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Description

The invention concerns a composite tool according to the generic term of claim 1 as well as a manufacturing method according to the generic term of claim 15. Such a composite tool and a corresponding manufacturing method are known from WO 2008/025387 A1.

Composite tools and in particular overall composite tools are usually characterized by the fact that at least two technologically different machining processes are performed in one tool and in one press stroke. In other words, several operations or functions are integrated in one tool or machining step. In the past, composite tools have been used mainly for geometrically simple components, which are generally manufactured from a sheet metal strip. In the manufacture of large, complex sheet metal components, e.g. car body components, from sheet metal blanks, e.g. in the form of individual blanks, the insert of overall composite tools is not common.

Sheet metal car body parts are usually produced in a sequence of operations involving drawing, trimming, hole punching and finish forming in several tools or tool stages. Finish forming, in particular, may represent a beveling operation. Typically, drawing the basic component shape from a flat sheet metal blank represents the first operation in the manufacturing process using line or transfer dies.

Drawing is typically a deep drawing, stretch drawing or combined operation in one tool. Subsequently, in operations separate from drawing, the other steps such as punching, cutting and final forming take place.

The most common cutting processes on car body sheet metal parts are e.g. shear cutting processes:

- Hole punching: To produce a closed inner contour on the workpiece.
- Trimming: This involves cutting off the outer drawing edge to create the outer contour of the component, or a preliminary outer contour that will be further machined in a subsequent operation.
- Other cutting processes of no relevance to the present invention include, e.g., cutting in or notching out.

Post-forming or finish-forming are further understood to mean forming operations mostly in the final tooling stage. One process of post-forming or finish-forming is beveling.

In this process, the edge of the drawn and trimmed sheet metal part is "bent over" by about 90°. Beveled rims on sheet metal parts serve e.g. as joining flanges or as a preform for a flanging or roll hemming operation in the body shop, where the individual part is joined with others to form an assembly. In most cases, beveling takes place in the last operation.

Figure 16A shows schematically an operation sequence known from the prior art drawing-trimming-beveling on a car body component K. First, the car body component K is drawn from a sheet metal blank K' (1.) before it is trimmed in a separate tool (2.) and an edge portion Ka is beveled off (3.). For various reasons, it may be advantageous to "tighten" the edge portion Ka, i.e. to preform the shape of the beveled rim in drawing to a certain depth. This is illustrated in more detail with reference to Figure 16B. Figures 16A and 16B each show the simple case in which all operations can be performed in the working direction of a press. In this case, a tool element (beveling bar) brushes past the edge portion to be beveled and bends it downward.

Other variants of post-forming or finish-forming are e.g. post-hitting or calibrating. This involves acting on an already formed component in certain areas in order to locally influence its geometry. For example, embossments are introduced or radii are reduced.

Also known is the combination of trimming and beveling in a progressive tool on a component drawn in a first tool, wherein the cutting blade (with a cutting bar) simultaneously serves as a beveling bar. This is shown schematically in Figures 17A to 17C.

Based on the prior art discussed above, the invention is based on the task of achieving a reduction in the total number of tools required to manufacture a sheet metal component and, via this, a reduction in the cost of operating resources and in development and procurement times, and of shortening process chains.

This task is solved with a composite tool of claim 1 as well as with a manufacturing method of claim 15.

According to a first aspect of the invention, a composite tool for manufacturing a flat sheet metal component with a first structure having a drawing die (hereinafter also abbreviated to "die") and a second structure having a drawing punch (hereinafter also abbreviated to "punch") is proposed. At least the first structure or the second structure is at least partially translationally adjustable in order to press the die and the punch against each other and thereby to form the sheet metal component from a sheet metal blank located between the die and the punch and adapted as a single sheet metal blank by

drawing, i.e., by a drawing process and manufacturing a drawn part. For this purpose, in addition to the punch, at least one blank holder which is translationally adjustable relative to the punch is provided on the second structure. Furthermore, according to the invention it is provided that

5 - the die of the first structure is designed in at least two parts, with an inner die and an outer die, wherein the inner die and the outer die on the first structure are adjustable relative to one another, and

 - the outer die and the blank holder, which is translationally adjustable relative to the punch, lie opposite one another and are arranged, during pressing of the two-part
10 die and the punch against one another, to hold between them a scrap piece of the sheet metal blank, which is cut off at an outer edge of the drawn sheet metal blank - or of the drawn part produced from the sheet metal blank - during pressing of the die and the punch against one another.

15 In this way, when the at least two-part die and the punch are pressed against each other, edge-side trimming (in at least one subsequent second adjustment phase) takes place in addition to the drawing of the sheet metal blank (in a first adjustment phase of the first and second structures). In this case, the translationally adjustable blank holder, in interaction with the at least two-part die, ensures the defined position and alignment
20 of the scrap piece to be cut off and, due to its adjustability relative to the punch, guarantees the integration of a trimming operation into the press stroke. In the following, "pressing the two-part die and the punch against each other" is understood to mean, in particular, that the two-part die and the punch are displaced towards each other under the action of an adjusting force applied by a press (equipped with the composite tool) and
25 that an actual pressing of at least a part of the at least two-part die against the punch does not take place until a temporal end of the drawing operation. "When pressing the two-part die and the punch against each other" and thus accompanying the displacement for the actual, subsequent pressing of the (drawing) die and the (drawing) punch, e.g. initially only the outer die is "pressed" against the blank holder - in the actual sense. In
30 particular, it is included that during the entire drawing process the outer die is pressed against the blank holder and that the inner die is pressed against the punch only at the end of the drawing process.

That the inner die and the outer dies on the first structure are adjustable relative to each other includes both that the inner die is adjustable relative to the outer die, and that the outer die is adjustable relative to the inner die. Due to the adjustability of the inner and outer dies relative to each other on the first structure, as well as due to the interaction with the adjustable blank holder of the second structure, a cut off of the scrap piece can be realized particularly easily via the press stroke. In principle, the outer die of the first structure can at least partially enclose the inner die.

In one embodiment, the outer die has a first form-fit region and the blank holder has a second form-fit region. The scrap piece of the sheet metal blank is (locally) deformed via the first and second form-fit regions of the outer die and the blank holder during pressing, so that at least one region of the scrap piece form-fittingly engages at least one of the first and second form-fit regions and/or at least one of the first and second form-fit regions form-fittingly engages the scrap piece. The first and second form-fit regions can thus serve to secure the scrap piece between the blank holder and the outer die during pressing, although this is not mandatory. The first and second form-fit regions may be adapted, for example, as protrusions and/or recesses. For example, a bulge is provided on the outer die for manufacturing a bead corresponding thereto on the scrap piece of the sheet metal blank.

The composite tool is thus arranged to use a pressing force applied to form the sheet metal blank simultaneously to cut off an outer edge of the sheet metal blank as a scrap piece and thus to trim the sheet metal blank. If necessary the edge of the sheet metal component is also finish-formed, or at least formed. In one press stroke, trimming and e.g. edge-side bending or beveling thus take place in addition to forming. Consequently, the first structure and the second structure can be arranged not only to cut off an outer edge of the sheet metal blank as a scrap piece when the die and the punch are pressed against each other. Rather, the first structure and the second structure may also be arranged to reform an edge portion of the sheet metal component at which a separating edge resulting from cutting off the scrap piece is present, before or after cutting off the scrap piece. In this connection, it can be provided in particular that with the pressing of the die and the punch against each other, the edge portion of the sheet metal component at which the separating edge is present is bent before the scrap piece is cut off or is beveled off after the scrap piece is cut off. In this case, a press on which the composite tool is set up with the first and second structures then represents the sole drive

for all tool functions, i.e., no further hydraulic or other actuators are used to implement trimming and finish forming.

In a composite tool according to the invention, at least one subsequent operation can be integrated in the drawing tool via the inner and outer dies, which are adjustable relative to one another. Here, at least one external trimming of the sheet metal component is integrated into the drawing stage. In particular, this can be a circumferential trimming, i.e. a complete trimming. However, it is also conceivable to perform only a first segment trimming in the drawing tool, which would be feasible e.g. in the special case of drawing with open heads. In principle, drawing and trimming are performed in one continuous stroke of the composite tool. The separating or trimmed edge produced can both represent the contour of the finished part and be further machined in further operations, e.g. a beveling or post-forming operation.

The composite tool according to the invention makes it possible to reduce the number of tools for manufacturing a sheet metal component by at least one operation. In this context, the invention is not limited, for example, to car body components for motor vehicles, but also extends to the manufacture of other flat sheet metal components, in particular sheet metal components made of steel, aluminum or other materials.

The integration of an edge-side trimming of the sheet metal blank must also be separated from the setting of a relief slit in an inner waste region of the component, e.g. in a window opening. Such a relief cut is made during the forming process, which favors the flow of material from "inside to outside". However, this is only a linear cut, i.e. not a trimming operation. No scrap piece is produced in this operation that would have to be removed from the tool. The region of the raised relief cut is not cut out until a downstream operation. Consequently, it is not a matter of integrating a trimming operation into the drawing tool.

It is also known to make internal relief cuts or holes when cutting a sheet metal blank to size. Here, too, it is not a matter of integrating a trimming operation into the drawing tool. It is also known that hole punches are installed in the drawing tool. These are used to cut holes in the scrap region of the component, which are used to center the drawn part in the subsequent operation. Again, this is not an integration of a trimming operation into the drawing tool as provided by the proposed solution.

In one embodiment, the composite tool integrates a circumferential outer component trim in the drawing stage. Further operations can be integrated into the drawing stage in possible further embodiments. These are, e.g., the integration of drawing, cutting and beveling or drawing, cutting, beveling and embossing. This makes it possible, for example, to realize the entire manufacture sequence of a sheet metal component in the composite tool and in a press stroke implemented with it.

The proposed solution also differs from progressive composite tools, which are characterized by the fact that the components are produced from a strip of sheet metal (from the coil) that is pushed or drawn step by step through a sequence of several tool stages. The finished component is not separated from the strip until the final stage. Progressive composite tools are generally used to produce only small to medium-sized, geometrically simple components in high volumes. By contrast, the proposed solution makes it possible to produce large, complex sheet metal components from a flat sheet metal blank (in the form of a single blank), wherein a forming operation precedes the trimming of the component.

The composite tool is typically a component-specific press tool in which a sheet metal blank is globally formed. This is followed by cutting off, preferably shearing, at the periphery of the three-dimensionally formed geometry, not laser or waterjet cutting in the horizontal plane. Furthermore, the sheet metal component is not cut out, but a scrap piece is cut off from the sheet metal blank.

Alternatively or additionally, in one embodiment, the blank holder on the second structure is adjustable relative to the punch into an insert position towards the outer die. In the insert position then assumed, the sheet metal blank is to be assembled with an edge-side portion on the blank holder. During subsequent pressing of the die and the punch against each other, the blank holder can be moved relative to the punch into a holding position different from the insert position, in which the scrap piece separated from the sheet metal blank is held between the outer die and the blank holder. For example, the blank holder is displaced from the insert position under the action of the first structure and, in particular, the outer die adjusted with the first structure. In this case, the scrap piece of the sheet metal blank provided between the outer die and the adjustable sheet metal holder may be deformed in a defined manner. In any case, the separated scrap piece is held in a defined position at the end of the press stroke by the blank holder, which is adjustable relative to the punch, and can be displaced relative to

the finished sheet metal component. This is particularly advantageous with regard to the removal of the scrap piece from the composite tool.

As already explained above, the proposed composite tool is arranged to use a press force applied to form the sheet metal blank and thus the press stroke at the same time to cut off the scrap piece and, if necessary, to finish forming the edge of the sheet metal component. Accordingly, in one embodiment, the translatory adjustment of the first structure and the second structure towards each other can then also adjust the blank holder relative to the punch and/or the inner and outer dies relative to each other. The blank holder can thus be adjusted relative to the punch during the press stroke, for example, not by external force actuated by an additional drive, but solely by the press force. A relative movement of the blank holder to the punch is thus caused solely by the adjustment of the first and second structures towards each other and the press stroke thus realized. An additional (motorized) adjustment drive is not provided for this purpose. The same applies to the alternative or supplementary adjustment of inner and outer dies relative to one another during pressing.

A punch addendum is additionally provided on the second structure, which is arranged between the blank holder and an insert region for a cutting edge of the first structure. By providing an additional punch addendum, for example, a design of a drawing shell in the composite tool with an open-angled frame can be made possible. This can in turn achieve a stretching of the sheet metal blank into the center of the component. This is necessary, for example, in the case of flat outer skin components, such as roofs or outer door panels, as (car body) sheet metal components to be produced. The punch addendum is located adjacent to a region of the second structure, the insert region, into which a cutting edge of the second structure intended for trimming the sheet metal blank can enter during pressing. In one embodiment, the punch addendum faces a hold-down device of the first structure against this background. In one embodiment, the punch addendum may be spaced from the punch and, on the other hand, from the blank holder (transversely to the direction of adjustment of the blank holder). However, in an alternative embodiment, the punch structure may be an integral part of the punch.

In principle, the first structure and the second structure of the composite tool can be arranged to cut off the scrap piece by shearing with the pressing of the die and the punch against each other.

In the case of the at least two-part die proposed in accordance with the invention, in which an inner die and an outer die are adjustable relative to one another, a cutting edge may be adapted or a cutting edge may be mounted on the outer die in one variant for cutting off the scrap piece. In the first mentioned case, an edge of the outer die adjacent to the inner die forms a cutting edge for cutting off the scrap piece. Here, the outer die is adjusted relative to the inner die (possibly together with the opposite blank holder) during the press stroke. In the other case mentioned above, a separate cutting edge, respectively a cutting blade with such a cutting edge, is mounted to the outer die.

A cutting edge (of a cutting knife) is provided on the first structure, relative to which the inner die of the at least two-part die is adjustably mounted on the first structure. In this variant, consequently, during the press stroke and an adjustment of the first structure towards the second structure, the inner die is displaced against the direction of adjustment with respect to the cutting edge, so that upon further adjustment of the first structure, the cutting edge cuts off the scrap piece, possibly forming the separating edge adjacent to the inner die.

In one embodiment, the cutting edge is adapted with a cutting bar which (a) simultaneously acts as a beveling bar when the die and the punch are pressed against each other or which (b) cooperates with a counter-holder when the die and the punch are pressed against each other and then acts as a beveling bar against this counter-holder. In the latter case, the cutting bar is provided, e.g., for beveling a flared and/or multi-stepped rim when the die and punch are pressed against each other.

In one embodiment, a cutting edge of the cutting bar has at least one first cutting edge portion and at least one second cutting edge portion, wherein, with respect to a direction pointing from the inner die to the outer die, the at least one first cutting edge portion is on the inside and the at least one second cutting edge portion is on the outside, such that an inner contour of the cutting edge is defined with the at least one first cutting edge portion and an outer contour of the cutting edge is defined with the at least one second cutting edge portion. The protrusion of different cutting edge portions can prove advantageous in particular when two edge portions are to be provided on the component, one edge portion of which is finished after drawing and trimming, while an adjacent edge portion still has to be subjected to bending after drawing and trimming of a laid-out rim. The movable cutting bar is then designed differently for these different edge regions.

In this context in particular, it can then be further provided that the at least one second cutting edge portion defining the outer contour of the cutting edge protrudes with respect to the at least one first cutting edge portion defining the inner contour, for example in a cutting edge adjustment direction in which the cutting edge is adjusted with respect to one another during pressing of the die and the punch. In this way, when the die and the punch are pressed against one another, the cutting edge first trims the sheet metal blank at a second edge portion (which is subsequently to be trimmed) by means of the second cutting edge portion of its cutting edge, before the cutting edge trims the sheet metal blank at a first edge portion different therefrom by means of the first cutting edge portion of its cutting edge.

The at least one second cutting edge portion of the cutting edge defining the outer contour protrudes - e.g. by 0.5 mm to 3.0 mm - in relation to the at least one first cutting edge portion defining the inner contour, depending on the component geometry, process, sheet metal material and thickness. In one embodiment, for example, a protrusion in the range of 0.7 mm to 1.4 mm is provided. In the second edge region of the bend, the second cutting edge portion thus advances by a certain amount relative to the cutting edge portion for the first edge region, e.g. by 0.5 mm to 3.0 mm. As a result, the trimming in the second edge region is completed first.

A counter-holder interacting with the cutting bar can further be adapted and provided to act as a counter-knife for a transition region of the cutting edge, where the cutting edge transitions from the at least one first cutting edge portion to the at least one second cutting edge portion, when pressing the die and the punch against each other. In this way, uncontrolled tearing in a transition edge region of the sheet metal blank can be limited to a minimum length or even completely prevented.

In particular, in a further development based thereon, a counter-holder cooperating with the cutting bar can be adapted and provided to be displaced by the cutting edge bearing against the counter-holder with the at least one first cutting edge portion during pressing of the die and the punch against each other, after trimming of the sheet metal blank has been performed by means of the at least one second cutting edge portion. After trimming has been carried out in a second edge region and a transition region, the cutting bar is consequently seated here in the first edge region on the counter-holder and begins to displace the latter downwards against a defined force as the press stroke progresses.

In one embodiment, a contour of a counter-holder cooperating with the cutting bar for a transition region of the cutting edge, at which the cutting edge transitions from the at least one first cutting edge portion to the at least one second cutting edge portion, is designed as a bottom blade. In this case, the trimming is performed leading in the first edge region and then peels over the transition edge region. Finally, the second cutting edge section is cut and beveled.

Alternatively or additionally, a cutting insert may be provided on an upper or lower knife at a transition region.

In one embodiment, the first structure and the second structure can be further arranged to provide at least one embossing on the edge portion of the sheet metal component to be produced by pressing the dies and the punch against each other. For this purpose, for example, at least one embossed or stepped forming surface for the sheet metal blank is provided on a counter-holder, which may be adjustable, of the first or second structure, so that during the press stroke and with the sheet metal blank inserted in the composite tool as intended, a corresponding embossing is present on the finished edge portion at the end of the press stroke. A forming surface for embossing can be provided, for example, on the first structure on a cutting bar, beveling bar or embossing bar and/or on the second structure on the punch.

In a further development, the cutting edge of the first structure, relative to which the inner die is adjustably mounted, may also be adapted with a cutting bar which, when the die and the punch are pressed against each other, acts simultaneously as a beveling bar and as a forming bar for providing the embossment, in order to provide the embossment at a flared edge portion of the edge portion.

Alternatively or additionally, an (embossment) insert can be provided on the first structure, by means of which an embossment is introduced in the component surface (and thus not on an edge-side flange), in particular a door handle recess, during drawing or after completion of drawing. The integration of an embossment process for manufacturing an embossment in the component surface in the press stroke can thereby facilitate the achievement of a higher surface quality. During the forming of the embossment located in the component surface, e.g. for a handle recess, by the (embossment) insert, the sheet metal blank is still to a certain extent under biaxial tensile stress from the drawing process and the component surface to be provided with the embossment is held between the punch and the inner die. This biaxial tensile stress

superimposes the stress conditions created in and around the embossment by the stamping process, and mitigates the influence of varying unwind lengths across the embossment.

5 In one embodiment, a hole punch is provided on the first structure for manufacturing at least one hole on the sheet metal component. In this case, the hole punch can be provided for manufacturing the at least one hole on the embossment produced by means of the insert. In a further development designed for this purpose, the insert is then mounted adjustably, e.g. on the first structure, so that the insert is displaced after manufacture of the embossment in a first adjustment phase during further pressing
10 of the die and the punch against one another - and thus in a subsequent, second adjustment phase - and the hole punch produces the at least one hole. Embossing and hole punching can thus also be performed here by means of the composite tool in one press stroke. It can be particularly advantageous here when the hole punch is guided in the (embossment) insert and the insert adopts the function of a hold-down device (in the
15 second adjustment phase).

As already explained at the outset, the composite tool can be designed as an overall composite tool and/or, in particular, be arranged and provided for manufacturing a flat car body component for a motor vehicle. An exemplary flat body component is, for example, a roof panel. Another flat car body component may be, for example, a door
20 panel, in particular an outer door panel of a motor vehicle door.

