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(54) **Title**: CUTTING INSERT WITH INTERNAL COOLING

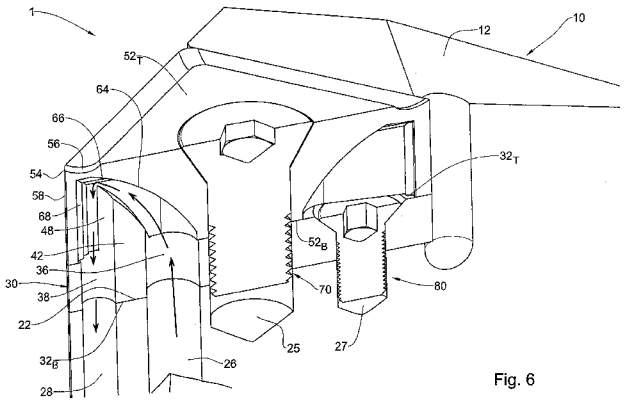


Fig. 6

(57) **Abstract**: A cutting element having a front face, an opposite rear face and at least one side face extending therebetween, and comprising a cooling cavity defined by a cavity surface. The cutting elemnt comprises at least one shell-like cutting zone defined by an external surface and an internal surface. The external surface is constituted by a cutting edge defined at the intersection between the front face and the at least one side face and corresponding rake and relief surfaces constituted by portions of the front fact and at least one side face respectively. The internal surface is constituted by a portion of the cavity surface, wherein the maximal distance between the cavity surface and the external surface at the cutting zone is considerably smaller than the distance between the front face and the opposite rear face. The cooling cavity is configured for receiving therein a cooling fluid for cooling the inner surface and thereby withdrawing heat from the cutting edge.

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CUTTING INSERT WITH INTERNAL COOLING

TECHNOLOGICAL FIELD

The present invention relates to cutting tools and inserts having an internal cooling mechanism.

BACKGROUND

It is known in the art to provide a cooling fluid to a cutting interface between a cutting tool and a workpiece during a cutting operation. The provision of the cooling fluid allows reducing the heat generated at the cutting interface during the cutting operation and thereby preventing damage to both the cutting edge and the workpiece.

In general, a cutting tool has a rake face and a relief face, defining at the intersection thereof a cutting edge of the cutting tool. Cooling fluid is generally provided directly to the cutting interface either from the side of the rake face or from the side of the relief face or from both.

In some examples, cutting inserts used in cutting tools are preformed with apertures configured for the provision of a cooling fluid. In other examples, cutting tools and/or cutting tool holders are provided with a cooling arrangement separate from the cutting insert, which is configured for provision of the cooling fluid.

Examples of cooling arrangements as discussed above are disclosed, for example, in EP0791420, US 5,346,335, US 5,775,854, US 5,901,623, US 6,705,805, US 7,634,957, US 7,934,891 and US 7,959,384. Another example is WO12070046 to the applicant.

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 element having a front face, an opposite rear face and at least one side face extending therebetween, said cutting element comprising a cooling cavity defined by a cavity surface, and at least one shell-like cutting zone defined by an external surface and an internal surface, the external surface being constituted by a cutting edge defined at the intersection between the front face and the at least one side face and corresponding rake and relief surfaces constituted by portions of the front fact and at least one side face respectively, and the internal surface being constituted by a portion of the cavity surface, wherein the maximal distance between the cavity surface and the external surface at the cutting zone is considerably smaller than the distance between the front face and the opposite rear face, said cooling cavity being configured for receiving therein a cooling fluid for cooling said inner surface and thereby withdrawing heat from the cutting edge.

The definition of 'shell-like' refers to the fact that the cutting zone is formed of a relatively thin shell owing to a hollow structure of the cutting element. In particular, the ratio between the maximal distance between the cavity surface and the external surface and the distance between the front face and its opposing rear face can be in the range of 1:5 to 1:10.

More specifically, the maximal distance between the cavity surface and the external surface ranges between 0.2-1mm, more particularly between 0.3-0.9mm, even more particularly between 0.4-0.8mm and still more particularly between 0.5-0.7mm.

According to one example, the cavity surface can be sloped towards the cutting zone in order to direct cooling fluid entering the cavity towards the cutting zone. The arrangement can be such that, in operation, cooling fluid entering the cavity is configured to impact the sloped cavity surface and directed to flow towards the cutting zone so as to cool down the cutting edge from its internal side.

According to one design embodiment, the cavity surface can be formed with a rib array extending along the cutting zone. In particular, said rib array can comprise rake ribs extending generally parallel to the rake surface and relief ribs extending generally parallel to the relief surface.

The ribs of the rib array can provide, *inter alia*, for at least one of the following:

- mechanical integrity to the cutting zone despite its shell-like configuration; and
- increase in surface area for increased cooling of the cutting edge.

In particular, it is appreciated that the ribs provide the shell-like structure of the cutting zone, which is considerably thinner than in a standard, non-hollow insert (full of material at the cutting zone) with the required mechanical integrity to withstand the loads exerted on the cutting element during a cutting operation.

It is also appreciated that the jagged design of the ribs yields that some points of the cavity surface are closer to the cutting edge than others. Thus, while the average shell-thickness can be T (an average of the distances of all points on the cavity surface at the cutting zone from the cutting edge), some points along the cavity surface at the cutting zone are extremely close to the cutting edge, with a thickness $\mathbf{t < T}$. This provides for considerable efficiency in the cooling of the cutting edge without deteriorating mechanical integrity of the cutting zone.

In other words, in a corresponding structure having a smoother cavity surface at the same average thickness T, the cooling efficiency would be lesser than in the above described example and the mechanical integrity may be lesser as well.

The arrangement can be such that the cooling fluid provided to the cavity is configured for cooling the cutting edge from the side of the cavity surface. In particular, cooling fluid provided into the cooling cavity is configured, by virtue of the geometry of the cavity so as not to come into direct contact with the cutting edge.

According to one example, each cutting edge of the cutting element can have a corresponding cooling cavity. Alternatively, the majority of said cutting element can be hollow, comprising a single cooling cavity facilitating cooling for all cutting edges of the cutting element.

In addition, it is appreciated that, on the one hand, the smaller the height of the cutting element (i.e. the distance between the front face and the rear face), the stronger the cutting element since the cutting edge is elevated over a smaller hollow area. On the other hand, the lesser the height of the cutting element, the lesser the space for cooling fluid to flow. Thus, the geometry of the cutting element and of the cavity can be such that meet the required cooling on the one hand while meeting mechanicam integrity requirements on the other.

In particular, the following differences should be noted between different cutting operations:

Milling – the cutting edge keeps coming in and out of contact with the workpiece. As a result, when it is in contact with the workpiece the cutting edge heats up, whereas when it is out of contact, the cutting edge cools down. However, this constant motion in and out of the workpiece causes the milling insert to be repeatedly 'impacted' by the workpiece, requiring sufficient mechanical robustness and stability. In such case, it may be beneficial to provide a more robust structure of the cutting element by using a configuration in which each cutting zone is provided with its individual cooling cavity;

Turning – the cutting edge remains within the workpiece throughout the cutting operation, whereby the effect of 'impact' by the workpiece, which occurs in milling, is eliminated. However, since the cutting edge is constantly in contact with the workpiece, it constantly heats up, requiring sufficient cooling to prevent mechanical damage to the cutting insert.

In addition, the front face of the cutting element can be formed with at least one drainage outlet being in fluid communication with the cooling cavity, and wherein the discharge outlet is arranged such that cooling fluid discharged therethrough does not come in contact with the cutting edge.

According to another aspect of the subject matter of the present application, there is provided a cutting tool comprising:

- a cutting tool holder comprising a seat portion having a base surface provided with a fluid inlet for providing cooling fluid to the seat portion and a fluid outlet configured for removing cooling fluid from the seat portion; and
- a cutting element according to any one of Claims 1 to 11 positioned within the seat portion of the cutting tool holder, over the base surface;

wherein, a cooling cavity of the cutting element is aligned with said inlet and said outlet, whereby cooling fluid is configured for being provided into the cooling cavity via said inlet and be withdrawn therefrom via said outlet.

In reference to the above, the base surface can be provided with a ramp element configured, when the cutting tool is assembled and the cutting element is mounted onto the base surface, to protrude into the cavity of the cutting element to thereby define a

fluid path. Specifically, the fluid path can be configured for receiving cooling fluid through said inlet, directing it towards the portion of the cavity surface at the cutting zone and then towards said outlet. According to a specific example, the cross-sectional area of the fluid path can decrease towards the cutting zone.

According to one design, the base surface can be unitary with the cutting tool holder. Alternatively, according to another design, the cutting tool holder can comprise an intermediate base plate formed with said base surface.

The intermediate base plate can be provided with an inlet bore aligned with the inlet of the cutting tool holder and the cooling cavity of the cutting element and an outlet bore aligned with the outlet of the cutting tool holder and the cooling cavity of the cutting element, to allow passage of cooling fluid therethrough.

The cutting tool can be a milling tool comprising a plurality of cutting elements mounted thereto, wherein said outlet has an open end at a rear portion of the seat so as to direct cooling fluid discharged from the outlet towards a subsequent cutting element of the milling tool.

According to still another aspect of the subject matter of the present application, there is provided a cutting tool holder for mounting thereon a cutting element to form a cutting tool, said cutting tool holder comprising a seat portion having a base surface onto which said cutting element is to be mounted, said base surface being provided with a fluid inlet for providing cooling fluid to the seat portion and a fluid outlet configured for removing cooling fluid from the seat portion.

In addition, the following points should be noted:

- the cutting element can be manufactured by a pressing process within a mold, simplifying production thereof;
- more efficient cooling of the cutting zone of a cutting insert can provide at least one of the following advantages: longer life span of the cutting element under standard cutting conditions, an increased feed and/or increased revolution speed of the cutting tool or of a corresponding workpiece, thereby reducing the required time for performing a predetermined cutting operation;
- the cooling fluid can be any know cooling fluid including water, air, nitrogen etc.; and
- producing the cutting element with a cavity saves valuable material (e.g. tungsten carbide).

The cavity of the cutting element can be formed at an angle to the cutting edge. I particular, it can be angled at 45° to a top or bottom surface of the cutting element. The insert bore, in turn, can be angled to a top and bottom surface thereof and configured for receiving therein a fastening member in a direction generally perpendicular to the top and bottom surface.

The cutting insert can have a first portion and a second portion, angled at about 135° with respect to each other.

The cutting element can comprise a flow channel at the top surface thereof, configured for concentrating fluid flow towards the cutting edge. An outlet of the flow channel can be located below the top surface, and a top surface of the cutting element can be of angled configuration while a bottom surface thereof is generally flat.

The cutting element can be configured for performing a drilling operation or mounting onto a tool holder to form a drilling tool configured for performing a drilling operation.

Specifically, the drilling element can comprise an outlet configured for emitting a cooling fluid to cool the cutting edge, wherein cooling is aided by centrifugal forces caused by rotation of the drilling tool itself.

In effect, centrifugal forces facilitate emission of the cooling fluid towards the cutting edge while rotation of the drilling tool with respect to a bottom surface of the workpiece allows the workpiece to remove cooling fluid away from the cutting edge.

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

Fig.1B is a schematic exploded isometric view of the turning tool shown in Fig. 1B;

Fig. 2 is a schematic isometric view of a tool holder used in the turning tool shown in Figs. 1A and 1B;

Fig. 3 is a schematic isometric view of a base plate used in the turning tool shown in Figs. 1A and 1B;

Fig. 4 is a schematic enlarged view of the base plate of Fig. 3 when mounted onto the tool holder of Fig. 2;

Fig. 5A is a schematic bottom isometric view of a turning insert used in the turning tool shown in Figs. 1A and 1B;

Fig. 5B is a schematic isometric section view of the turning insert shown in Fig. 5A;

Fig. 6 is a schematic section view of a portion of the turning tool shown in Figs. 1A and 1B;

Fig. 7A is a schematic exploded isometric view of a mold for the manufacture of the turning insert shown in Figs. 5A and 5B;

Fig. 7B is a schematic enlarged isometric view of a male part of the mold shown in Fig. 7A;

Fig. 8A is a schematic isometric view of a turning tool according to another example of the subject matter of the present application;

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

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

Fig. 9A is a schematic isometric view of a turning tool according to another example of the subject matter of the present application;

Fig. 9B is a schematic exploded isometric view of the turning tool shown in Fig. 9A;

Fig. 9C is a schematic isometric view of the turning tool shown in Fig. 9A, demonstrating the flow of a cooling fluid;

Fig. 9D is a schematic isometric view of the turning tool shown in Fig. 9, with a turning insert thereof being removed;

Fig. 10 is a schematic bottom isometric view of the turning insert shown in Fig. 9C;

Fig. 11 is a schematic section view of the turning tool shown in Fig. 9A;

Fig. 12 is a schematic isometric view of a turning tool according to still another example of the subject matter of the present application;

Fig. 13A is a schematic isometric view of a turning insert used in the turning tool shown in Fig. 12;

Fig. 13B is a schematic bottom isometric view of the turning insert shown in Fig. 13A;

Fig. 14 is a schematic isometric view of a male part of a mold for the manufacture of the turning insert shown in Fig. 13B;

Fig. 15A is a schematic isometric view of a milling tool according to another example of the subject matter of the present application;

Fig. 15B is a schematic enlarged view of an insert seat of the milling tool shown in Fig. 15A;

Fig. 15C is a schematic isometric view of the insert seat shown in Fig. 15B, demonstrating the flow of a cooling fluid;

Fig. 15D is a schematic isometric section view of the milling tool shown in Fig. 15A, demonstrating the flow of cooling fluid;

Fig. 16A is a schematic isometric view of a milling insert used in the milling tool shown in Fig. 15A;

Fig. 16B is a schematic bottom isometric view of the milling insert shown in Fig. 16A;

Fig. 17A is a schematic exploded isometric view of a mold for the manufacture of the milling insert shown in Figs. 16A and 16B;

Fig. 17B is a schematic isometric view of a male part of the mold shown in Fig. 17A;

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

Fig. 18B is a schematic isometric view of a turning insert used in the turning tool shown in Fig. 18A;

Fig. 18C is a schematic bottom isometric view of the turning insert shown in Fig. 18B;

Fig. 18D is a schematic side view of the turning insert shown in Fig. 18B;

Fig. 19 is a schematic isometric section view of the turning tool shown in Fig. 18A, taken along plane I-I shown in Fig. 18A, demonstrating the flow of cooling fluid;

Fig. 20A is a schematic exploded isometric view of a mold for the manufacture of the turning insert shown in Figs. 18B and 18C;

Fig. 20B is a schematic isometric view of a male part of the mold shown in Fig. 20A;

Fig. 20C is a schematic section view of a female part of the mold shown in Fig. 20A;

Fig. 21A is a schematic isometric view of a turning tool according to still another example of the subject matter of the present application;

Fig. 21B is a schematic isometric view of the turning tool shown in Fig. 21A, with a turning insert thereof being removed;

Fig. 21C is a schematic exploded isometric view of the turning tool shown in Fig. 21A;

Fig. 22A is a schematic isometric view of a turning insert used in the turning tool shown in Fig. 21A;

Fig. 22B is a schematic front view of a turning insert used in the turning tool shown in Fig. 21A;

Fig. 22C is a schematic top view of a turning insert used in the turning tool shown in Fig. 21A;

Fig. 22D is a schematic side view of a turning insert used in the turning tool shown in Fig. 21A;

Fig. 23 is a schematic isometric longitudinal section view of the turning tool shown in Fig. 21A;

Fig. 24A is a schematic exploded isometric view of a mold for the manufacture of the turning insert shown in Figs. 22A-22D;

Fig. 24B is a schematic isometric enlarged view of a male part of the mold shown in Fig. 24A;

Fig. 24C is a schematic section view of a female part of the mold shown in Fig. 24A;

Fig. 25A is a schematic isometric view of a turning tool according to still another example of the subject matter of the present application;

Fig. 25B is a schematic enlarged view of detail N of the turning tool shown in Fig. 25A;

Fig. 25C is a schematic isometric longitudinal section view of the turning tool shown in Fig. 25A, demonstrating the flow of cooling fluid;

Fig. 25D is a schematic isometric view of the turning tool shown in Fig. 25A, with a turning insert thereof being removed;

Fig. 25E is a schematic exploded isometric view of the turning tool shown in Fig. 25A;

Fig. 26A is a schematic bottom view of a turning insert used in the turning tool shown in Fig. 25A;

Fig. 26B is a schematic side view of a turning insert used in the turning tool shown in Fig. 25A;

Fig. 27 is a schematic enlarged view of the turning insert shown in Fig. 26A, with a turning insert thereof being removed, demonstrating the flow of cooling fluid;

Fig. 28 is a schematic isometric view of a turning tool according to still another example of the subject matter of the present application;

Fig. 29A is a schematic side view of a turning insert used in the turning tool shown in Fig. 28;

Fig. 29B is a schematic side view of a turning insert, demonstrating the differences between the turning insert shown in Figs. 26B and 29A;

Fig. 30A is a schematic isometric view of a turning tool according to still another example of the subject matter of the present application;

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

Fig. 31A is a schematic isometric view of a turning insert used in the turning tool shown in Fig. 30A;

Fig. 31B is a schematic isometric section view of the turning tool shown in Fig. 30A, demonstrating the flow of cooling fluid;

Fig. 31C is a schematic section view of the turning tool shown in Fig. 30A, demonstrating the turning insert's fastening mechanism;

Fig. 32 is a schematic isometric view of a turning tool according to still another example of the subject matter of the present application;

Fig. 33A is a schematic top view of a turning insert used in the turning tool shown in Fig. 32;

Fig. 33B is a schematic side view of a turning insert used in the turning tool shown in Fig. 32;

Fig. 33C is a schematic isometric enlarged view of a turning insert used in the turning tool shown in Fig. 32;

Fig. 34A is a schematic isometric view of a milling tool according to still another example of the subject matter of the present application;

Fig. 34B is a schematic enlarged view of the milling tool shown in Fig. 34A;

Fig. 35A is a schematic enlarged view of an insert seat of the milling tool shown in Fig. 34A;

Fig. 35B is a schematic isometric section view of the milling tool shown in Fig. 34A, demonstrating the flow of cooling fluid;

Fig. 36A is a schematic isometric view of a milling insert used in the milling tool shown in Fig. 34A;

Fig. 36B is a schematic top view of the milling insert shown in Fig. 36A;

Fig. 36C is a schematic bottom view of the milling insert shown in Fig. 36A;

Fig. 36E is a schematic side view of the milling insert shown in Fig. 36A;

Fig. 37A is a schematic isometric view of a drilling tool according to the subject matter of the present application;

Fig. 37B is a schematic enlarged view of the drilling tool shown in Fig. 37A;

Fig. 38 is a schematic isometric section view of the drilling tool shown in Fig. 37A, demonstrating the flow of cooling fluid;

DETAILED DESCRIPTION OF EMBODIMENTS

Turning to Figs. 1A and 1B, a turning tool according to the subject matter of the present application is shown generally designated as **1,** and comprising a tool holder **10**, a base plate **30** (made of widia) , a turning insert **50** and two clamping screws **70**, **80**. The turning tool **1** is designed so as to allow cooling of the area of the cutting edge thereof during a turning operation.

With particular reference being made to Fig. 2, it is observed that the cutting tool holder **10** has a main body **12** comprising a seat portion **20** for mounting thereon the base plate **30** and the cutting insert **50**. The body **12** is provided with a cooling fluid provision channel **16** passing therethrough and configured for providing a cooling fluid to the seat portion **20**.

The seat portion **20** has a bottom face **22** configured for positioning thereon of the base plate **30**, and is delimited by two side walls **24**. The bottom face **22** is formed

with an auxiliary bore **27** configured for receiving therein an auxiliary securing bolt **80** for fastening of the base plate **30** into the seat **20**, and a main bore **25** configured for receiving therein a main securing bolt **70** for fastening of the cutting insert **50** into the seat **20**.

The seat portion **20** is also formed with an cooling inlet **26** configured for emitting the cooling fluid provided through the channel **16**, and an outlet **28** configured for removal of the cooling fluid from the area of the seat portion **20**.

Turning now to Figs. 3 and 4, the base plate **30** comprises a main body **32** having a top face **32**T, a bottom face **32**B and side faces **32**S extending therebetween. The main body **32** comprises a main bore **35** for passing therethrough of the main securing bolt **70** and an auxiliary bore **37** for passing therethrough of the auxiliary securing bolt **80**.

The base plate **30** further comprises an inlet hole **36** and an outlet hole **38** which, when the base plate **30** is mounted into the seat portion **20** of the cutting tool holder **10**, are aligned with the respective inlet and outlet **26**, **28** of the cutting tool holder **10**.

The base plate **30** further comprises a fluid ramp **40** projecting from the top surface **32**T thereof, disposed between the inlet **36** and the outlet **38**, and configured for directing the flow of the cooling fluid towards a designated area of the cutting insert **50**.

In particular, as shown in Fig. 4, cooling fluid incoming through the channel **16** is emitted through the inlet **26** and immediately through inlet **36**. As will be explained in detail later with respect to Fig. 6, fluid flow is restricted by the geometry of the cutting insert **50** and is directed towards the outlet **38** and subsequently **28** to be emitted from the cutting tool **1.**

Attention is now drawn to Figs. 5A and 5B in which a cutting insert **50** is shown, comprising a body **52** with a top surface **52**T, bottom surface **52**B and side surfaces **52**S extending therebetween. The cutting insert **50** has four cutting edges **54** defined at the respective four corners of the insert at the intersection between the top face **52**T and the side faces **52**S. Each cutting edge **54** is delimited by a rake surface **56** and a relief surface **58** located on opposite sides of the cutting edge **32**. The cutting edge **54**, rake surface **56** and relief surface **58** constitute together the external surface of the cutting zone of the cutting insert **50**.

In addition, the cutting insert **50** comprises four cooling cavities **60**, each associated with a respective cutting edge **54**. Each cooling cavity has an inner space **62**

delimited by side walls and a ramp **64**, tapering away from the cutting edge **54**. The inner surface of the cavity provides each cutting corner of the cutting insert **50** with a shell-like geometry (a thin-walled structure) which has an external, operational surface (comprising the cutting edge **54**) and an internal, cooling surface constituted by the surface of the cavity **60**.

It is observed that the cooling surface is formed with an array of ribs, including rake ribs **66** which extend generally parallel to the rake surface **56** and relief ribs **68** which extend generally parallel to the relief surface **58**. With particular reference to Fig. 5B, the rib array allows the shell-like geometry to be of relatively small thickness **t**, reaching extremely close to the cutting edge **54**. In other words, the arrangement is such that the cavity surface **64** at the cutting zone is much closer to the cutting edge **54** than to the rear surface **52**B of the cutting insert **50**.

Turning to Fig. 6, a section of the cutting tool **1** is shown, demonstrating how the cutting insert **50** is positioned on the base plate **30**. It is observed that since the pockets **40** are only at the vicinity of the cutting corners, the majority of the bottom surface **52**B of the cutting insert **50** rests on the base plate **30** and thus provides sufficient stability and support to the cutting insert **50**.

It is also noted that the geometry of ribs (as opposed to a straight wall) provides for a much stronger construction, allowing the pocket **60** to be even closer to the cutting edge **54**, i.e. provide a smaller thickness between the external, operative surface and internal, cooling surface (as small as 0.5mm).

In operation, during cutting of a workpiece (not shown), the cutting edge **54** heats up due to constant friction with the workpiece. This heat, reduction of which is usually facilitated by providing a cooling fluid directly to the cutting edge, propagates towards the center of the cutting insert **50** so that the body **52** of the cutting insert **50** becomes a heat accumulator.

In order to mitigate this effect, the arrangement according to the subject matter of the present application allows cooling the inner portion of the cutting zone of the cutting insert **50** thereby facilitating both increased cooling of the cutting edge **54** (external cooling is used anyway, though not shown here) and cooling of the body **52** of cutting insert **50** itself.

With additional reference being made to Fig. 4, in operation, cooling fluid W is provided to the seat portion **20**. Reaching the seat portion **20** (position W2), the cooling

fluid is emitted from the inlet **36** and is urged into the pocket **60** of the cutting insert **50**. There (position W3), the slope **64** and the ramp **44** define together a gradually tapering channel, with a gradually reducing cross-sectional area, in which the velocity of the cooling fluid is increased. The cooling fluid is thus pushed towards the inner surface of the cutting edge **54**, in between the ribs **66**, **68** which maximize heat dissipation between the cutting edge **54** and the cooling fluid W by increasing surface area. The cooling fluid W is then emitted (position W4) from the cutting insert **50** through the open end of the cavity **60** and is discharged from the cutting tool holder **10** via outlets **36** and **26** respectively.

The above described cutting insert **50** is configured for both milling and turning operations. In this regards, the following differences should be noted between these two operations:

Milling – the cutting edge keeps coming in and out of contact with the workpiece. As a result, when it is in contact with the workpiece the cutting edge heats up, whereas when it is out of contact, the cutting edge cools down. However, this constant motion in and out of the workpiece causes the milling insert to be repeatedly 'impacted' by the workpiece, requiring sufficient mechanical robustness and stability;

Turning – the cutting edge remains within the workpiece throughout the cutting operation, whereby the effect of 'impact' by the workpiece, which occurs in milling, is eliminated. However, since the cutting edge is constantly in contact with the workpiece, it constantly heats up, requiring sufficient cooling to prevent mechanical damage to the cutting insert.

The above described cutting insert **50** provides both for sufficient mechanical integrity to withstand a milling operation as well as sufficient heat removal space for the cooling fluid.

Turning now to Figs. 7A and 7B, the cutting insert **50** is manufactured in a press mold **100** comprising a female part **110** and a male part **130.** The male part **13** comprises a body **132** formed on a surface thereof with four projections **140** which correspond in shape and size to the required pockets **60** to be formed within the cutting insert **50**. Each projection **140** comprises a body **142** formed with a ramp portion **144,** rake ribs **146** and relief ribs **148.**

Attention is now drawn to Figs. 8A to 8C, in which a variation of the above cutting tool is shown, generally designated as **1'**. Similar designation numbers have

been used with the addition of a prime ('), i.e. cutting tool holder **10'** is equivalent to cutting tool holder **10** and so on.

The only difference between the cutting tool **1'** and cutting tool **1'** lies in that the outlets **28**, **38** of the cutting tool holder **10'** and base plate **30'** respectively, are in the shape of open channels.

Specifically, the heated cooling fluid emitted from the pocket **60** of the cutting insert **50** does not pass through a closed channel as shown in cutting tool **1,** but rather through an open channel **38'**, **28'** as shown in the above Figs.

The open channel configuration allows increasing the flow rate of the cooling fluid W by increasing the drainage rate of the cooling fluid.

Turning now to Figs. 9A and 9B, another example of a cutting tool is shown, generally designated **1''**, and comprising a cutting tool holder **10''**, a base plate **30''**, a cutting insert **50''** and securing bolts **70**, **80**.

In the present example, the seat portion **20''** of the cutting tool holder **10''** comprises one inlet **26''** located at the proximity of the working corner and two outlets **28''** located spaced therefrom.

Respectively, the base plate **30''** comprises an inlet **36''** configured to be aligned with the inlet **26''** and two outlets **38''** spaced therefrom and configured for being aligned with the outlets **28''**. Contrary to the previously described example, the base plate **30''** does not comprise a fluid ramp.

Turning to Fig. 10, the cutting insert **50''** comprises a main body **52''** with a top face **52T''**, a bottom face **52B''** and side faces **52S''** extending therebetween. However, whereas in the previous examples the pockets **60** were individual for each cutting corner, in the present example, the cutting insert **50** has a main **60''** cavity, so that the entire cutting insert is shell-like (i.e. in the form of a thin-walled structure).

Reverting to Figs. 9C and 9D, under the above configuration, cooling fluid W is provided through an internal channel **16''** (position **W1)** and is urged towards the seat portion **20''**. There, the cooling fluid enters through the inlets **26''**, **36''** (position W**2)** and is emitted into the cavity **60''** of the cutting insert **50''** and spreads sideways (position W3), filling the entire cavity **60''**. The cooling fluid **W** is then emitted through the discharge outlets **38''** and away from the cutting tool **1''**.

It is observed that, as opposed to the previously described example, the cutting insert **50''** of the present example comprises much less material, and is therefore less

robust. As a result, it may be that the above cutting insert **50"** is more suitable for turning operation rather than milling.

However, it is noted that the above cutting insert may also be used in milling, in particular, in milling operations in which three corners of the cutting insert **50"** come into contact with the workpiece. In this case, it is appreciated that the cooling fluid W facilitates cooling not only of the main corner towards which the fluid is discharged but also to the adjacent cutting corners due to flow of the cooling fluid towards the evacuation outlets **38"**.

Attention is now drawn to Fig. 12, in which another example of a turning tool is shown, generally designated **1'"**. This tool is generally similar to previously described tool **1"** with the difference being in two features:

Reduced corner – the cutting insert **50'"** has a chipped-away portion **59'"** at each corner proximal to the bottom face **52**B'", which provides an additional drainage outlet for the cooling fluid during operation, via a formed gap **g**; and

Additional holes – the top face **52**T'" of the cutting insert **50'"** is provided with four through going drainage holes **57'"** which are configured for facilitating greater removal of cooling fluid from the cutting insert **50'"**.

It is noted that the drainage outlet holes **57'"** are not directed to the cutting corner as they are not intended for providing cooling fluid to the external surface of the cutting edge **54'"**. To the contrary – the drainage holes **57'"** are only configured for allowing increased evacuation of cooling fluid from the cutting insert **50'"**. Thus, it can be posited that the majority of the cooling fluid emitted from the drainage holes **57'"** does not reach the operative cutting corner at all.

Turning to Fig. 14, a male part **130'"** is shown constituting part of a mold (not shown) for the manufacture of the cutting insert **50'"**. It is noted that the part **130'"** comprises four corner projections **140'"**, each being formed with a hole **147'"** configured for receiving therein a corresponding projection from the female part (not shown) in order to form the drainage holes **57'"**.

The male part **130'"** also comprises eight mid-projections **150'"** which are configured for the forming of the ribs disposed along the side of the cutting insert **50'"**, between two neighboring corners.

Turning now to Fig. 15A, a milling tool is shown, generally designated as **201** and comprising a tool holder **210** formed with a plurality of seat portions **220,** each being configured for receiving therein a cutting insert **250.**

With particular reference being made to Figs. 15B and 15C, each seat comprises a securing bore **225** configured for receiving therein a securing bolt **70** for fixing the cutting insert **250** into the seat portion **220.**

In addition, each seat comprises an inlet **226** configured for provisional cooling fluid into the seat **220** and an outlet **228** configured for removal of cooling fluid therefore. As opposed to the cutting tool **1** previously described, in this case there is no base plate **230,** and the seat itself serves as a base plate.

Thus, the seat surface **222** is formed with a ramp element **240** projecting from the seat and has a body **242** with a ramp surface **244,** an inlet channel **246** and an outlet channel **248** merging with respective inlet and outlet **226, 228.** It is also noted that the outlet channel **228** extends along the seat and has a discharge opening **229** at the rear side of the seat, the purpose of which will not be explained.

Turning to Fig. 15D, when the cutting insert **250** is mounted onto the seat **220,** a configuration similar to that shown in Fig. 1A is achieved. Thus, during operation, cooling fluid W passes through the tool holder **210,** enters the seat **220** via the inlet **226** and is discharged into the pocket **260** of the cutting insert **250.** From there, owing to the ramp **240** and slope **264,** the fluid is directed to the outlet **228.**

In this case, the cooling fluid is discharged from the seat **220** via a rear outlet **229.** It is noted here that the outlet **229** is arranged such the discharged fluid is aimed at the cutting corner of the subsequent cutting insert **250,** so it also serves as an addition to the standard external cooling. However, it is noted that the cooling fluid passing through the seat is not used for external cooling of the cutting edge of the cutting insert mounted into that seat.

Reference is now made to Figs. 16Aa and 16B, in which a milling insert **250** is shown. In principle, the milling insert **250** is generally similar to the turning insert **50** rpeviously described with the difference being it has two cutting corners and two corresponding pockets **260.**

With reference to Figs. 17A, 17B, the milling insert **250** is manufactured in a pressing process within a mold **300** comprising a male part **330** and a female part **310.**

With regards to all of the above cutting inserts **50**, **50'**, **50"**, **50"'** and **250** – all can be manufactured in a pressing/sintering process, allowing for convenient mass production of the cutting inserts.

Attention is now drawn to Figs. 18A to 20C, in which another example of a turning tool is shown, generally designated 401, and a mold for the manufacture of its cutting insert 450.

As observed specifically from Figs. 18B and 18C, the cutting insert 450 comprises an insert bore 455 which is diagonally oriented with respect to the top and bottom faces 452T, 452B respectively.

Such an orientation of the insert bore allows forming the cooling cavities 460a, 460b, closer to the cutting edge 454, since the diagonal orientation leaves more material area to be worked with. This, in turn, allows for a more robust structure of the cutting insert, the mechanical integrity of which is not greatly deteriorated due to the forming of the cooling cavity 460a.

With reference being made to Fig. 19, showing a cross-section of the turning tool 401, it is observed that the cooling cavity 460 is of conical shape, allowing to concentrate the flow of cooling fluid towards the back side of the cutting edge 454a (the flow being designated by arrows 428).

Turning now to Figs. 20A to 20C, a mold 501 for the manufacture of the cutting insert 450 is shown, comprising a male member 530 and a female member 510 having a cavity for receiving therein the male member 530.

It is observed that the cutting insert 450 produced by the mold 501 is oriented at a 45° angle with respect to the longitudinal axis of the mold (the axis along which the members 510, 530 displaced when pressing). As a result, the cooling cavities 460, which are formed generally along the longitudinal axis, are eventually angled to the cutting edge 454 of the cutting insert 450 and the desired angle.

It is important to note that while the pressing is performed along a pressing axis which extends generally along the longitudinal direction of the male and female member, the operative surfaces of the latter, the ones used to form the top and bottom surfaces of the cutting insert are angled at 45° to the pressing axis, allowing the forming of the cavity at the desired angle.

It is also observed that the female member 530 comprises a side ledge 550 configured for forming the cutting edge of the cutting insert at a location other than the

split line at which the male and female members meet during press molding. This yields a side channel 459 formed along two sides of the cutting insert 450.

Turning now to Figs. 21A to 22D, there is provided another example of a cutting tool designated 601, and comprising a cutting insert 650 mounted on a tool holder 610. Similar to the previous example, the cutting insert 650 is formed with two opposite cutting edges 654, each comprising a cooling cavity angled to the top surface at 45°.

Similar elements have been designated with similar reference numbers, with the addition of 600 (i.e. cutting insert 650 uses a similar reference number as cutting insert 450, both having cutting edge 454, 654 etc.)

However, contrary to the previous example, the cutting insert 650 comprises two portions which are angled to one another at 135°, yielding that the cooling cavities 660 are generally parallel to one another.

This provides a very important advantage with respect to the pressing process. In particular, contrary to the previous example which required forming the cutting insert at an orientation angled to the pressing axis, in this example, the cutting insert can be formed symmetrically with the pressing axis as the projections forming the cooling cavities extend generally along the pressing axis.

The above yields an angled configuration of the cutting insert itself 650, in this particular example, each portion of the cutting insert is of a triangular shape, the portioned being angled to one another, as shown in Fig. 22B.

In addition, with particular reference being made to Fig. 23, it is noted that the cutting insert, when mounted onto the cutting tool holder 610, is supported by three different surface – a base surface provided by an intermediary plate 630 and two side surfaces of the cutting tool holder 624. It is noted that the bottom surface of the other portion of the cutting insert 650, does not come into contact with a base surface of the holder 630, as shown by the gap ε.

Reverting back to Figs. 22A to 22D, the cutting insert 650 is shown to have an additional flow outlet 657 at the top surface of the cutting insert, and is provided with a flow channel 659 configured for directing the flow of the cooling fluid towards the cutting edge. It is also noted that the outlet 657 is located below the top surface 652T of the cutting insert.

The flow channel 659 merges with the chip breaking channel 656 of the cutting insert, allowing fluid flow to reach very close to the cutting edge and, at the same time, lift chips removed from the workpiece during a cutting operation.

Attention is now drawn to Figs. 25A to 27, in which another example of a turning tool is shown, generally designated 601', which is generally similar to the previously described cutting tool 601.Similar elements have been designated with similar reference numbers, with the addition of a prime (i.e. cutting insert 650 uses a similar reference number as cutting insert 650', both having cutting edge 654, 654' etc.).

The main differences between the turning tool 601' and 601 are as follows:

First of all, the holder 610' is designed with an additional flow channel 618' and 619' (Fig. 25C) which is configured for recycling cooling fluid used previously for cooling the cutting edge 654' back to the holder so that it is ejected therefrom to impinge on the relief surface of the cutting insert 650' as shown in Fig. 25C.

Secondly, the flow channel 659' is provided with a blocker 651' which is configured for preventing chips removed from the workpiece by the cutting edge 654' from flowing towards the outlet 657' and blocking it. On the other hand, the blocker 651' has a stream-line design configured for minimally obstructing cooling fluid emitted from the outlet 657' towards the cutting edge 654' (see Fig. 27).

Contrary to the previously described example 601, the cutting insert 650' further comprises supports 690 in the form of triangular projections 692' and 694', configured for being received with the holder 610'. The arrangement of the supports 692', 694' is such that allows the cutting insert 650' more surface contact with the holder 610' (compared to the example 601).

Since the bottom surface of the other portion of the cutting insert (the one that, at a given moment, does not perform a cutting operation) is not mated against a base surface of the holder, the supports 692', 694' allow preventing a see-saw motion of the cutting insert which could lead to disengagement of between the bottom surface 652B' of the operational cutting portion and the plate 630'.

Attention is now drawn to Figs. 28 to 29B, in which yet another example of a turning tool is shown, generally designated 601". Similar elements have been designated with similar reference numbers, with the addition of a double prime (i.e. cutting insert 650 uses a similar reference number as cutting insert 650", both having cutting edge 654, 654" etc.).

The main difference between the cutting insert 650" and the previously described cutting insert 650' lies in the design of the bottom surface of the cutting insert, 652B". Whereas the previous cutting insert 650' was shown to has a see-saw configuration, the cutting insert 650" has a flat bottom surface 652B".

With particular reference being made to Fig. 29B, it is noted that when comparing the geometry of the cutting insert 650' and 650", the material removed from the tip of the see-saw of cutting insert 650', is compensated by addition of material at the sides in cutting insert 650".

Attention is now drawn to Figs. 30A to 31C, in which still another example of a cutting tool is shown, generally designated 610"'. Similar elements have been designated with similar reference numbers, with the addition of a double prime (i.e. cutting insert 650 uses a similar reference number as cutting insert 650"', both having cutting edge 654, 654"' etc.).

The main difference between the cutting tool 601"' and the cutting tool 601" lies in the fastening mechanism used to secure the cutting insert 650"' to the tool holder 610"'. In particular, a clamping mechanism 700 is used, which operates in conjunction with a recess 635"' of the cutting insert 650"', contrary to an insert bore as described with respect to the previous examples.

Turning now to Figs. 32 to 33C, another example of a cutting tool is shown, generally designated 801, and comprising a cutting insert 850 mounted onto a cutting tool holder 810.

Similar elements have been designated with similar reference numbers, with the addition of 800 (i.e. cutting insert 850 uses a similar reference number as cutting insert 650, both having cutting edge 654, 854 etc.).

The cutting insert 850 is formed with openings along the circumference thereof configured for allowing cooling fluid to flow therein and reach the entire length of the cutting edge 854 of the cutting insert 850.

Cooling fluid is provided through the cutting tool holder 810 and intermediate plate 830, and emitted from outlets O (see Fig. 32). The cooling fluid emitted therefrom spreads along the hollow bottom of cutting insert 850 and is later emitted therefrom through the arcuate openings 860a, 860b, 860c.

It is noted that the wall of the openings are arrange so as to face the cutting corner of the cutting insert (rather than being perpendicular to the side surfaces 852S of the cutting insert 850).

Turning now to Figs. 34A to 36E, a milling tool is shown, generally designated 901 and comprising a cutting tool holder 910 and a plurality of cutting inserts 950. The cutting inserts 950 are similar to cutting inserts 650" previously described, i.e. having a see-saw configuration (see Fig. 36E).

In addition, as shown in Fig. 34B, cooling fluid used for internal cooling of the milling inserts 950 is redirected, after removing heat from the internal side opposite the cutting edge, to two directions:

A first portion of the cooling fluid is directed, similar to cutting tool 601', back towards the relief surface of the cutting insert 950 via outlet 919b.

A second portion of the cooling fluid is directed backwards to impact the cutting edge of the subsequent milling insert 950, via outlets 918b.

In this manner, cooling fluid usage is somewhat optimized to remove heat not only from the cutting insert to which it is originally directed but from a subsequent cutting insert as well. It is appreciated that the subsequent cutting insert has a cooling mechanism of its own and that a portion of the cooling fluid used therein is directed to a cutting insert subsequent thereto and so on, and so forth.

Attention is now brought to Figs. 37A to 38, in which a drilling tool is shown, generally designated 1101, an comprising a tool holder 1110 and a drilling insert 1150. Similar elements have been designated with similar reference numbers, with the addition of 1000 (i.e. cutting insert 1150 uses a similar reference number as cutting insert 650, both having cutting edge 654, 1154 etc.).

In the example described herein, as in previous examples, the cooling cavity 1136 almost reaches the cutting edge of the drilling tool, allowing to provide cooling fluid directly to the cutting edge.

However, due to the geometry of the drilling tool (see Fig. 38, the cooling fluid provided thereto ends up at a 'dead-end' in terms of flow. In order to remove cooling fluid from such a dead-end and allowing new cooling fluid to flow in and replace it, the drilling tool makes use of its own spinning and interaction with the workpiece.

In particular, when the drilling tool revolves with respect to the workpiece, the bottom surface of the bore formed in the workpiece constantly carries away with it,

during respective turning of the drilling tool, the cooling fluid 'stuck' at the dead-end and removes it from the area. This also allows breaking up the boundary layers at the front surface of the drill, allowing for more efficient cooling and fluid flow.

With particular reference to Fig. 38, the chamfered surface indicated by arrow R does not come into contact with the workpiece, allowing cooling fluid to flow away from the cutting edge as it is removed from the cutting area.

