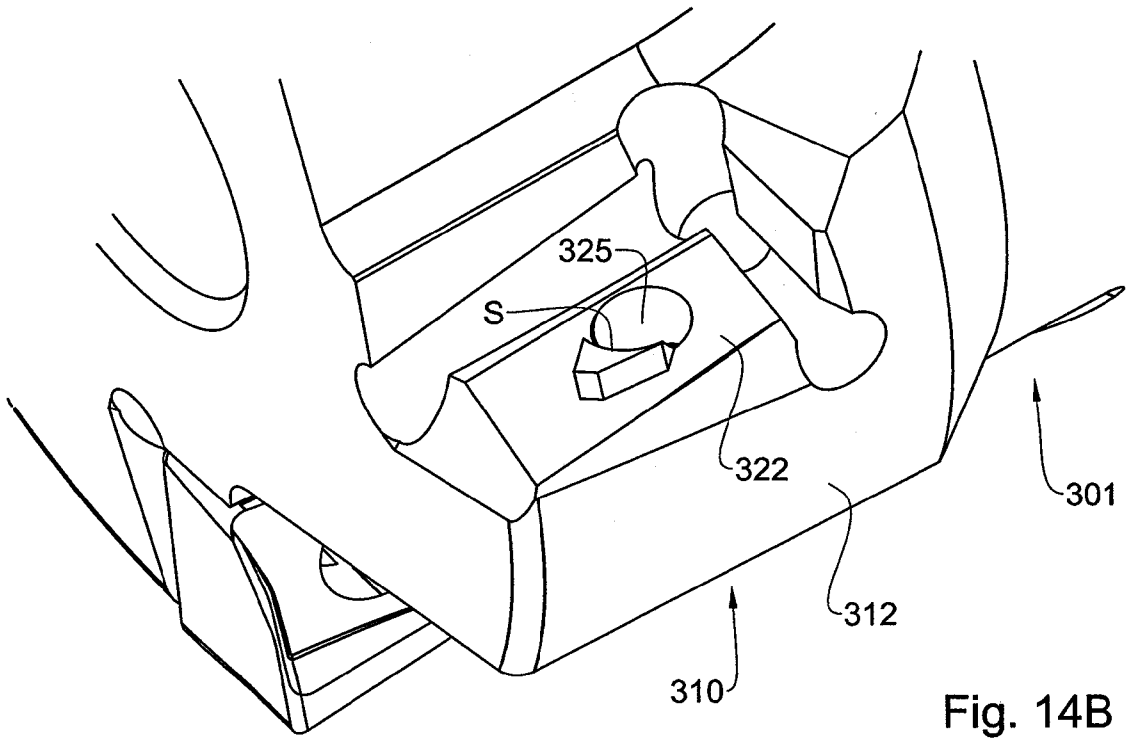

Fig. 14B

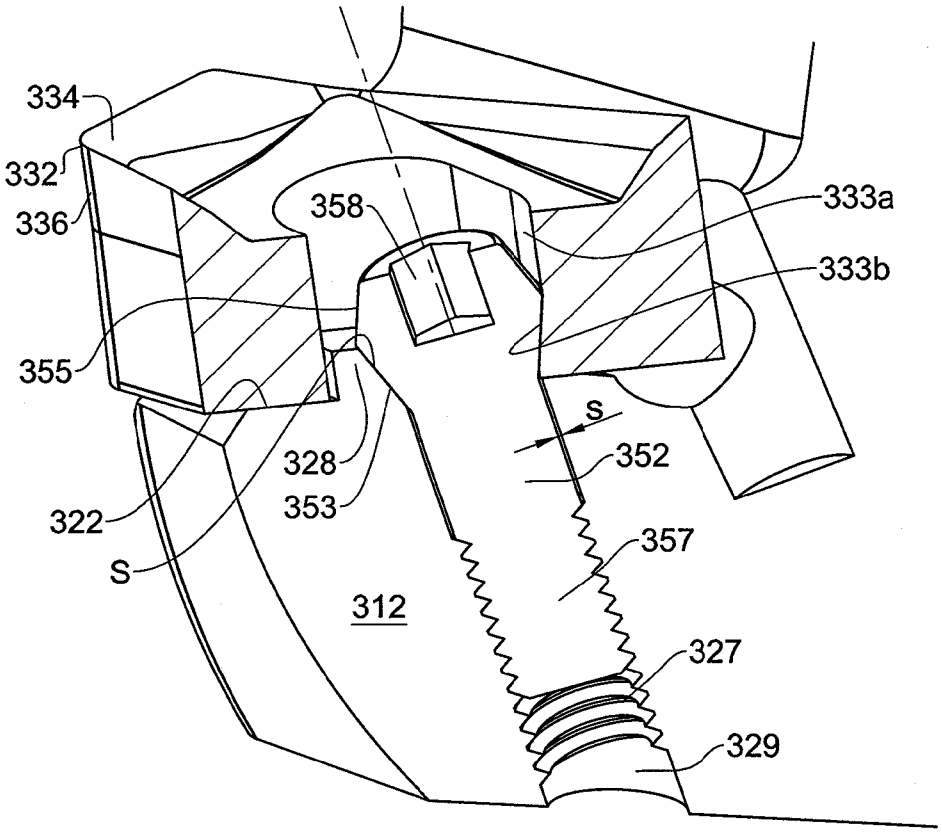

Fig. 15A

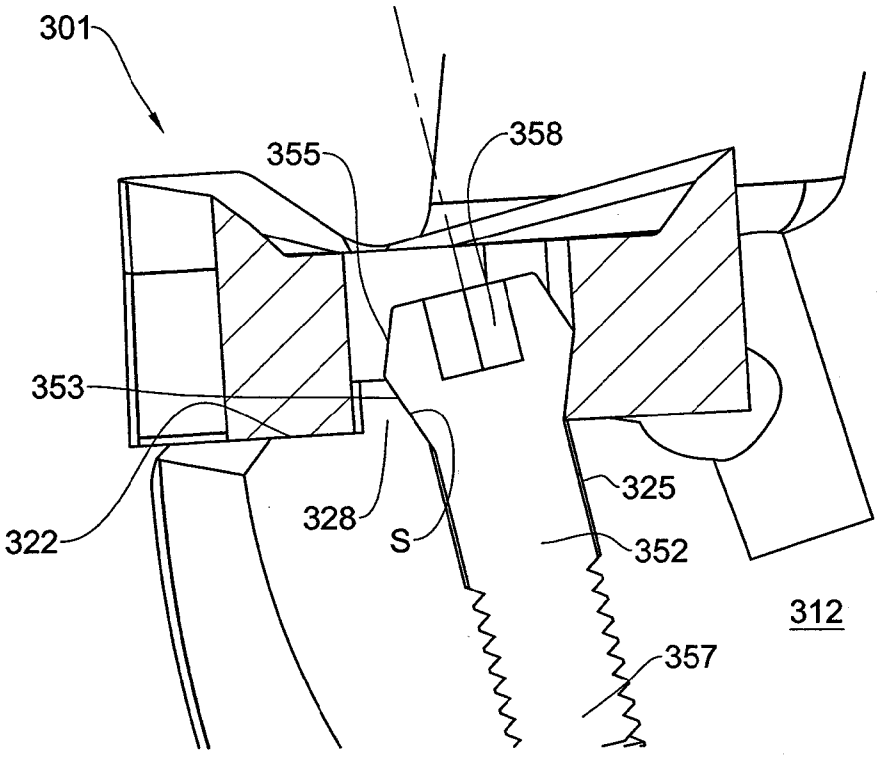

Fig. 15B

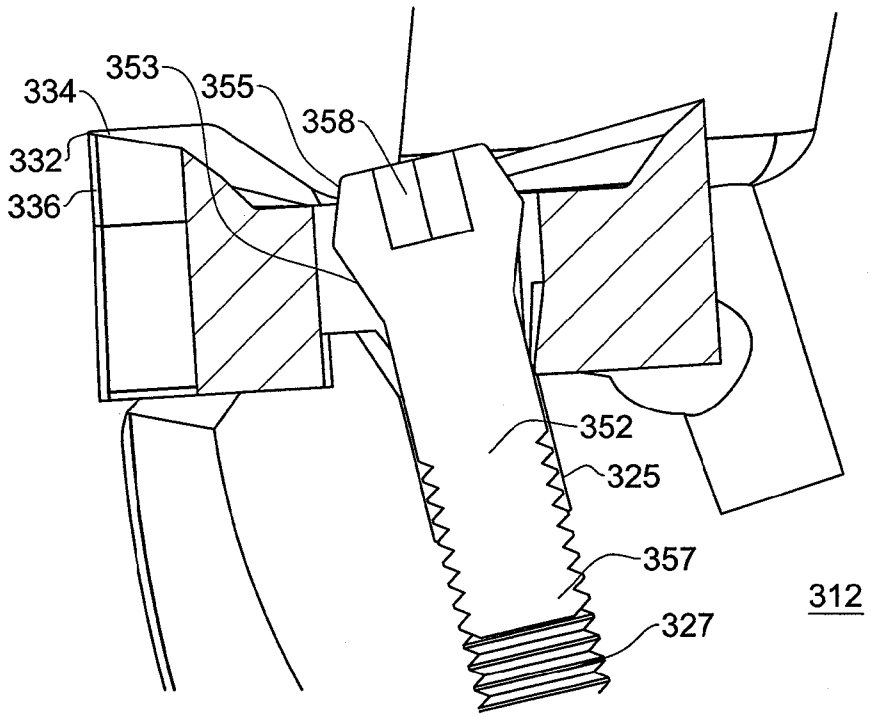

Fig. 15C

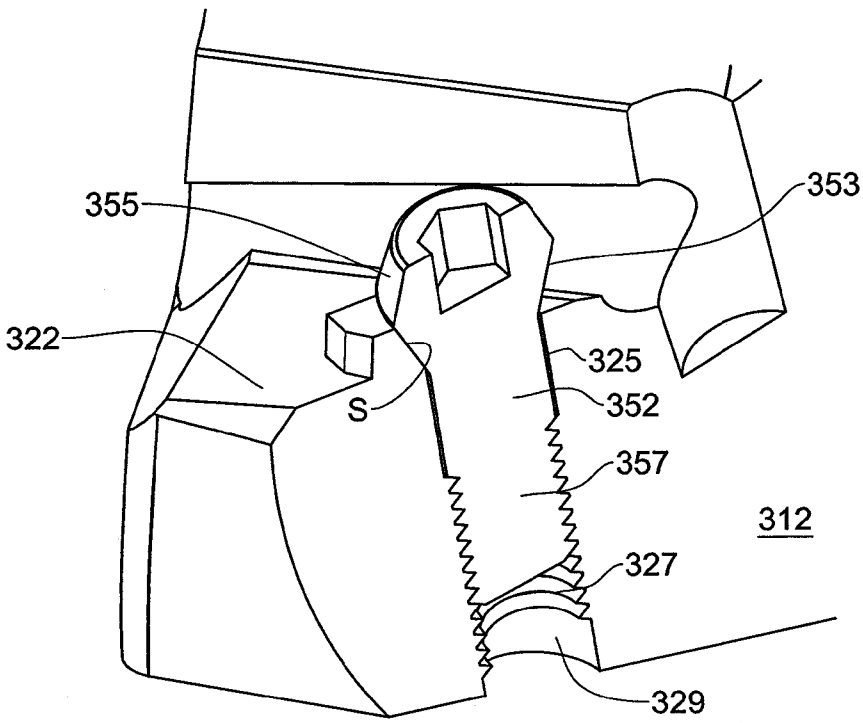

Fig. 16

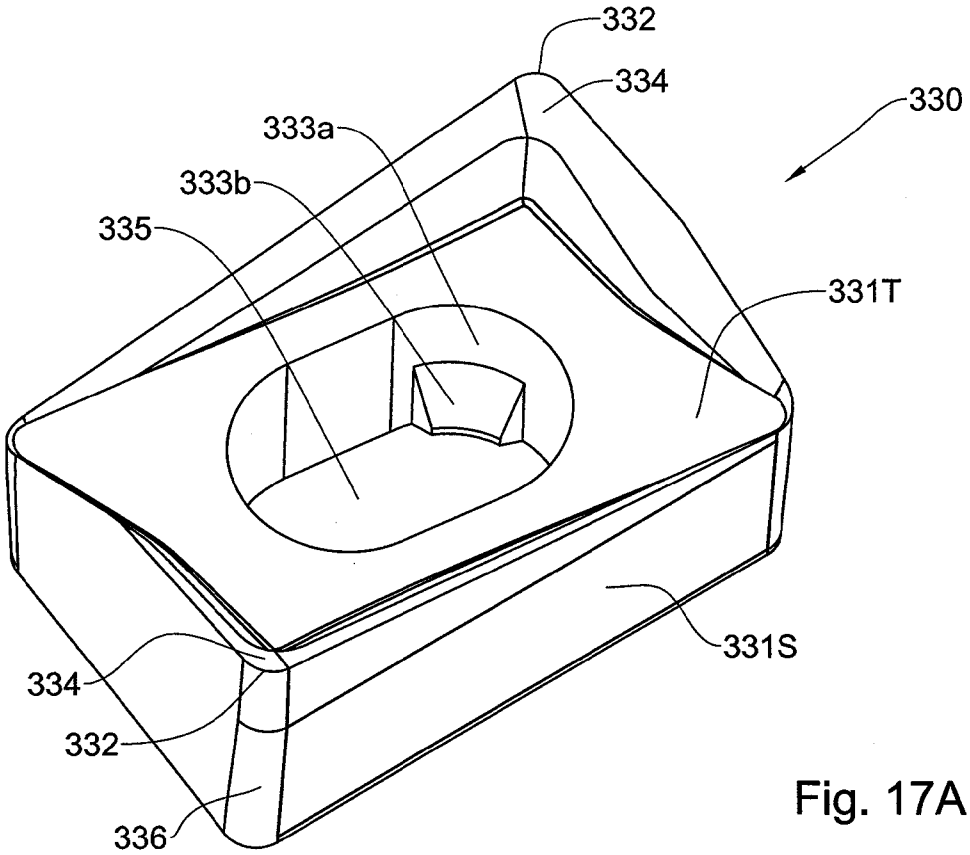

Fig. 17A

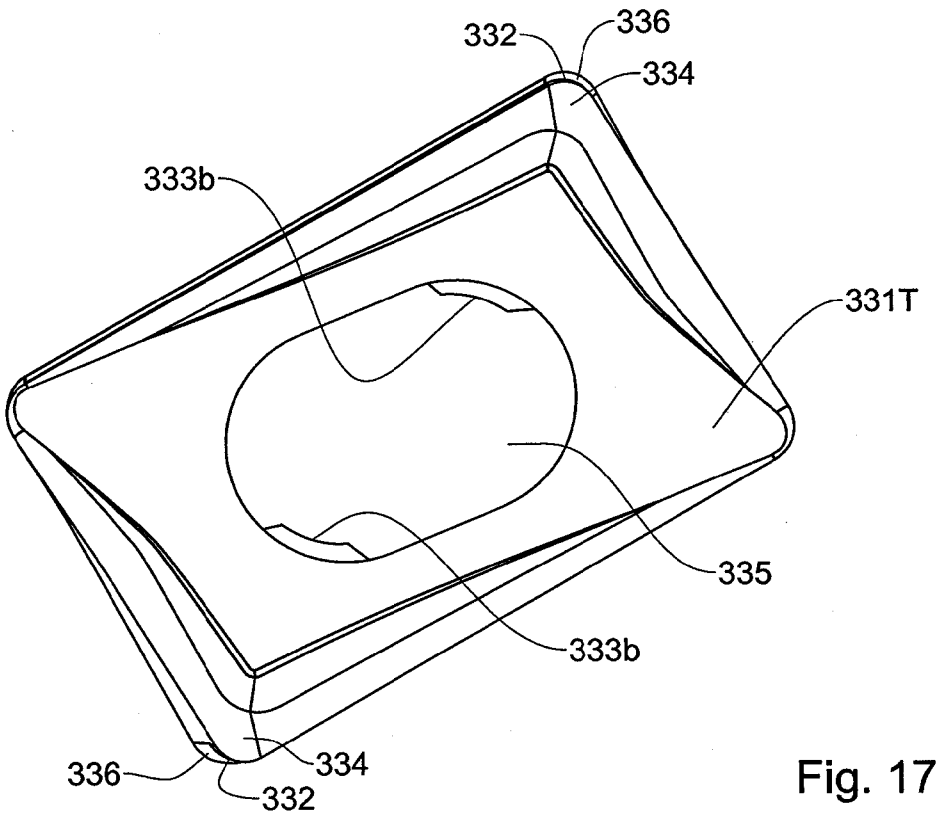

Fig. 17B

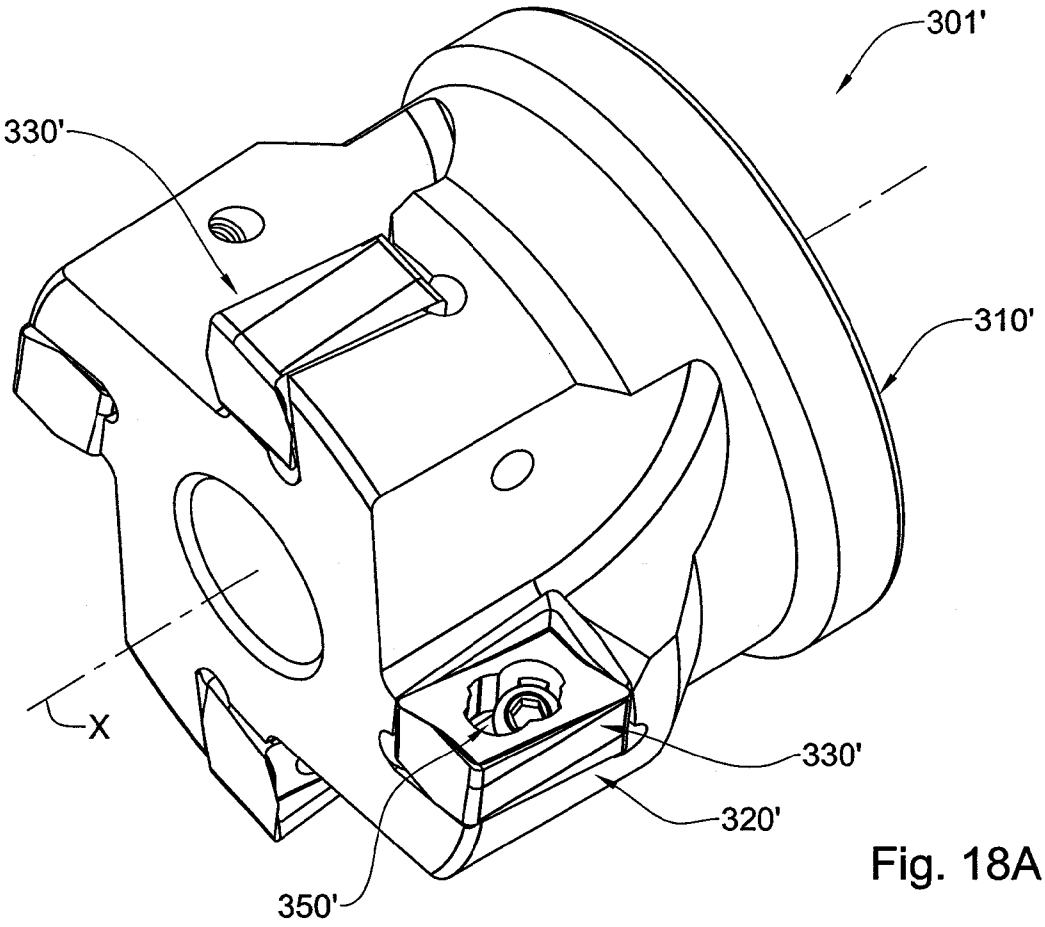

Fig. 18A

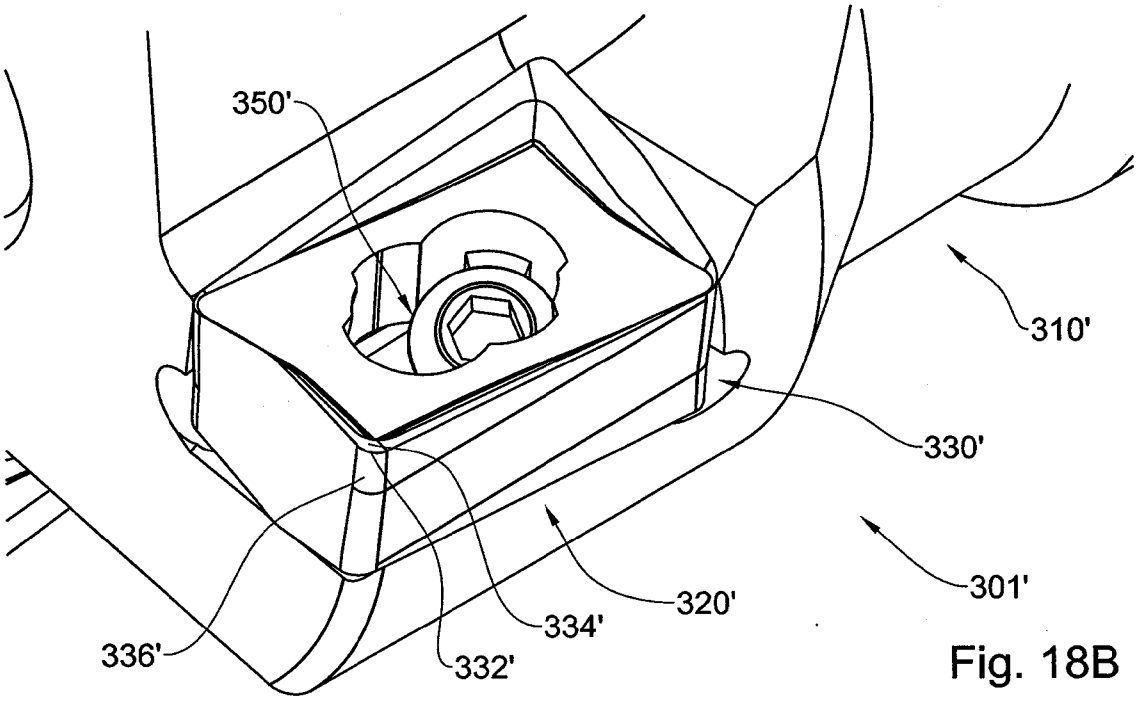

Fig. 18B

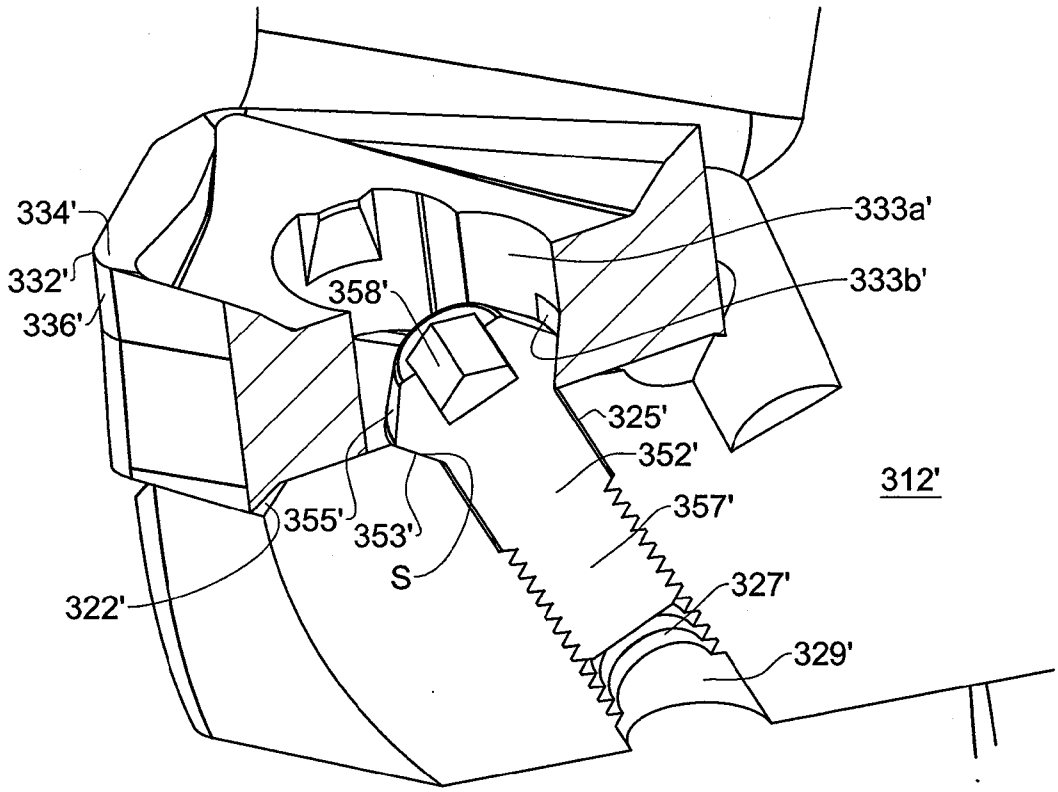

Fig. 19A

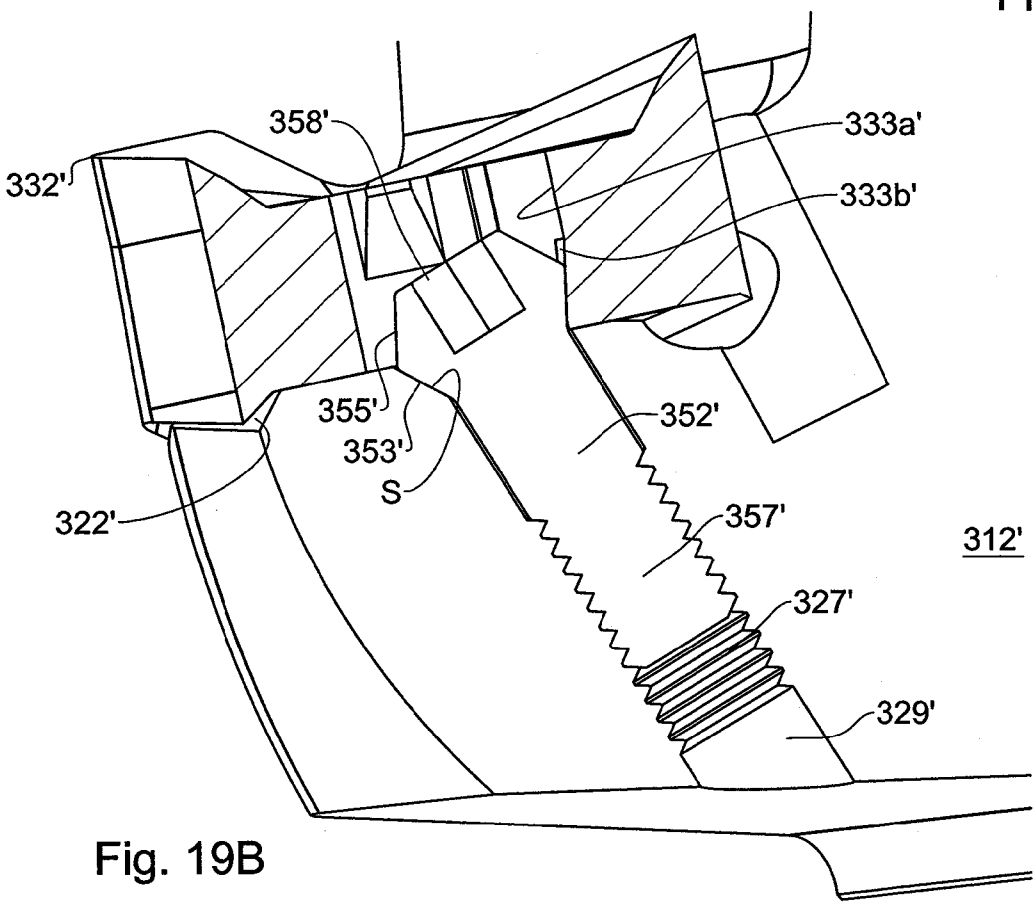

Fig. 19B

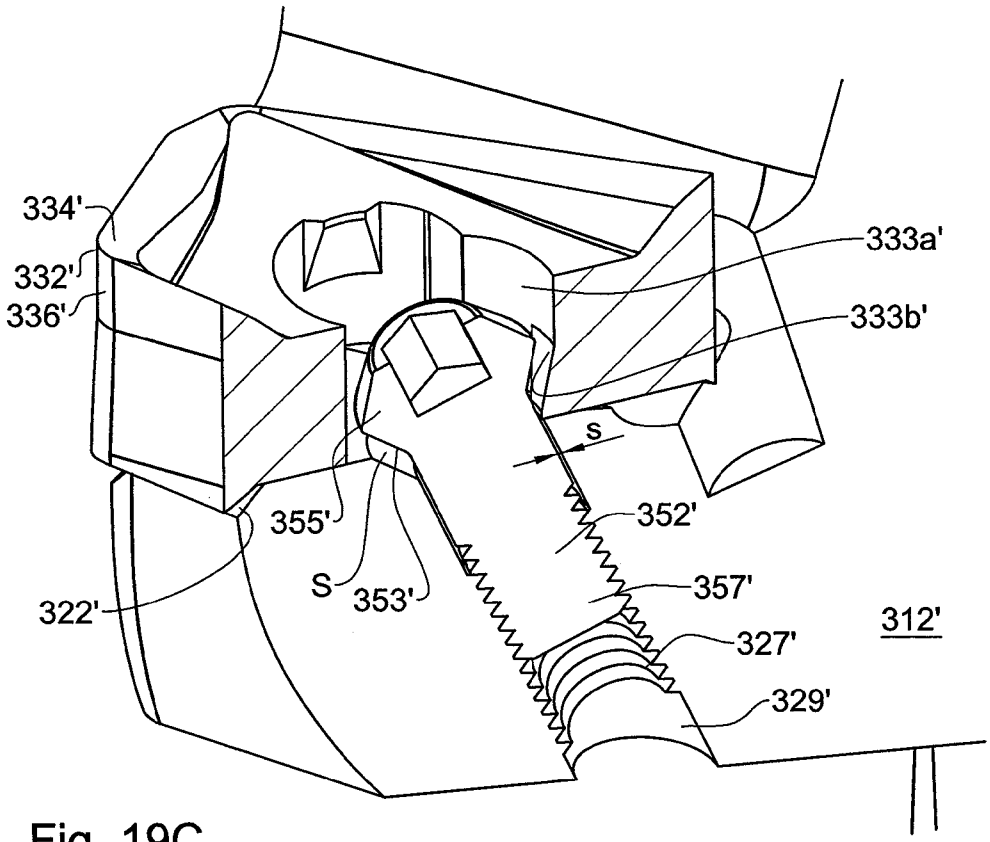

Fig. 19C