Another aspect of the proposed solution concerns a method for manufacturing a flat sheet metal component by means of a pressing device comprising a first structure having a die and a second structure having a punch.

In analogy to the proposed composite tool, which can be part of a corresponding
25 drawing device, the proposed method provides that when the die and the punch are pressed against each other to form the sheet metal component by drawing, an outer edge of the sheet metal blank is also drawn off as a scrap piece and thus a trimming of the sheet metal blank is also performed at the same time within the composite tool. For drawing the sheet metal blank, at least one blank holder is used which is translationally adjustable relative to the punch and on which an outer edge of the sheet metal blank to be drawn is
30 held. Within the scope of the method, an at least two-part die with an inner die and an outer die is used, in which the inner die and the outer die are adjustable relative to each other at the first structure. The outer die and the blank holder which is translationally

adjustable relative to the punch face each other, wherein the outer die and the blank holder hold between them, when the two-part die and the punch are pressed against each other, the scrap piece which is cut off at the outer edge of the drawn sheet metal blank when the die and the punch are pressed against each other. A cutting edge is provided for cutting off the scrap piece on the first structure, and a punch addendum (2B) is additionally provided on the second structure, which is arranged between the blank holder and an insert region for the cutting edge of the first structure.

Here, too, both forming and trimming are consequently implemented in one press stroke, wherein the trimming is implemented mechanically by means of the parts of the press device that are adjusted relative to one another during pressing, without these having to be adjusted via their own adjustment drive.

For example, a final forming is additionally provided in that, with the pressing of the die and the punch against each other, the edge portion of the sheet metal component at which a separating edge resulting from the cutting off of the scrap piece is present is bent before the scrap piece is cut off or is beveled after the scrap piece is cut off.

In a proposed manufacturing method, a press with a composite tool according to the invention may be used, in particular set up. The press equipped with the composite tool then drives the composite tool. Advantages and features explained above and below for embodiments of a composite tool thus also apply to embodiments of a proposed manufacturing method, and vice versa.

The attached Figures illustrate exemplary possible embodiments of the proposed solution.

They show:

Figure 1 a first embodiment of a composite tool with a two-part die, wherein an inner and an outer die of the composite tool are mounted adjustably relative to one another and a cutting edge for cutting off a scrap piece from a sheet metal blank is adapted on an outer die;

Figure 1A a detail of an enlarged view in the region of the inner and outer dies of the composite tool of Figure 1 at the cutting edge of the outer die;

Figures 2A-2F various phases of a manufacturing process of a sheet metal component, here e.g. in the form of a car body component, using the composite tool of Figures 1 and 1A;

Figure 3 a further design variant of a composite tool with a

cutting edge of a cutting blade mounted on the outer die;

Figures 4A-4E different phases of a manufacturing process of a car body component using the composite tool of Figure 3;

Figure 5 a further embodiment of a composite tool with
5 an inner and outer die and separate cutting edge and punch addendum;

Figures 6A-6G different phases of a manufacturing process of a car body component using the composite tool of Figure 5;

Figure 7 in enlarged scale, a further development of the embodiment of
Figures 5 and 6A to 6G with an undercut punch;

10 Figure 8 a section of a sheet metal component to be produced in the form of
A car body part to be produced with a tongue-like projecting flange in the region of the
finish-formed edge portion;

Figure 9 a further embodiment of a car body component to be produced with
a stamped rim on the finish-formed edge portion;

15 Figure 10A a further embodiment of a composite tool with a separate cutting
edge, which has two cutting edge portions extending at an angle to one another;

Figure 10B in enlarged scale, looking at the punch of the composite tool of
Figure 10A, a possible further development for manufacturing a stamped rim on the car
body part corresponding to Figure 9;

20 Figure 11 in enlarged scale looking at the punch of the composite tool, a possible
further development for manufacturing a multi-stepped rim;

Figure 12 a further embodiment of a composite tool with an insert for
manufacturing a trough-shaped embossment in the component surface of a car body
component to be produced in the press stroke and with a hole punch guided in the insert
25 for manufacturing a hole in the trough-shaped embossment;

Figures 13A - 13G different phases of a manufacturing process of a car body
component using the composite tool of Figure 12;

Figure 14 schematic of a further development of a composite tool of Figure 5
with punch addendum integrated in the punch, which cooperates with a hold-down
30 device for manufacturing the car body component;

Figure 15A a flat sheet metal component to be manufactured in the form of
a roof panel for a motor vehicle;

Figure 15B a flat sheet metal component to be manufactured in the form of an outer door panel for a motor vehicle door;

Figures 16A-16B schematic sequences known from the prior art for drawing, trimming and beveling on a car body component;

5 Figures 17A-17C in different phases, a usual combination of trimming and beveling on a car body component previously drawn in a separate drawing die;

Figure 18 a car body component with finished trim and bevel regions;

Figures 18A-18B a section of a further development of a composite tool of Figures 5 and 6A to 6G illustrating different cutting edge portions for a cutting bar for
10 manufacturing the car body component of Figure 18;

Figure 19 a section of an embodiment of a cutting bar in a composite tool corresponding to Figures 18A and 18B in oblique view from below;

Figure 20 the contour of a counter-holder cooperating with the cutting bar of Figure 19 in plan view.

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Figure 15A shows a car body component K in the form of a car roof panel with a circumferential beveled rim. Figure 15B shows a car body component K in the form of an outer door panel for a motor vehicle door with a handle recess M in holes L1 and L2 adapted therein for the attachment of a door handle. Details A and B in Figure 15B show
20 in section the design of the various edges of the outer door panel including the flanges. The conventional sequence of operations in the manufacture of such sheet metal components of Figures 15A and 15B consists of drawing, cutting and beveling in typically four tools and, if necessary, in addition - in the case of the outer door panel - embossment and hole punching. All trim edge regions are more or less perpendicular to the working
25 direction of the press device to be used. The trimmed regions are free of undercuts.

Figures 1 to 14 illustrate different variants for manufacturing a flat car body part K or a modified car body part K from a (sheet metal) blank K' in the form of a flat individual blank.

The variants of Figures 1, 1A, and 2A to 2F on the one hand and Figures 3 and 4A to
30 4E on the other hand propose drawing and complete trimming in one (overall) composite tool W. The beveling is carried out in a separate tool.

The variant of Figures 5 and 6A to 6G proposes drawing, complete trimming and circumferential beveling in a further (overall) composite tool W, i.e. the entire

manufacturing process of the car body component K takes place in the composite tool W. A possible further development is aimed at slightly different component geometries with flared flanges KF as shown in Figure 8. It comprises drawing, complete trimming, beveling and post-forming in a single tool. The post-forming refers to the adjustment of the flange angles in the closed tool, whereby a specific compensation of the elastic angular deflections is achieved when the tool is opened.

The variant of Figures 10A and 10B proposes drawing, complete trimming, beveling and embossing in a composite tool W, wherein flared flange regions KF have embossments P (cf. Figure 9). The embossing operation can be used at the same time to adjust the flange angles (deflection compensation).

Figure 11 illustrates the manufacture of multiple stepped rims by means of the composite tool W.

A composite tool W shown in Figures 12 and 13A to 13G and the process implemented with it provides for drawing, complete trimming, beveling, embossing and hole punching, e.g. for the manufacture of an outer door panel of Figure 15B. Here, beveling is performed on straight and flared flanges. Embossing takes place in the component surface; alternatively or additionally, however, it can (also) take place in the region of the flange.

In the variant of Figures 1, 1A, and 2A to 2F, the composite tool W comprises an upper structure O with a multi-part die 1 and a lower structure U with a punch 2 and a blank holder 3 which can be adjusted for this purpose. In the present case, the composite tool W is set up on a press, wherein the upper structure O is attached to a (press) ram 7 of the press and the lower structure U is attached to a (press) table 6 of the press. The present die 1, which is made in two parts, has an inner die 1A and an outer die 1B. The inner and outer dies 1A, 1B are movable relative to each other. The outer die 1B at least partially surrounds the inner die 1A.

The inner die 1A and the outer die 1B are adjustably mounted on an upper part 5 of the upper structure O via (upper air) bolts Bo. These bolts Bo project through through-holes 50 of the upper part 5 and through-holes 70, aligned therewith, of a ram 7 of the press which is assembled above the upper part 5 and to which the upper part 5 is fixed. In the region of the outer die 1B, at least one spacer Z is provided on the upper part 5. Via this spacer Z, the upper part 5 can act on the outer die 1B during a press stroke along an

adjustment direction V_u and cause an adjustment movement of the inner and outer dies 1A, 1B relative to each other.

Opposite the inner die 1A is the punch 2 of the lower structure U, which is immovably fixed to a lower part 4 of the lower structure U. The lower part 4 in turn rests
 5 on the table 6 of the press. The punch 2 forms a punch surface 20. This punch surface 20 faces a die surface 10A of the inner die 1A.

Adjacent to the outer die 1B, the inner die 1A forms an edge-side bending ridge 11A. This bending ridge 11A projects toward the punch 2 and corresponds to an edge-side recess 21 on the punch 2. When the die 1 and the punch 2 are pressed together about the
 10 approach of the upper structure O to the lower structure U, a bent-over edge portion Ka is formed on the car body component K via the bending ridge 11A of the inner die 1A and the recess 21 of the punch 2.

This edge portion Ka is formed at a separating edge at which a scrap piece A is cut off from the blank K' by shearing. For this purpose, the outer die 1B forms a cutting edge
 15 11B and cooperates with a blank holder 3 of the lower structure U. The blank holder 3 is mounted on the lower structure U so that it can be moved in translation and forms a blank holder surface 30 on which the scrap piece A of the blank K' to be cut off is placed. The punch surface 20, together with the die surface 10A of the inner die 1A, the blank holder
 20 surface 30 and an opposite die surface 10B of the outer die 1B, defines an intermediate space R between the punch 2, blank holder 3 and the two-part die 1. The blank K' is inserted into this intermediate space R in order to form and trim the car body component K from it in a press stroke. The scrap piece A is pressed in and held securely between the sheet holder surface 30 and the opposite die surface 10B of the outer die 1B.

For fixing the scrap piece A, in particular during the cutting off of the same from the
 25 remainder of the blank K', the blank holder 3 and the outer die 1B form form-fit regions in the form of a groove-like recess 32 and a projection 12B.

The press stroke and thus the machining of the (sheet metal) blank K' takes place on the composite tool W shown in 8 phases, which are illustrated with reference to
 Figures 2A to 2F.

30 First, the composite tool W is open, i.e., the intermediate space R is accessible and the blank holder 3 is adjusted to a raised insert position toward the outer die 1B. The adjustment of the blank holder 3 along an adjustment direction V_o is controlled in this case by (under-air) bolts Bu. When the blank holder 3 is in its insertion or starting position,

the blank holder surface 30 is approximately at the level of the highest point of the punch surface 20. The inner die 1A and the outer die 1B, controlled by the (upper air) bolts Bo, are retracted to such an extent that blank K' can be inserted and comes to rest on the blank holder surface 30 (Figure 2A).

5 Then the inner die 1A and the outer die 1B move down together with the upper part 5. During this process, a surface 110A at the outermost projecting end of the bending ridge 11A remains level with the die surface 10B of the outer die without any offset (cf. Figure 1A). Drawing or locking beads or clamping steps for material flow control are formed on the blank K' via the form-fit regions 12B and 32 on the outer die 1B and the
10 blank holder 3. The edge of the blank K' comprising the later scrap piece A is clamped between the blank holder surface 30 and the die surface 10B of the outer die 1B (Figure 2B).

 The force of the upper air cushion (ram cushion) defined by the bolts Bo is greater than the force of the lower air cushion (table drawing cushion) defined by the bolts Bu.
15 As a result, the outer die 1B displaces the lower air cushion as the stroke progresses, i.e., as the upper structure O continues to approach the lower structure U along the direction of adjustment Vu. The drawing process begins. The blank K' stretches over the punch 2. During this process, the surfaces 110A and 10B of the inner and outer dies 1A, 1B furthermore remain at the same level, since they are each supported against the common
20 upper air cushion via the row of bolts Bo (Figure 2C).

 When the inner die 1A is seated on the punch 2, the car body component K is formed and the drawing process is completed. As the press stroke progresses, the upper air bolts Bo are displaced via the inner die 1A into the (press) ram 7. As this happens, the upper air bolts Bo retract empty behind the outer die 1B. The inner die 1A, the outer die
25 1B and the blank holder 3 briefly come to a stop until the outer die 1B rests on the at least one spacer Z (Figure 2D).

 If the press stroke continues to progress continuously, the inner die 1A furthermore remains stationary, while the inner die 1A further displaces the upper air bolts Bo engaging it. The outer die 1B, on the other hand, is supported via the at least one spacer
30 Z against the upper part 5 and the press ram 7. This causes the outer die 1B to move further downward in the adjustment direction Vu, displacing the blank holder 7, relative to the inner die 1A. Thus, for the first time, there is a relative movement between the inner and outer dies 1A, 1B. The cutting process begins.

The inner die 1A fixes the car body component K on the punch 2 and thus assumes the function of a cutting hold-down. The punch 2 now has the function of a cutting attachment. The cutting edge 11B of the outer die 1B adopts the function of a cutting knife. The cutting edge 11B plunges into the sheet metal material in a shearing action until it breaks through. A cutting gap s is determined by a horizontal offset between punch 2 and outer die 1B (Fig. 1A). The cutting operation is thus completed. A drawing edge defined by the scrap piece A has been cut off from the car body component K (Figure 2E).

After reaching the bottom dead center, the upper structure O moves upward (in the adjustment direction V_o) with the press ram 7 and the upper part 5, taking the inner and outer dies 1A, 1B with it. It does not matter whether the upper air is pressurized or depressurized during this phase. Now the car body component K and the scrap piece A can be removed. This can be done simultaneously or one after the other, manually or mechanized, e.g. by robotic suction spinning. It is advantageous for removal that the cut scrap piece comes to rest at a level below the separating edge of the car body component (cf. Figure 2E).

Preferably, the lower air with the blank holder 3 does not move up again until after the car body component K and the scrap piece A have been removed, in order to prevent the scrap from colliding with the car body component K. After the blank holder 3 has reached the insert position (initial position), a new blank K' in the form of a single flat sheet bar can be inserted.

The method explained above can also be varied, in deviation from the attached figures, e.g. to the effect that

- Punch 2 and blank holder 3 are assembled in the upper structure O and inner and outer dies 1A, 1B are assembled in the lower structure U,
- instead of upper and/or lower air (controlled) gas springs or other suitable spring elements are used, and/or
- in deviation from the sequence shown, not the punch 2 is stationary, but any other tool element of the composite tool W, while the other tool elements move accordingly relative thereto, irrespective of the drive technology required for this on the tool or press side.

Figures 3 and 4A to 4E show a further embodiment of the composite tool W. The process sequence is in principle identical to those of the embodiment of Figures 1, 1A and

2A to 2F. The variant of Figures 3 and 4A to 4E differs from the variant explained previously essentially in the following respects:

1. Particularly in the case of flat outer panel parts, such as car roofs, it may be necessary to add a so-called add-on to the (draw) punch. The add-on at the lateral edge of the punch 2 is adapted in one piece with the punch 2 and defines two mutually offset steps 21a and 21b at the recess 21. The add-on thus allows an increased drawing depth and an open design of the frame. This results in improved stretching of the car body component K right into its center. If such an add-on is used, the trimming is not carried out in the separating plane of the punch 2 and blank holder 3 as in the variant of Figures 1, 1A and 2A to 2F, but on the step 21b defined by the add-on and projecting laterally relative to the inner die 1A. The add-on also functions as a trimming bench.

2. The outer die 1B is fixed to the upper part 5 and thus is not mounted adjustably thereon. The inner die 1A is supported against the upper part 5 by gas springs Go or other spring elements. After completion of the drawing process, the spring elements, here in the form of the gas springs Go, are displaced. A variant with gas springs Go is particularly suitable, e.g., for insertion on presses that do not have any upper air.

3. The actual cutting element is designed as a separate cutting edge 9 in the form of a cutting bar, shown here with clearance angles. Instead of the cutting edge 11B, a rounding 13B is provided on the outer die 1B. The cutting edge 9 is mounted on a recess 19B of the outer die 1B acting as a mounting bracket. Providing a separate cutting edge 9 allows easier adjustment of the cutting gap and cutting overflow, as well as separate material selection, machining, heat treatment or coating of the cutting elements compared to forming the cutting edge on the outer die 1B. By appropriate design of the cutting bars, peeling or crossing cutting can be performed instead of full-edge cutting. This significantly reduces the cutting forces and the cutting impact when breaking through. Needless to say, the punch 2 can also be equipped with a cutting edge, in particular in the form of cutting bars, and/or provided with a clearance angle.

4. In this embodiment, moreover, the cutting edge 9 can also be recessed with respect to the inner die 1A until the end of the drawing operation, without affecting the drawing result.

The variants of Figures 1, 1A and 2A to 2F and of Figures 3 and 4A to 4E can also be combined with each other. Thus, a composite tool W according to variant of Figures 1, 1A and 2A to 2F can be

- also be equipped with cutting bars, and/or
- 5 - using gas springs instead of table cushion bolts, and/or
- using spring elements instead of upper air bolts, and/or
- having clearance angles at the cutting edge 11B and/or punch 2.

10 The variants of Figures 1, 1A and 2A to 2F and Figures 3 and 4A to 4E show component manufacture with the rim tightened. The tightening of the rim is necessary to ensure the positioning of the drawn and trimmed car body component K when it is inserted into the subsequent bevel tool. However, there is a risk of so-called edge throw-up. The edge throw-up represents a surface defect of the component along the bevel line, which is visible in particular on the painted vehicle and therefore cannot be tolerated.

15 This risk is avoided in the variant of Figures 5 and 6A to 6G. With this variant, the following can be achieved:

- the beveling is also integrated into the composite tool W. Compared with the conventional manufacture sequence for the roof paneling, two tools are saved.
- tightening of the rim as a positioning aid for a separate bevel tool can thus
- 20 be dispensed with. The risk of edge throw-up is eliminated.
- the slim nose-like projecting bending ridge 11A on the inner die 1A for tightening the rim is eliminated. The composite tool W thereby becomes more robust.
- a hold-down device 1C can be used on the upper structure O when this is advantageous for the cutting edge process.
- 25 - a counter-holder 8 can be used on the lower structure U when this is advantageous for the beveling.
- the distance between car body component K and scrap piece A at the end of the press stroke is greater than in the variants of Figures 1, 1A and 2A to 2F and Figures 3 and 4A to 4E, which facilitates controlled removal and separation of car body component
- 30 K and scrap piece A.

The process sequence for manufacturing the car body component K is divided here into seven phases, illustrated by a tool assembly with counter-holder 8 and hold-down

device 1C corresponding to Figures 6A to 6G. These two elements are not mandatory, but can improve quality and process reliability depending on the component. In the present case, the counter-holder 8 is supported on the lower part 4 via a spring element in the form of a gas pressure spring Gu and is preloaded in the direction of the upper part 5. The counter-holder 8 faces the cutting edge 9 of the upper structure O and is assembled between the punch 2 and a punch addendum 2B. The punch addendum 2B is arranged between the blank holder 3 and an insert region E for the cutting edge 9 of the first structure O. The hold-down device 1C is again arranged opposite the punch addendum 2B and is located between the cutting edge 9 and the outer die 1B.

Initially, the composite tool W is opened. The inner die 1A and the hold-down device 1C rest on the extended bolt Bo of the ram cushion. The counter-holder 8 and the blank holder 3 are each in a raised insertion or starting position. The blank K' is inserted (Figure 6A).

The ram 7 with the upper part 5 moves downward. The outer die 1B rests on the blank holder 3. The beads on the scrap piece A are formed and the blank edge of the blank K' is clamped between the blank holder 3 and the outer die 1B (Figure 6B).