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

CLAIMS:

1. A cutting element having a front face, an opposite rear face and at least one side face extending therebetween, said cutting element comprising a cooling cavity defined by a cavity surface, and at least one shell-like cutting zone defined by an external surface and an internal surface, the external surface being constituted by a cutting edge defined at the intersection between the front face and the at least one side face and corresponding rake and relief surfaces constituted by portions of the front fact and at least one side face respectively, and the internal surface being constituted by a portion of the cavity surface, wherein the maximal distance between the cavity surface and the external surface at the cutting zone is considerably smaller than the distance between the front face and the opposite rear face, said cooling cavity being configured for receiving therein a cooling fluid for cooling said inner surface and thereby withdrawing heat from the cutting edge.

2. A cutting element according to Claim 1, wherein the ratio between the maximal distance between the cavity surface and the external surface and the distance between the front face and its opposing rear face is in the range of 1:5 to 1:10.

3. A cutting element according to Claim 1 or 2, wherein the maximal distance between the cavity surface and the external surface ranges between 0.2-1mm, more particularly between 0.3-0.9mm, even more particularly between 0.4-0.8mm and still more particularly between 0.5-0.7mm.

4. A cutting element according to Claim 1, 2 or 3, wherein the cavity surface is sloped towards the cutting zone in order to direct cooling fluid entering the cavity towards the cutting zone.

5. A cutting element according to any one of Claims 1 to 4, wherein said cavity surface is formed with a rib array extending along the cutting zone.

6. A cutting element according to Claim 5, wherein said rib array comprises rake ribs extending generally parallel to the rake surface and relief ribs extending generally parallel to the relief surface.

7. A cutting element according to Claim 5 or 6, wherein the ribs of the rib array are configured for providing at least one of the following:

- mechanical integrity to the cutting zone despite its shell-like configuration; and

- increase in surface area for increased cooling of the cutting edge.

8. A cutting element according to any one of Claims 1 to 7, wherein cooling fluid provided into the cooling cavity is configured, by virtue of the geometry of the cavity so as not to come into direct contact with the cutting edge.

9. A cutting element according to any one of Claims 1 to 8, wherein each cutting edge of the cutting element has a corresponding cooling cavity.

10. A cutting element according to any one of Claims 1 to 8, wherein said cutting element is entirely hollow, comprising a single cooling cavity facilitating cooling for all cutting edges of the cutting element.

11. A cutting element according to any one of Claims 1 to 10, wherein said front face is formed with at least one drainage outlet being in fluid communication with the cooling cavity, and wherein the discharge outlet is arranged such that cooling fluid discharged therethrough does not come in contact with the cutting edge.

12. A cutting element according to any one of Claims 1 to 11, wherein the cavity is formed at an angle to the cutting edge.

13. A cutting element according to Claim 12, wherein the cavity is angled at 45° to a top or bottom surface of the cutting element.

14. A cutting element according to any one of Claims 1 to 13, wherein the insert bore is angled to a top and bottom surface thereof and configured for receiving therein a fastening member in a direction generally perpendicular to the top and bottom surface.

15. A cutting element according to any one of Claims 1 to 14, wherein said cutting insert has a first portion and a second portion, angled at about 135° with respect to each other.

16. A cutting element according to Claim 15, wherein said cutting element comprises a flow channel at the top surface thereof, configured for concentrating fluid flow towards the cutting edge.

17. A cutting element according to Claim 16, wherein an outlet of the flow channel is located below the top surface.

18. A cutting element according to any one of Claims 15 to 17, wherein a top surface of the cutting element is of angled configuration while a bottom surface thereof is generally flat.

19. A cutting tool comprising:

- a cutting tool holder comprising a seat portion having a base surface provided with a fluid inlet for providing cooling fluid to the seat portion and a fluid outlet configured for removing cooling fluid from the seat portion; and
- a cutting element according to any one of Claims 1 to 11 positioned within the seat portion of the cutting tool holder, over the base surface;

wherein, a cooling cavity of the cutting element is aligned with said inlet and said outlet, whereby cooling fluid is configured for being provided into the cooling cavity via said inlet and be withdrawn therefrom via said outlet.

20. A cutting tool according to Claim 19, wherein said base surface is provided with a ramp element configured, when the cutting tool is assembled and the cutting element is mounted onto the base surface, to protrude into the cavity of the cutting element to thereby define a fluid path.

21. A cutting tool according to Claim 20, wherein said fluid path is configured for receiving cooling fluid through said inlet, directing it towards the portion of the cavity surface at the cutting zone and then towards said outlet.

22. A cutting tool according to Claim 21, wherein the cross-sectional area of the fluid path decreases towards the cutting zone.

23. A cutting tool according to any one of Claims 19 to 22, wherein said base surface is unitary with the cutting tool holder.

24. A cutting tool according to any one of Claims 19 to 23, wherein said cutting tool holder comprises an intermediate base plate formed with said base surface.

25. A cutting tool according to Claim 24, wherein said intermediate base plate is provided with an inlet bore aligned with the inlet of the cutting tool holder and the cooling cavity of the cutting element and an outlet bore aligned with the outlet of the cutting tool holder and the cooling cavity of the cutting element, to allow passage of cooling fluid therethrough.

26. A cutting tool according to any one of Claims 19 to 25, wherein said cutting tool is a milling tool comprising a plurality of cutting elements mounted thereto, and wherein said outlet has an open end at a rear portion of the seat so as to direct cooling fluid discharged from the outlet towards a subsequent cutting element of the milling tool.

27. A cutting tool holder for mounting thereon a cutting element to form a cutting tool, said cutting tool holder comprising a seat portion having a base surface onto which said cutting element is to be mounted, said base surface being provided with a fluid inlet for providing cooling fluid to the seat portion and a fluid outlet configured for removing cooling fluid from the seat portion.

28. A cutting tool according to Claim 27, wherein said base surface is provided with a ramp element configured, when the cutting tool is assembled and the cutting element is mounted onto the base surface, to protrude into the cavity of the cutting element to thereby define a fluid path.

29. A cutting tool according to Claim 28, wherein said fluid path is configured for receiving cooling fluid through said inlet, directing it towards the portion of the cavity surface at the cutting zone and then towards said outlet.

30. A cutting tool according to Claim 29, wherein the cross-sectional area of the fluid path decreases towards the cutting zone.

31. A cutting tool according to any one of Claims 27 to 30, wherein said base surface is unitary with the cutting tool holder.

32. A cutting tool according to any one of Claims 27 to 30, wherein said cutting tool holder comprises an intermediate base plate formed with said base surface.

33. A cutting tool according to Claim 32, wherein said intermediate base plate is provided with an inlet bore aligned with the inlet of the cutting tool holder and the cooling cavity of the cutting element and an outlet bore aligned with the outlet of the cutting tool holder and the cooling cavity of the cutting element, to allow passage of cooling fluid therethrough.

34. A cutting tool according to any one of Claims 27 to 33, wherein said cutting tool is a milling tool comprising a plurality of cutting elements mounted thereto, and wherein said outlet has an open end at a rear portion of the seat so as to direct cooling fluid discharged from the outlet towards a subsequent cutting element of the milling tool.

35. A press-mold for manufacturing a cutting element comprising a top surface and a bottom surface generally parallel thereto, and a cavity having a characterizing axis, said axis being angled to the top or bottom surface between 35-65°, wherein said press mold comprises a male member and a female member, each of the male and female members having a base surface angles at between 35-65° to a pressing axis of the mold,

the base surfaces being used to form the top and bottom surface of the cutting element, and the male member further having a projection oriented generally along the pressing axis, configured for forming the cavity.

36. A cutting element according to any one of Claims 1 to 18, wherein the cutting element is configured for performing a drilling operation or mounting onto a tool holder to form a drilling tool configured for performing a drilling operation.

37. A cutting element according to Claim 36, wherein the drilling element comprises an outlet configured for emitting a cooling fluid to cool the cutting edge, wherein cooling is aided by centrifugal forces caused by rotation of the drilling tool itself.

38. A cutting element according to Claim 37, wherein centrifugal forces facilitate emission of the cooling fluid towards the cutting edge while rotation of the drilling tool with respect to a bottom surface of the workpiece allows the workpiece to remove cooling fluid away from the cutting edge.

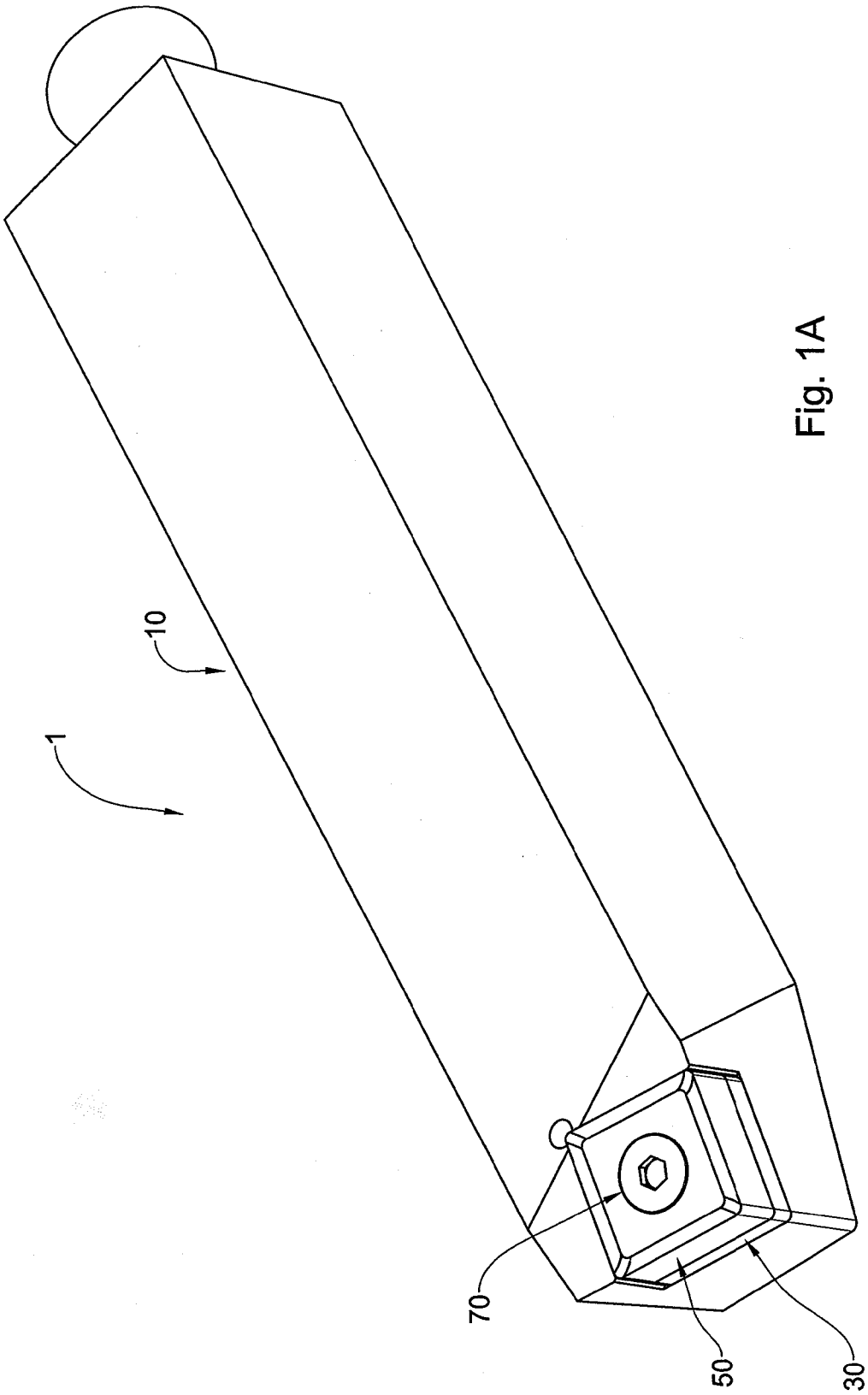


Fig. 1A

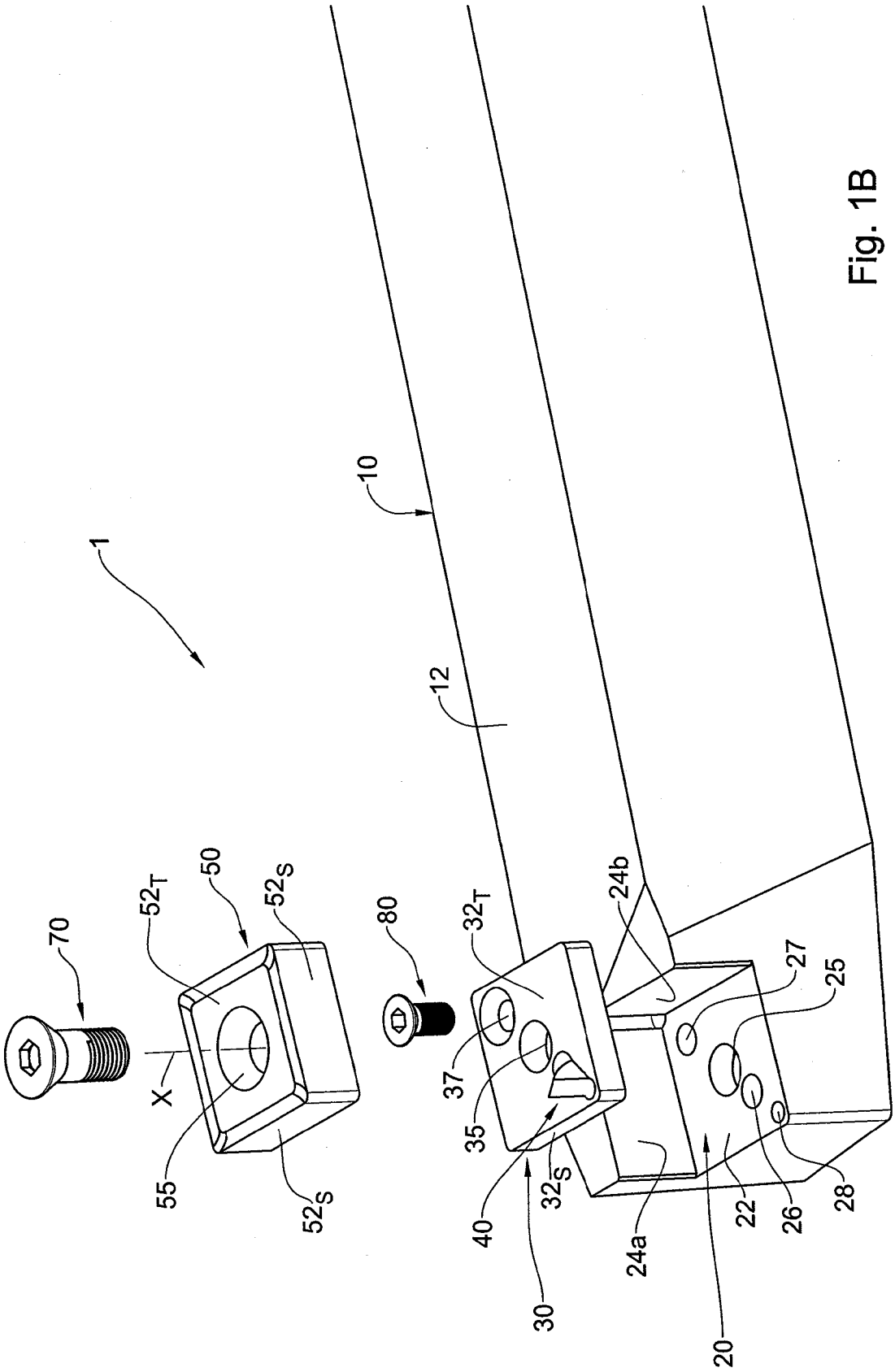

1
10
12
20
22
24a
24b
25
26
27
28
30
32S
32T
35
37
40
50
52S
52T
55
70
80
X

Fig. 1B

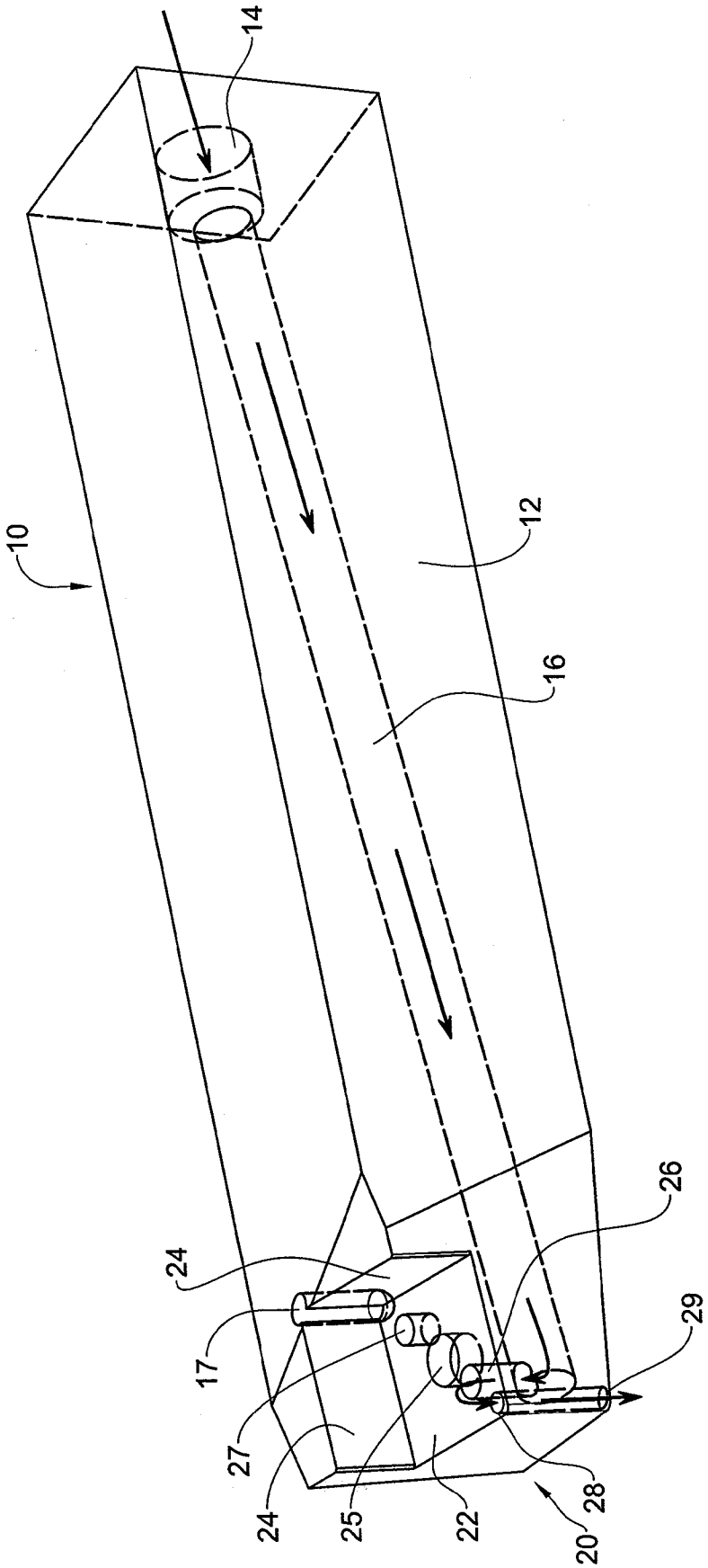


Fig. 2

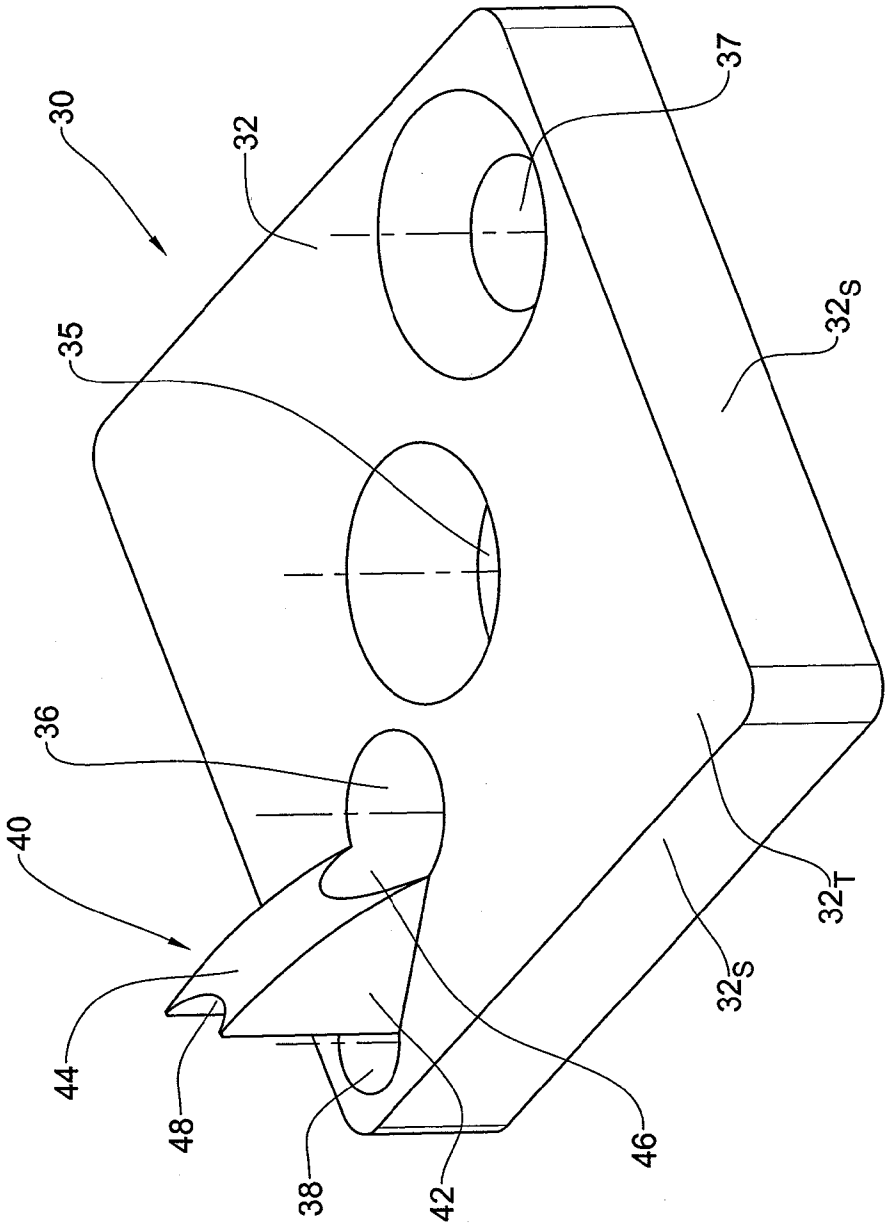


Fig. 3

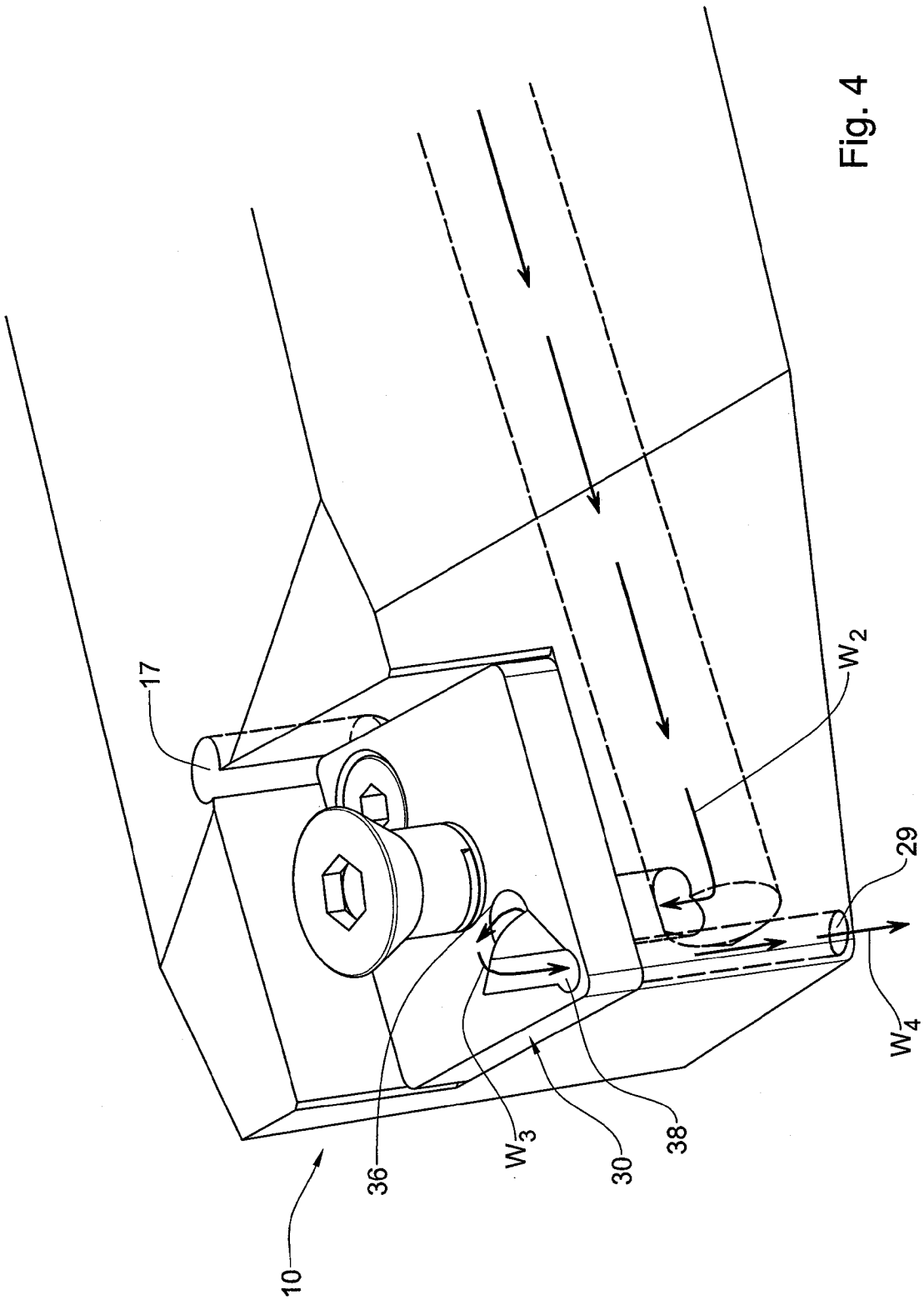


Fig. 4

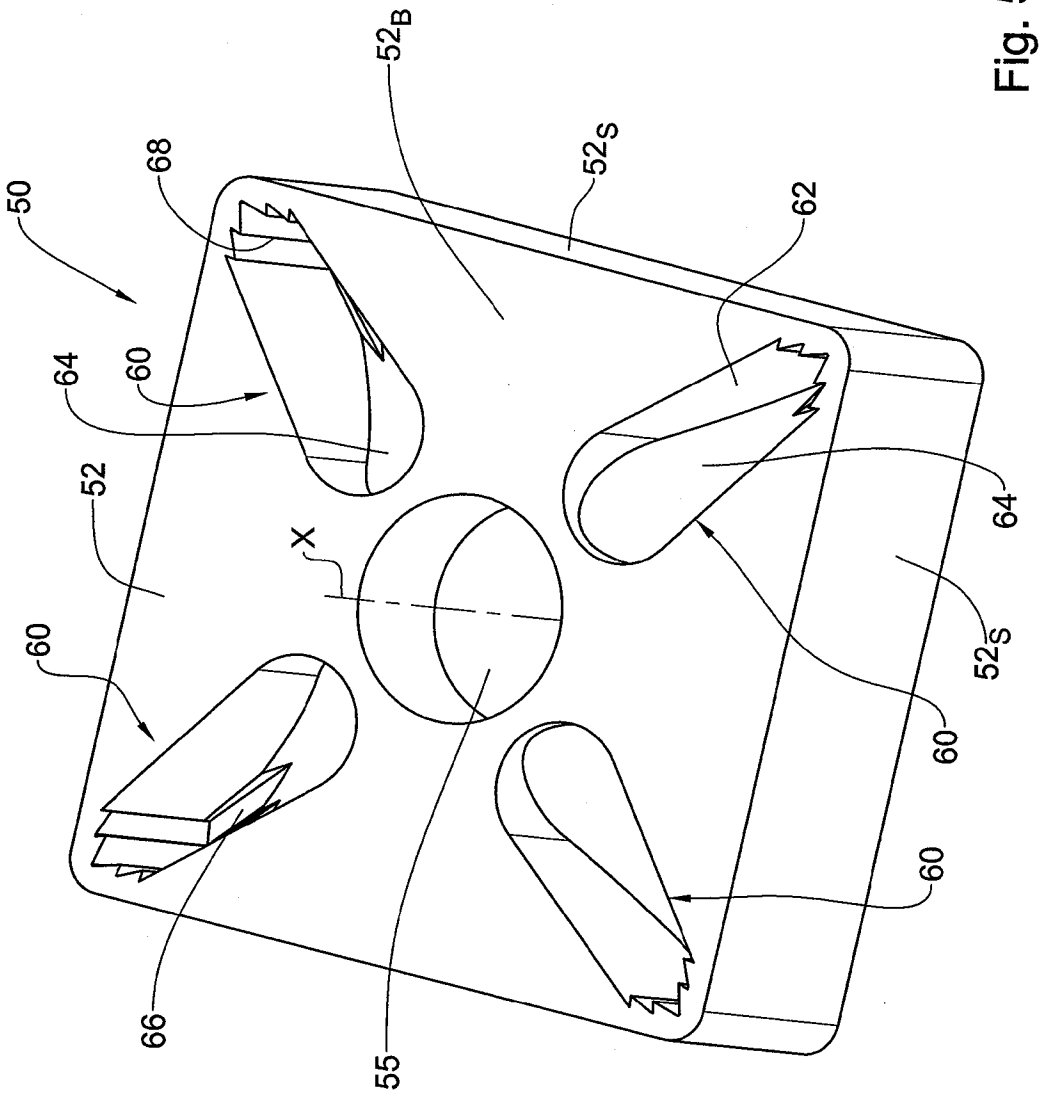


Fig. 5A

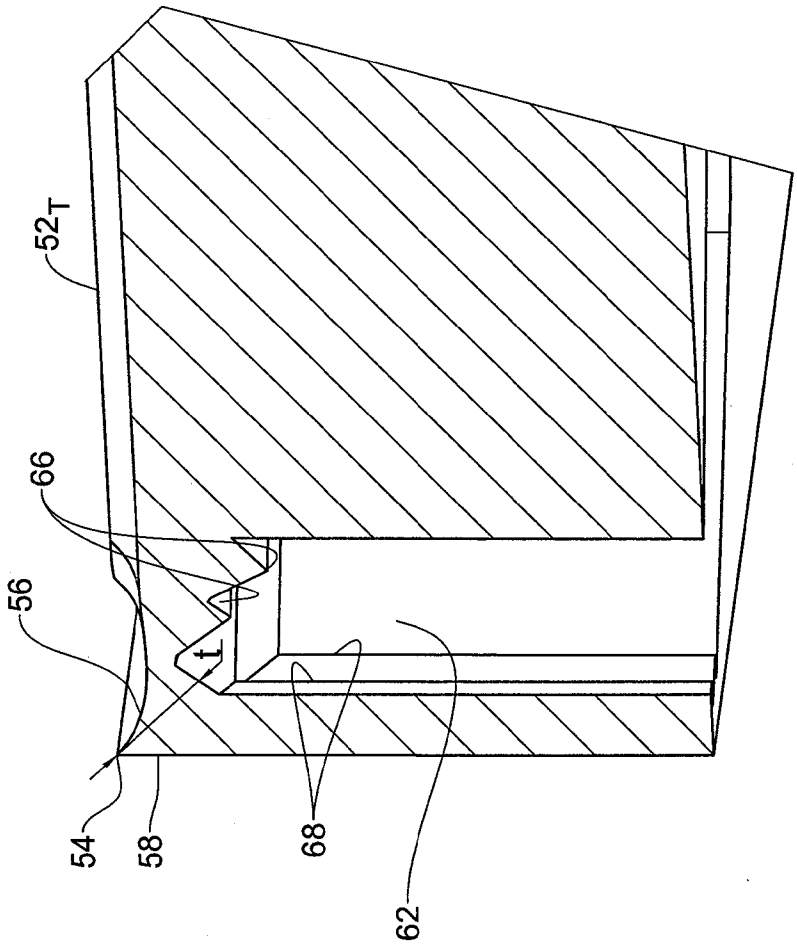


Fig. 5B

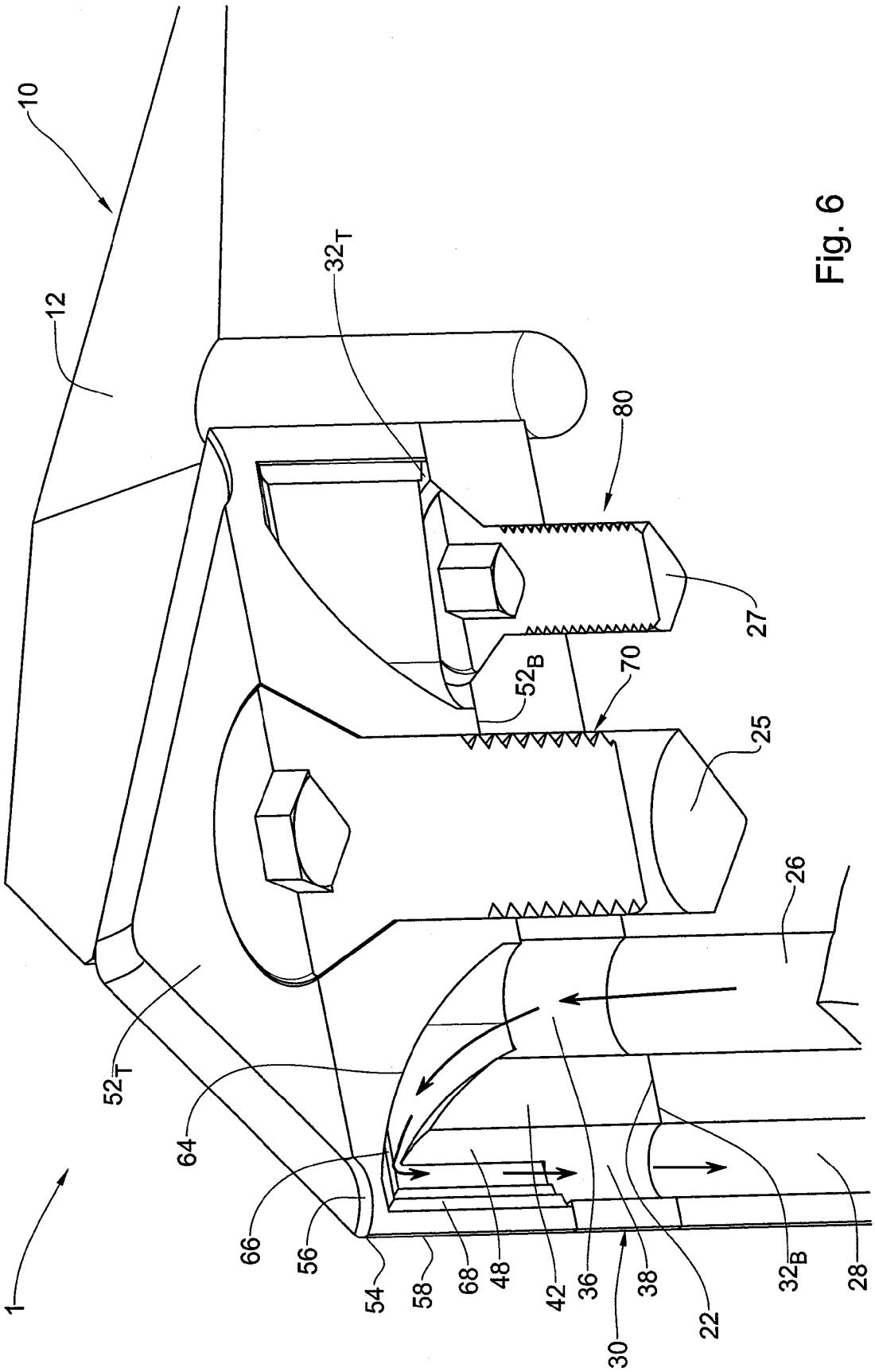

10
12
32T
80
27
52B
70
25
26
52T
64
66
56
54
58
68
48
42
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30
38
22
32B
28
1

Fig. 6

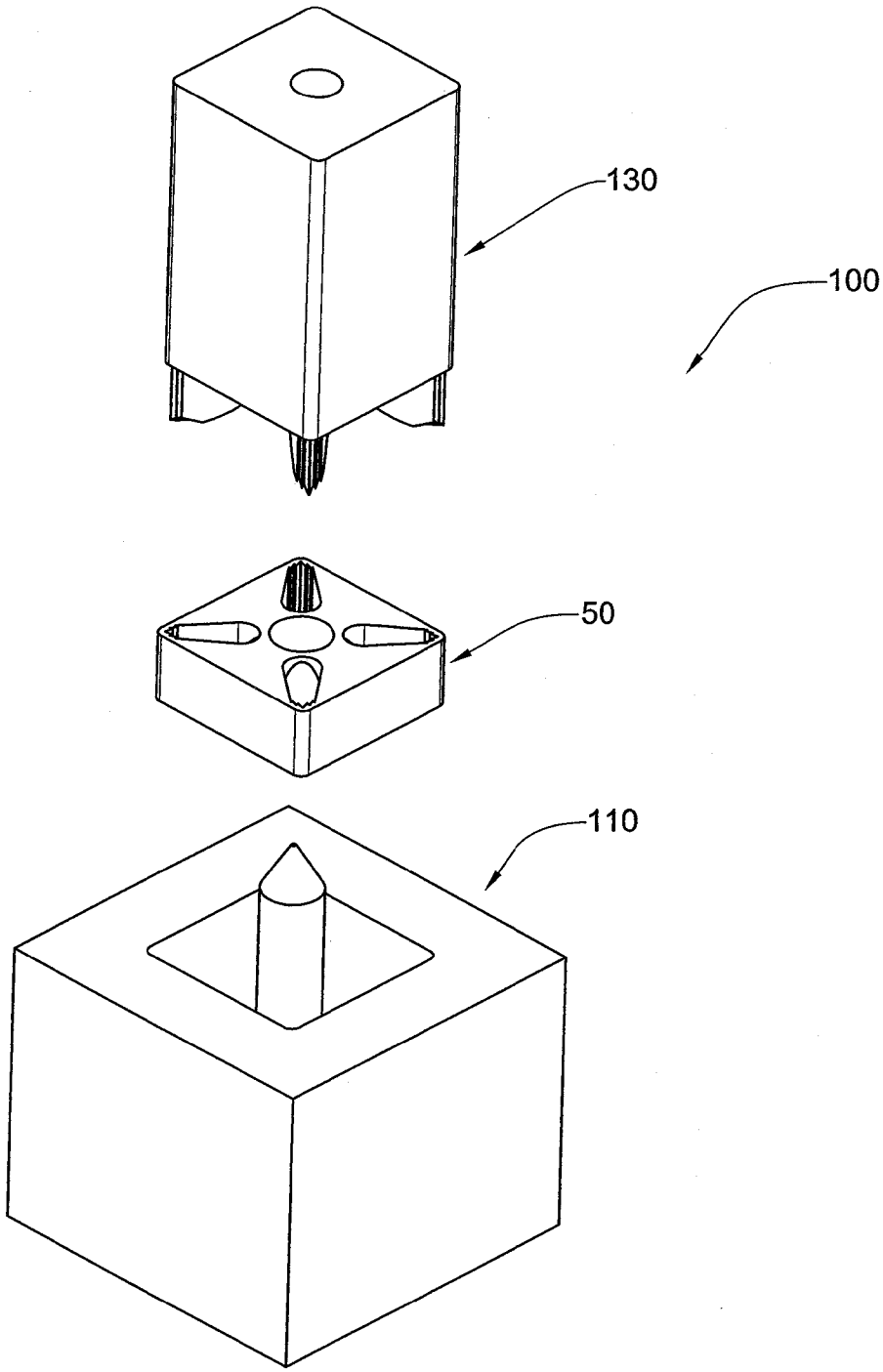
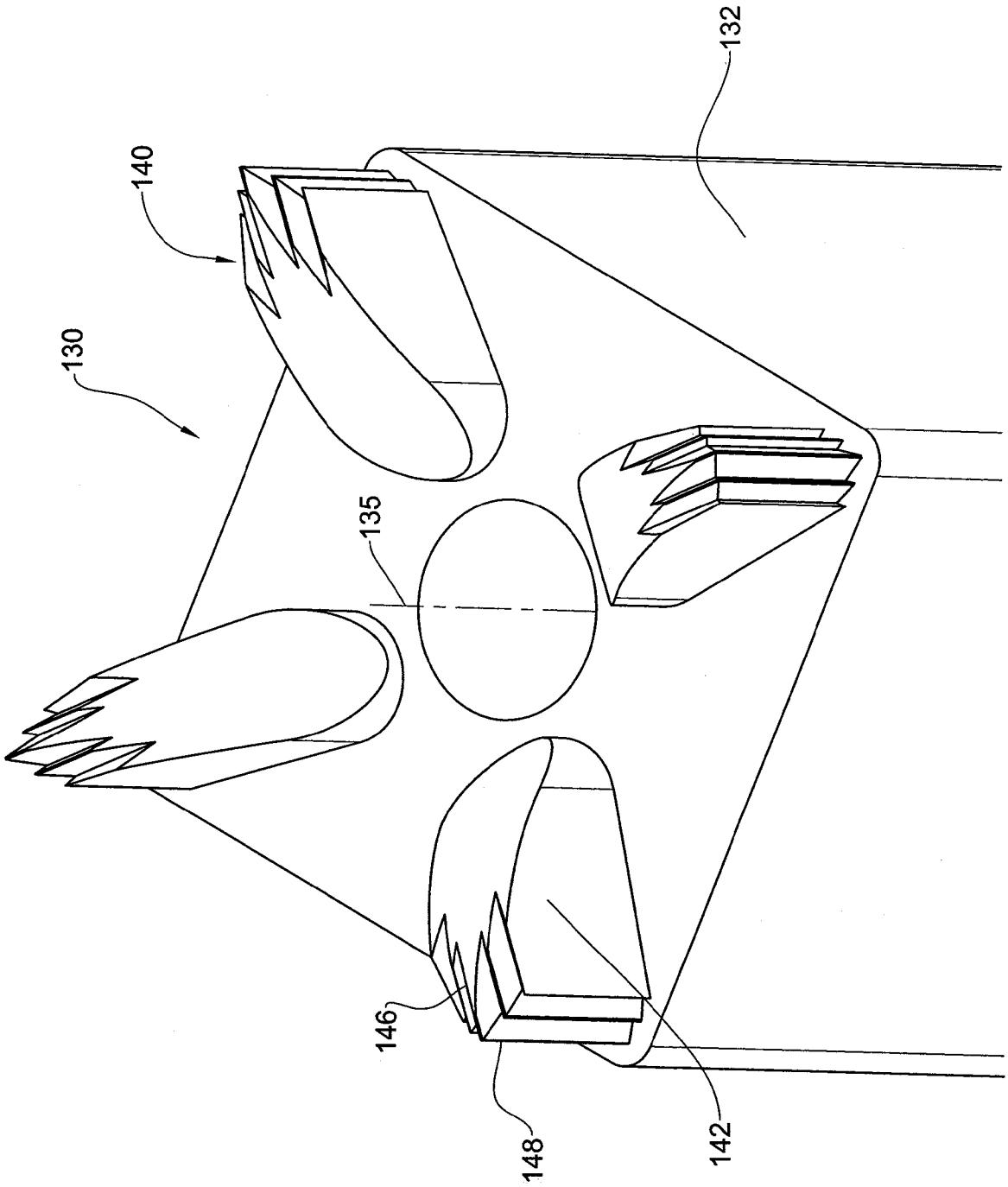