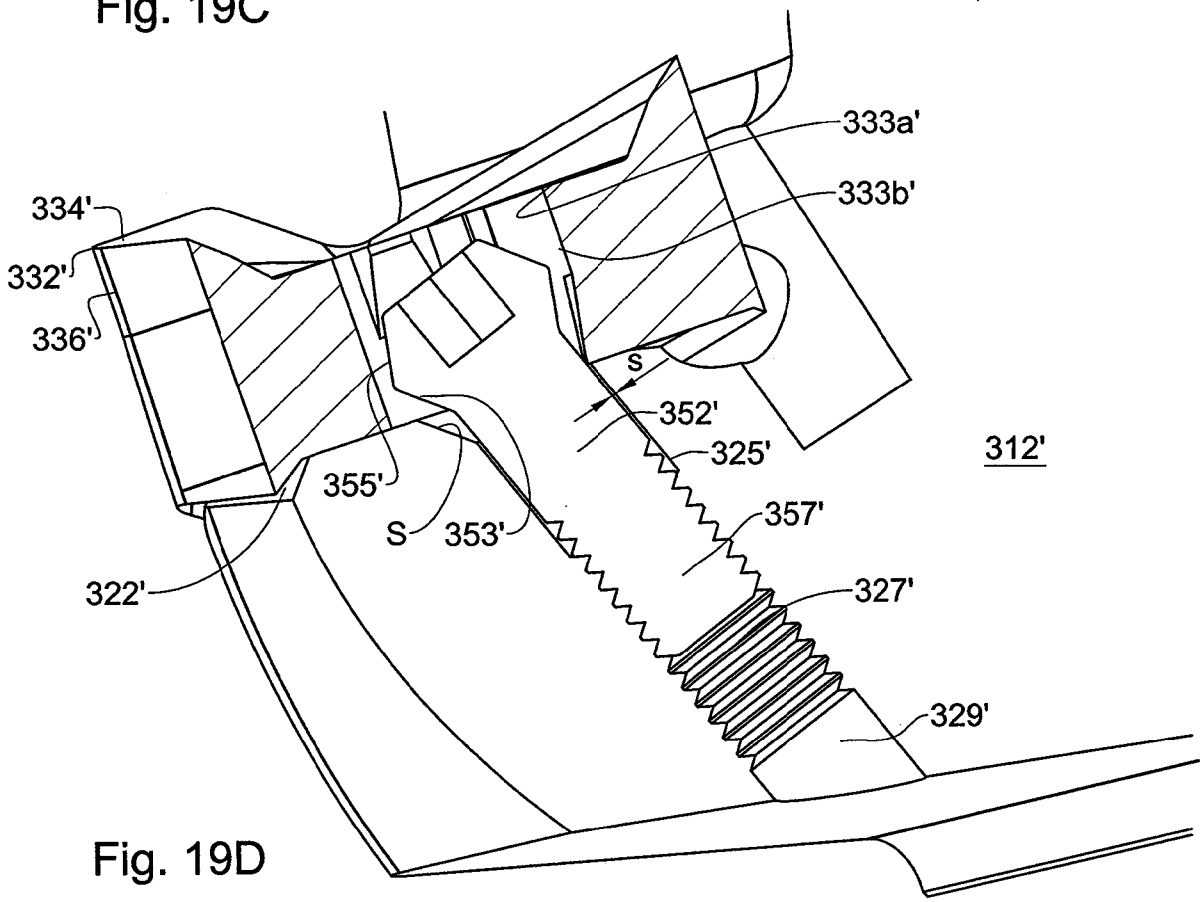

Fig. 19D

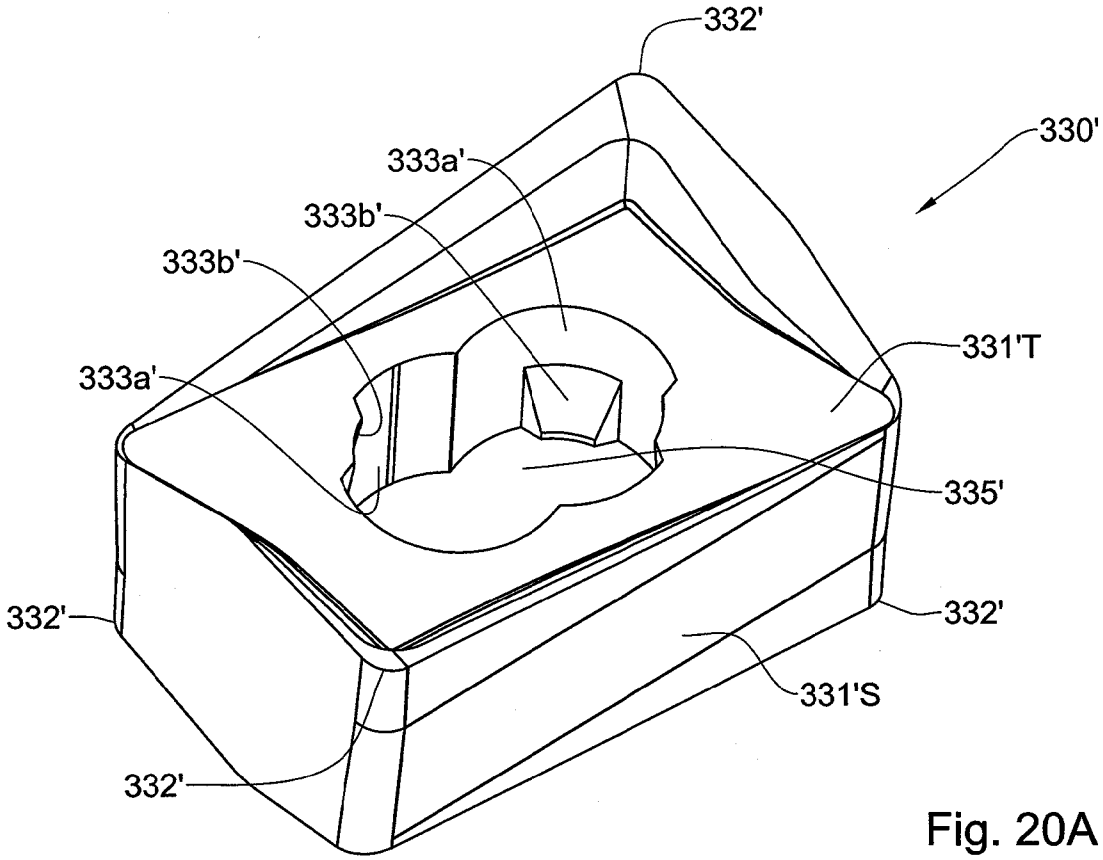

Fig. 20A

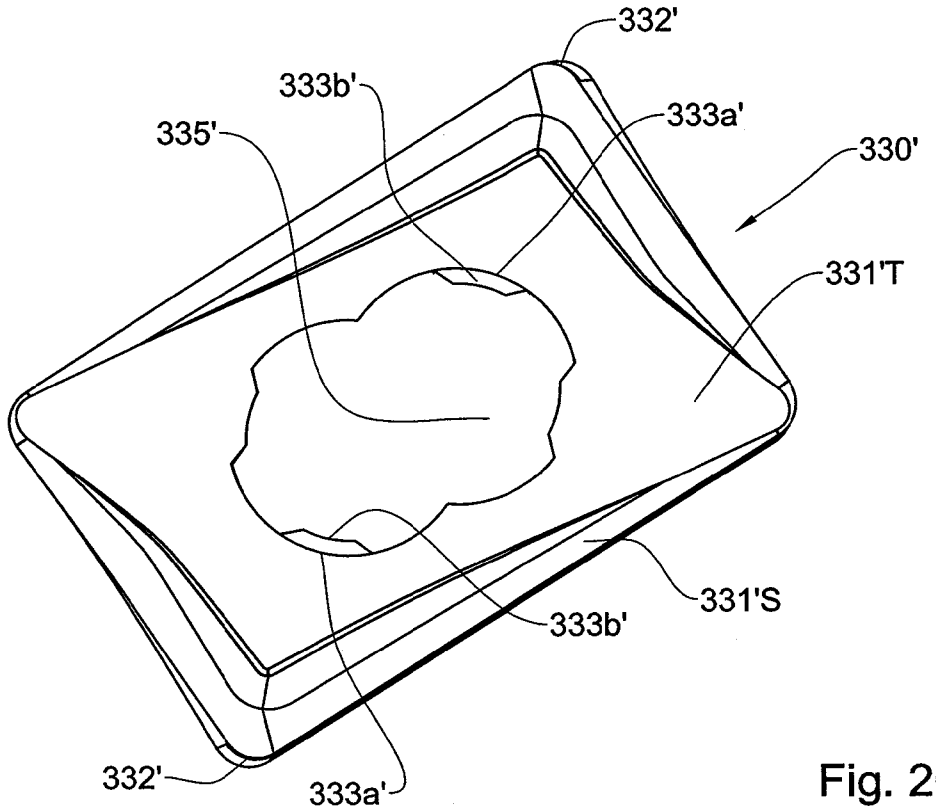

Fig. 20B

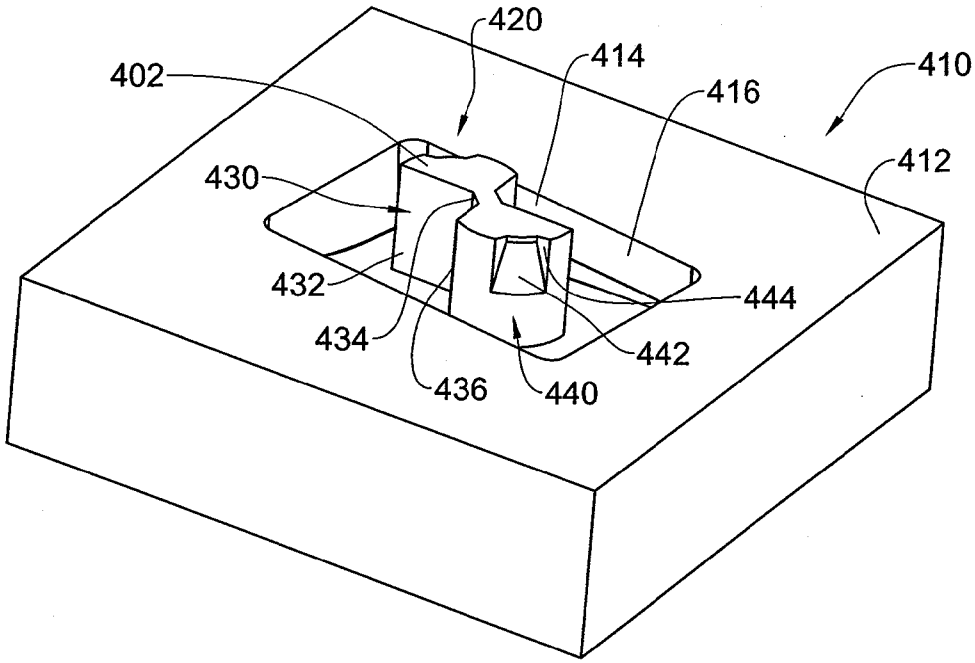
420
414
410
402
416
412
430
432
444
434
442
436
440

Fig. 21

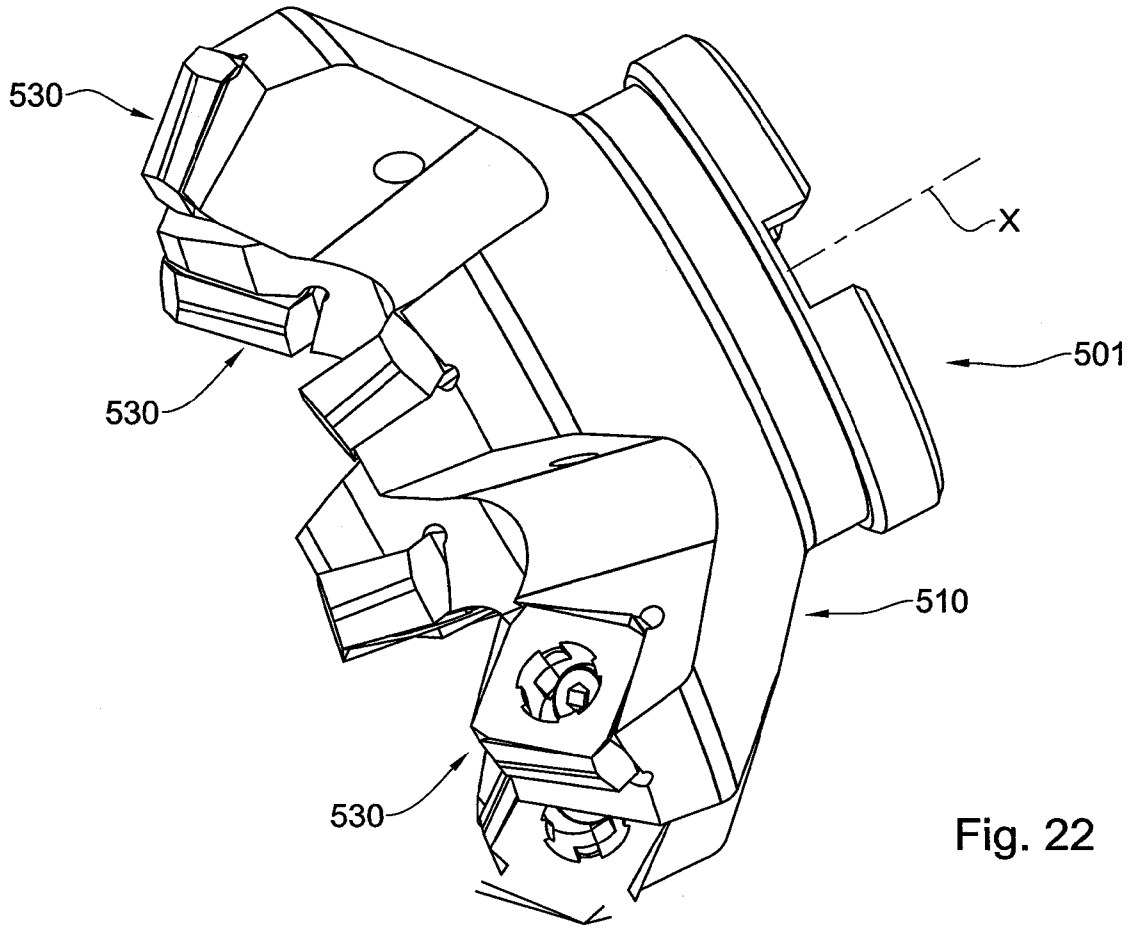
530
X
501
530
510
530

Fig. 22

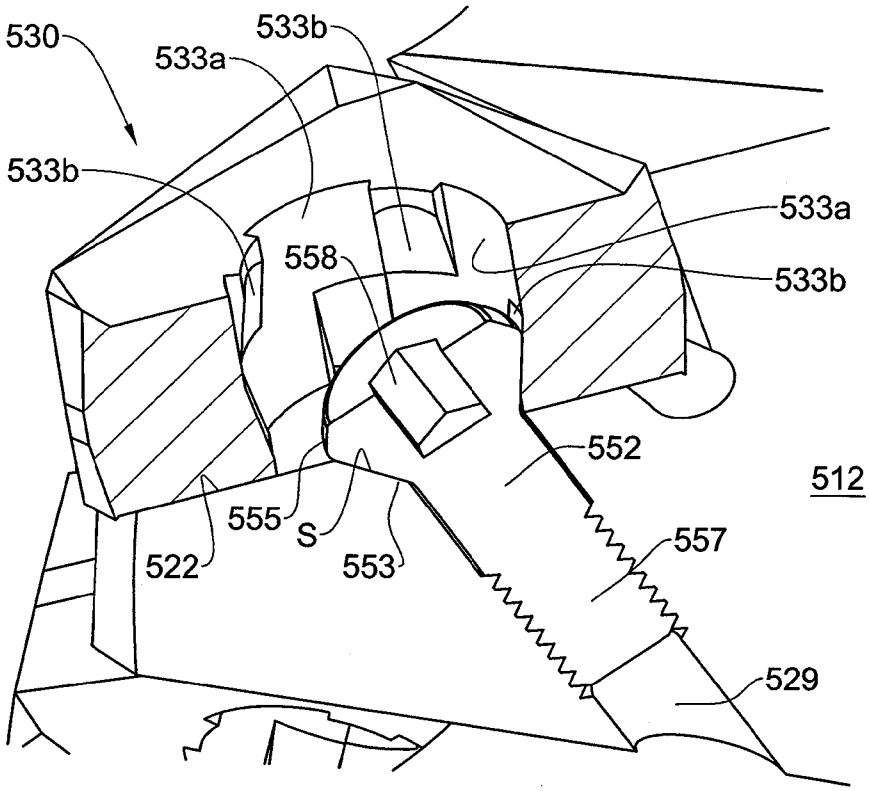

Fig. 23A

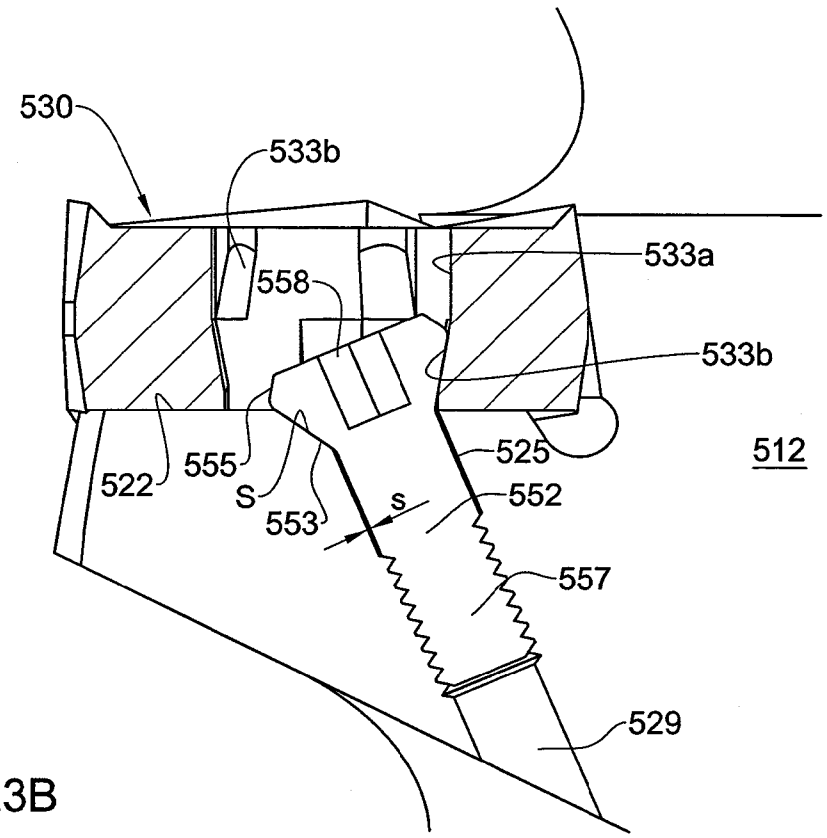

Fig. 23B

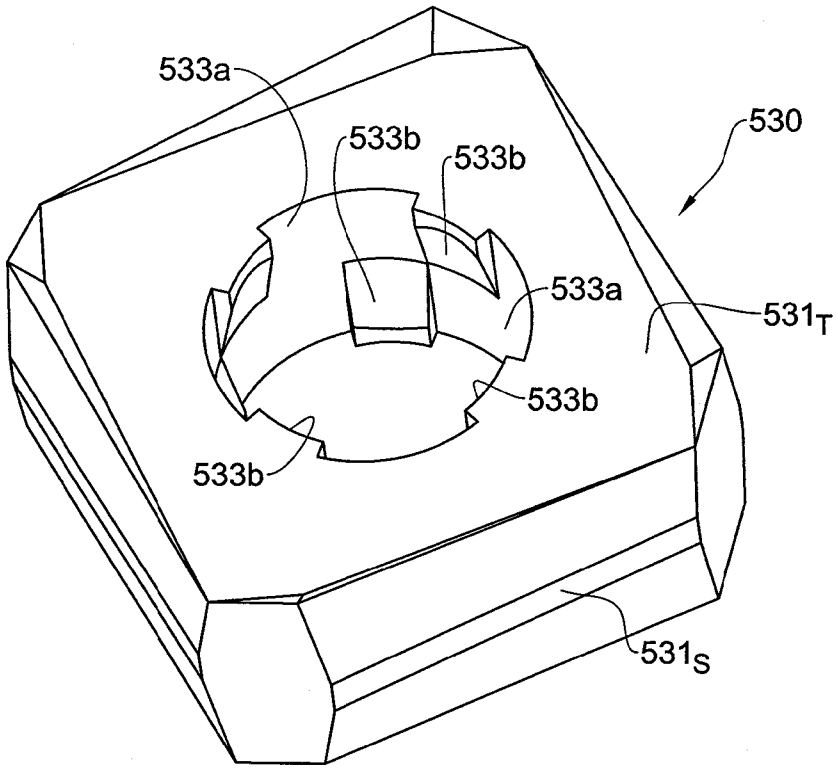
533a
533b
533b
530
533a
531_T
533b
533b
531_S

Fig. 24

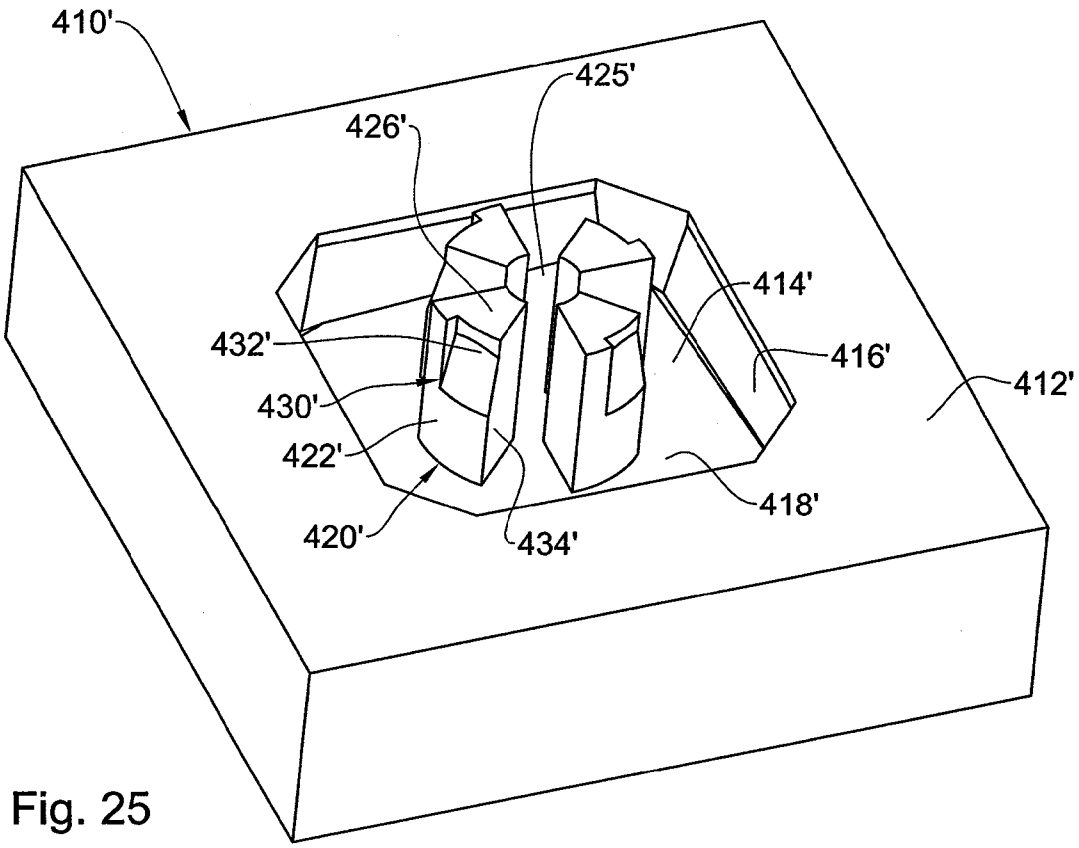
410'
425'
426'
414'
432'
416'
412'
430'
422'
418'
420'
434'