In the further downward movement, the sheet metal is clamped over the punch 2 and formed in the process. The drawing process is completed when the inner die 1A and the hold-down device 1C are seated on the sheet metal or the car body component K. A region of the scrap piece A then rests on a clamping surface 20B of the punch addendum 2B and is clamped between the hold-down device 1C and the punch addendum 2B, while a region of the scrap piece A closer to the edge is fixed between the outer die 1B and the blank holder 3 (Figure 6C).

Optionally, the lower air can be depressurized. The free lowering of the blank holder 3 releases the bead. This allows the car body component K to spring back elastically by a certain amount. As a result, the car body component K is trimmed under lower tension, which may have a positive effect on its quality and dimensional accuracy.

As the press ram 7, and thus the upper structure O with the upper part 5, continues to lower, the inner die 1A and the hold-down device 1C displace the ram cushion. The cutting edge 9 of the cutting blade comes to engage with the blank K' and performs the trimming. In deviation from the simplified illustration, punch addendum 2B and cutting edge 9 may be provided with clearance angles for trimming. The rim is first freely bent by a certain angle until the counter-holder 8 begins to act. From here on, the cutting blade

with cutting edge 9 acts as a beveling bar. For this purpose, the cutting knife is preferably provided with a radius on its edge facing the punch 2 (not shown). At the same time, the blank holder 3 is continuously displaced further against the table cushion (Figure 6D).

As the process continues, the cutting edge 9 of the blade comes to rest on the counter-holder 8 of the lower structure U. The car body part K is clamped under pressure between cutting edge 9 and counter-holder 8. During the further downward movement, the sheet metal of the

Body part K is pulled out in a controlled manner between these two elements 8, 9 and successively formed into the rim. At the same time, upper and lower air are further displaced. The continued movement of the blank holder 3 and outer die 1B draws the scrap piece further outward and spatially separates it from the car body part K. If no counter-holder 8 is used, free beveling of the rim takes place during this phase (Figure 6E).

When the composite tool W reaches its bottom dead center and the upper structure O and the lower structure U are thus maximally approximated to each other along the adjustment direction Vu, the composite tool W is completely closed. The rim is fully formed (Figure 6F).

Subsequently, the upper structure O moves along the opposite adjustment direction Vo to its initial position. One after the other, the cutting knife with the cutting edge 9 is retracted. The inner die 1A and the hold-down device 1C release the car body component K. The car body component K and the scrap piece A can be removed. Advantageously, the blank holder 3 initially remains in its lower position, i.e. in the design shown, the lower air only moves up after a delay. This allows the scrap piece A to be gripped from its stable position on the blank holder 3 and the punch addendum 2B. The counter-holder 8 should also only be raised with a delay to prevent deformation of the rim. This is realized in the illustrated design with a controlled gas pressure spring Gu (Figure 6G).

In a possible further development of the composite tool W shown in Figure 7, the punch 2 has a defined undercut angle α in the region of the beveled section Ka of the car body component K (which forms the beveled rim). A side wall 22 of the punch 2 thus springs back here relative to the inner die 1A by the undercut angle α . In conjunction with appropriate design of the punch edge radius, additional complementary surfaces on the cutting edge 9 and/or the inner die 1A, and precise incorporation of the pressure ratios in the composite tool W, targeted overbending of the rim in the closed tool can be achieved.

After elastic deflection during opening of the composite tool W, the rim then assumes the required angular position.

The enlarged representation of Figure 7 further illustrates the holding surface 80 of the counter-holder 8, which is inclined relative to the horizontal by an angle β . In this case, the inclined holding surface 80 supports the controlled extraction of the car body part K between the counter-holder 8 and the cutting edge 9.

A further embodiment relates to the manufacture of sheet metal components with a flange KF which adjoins the beveled rim at least in certain regions and is, for example, tongue-shaped, fulfills the function of a joining flange, for example, and extends predominantly perpendicular to the working direction of the press. A corresponding car body part K is shown by way of example in Figure 8.

In the manufacture of such a car body part K, a composite tool W corresponding to the variant of Figures 5 and 6A to 6G is used in principle, wherein a counter-holder 8 is mandatory here. Since the designed rim length is greater overall in the regions of the additional flange KF, the trimming is carried out further out. The cutting knife with cutting edge 9 and the counter-holder 8 are wider by the corresponding amount. At bottom dead center, the counter-holder 8 preferably rests on at least one rigid spacer which limits the downward stroke of the counter-holder (in the adjustment direction Vu). In contrast to the variant of Figures 5 and 6A to 6G, the stroke is already terminated when there is still such a dimension of sheet metal between cutting edge 9 and counter-holder 8 as corresponds to the width of flange KF.

It is also significant here that the cutting edge 9 and the counter-holder 8 can have a positive or negative angle β to the horizontal (see also Figure 7). This angle β is used to form flanges KF that have a corresponding position in the composite tool W. In a preferred manner, the angle β is dimensioned in such a way that it compensates for the elastic deflection of the flange when the composite tool W is opened by selective overbending.

Joining flanges on a sheet metal component often have additional steps or embossments P or the like, as shown by way of example in Figure 9. In order to form these embossments P, an embossing operation is required. This can be realized with a design variant of the composite tool W as shown in Figures 10A and 10B. In this case, the cutting blade with the cutting edge 9 and its cutting bar also adopts the function of a beveling bar and, lastly, a forming bar for embossing.

In this variant, drawing and trimming are first performed in accordance with the variant of Figures 5 and 6A to 6G. The hold-down device 1C of the upper structure 0 is again optional. During the process of beveling, the flow of material is preferably controlled by a counter-holder 8 to ensure defect-free forming. The composite tool W and the manufacturing process to be implemented with it are coordinated so that the trimming or separating edge of the sheet metal leaves the counter-holder 8 shortly before reaching bottom dead center. The punch outline thus largely corresponds to the contour of the finished car body part K.

Deviating from the variant of Figures 5 and 6A to 6G, the punch 2 and the cutting edge 9 have opposing and mutually complementary shaped forming surfaces which correspond to the geometry of the flared rim on the car body part K. Accordingly, the forming surface 210 of the recess 21 on the punch 2 opposite a first cutting edge portion 90a has steps for manufacturing the embossments P. On the other hand, the holding surface 80 of the counter-holder 8, as well as the complementary surface of a second cutting edge portion 90b opposite this holding surface 80 and extending at an obtuse angle to the surface of the first cutting edge portion 90a, is substantially flat (Figure 10B). Once the sheet metal of the car body part K has left the counter-holder 8, it now lies between the (forming) surfaces of the punch 2 and the cutting edge 9. The embossments P are formed on a remaining stroke up to the bottom dead center, which corresponds only to the height of the embossments P or a little more.

The region between the cutting edge 9 and the punch 2 is again advantageously set at an angle β (cf. Fig. 7) relative to the horizontal in order to form corresponding layers of the flared rim or to introduce specific overbends.

As shown in the sectional view of Figure 11, it is also possible to produce multiple stepped rims using a composite tool W. In a further development according to Figure 11, for example, adjacent cutting edge portions 90a, 90b of the cutting edge 9 are stepped for this purpose, so that one cutting edge portion 90b protrudes relative to the other cutting edge portion 90a in the adjustment direction Vu. Accordingly, the counter-holder 8 opposite the cutting edge 9 has a holder surface 80 stepped in a complementary manner to the cutting edge portions 90a, 90b so that a rim formed between the cutting edge 9 and the counter-holder 8 at the end of the press stroke is stepped a plurality of times.

A variant of a composite tool W illustrated with Figures 12 and 13A to 13G is based on the embodiment variant of Figures 5 and 6A to 6G and provides for the formation of a

trough-shaped embossment in the component surface by means of an (embossment) insert 16 on the upper structure O during cutting and beveling in the edge region. The insert 16 is mounted on the upper part 5 so as to be elastically adjustable relative to the inner die 1A. The elastic mounting is realized via several spring elements F1, F2, via which the insert 16 is supported on the upper part 5. The embossment on the car body part - here e.g. in the form of handle recess M corresponding to Figure 15B - is also produced in the press stroke and without additional adjustment drives. For this purpose, an embossing recess 201 of the punch 2 adapted in the punch surface 20 is located opposite the insert 16. The insert 16 can dip into this embossing recess 201 when the inner die 1A and the punch 2 are pressed against each other.

In order to make another hole L1 in the embossment M in a first adjustment phase after forming the trough-shaped embossment M on the sheet metal blank K', a hole punch 17 rigidly fixed to the upper part 5 is guided on the insert 16. Thus, after the embossment M has been formed, the insert 16 is displaced against the spring elements F1, F2 in the upper part 5 during further adjustment of the upper part 5 in adjustment Vu and thus in a further, second adjustment phase. The hole punch 17 engages and hole punches the car body component K during further adjustment, wherein the insert 16 adopts the function of a hold-down device. Hole waste LA produced during hole punching is disposed of via an opening in the embossing recess 201, into which the hole punch 17 plunges and which opens into a scrap channel 2010.

Typically, it is not practical to introduce embossments in the manner of the handle recess M in a drawing stage by means of a suitably contoured die and punch. This often results in unevenness, waviness, edge throw-ups, flat spots or sink marks on or around the handle recess M, which represent intolerable surface defects of the car body part. Therefore, such embossments are often formed in subsequent operations with different hold-down devices and form inserts.

In contrast, the proposed embodiment of Figures 12 and 13A to 13G facilitates the achievement of a component surface of high quality, since during the forming of the handle recess M by the insert 16 the sheet metal blank K' is still under biaxial tensile stress from drawing and is held between the punch 2 and the inner die 1A. This tensile stress superimposes the stress conditions created by the embossing process in and around the handle recess M and reduces the influence of the different unwinding lengths over the handle recess M.

Contrary to the representation in Figures 12 and 13A to 13G, holes can also be made independently of an embossing function in the case of deviating component geometries by guiding the hole punch 17 in the inner die 1A. In this case, the inner die 1A adopts the function of a hold-down device in the second adjustment phase for the hole punching. It is readily apparent, moreover, that due to the support of the inner die 1A against the (upper air) bolts Bo, it is also possible to emboss and/or punch holes in a direction deviating from the working direction of the press when appropriate drives are provided for the embossing and/or cutting elements.

Figure 14 further schematically illustrates a further development of a composite tool W of Figure 5 with punch addendum 2B integrated in the punch 2. The punch addendum 2B is separated from the punch surface 20 of the punch 2, which cooperates with the inner die 1A, only by the insert region E for the cutting edge 9. The punch addendum 2B cooperating with the separate hold-down device 1C of the upper part 5 is thus here not spatially separated from the punch 2 as in the variants explained before, but is a part of the punch 2. An integration of the punch addendum 2B into the punch 2 is thereby of course also possible in the variants of embodiment explained before.

Figures 18, 18A and 18B and Figures 19 and 20 illustrate a further development of a composite tool of Figures 5 and 6A to 6G.

Figure 18 here first shows a car body component K which has different edge regions I, II and III. A first edge region I is finished after drawing and trimming. Adjacent edge regions II are beveled after drawing and trimming of a flared rim Ka. In the edge regions I and II, the movable cutting edge 9 must therefore have a correspondingly different design, as illustrated by Figures 18A and 18B, which show different cutting edge portions 900A, 900B in sections for a cutting bar for manufacturing the car body component K of Figure 18:

- in the edge region I, a cutting edge 900, which is located on a cutting bar of the cutting edge 9, is located inside on the inner die 1A. The punch 2 serves as a rigid counter cutting edge.

- in the edge region II, the cutting edge 900 is located on the outside of the hold-down device 1C. The punch addendum 2B serves as a counter cutting edge. The cutting edge 9 here also fulfills the function of a beveling bar.

The cutting edge 900 of the cutting bar thus has first cutting edge portions 900A, second cutting edge portions 900B and transition regions 901 located therebetween. With reference to a direction pointing from the inner die 1A to the outer die 1B, the first cutting edge portions 900A each lie on the inside and the second cutting edge portion 900B lies on the outside, so that with the first cutting edge portions 900A an inner contour of the cutting edge 900 and the second cutting edge portion 900B an outer contour of the cutting edge 900 are defined. 1.

A transition edge region III is located between the first and second edge regions I and II. As shown in the oblique view from below of the cutting edge 9 in Figure 19, the cutting edge 9 is designed for this purpose in such a way that in a transition region 901 the cutting edge 900 extends from the inner contour to the outer contour of the cutting bar. This transition for a trimming contour KC implies however that in the region between punch 2 and punch addendum 2B no counter cutting edge acts in the (tool) lower part 4 in order to avoid an uncontrolled deformation and/or an intolerable tearing off of the sheet metal. With this in mind, the following is provided in the composite tool shown:

1. In the second edge region II of the beveling, the cutting edge 9 is designed in such a way that a second cutting edge portion 900B protrudes or runs ahead by a certain dimension with respect to a cutting edge portion 900A for a first edge region I. Depending on the component geometry, process, sheet material and thickness, this dimension is e.g. 0.5 mm to 3.0 mm, in particular 0.7 mm to 1.4 mm. As a result, the trimming in the second edge region II is completed first.

2. After the trimming has been carried out in the second edge region II, the cutting edge 900 advances in a peeling manner over the transition edge regions III to the first edge regions I by means of the transition regions 901 (adapted with height offset) of the cutting edge 9 and cutting surfaces 9000 provided here. The rim Ka to be beveled is already slightly bent in the second edge region II via a beveling surface 902 of the cutting edge 9.

3. The first edge regions I are then cut. In the long stroke, the scrap can be pressed down in the first edge regions I while at the same time being drawn outward by the blank holder 3.

The second cutting edge portion 900B of the cutting edge 900 defining the outer contour thus protrudes here relative to the one first cutting edge portion 900A defining

the inner contour, so that, when the die 1 and the punch 2 are pressed against one another, the cutting edge 9 first trims a second edge region II (to be subsequently beveled) by means of the second cutting edge portion 900B of its cutting edge 900, before the cutting edge 9 trims the first edge regions I by means of the first cutting edge portion 900A of its cutting edge 900.

Furthermore, for the first edge region I, a counter-holder 8 is provided in the (tool) lower part 4, which is complementary to the cutting edge 9 at least in regions and is shown in the plan view of Figure 20. This counter-holder 8 is in its upper position during the trimming of the second edge regions II and the transition edge regions III and acts as a counter-knife in the transition edge region III. This limits uncontrolled tearing in the transition edge region III to a minimum length or even prevents it completely. After trimming in the second edge regions II and the transition edge regions III, the cutting edge 9 sits on the counter-holder 8 in the first edge region I and begins to displace it downwards (in the adjustment direction Vu) against a defined force as the press stroke progresses.

The option of inserting a separate counter-holder 8 in the region of the bevel is unaffected when this is convenient from the point of view of the component and/or the process. In this case, the counter-holder 8 for cutting and the counter-holder 8 for beveling can also be made in one piece if the design is appropriate and/or be supported against the same pressure elements in the lower part 4.

If a counter-holder 8 for beveling is used from the outset in the second edge region II, its contour in the transition edge region III can also be designed as a lower knife. In this case, the trimming is carried out in advance in the first edge region I and then peels over the transition edge region III. Finally, the second edge are region II is then trimmed and beveled.

Incidentally, the function and tool design described do not necessarily imply full-edge cutting in the first and second edge regions I and II. Crossing or peeling cutting can also be provided here as required.

In one embodiment, a cutting insert is provided on the upper or lower knife in the transition region 901. Its cutting edge then protrudes by a dimension of 0.5 mm to 3.0 mm relative to those of the cutting bar(s) in the edge regions I and II, for example. The cutting insert cuts into the transition edge region III and is then displaced to such an extent that its cutting edge is at the same level as that of the first and second edge regions I and

II. Then, the cutting edge portions 900A, 900B engage the first and second edge regions I and II.

The solution according to the invention exemplified by the above-described embodiments may offer advantages in several respects:

5 - by reducing the total number of tools or tooling stages required to manufacture a component, a reduction in the cost of operating resources and in development and procurement times can be achieved.

 - by shortening process chains, existing press (lines) can be utilized more efficiently, and setup and maintenance costs can be minimized.

10 - if changes occur in the component (e.g. by the component developer) or are required in the tool (e.g. to compensate for springback), fewer tool working surfaces have to be reworked. In contrast to the reworking of entire tool sets, this can save time and costs.

 - by reducing handling operations between individual tools, the risk of deforming, scratching or otherwise damaging the component in the process is reduced.

 - shortening the process chain reduces the risk of tinsel, dust, oxide or other particles being carried into downstream tools, where they cause damage to the surface. The same applies to impressions that can occur on the component surface when the tools are closed. By integrating all machining steps in a composite tool, these risks are completely eliminated.

 - by reducing the number of tool steps, the risk of deformation of the component occurring when the subsequent tool is closed is reduced or eliminated, e.g. as a result of springback from the preceding tool that is not compensated in a process-safe manner.

25 - particularly in the case of flat, weakly contoured components without holes, the state of the art poses the problem of positioning the component on the subsequent tool precisely and without slippage. The integration of subsequent operations, which would take place after trimming, makes this problem obsolete, since there is no need to transfer the component to the subsequent tool.

30

The characteristic design features of the individual variants are, within the scope of the invention as defined by the claims, freely combinable with one another. Conceivable in principle, but not shown, is the integration of slide functions in the composite tool W,

with which local cutting, hole punching or forming operations can be realized deviating from the working direction of the press.

List of reference numerals

5		
	1	(Drawing) die / die assembly
	10A, 10B	Die surface
	10C	Clamping surface
	110A	Surface
10	11A	Bending ridge
	11B	(Cutting) edge
	12B	Protrusion (1st form-fit region)
	13B	Rounding
	16	(Embossment) insert
15	17	Hole punch
	19B	Recess
	18	Inner die
	19	Outer die
	20	Hold-down device
20	2	(Draw) punch
	20	Punch surface
	201	Embossing recess
	2010	Scrap channel
	20B	Clamping surface
25	21	Recess
	210	Stepped forming surface
	21a, 21b	Step
	22	Recessed side wall
	2B	Punch addendum
30	3	Blank holder
	30	Sheet metal holder surface
	32	Recess (2nd form-fit region)
	4	Lower part

	40	Through-hole
	5	Upper part
	50	Passage-hole
	6	Table
5	60	Through-hole
	7	Ram
	70	Through-hole
	8	Counter-holder
	80	Holder surface
10	9	Cutting edge
	900	Cutting edge
	9000	Cutting surface
	900A, 900B	Cutting edge portion
	901	Transition region with height offset
15	902	Beveling surface
	90a, 90b	Cutting edge portion
	A	Scrap piece
	Bo, Bu	Bolt
	E	Insert region
20	F1, F2	Spring element
	Go, Gu	Gas spring
	K	Car body component (sheet metal component)
	K'	Blank
	Ka	Edge portion / rim
25	KB	Rim
	KC	Trim contour
	KF	Flange
	L1, L2	Hole
	LA	Hole punching scrap
30	M	Handle recess
	O	Upper structure (first structure)
	P	Embossment
	R	Intermediate space

	s	Cutting gap
	U	Lower structure (second structure)
	Vo, Vu	Adjustment direction
	W	Composite tool
5	Z	Spacer
	α, β	Angle

Patentkrav

1. Kompositværktøj til fremstilling af en flad pladekomponent (K) med en første struktur (O), der har en trækmatrice (1), og en anden struktur (U), der har et trækstempel (2), idet mindst den første struktur (O) eller den anden struktur (U)
- 5 kan indstilles i det mindste delvis translatorisk, og der på den anden struktur (U) foruden trækstemplet (2) er anbragt mindst en i forhold til trækstemplet (2) translatorisk indstillelig pladeholder (3) for at presse trækmatricen (1) og trækstemplet (2) mod hinanden og at forme pladekomponenten (K) ved trækning ud fra et pladeemne (K'), der befinder sig mellem trækmatricen (1) og
- 10 trækstemplet (2) og er udformet som enkeltplatin, idet pladeholderen (3) er indrettet til at holde en ydre rand af det pladeemne (K'), der skal trækkes, på pladeholderen (3),
- hvor
- den første strukturs (O) trækmatrice (1) er fremstillet mindst todelt med en
 - 15 indre matrice (1A) og en ydre matrice (1B), idet den indre matrice (1A) og den ydre matrice (1B) kan indstilles i forhold til hinanden på den første struktur (O), og
 - den ydre matrice (1B) og den i forhold til trækstemplet (2) translatorisk indstillelige pladeholder (3) ligger over for hinanden og er indrettet til ved
 - 20 presning af den todelte trækmatrice (1) og trækstemplet (2) mod hinanden at holde et affaldsstykke (A) af pladeemnet (K') mellem hinanden, som skilles fra ved presningen af trækmatricen (1) og trækstemplet (2) mod hinanden på den ydre rand af det trukne pladeemne (K'),
- kendetegnet ved, at**
- 25 der på den første struktur (O) er anbragt et skær (9) til fraskillelsen af affaldsstykket (A) og på den anden struktur (U) desuden en stempeltilføjelse (2B), der er anbragt mellem pladeholderen (3) og et indføringsområde (E) til den første strukturs (O) skær (9).
- 30 **2.** Kompositværktøj ifølge krav 1, **kendetegnet ved, at** den første struktur (O) og den anden struktur (U) er indrettet til med presningen af trækmatricen (1) og

trækstemplet (2) mod hinanden også at omforme et randafsnit (Ka) af pladekomponenten (K), på hvilken en ved fraskillelsen af affaldsstykket (A) opstående skillekant foreligger, efter fraskillelsen af affaldsstykket (A), idet den første struktur (O) og den anden struktur (U) er indrettet til med presningen af

5 trækmatricen (1) og trækstemplet (2) mod hinanden at affase det randafsnit (Ka) af pladekomponenten (K), på hvilket skillekanten findes, efter fraskillelsen af affaldsstykket (A).