Fig. 7A

Fig. 7B



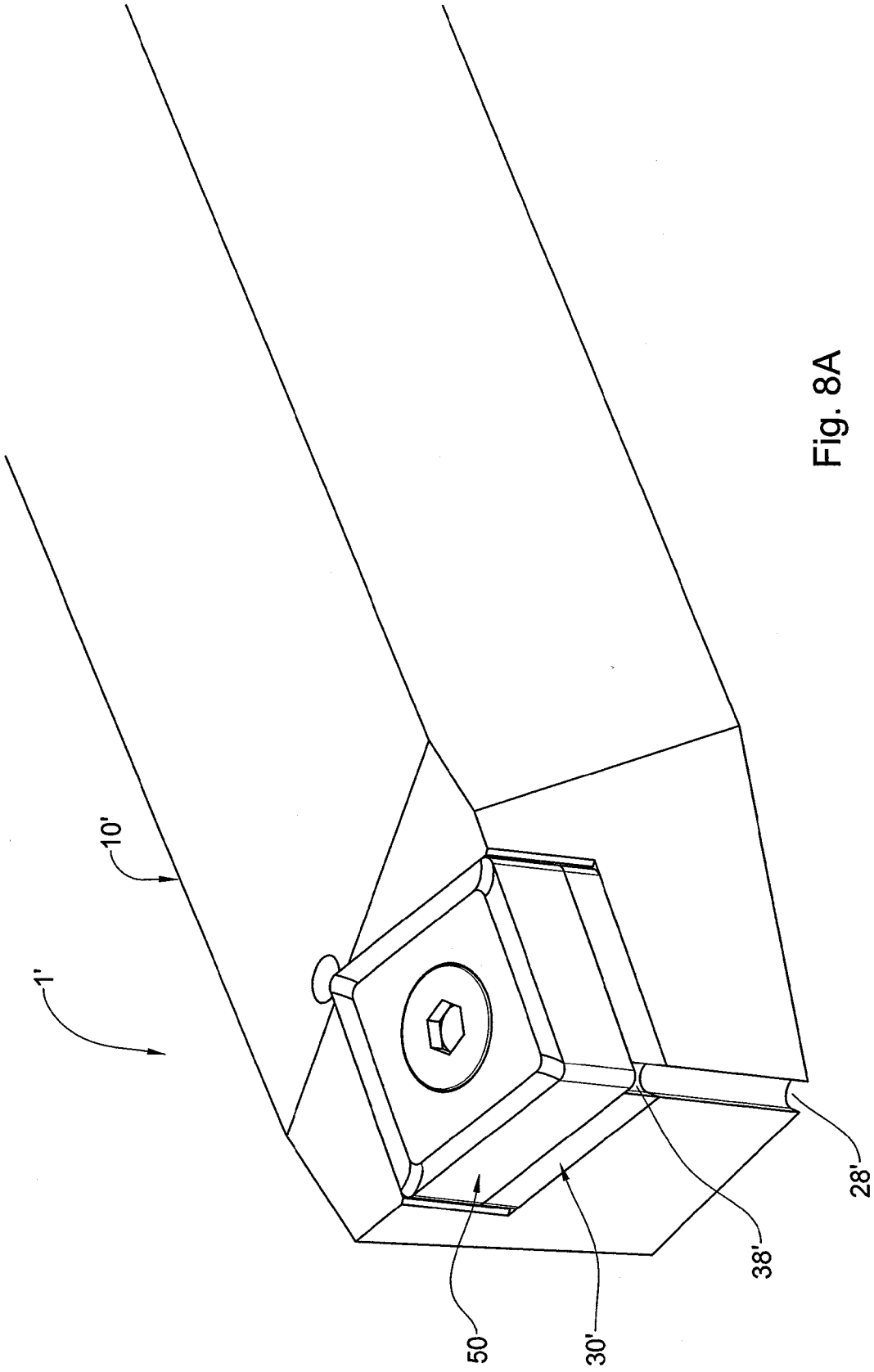
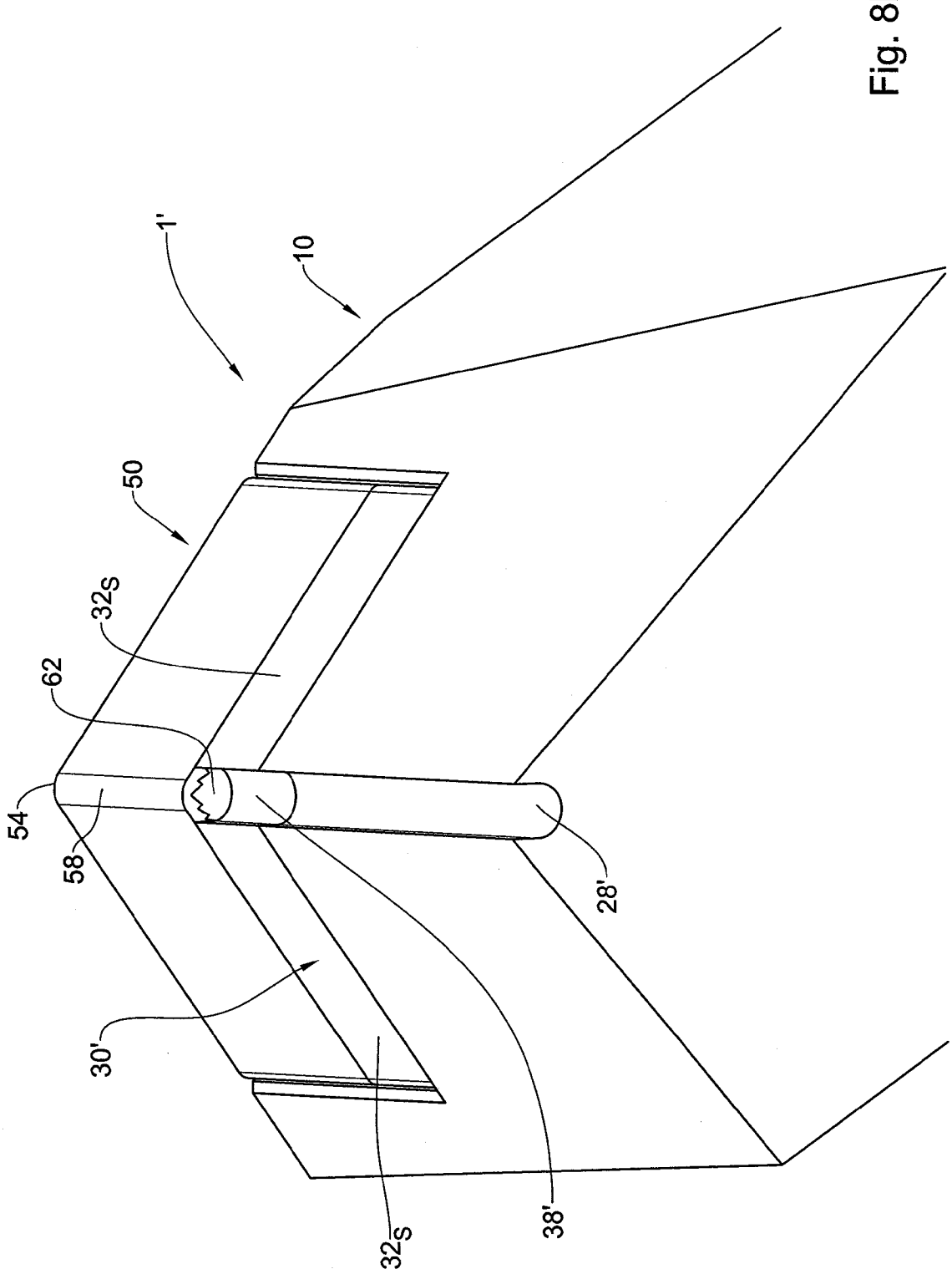