Fig. 25

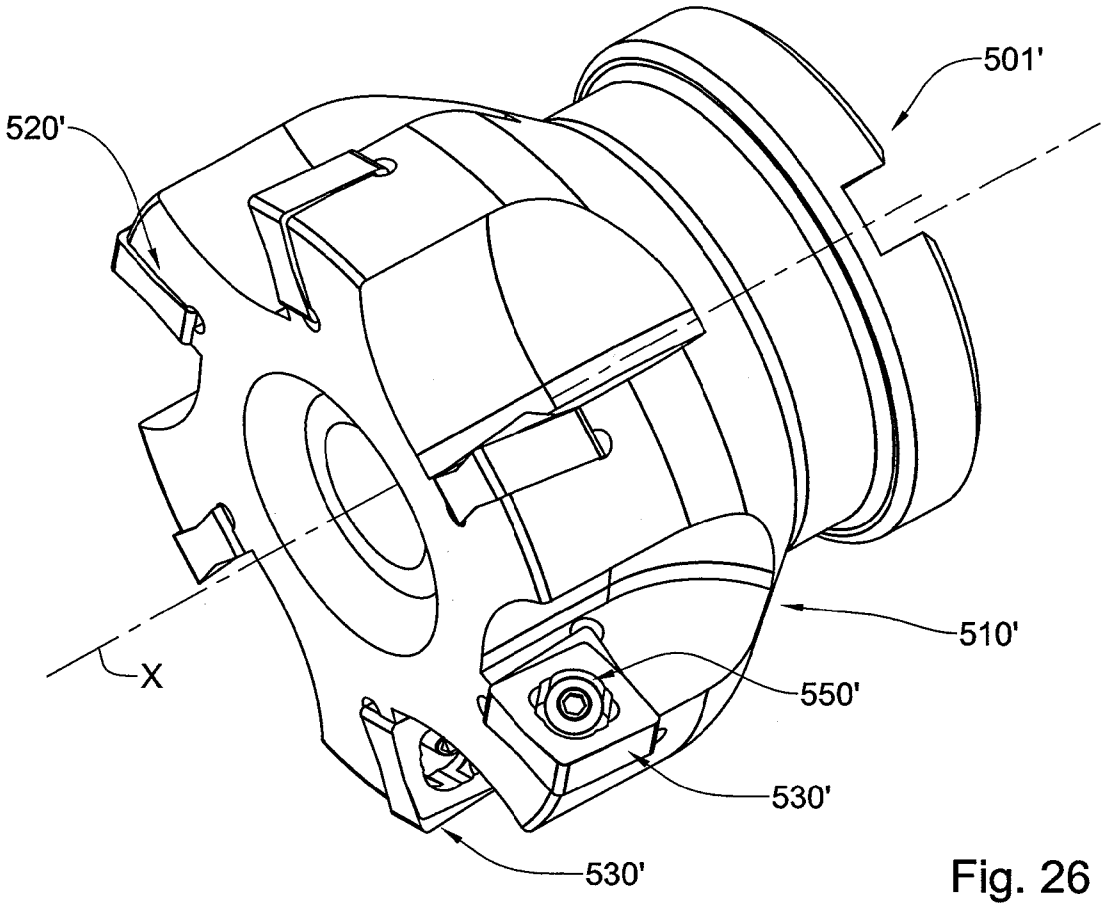

Fig. 26

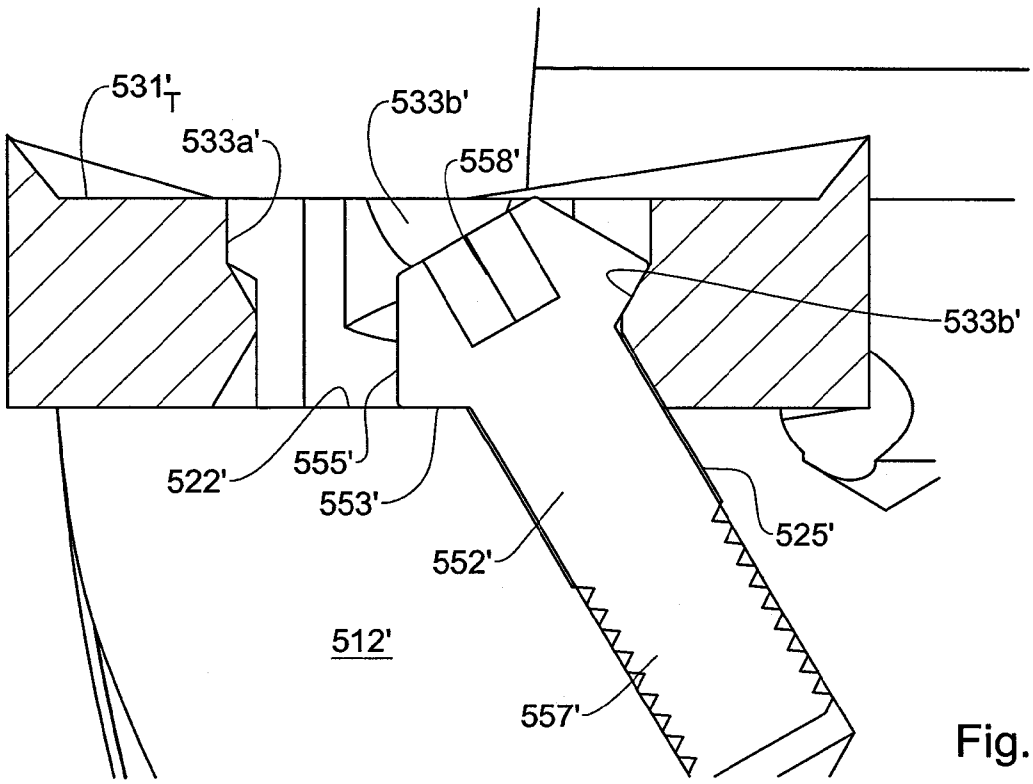

Fig. 27A

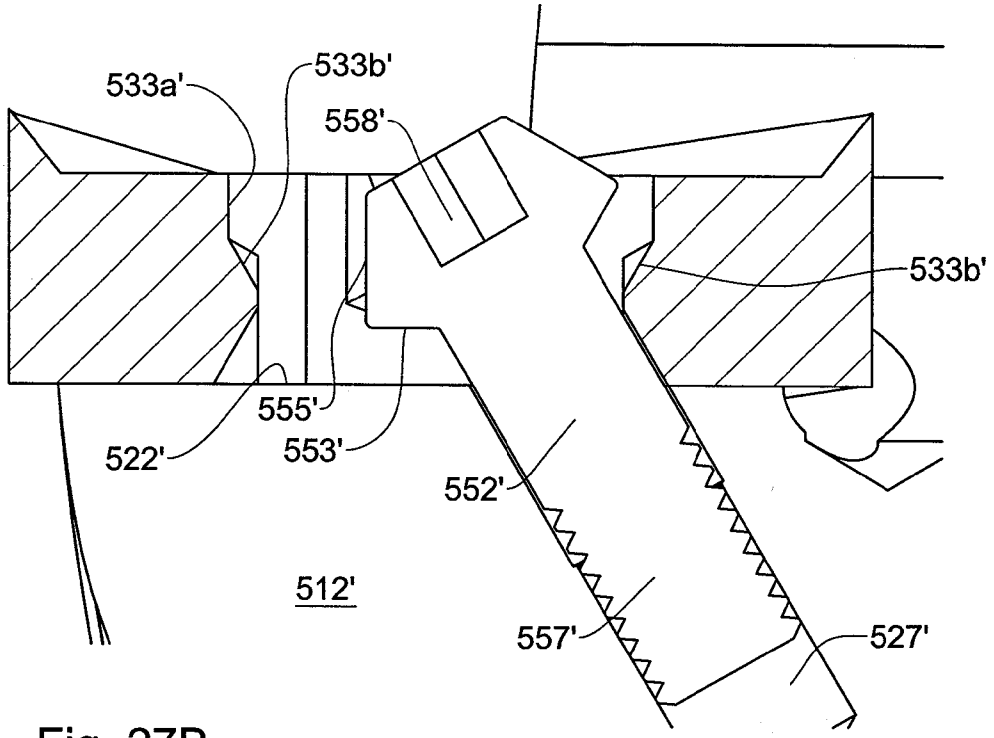

Fig. 27B

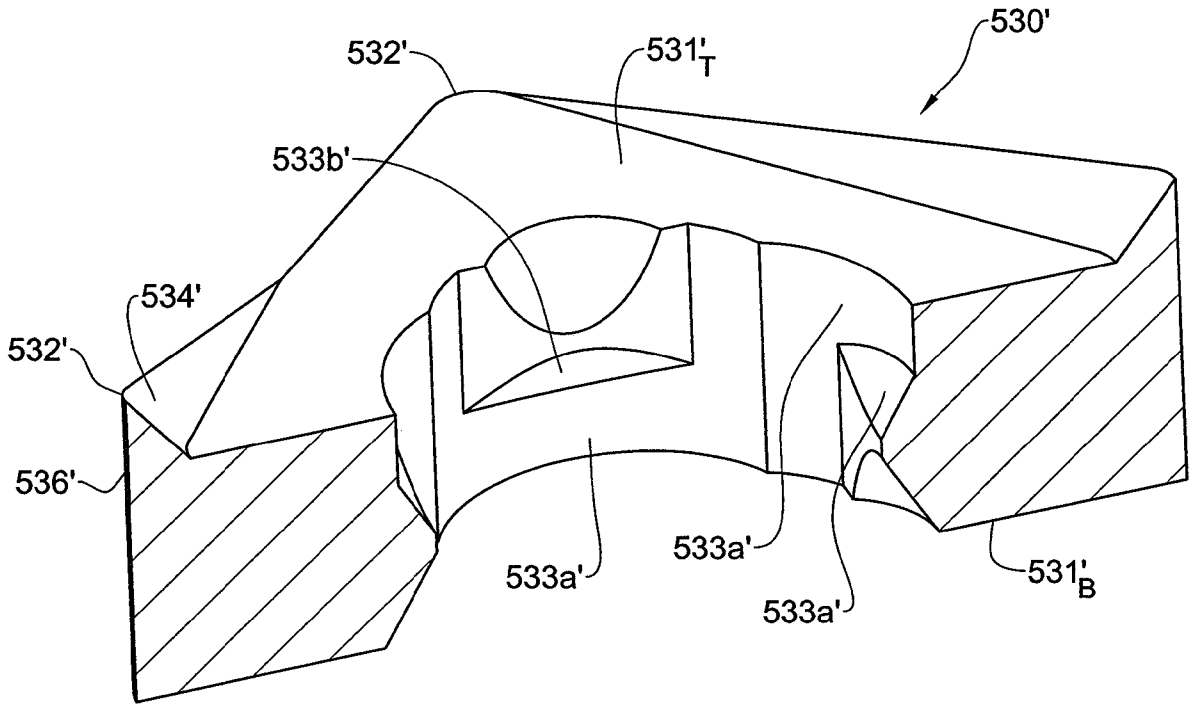

Fig. 28

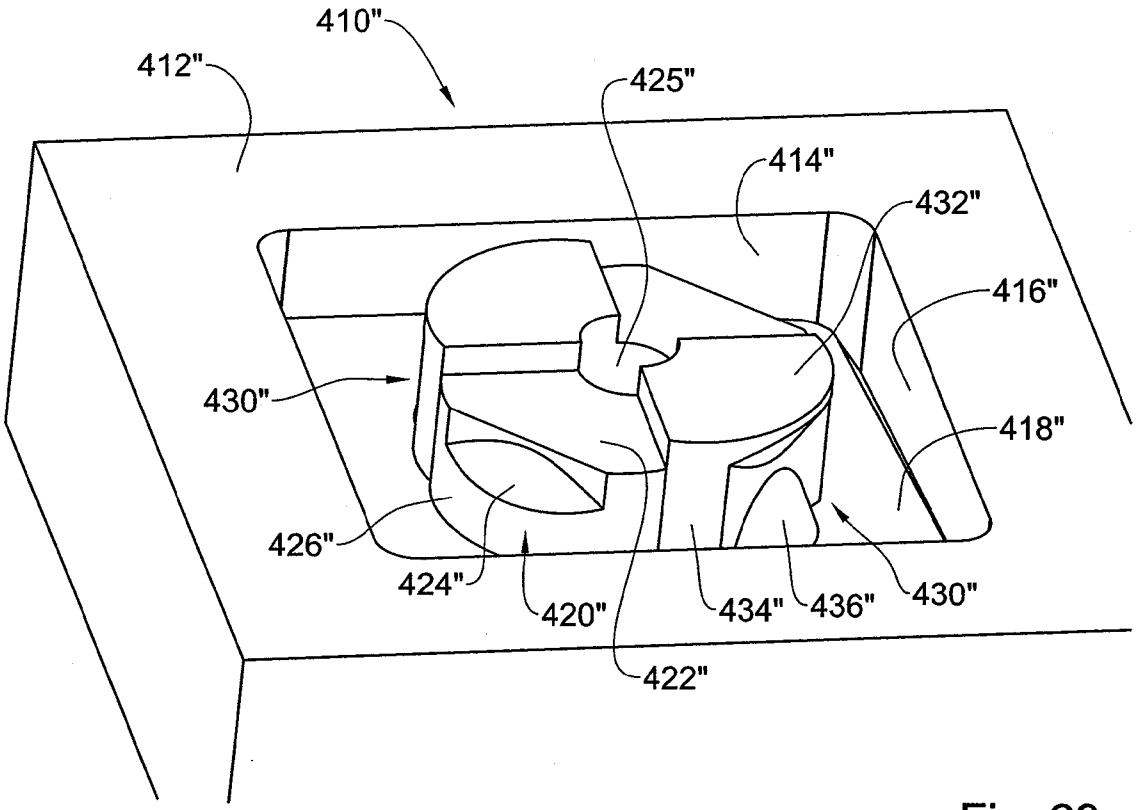

Fig. 29

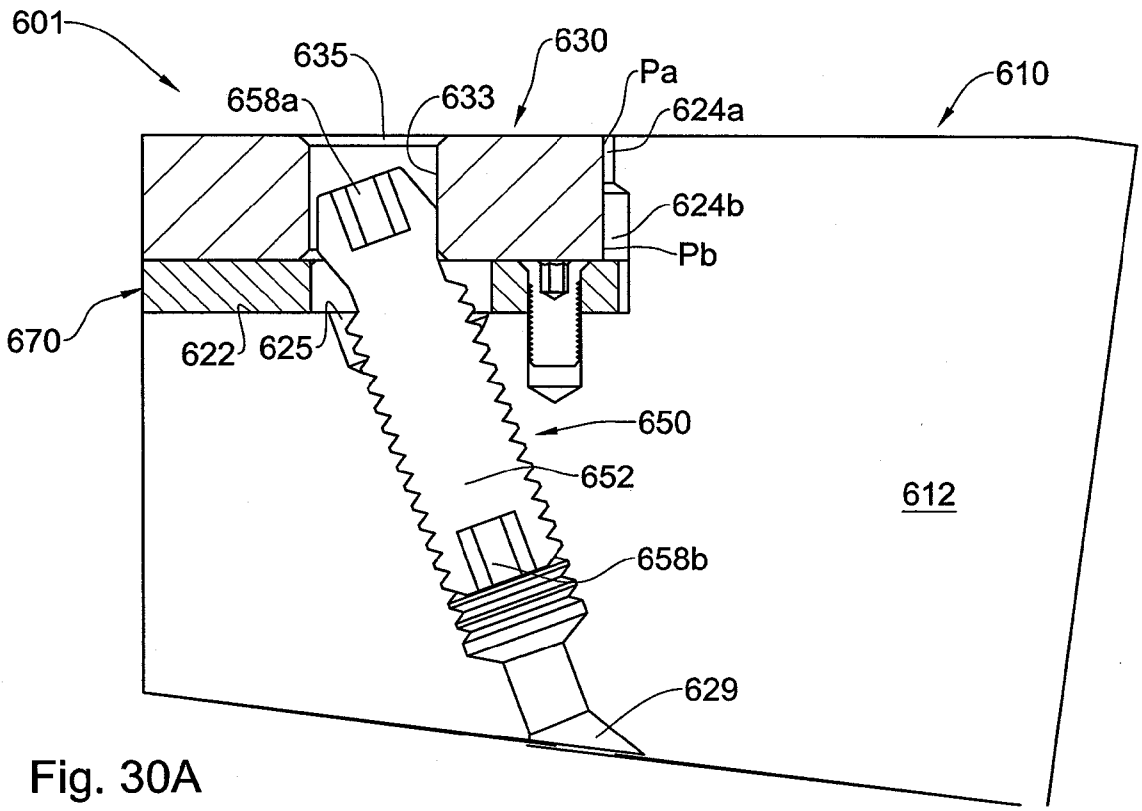

Fig. 30A

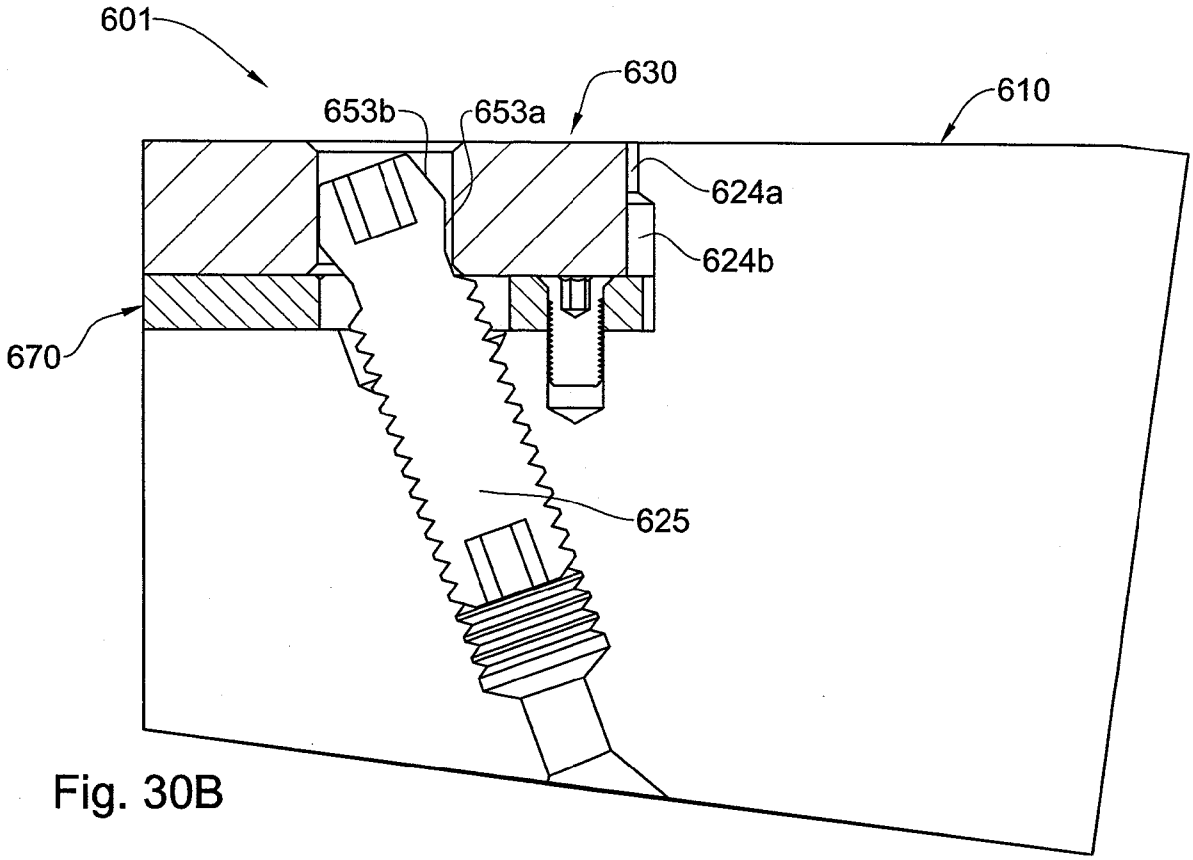

Fig. 30B

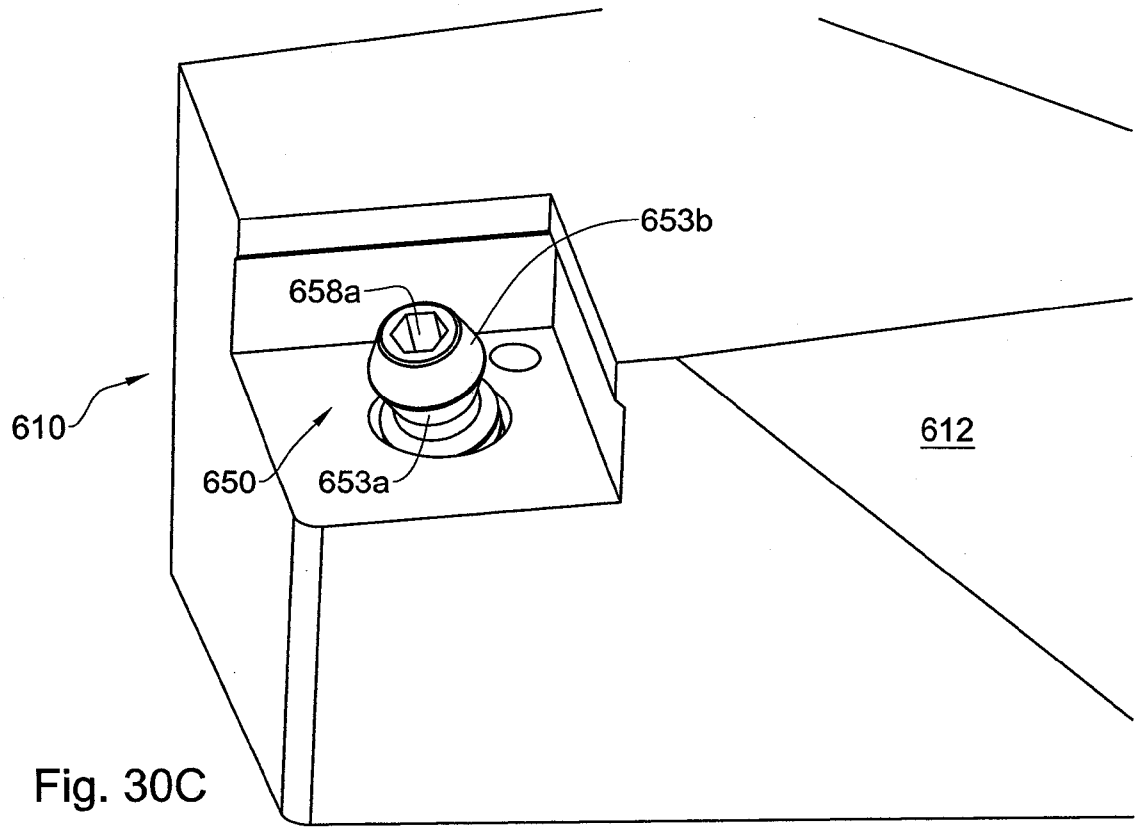

Fig. 30C

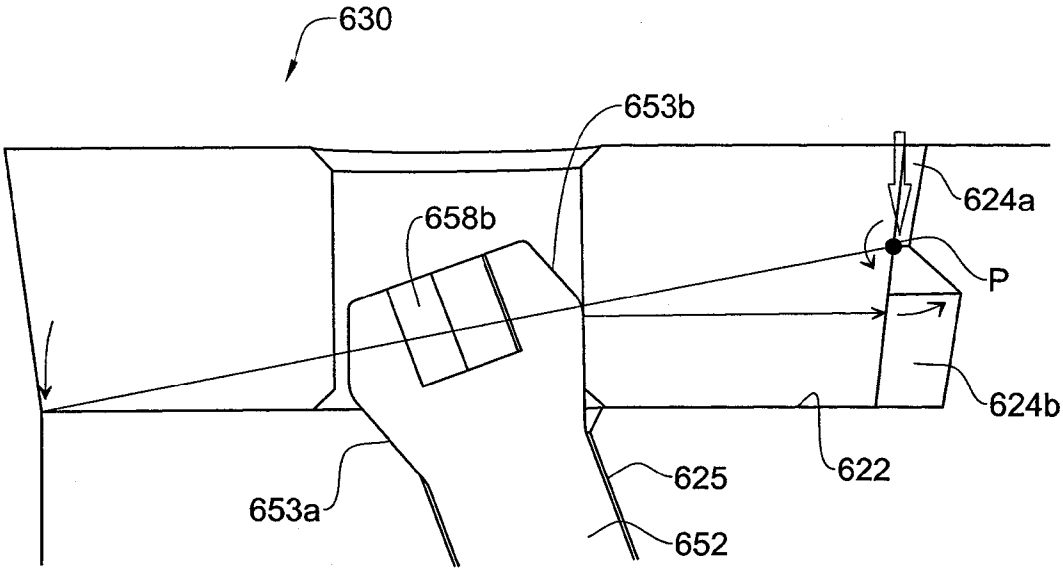

Fig. 30D

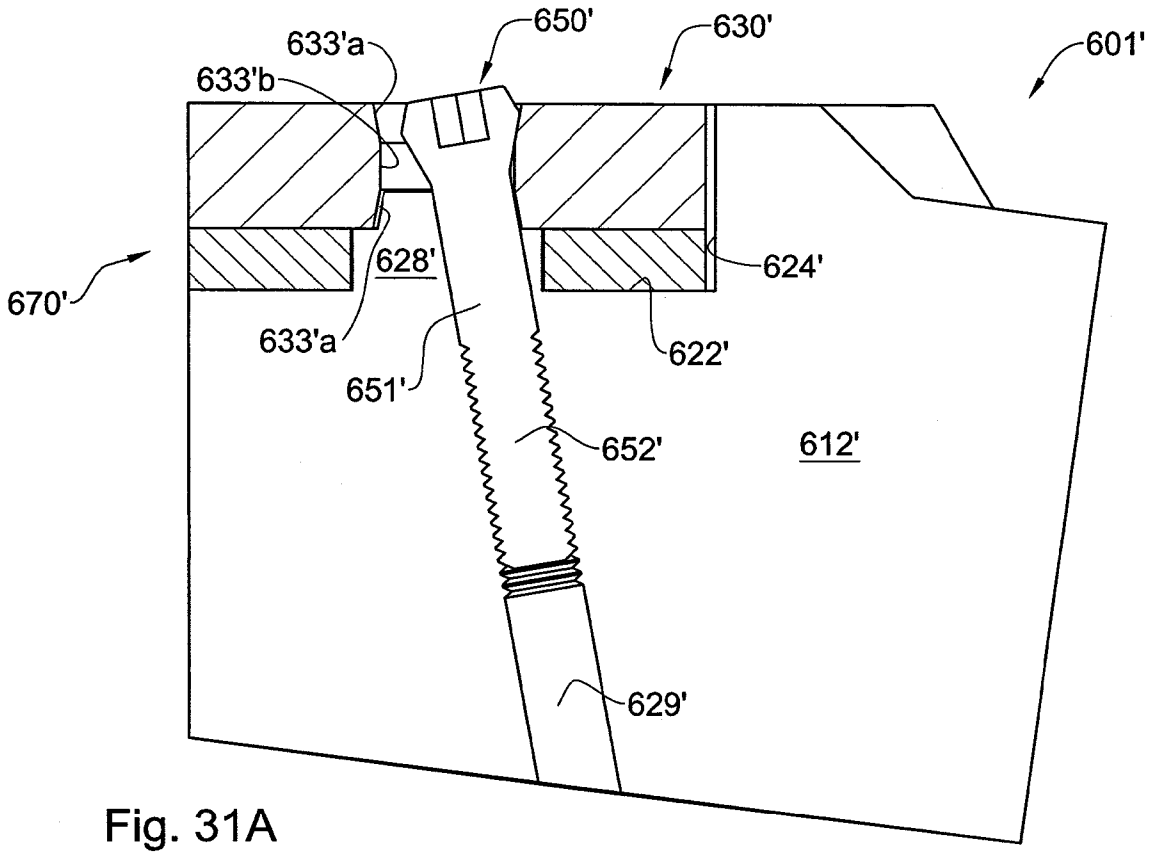