3. Kompositværktøj ifølge krav 1 eller 2, kendetegnet ved, at

- 10 (a) den første strukturs (O) ydre matrice (1B) omslutter den indre matrice (1A) i det mindste delvis, og/eller
- (b) den indre matrice (1A) kan indstilles på den første struktur (O) i forhold til den ydre matrice (1B), eller den ydre matrice (1B) kan indstilles på den første struktur (O) i forhold til den indre matrice (1A)

15

4. Kompositværktøj ifølge et af de foregående krav, kendetegnet ved, at

pladeholderen (3) kan indstilles translatorisk til trækningen og randbeskæringen af pladeemnet (K') ved presningen af den todelte trækmatrice (1) og trækstemplet (2) mod hinanden.

20

5. Kompositværktøj ifølge krav 4, kendetegnet ved, at pladeholderen (3)

- kan indstilles på den anden struktur (U) i forhold til trækstemplet (2) til en indlægningsstilling på den ydre matrice (1B), i hvilken pladeemnet (K') skal anbringes med et randafsnit på pladeholderen (3), og
- 25 - ved presning af trækmatricen (1) og trækstemplet (2) mod hinanden kan indstilles i forhold til trækstemplet (2) i en fra indlægningsstillingen forskellig holdestilling, i hvilken det af pladeemnet (K') fraskilte affaldsstykke (A) holdes mellem den ydre matrice (1B) og pladeholderen (3).

30 **6. Kompositværktøj ifølge et af de foregående krav, kendetegnet ved, at**

- (a) pladeholderen (3) kan indstilles i forhold til stemplet (3), og/eller den indre og den ydre matrice (1A, 1B) kan indstilles i forhold til hinanden, ved

den translatoriske indstilling af den første struktur (O) og den anden struktur (U) i forhold til hinanden, og/eller

(b) der på den første strukturs (O) desuden er tilvejebragt en afstryger (1C), der er anbragt mellem den indre matrice (1A) og den ydre matrice (1B),

5 og/eller

(c) den første struktur (O) og den anden struktur (U) er indrettet til med presningen af trækmatricen (1) og trækstemplet (2) mod hinanden at fraskille affaldsstykket (A) ved stansning ved hjælp af en relativ bevægelse mellem den ydre og den indre matrice (1A, 1B).

10

7. Kompositværktøj ifølge et af de foregående krav, kendetegnet ved, at

(a) skæret (9) er monteret på den ydre matrice (1B), eller

(b) den indre matrice (1A) i den mindst todelte trækmatrice (1) er monteret indstilleligt på den første struktur (O) i forhold til skæret (9).

15

8. Kompositværktøj ifølge krav 7, kendetegnet ved, at skæret (9), når skæret (9) er tilvejebragt på den første struktur (O), i forhold til hvilken den mindst todelte trækmatrice (1) indre matrice (1A) er monteret indstilleligt på den første struktur (O), er udformet med en skæreliste, som (a) ved presningen af trækmatricen (1)

20 og trækstemplet (2) mod hinanden samtidig virker som affasningsliste, eller som (b) ved presningen af trækmatricen (1) og trækstemplet (2) mod hinanden samvirker med et modhold (8) og virker som affasningsliste mod dette modhold (8).

25 **9. Kompositværktøj ifølge krav 8, kendetegnet ved, at** en skærekant (900) på skærelisten har mindst et første skærekantafsnit (900A) og mindst et andet skærekantafsnit (900B), idet den mindst ene første skærekantafsnit (900A) ligger indad og det mindst ene andet skærekantafsnit (900B) ligger udad i forhold til en fra den indre matrice (1A) mod den ydre matrice (1B) pegende retning, således at

30 der med det mindst einen første skærekantafsnit (900A) er defineret en indre kontur af skærekanten (900) og med det mindst ene andet skærekantafsnit (900B)

en ydre kontur af skærekanten (900).

10. Kompositværktøj ifølge krav 9, kendetegnet ved, at

- (a) det mindst ene andet den ydre kontur definerende skærekantafsnit (900B) af skærekanten (900) stikker frem i forhold til det mindst ene første den indre kontur definerende skærekantafsnit (900A), og/eller
- (b) det med skærelisten samvirkende modhold (8) er udformet og tilvejebragt til for et overgangsområde (901) af skærekanten (900), på hvilket skærekanten (900) går over fra det mindst ene første skærekantafsnit (900A) til det mindst ene andet skærekantafsnit (900B), at virke som modkniv ved presning af trækmatricen (1) og trækstemplet (2) mod hinanden, og/eller
- (c) det med skærelisten samvirkende modhold (8) er udformet og tilvejebragt til ved presning af trækmatricen (1) og trækstemplet (2) mod hinanden at fortrænges af det skær (9), der ligger an mod det mindst ene første skærekantafsnit (900A) på modholdet (8), efter at en beskæring af pladeemnet (K') er foretaget ved hjælp af det mindst ene andet skærekantafsnit (900B).

- 11. Kompositværktøj ifølge et af de foregående krav, kendetegnet ved, at den første struktur (O) og den anden struktur (U) er indrettet til med presningen af trækmatricen (1) og trækstemplet (2) mod hinanden på et randafsnit (Ka) af pladekomponenten (K), på hvilket en ved fraskillelsen af affaldsstykket (A) opstående skillekant foreligger, at bibringe pladekomponenten (K) mindst en prægning (M, P).**

- 12. Kompositværktøj ifølge krav 7 og 11, kendetegnet ved, at skæret (9) ved et på den første struktur (O) tilvejebragt skær (9), i forhold til hvilket den mindst todelte trækmatricen (1) indre matrice (1A) er monteret indstilleligt på den første struktur (O), er udformet med en skæreliste, der ved presningen af matricen (1) og trækstemplet (2) mod hinanden samtidig virker som affasningsliste og som formliste til at tilvejebringe prægningen (P), for at tilvejebringe prægningen (P) på**

en bertlet kant af randafsnittet (Ka).

13. Kompositværktøj ifølge et af de foregående krav, **kendetegnet ved, at** der på den første struktur (O) er anbragt en indsætning (16), ved hjælp af hvilken en
5 prægning (M) indarbejdes ved trækningen eller efter trækningens afslutning, og/eller der på den første struktur (O) endvidere er anbragt et hulstempel (17) til frembringelse af mindst et hul (L1, L2) i pladekomponenten (K).

14. Kompositværktøj ifølge krav 13, **kendetegnet ved, at** hulstempellet (17) til
10 fremstilling af det mindst ene hul (L1, L2) er tilvejebragt på den ved hjælp af indsatsen (16) frembragte prægning (M), og indsatsen (16) er monteret indstilleligt på den første struktur (O), således at indsatsen (16) efter fremstilling af prægningen (M) i en første indstillingsfase ved videre presning af trækmatricen (1) og trækstempellet (2) mod hinanden i en efterfølgende anden indstillingsfase
15 fortrænges, og hulstempellet (17) frembringer det mindst et hul (L1, L2).

15. Fremgangsmåde til fremstilling af en flad pladekomponent (K) ved hjælp af et trækapparat, der omfatter med første struktur (O) med en trækmatrice (1) og en anden struktur (U) med et trækstempel (2), idet mindst den første struktur (O) eller
20 den anden struktur (U) i det mindste delvis indstilles translatorisk, og der på den anden struktur (U) foruden trækstempellet (2) er anbragt mindst en i forhold til trækstempellet (2) translatorisk indstillelig pladeholder (3) for at presse trækmatricen (1) og trækstempellet (2) mod hinanden og forme pladekomponenten (K) ved trækning ud fra et pladeemne (K'), der befinder sig mellem trækmatricen (1) og
25 trækstempellet (2) og er udformet som enkeltplatin, idet en ydre rand af det pladeemne (K'), der skal trækkes, holdes på pladeholderen (3), ved hvilken

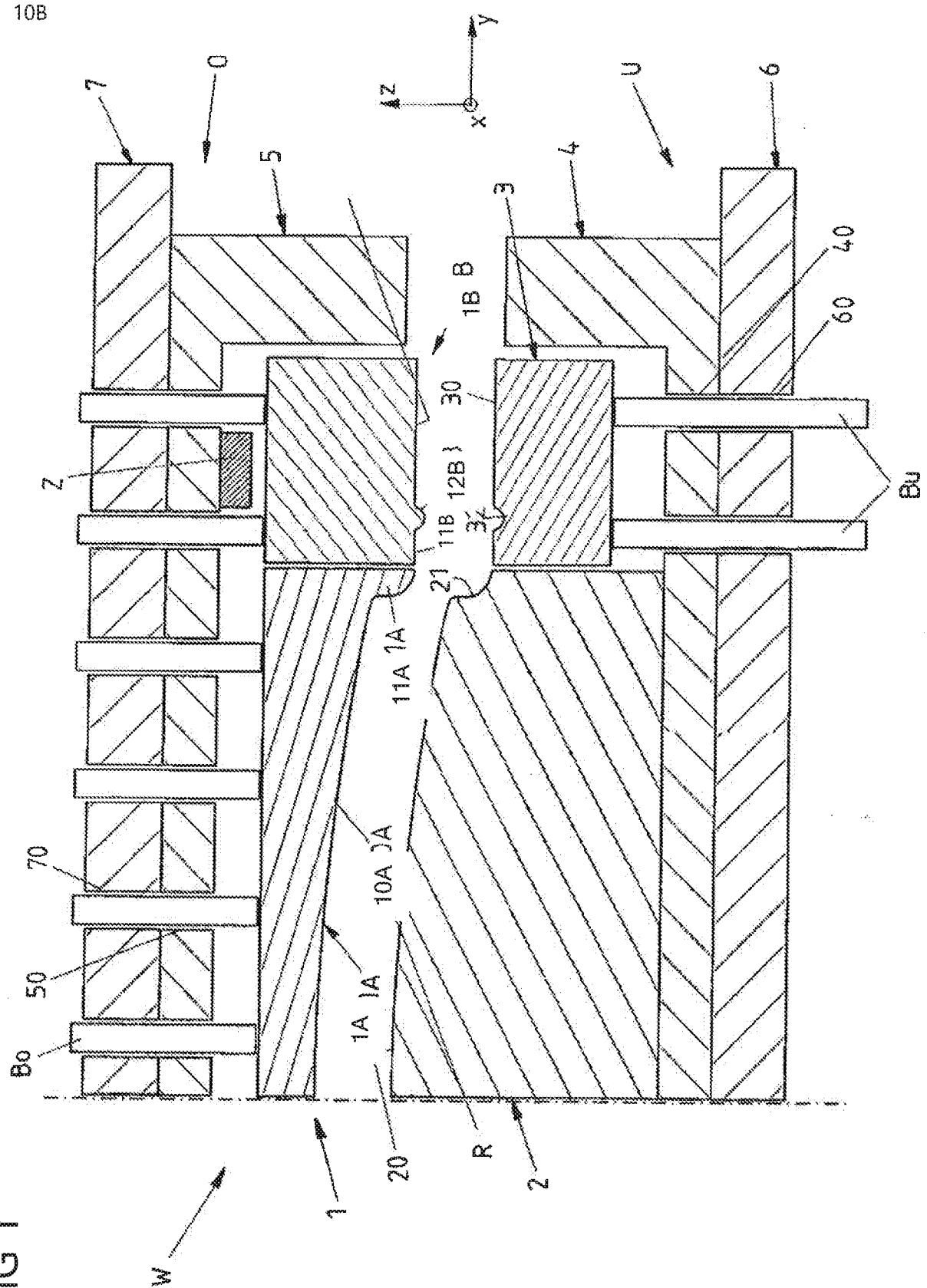
- den første strukturs (O) trækmatrice (1) er fremstillet mindst todelt med en indre matrice (1A) og en ydre matrice (1B), idet den indre matrice (1A) og
30 den ydre matrice (1B) kan indstilles i forhold til hinanden på den første struktur (O), og

- den ydre matrice (1B) og den i forhold til trækstemplet (2) translatorisk indstillelige pladeholder (3) ligger over for hinanden, og den ydre matrice (1B) og pladeholderen (3) holder mellem hinanden ved presningen af den todelte trækmatrice (1) og trækstemplet (2) mod hinanden et affaldsstykke (A) af pladeemnet (K'), der skilles fra ved presningen af trækmatricen (1) og trækstemplet (2) mod hinanden på det trukne pladeemnes (K') ydre rand,

kendetegnet ved, at

der til fraskillelsen af affaldsstykket (A) på den første struktur (O) er tilvejebragt et skær (9) og på den anden struktur (U) desuden er tilvejebragt en stempeltilføjelse (2B), der er anbragt mellem pladeholderen (3) og et indføringsområde (E) til skæret (9) i den første struktur (O).