Fig. 8A

Fig. 8B



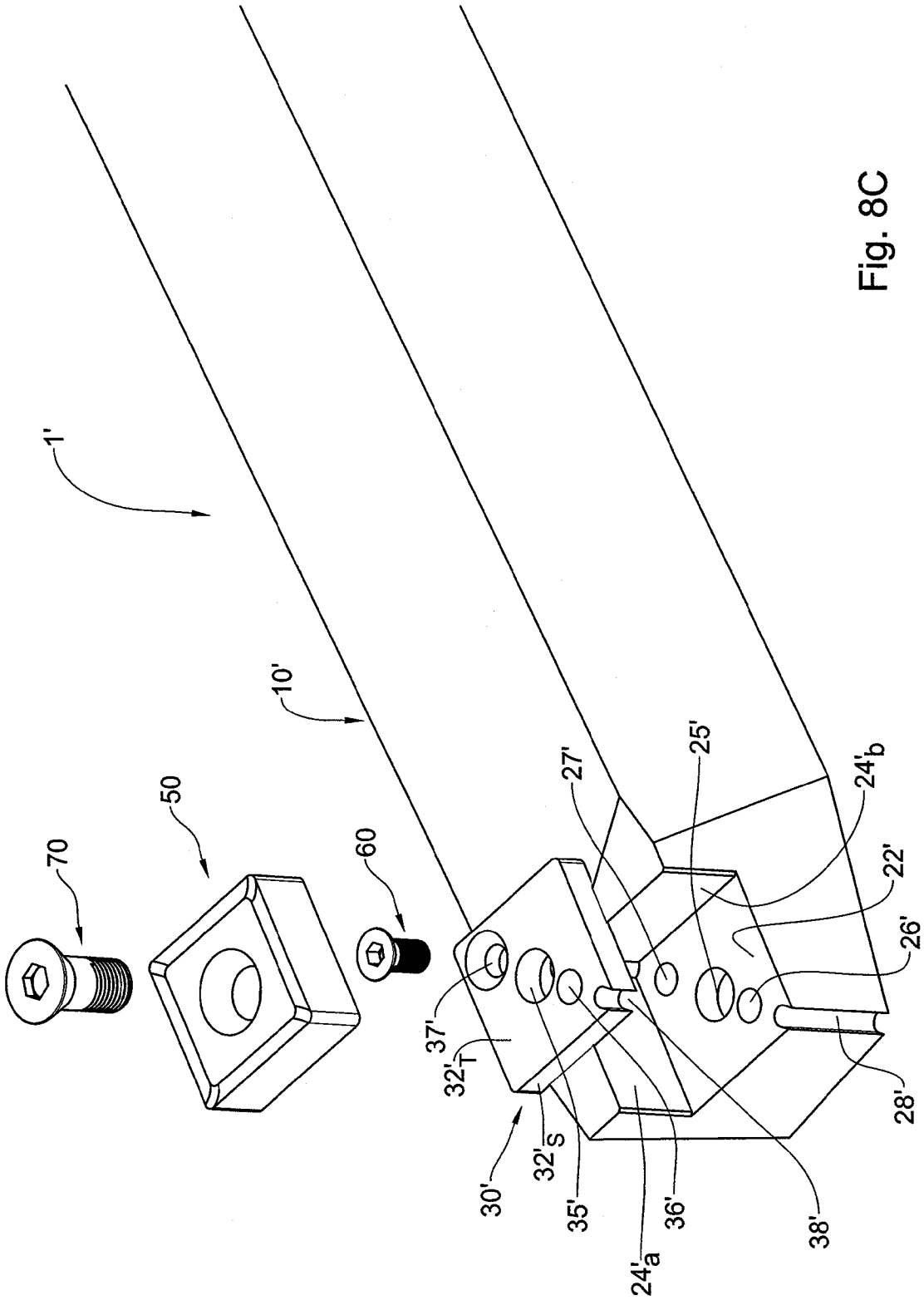


Fig. 8C

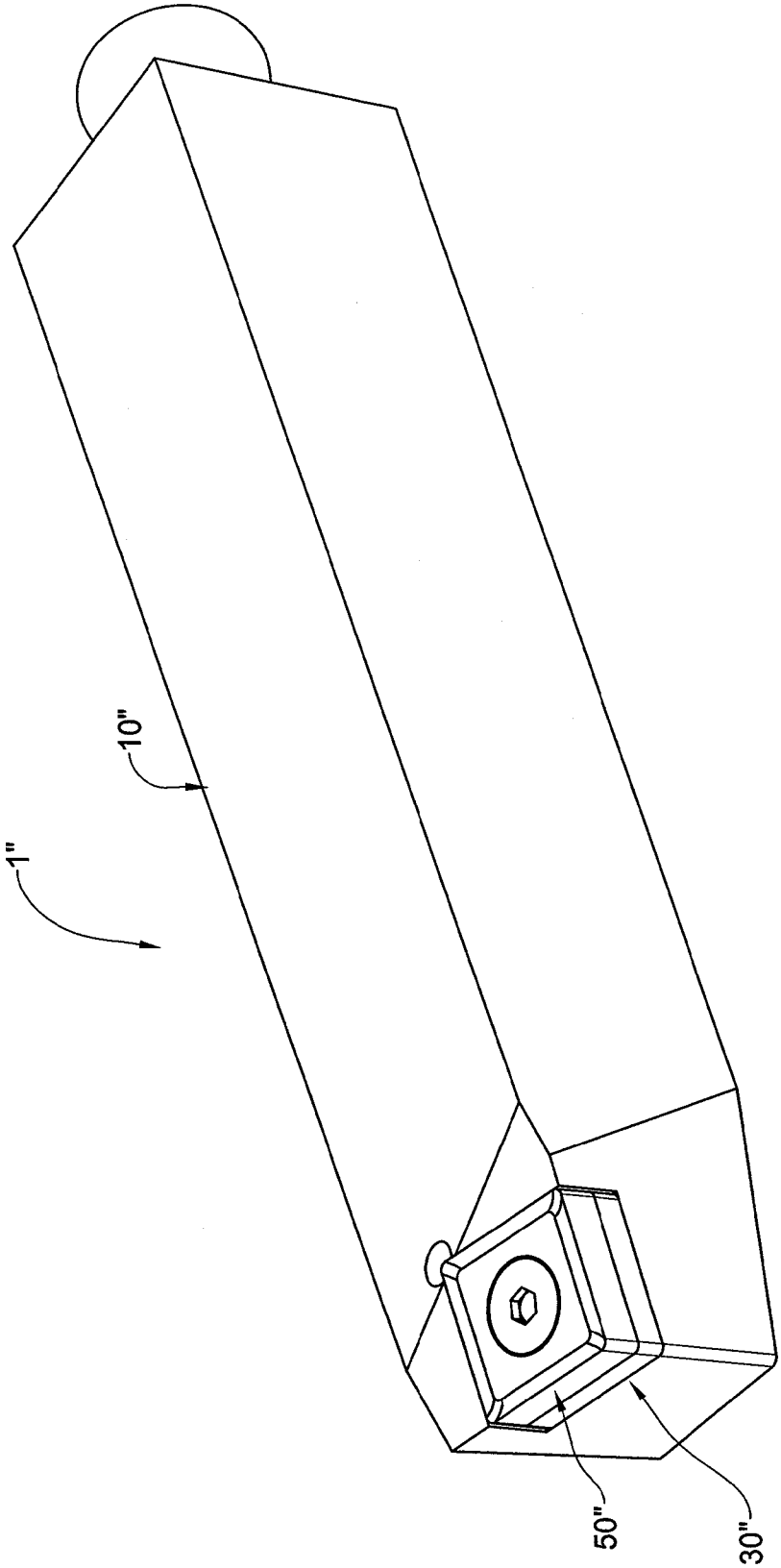


Fig. 9A

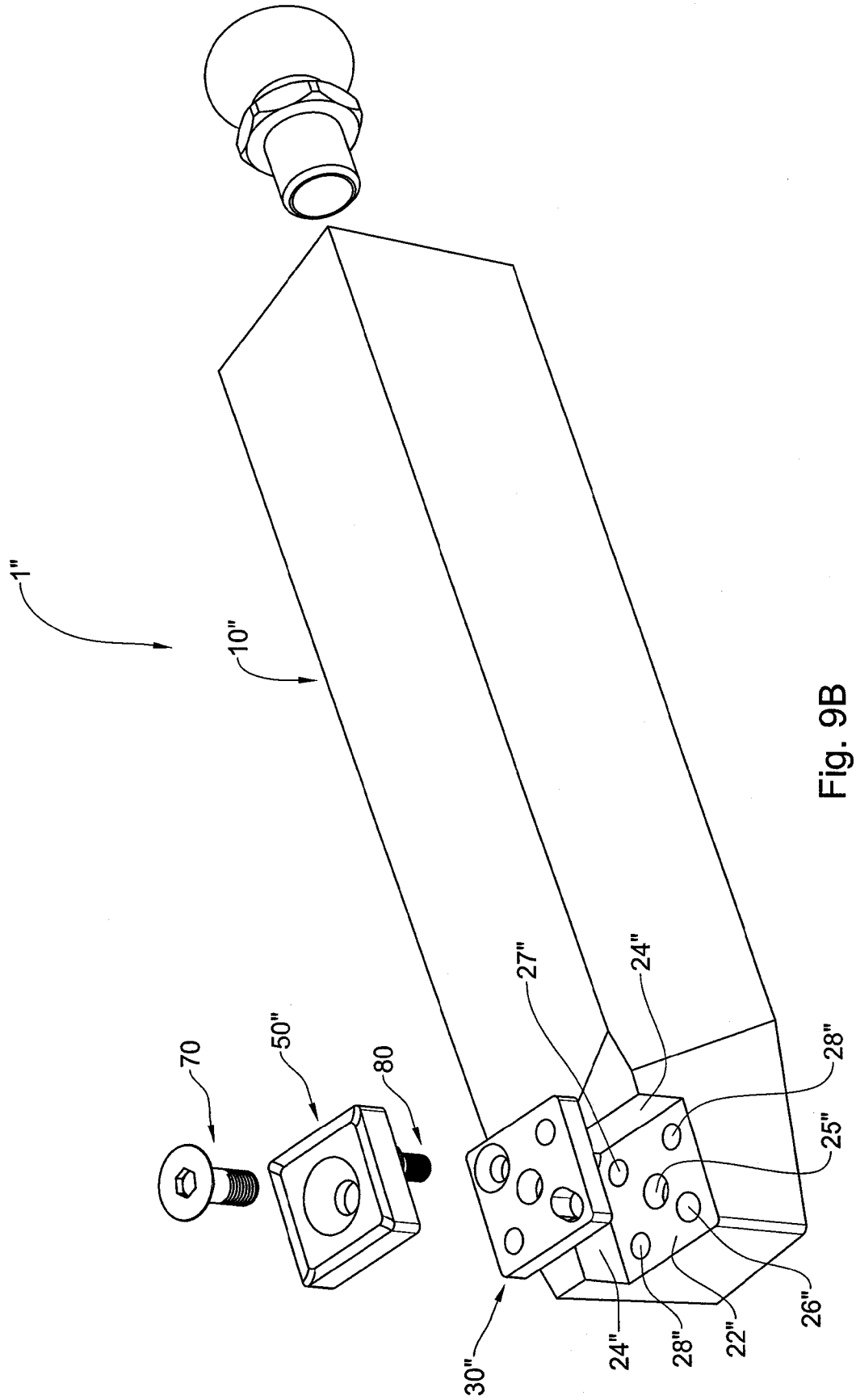


Fig. 9B

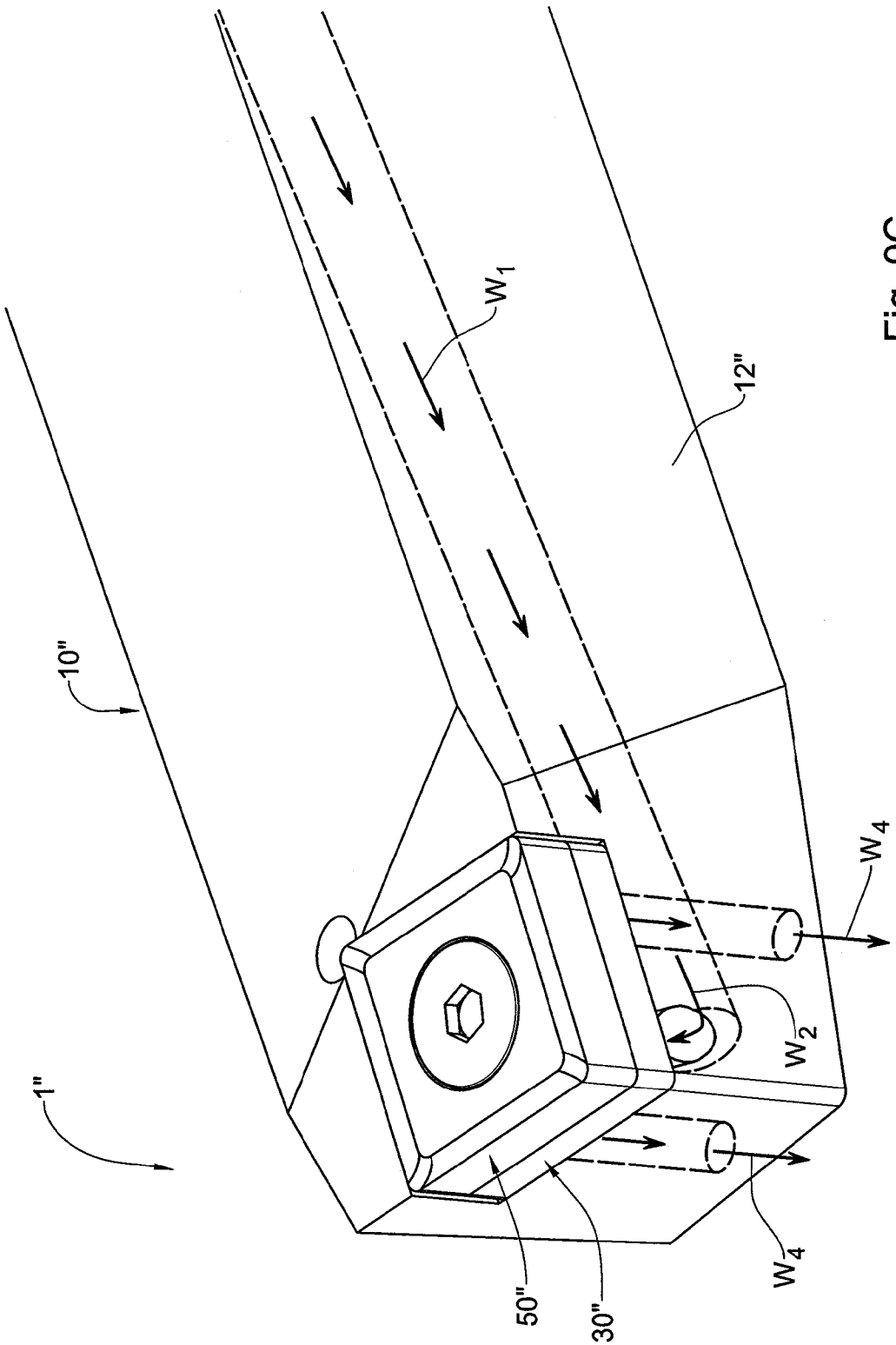


Fig. 9C

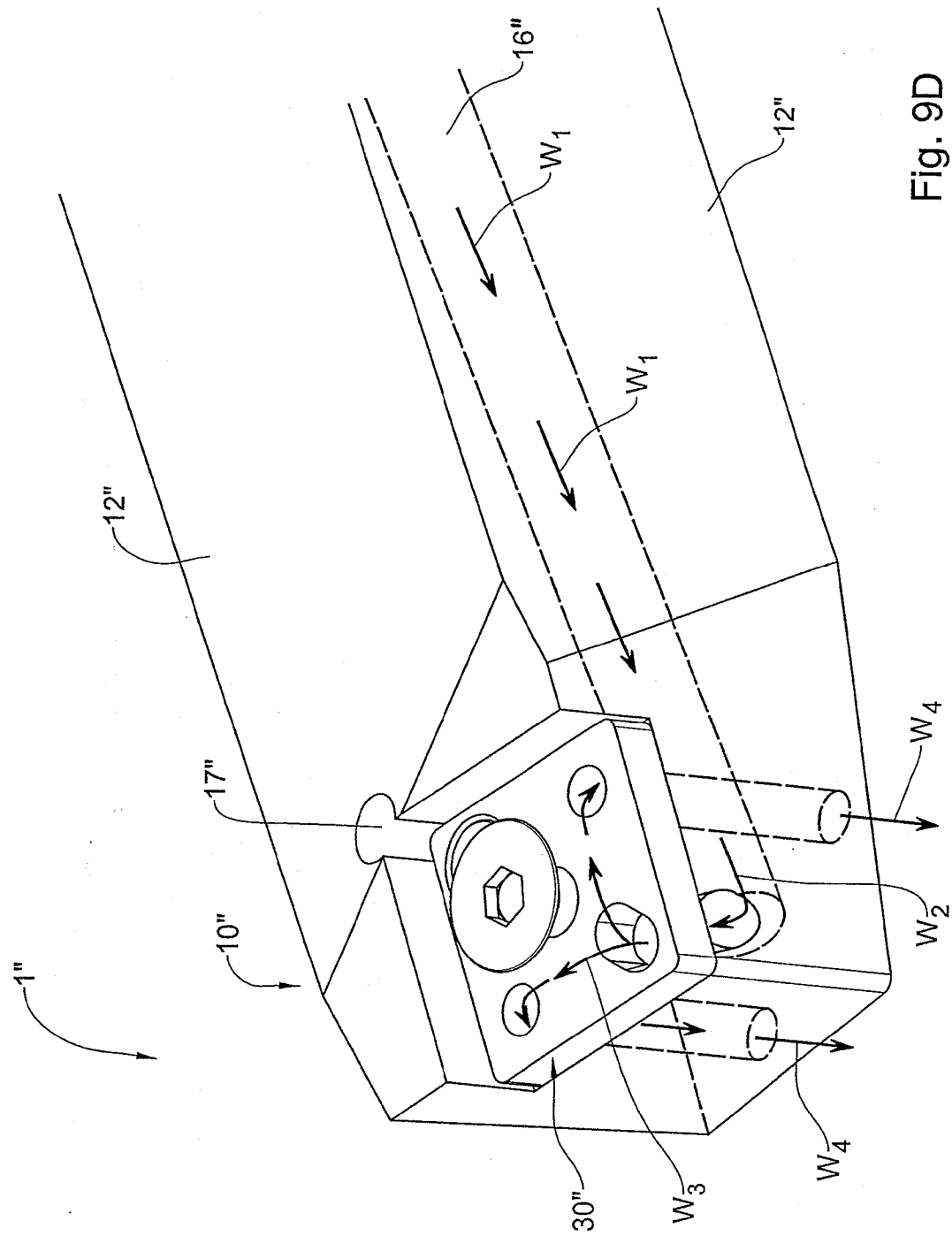


Fig. 9D

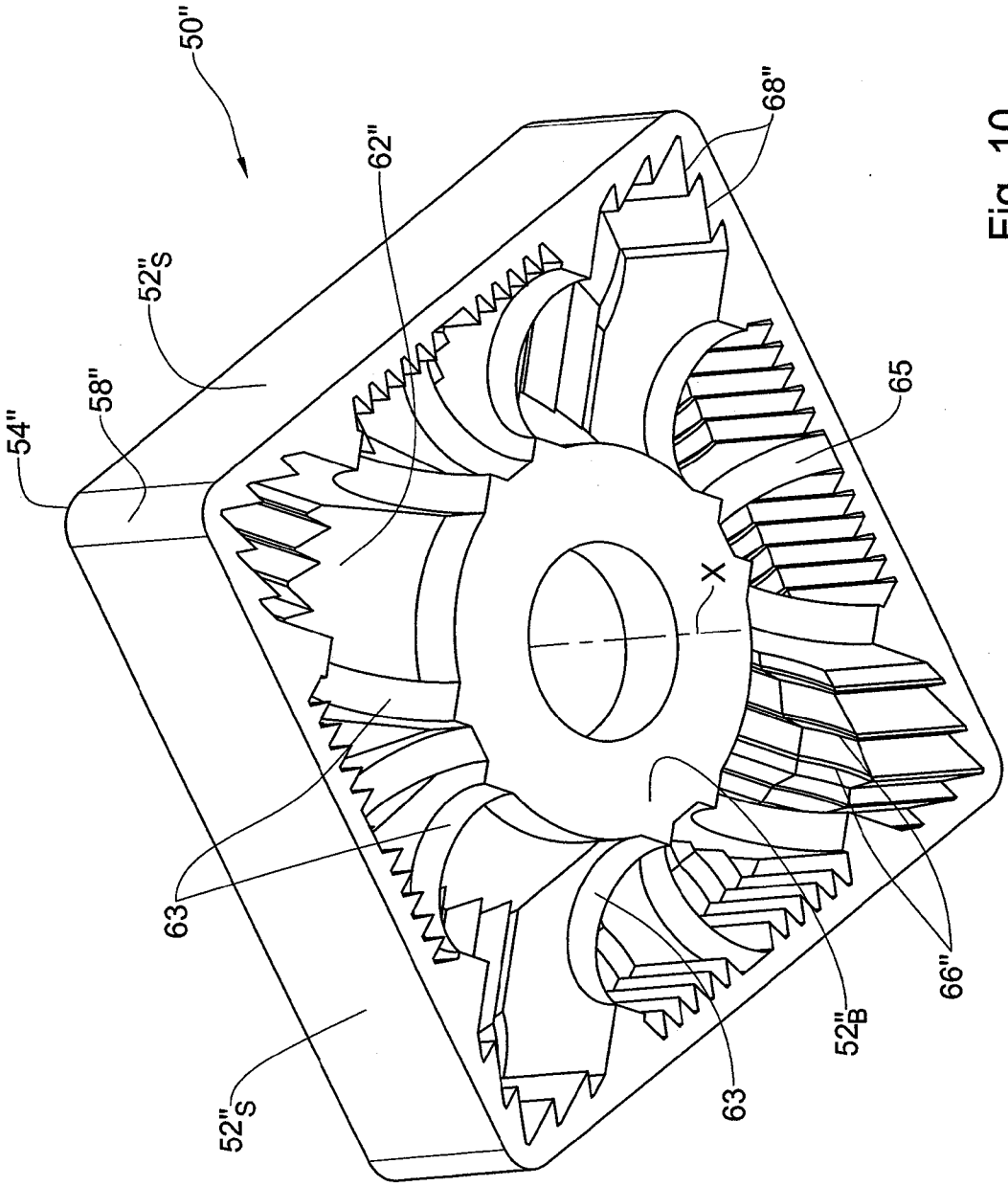


Fig. 10

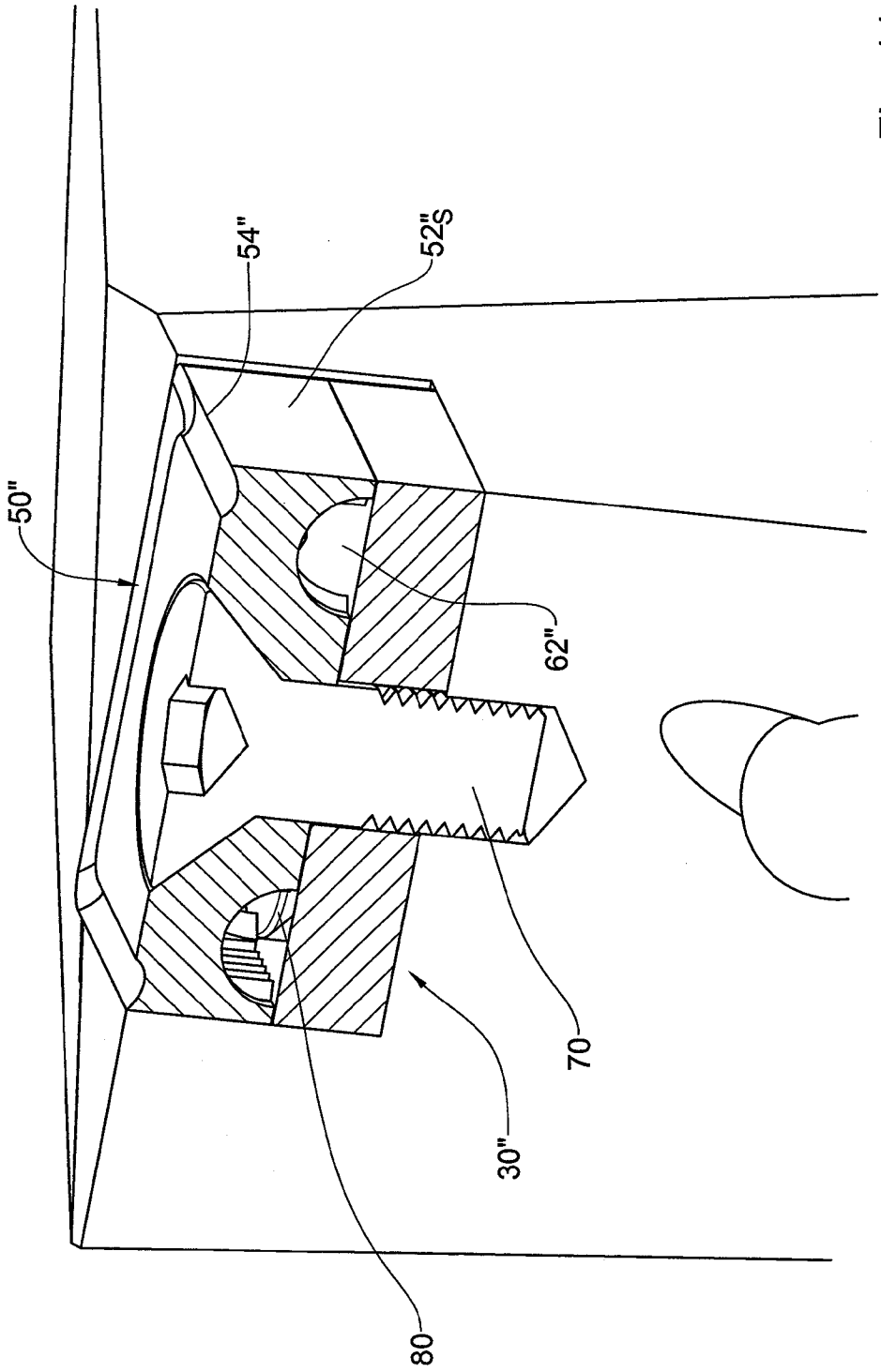


Fig. 11

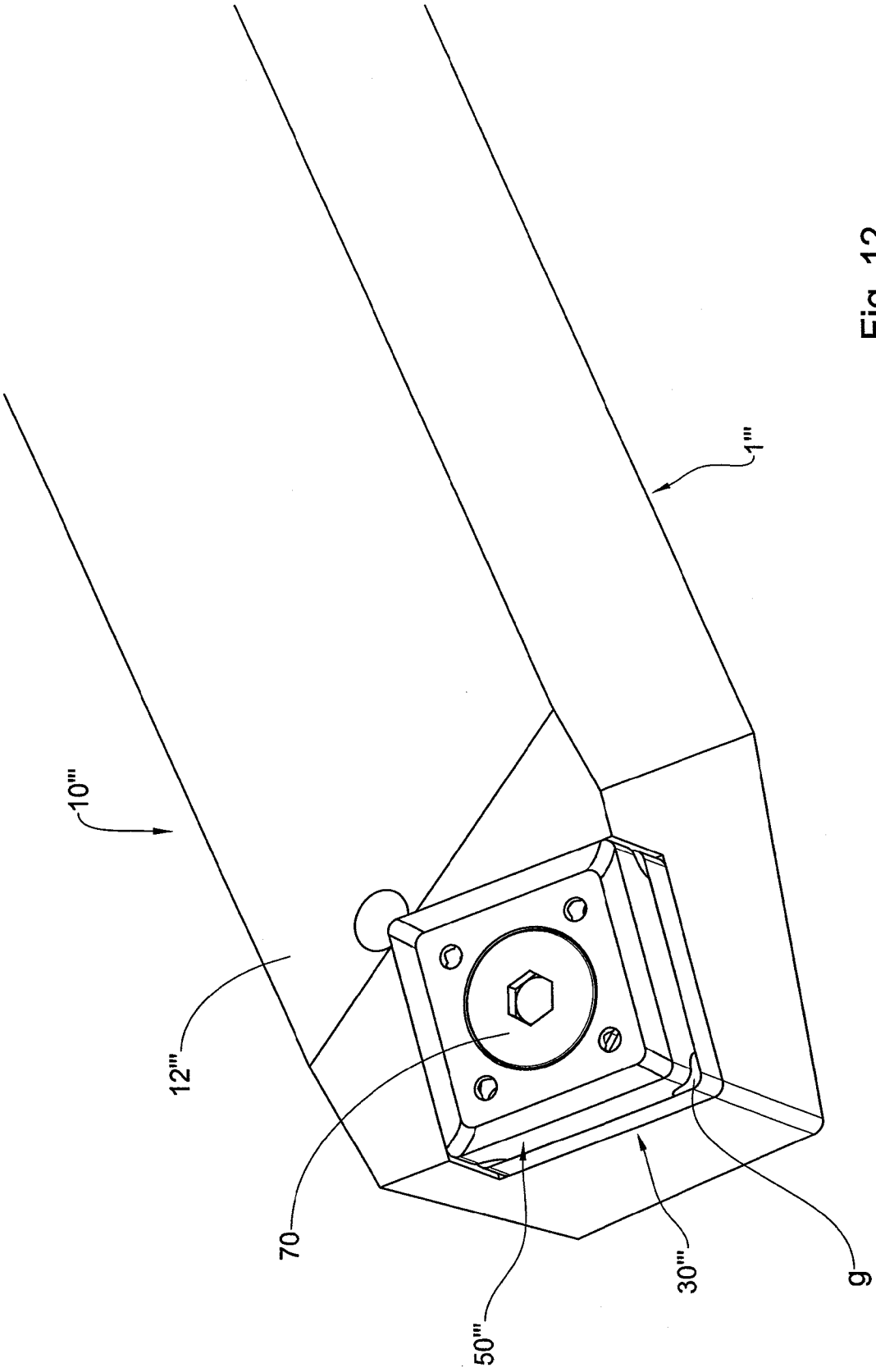


Fig. 12

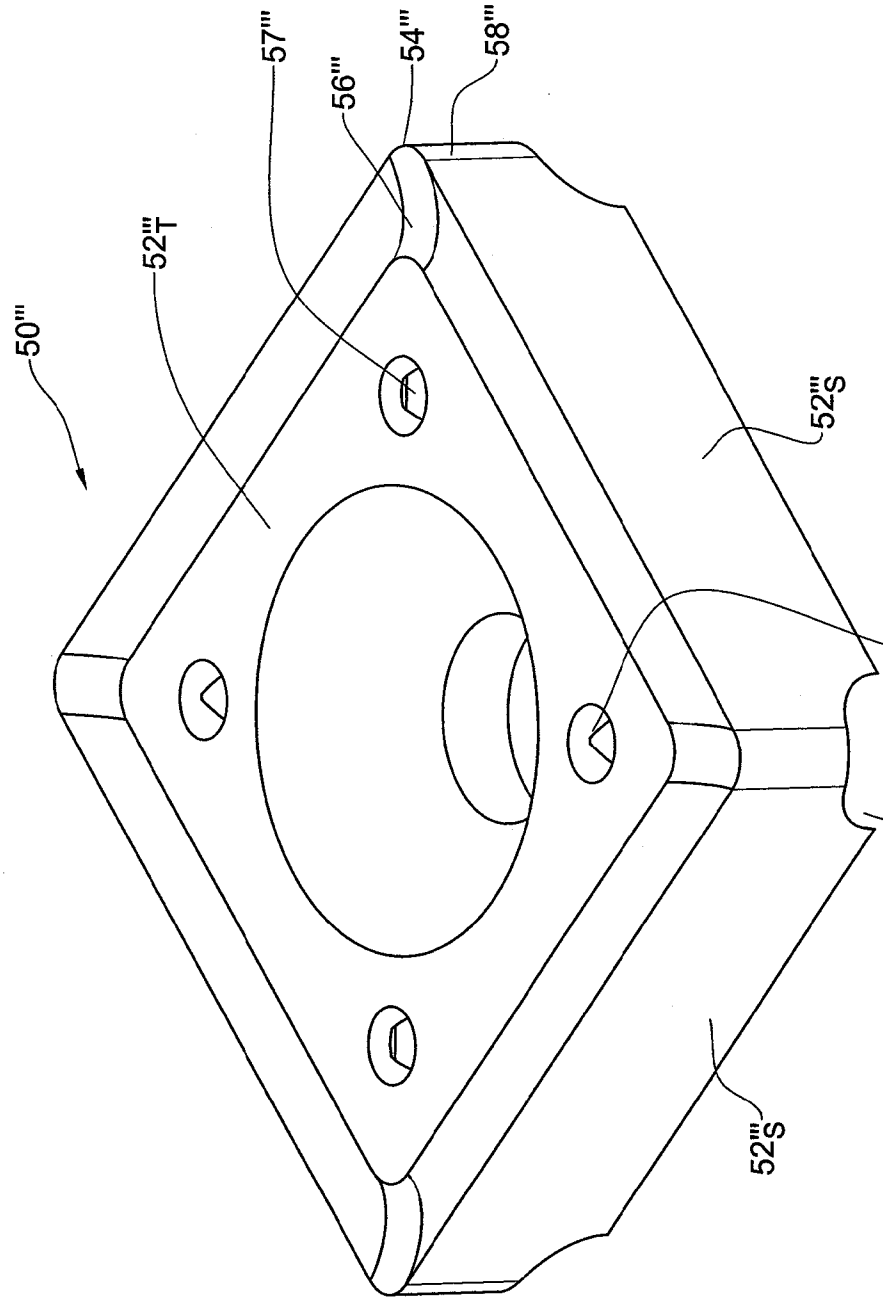


Fig. 13A

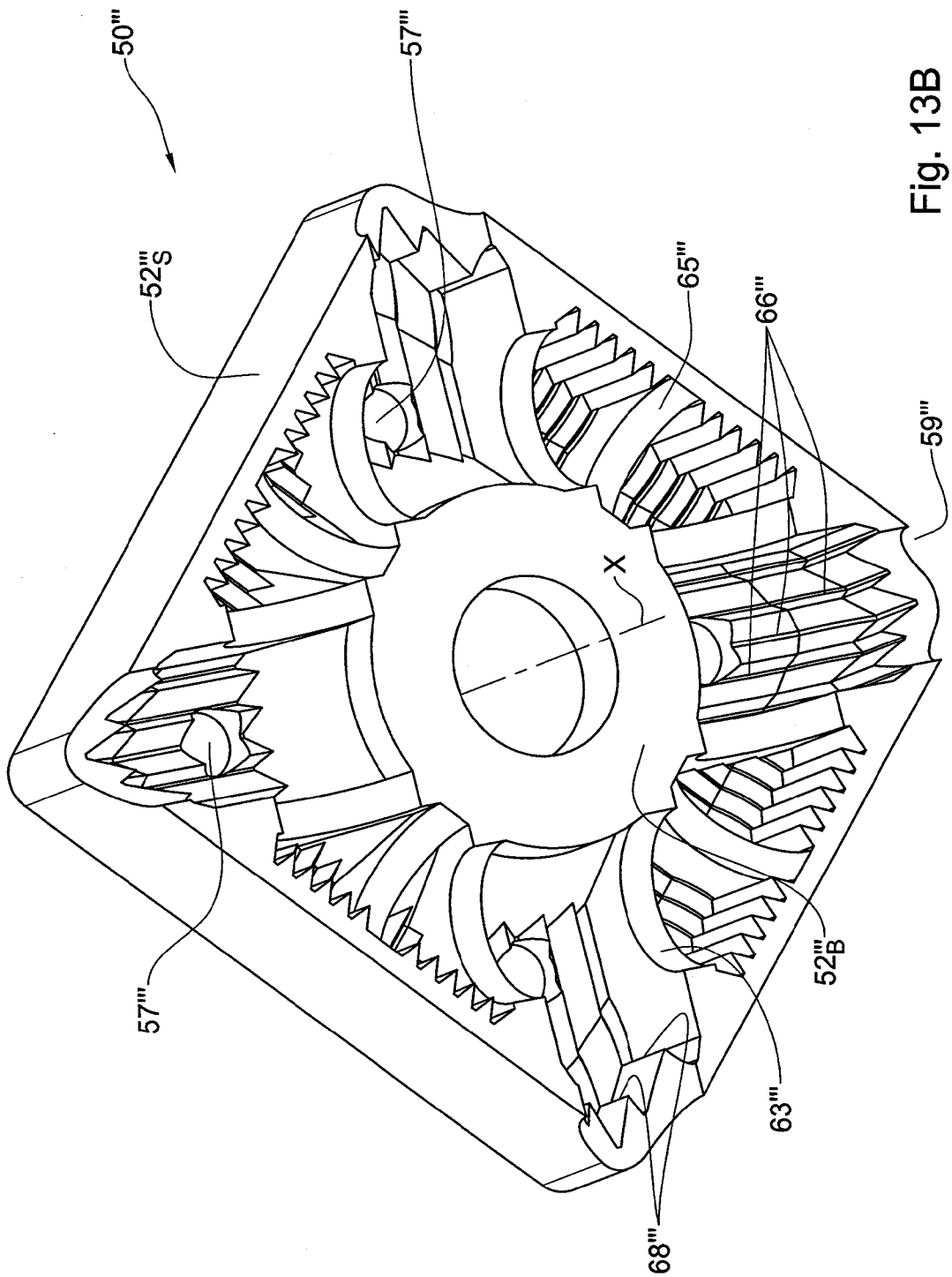


Fig. 13B

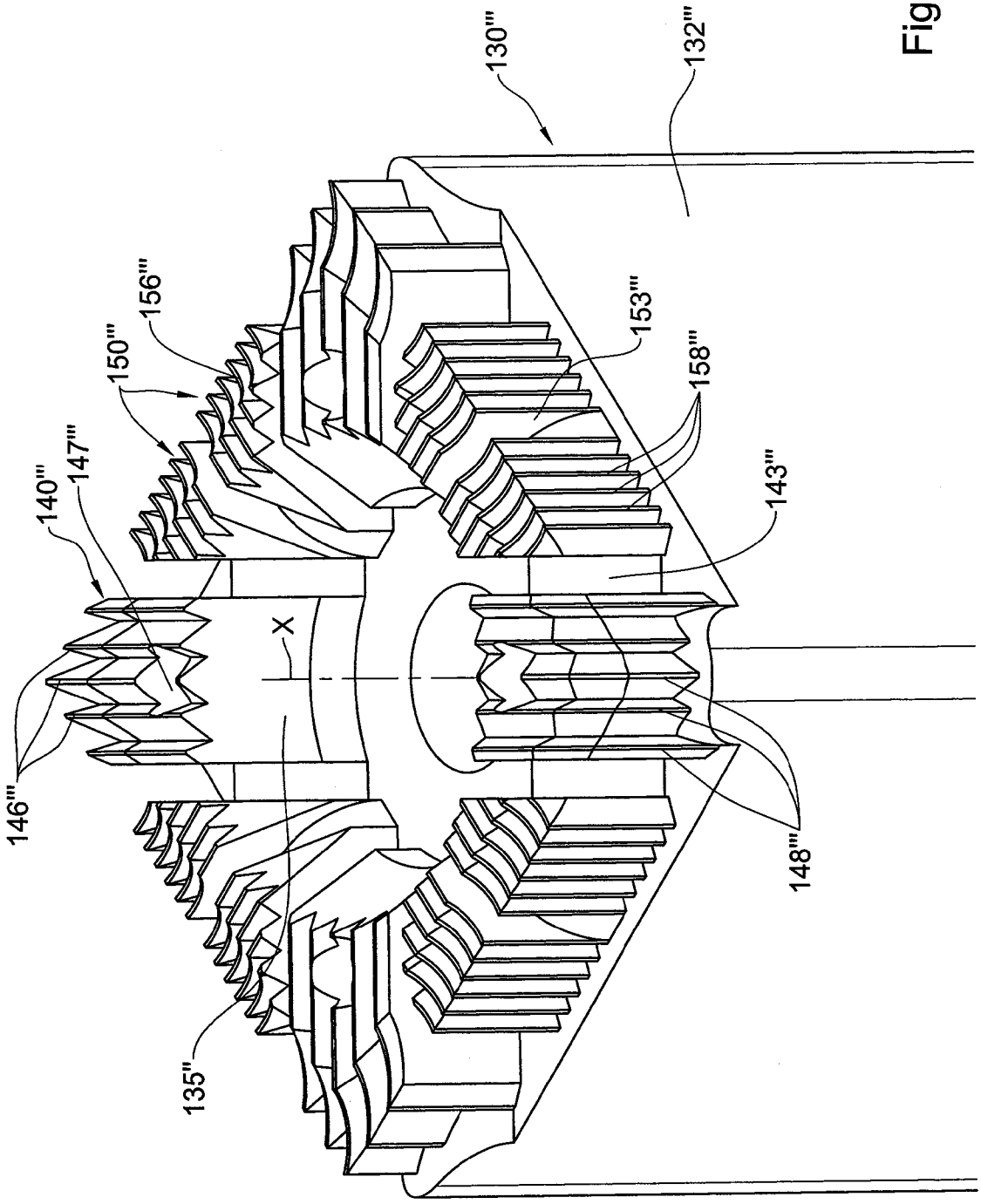


Fig. 14

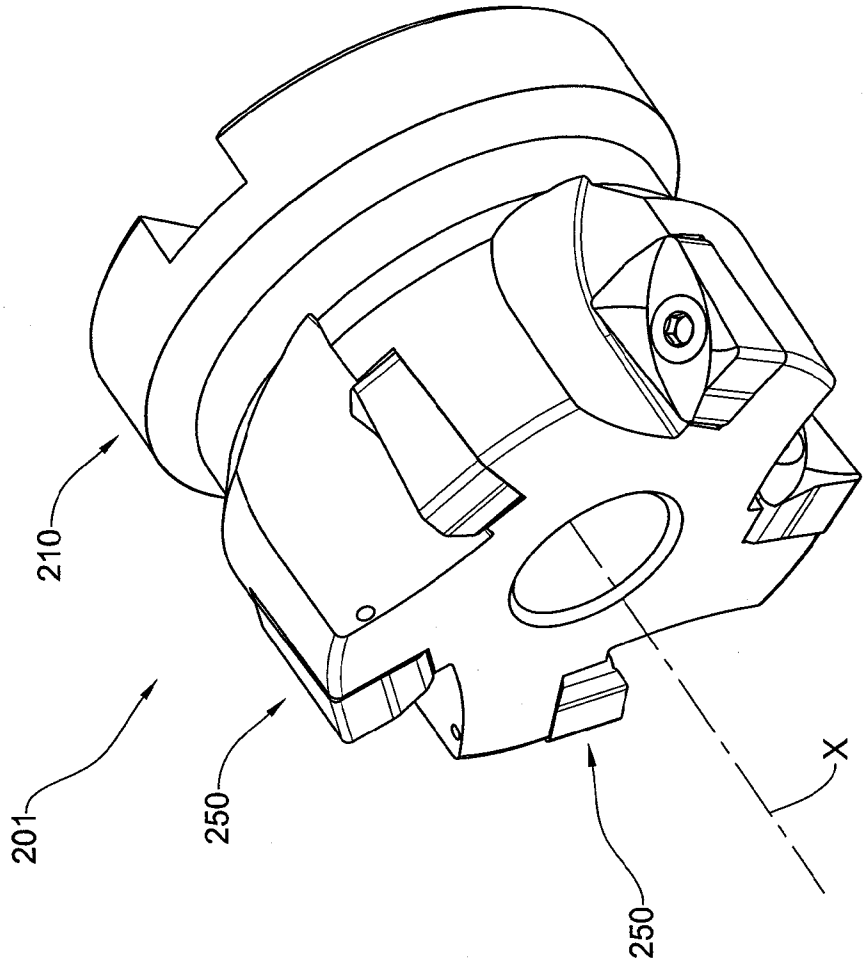


Fig. 15A

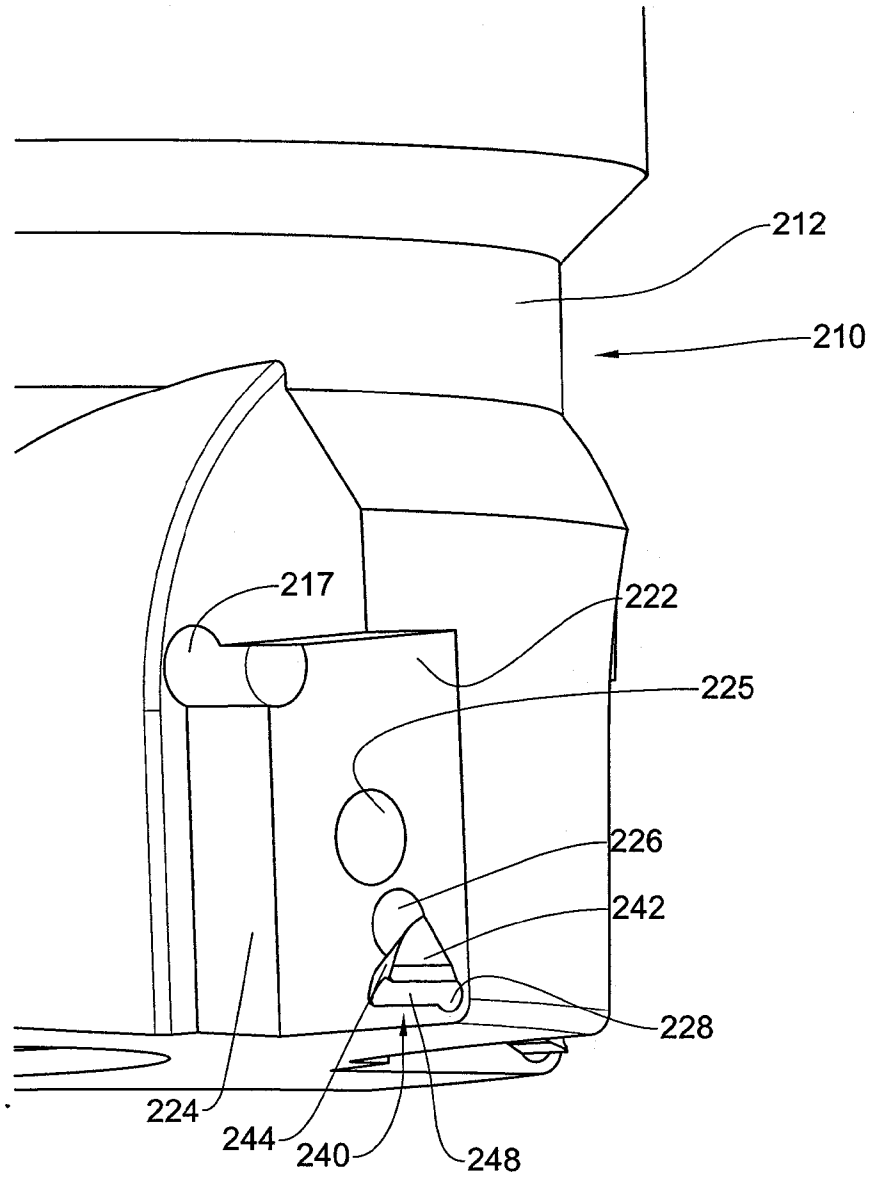


Fig. 15B

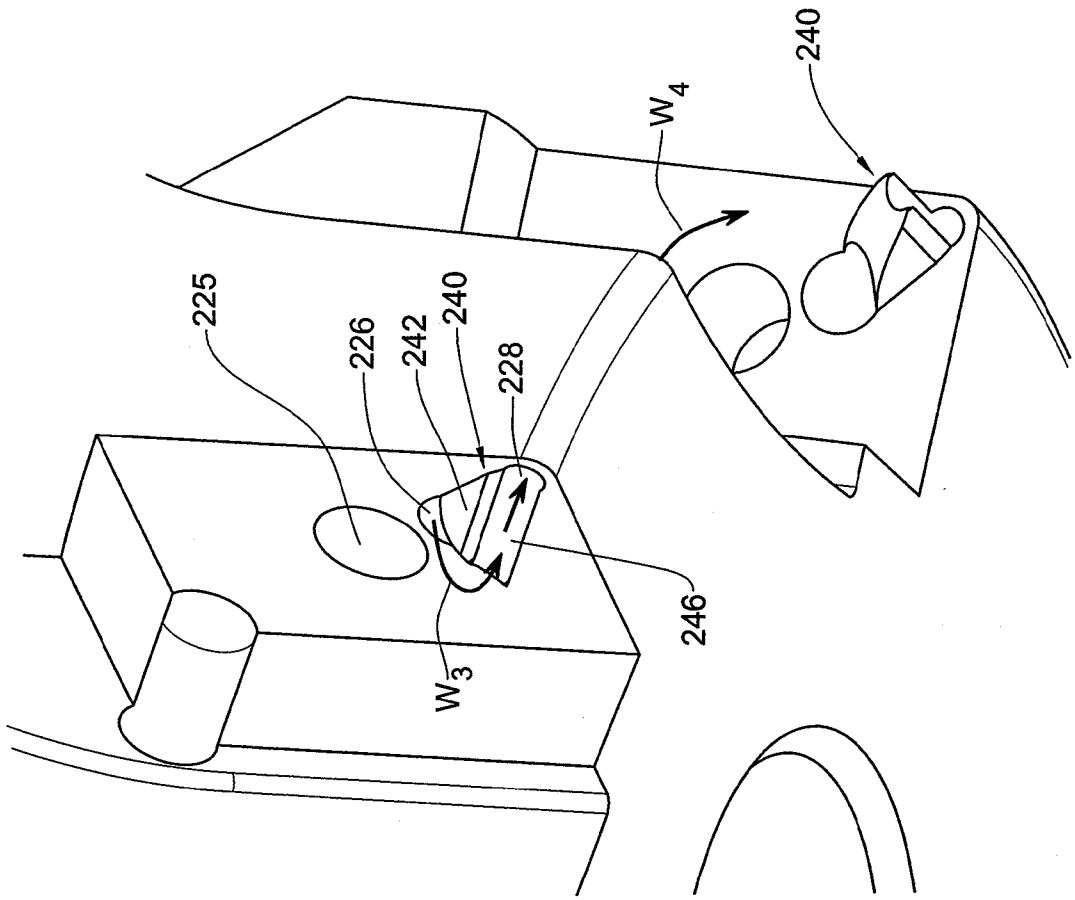


Fig. 15C

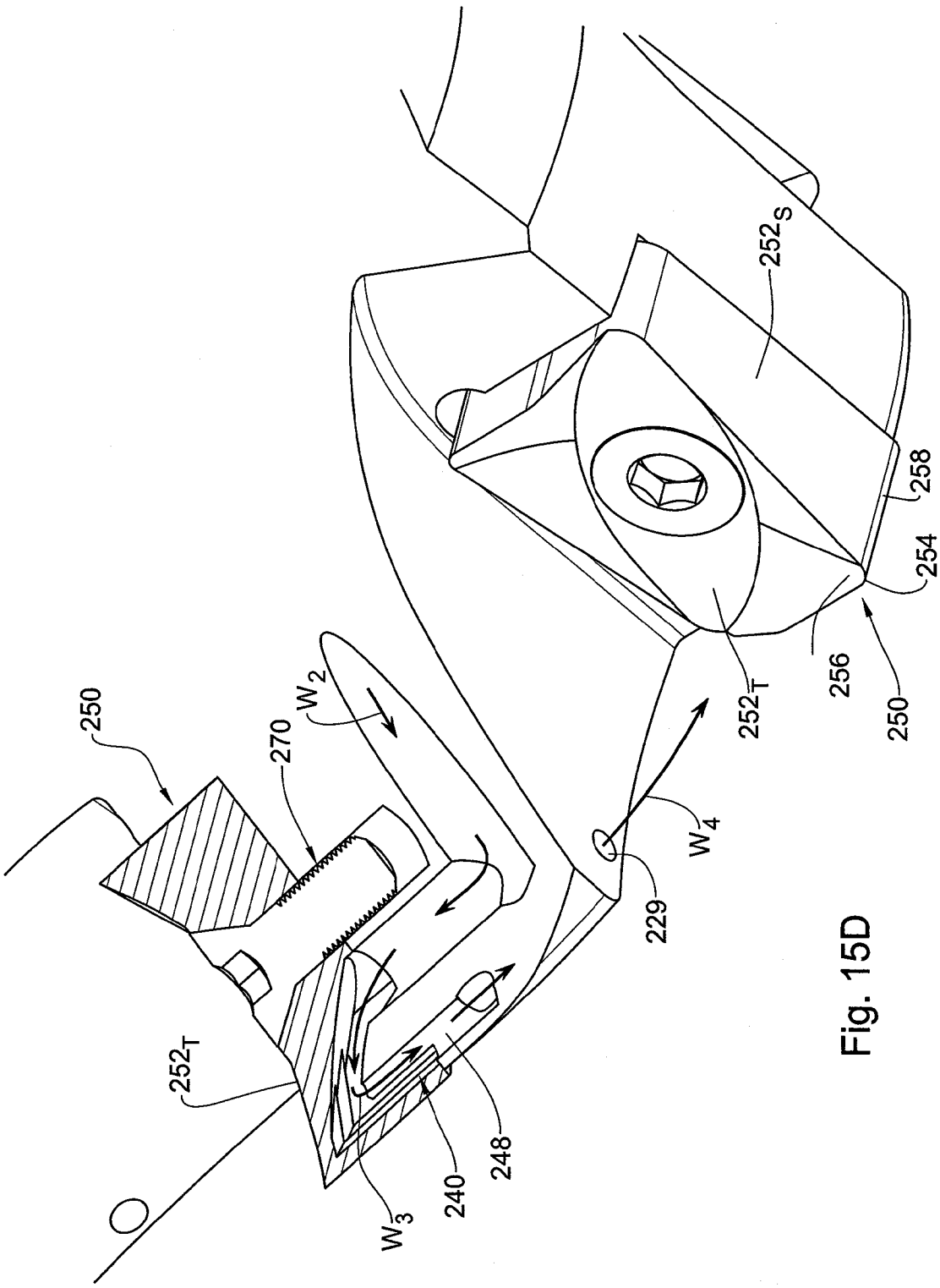


Fig. 15D

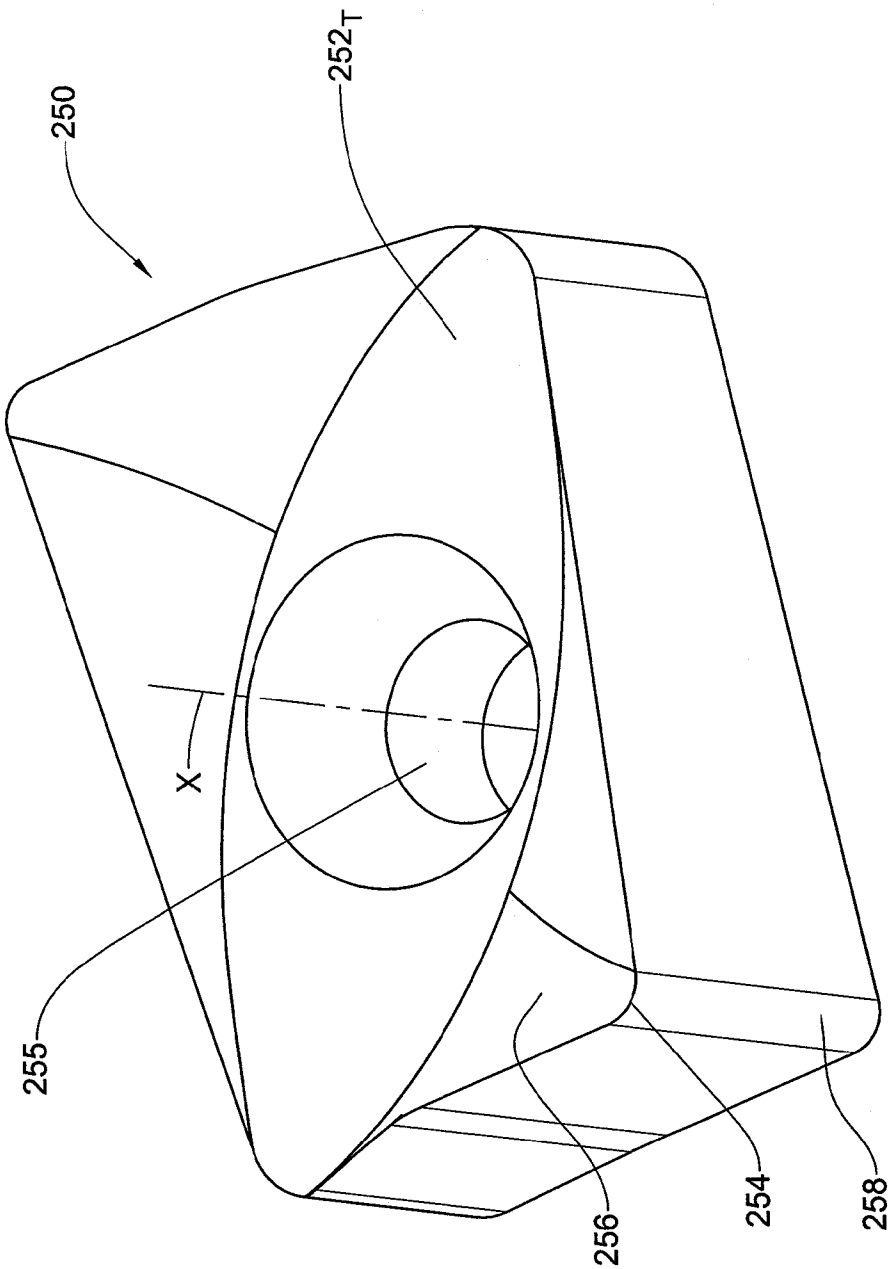


Fig. 16A

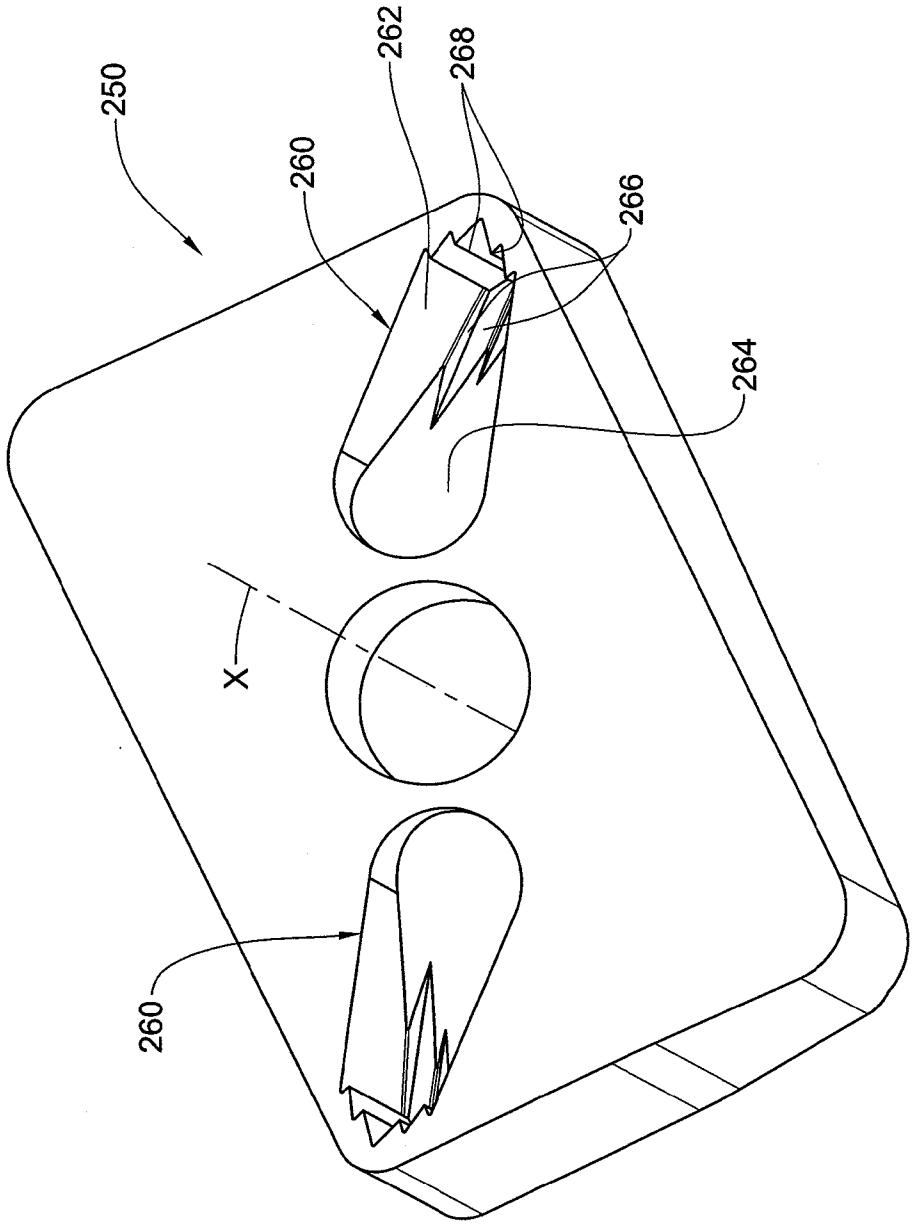


Fig. 16B

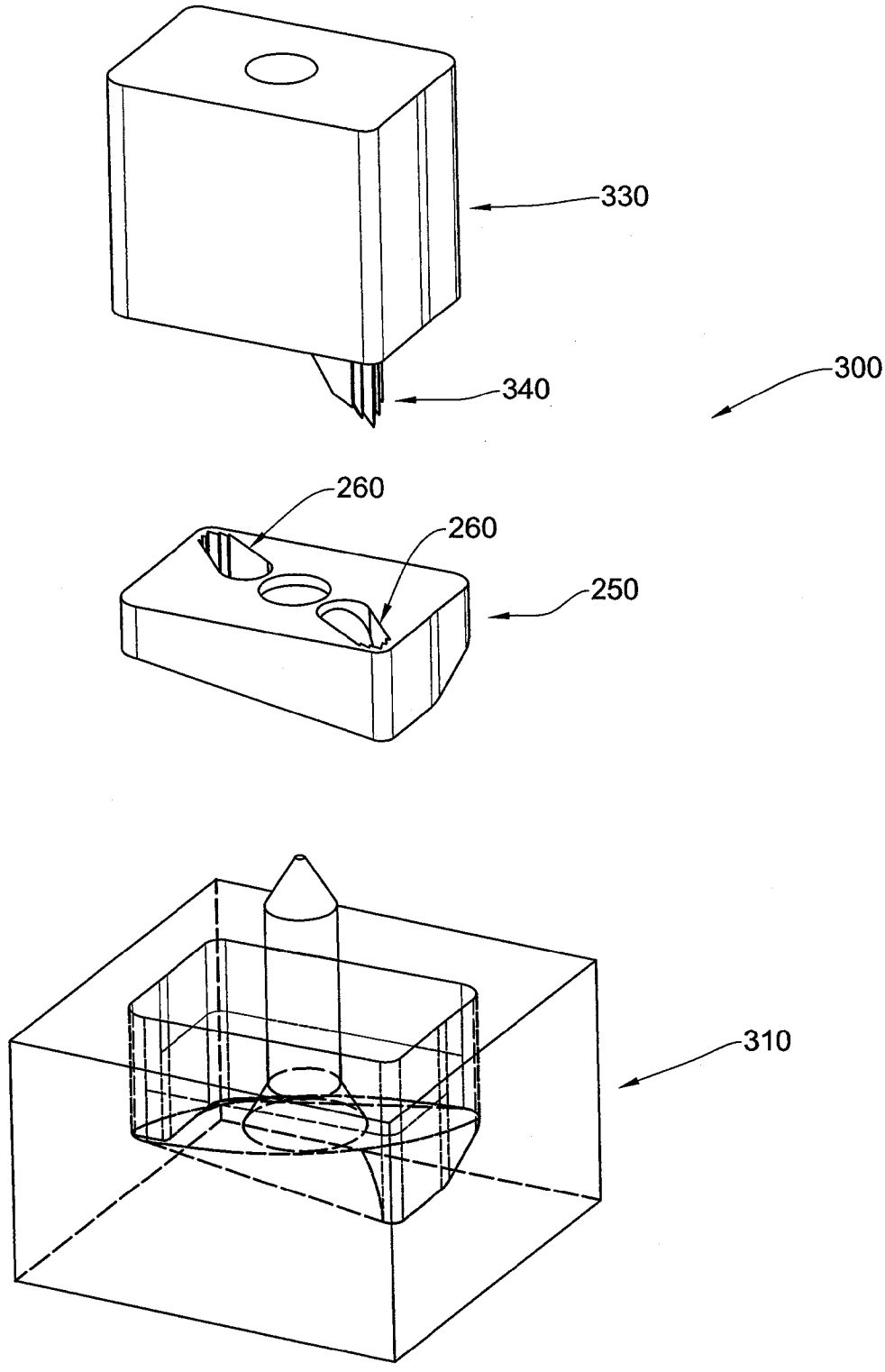
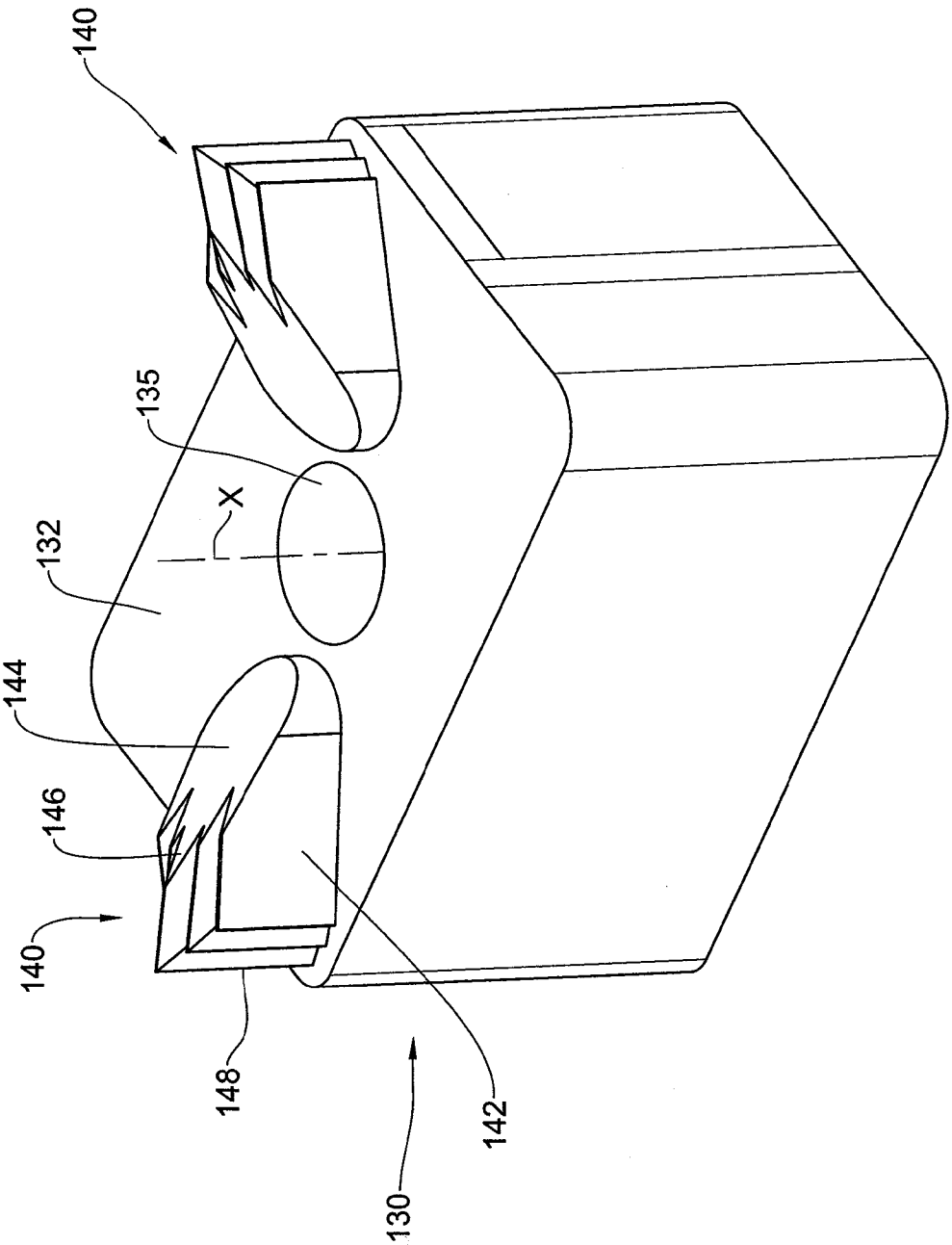