Fig. 31A

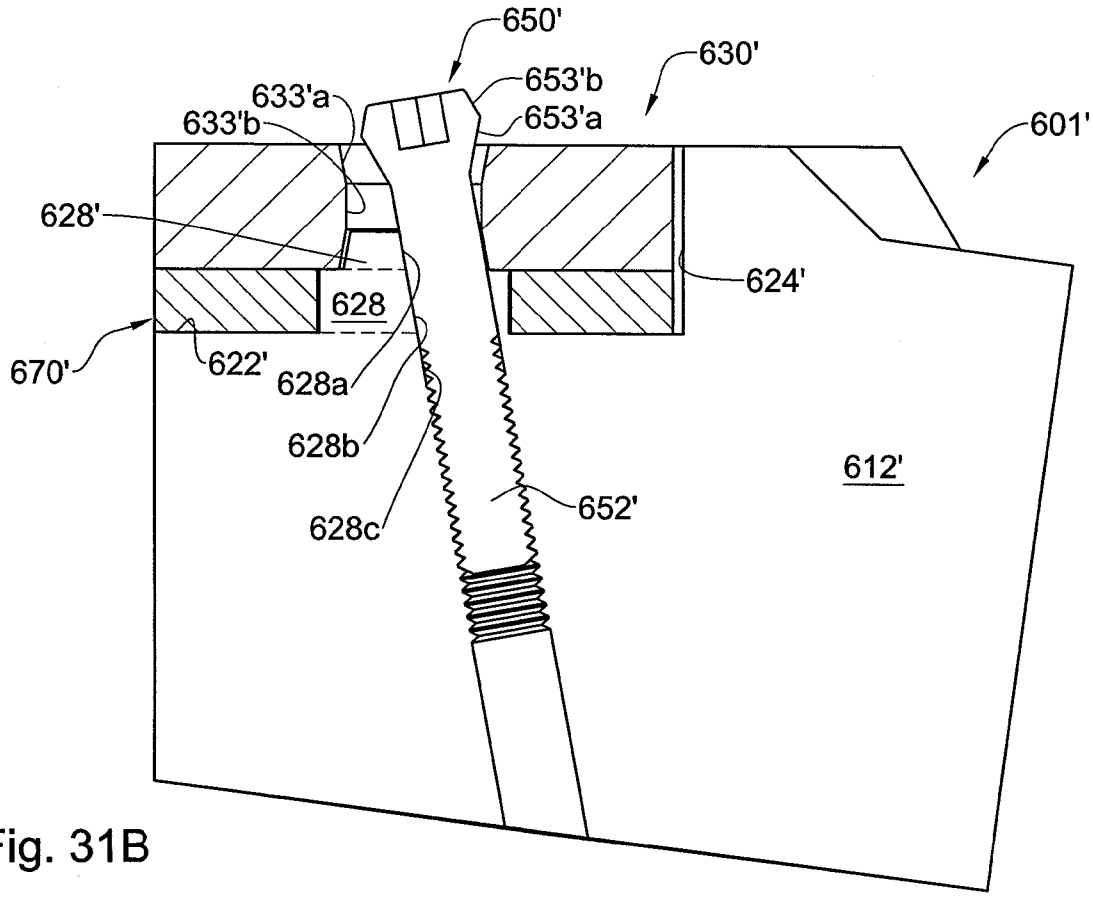

Fig. 31B

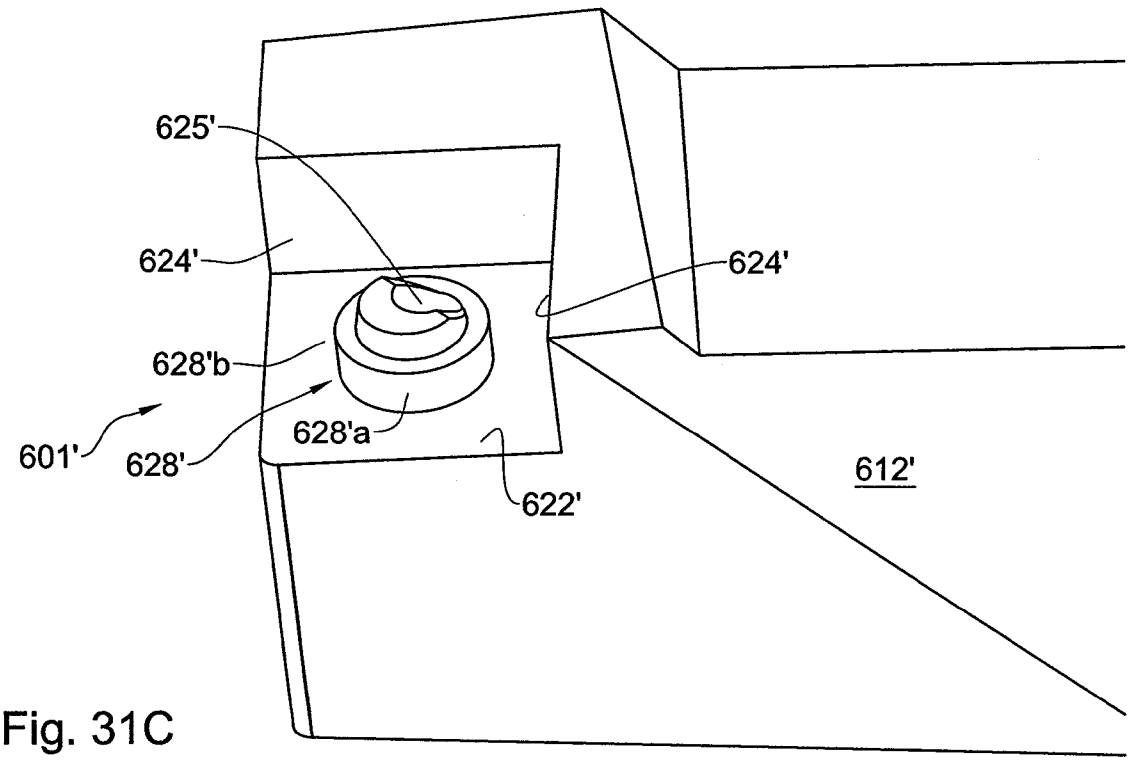

Fig. 31C

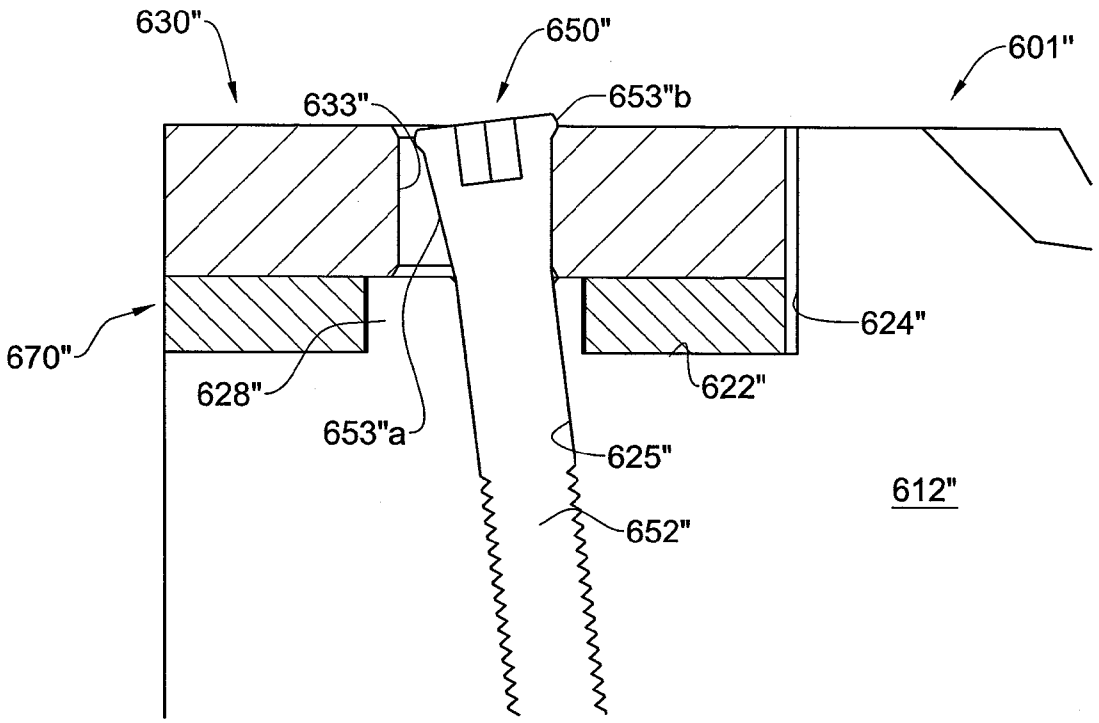

Fig. 32A

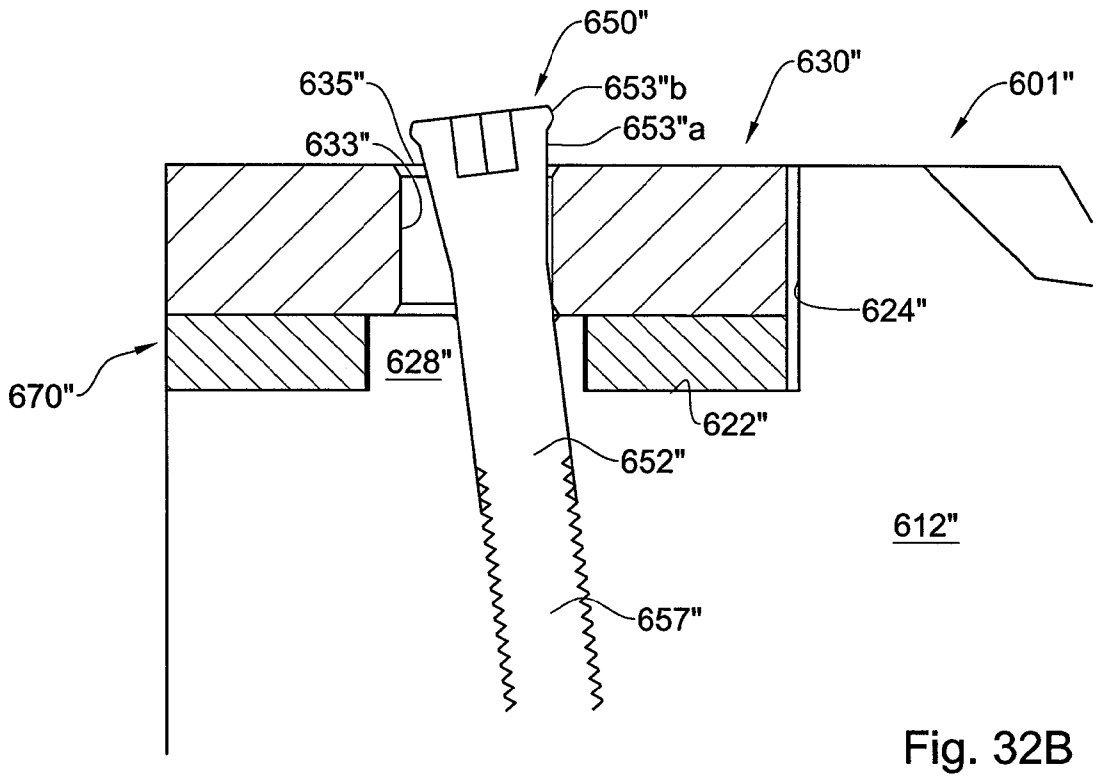

Fig. 32B

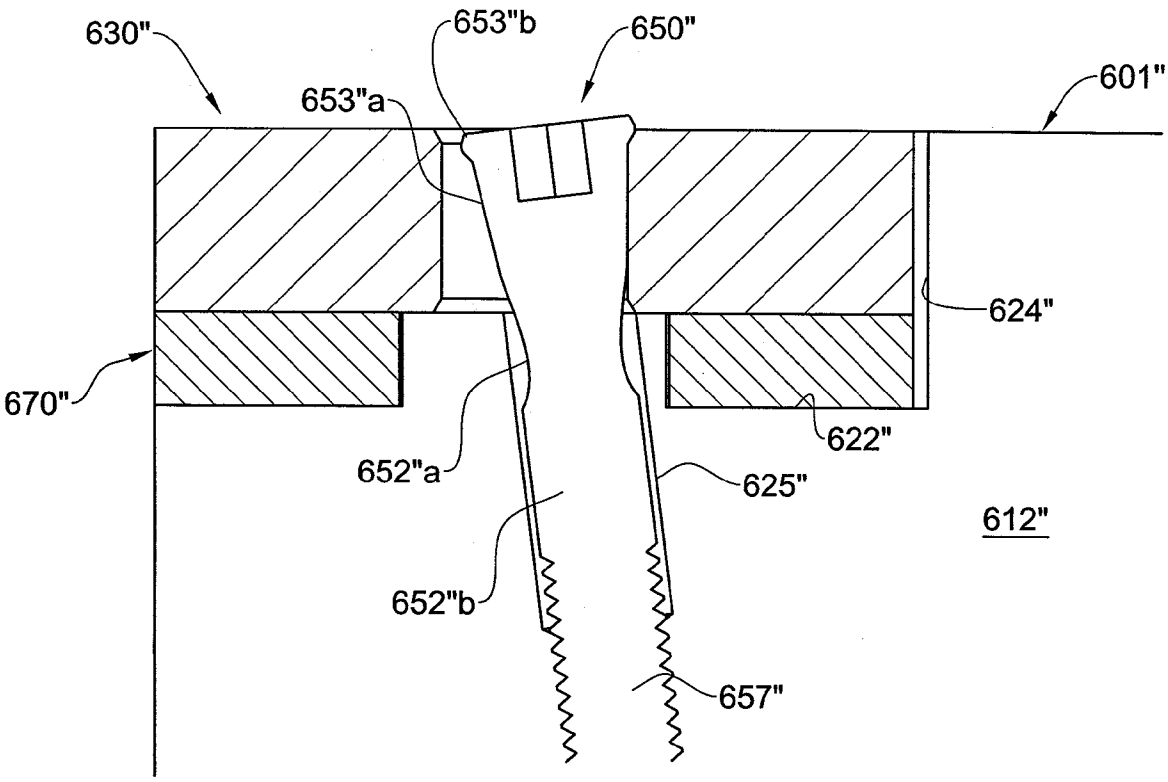

Fig. 32C

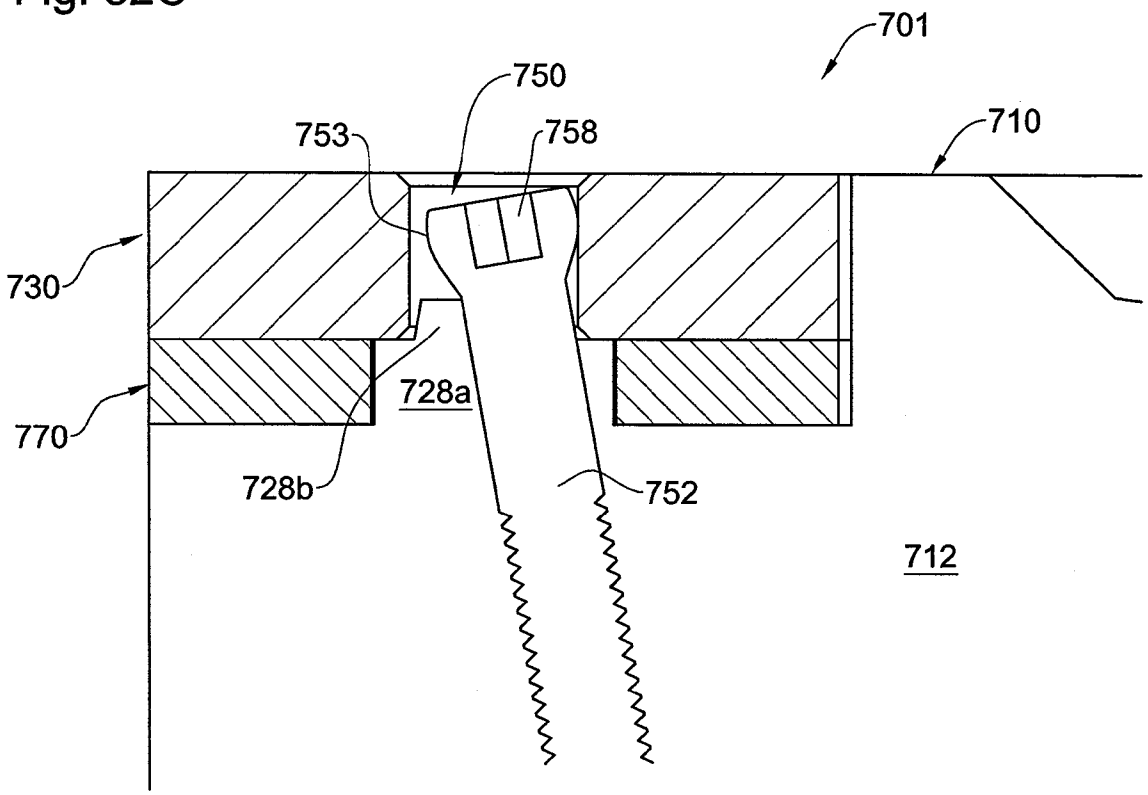

Fig. 33A

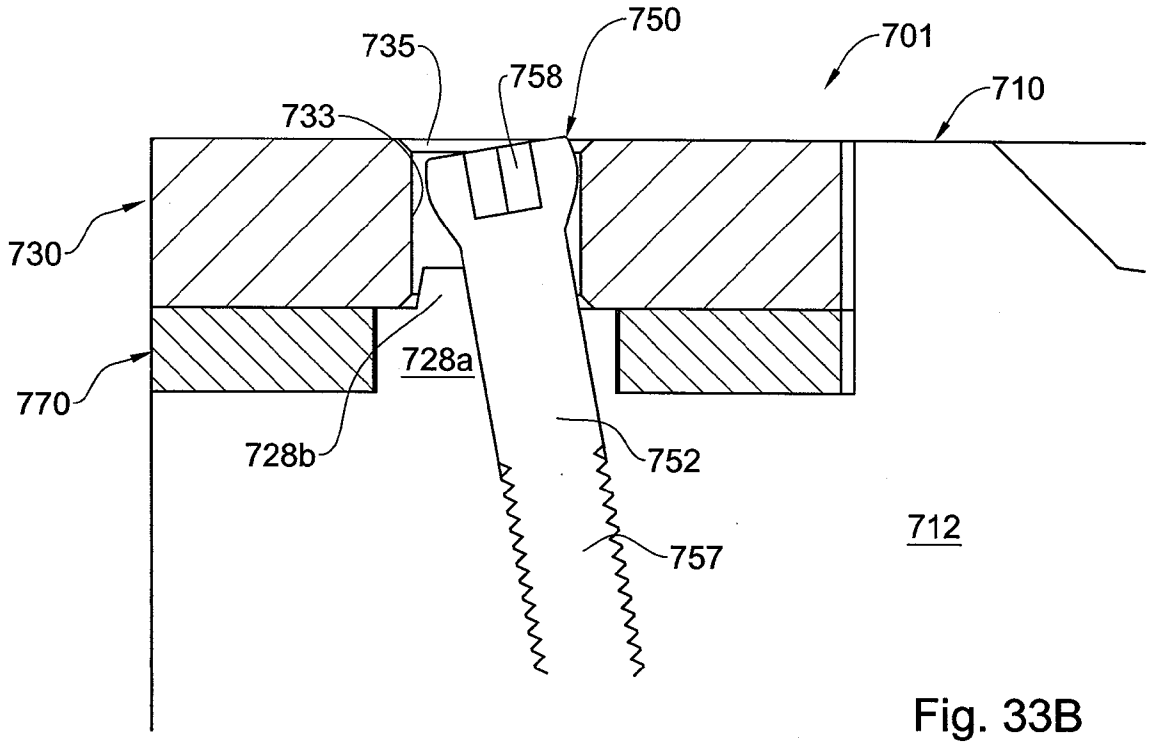

Fig. 33B

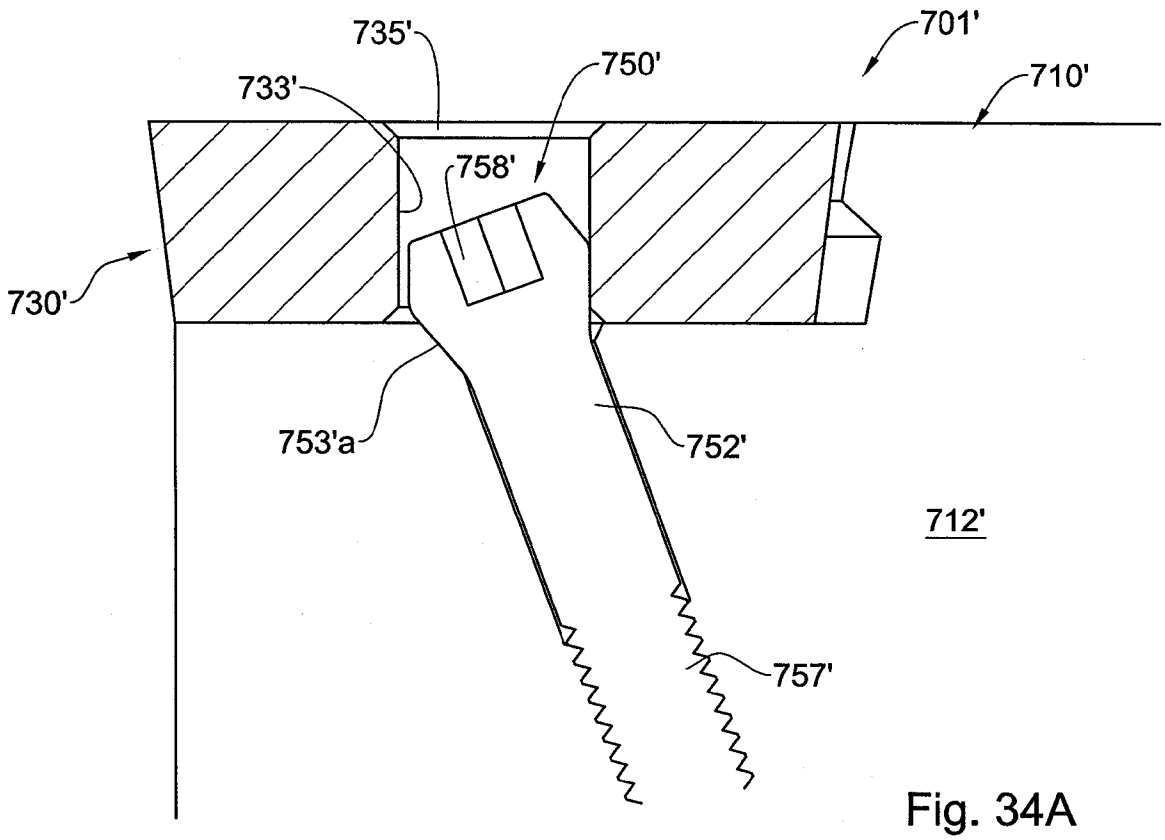

Fig. 34A

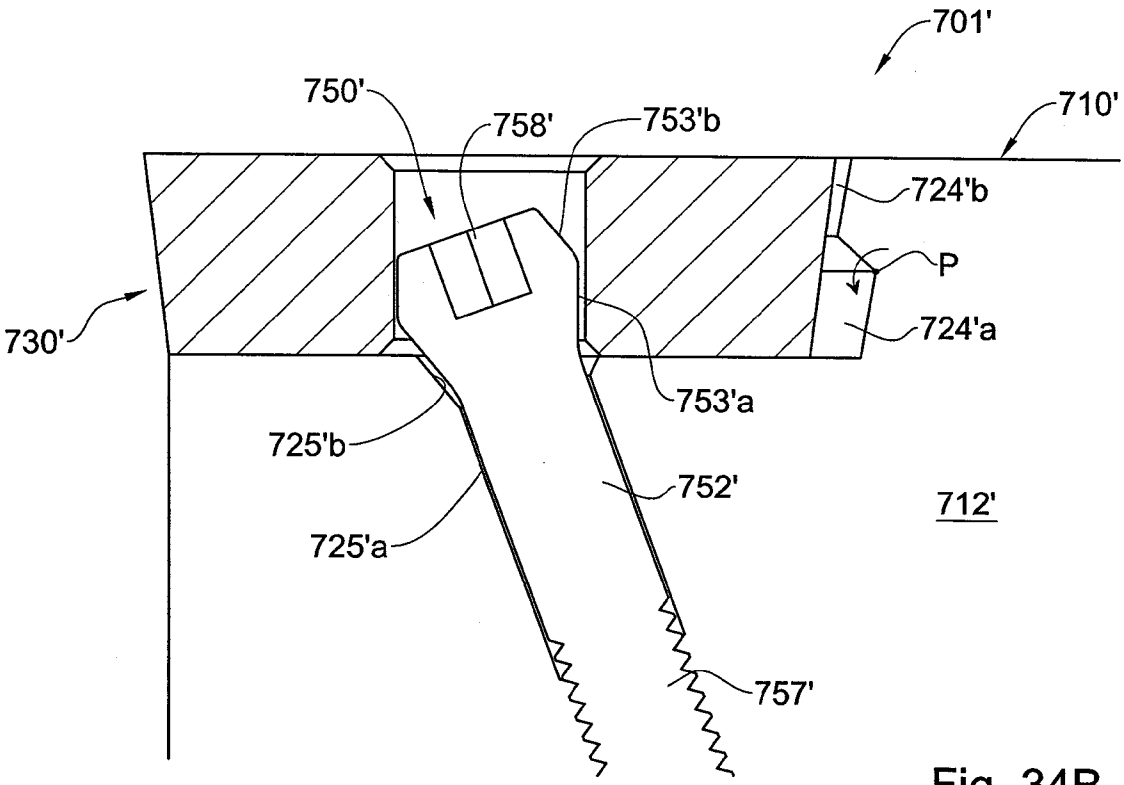

Fig. 34B