FIG 1



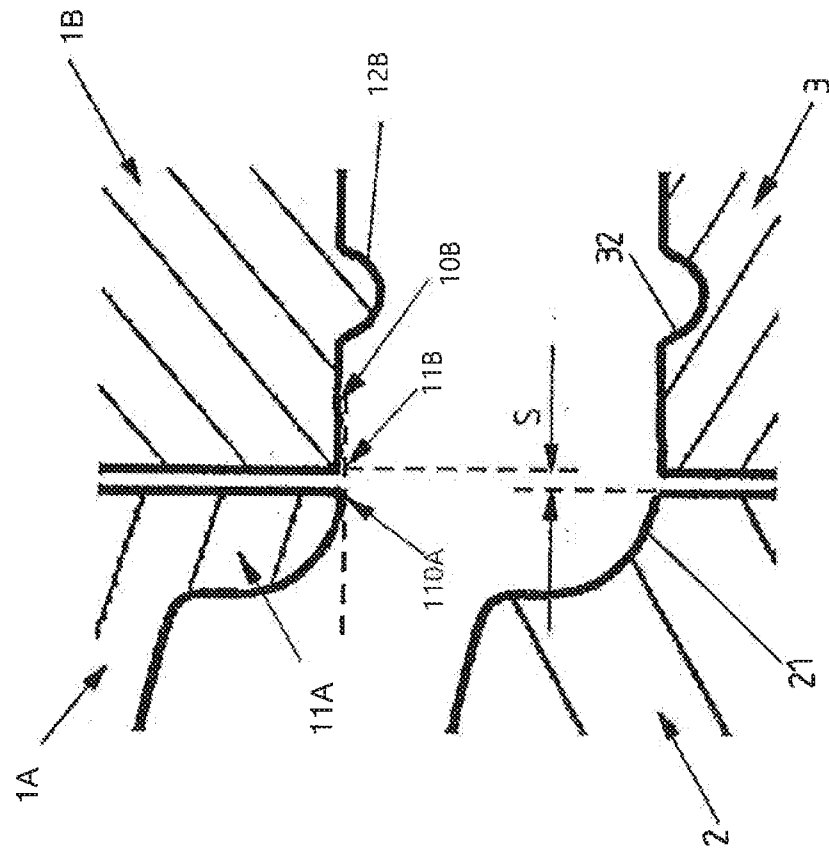
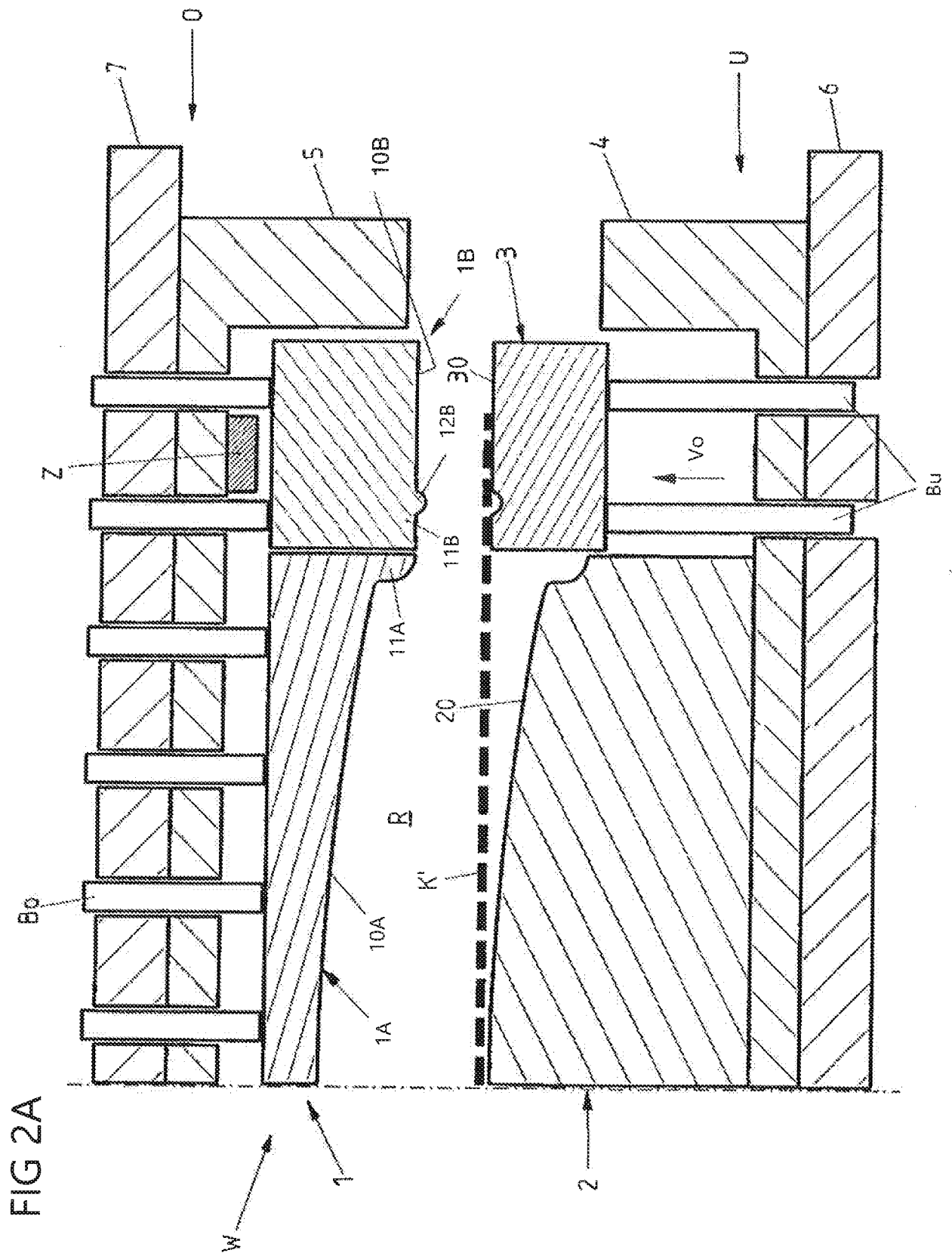
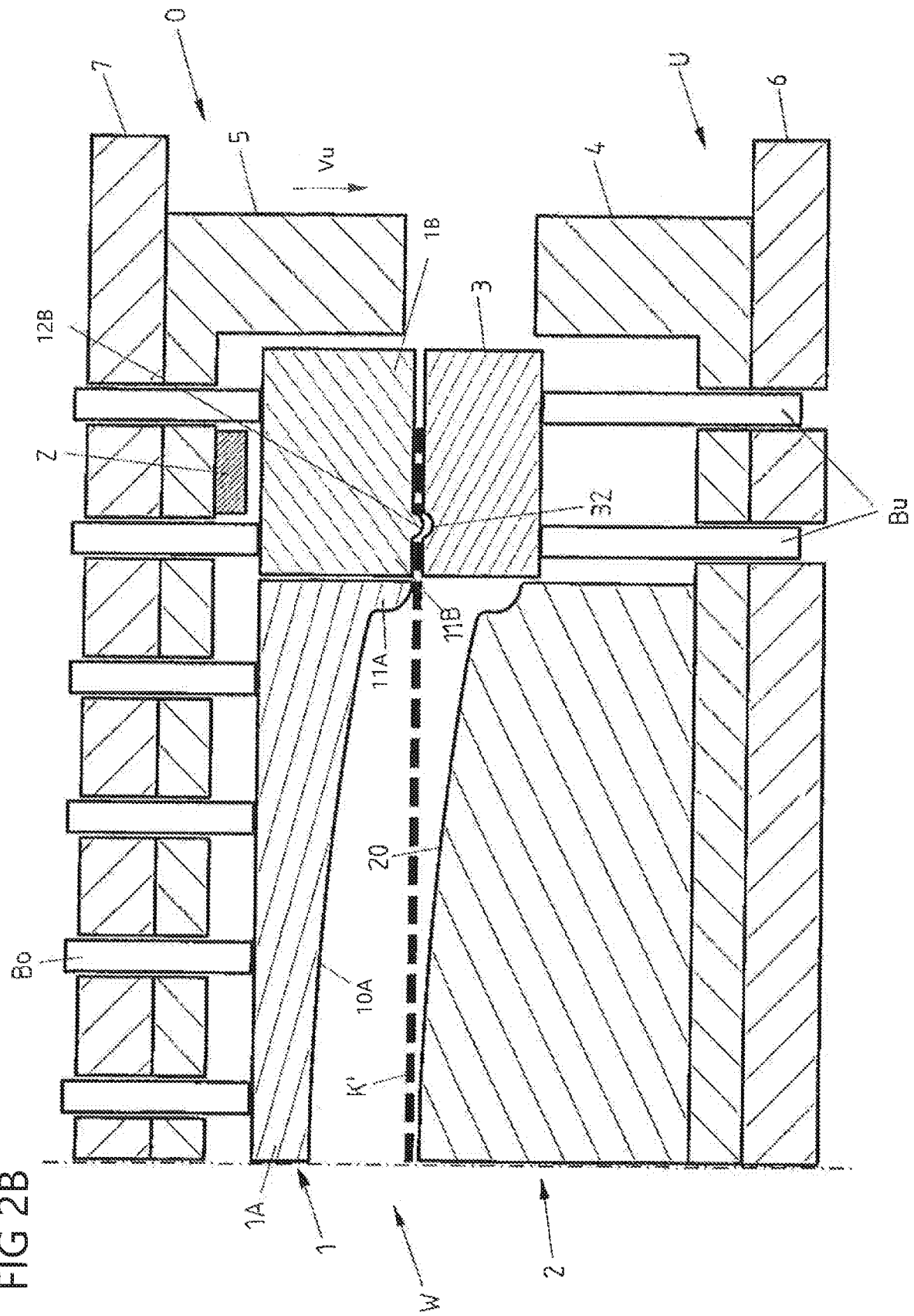
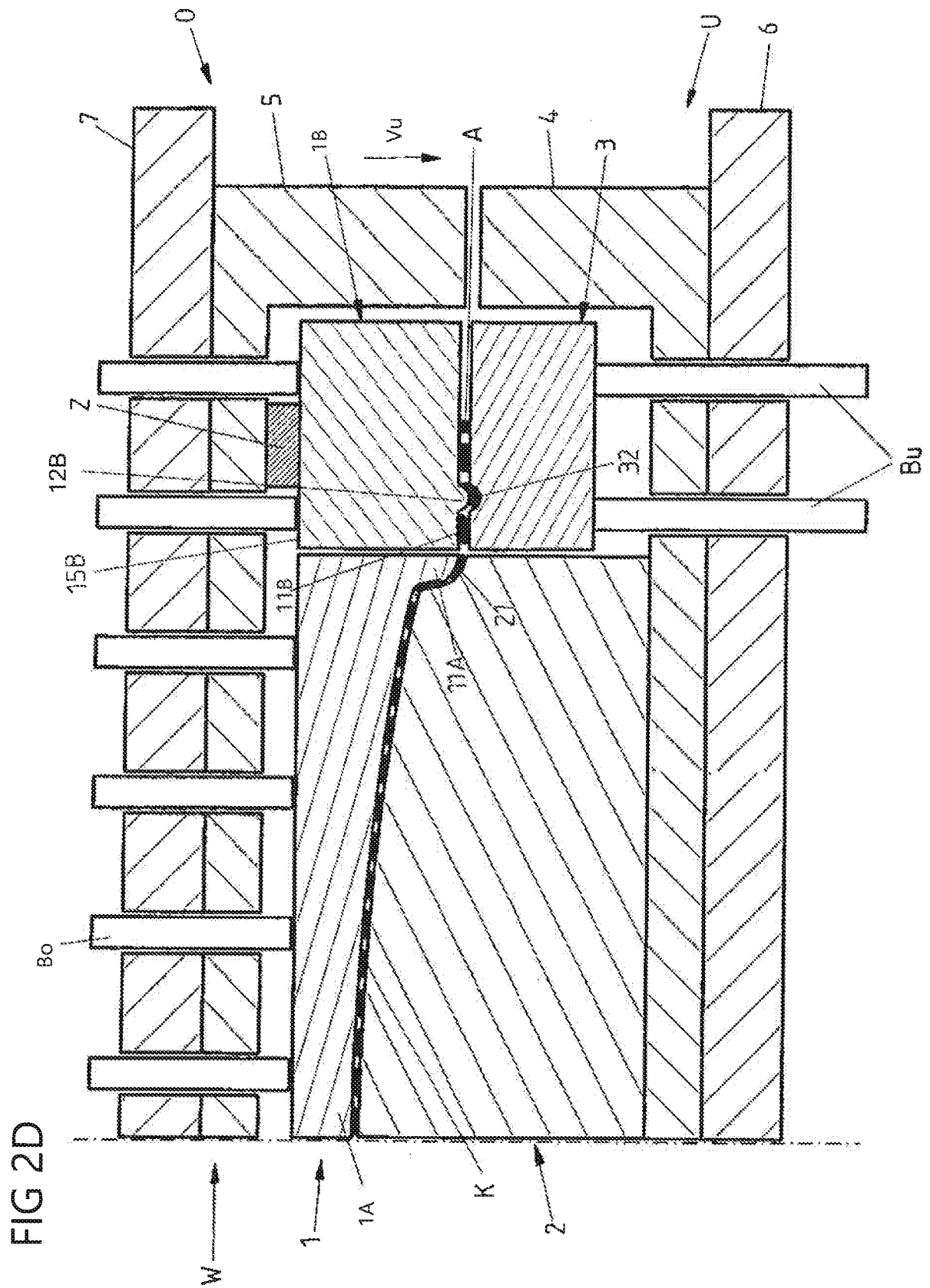
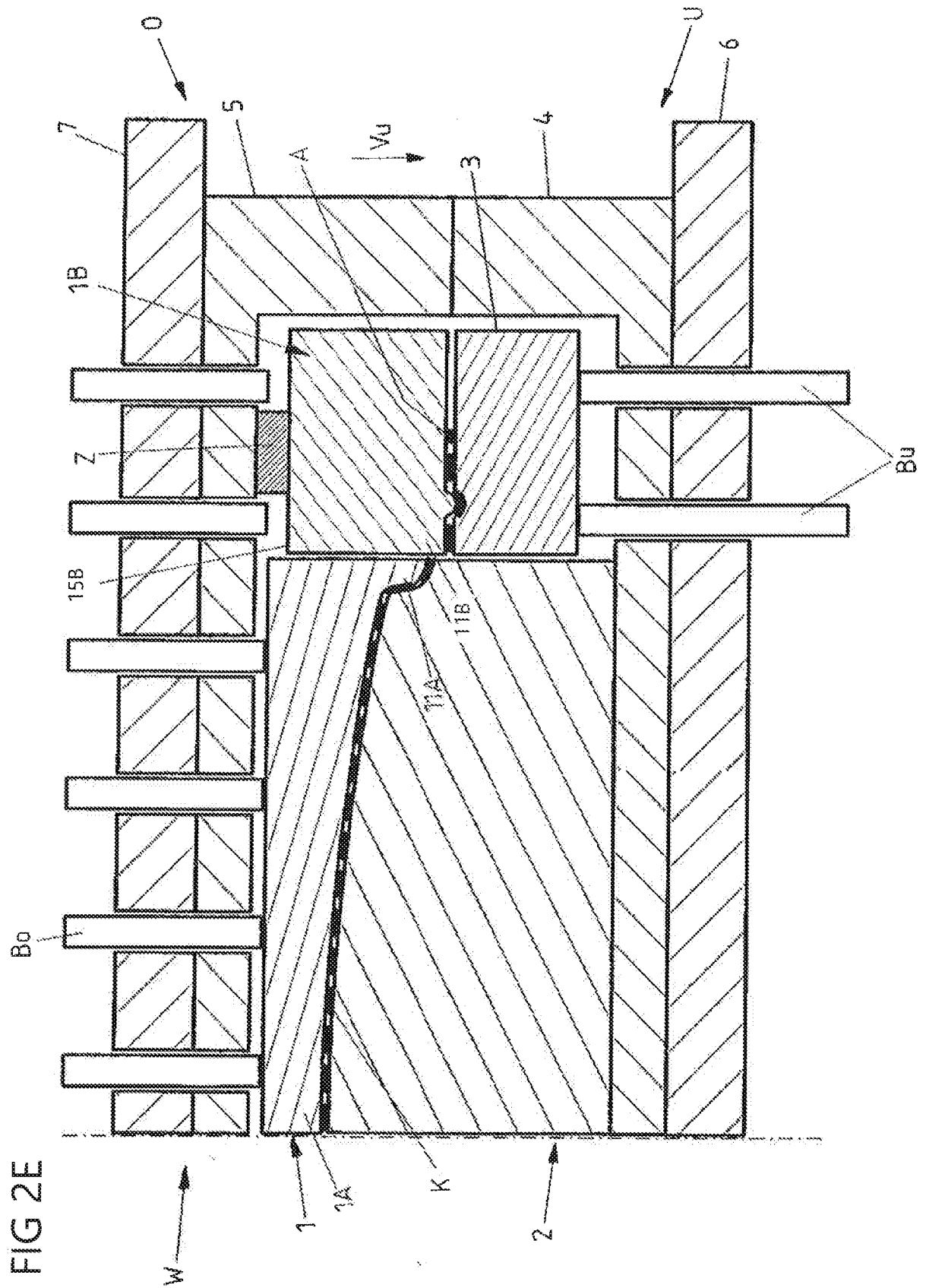