Fig. 17A

Fig. 17B



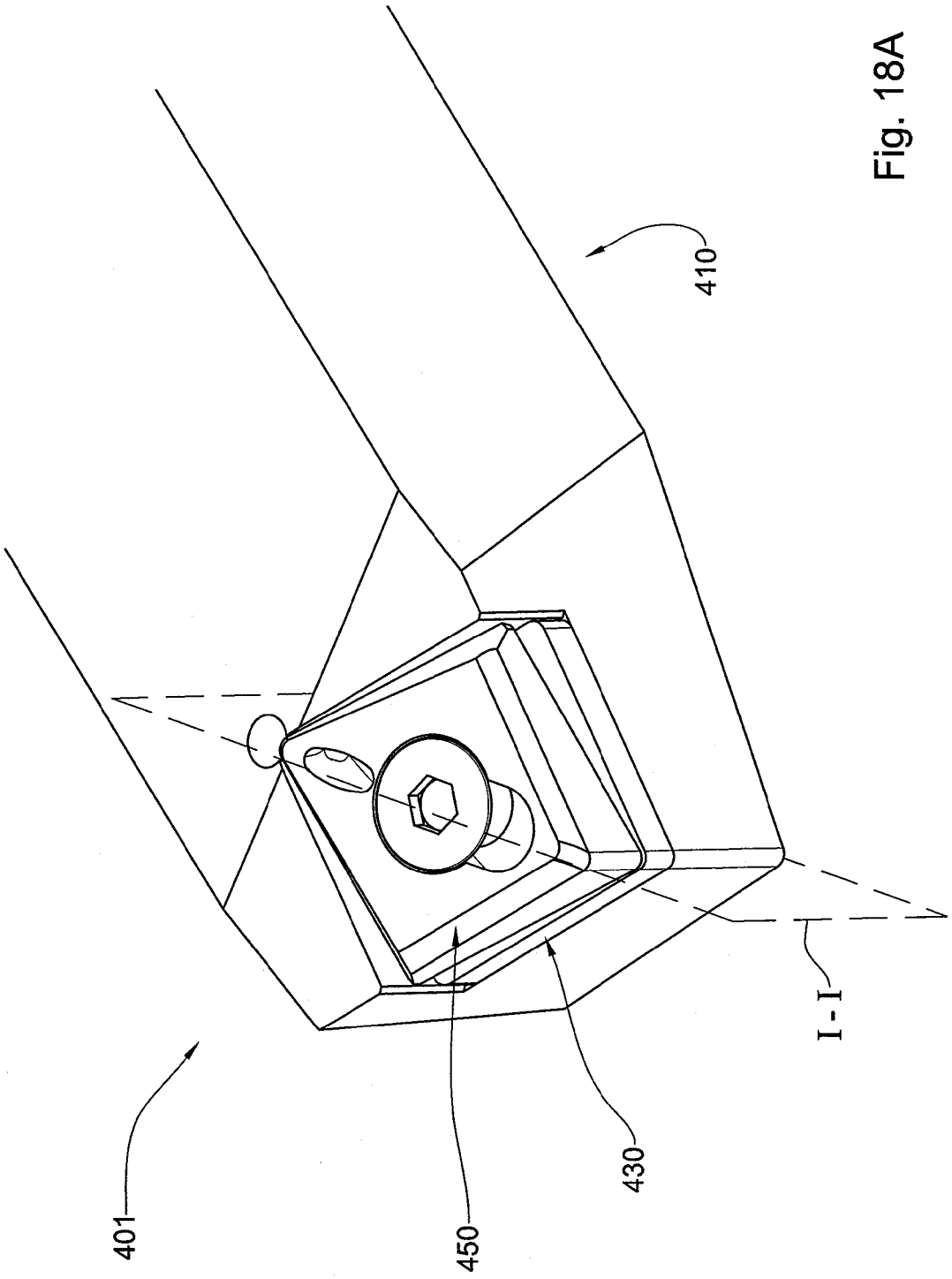


Fig. 18A

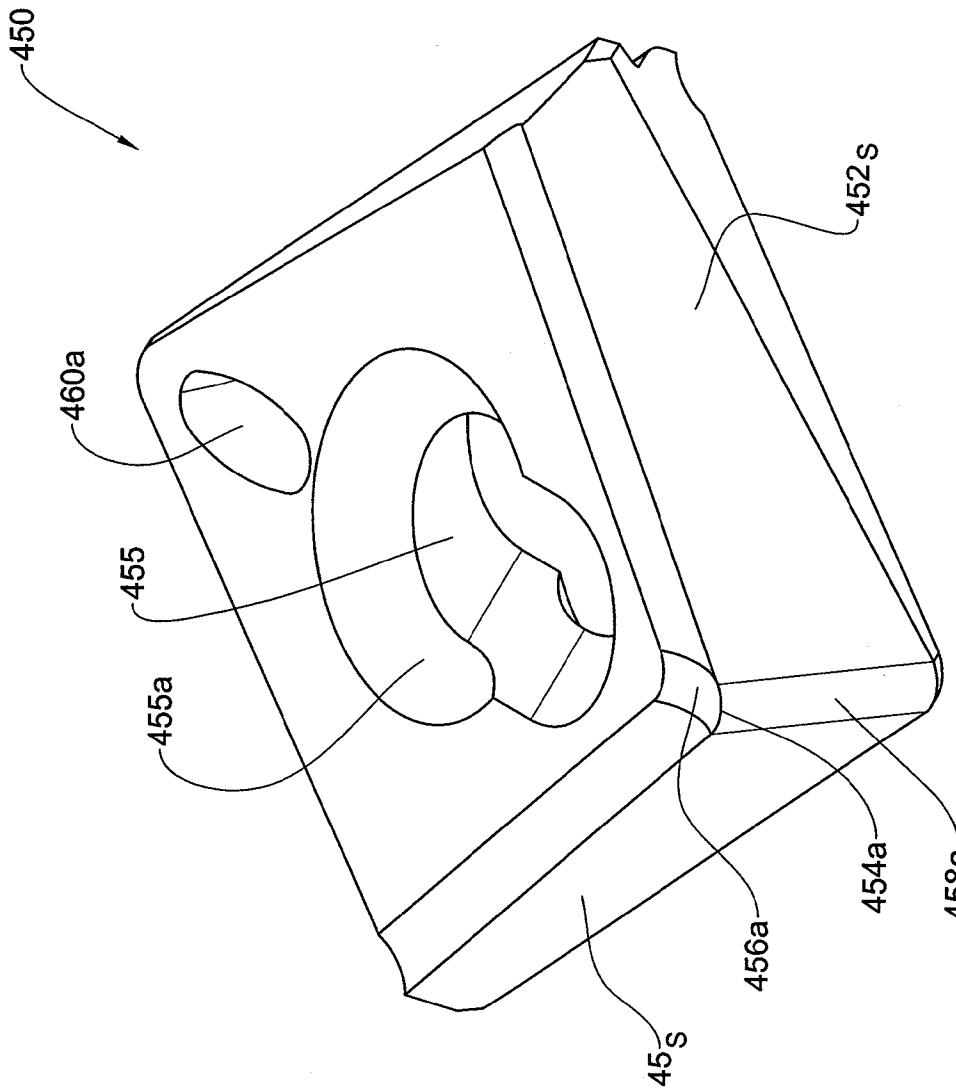


Fig. 18B

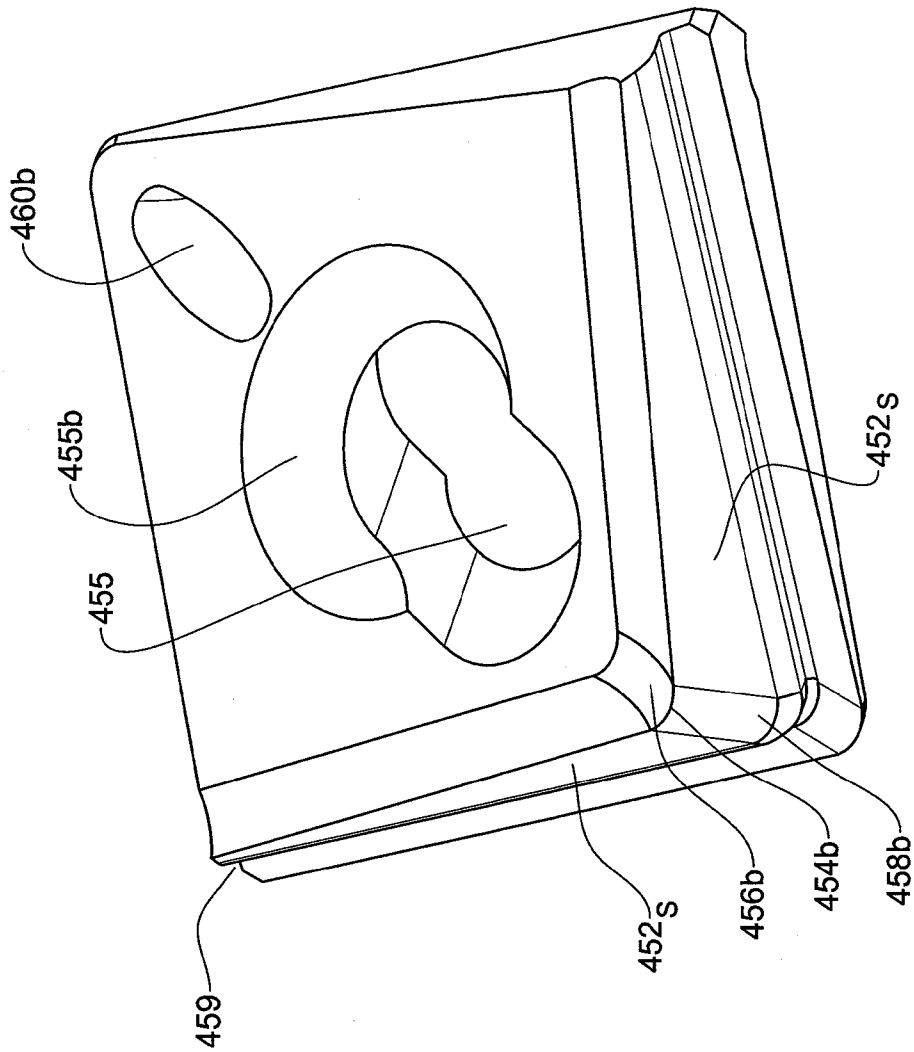


Fig. 18C

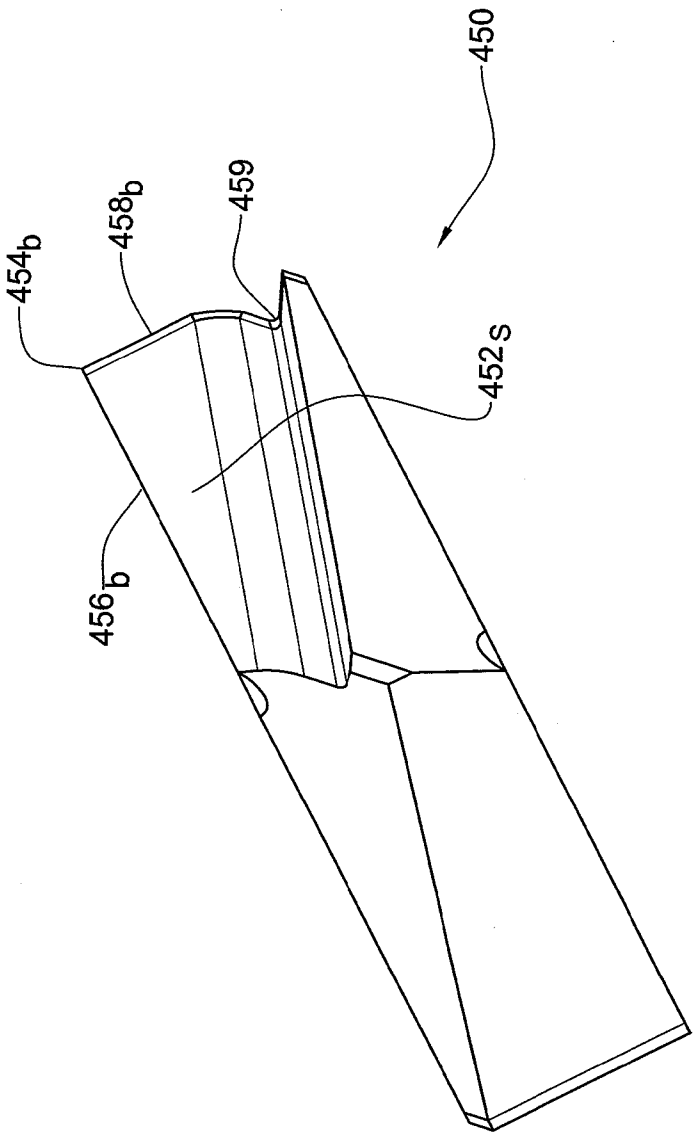
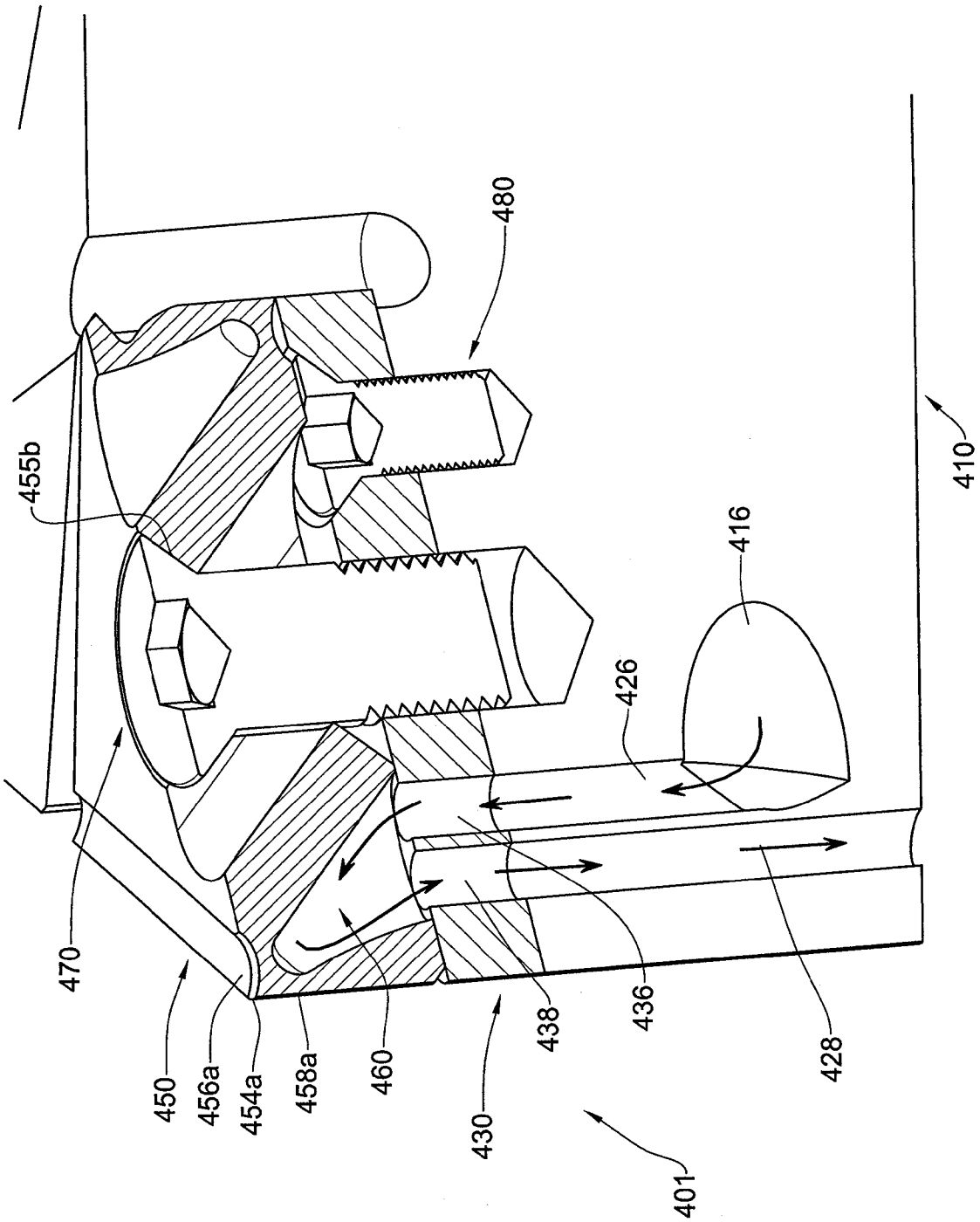


Fig. 18D

Fig. 19


480
455b
410
416
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470
450
456a
454a
458a
460
430
438
436
428
401

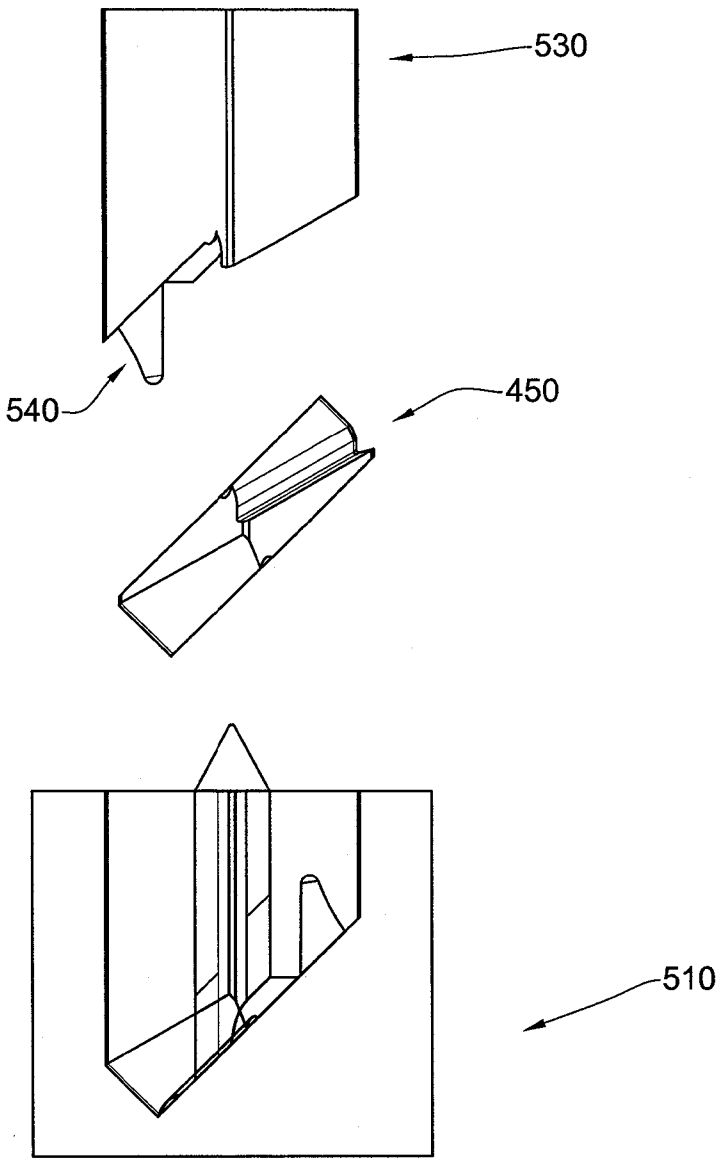


Fig. 20A

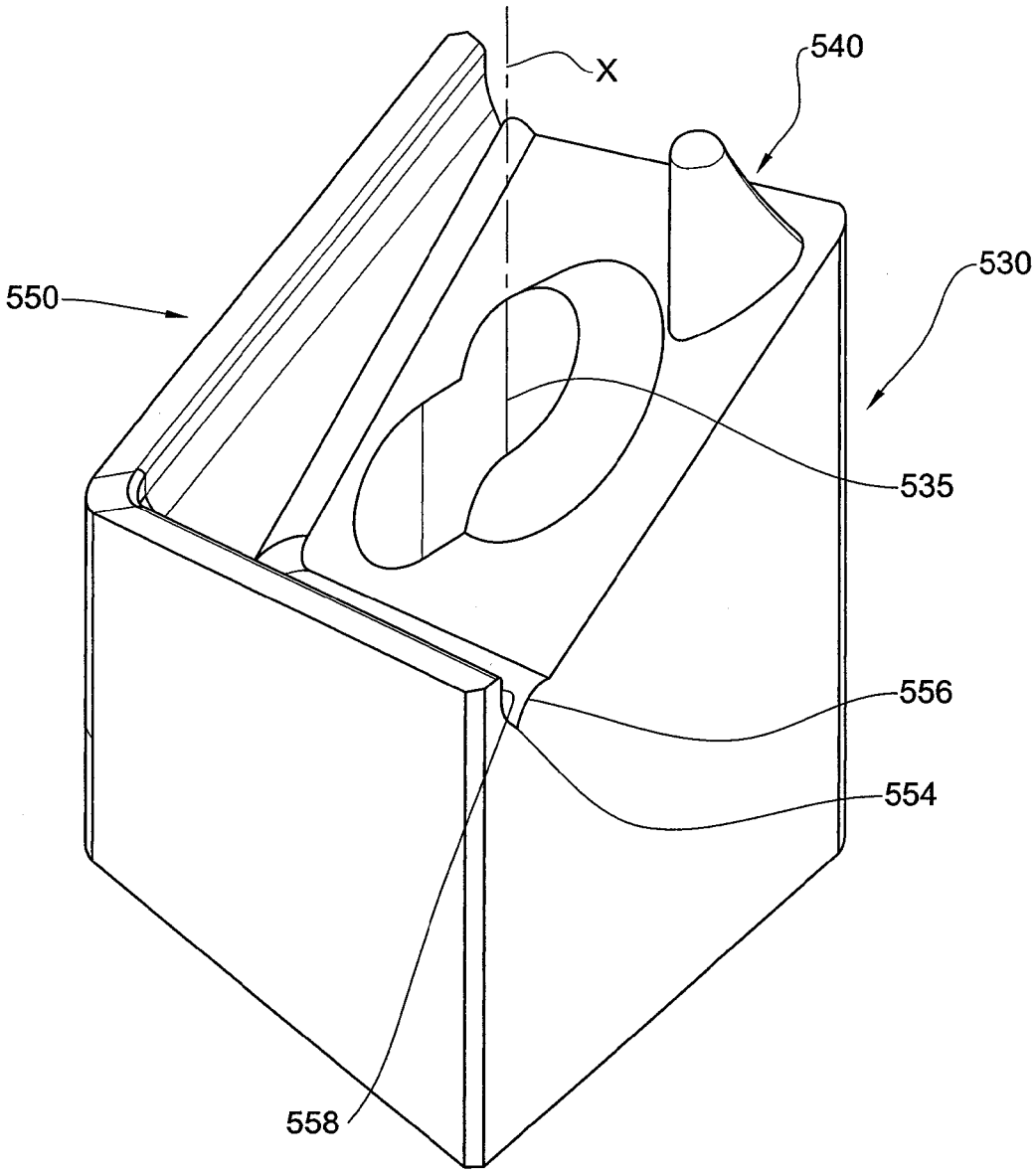


Fig. 20B

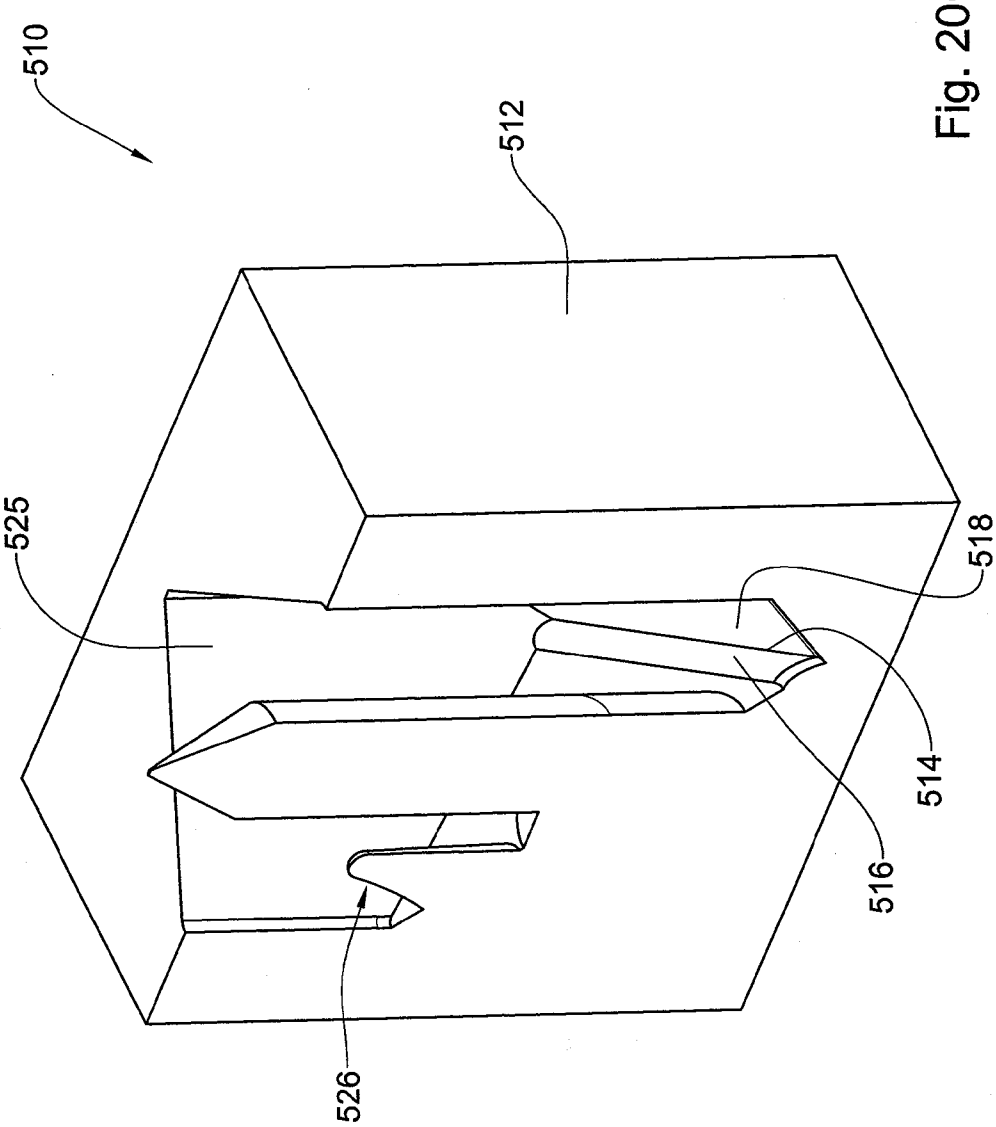


Fig. 20C

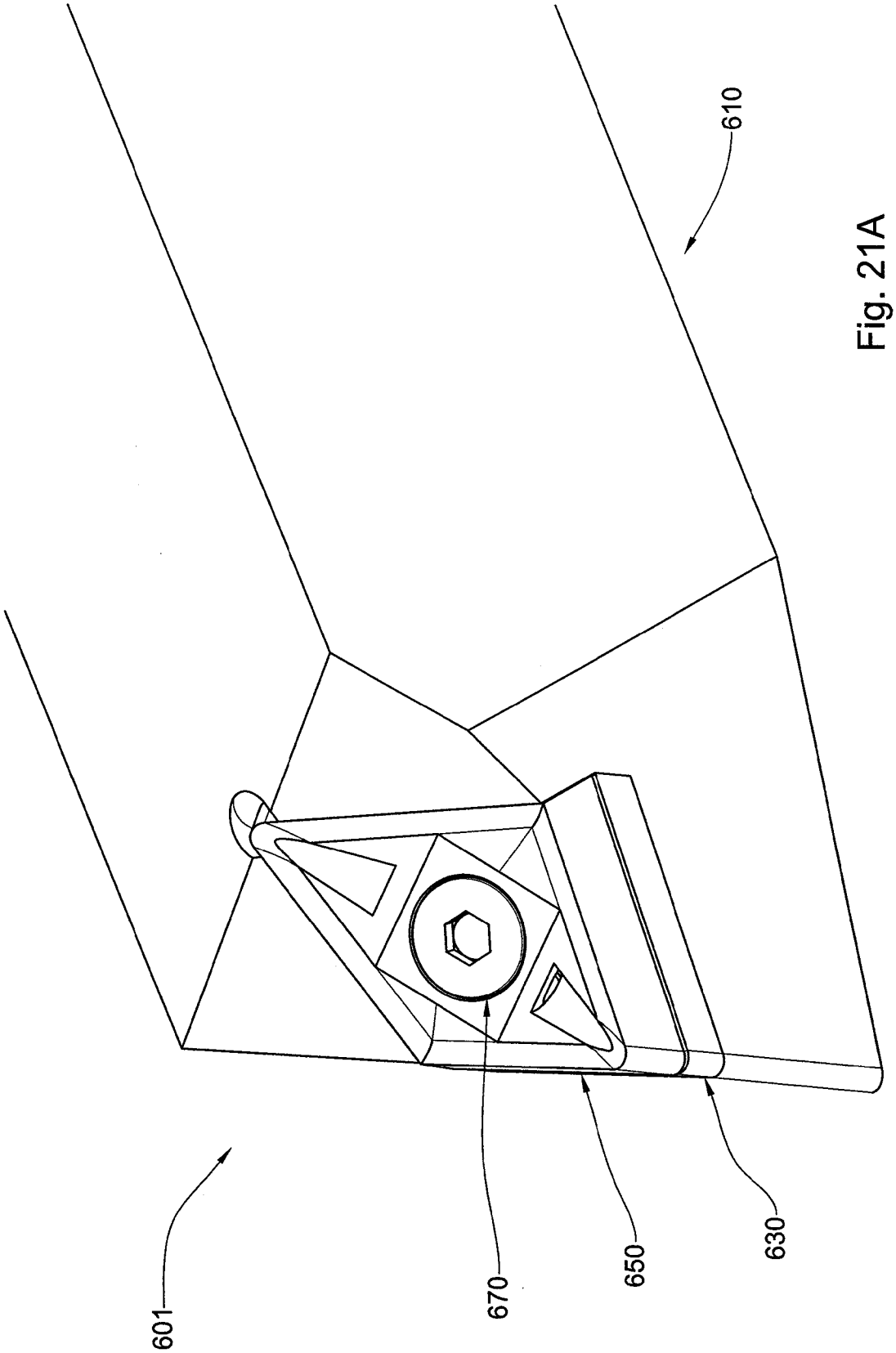


Fig. 21A

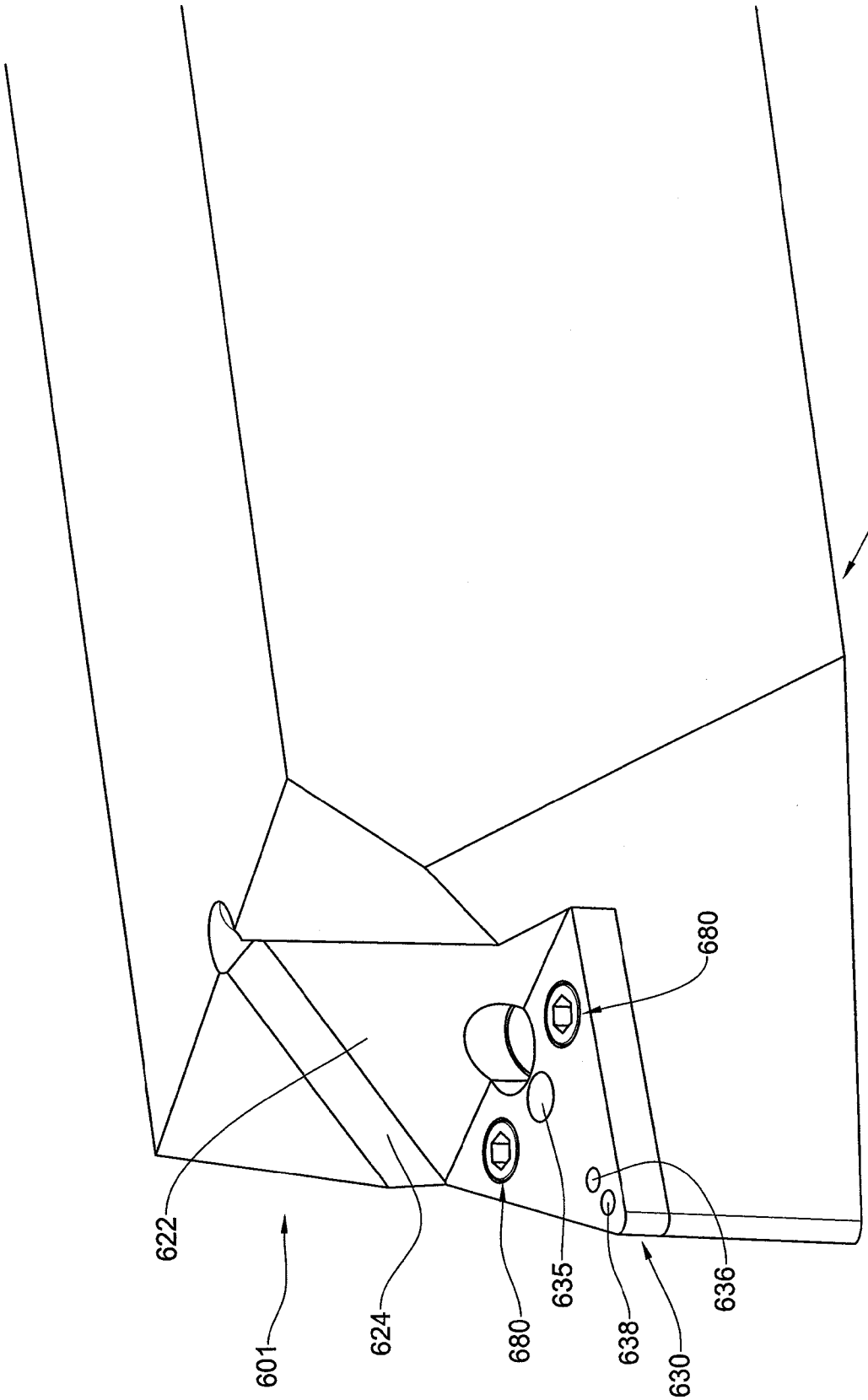


Fig. 21B

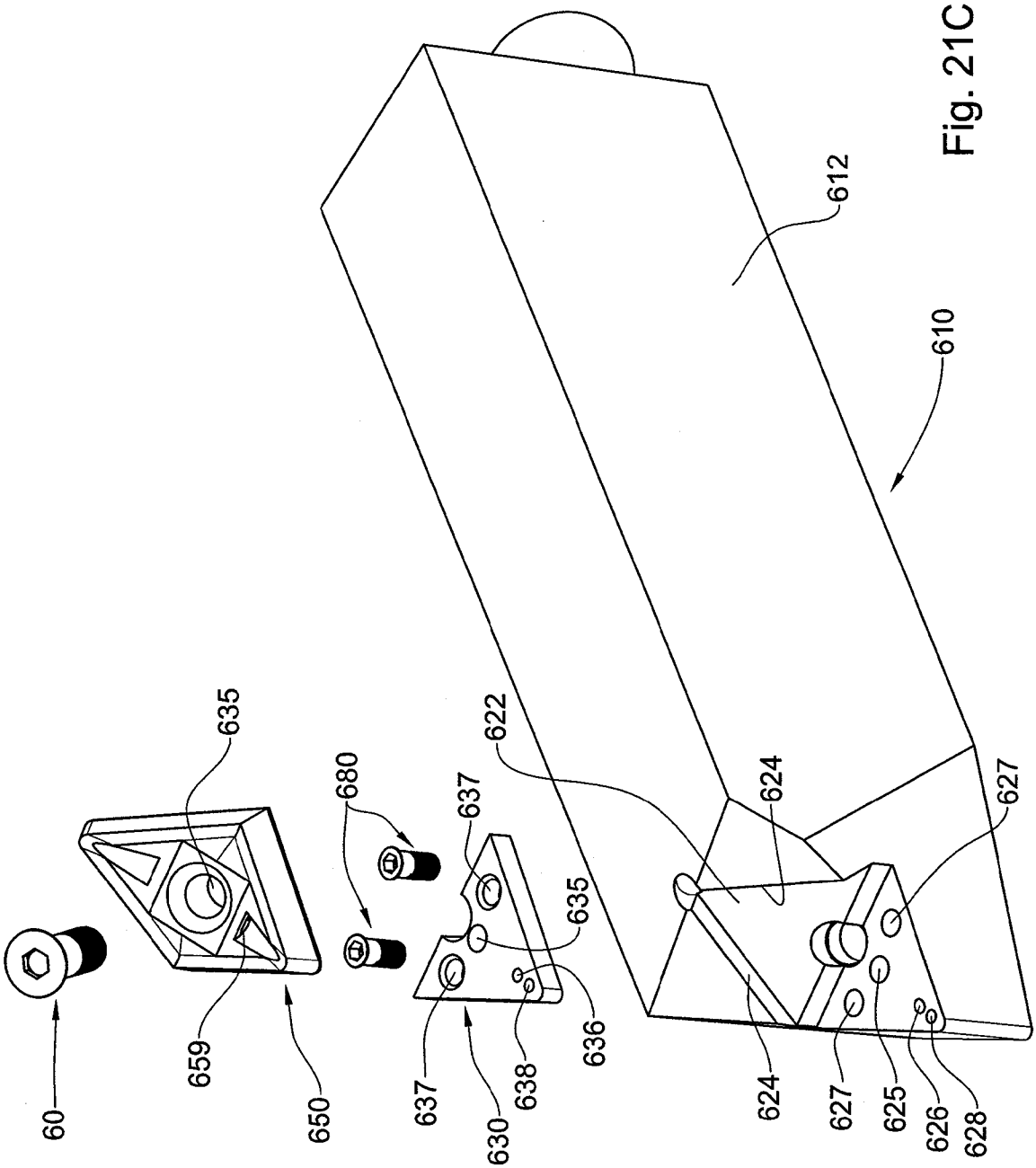

612
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626
628
60

Fig. 21C

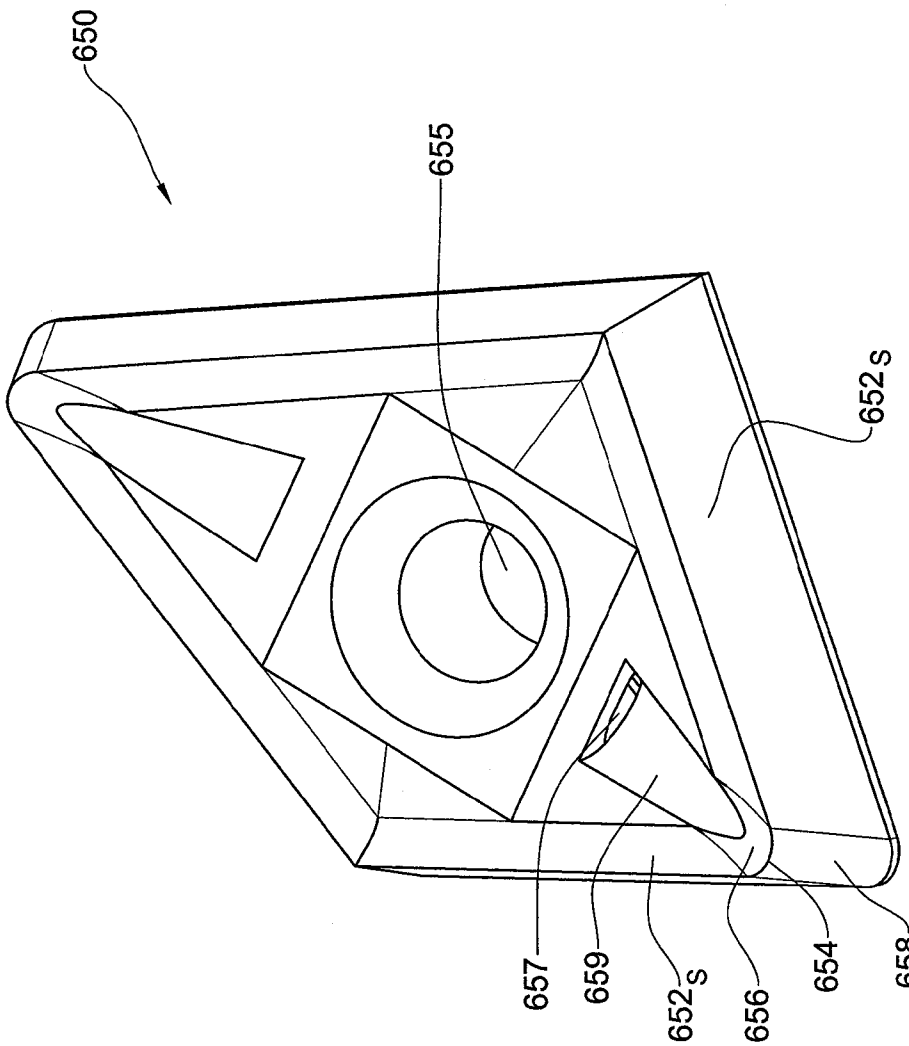


Fig. 22A

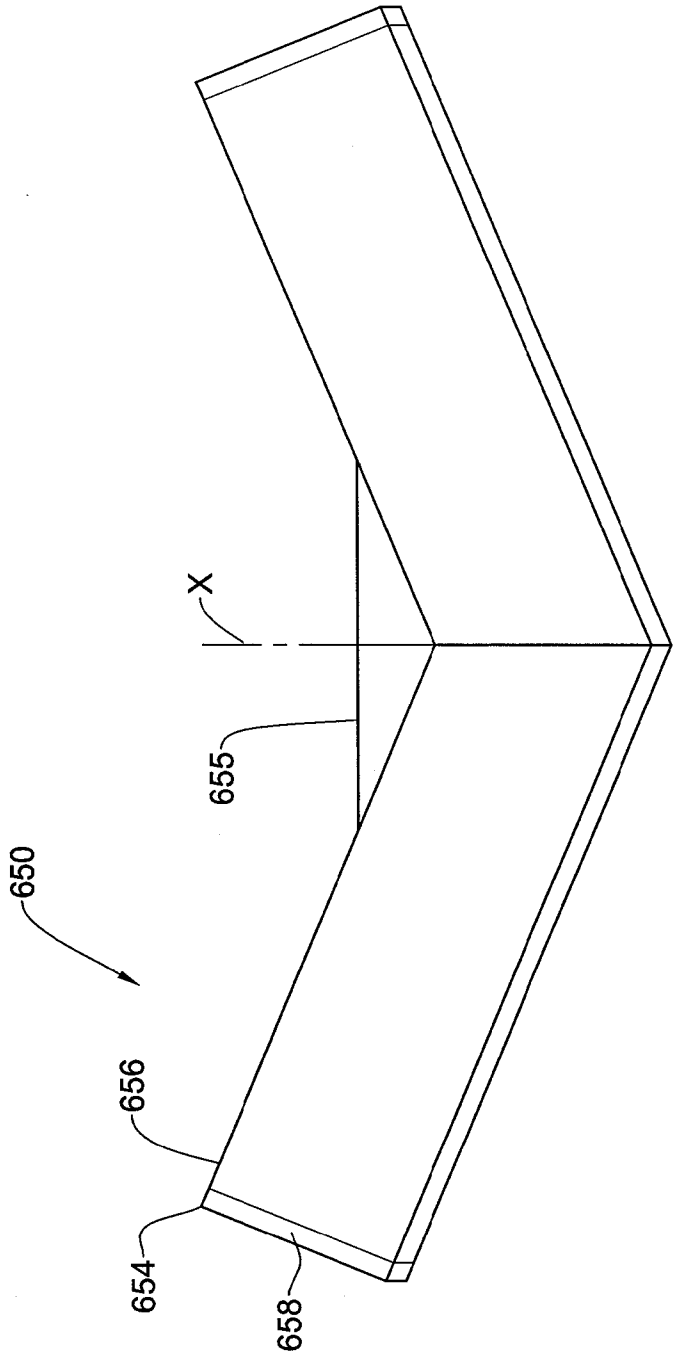


Fig. 22B

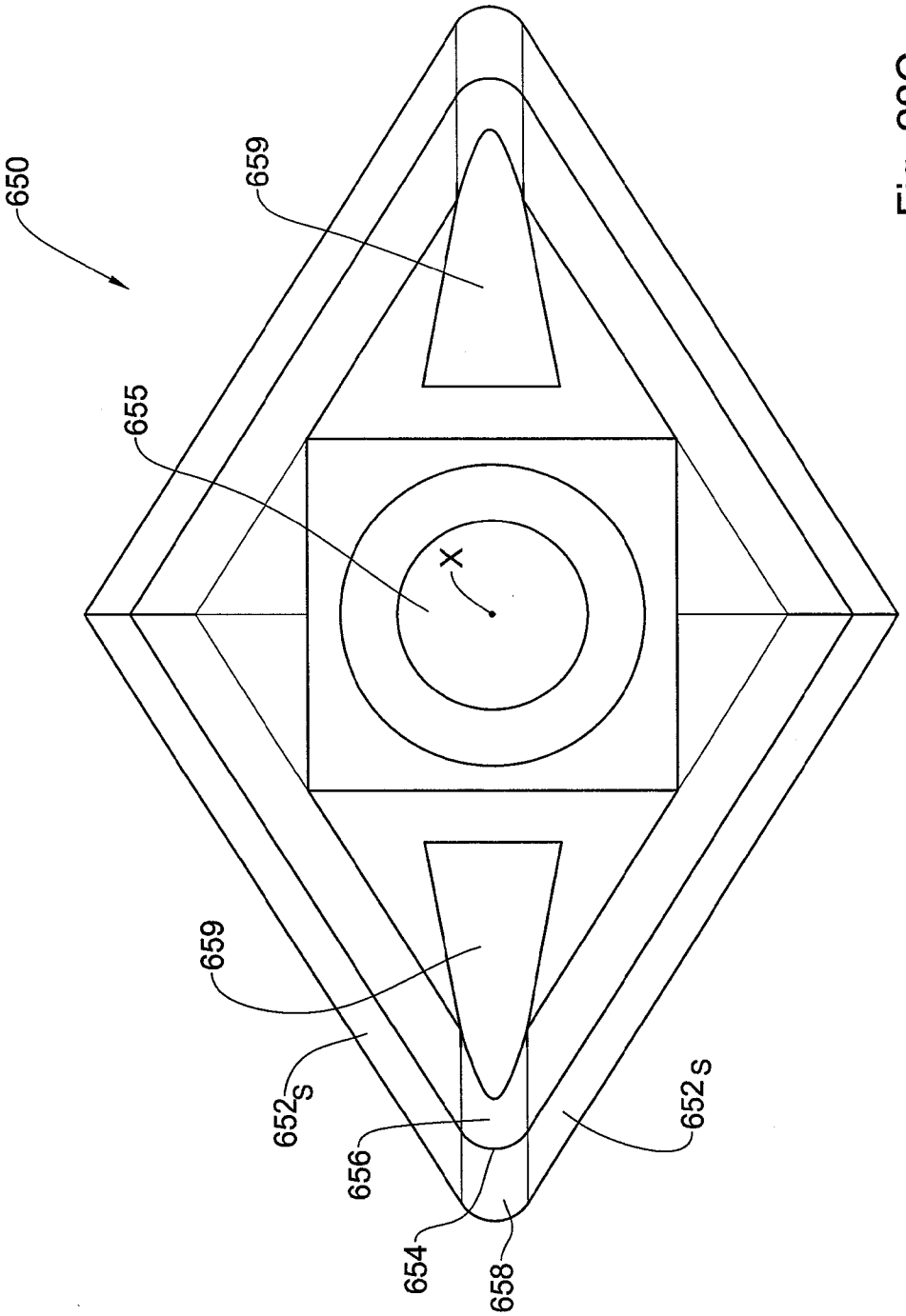


Fig. 22C

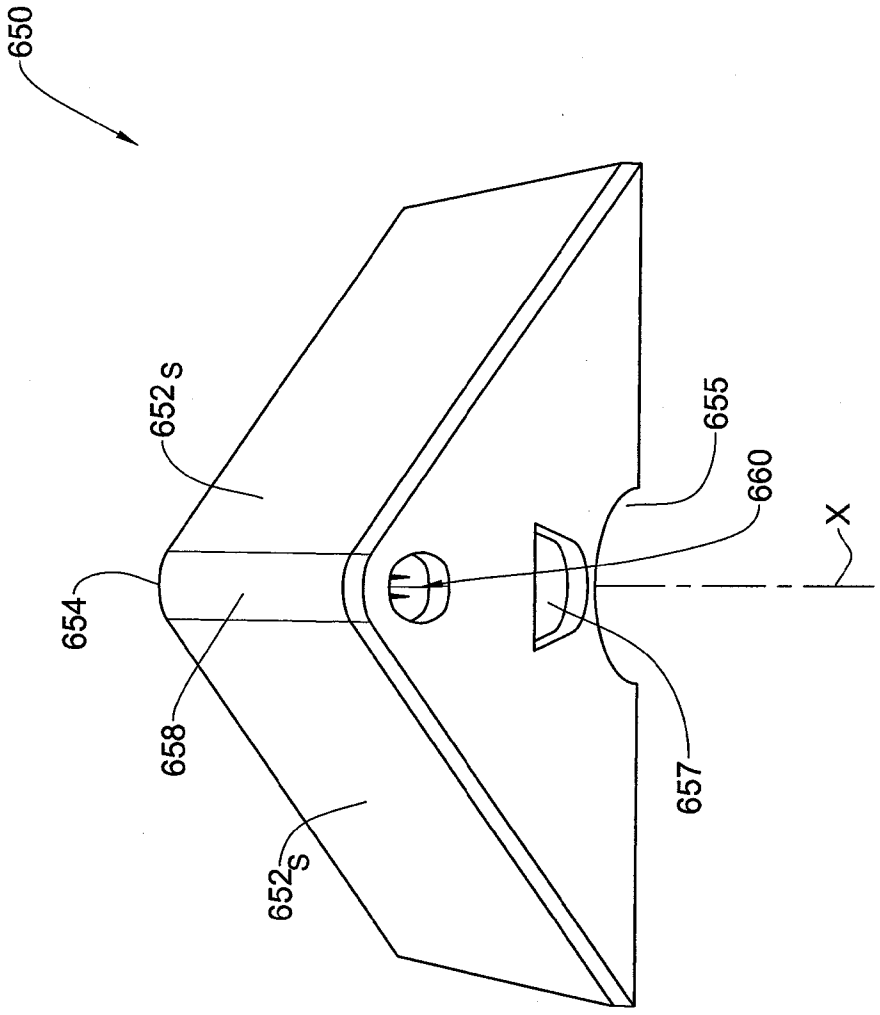
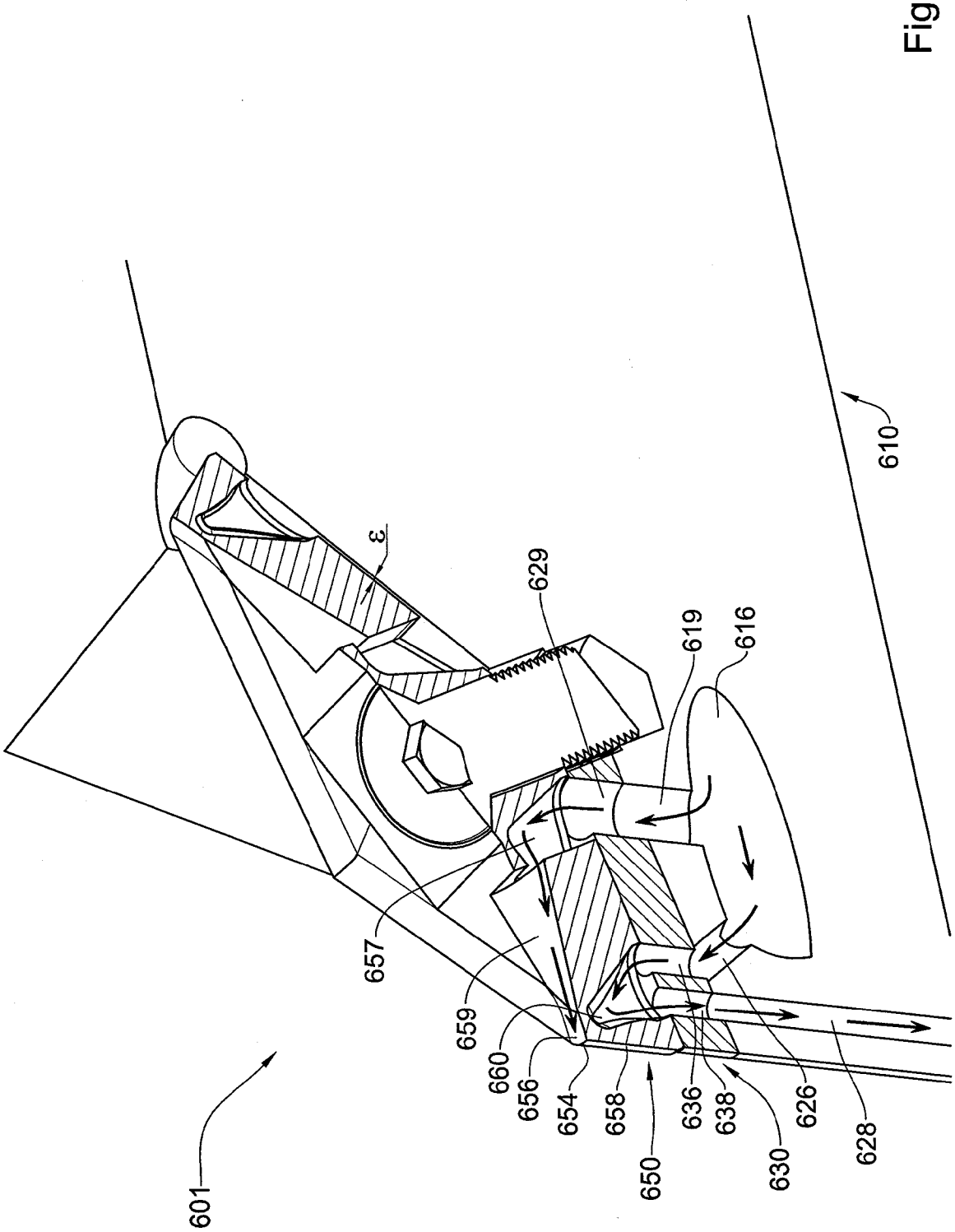