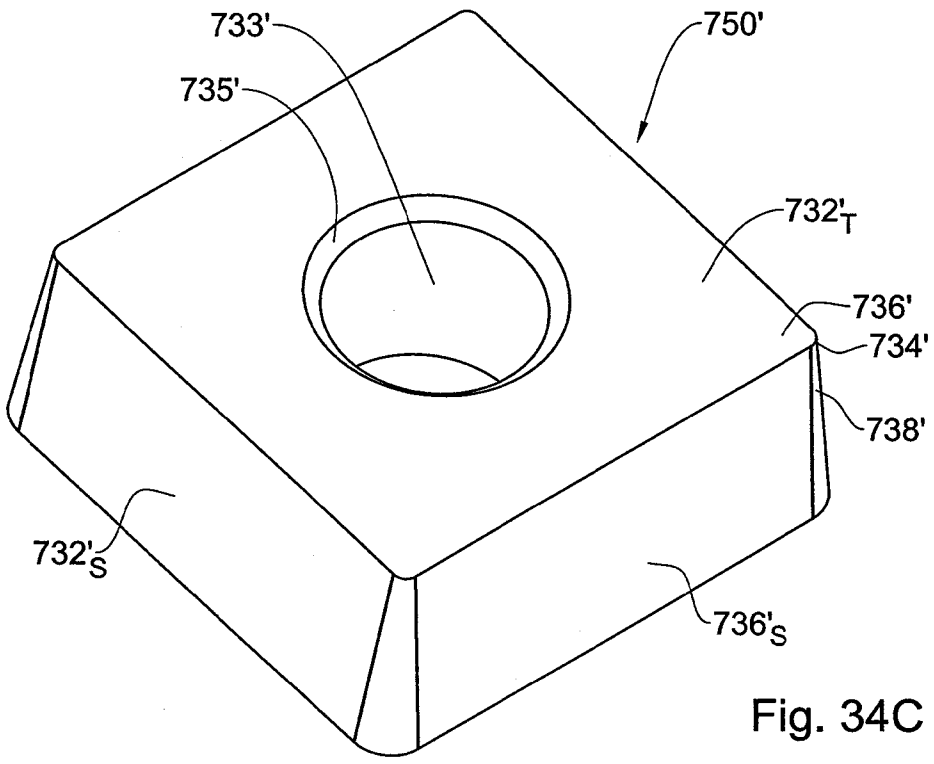

Fig. 34C

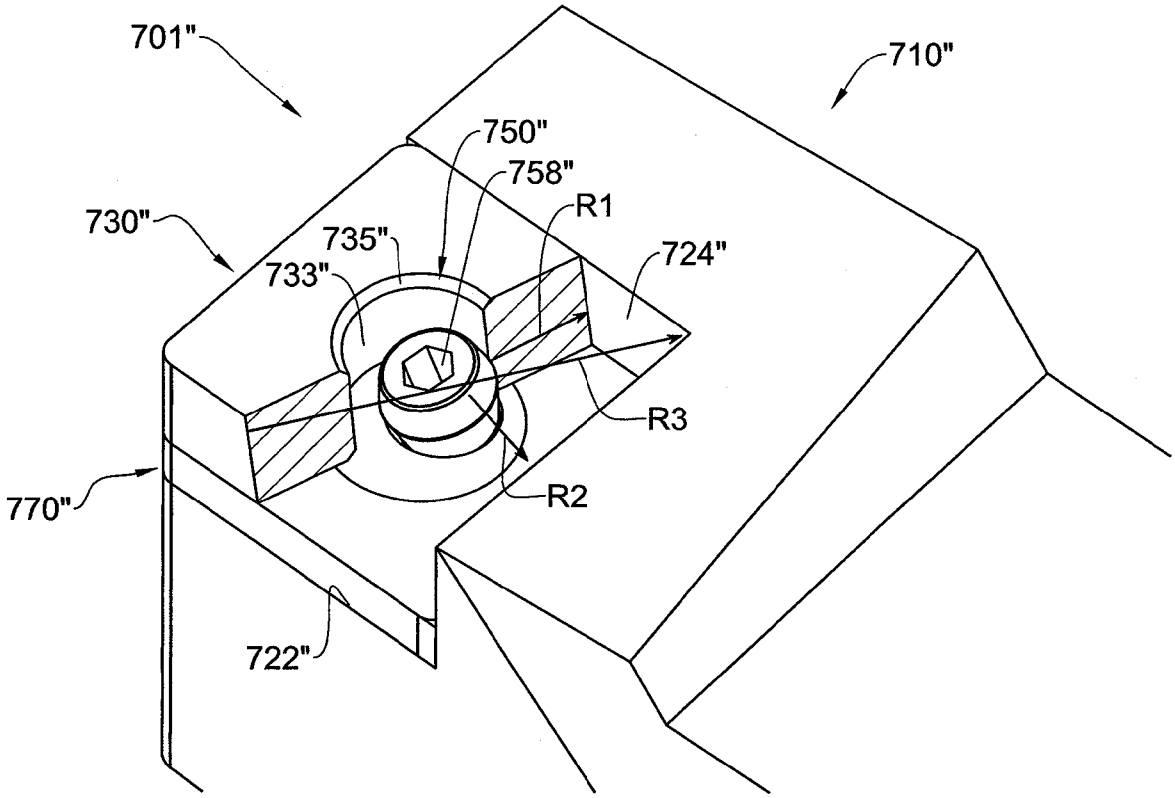

Fig. 35A

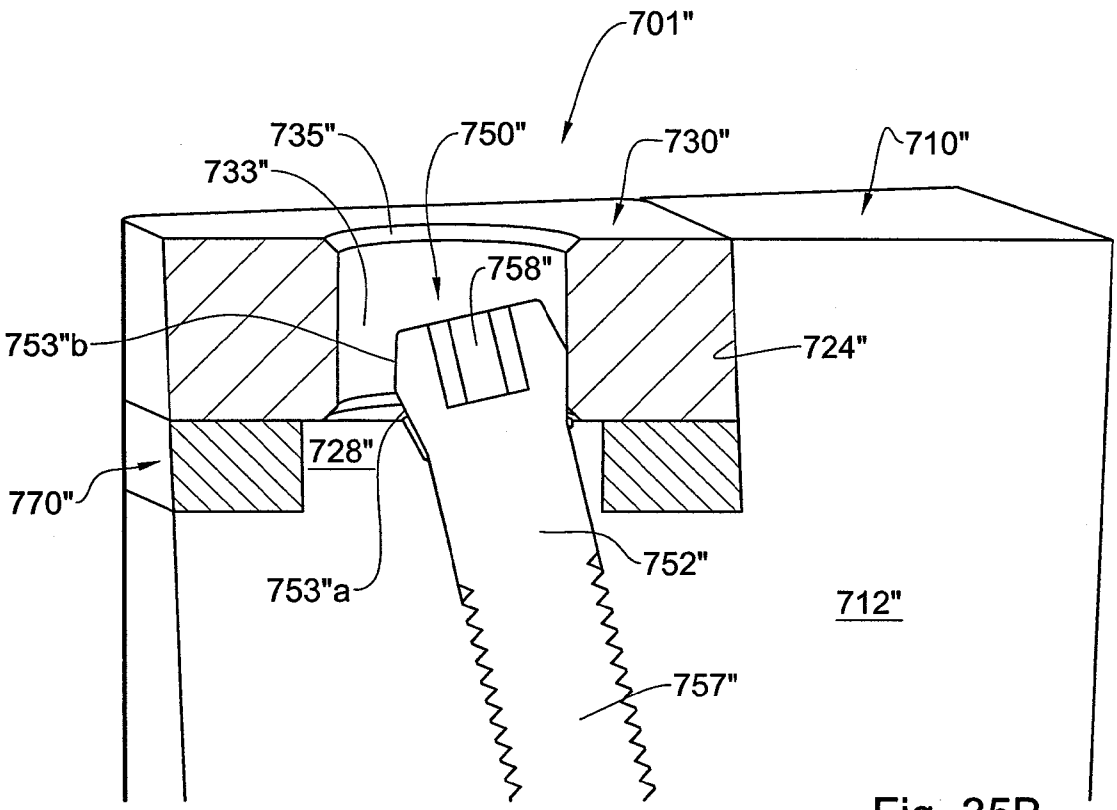

Fig. 35B

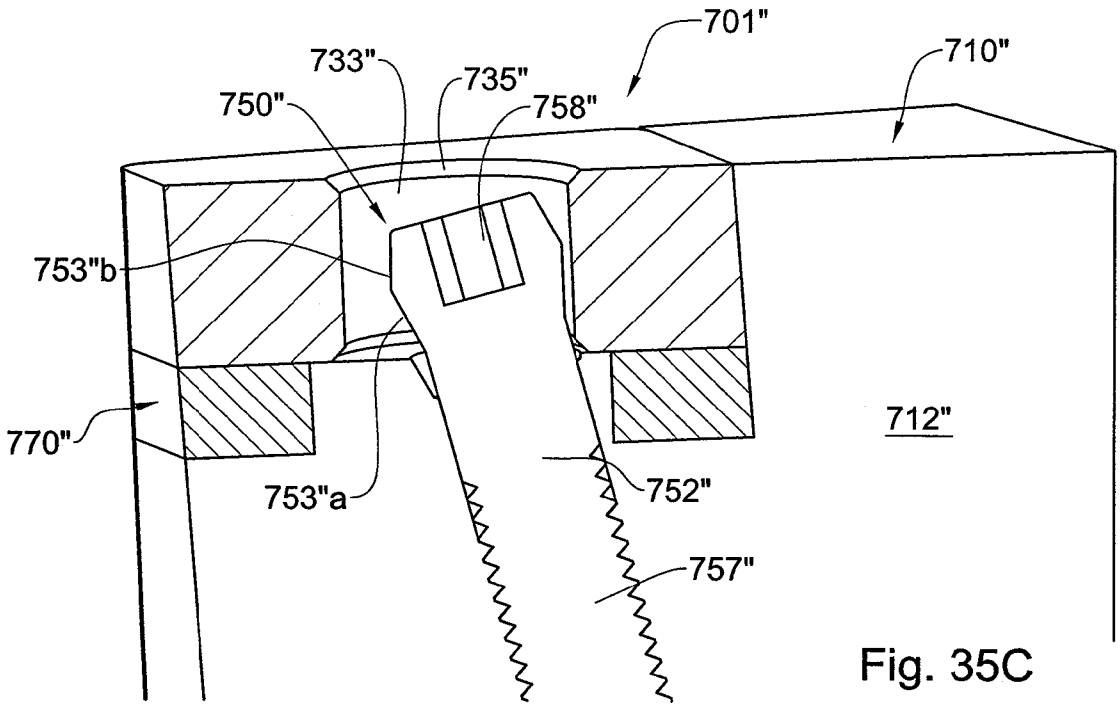

Fig. 35C

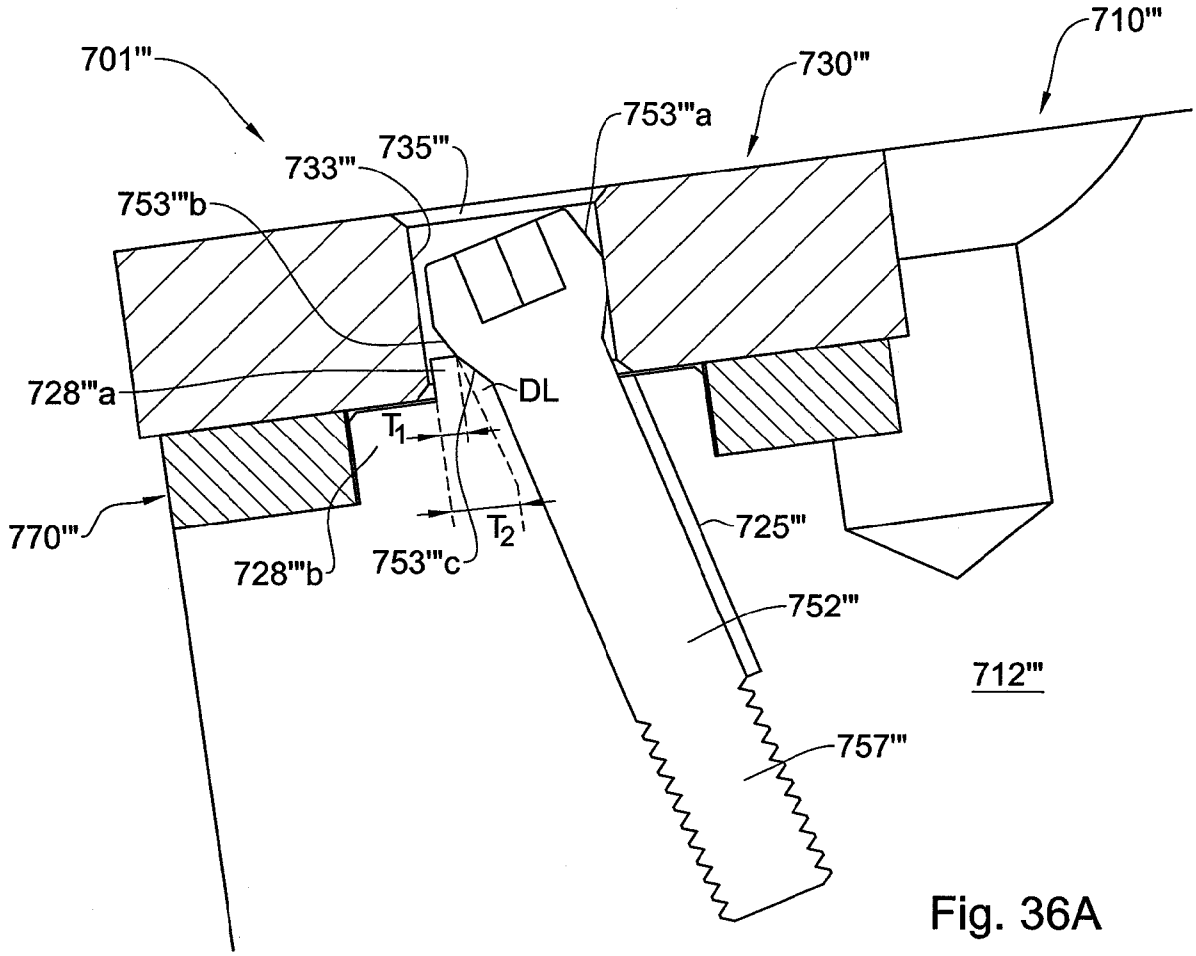

Fig. 36A

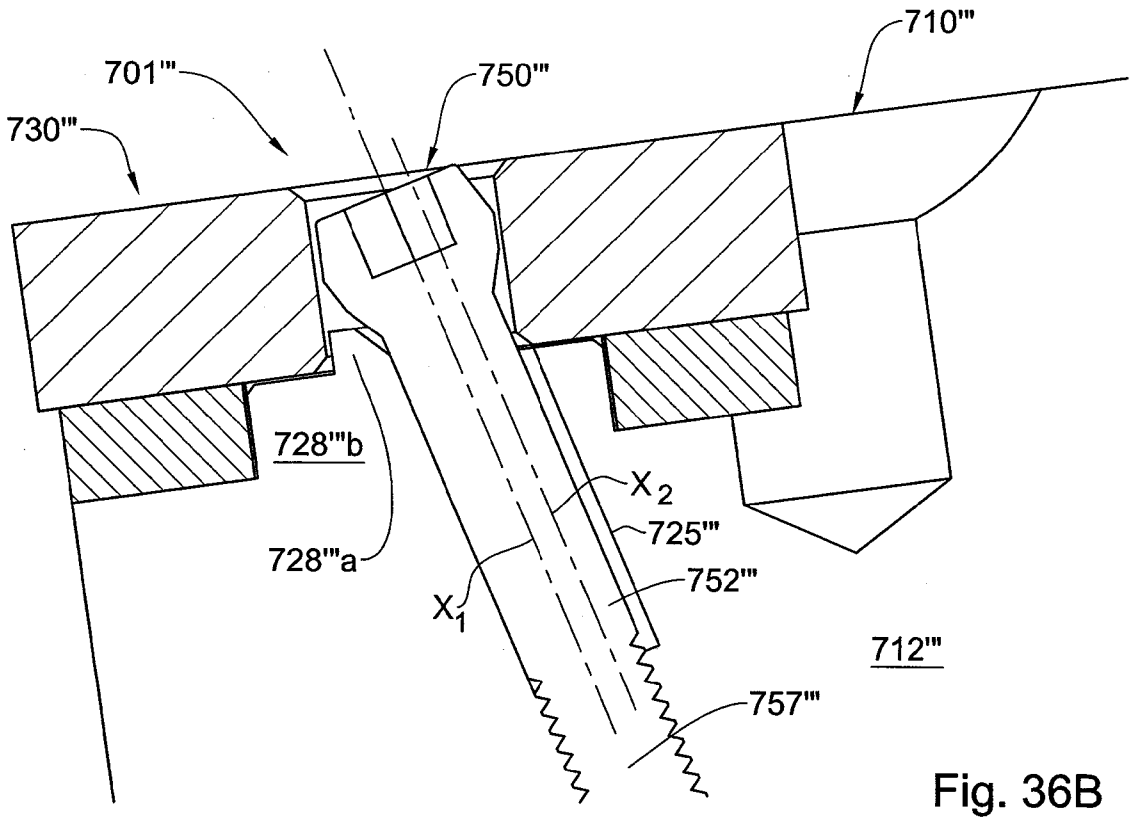

Fig. 36B

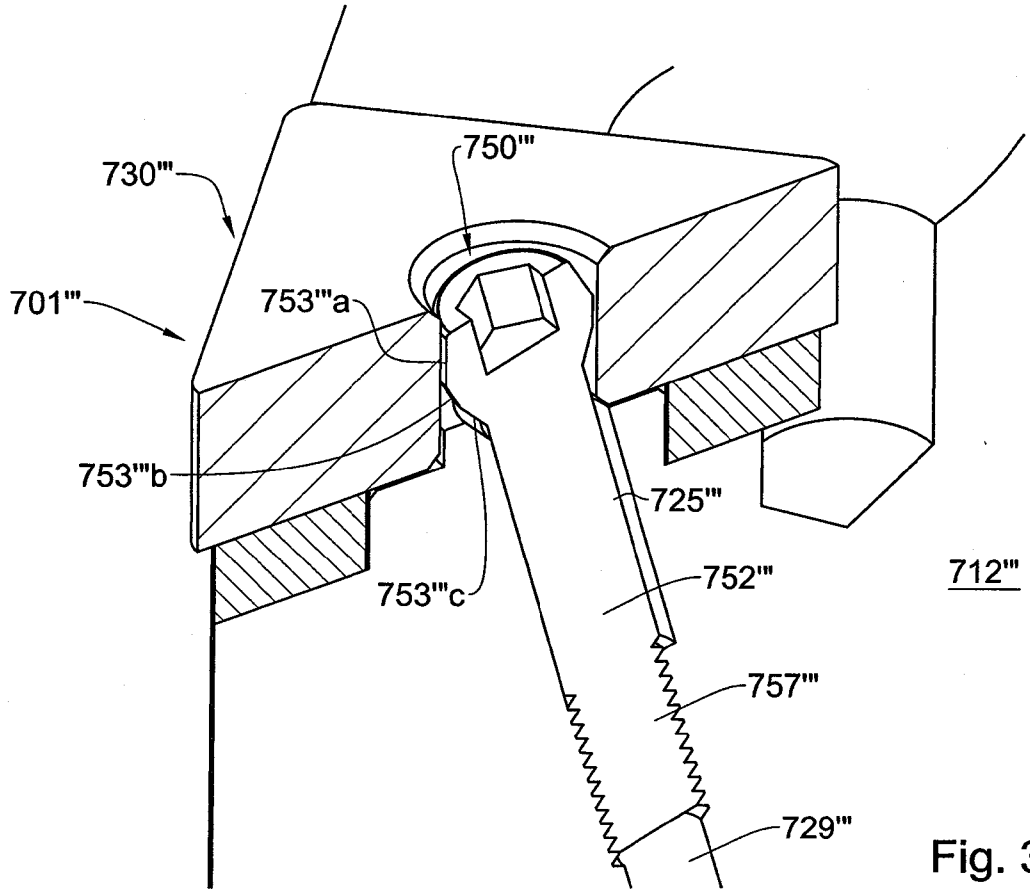

Fig. 36C

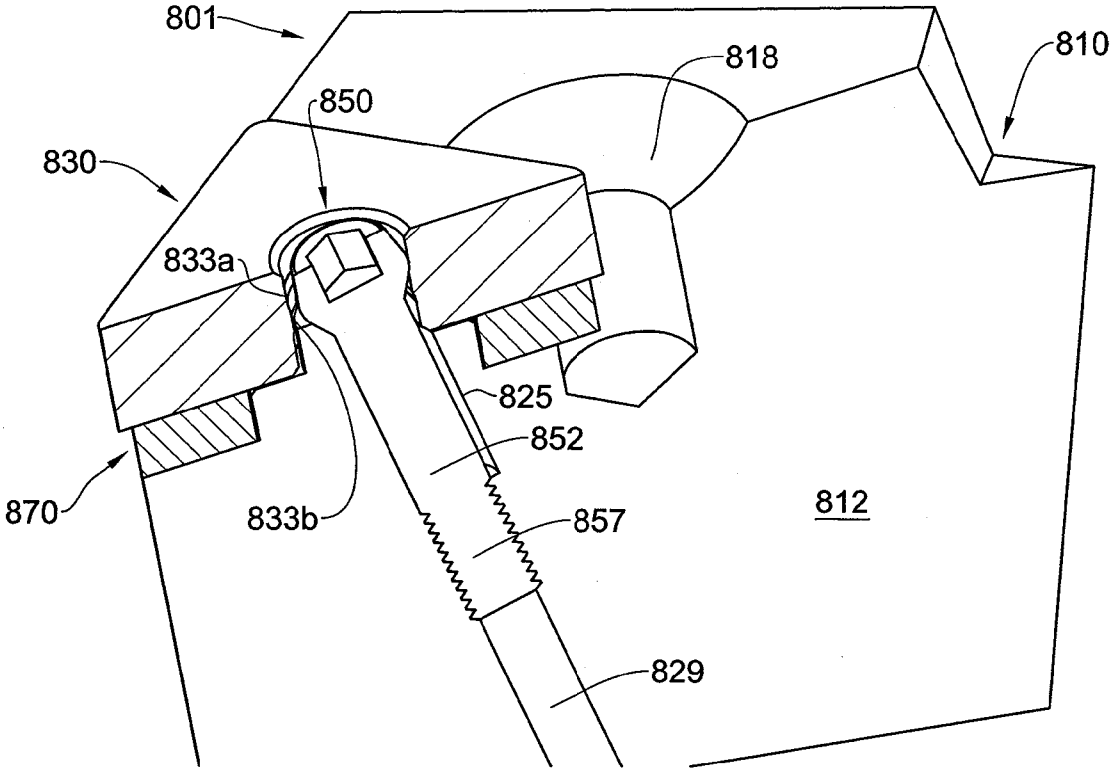

Fig. 37A

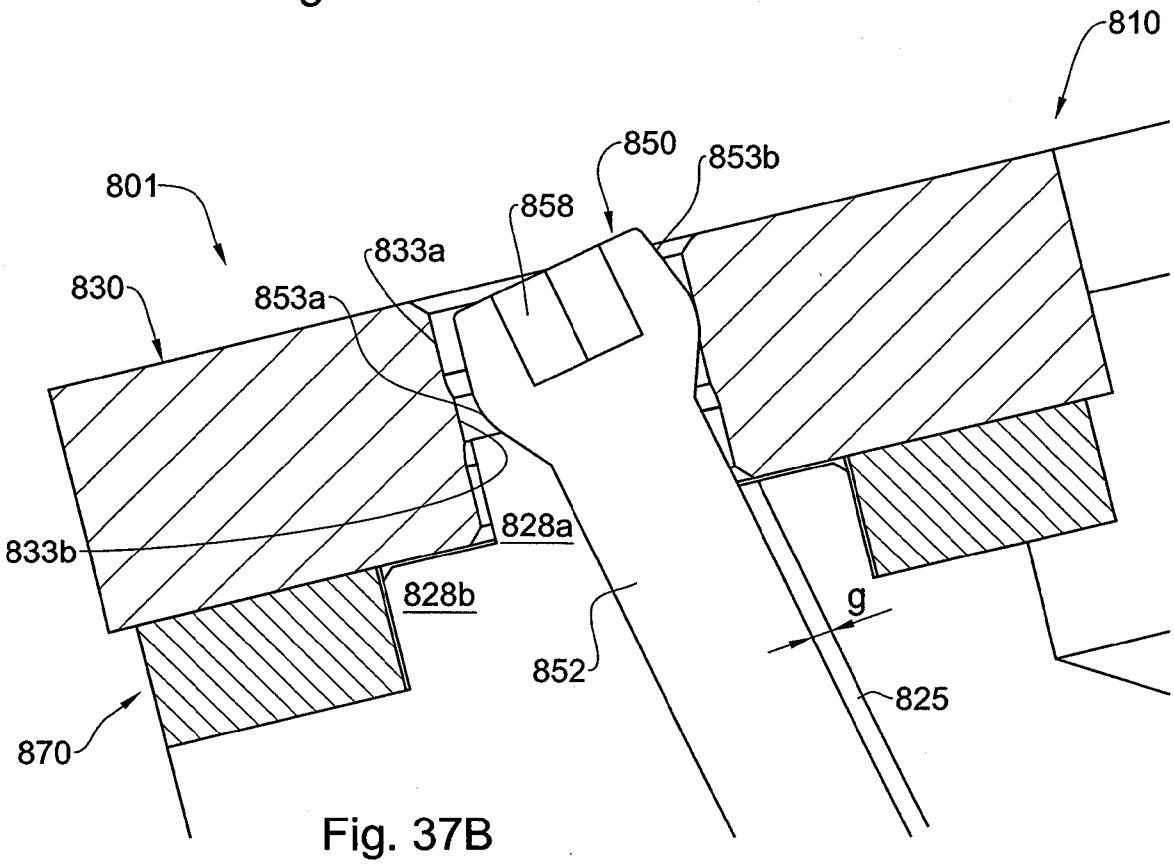

Fig. 37B

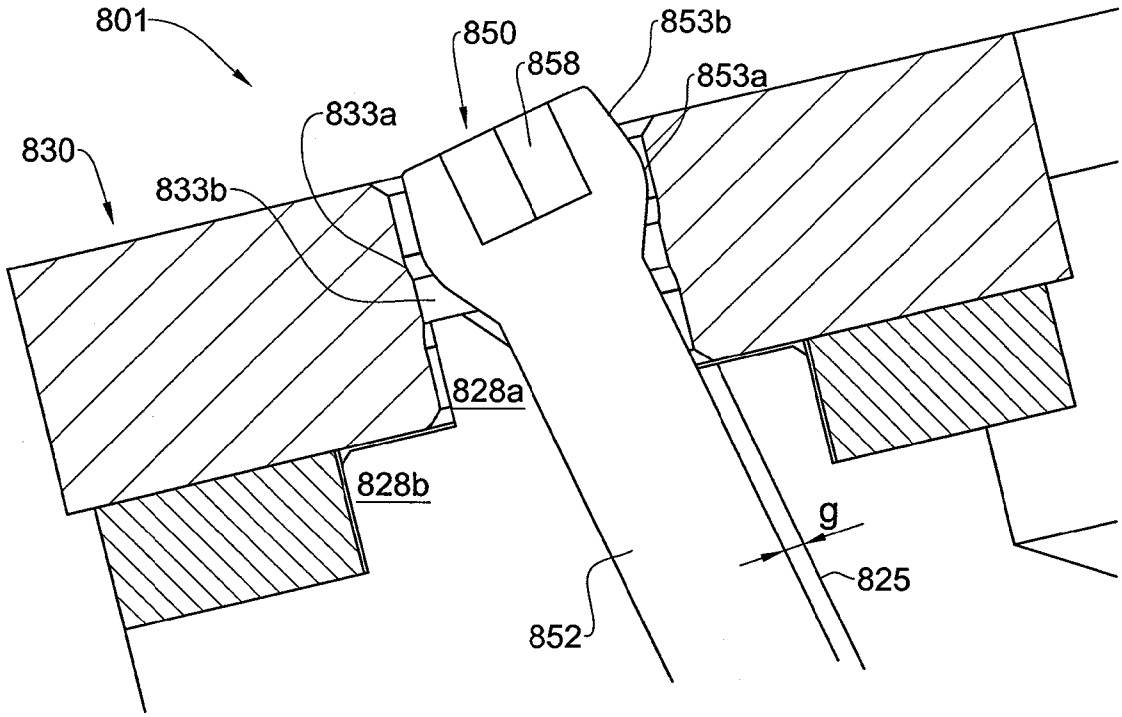

Fig. 37C