FIG 1A

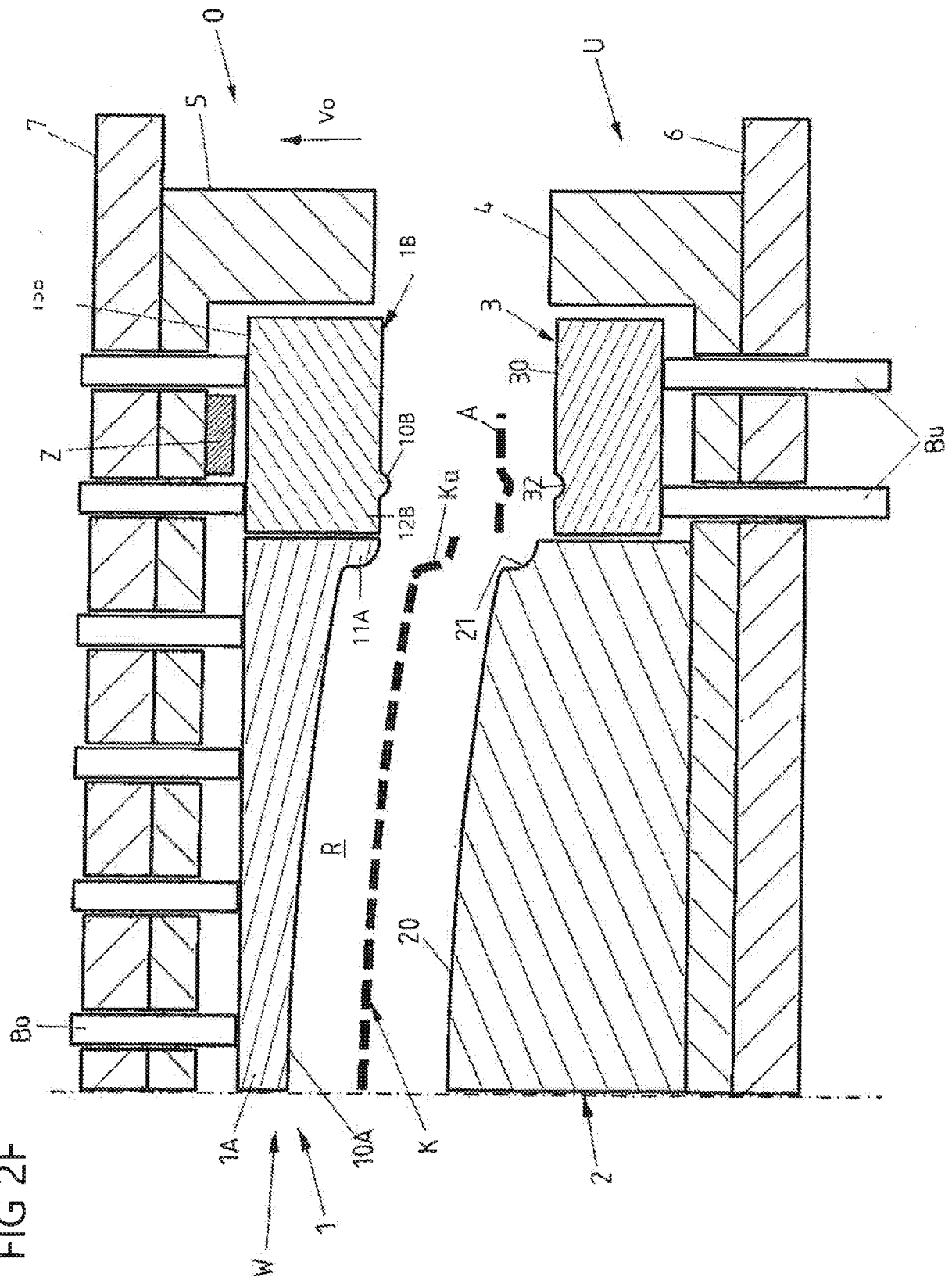


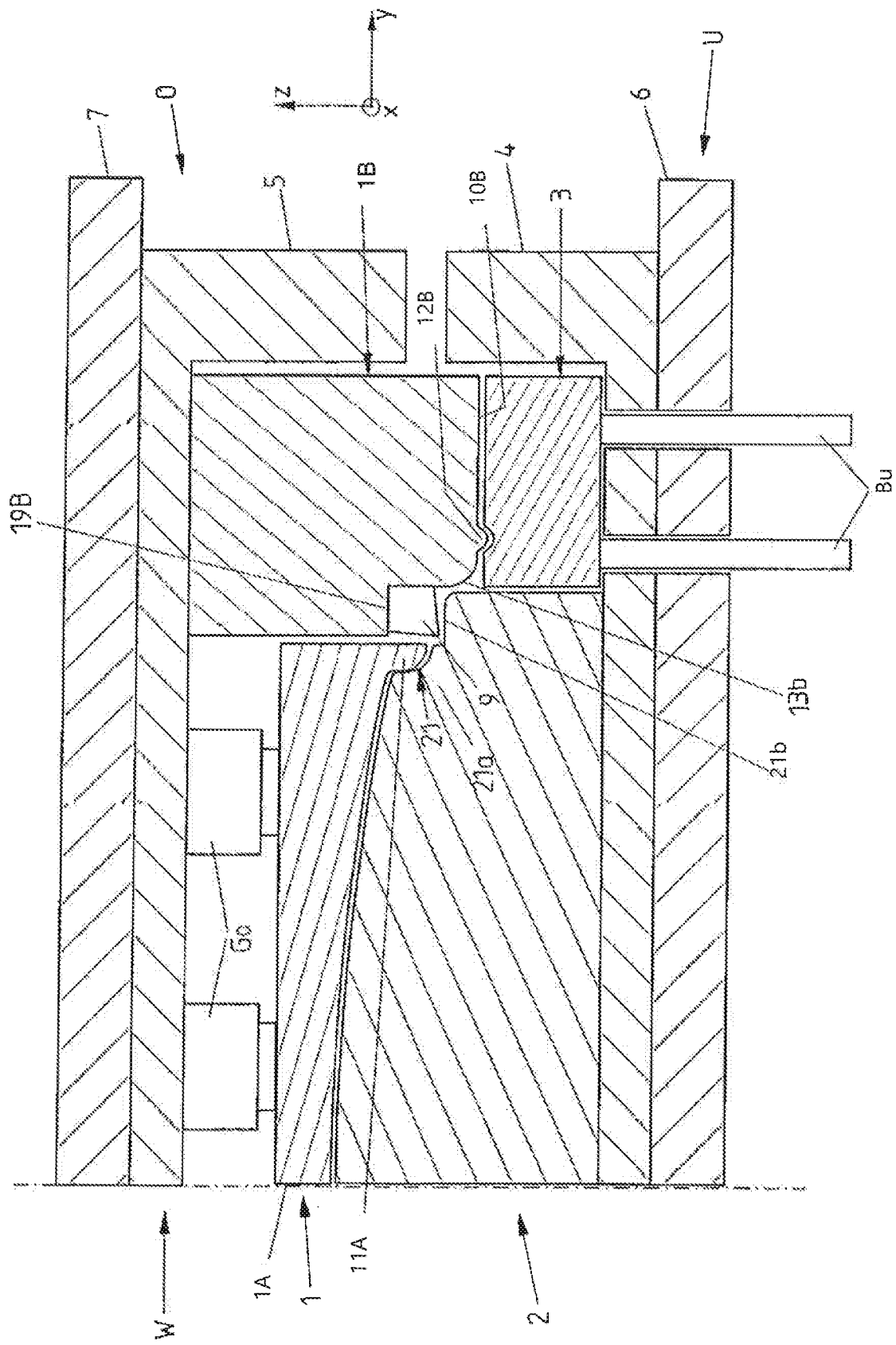






LENG



3
G
L

4A
GF

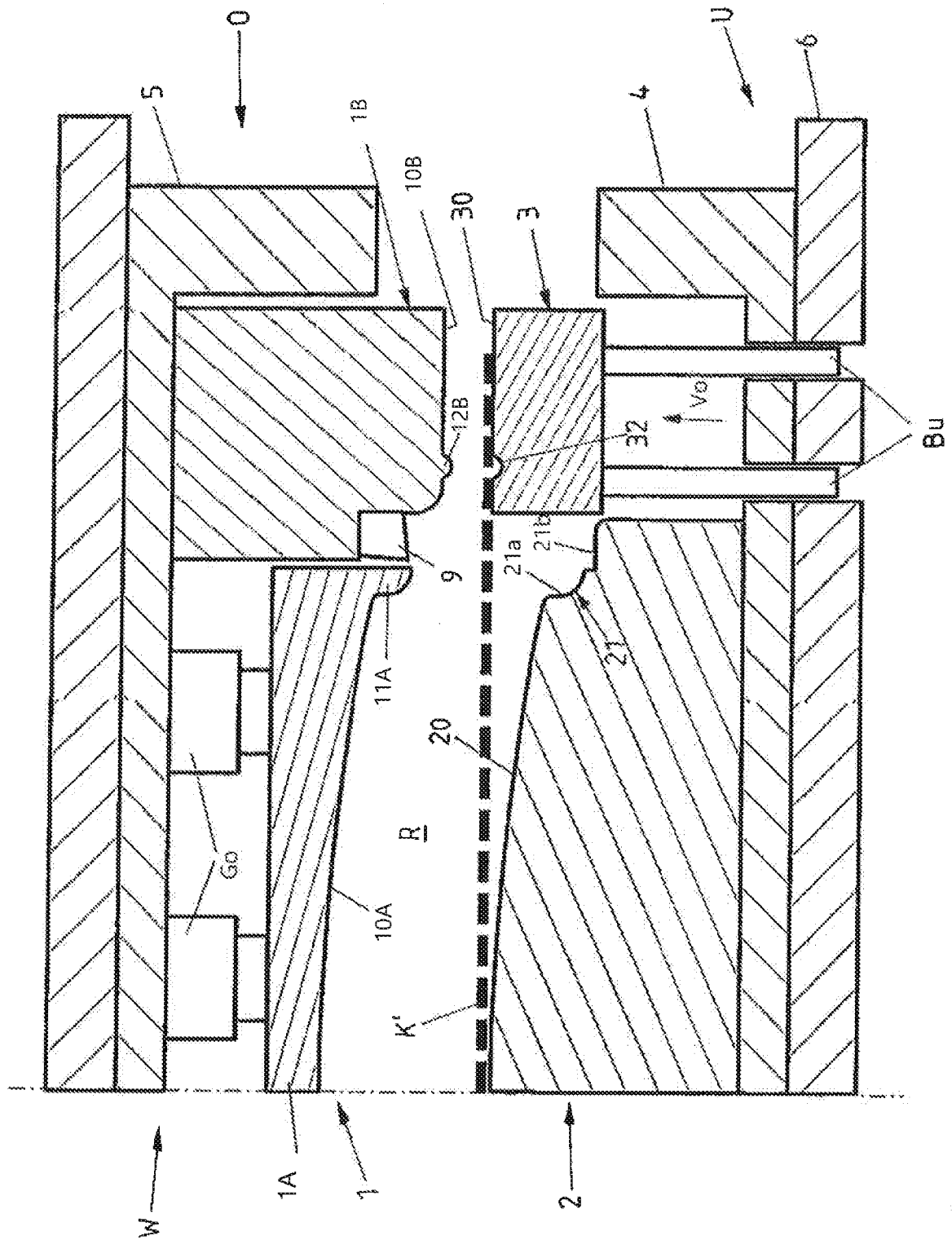


FIG 4B

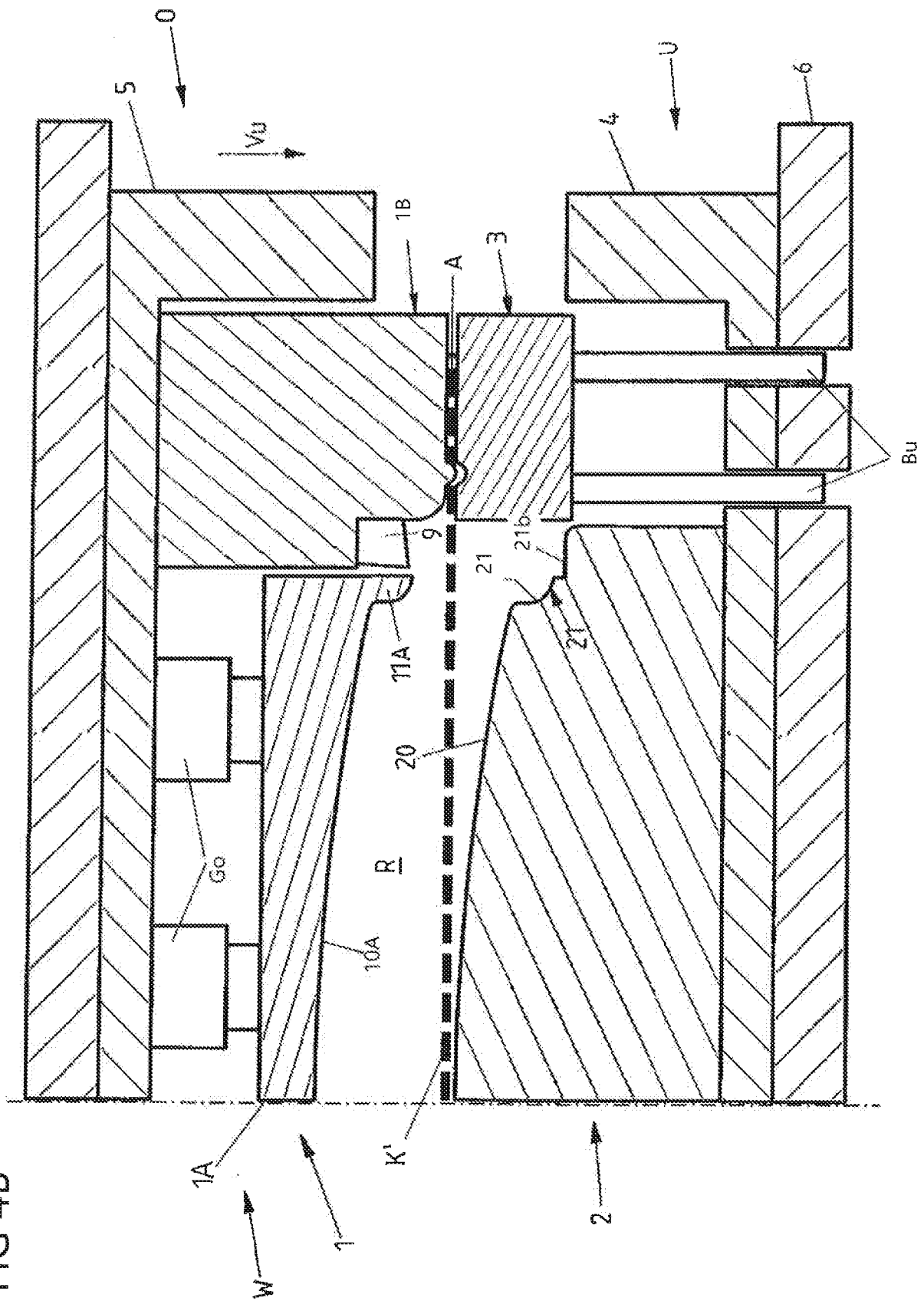


FIG 4C

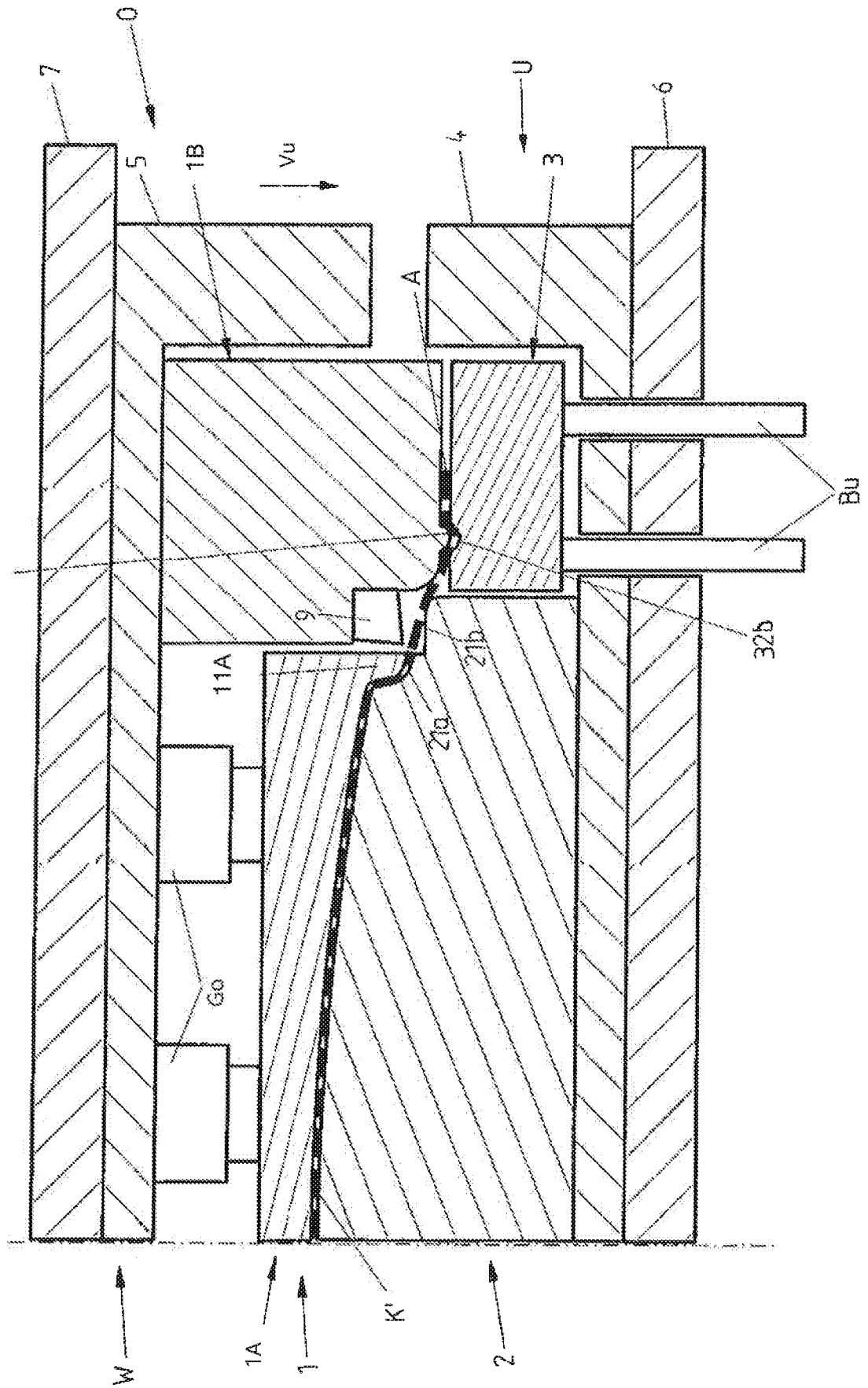


FIG 4D

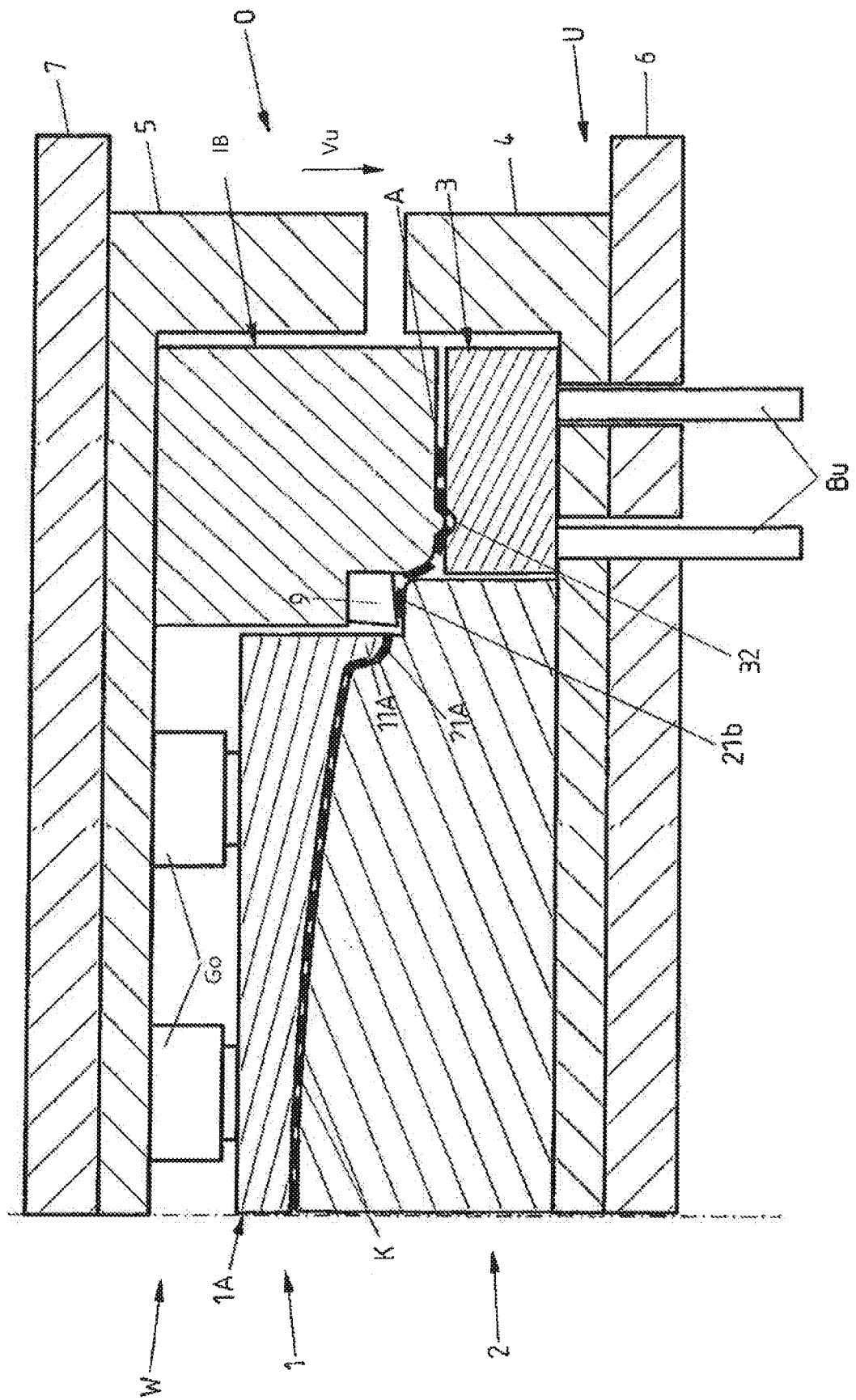
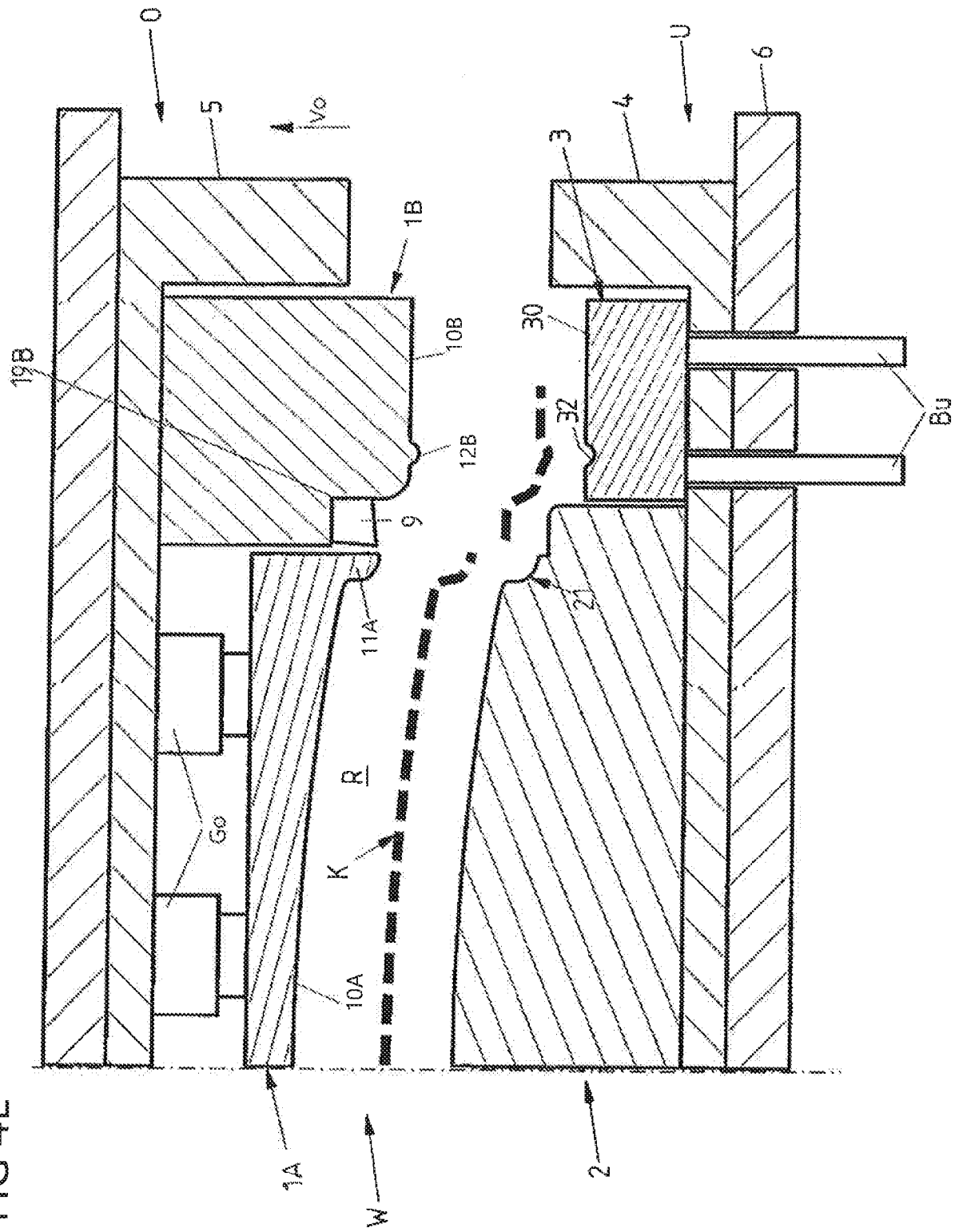