Fig. 22D

Fig. 23


610
ε
629
619
616
657
659
660
656
654
658
650
636
638
630
626
628
601

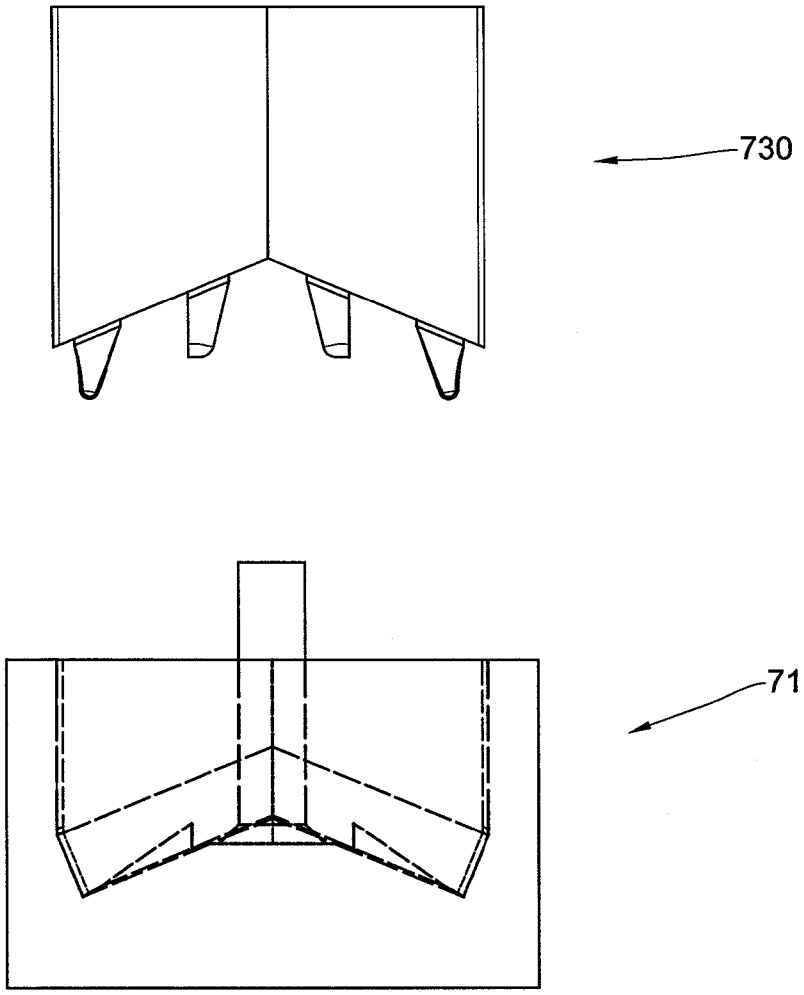


Fig. 24A

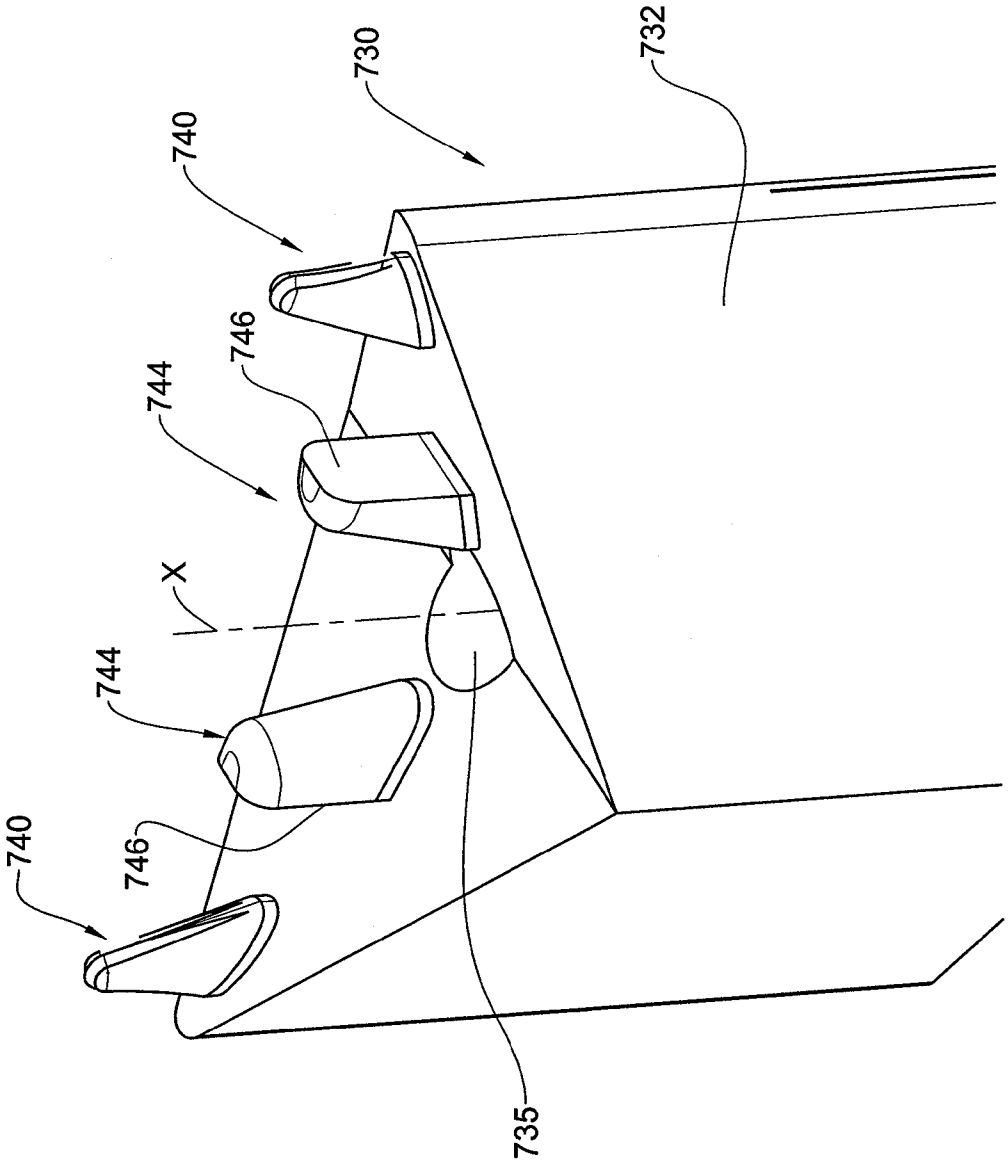


Fig. 24B

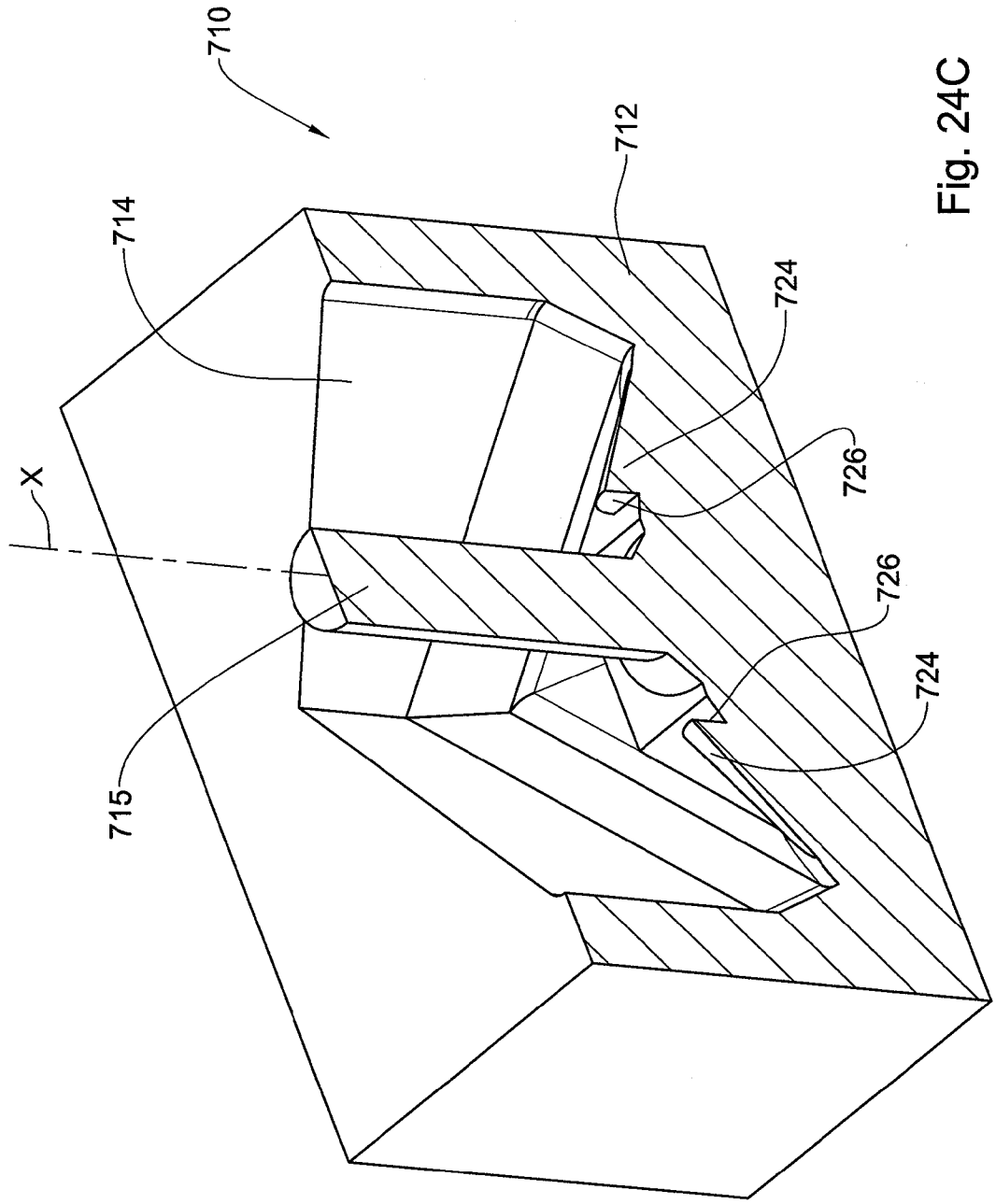


Fig. 24C

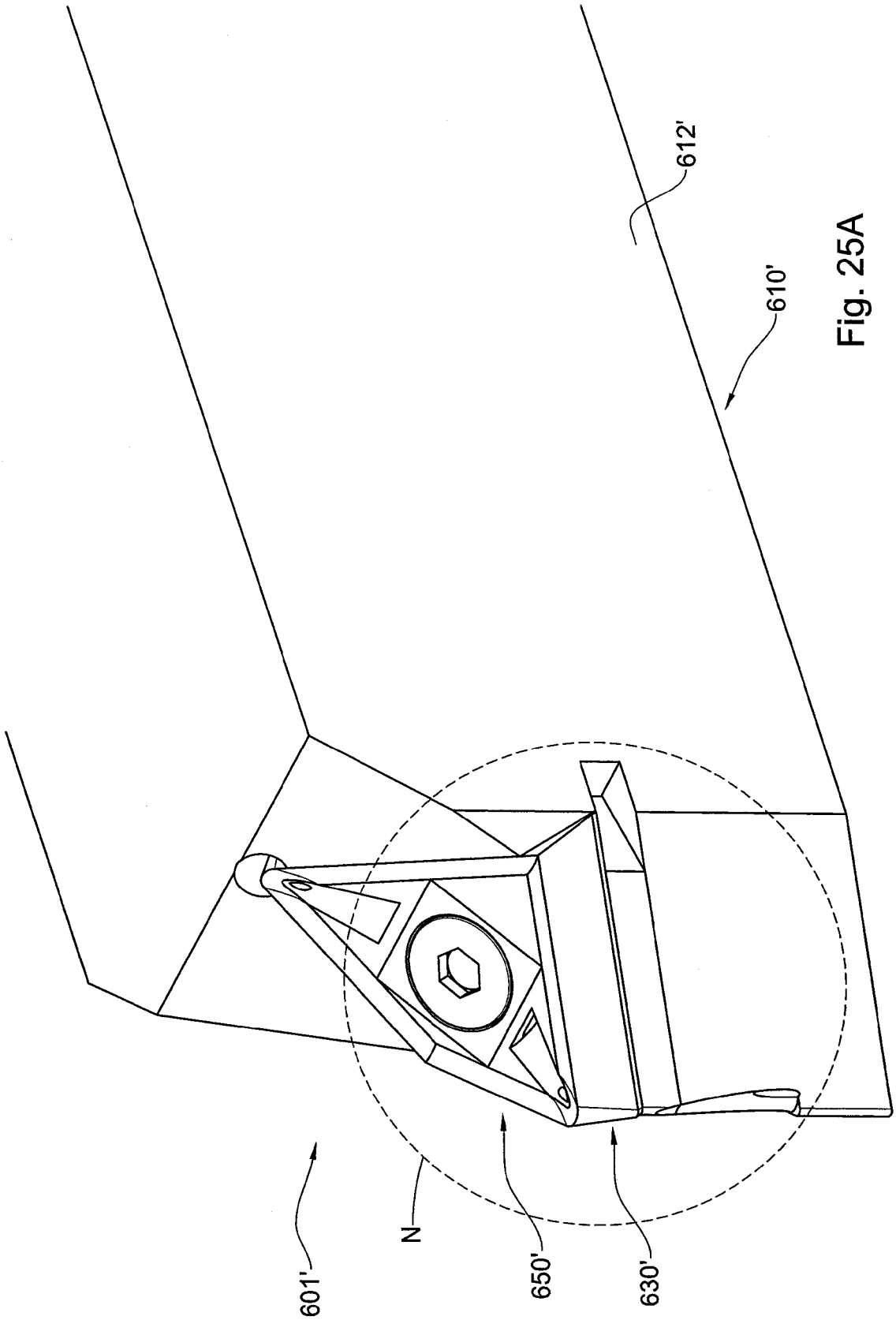


Fig. 25A

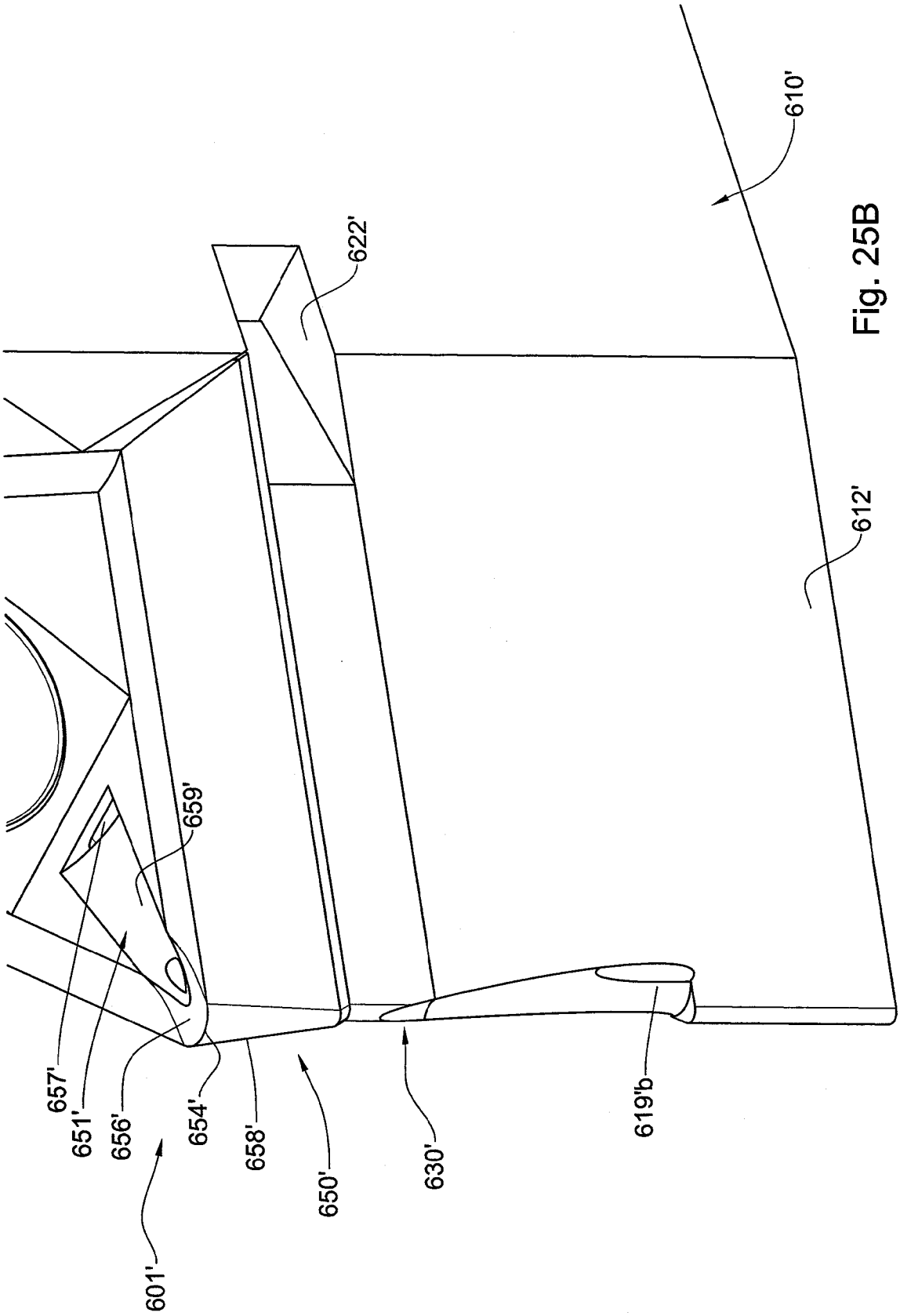


Fig. 25B

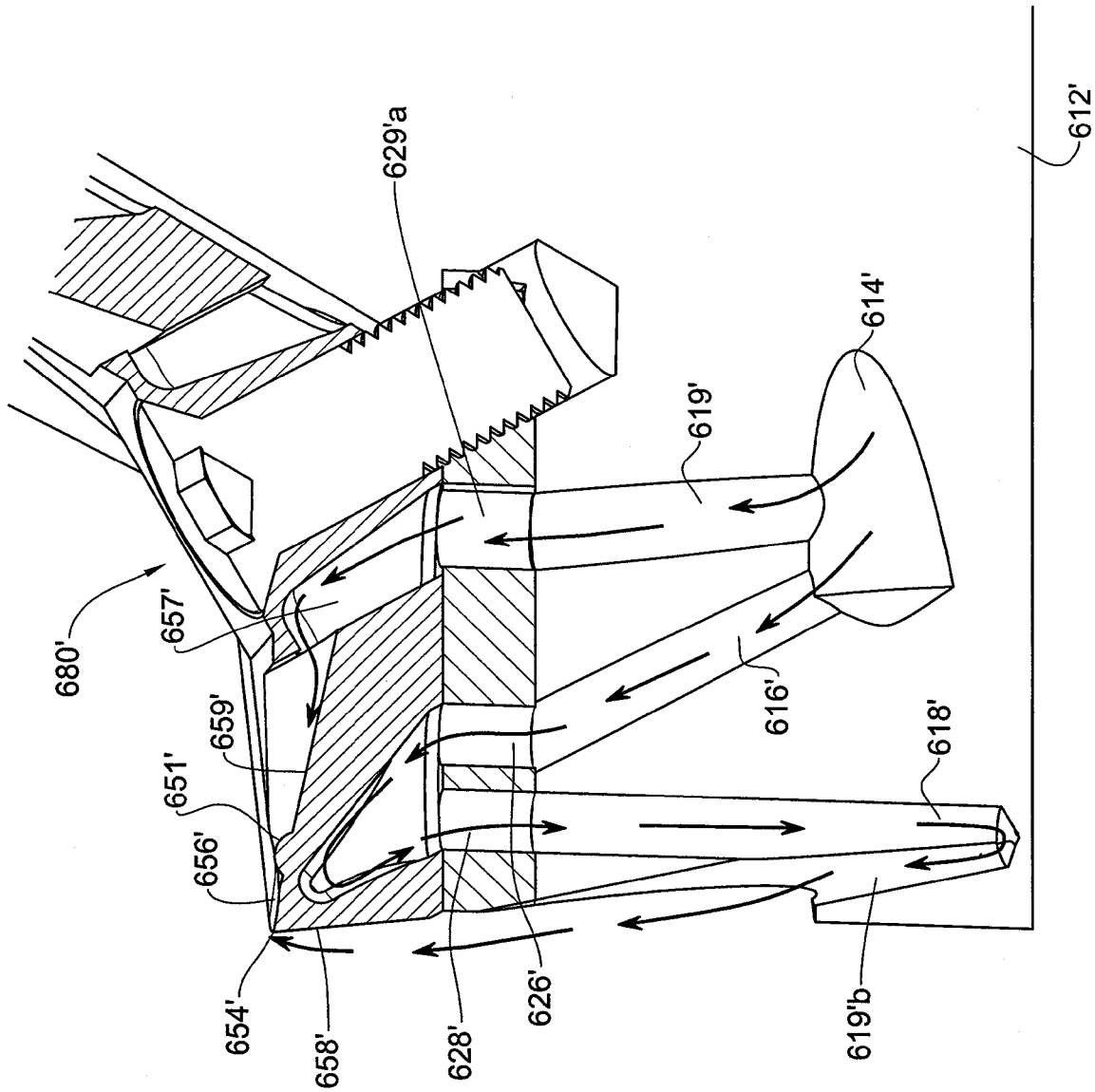

612'
629'a
614'
619'
680'
657'
659'
651'
656'
654'
658'
628'
626'
616'
618'
619'b

Fig. 25C

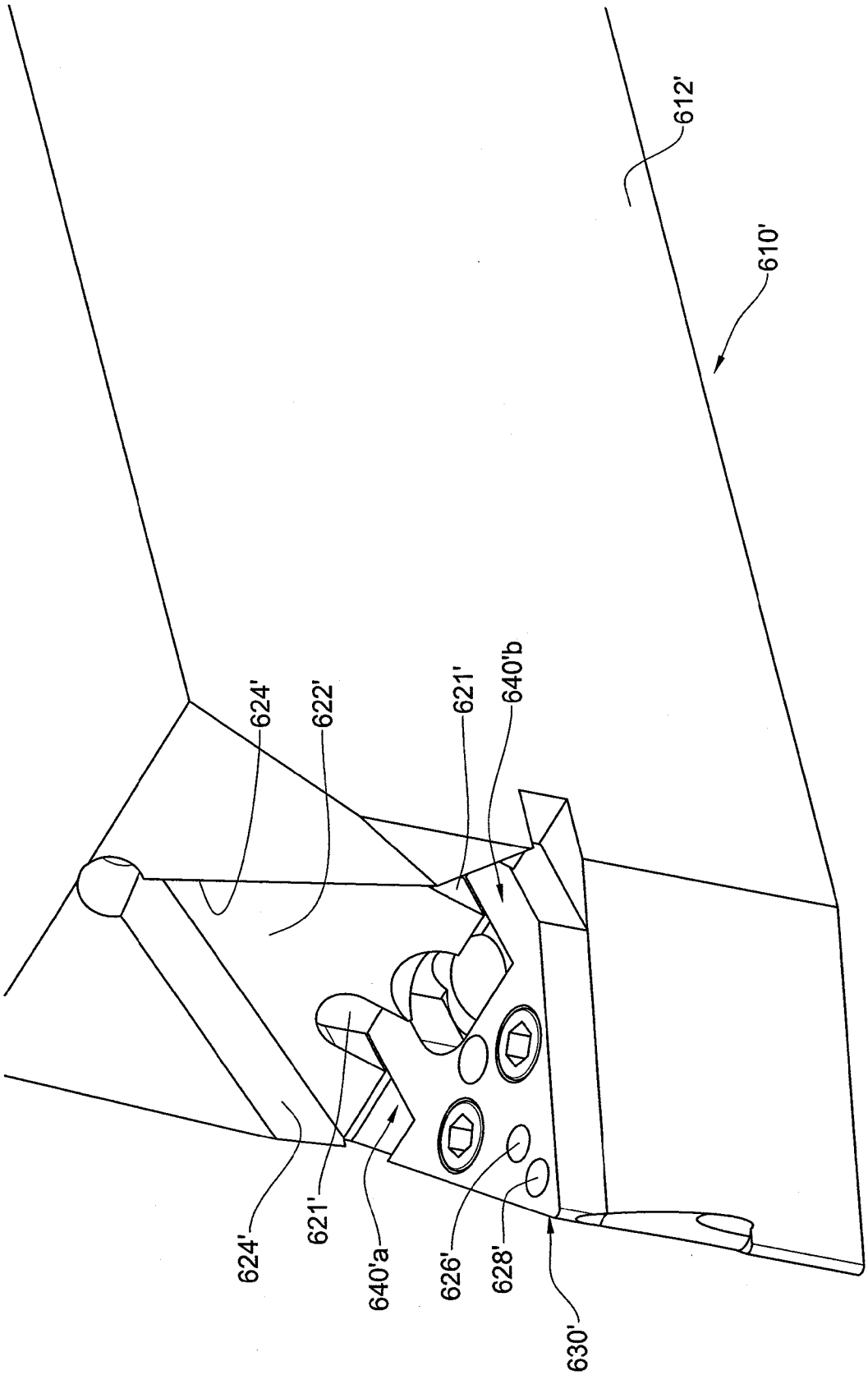
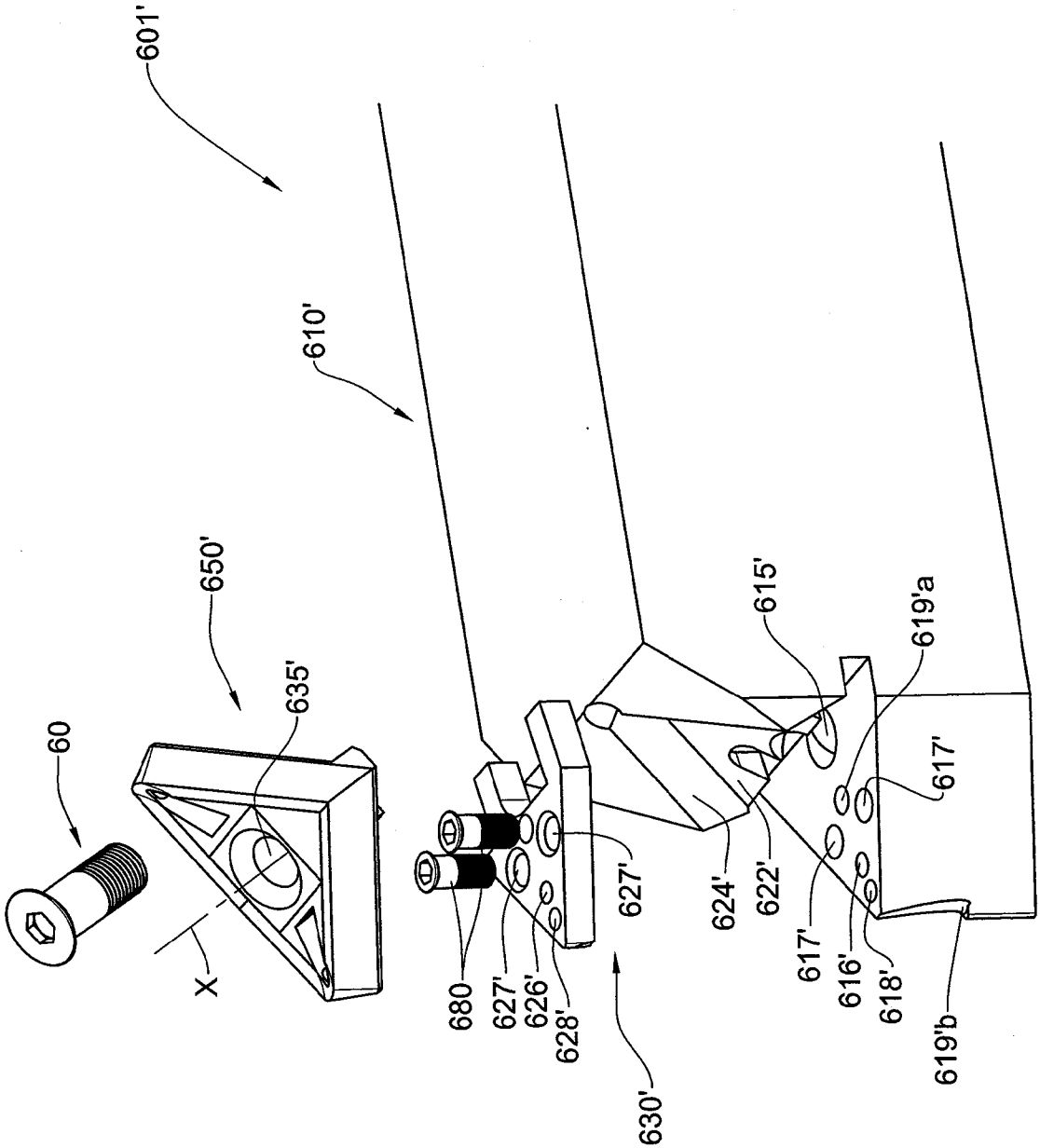


Fig. 25D

Fig. 25E


601'
610'
650'
635'
60
X
680
627'
626'
628'
627'
630'
624'
622'
615'
619'a
617'
617'
616'
618'
619'b

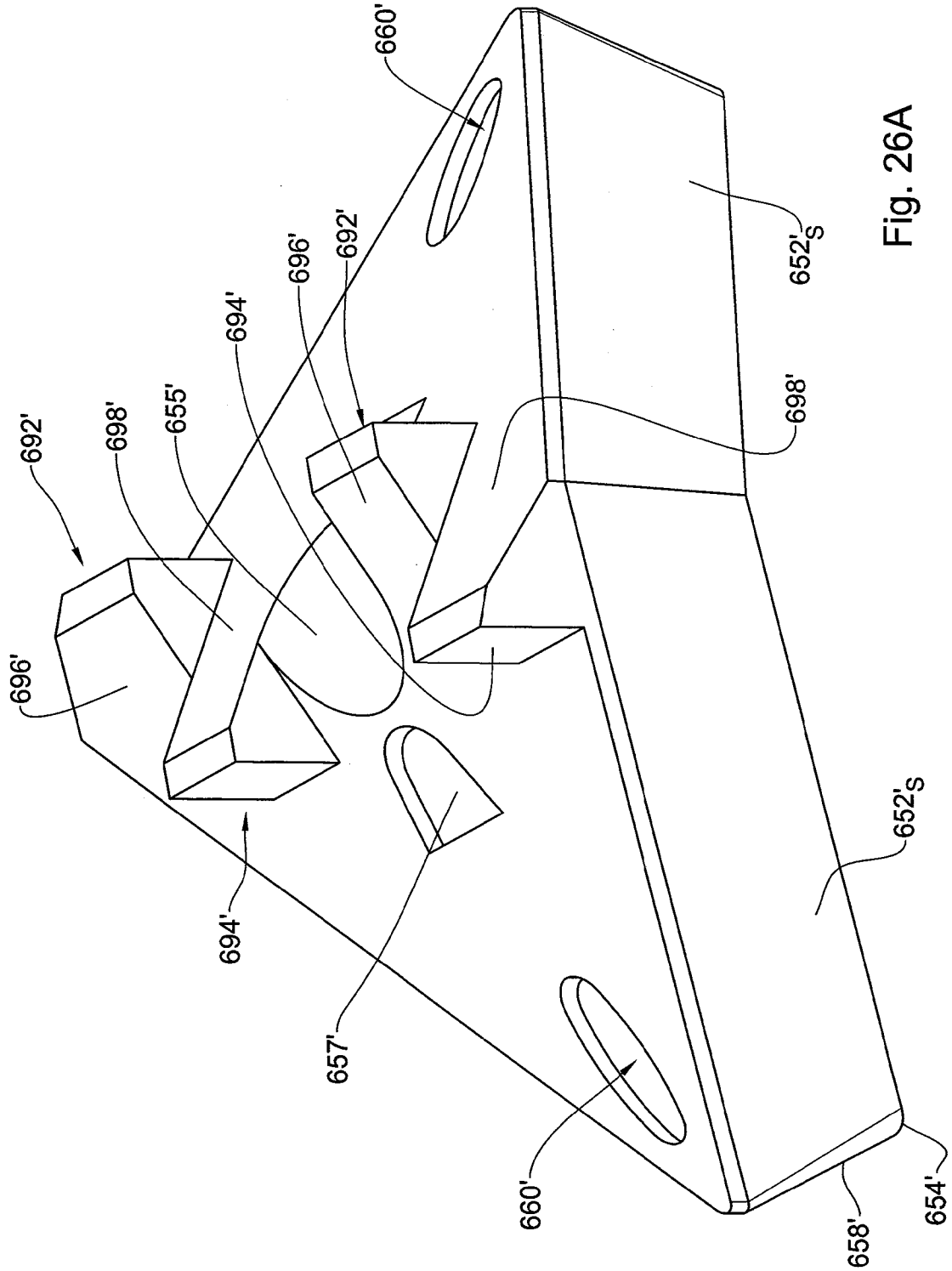

660'
652'S
692'
696'
694'
698'
655'
698'
692'
696'
694'
657'
652'S
660'
658'
654'