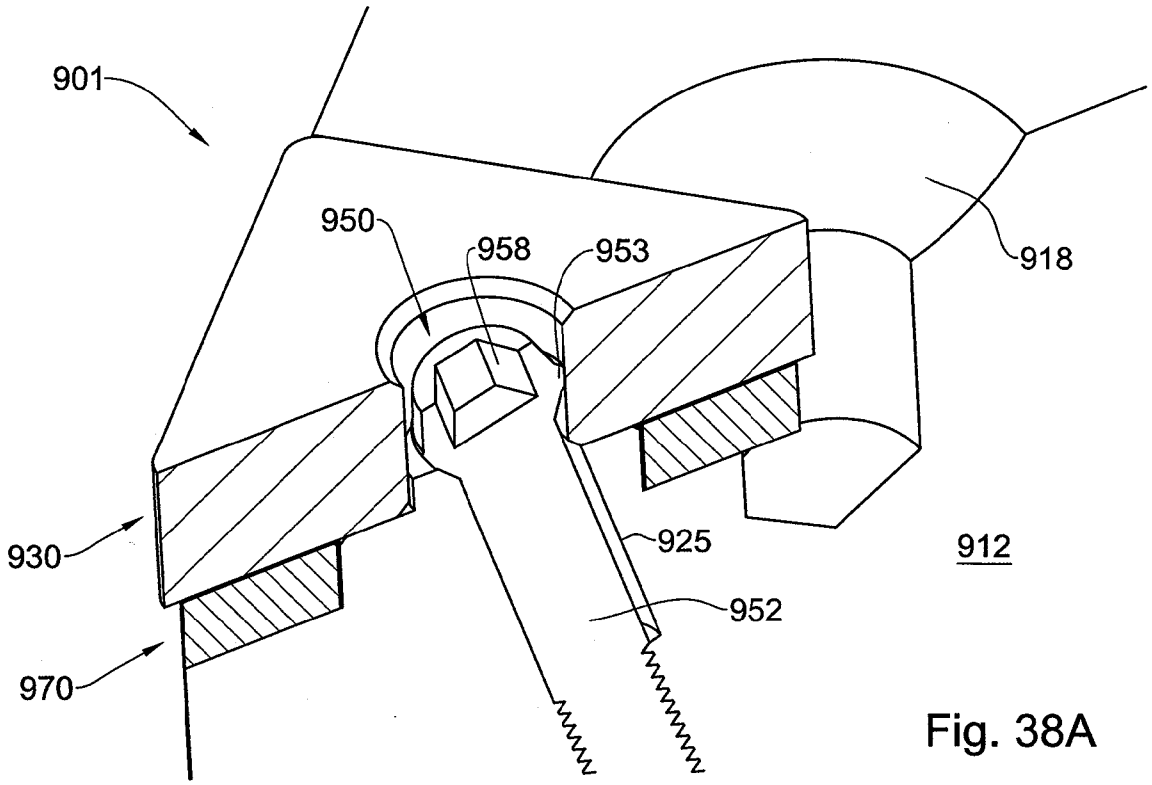

Fig. 38A

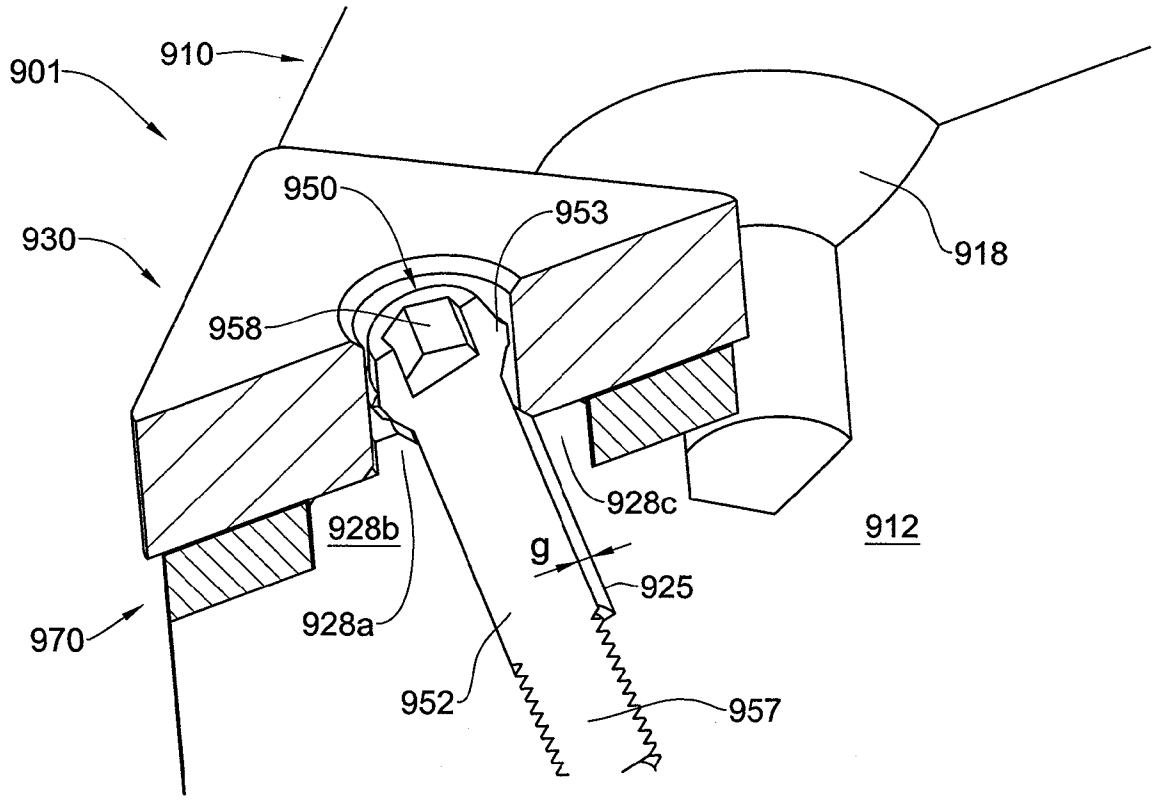

Fig. 38B

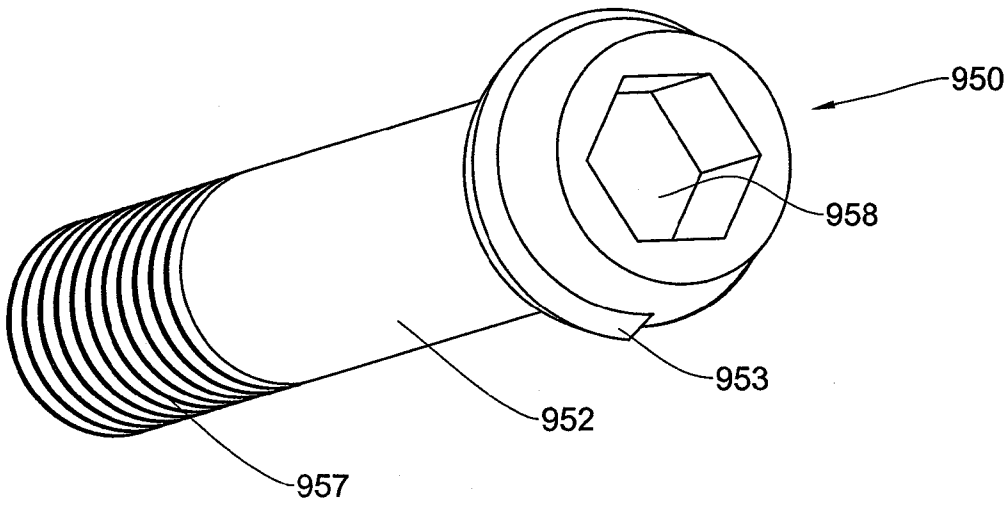

Fig. 38C

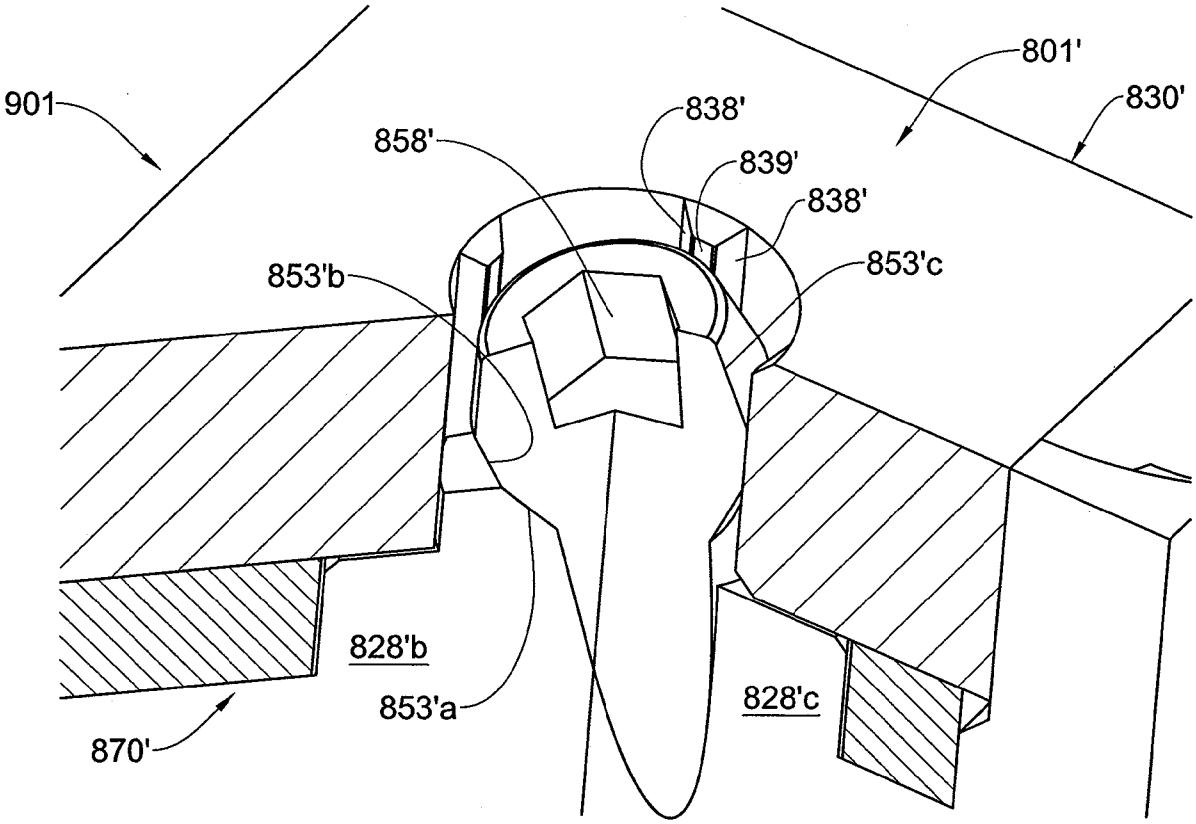

Fig. 39A

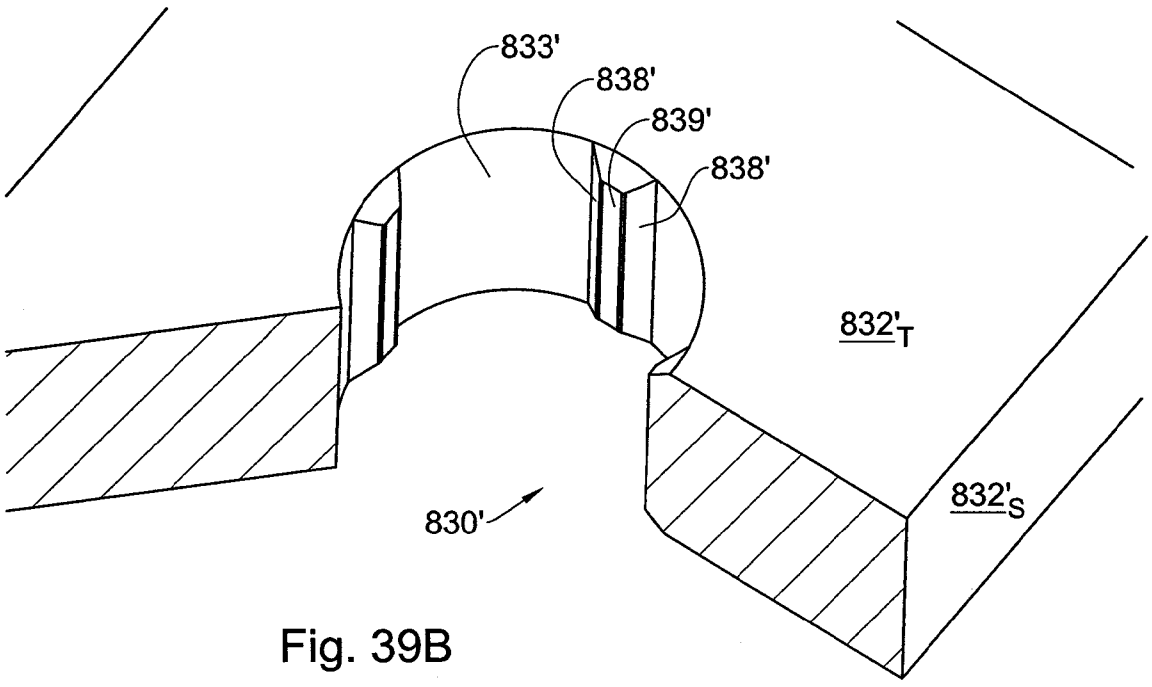

Fig. 39B

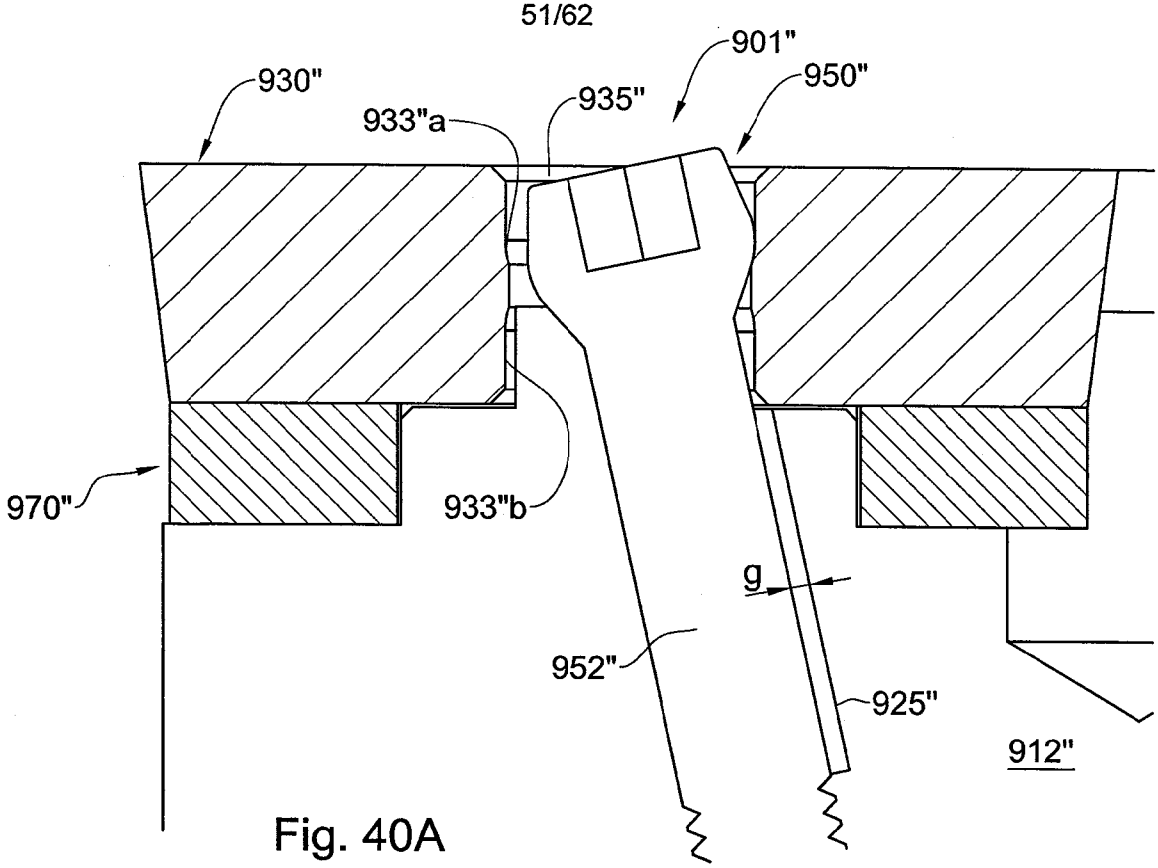

Fig. 40A

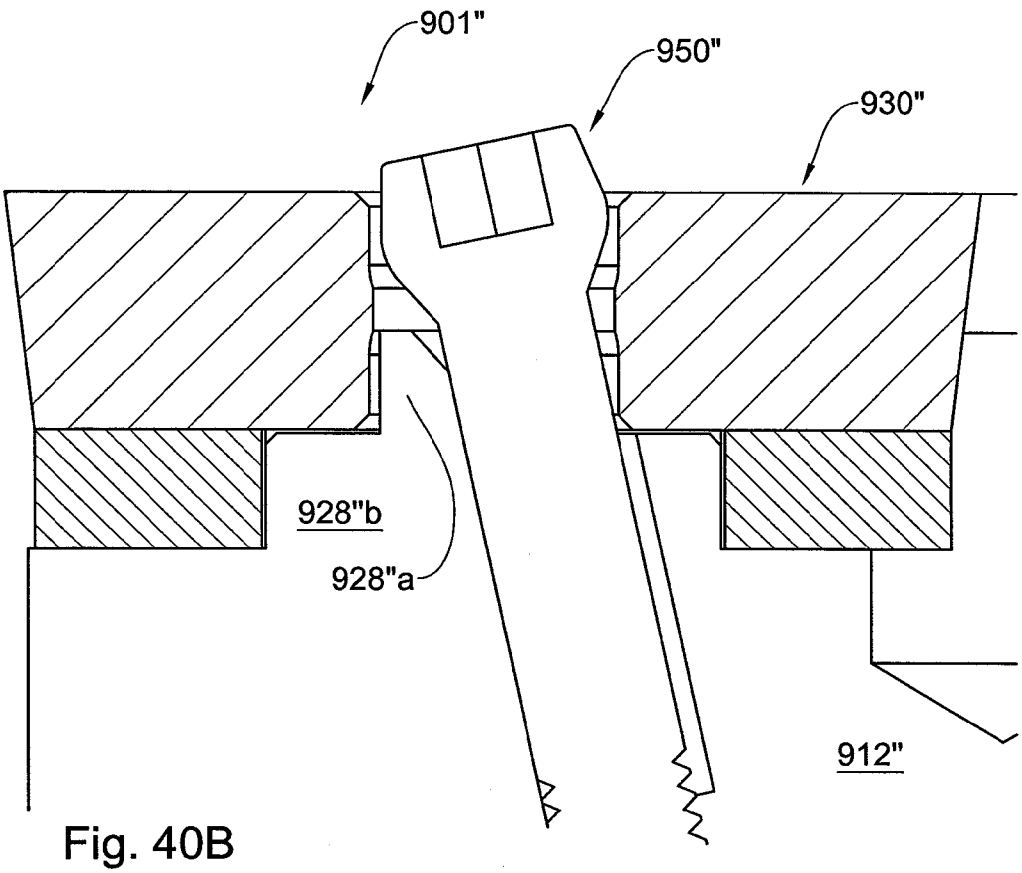

Fig. 40B

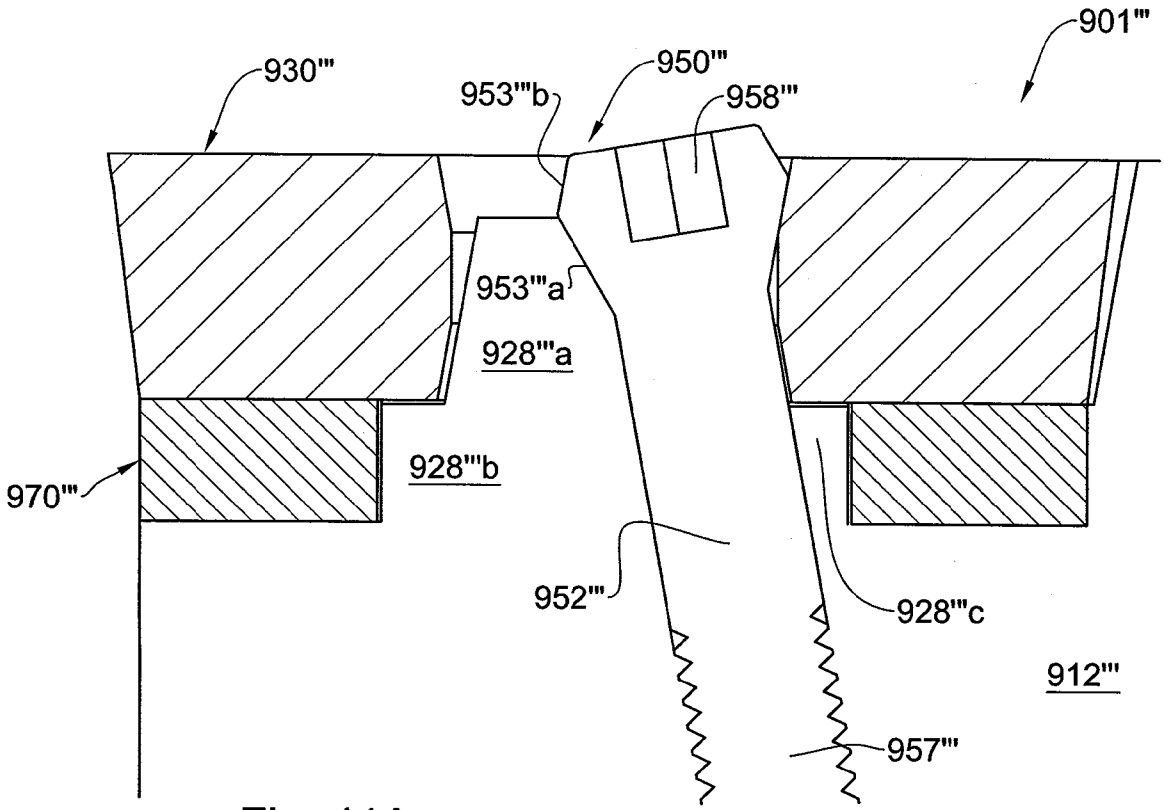

Fig. 41A

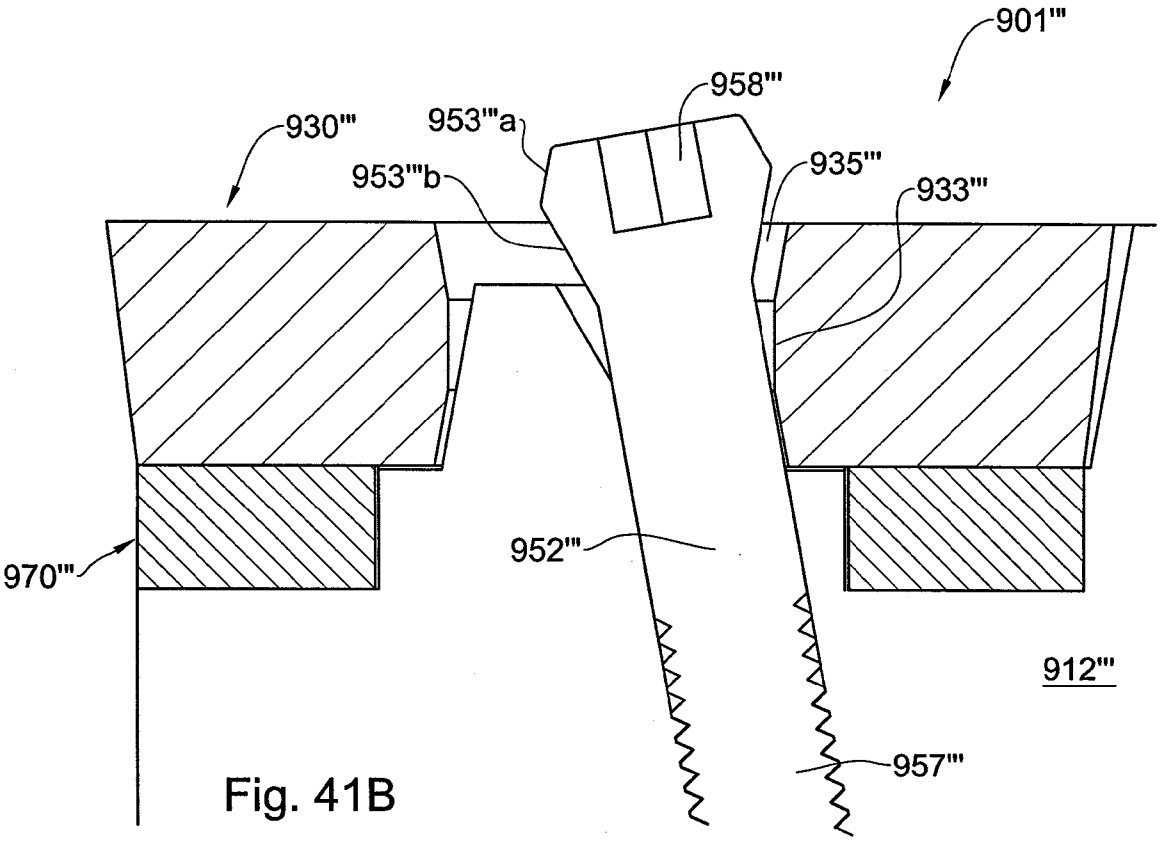

Fig. 41B

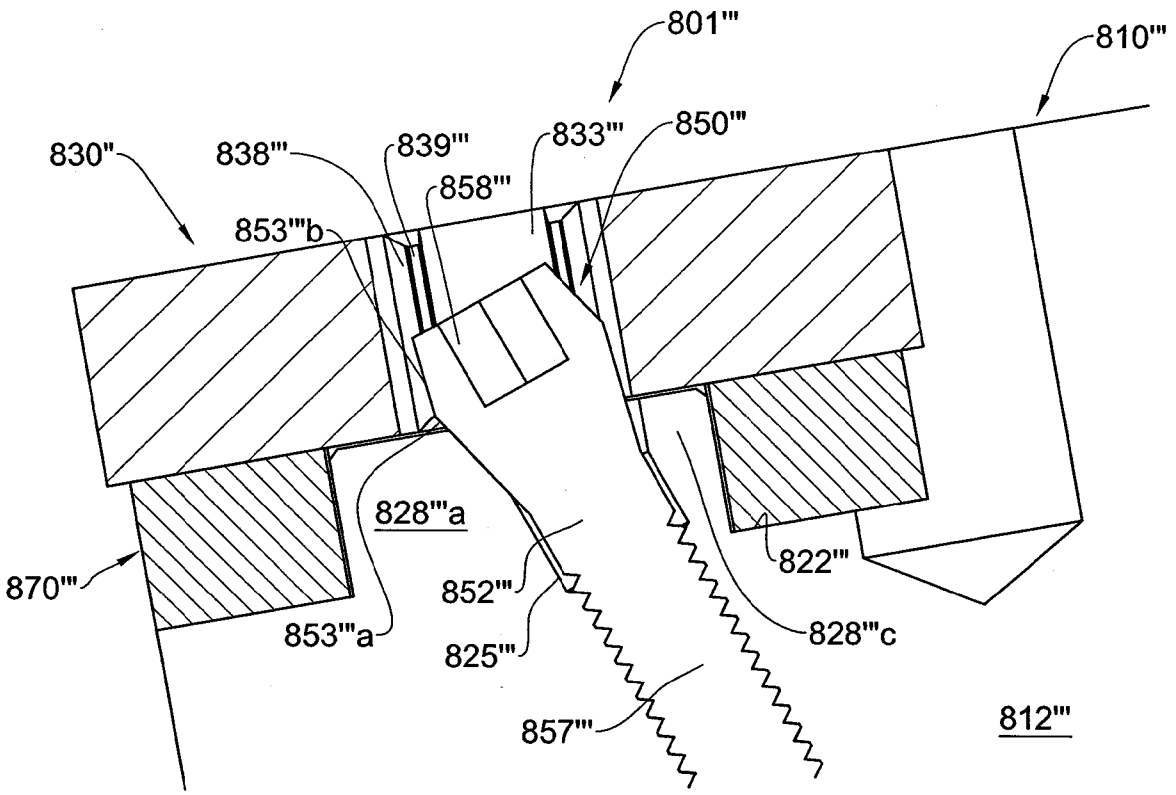