FIG 4E



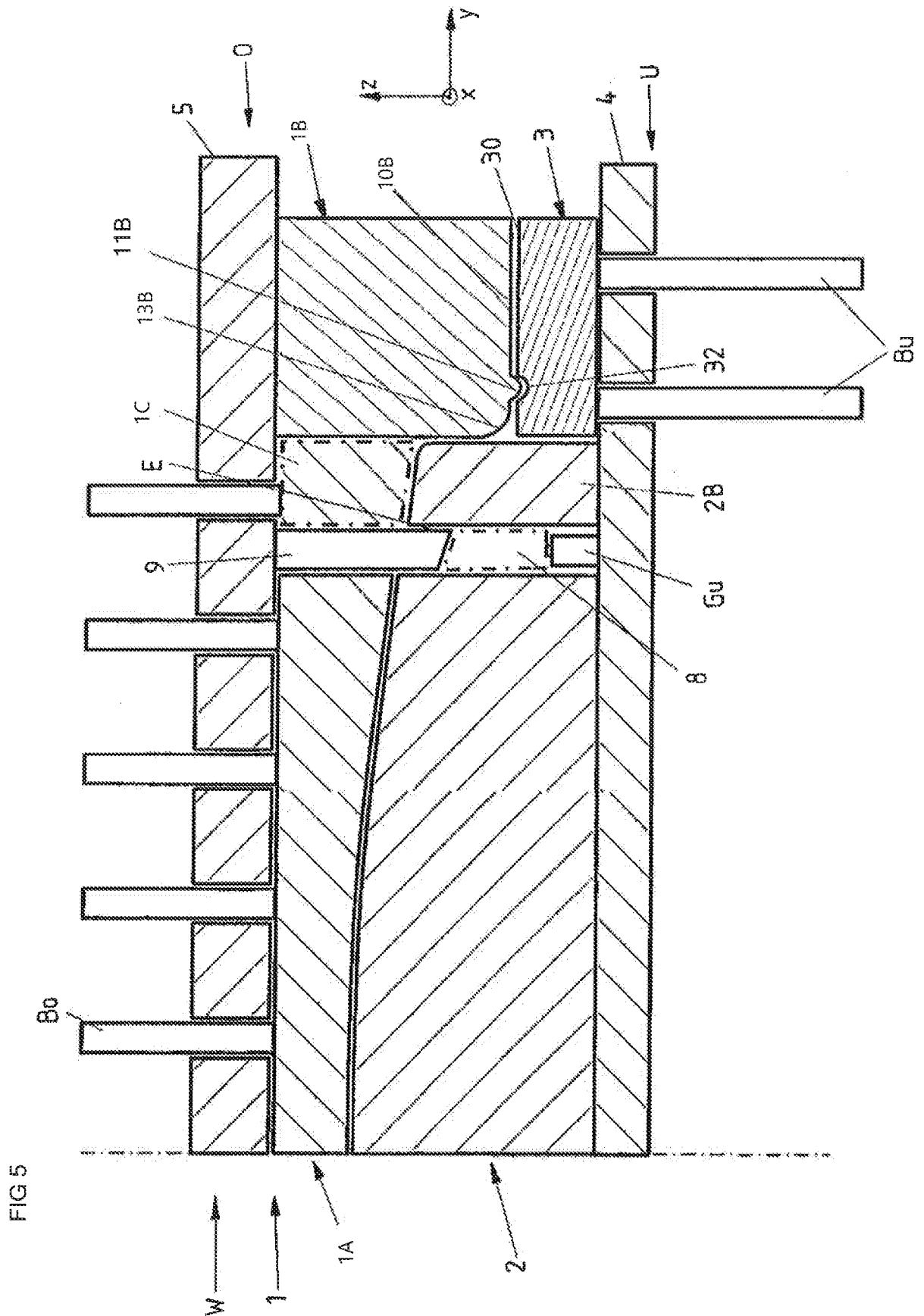
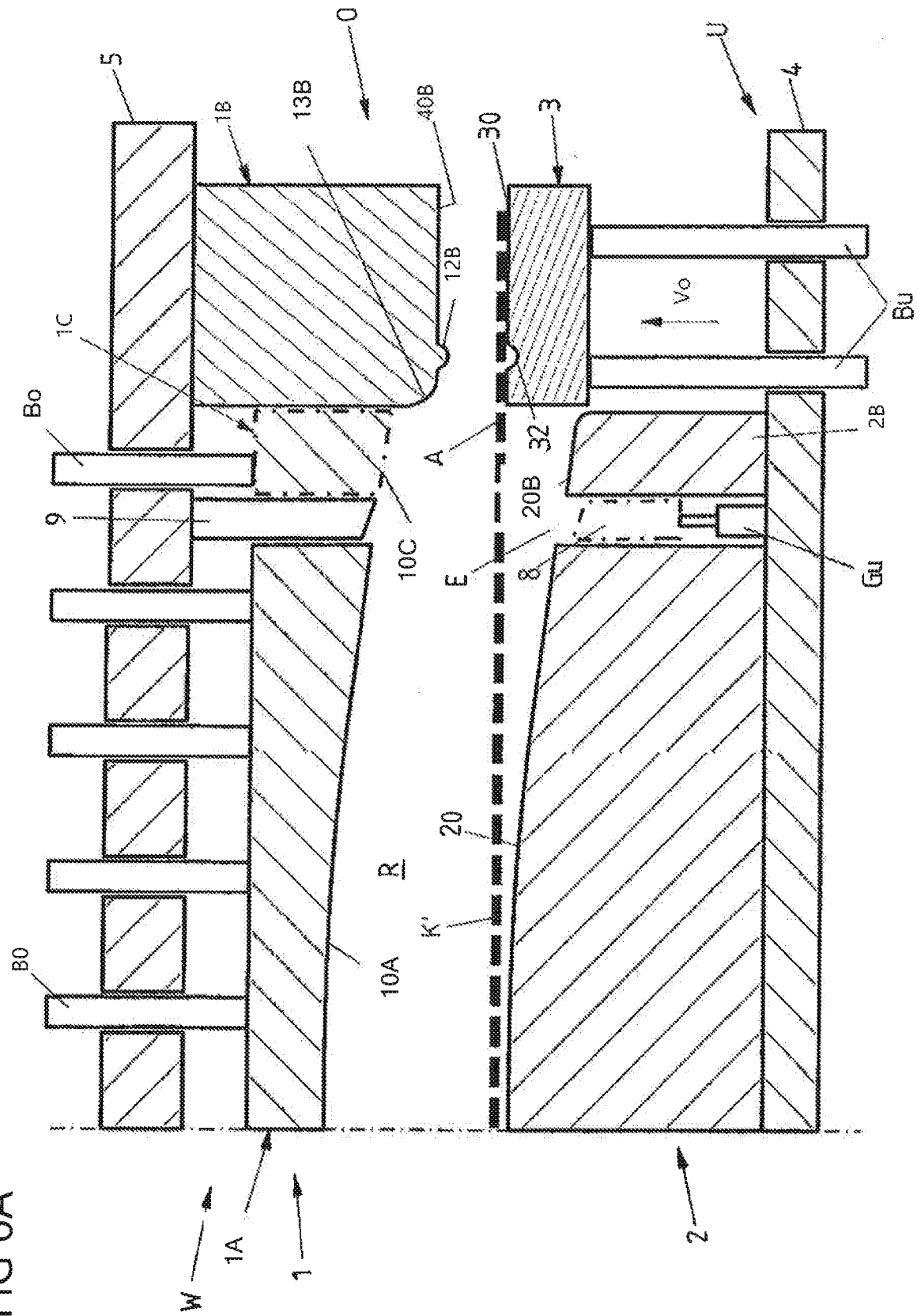
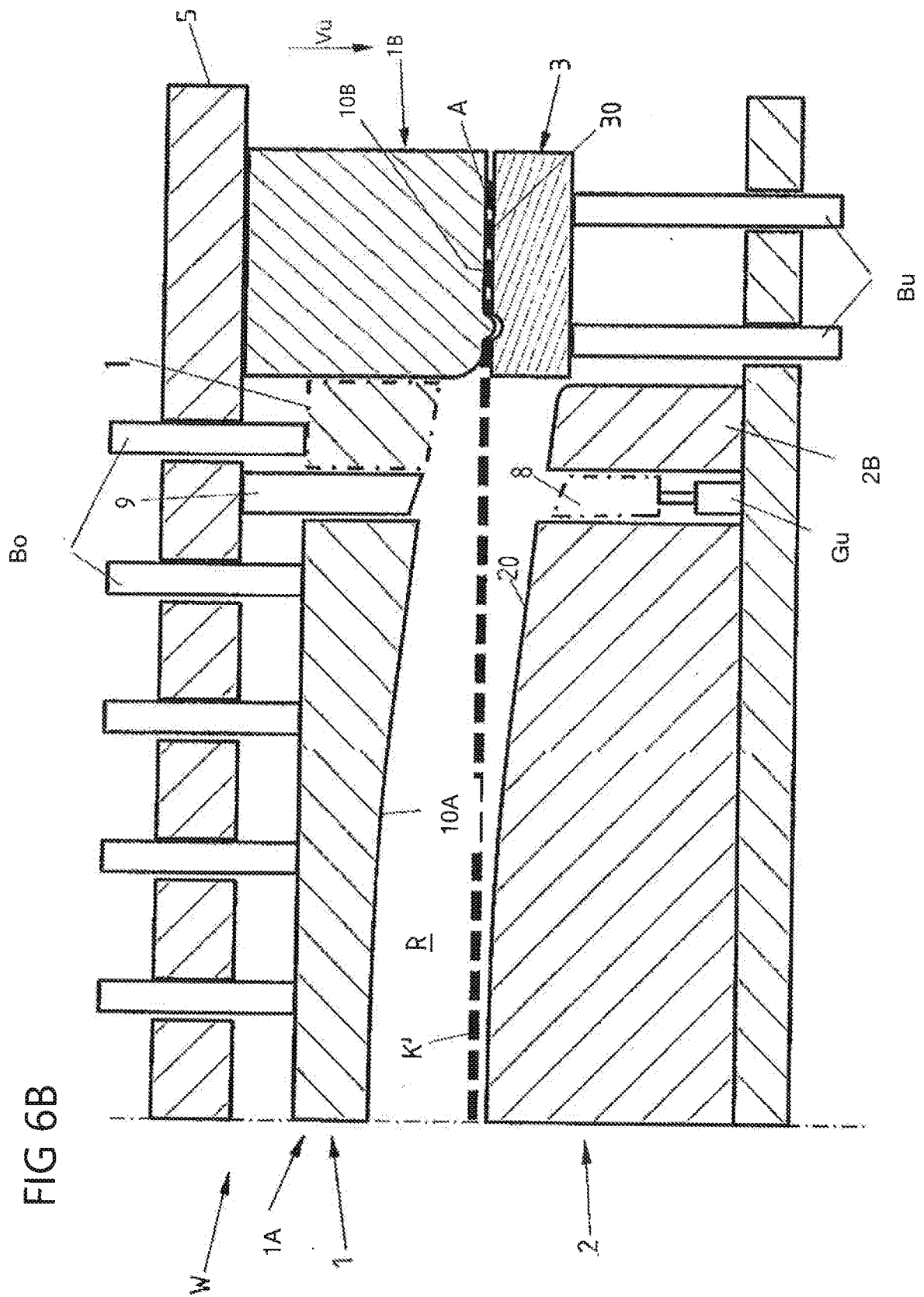
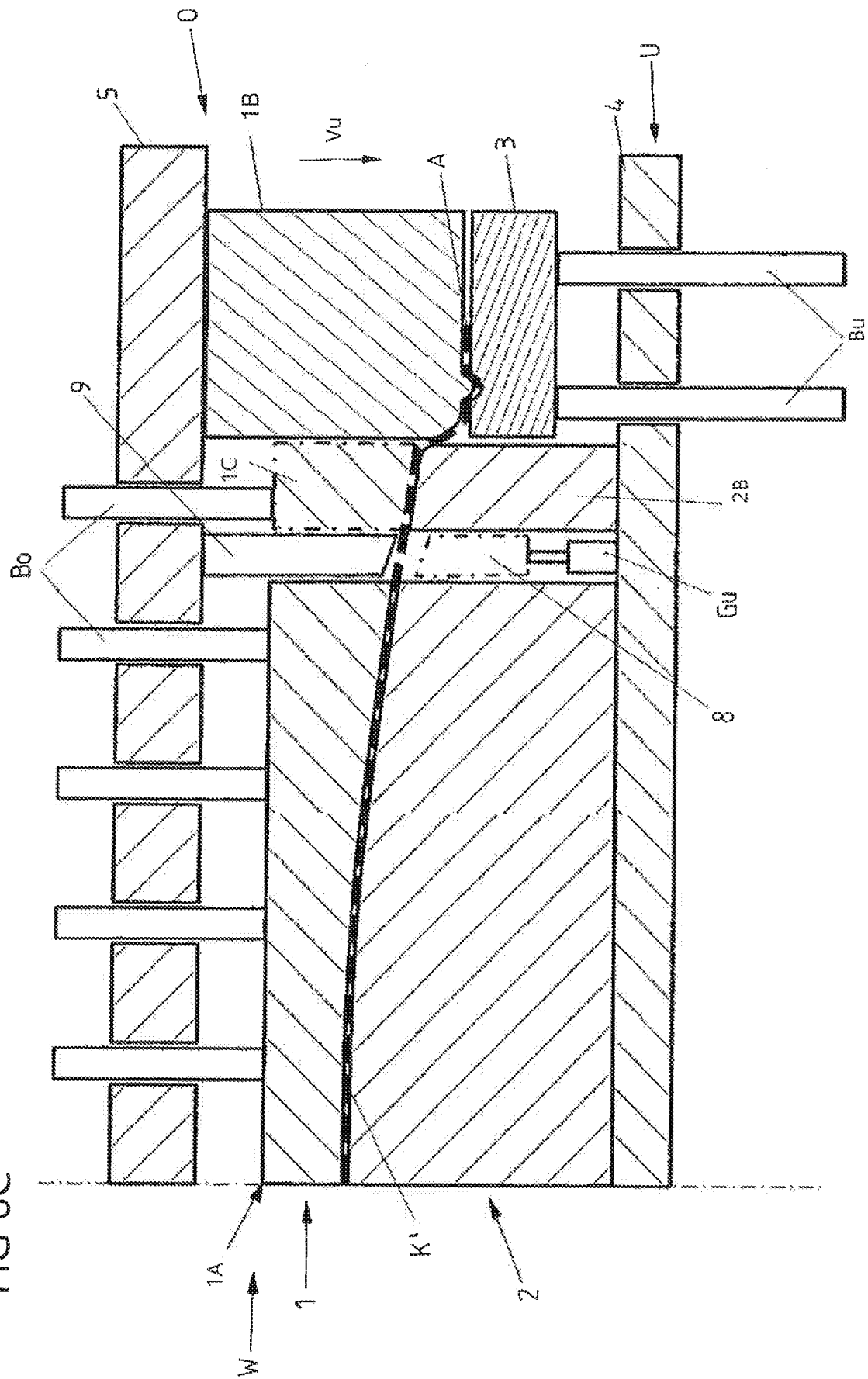


FIG 6A



மேலே





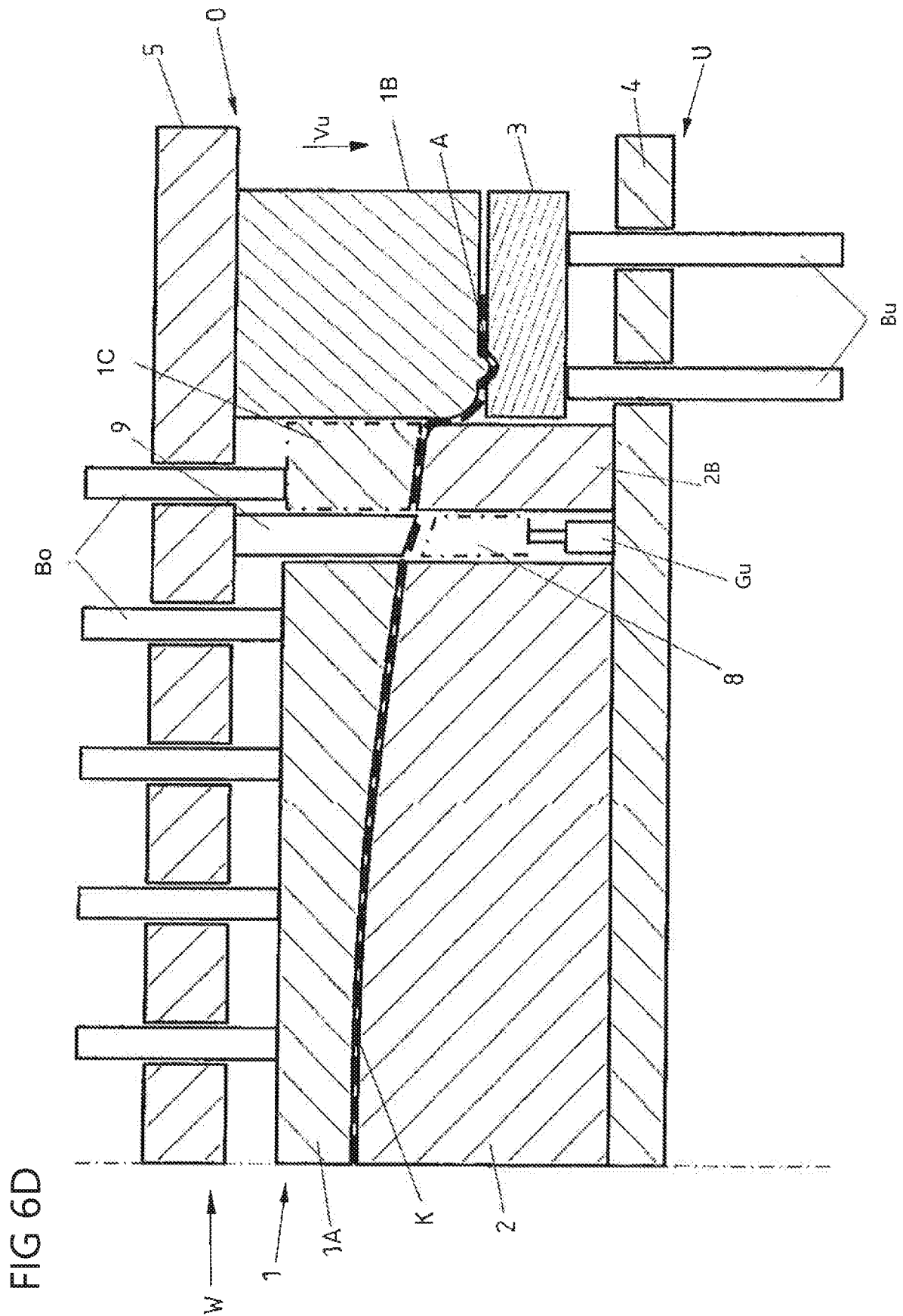
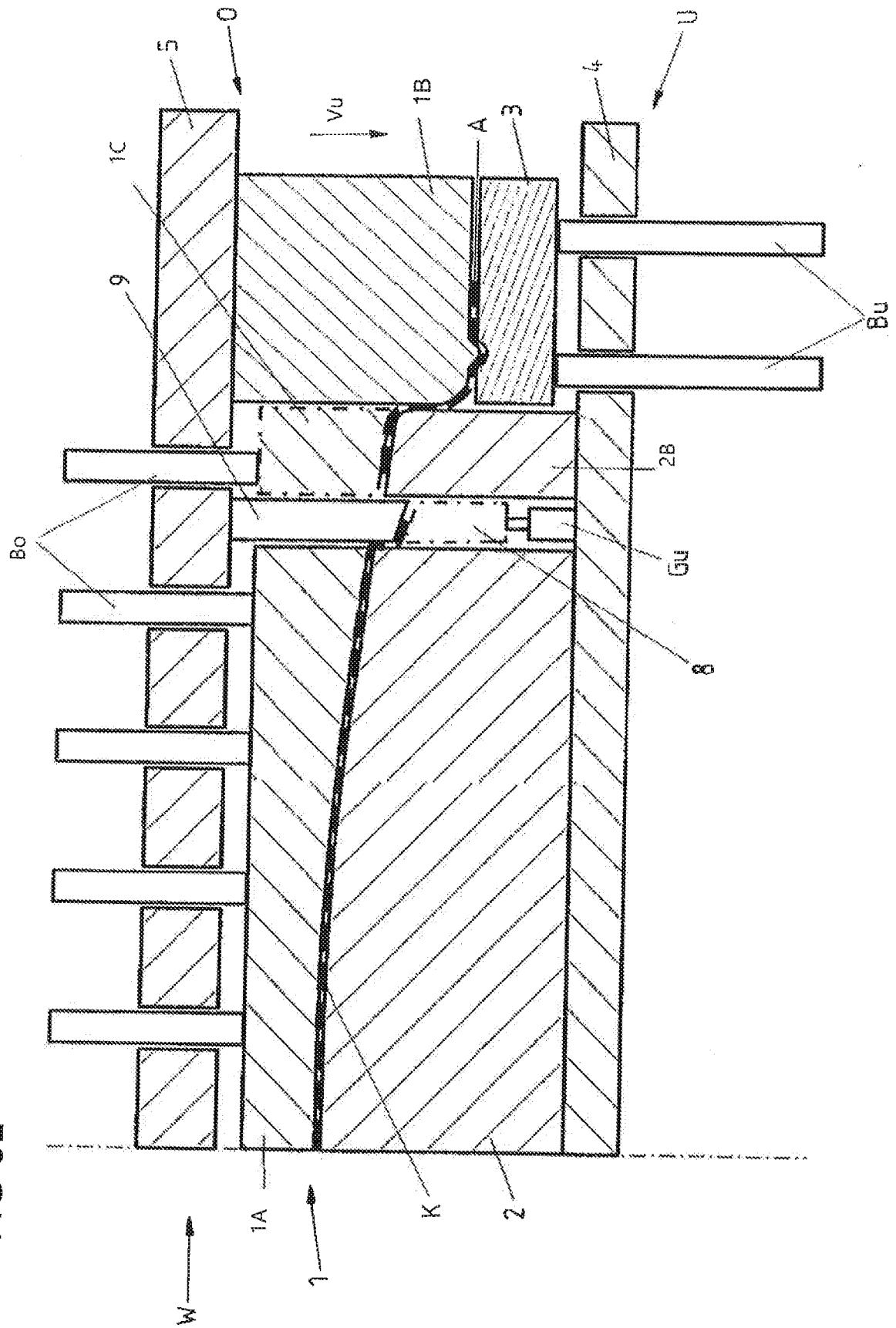
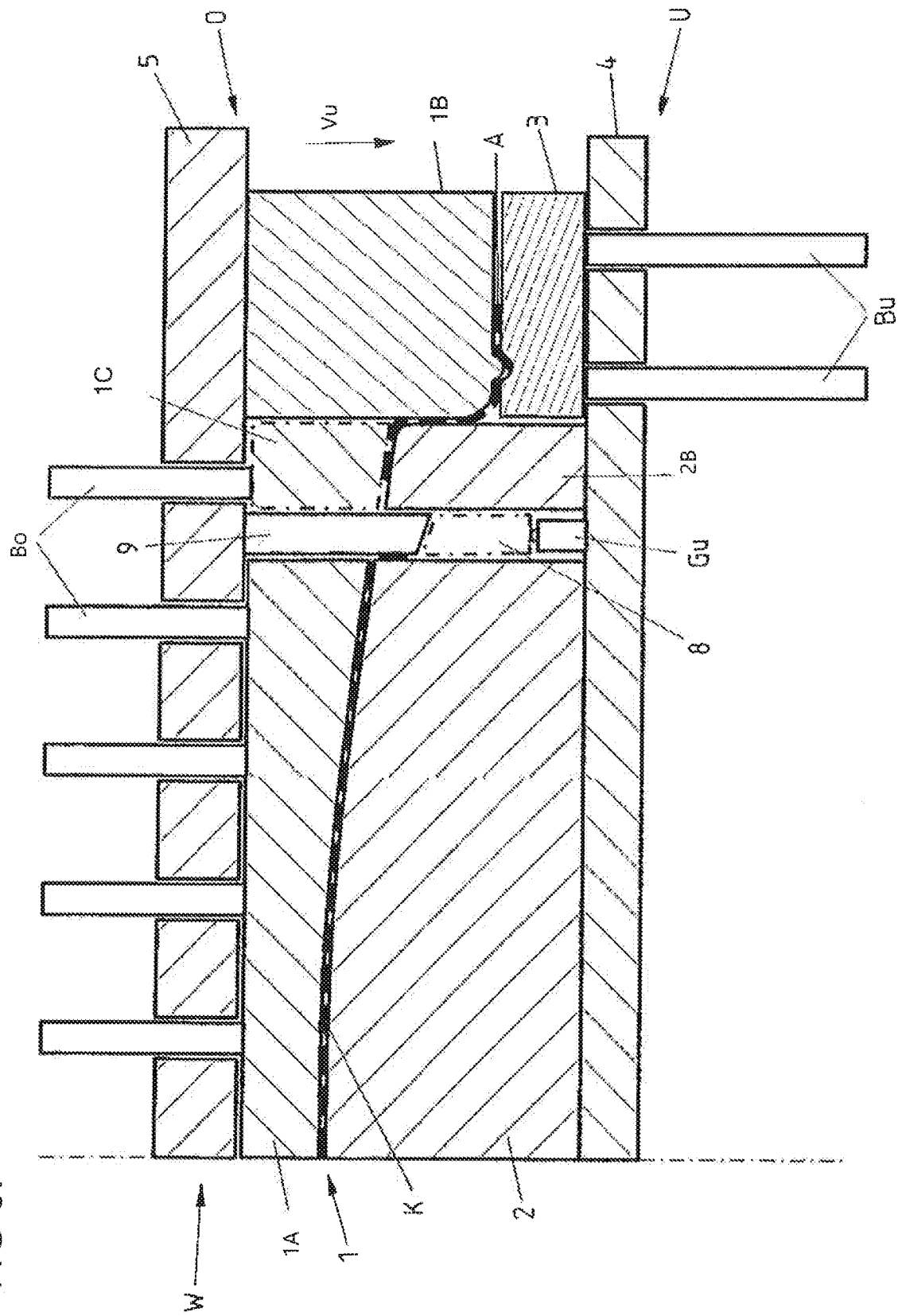