Fig. 26A

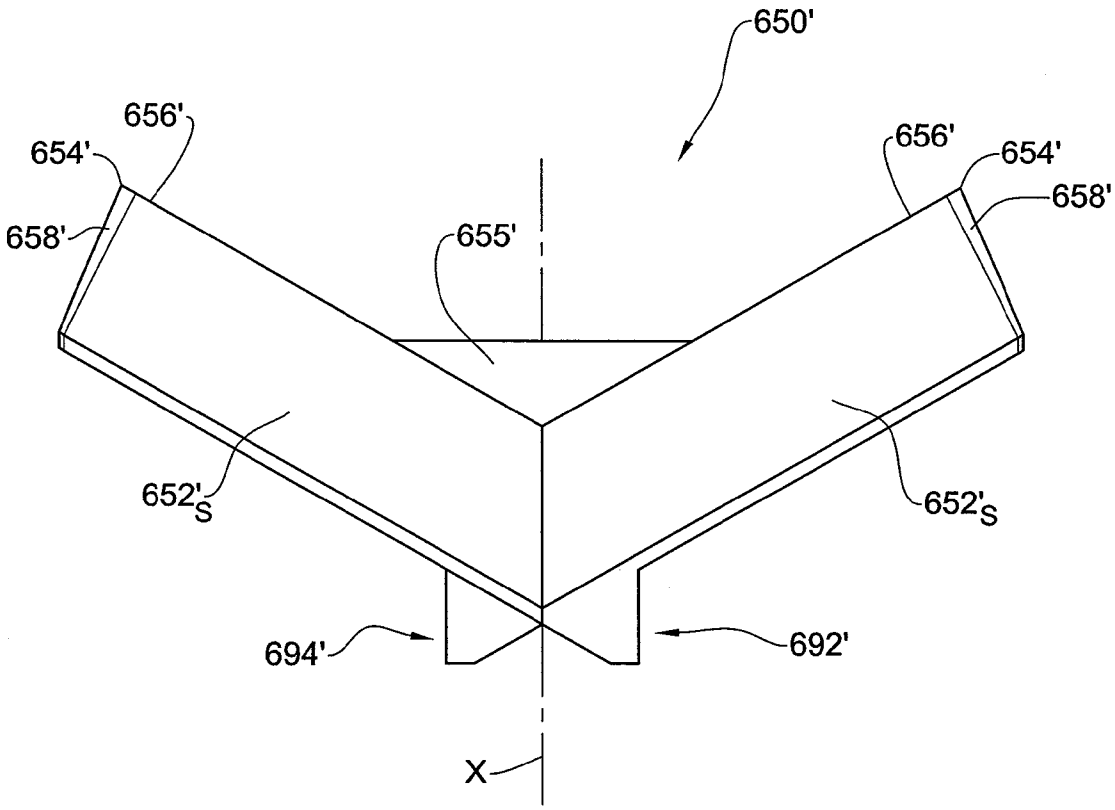


Fig. 26B

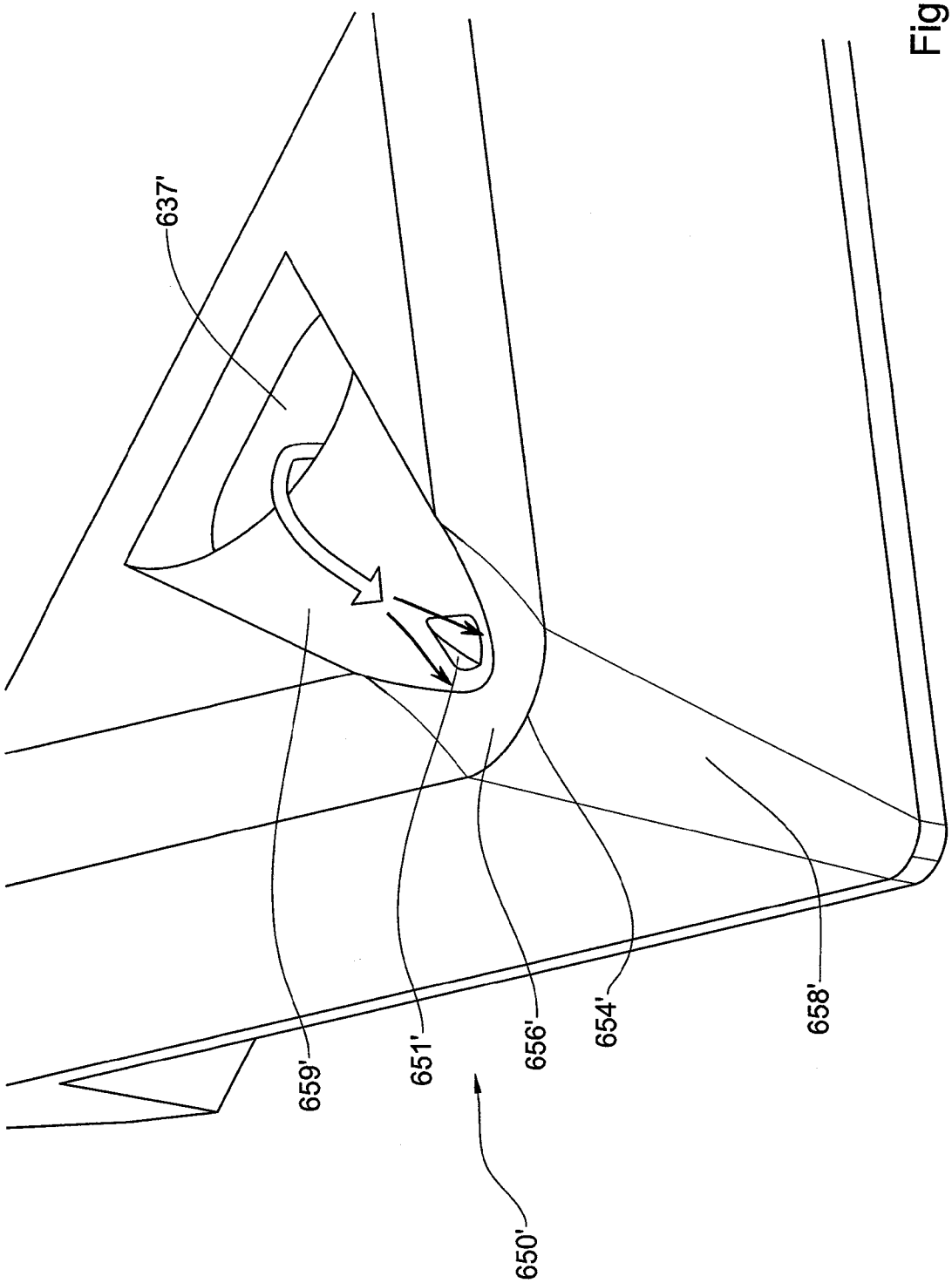


Fig. 27

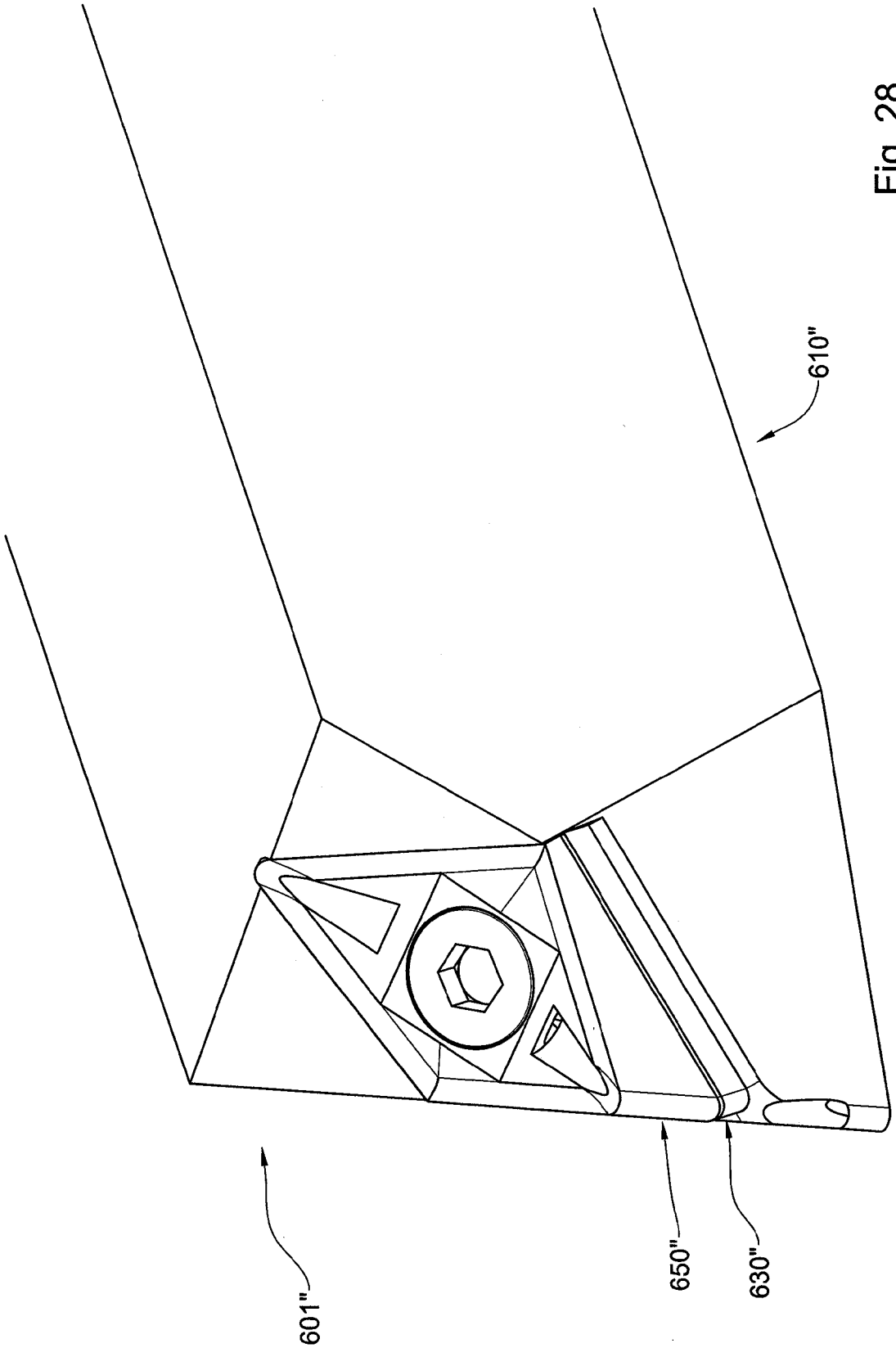


Fig. 28

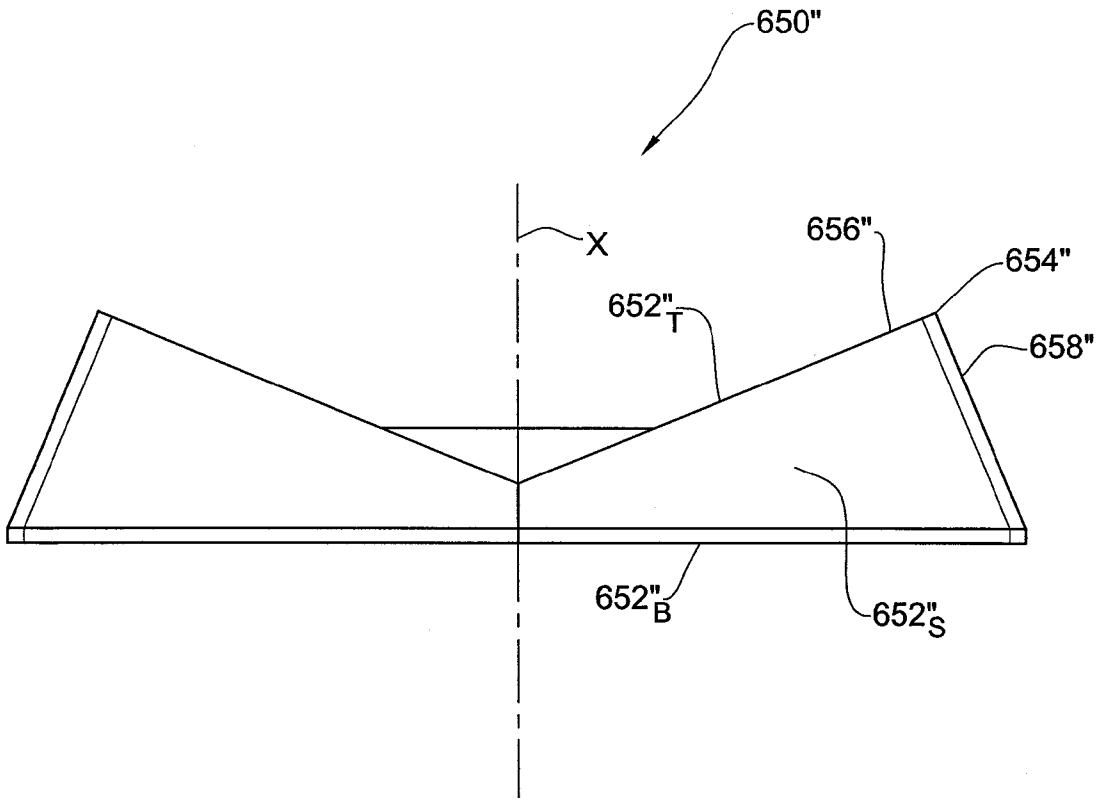


Fig. 29A

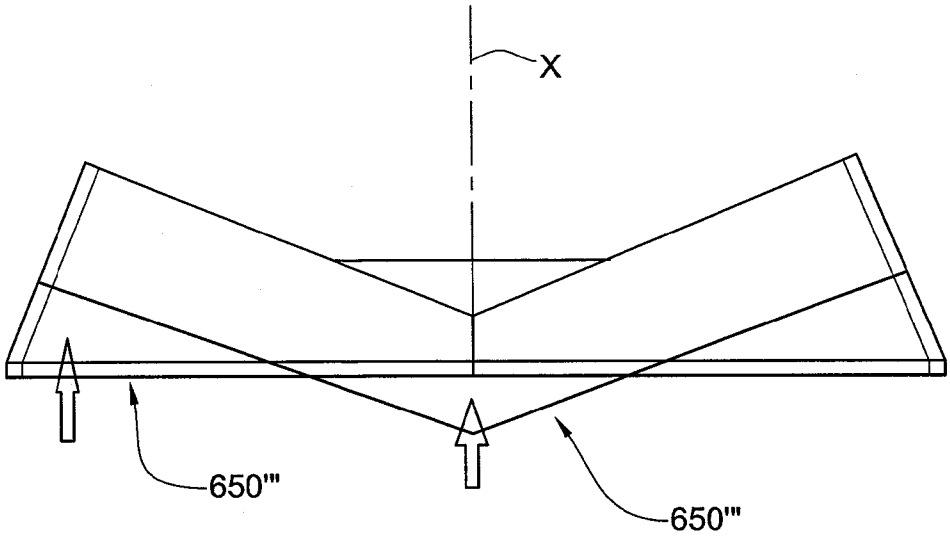


Fig. 29B

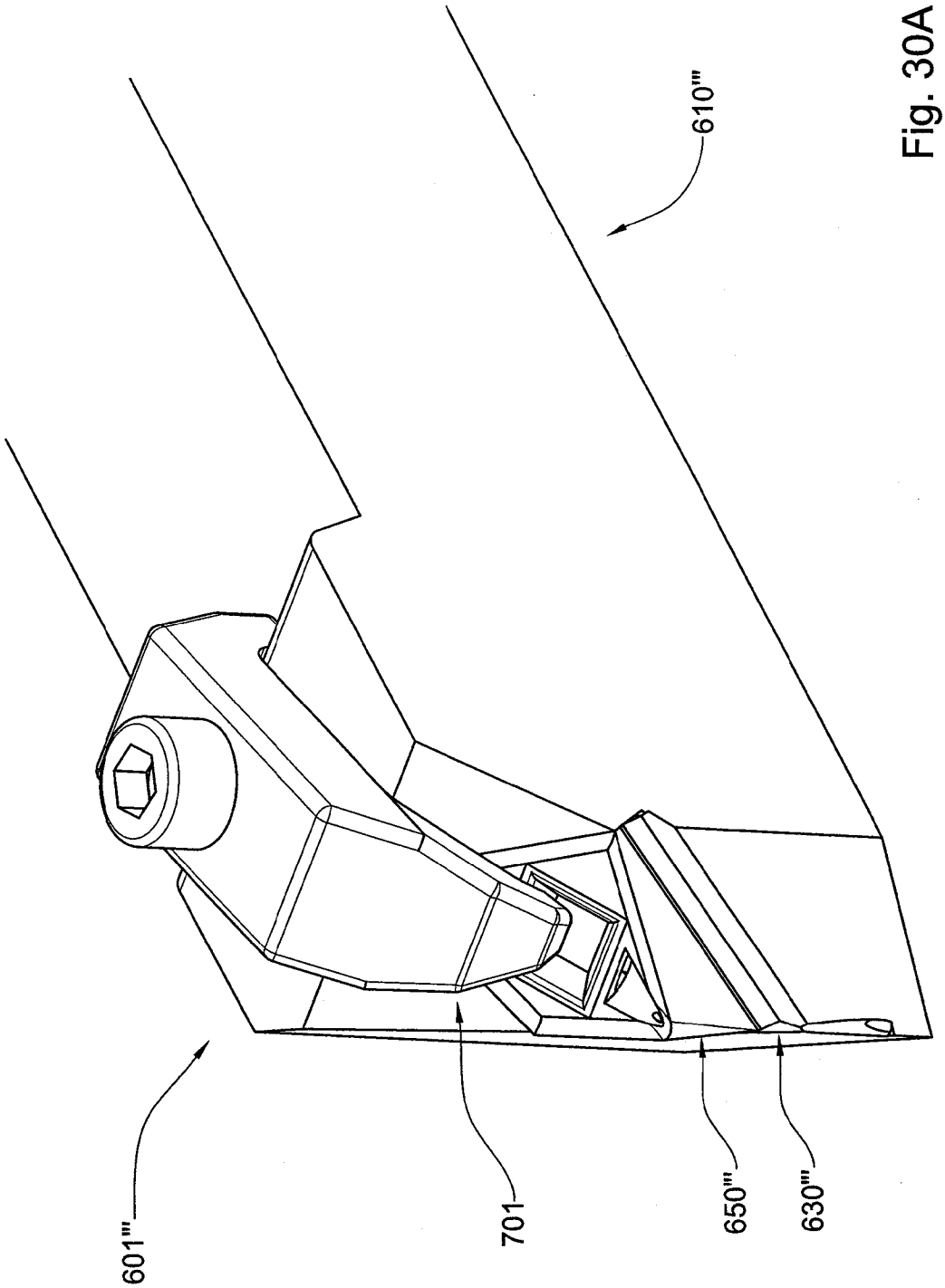


Fig. 30A

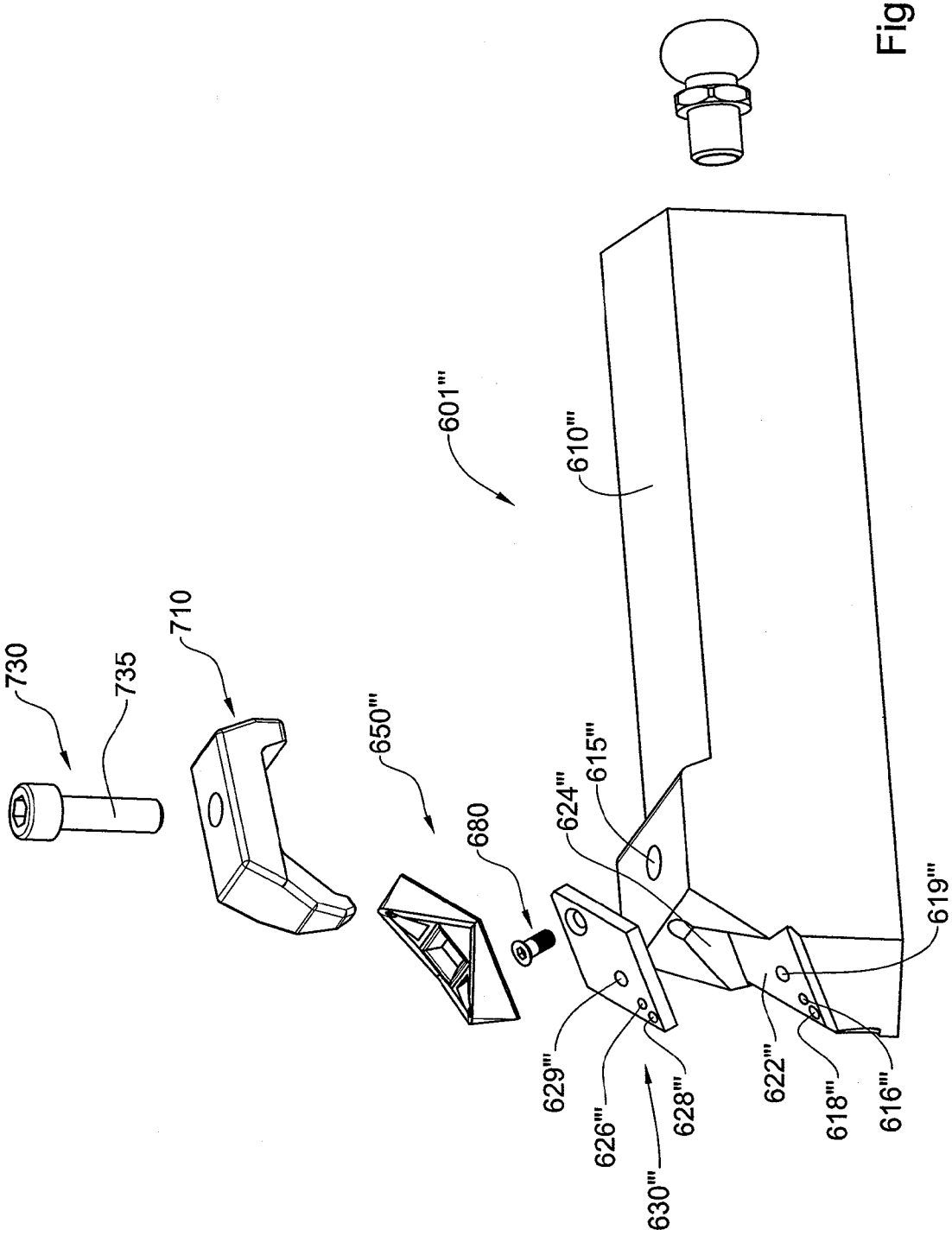
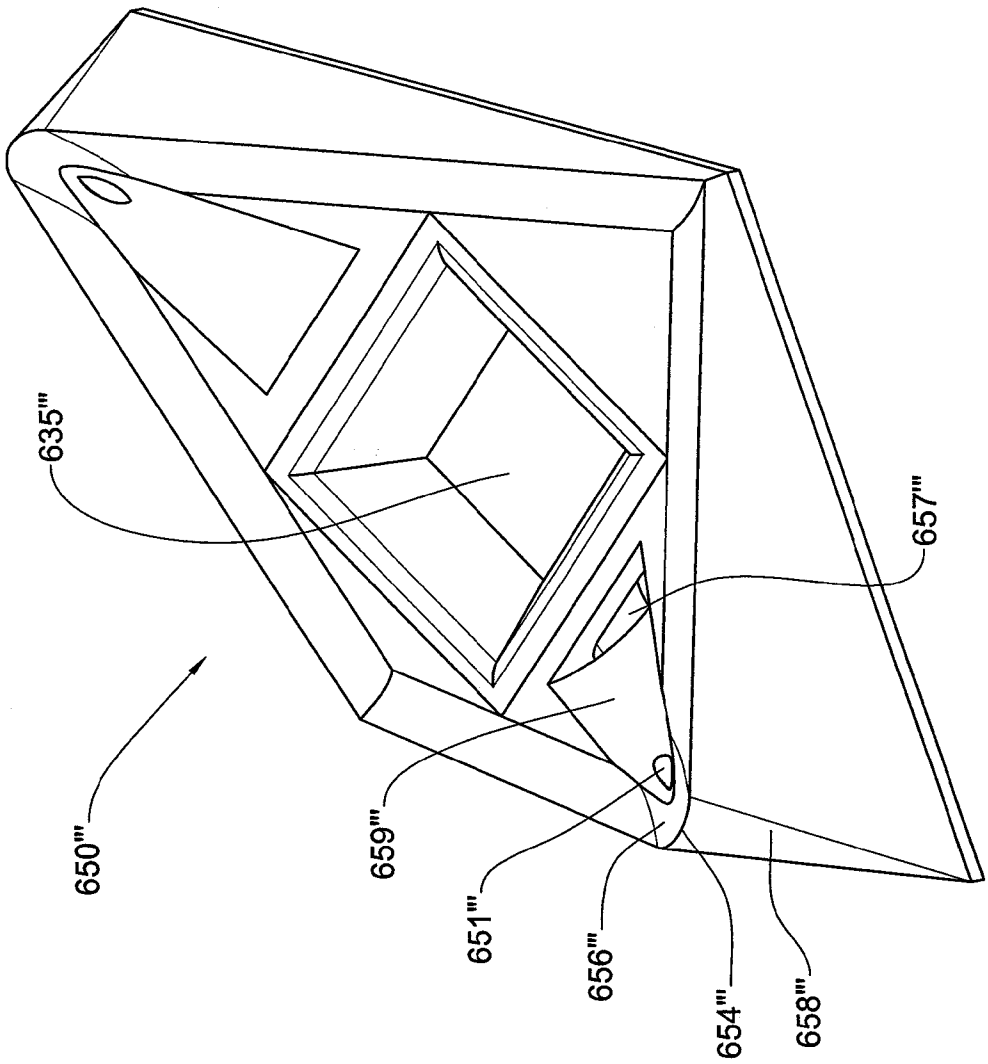

730
735
710
650'''
680
601'''
610'''
624'''
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619'''
629'''
626'''
628'''
630'''
622'''
618'''
616'''

Fig. 30B

Fig. 31A



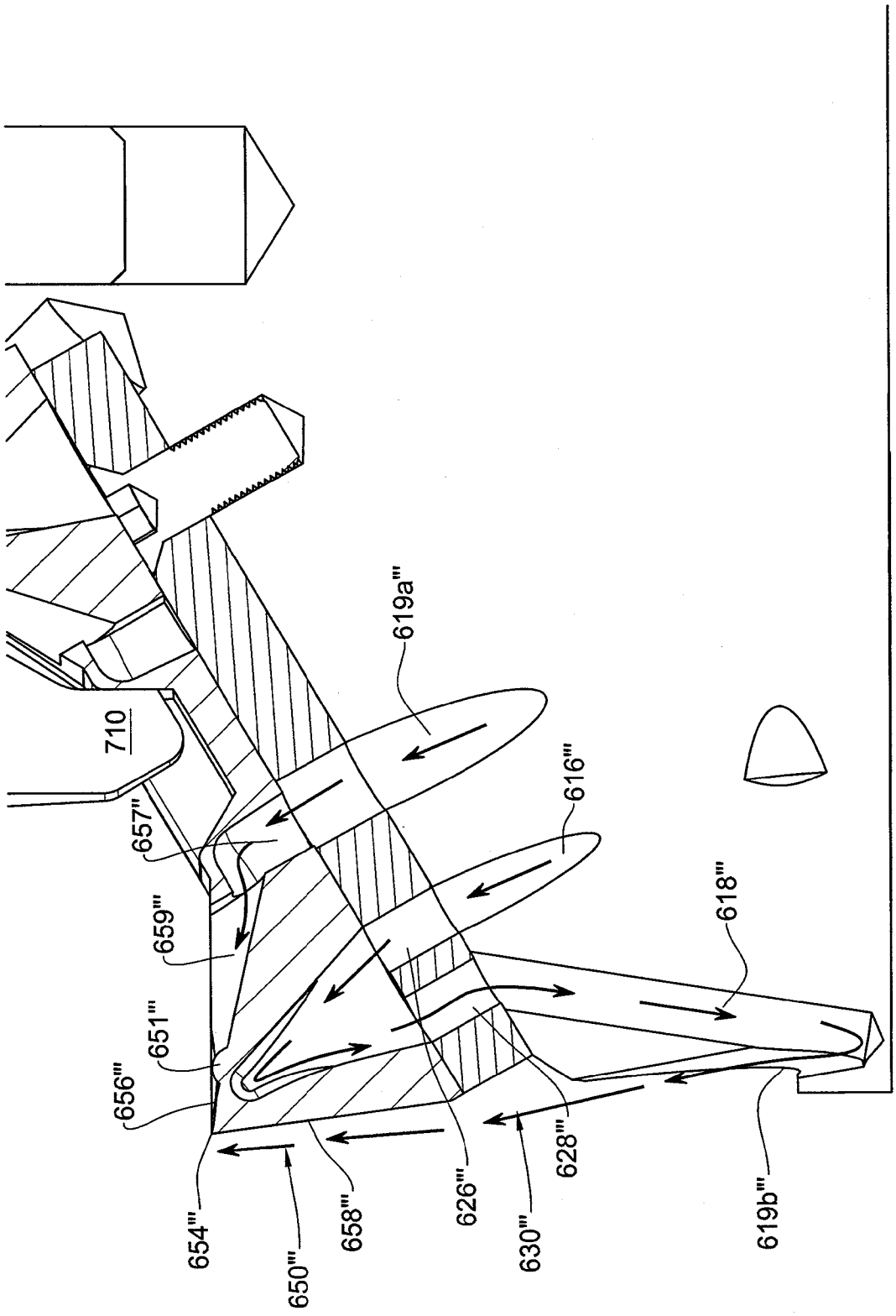


Fig. 31B

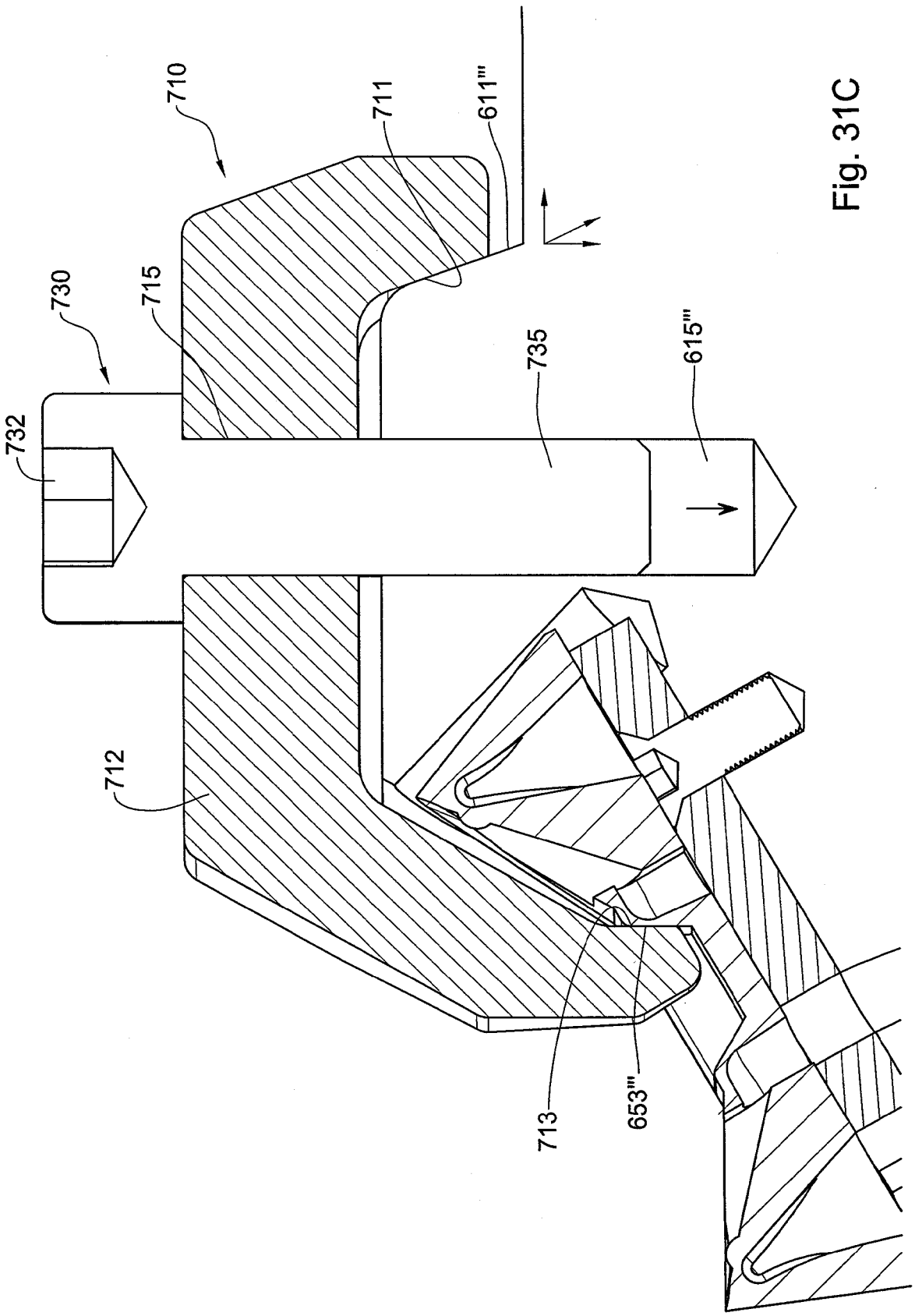


Fig. 31C

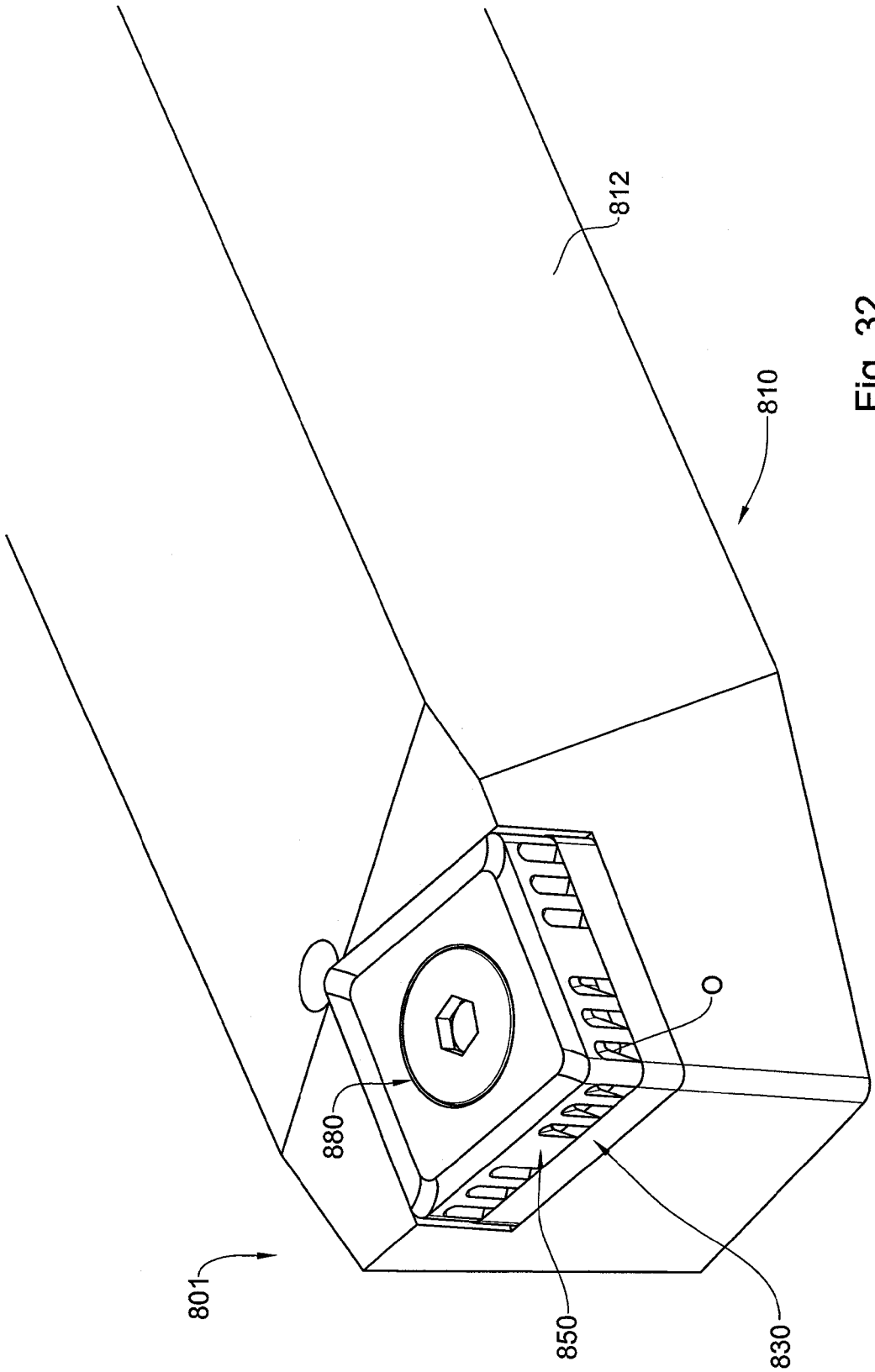
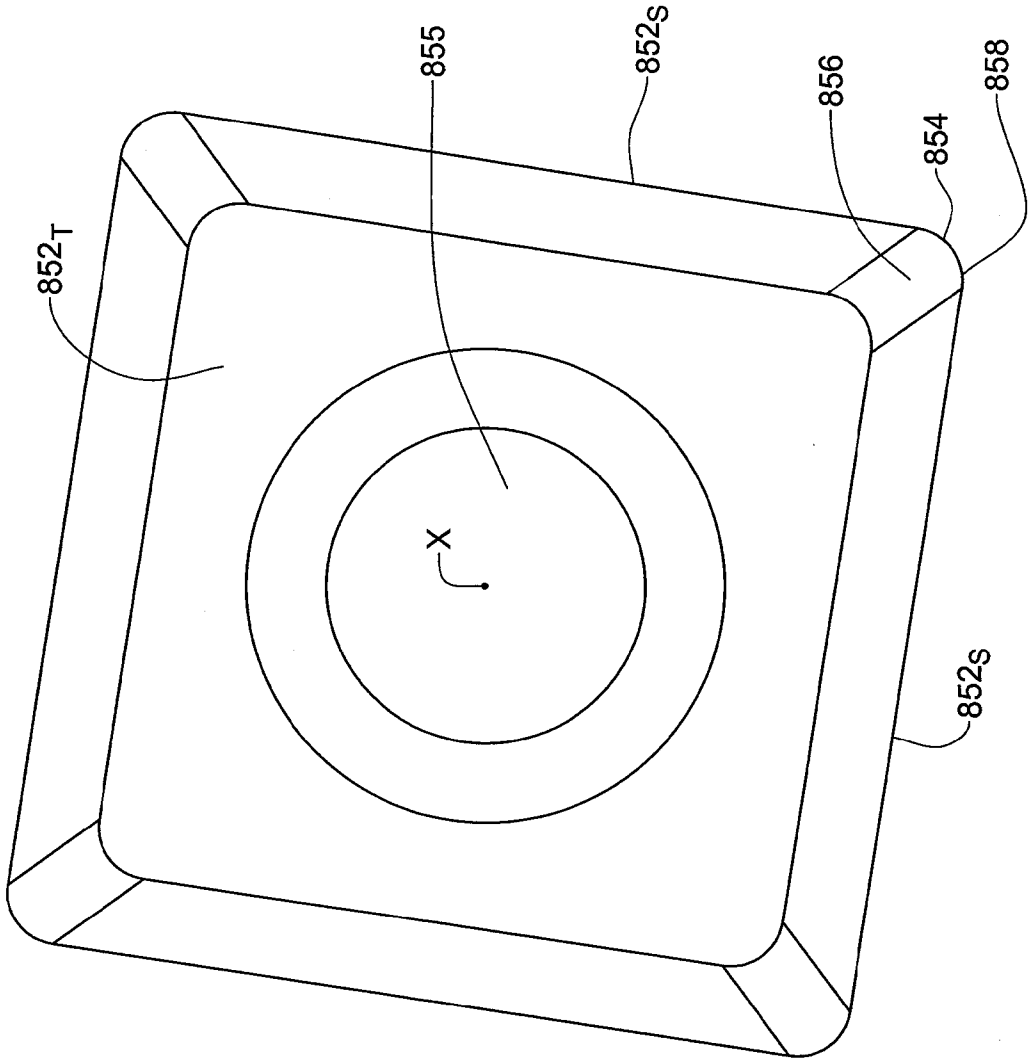