Fig. 42A

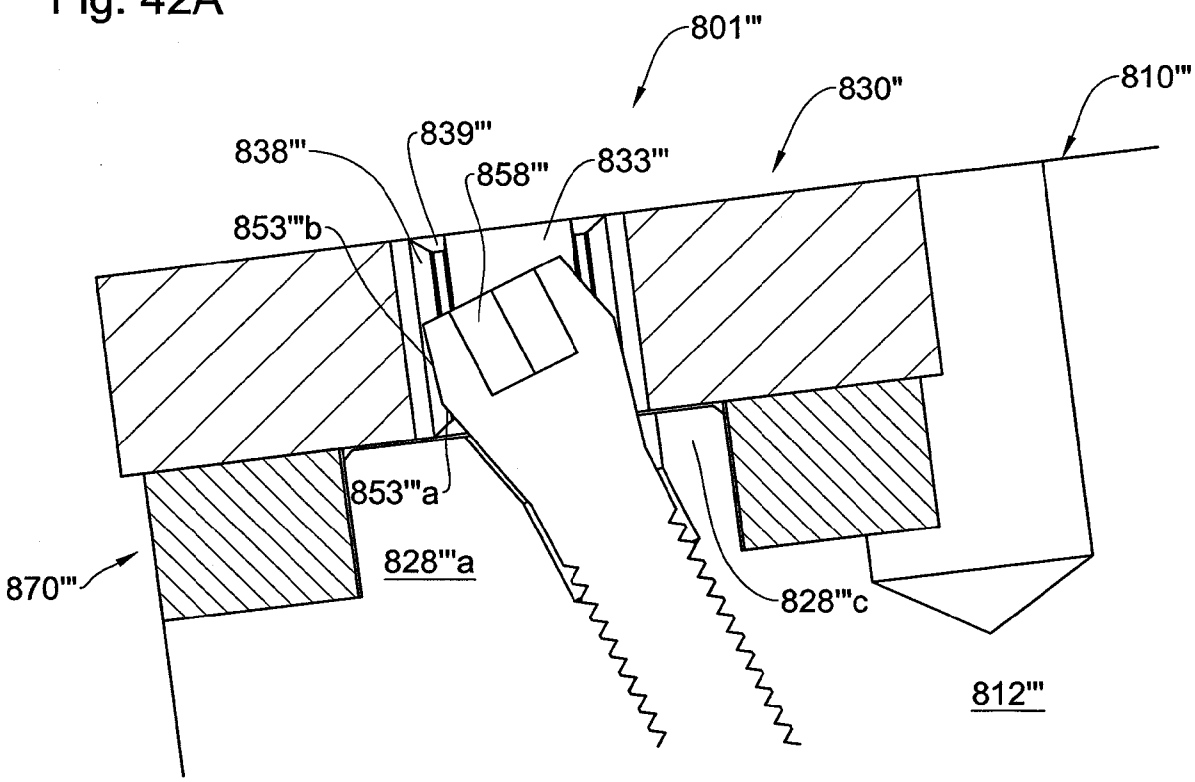

Fig. 42B

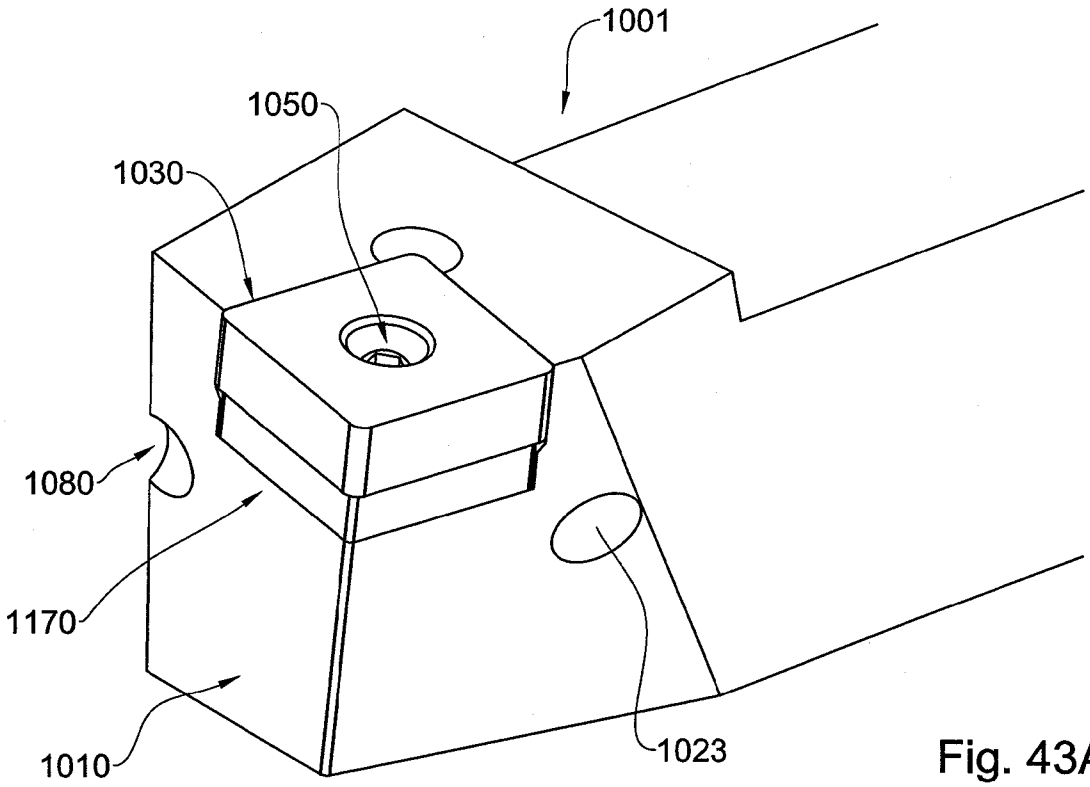

Fig. 43A

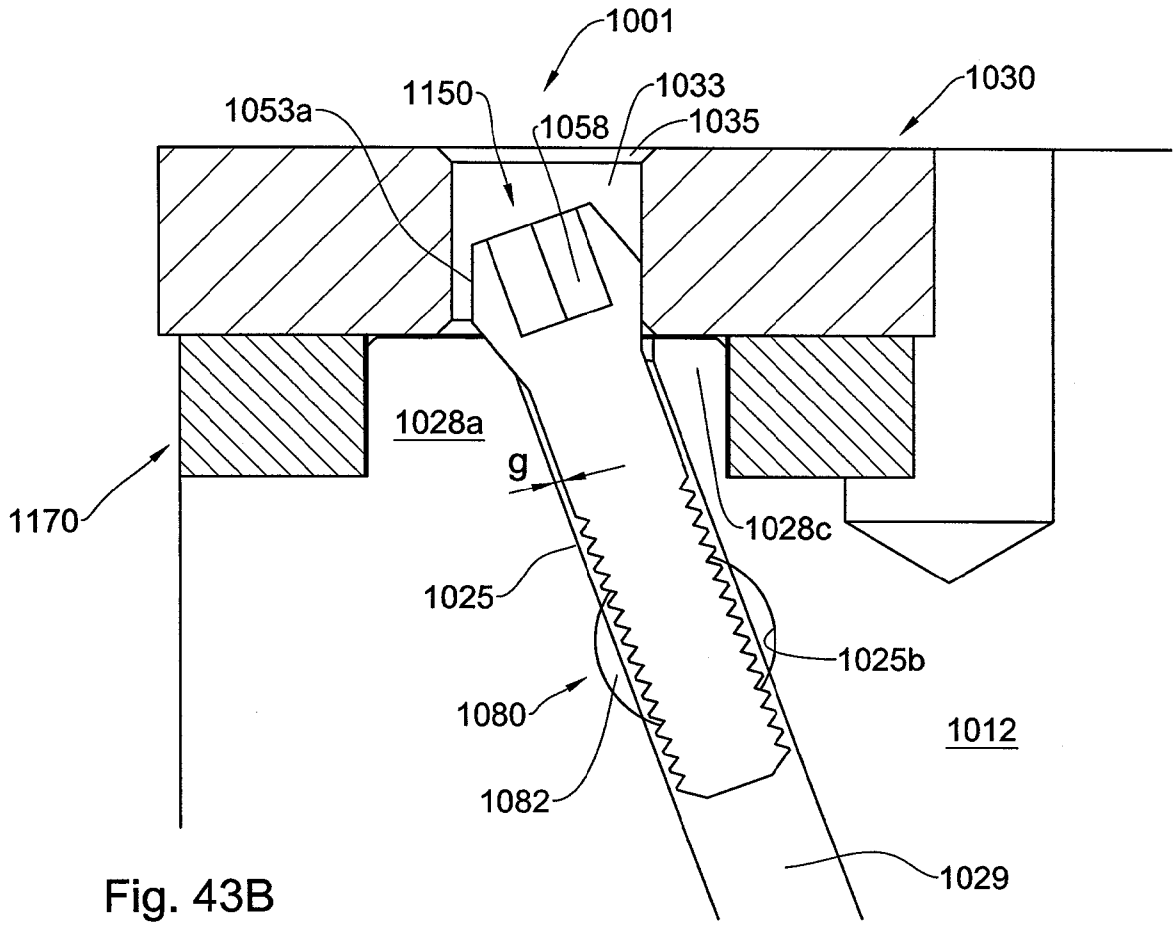

Fig. 43B

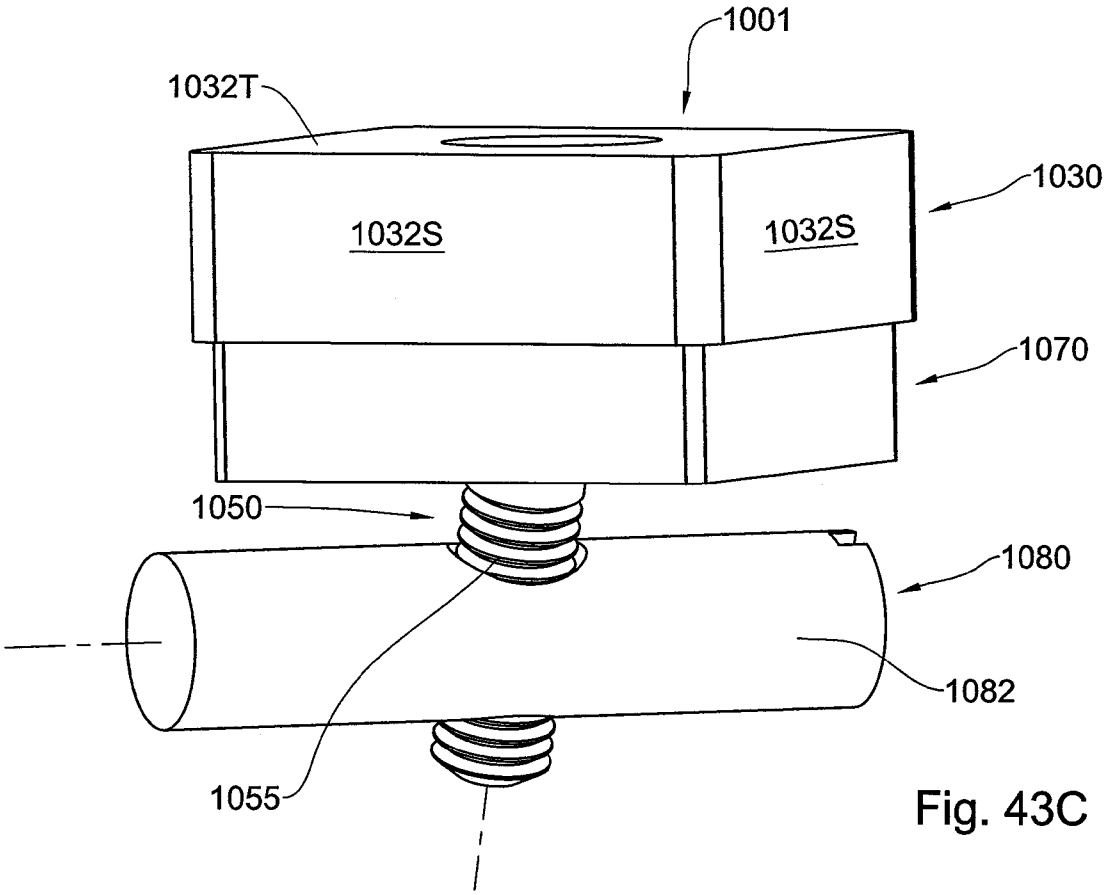

Fig. 43C

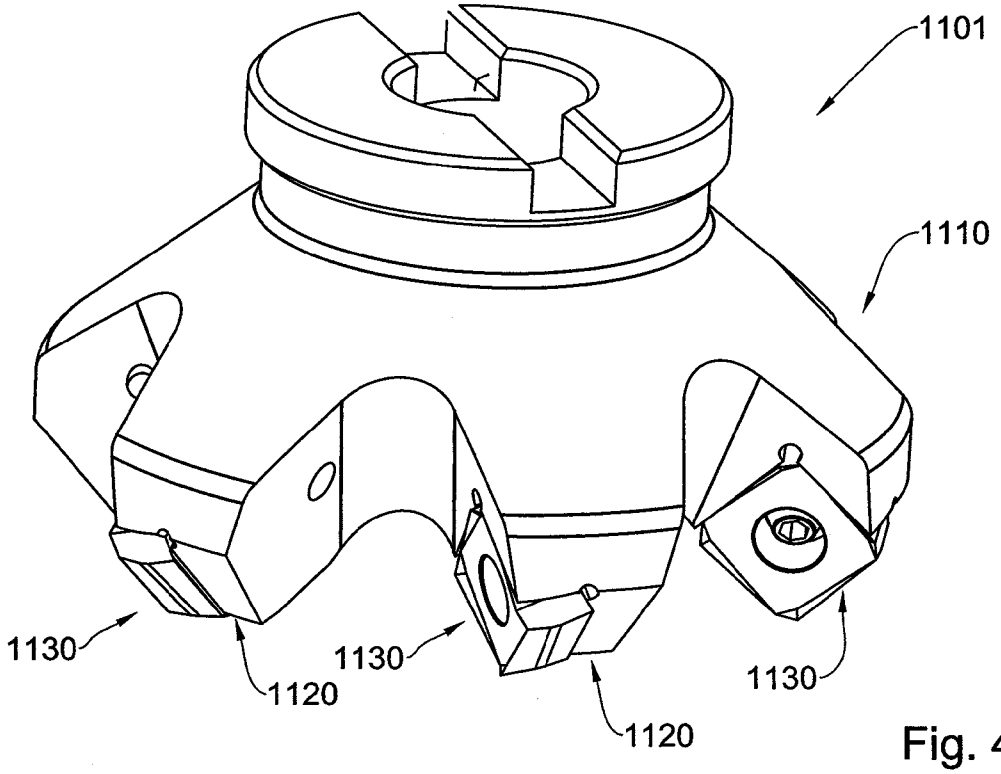

Fig. 44A

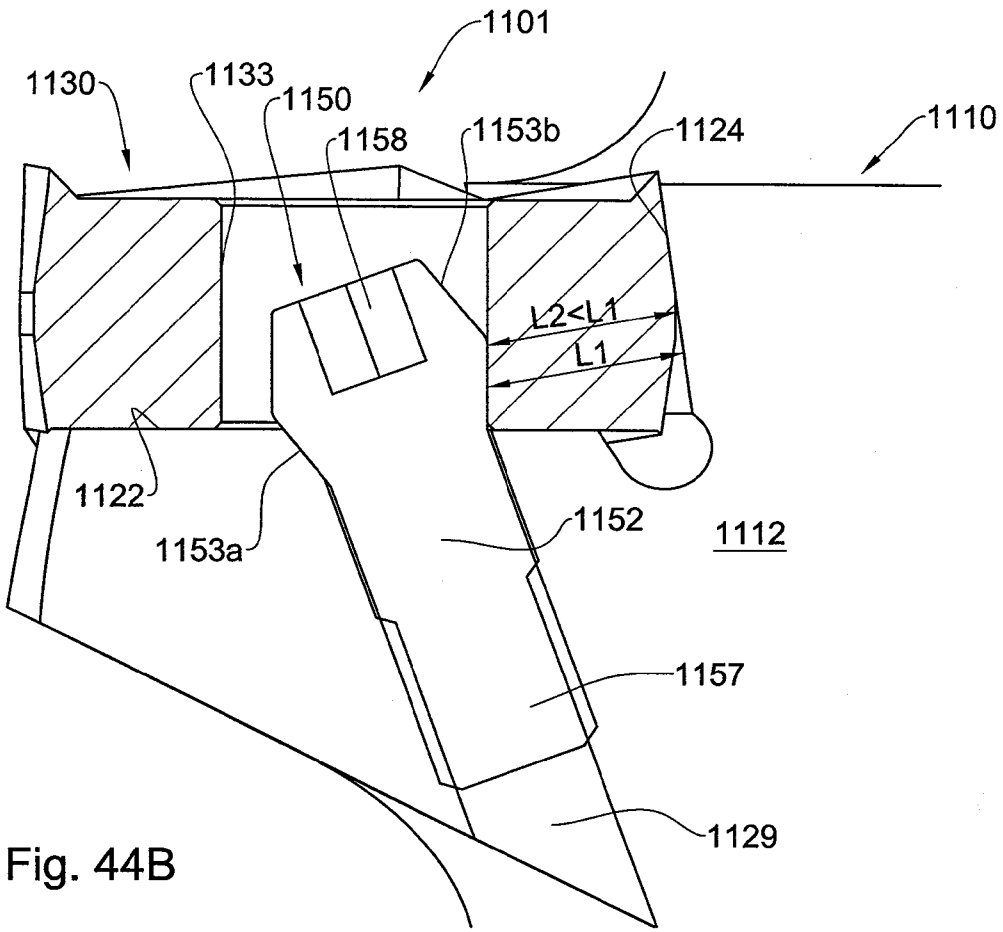

Fig. 44B

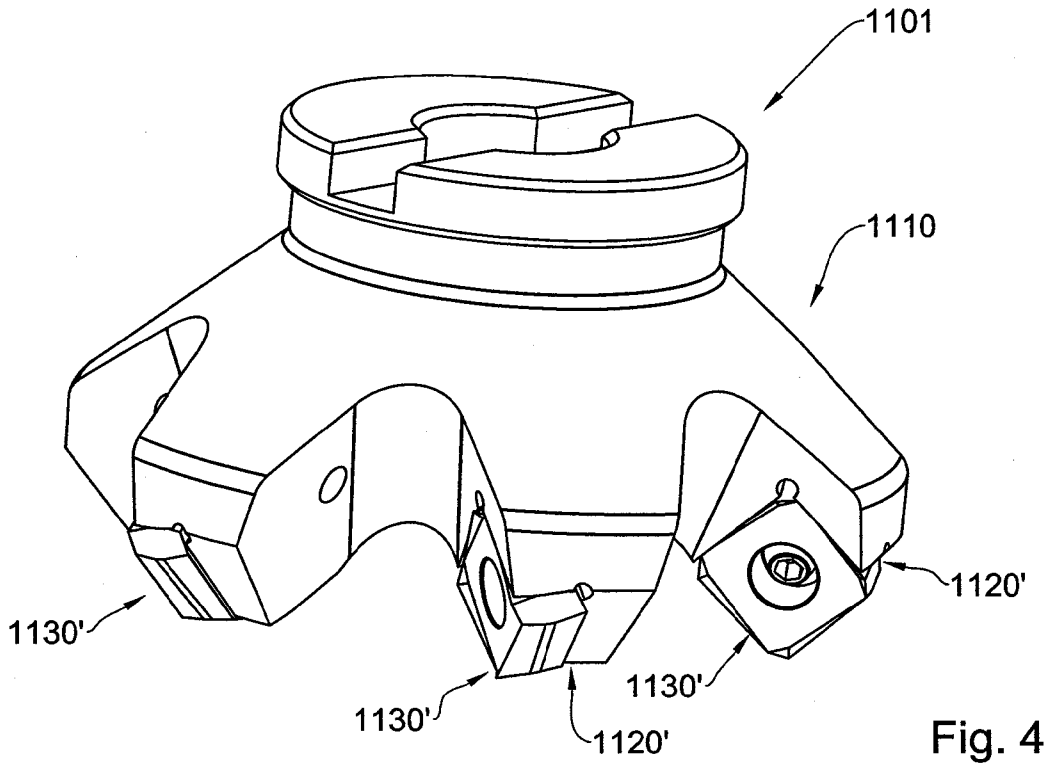

Fig. 45A

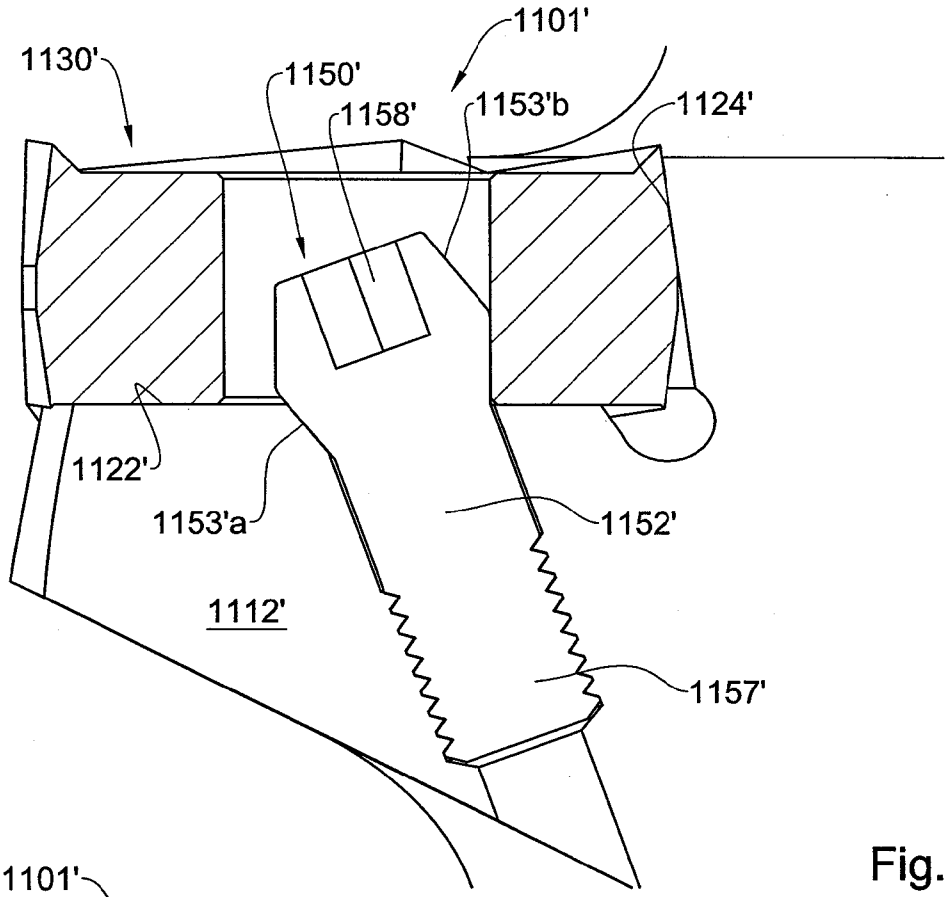

Fig. 45B

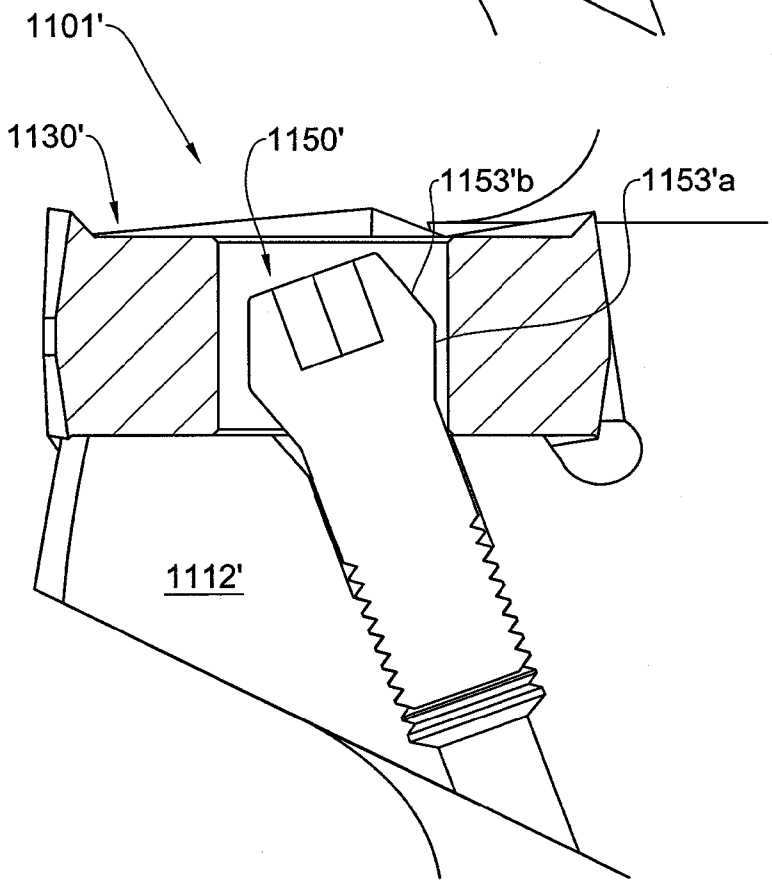

Fig. 45C