Fig. 32

Fig. 33A



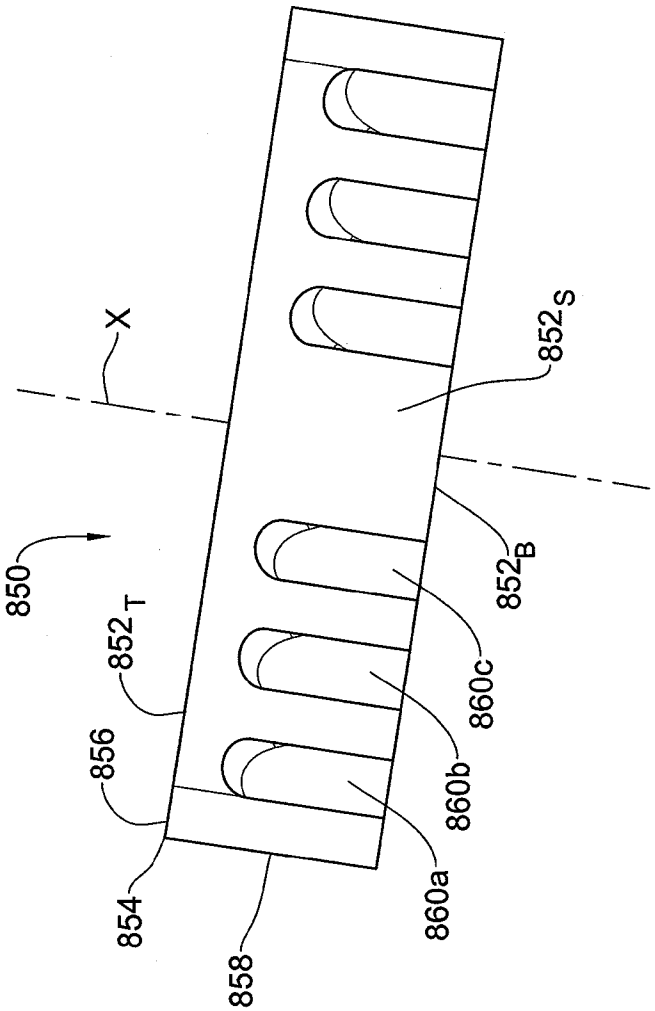


Fig. 33B

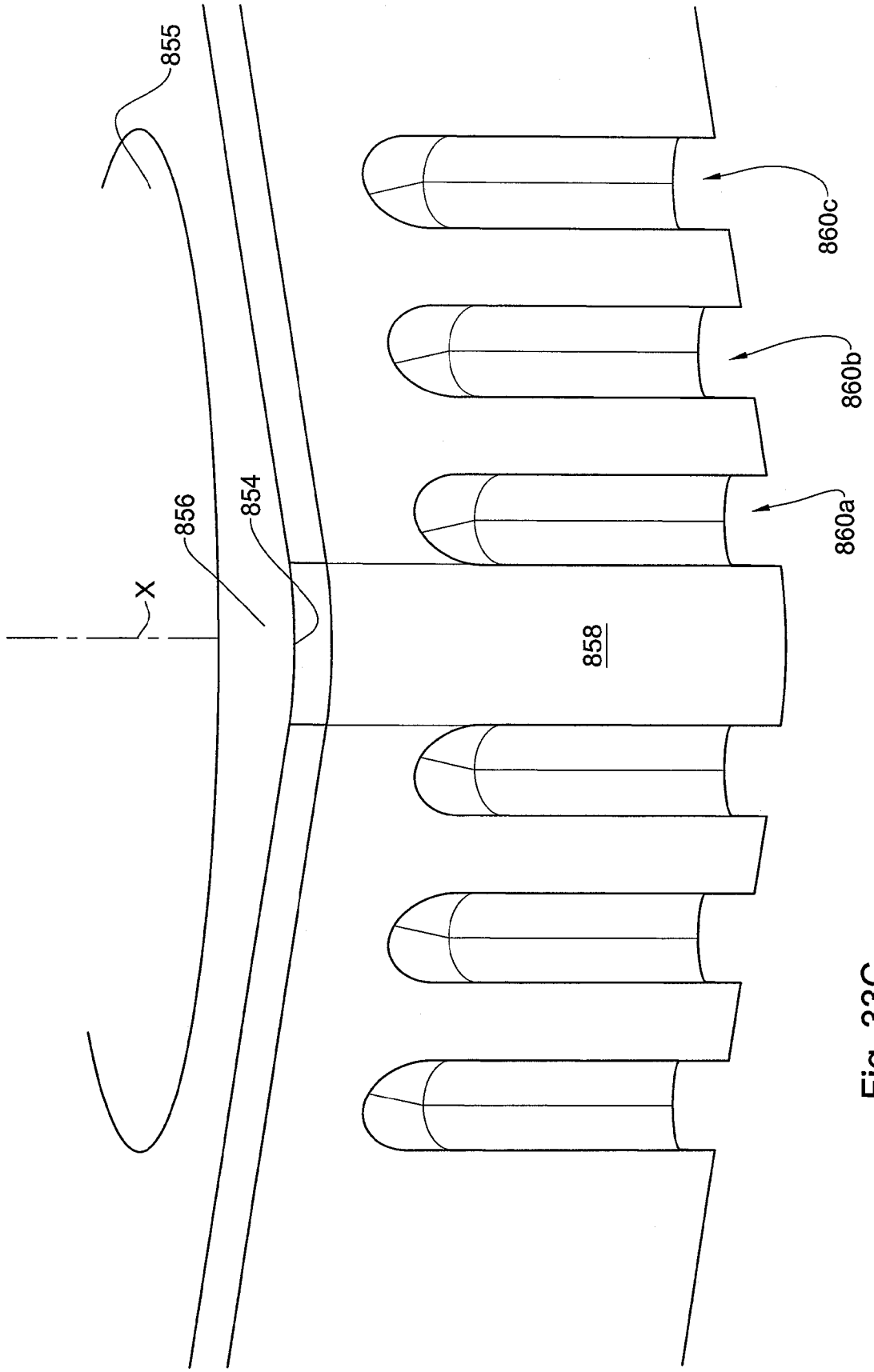


Fig. 33C

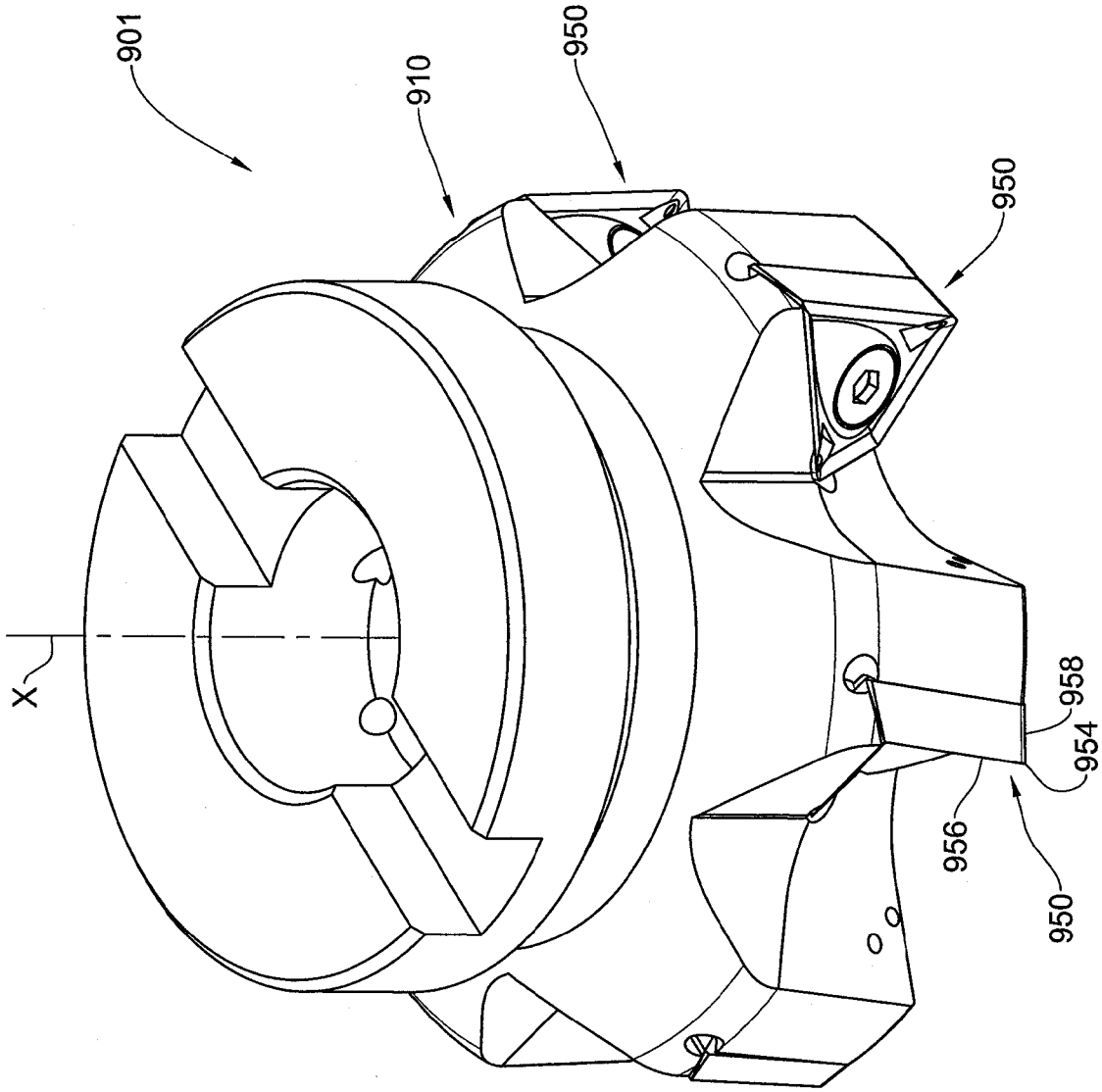


Fig. 34A

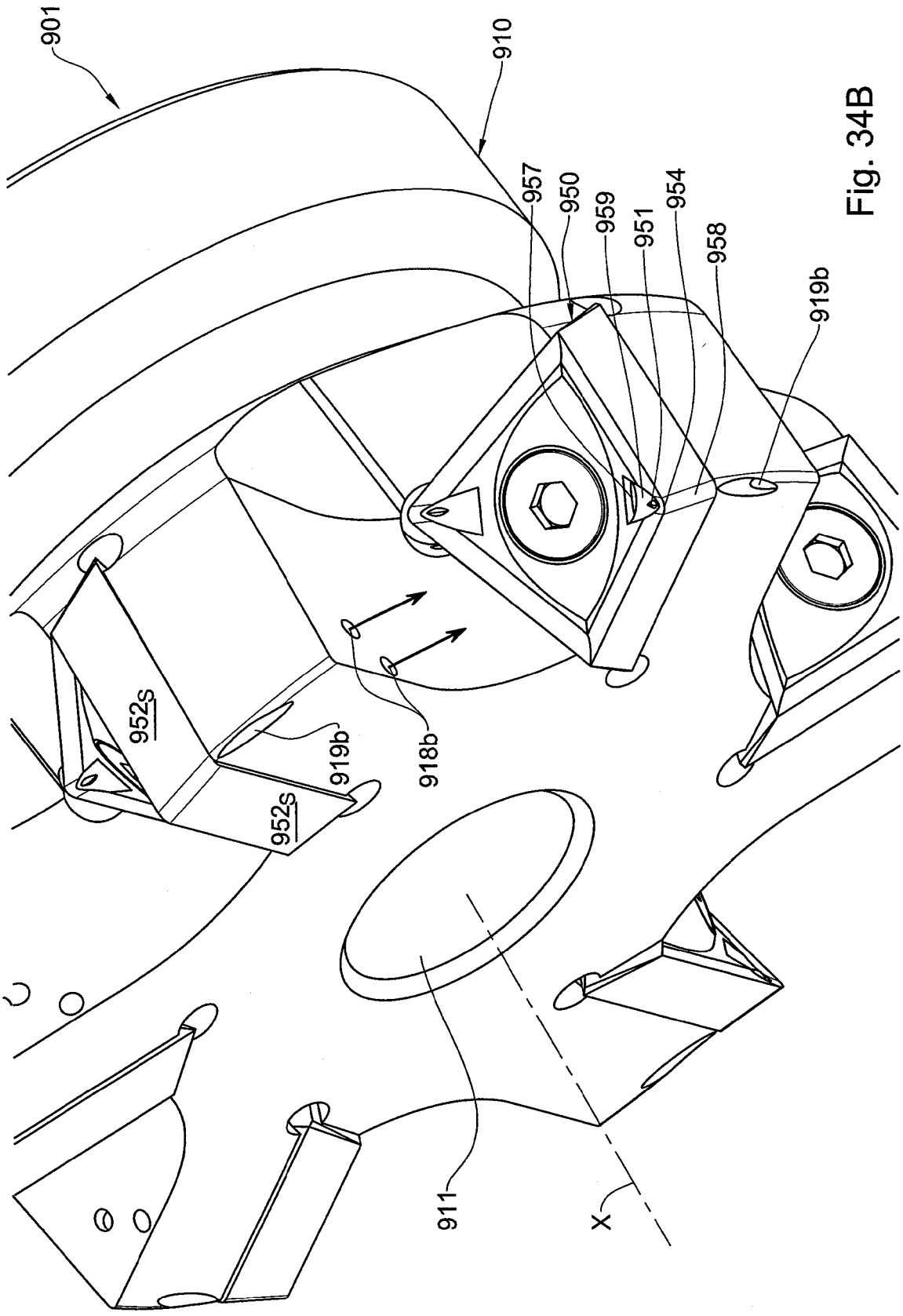


Fig. 34B

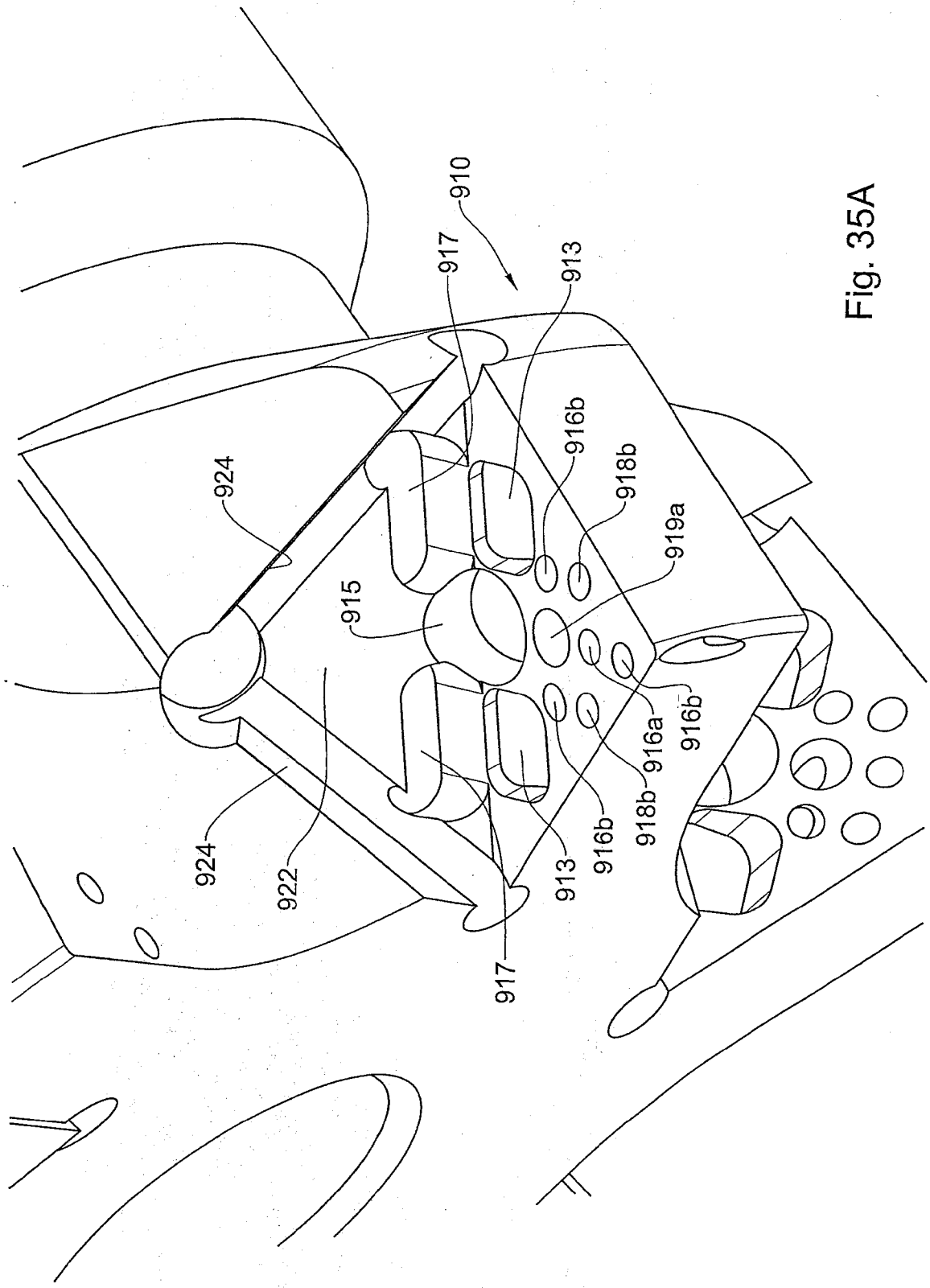

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Fig. 35A

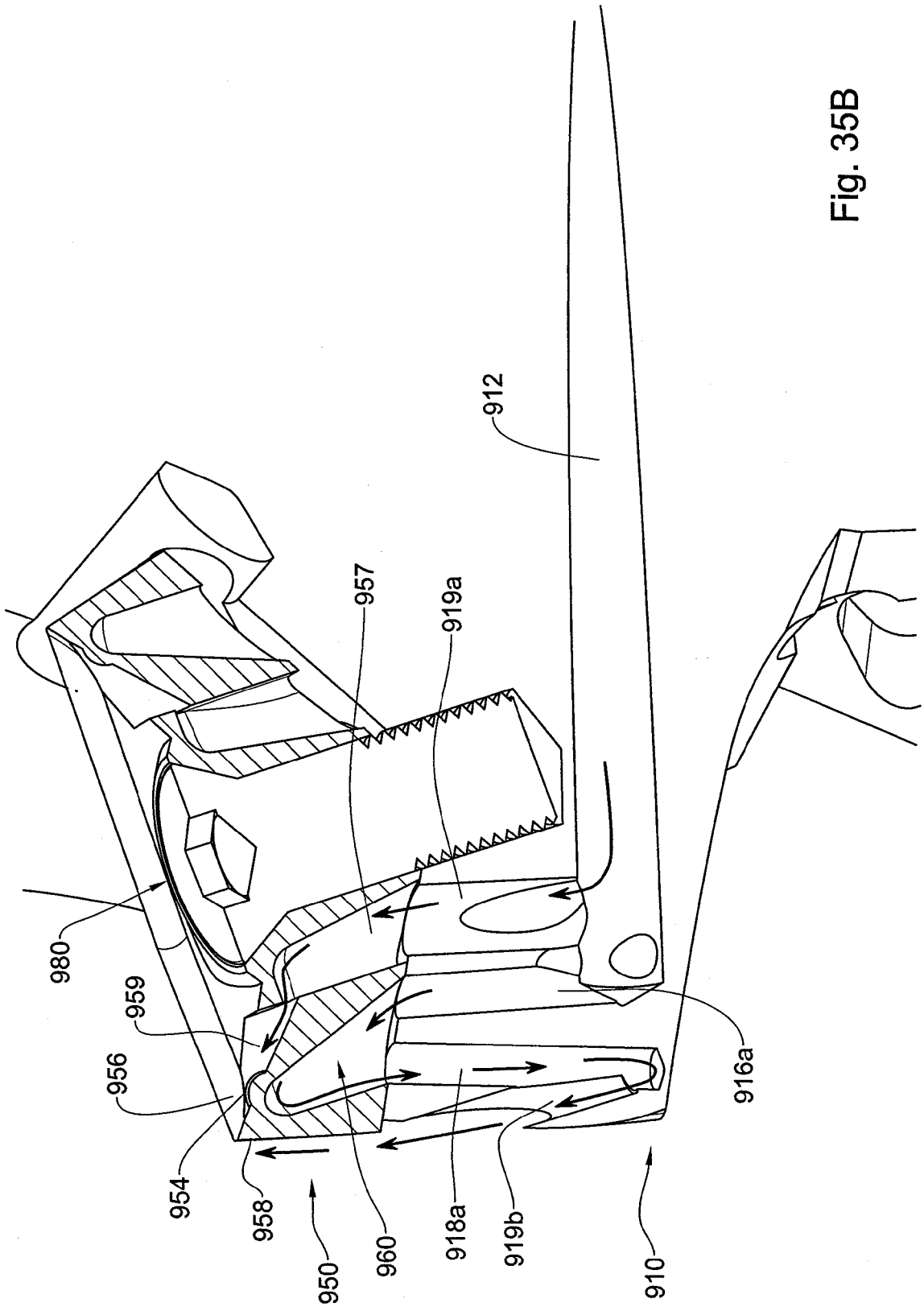


Fig. 35B

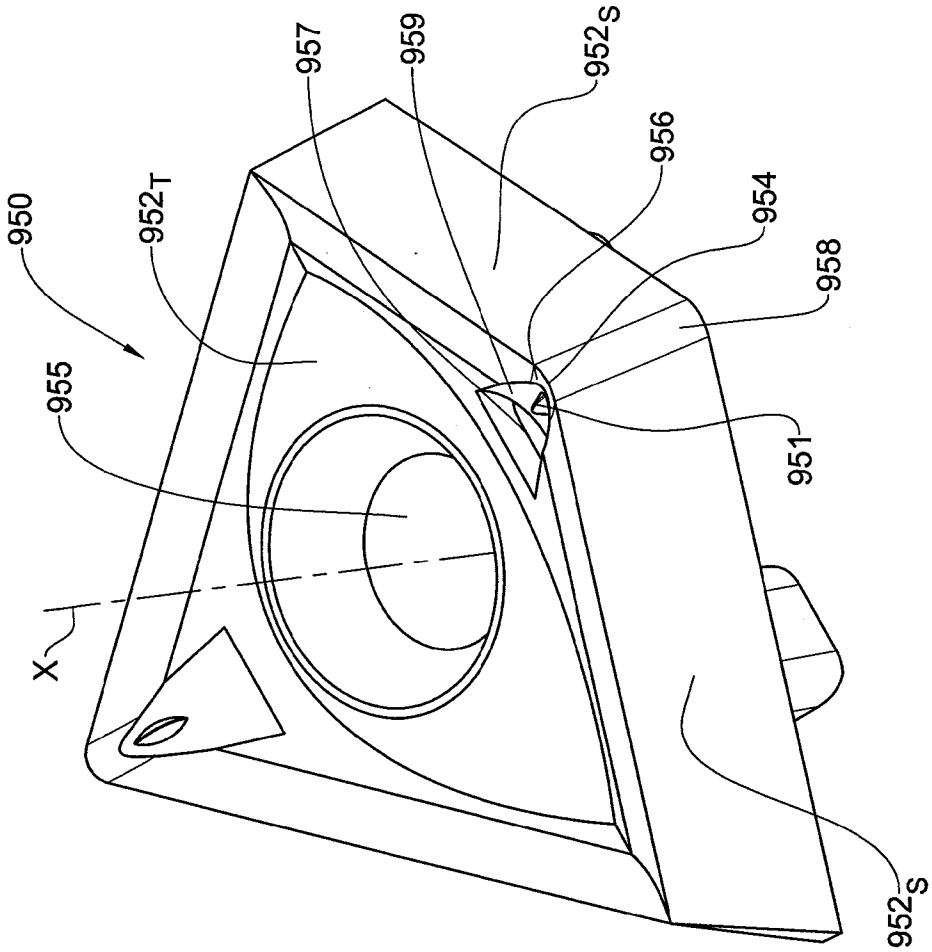


Fig. 36A

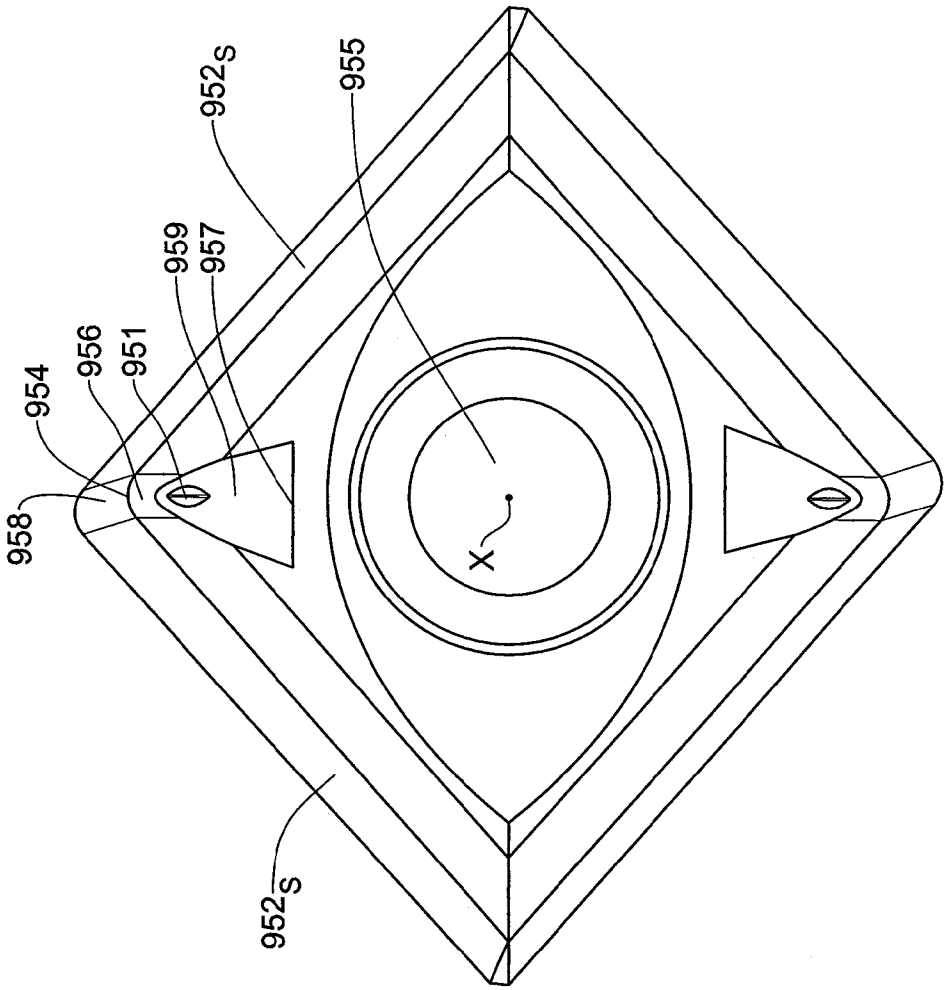


Fig. 36B

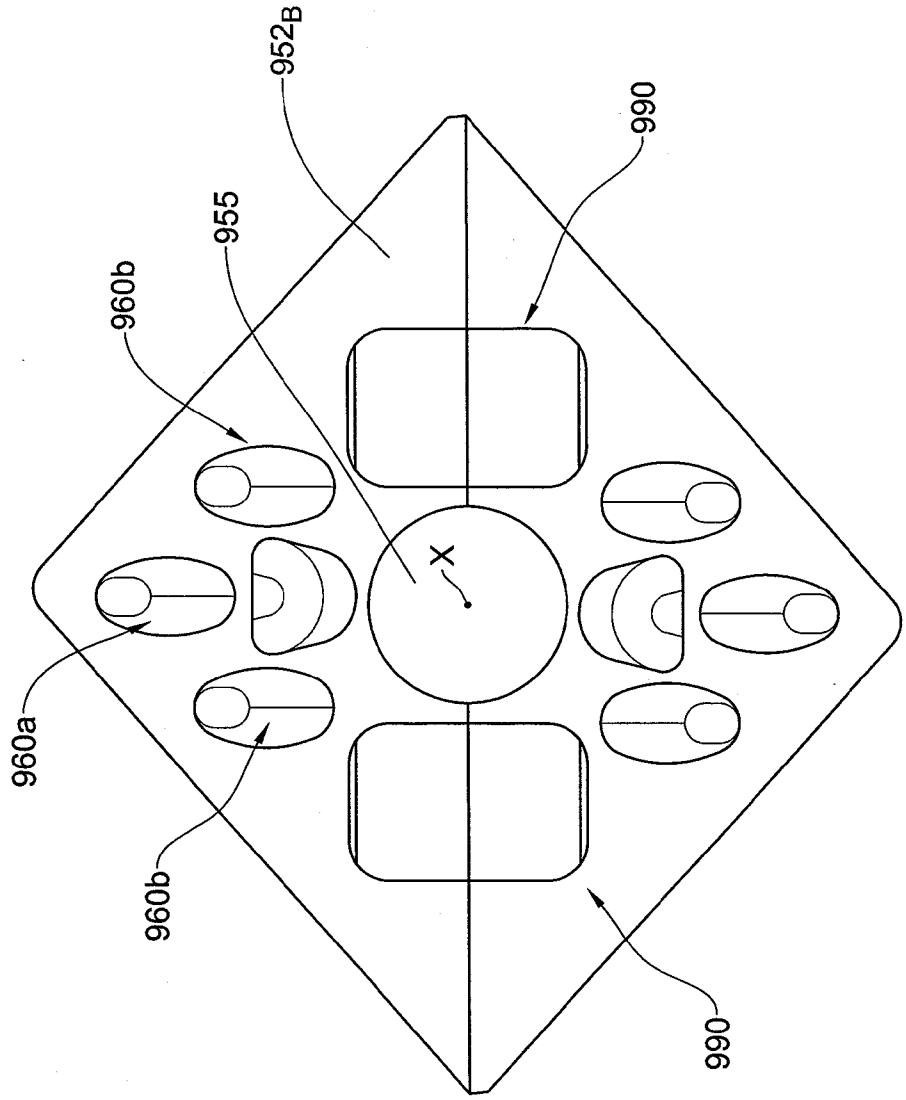


Fig. 36C

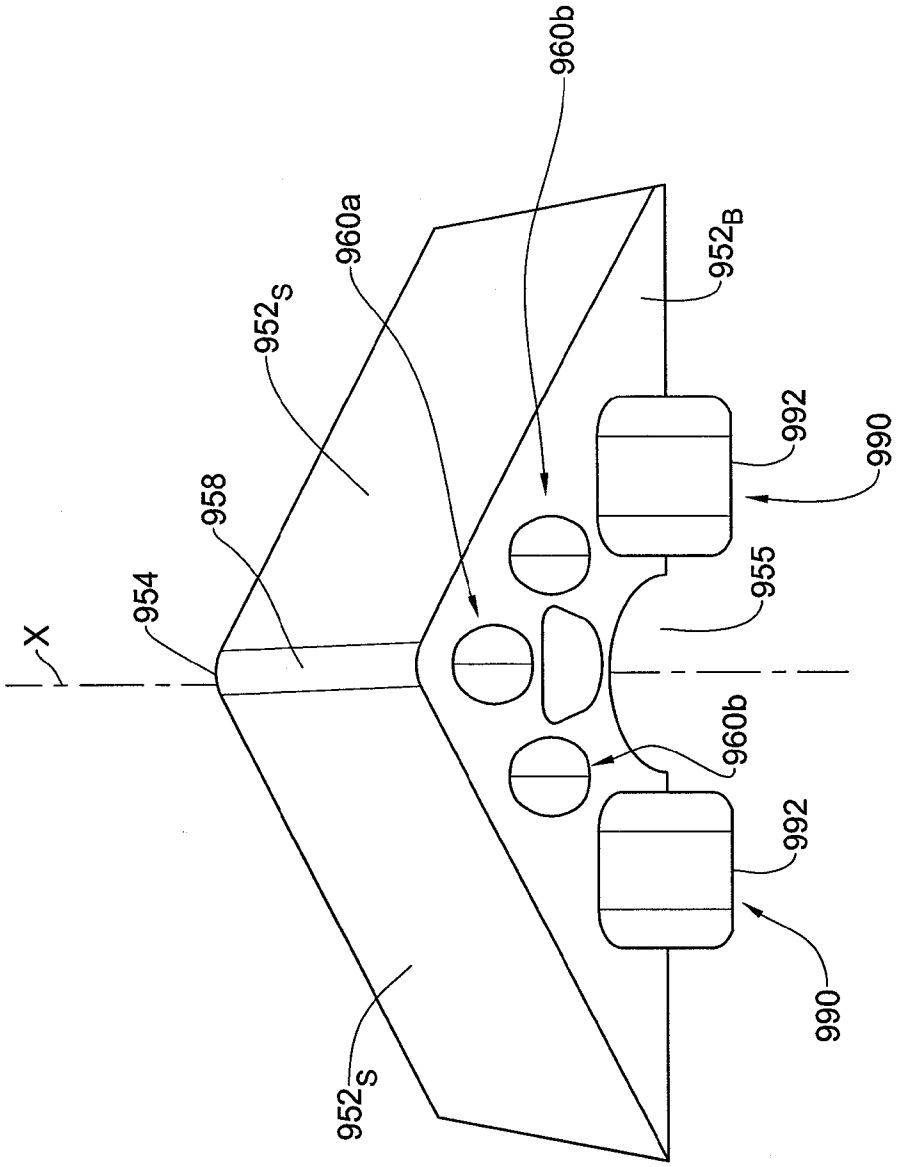


Fig. 36D

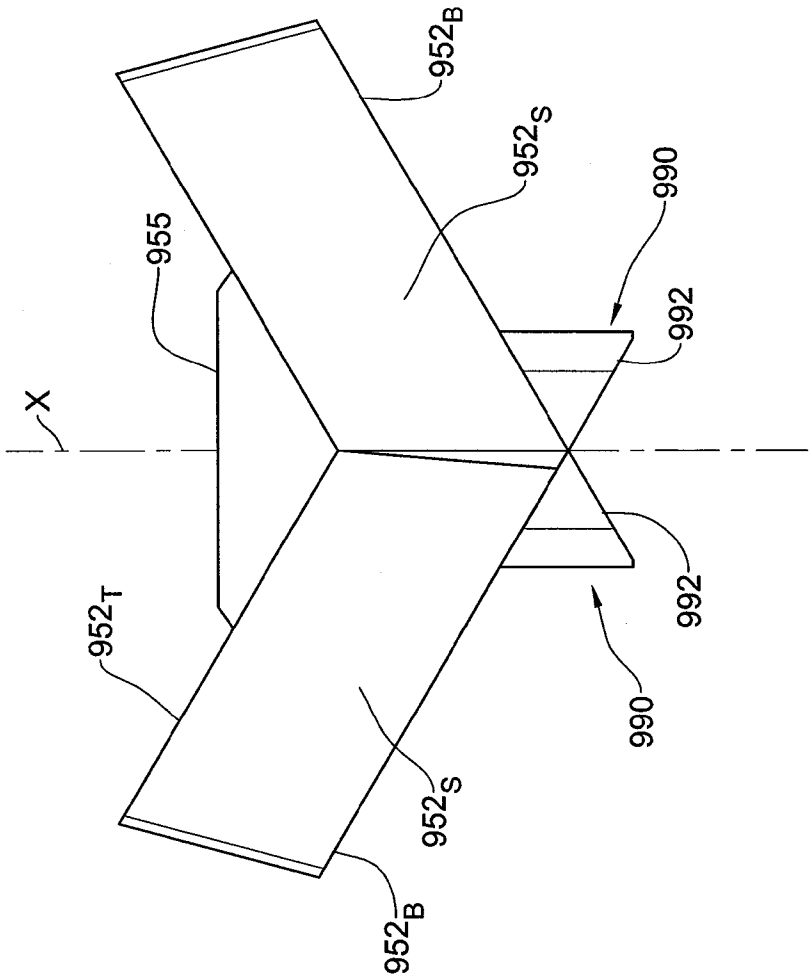


Fig. 36E

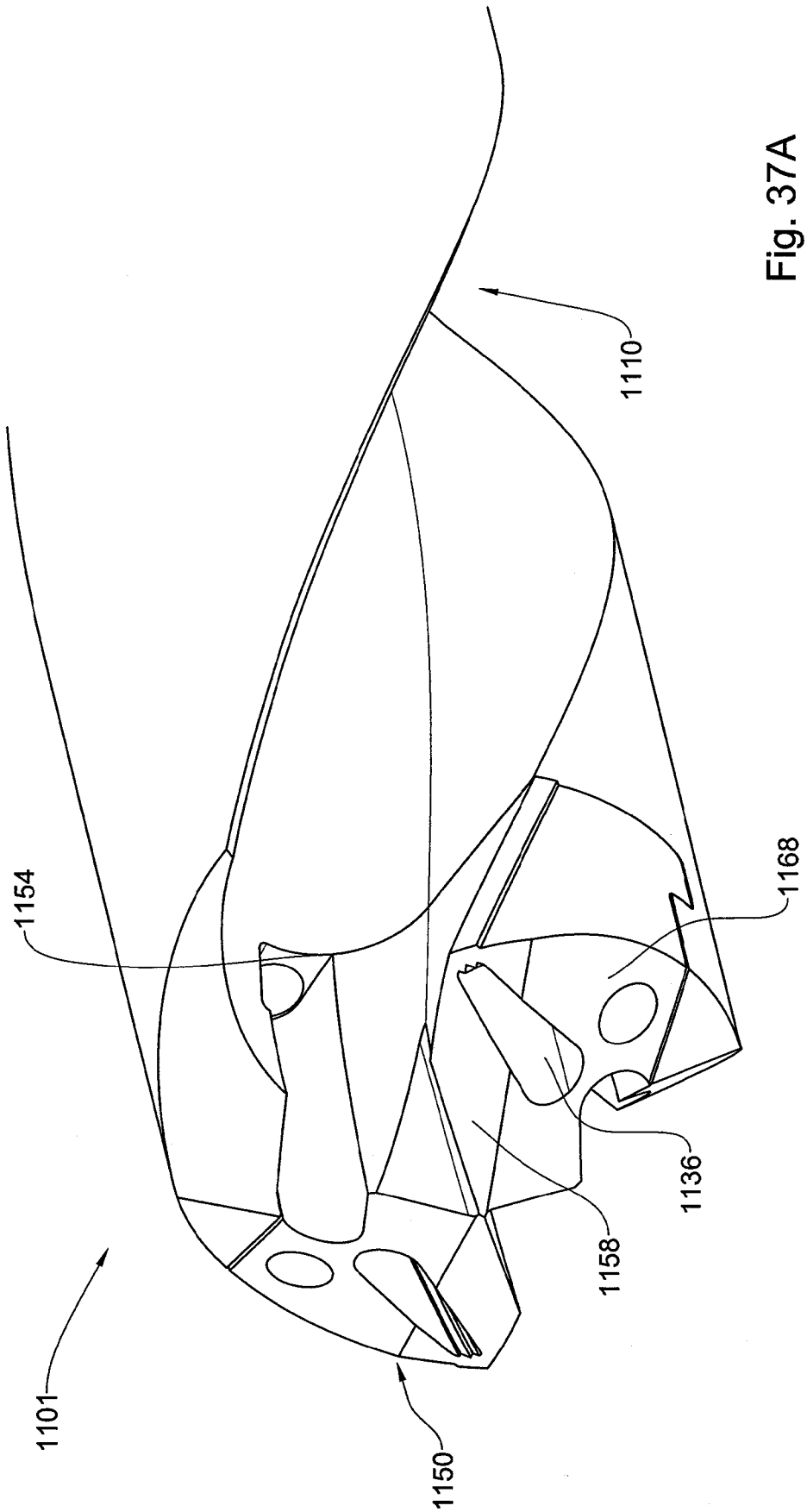


Fig. 37A

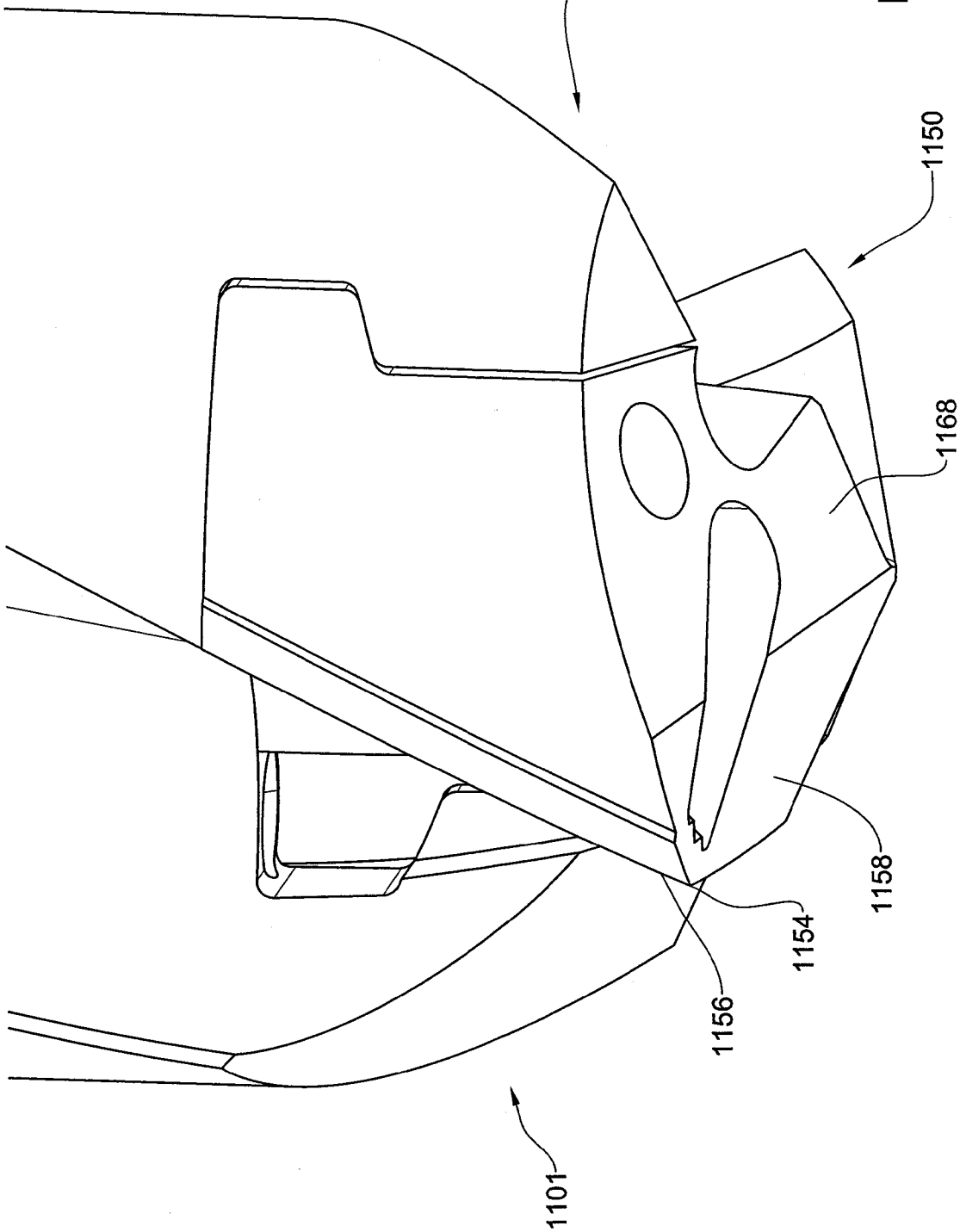


Fig. 37B

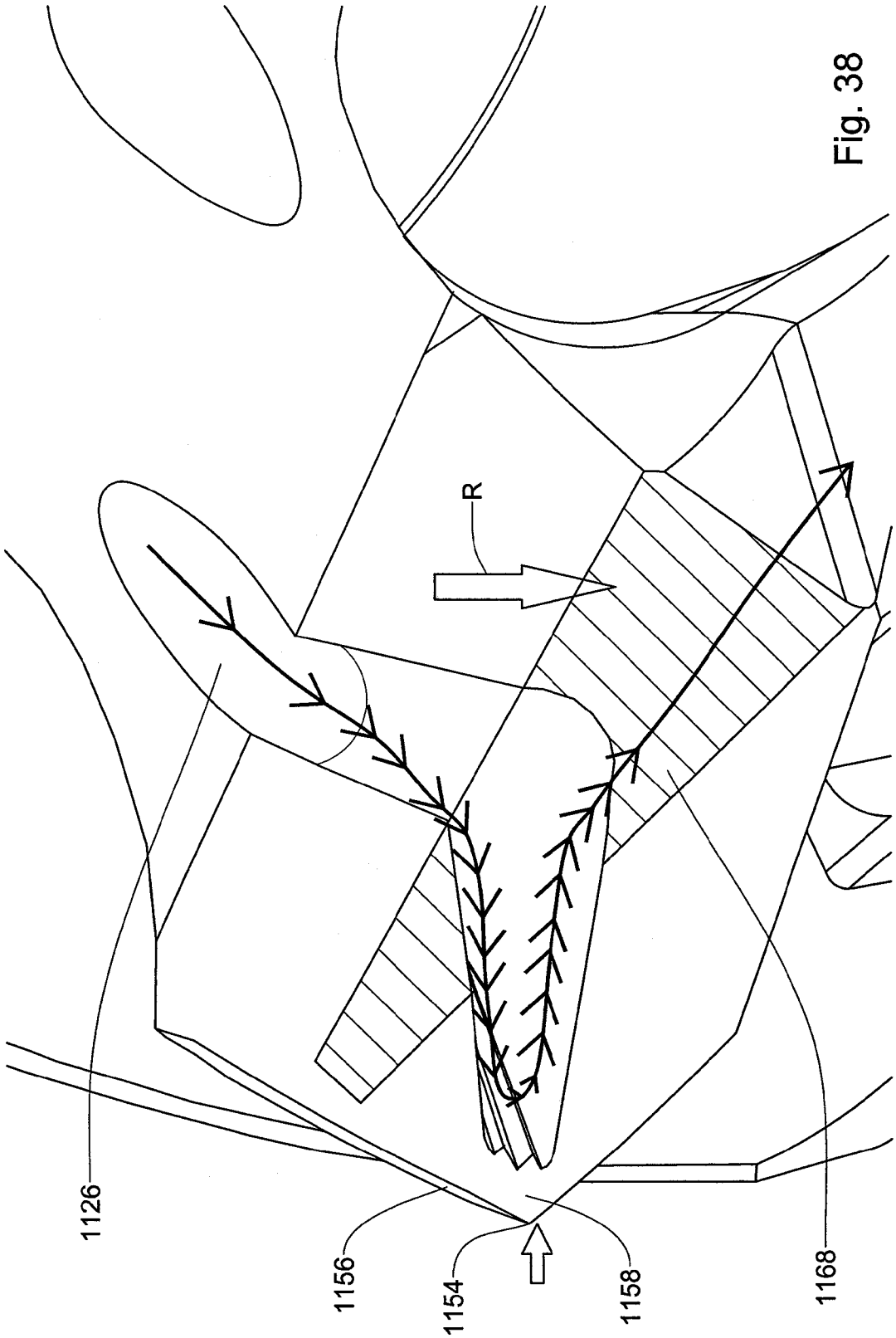


Fig. 38