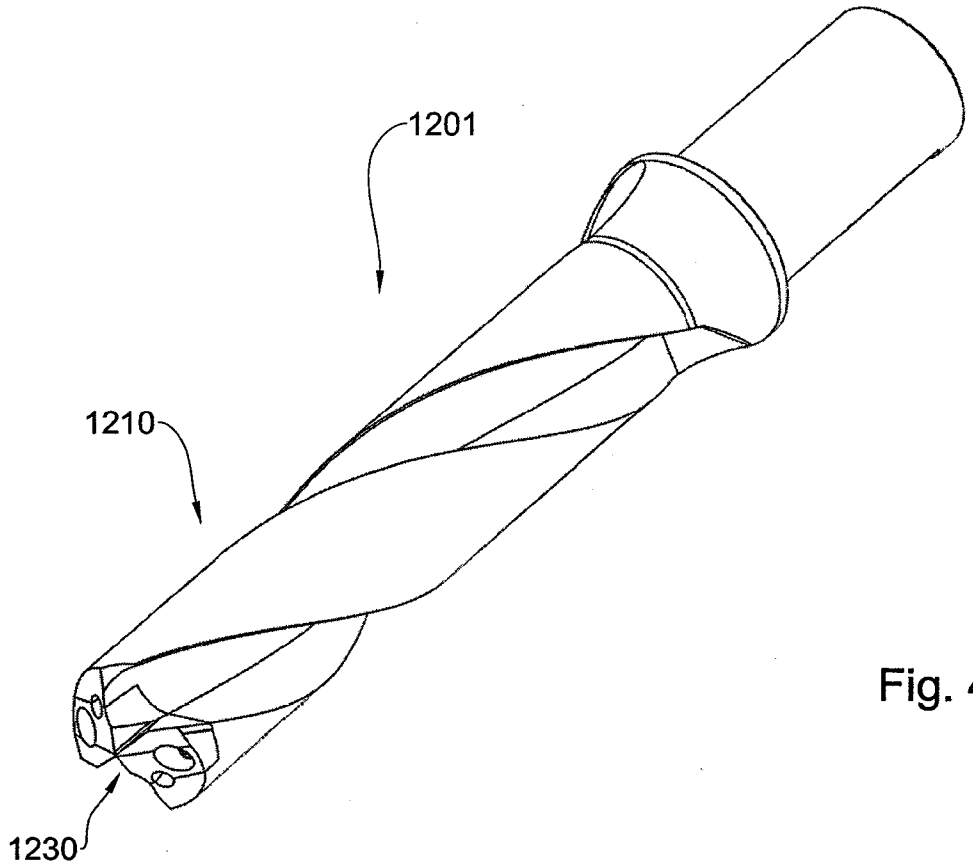

Fig. 46A

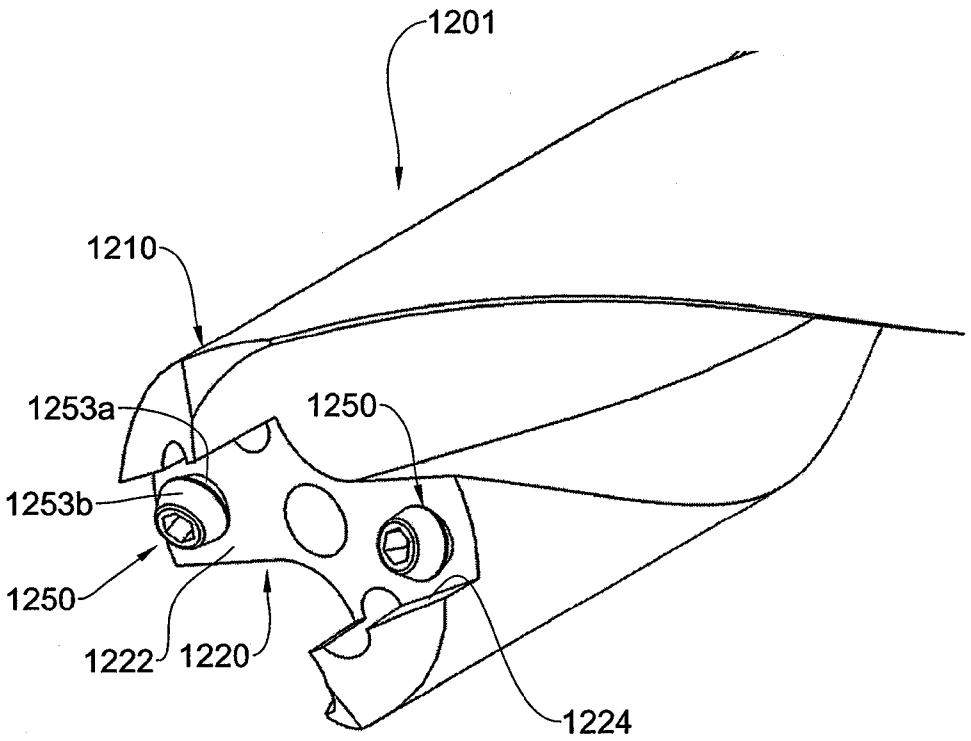

Fig. 46B

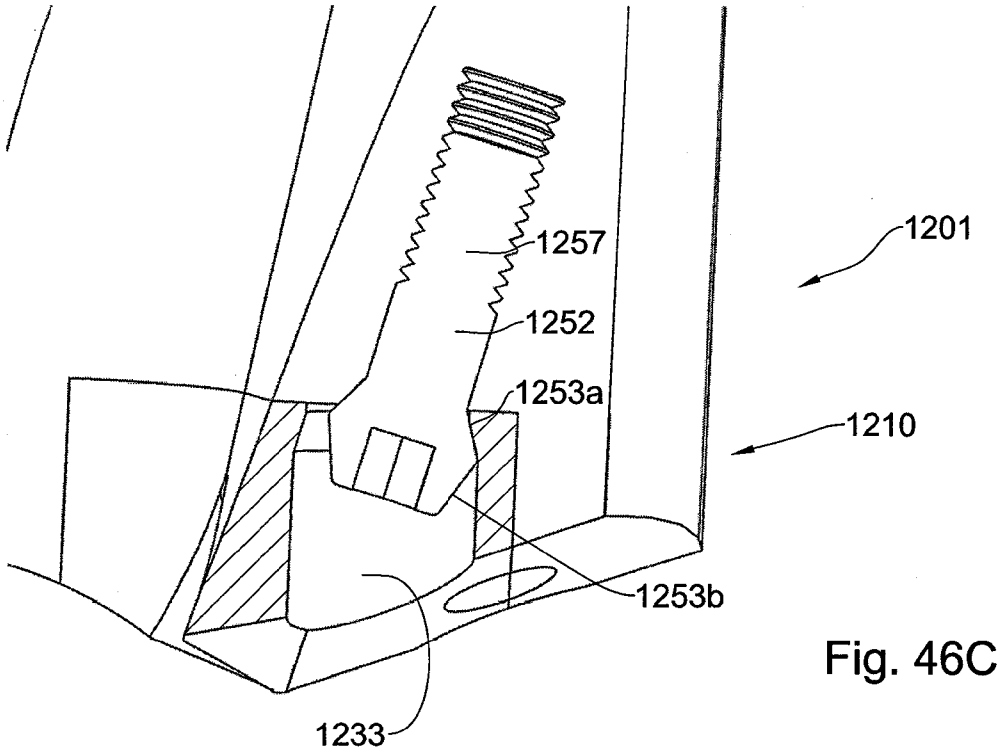

Fig. 46C

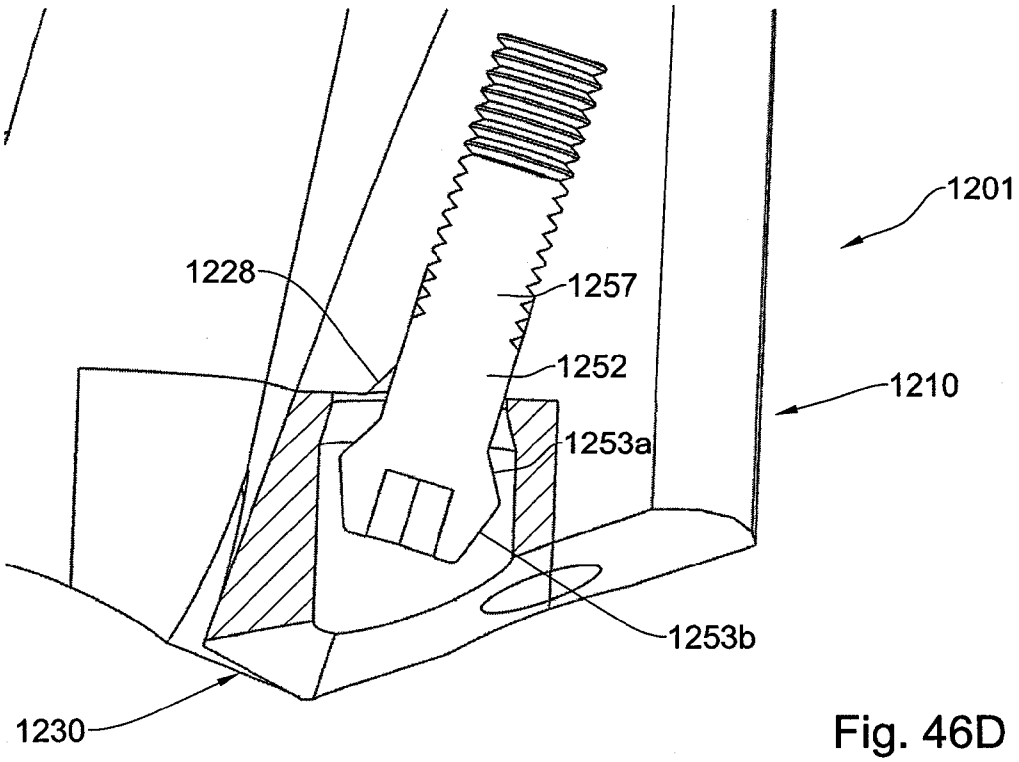

Fig. 46D

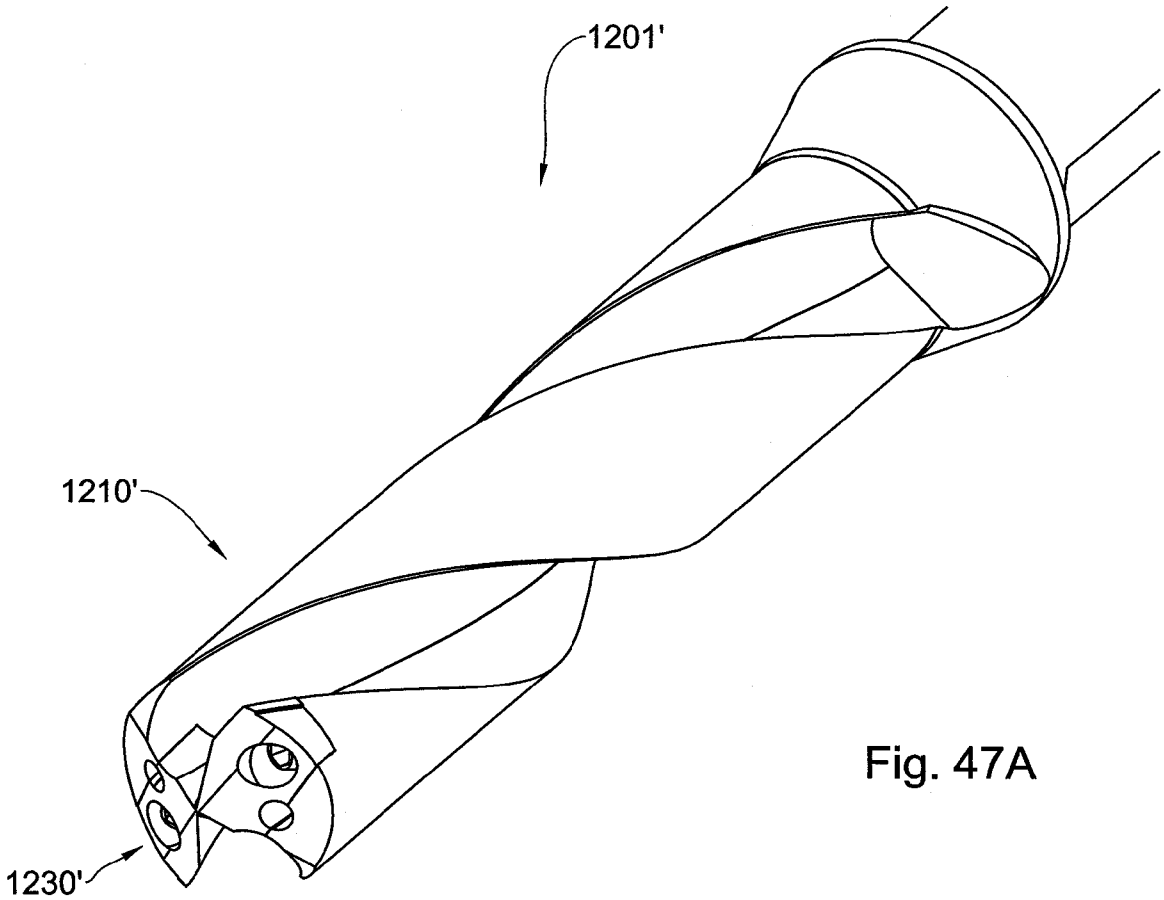

Fig. 47A

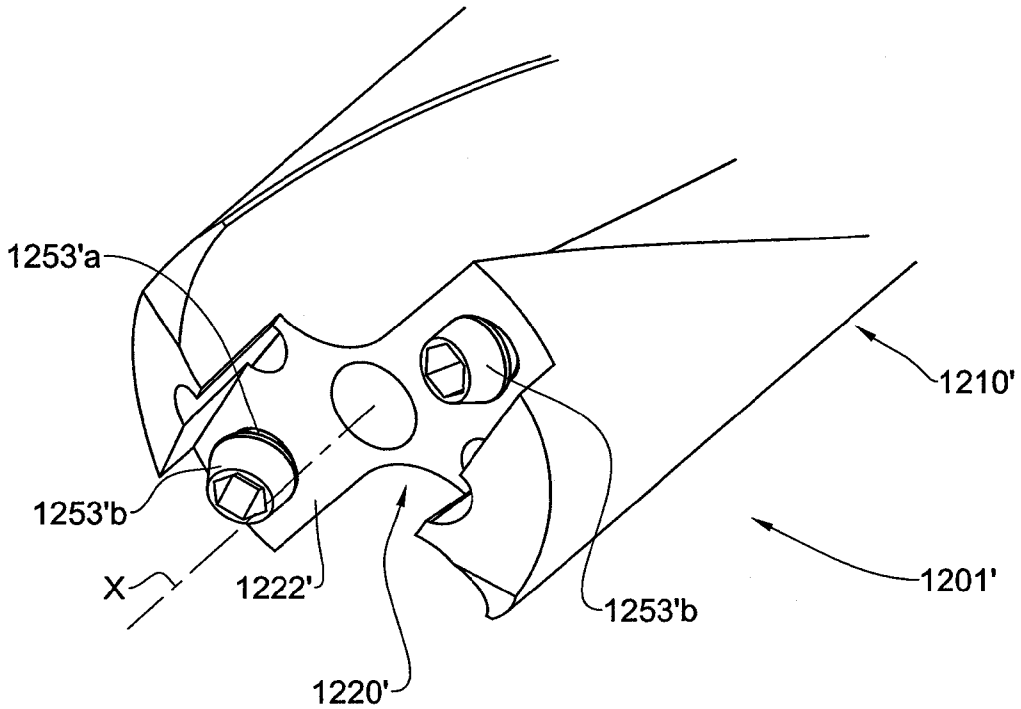

Fig. 47B

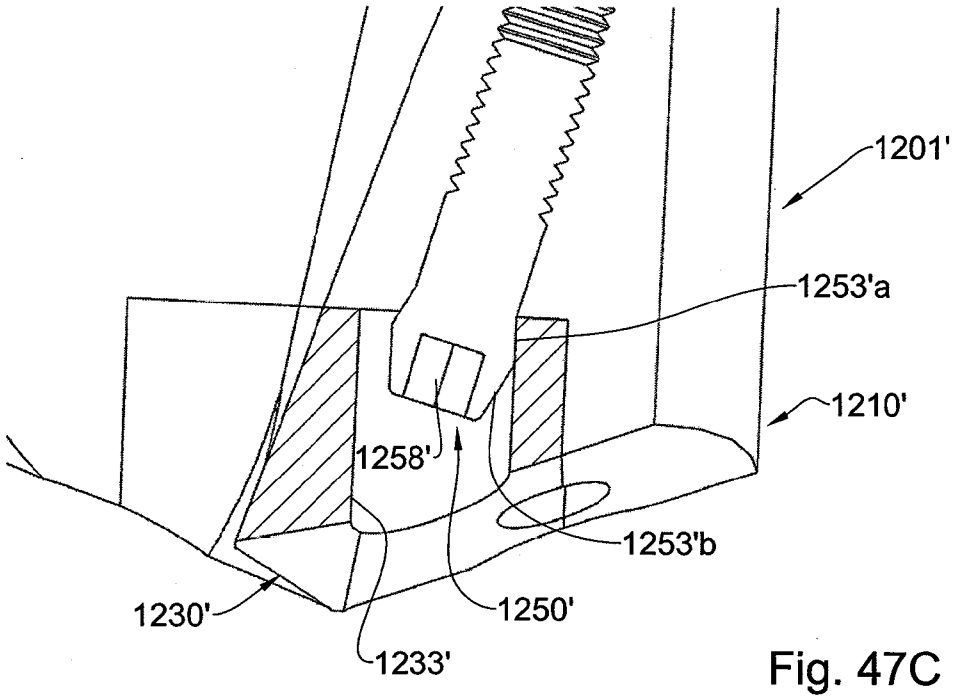

Fig. 47C

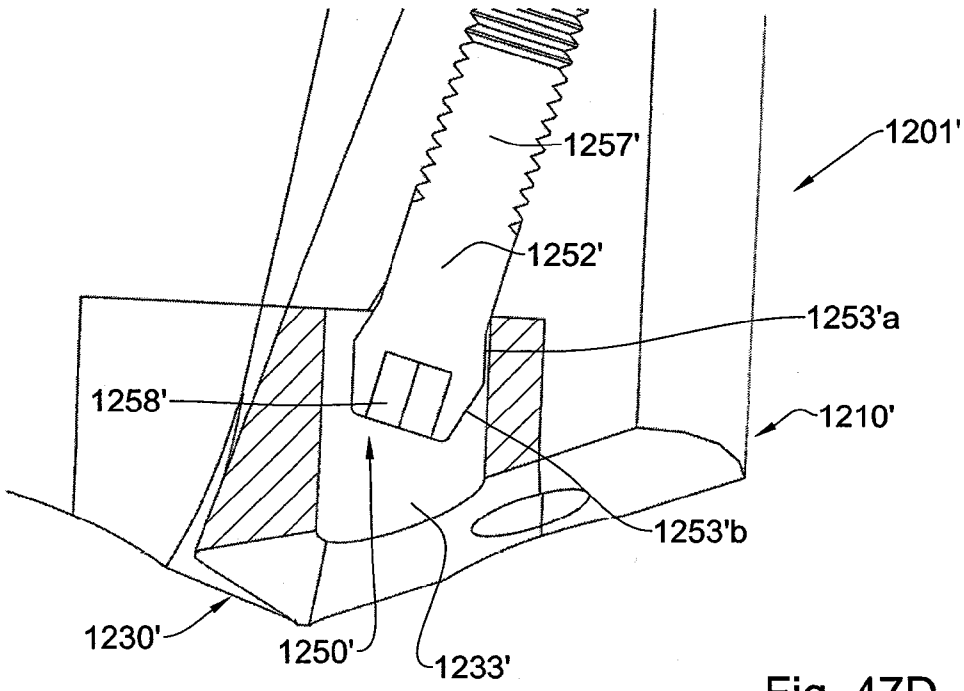

Fig. 47D

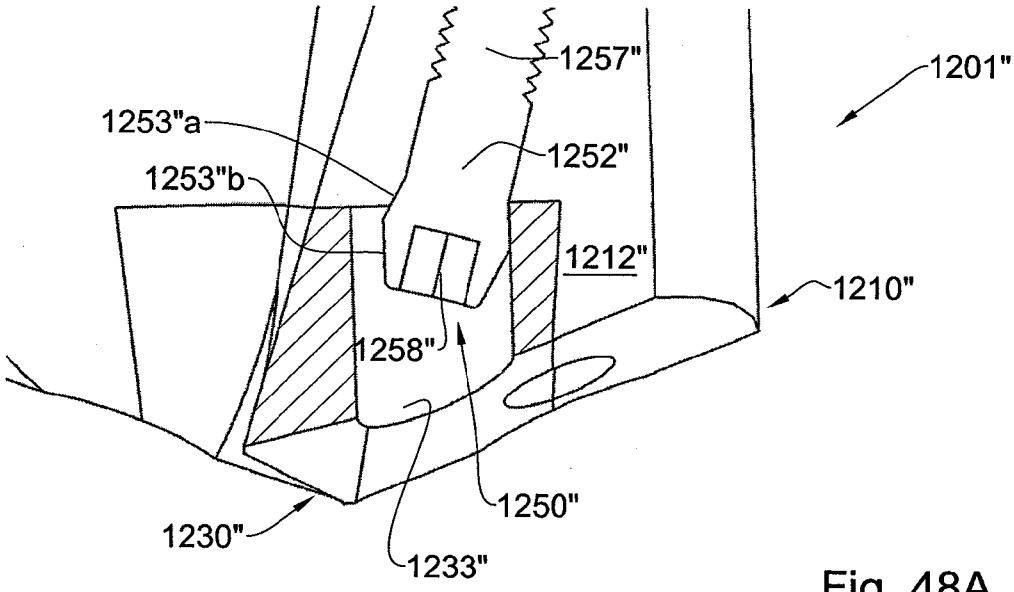

Fig. 48A

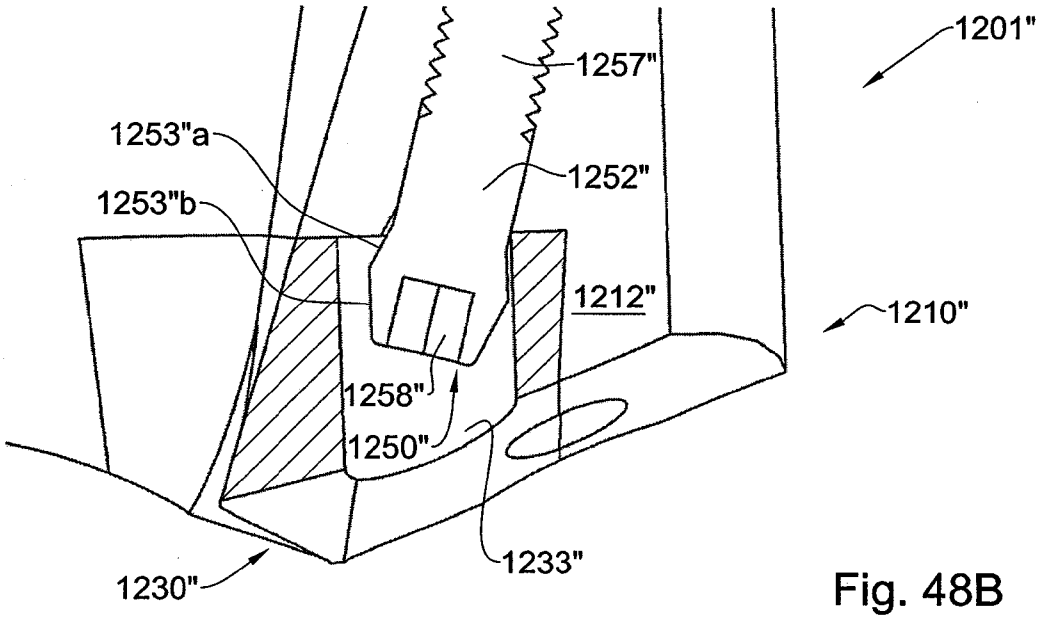

Fig. 48B