FIG 6E



LEGE



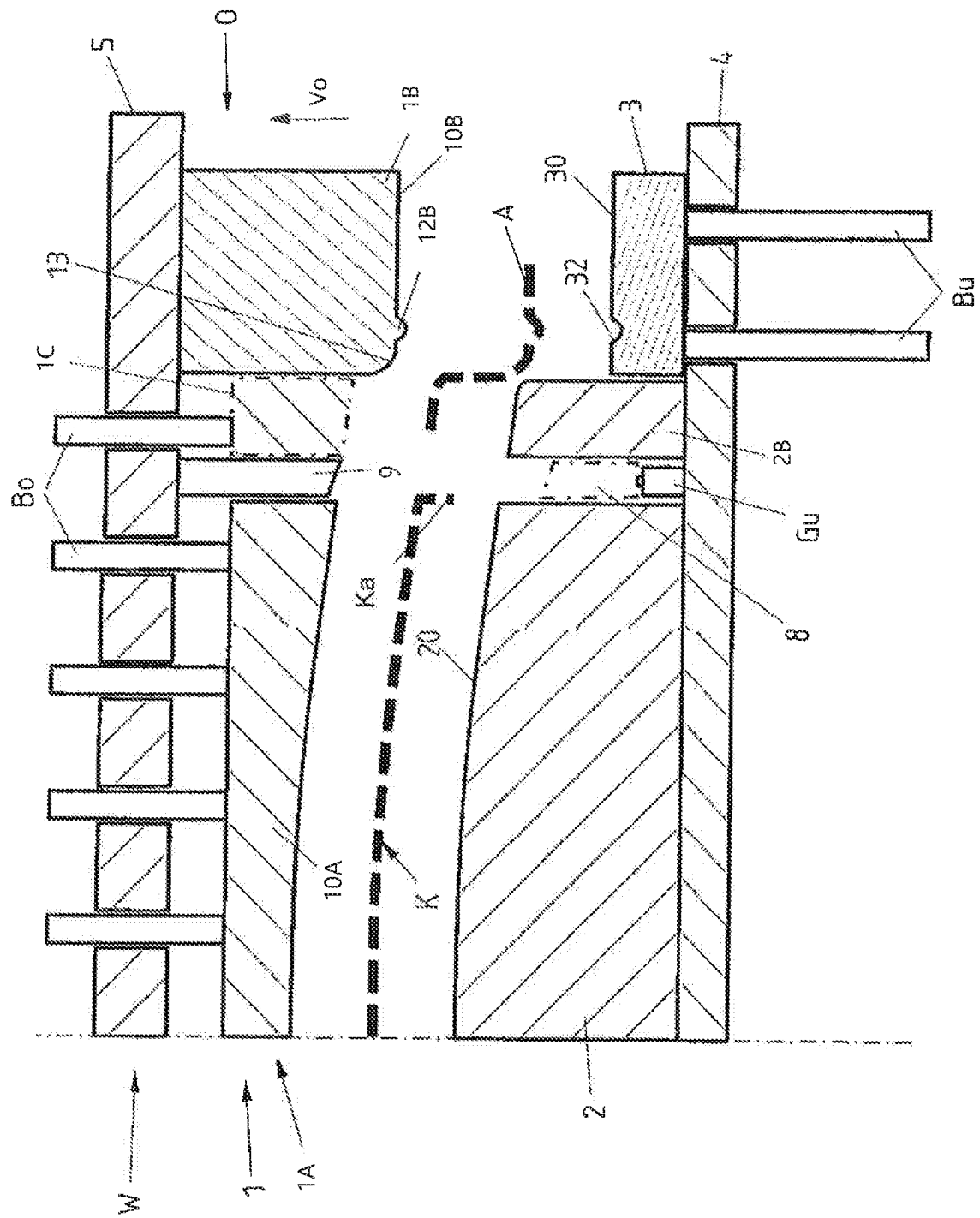


FIG 7

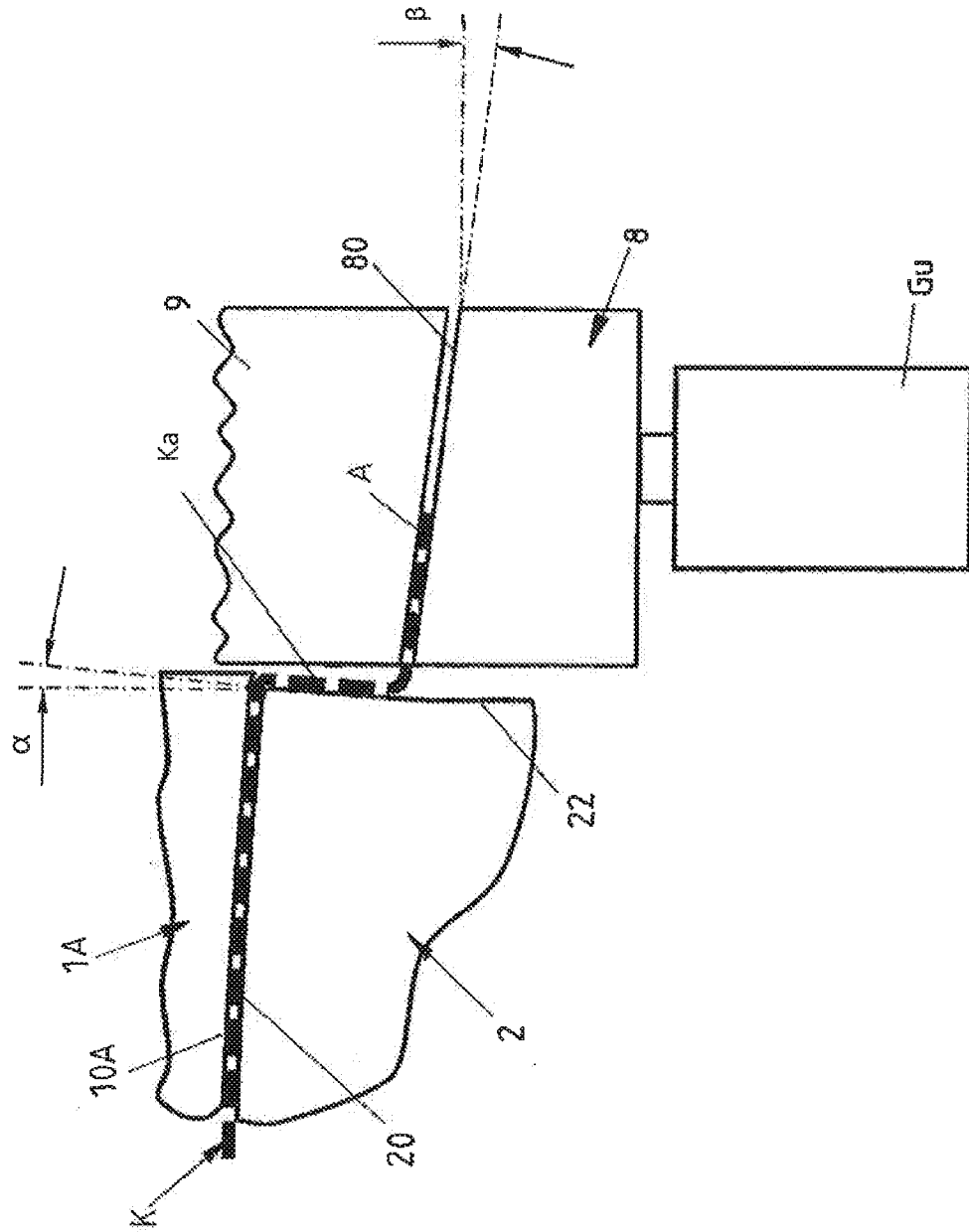
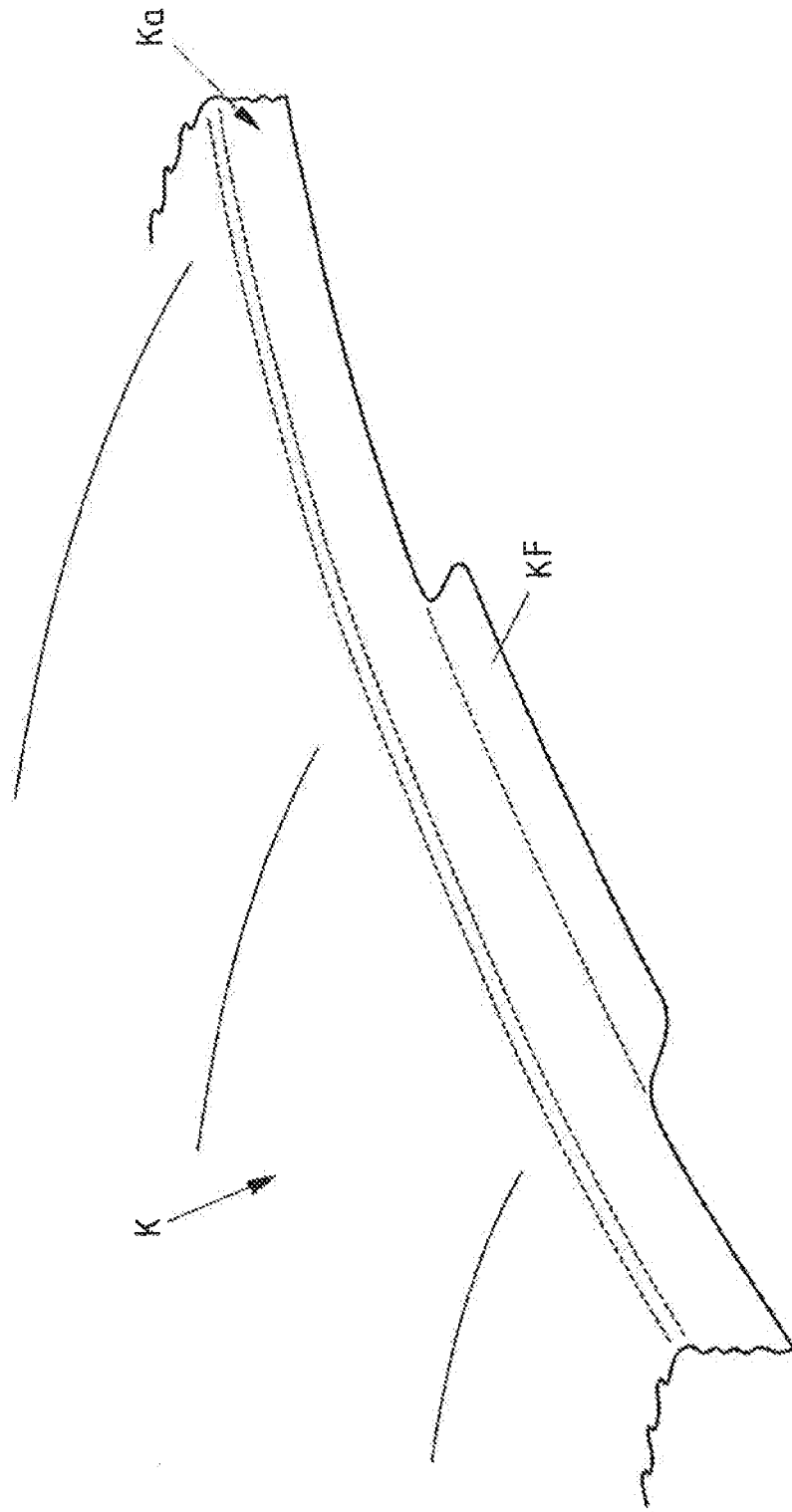


FIG 8



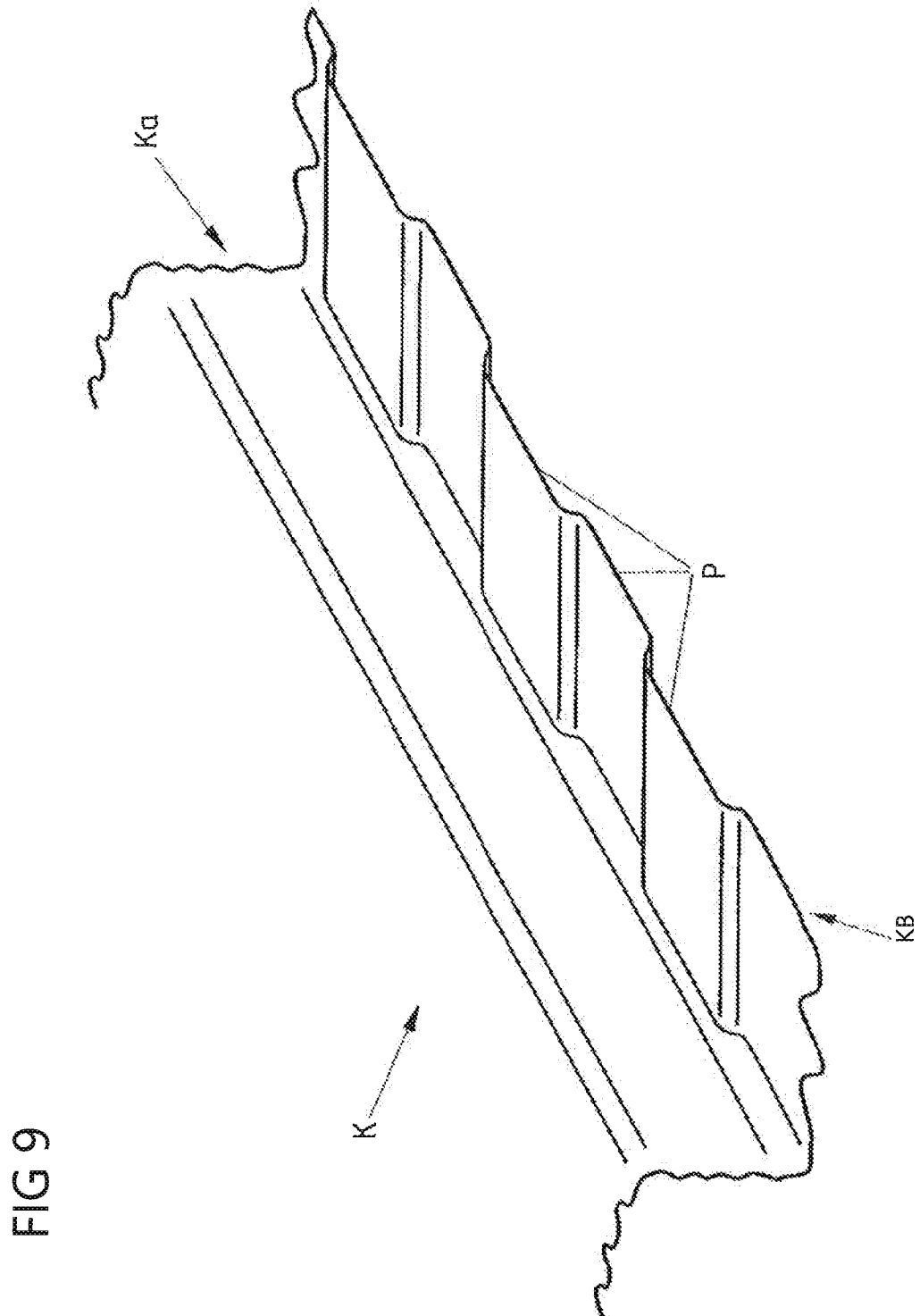


FIG 10A

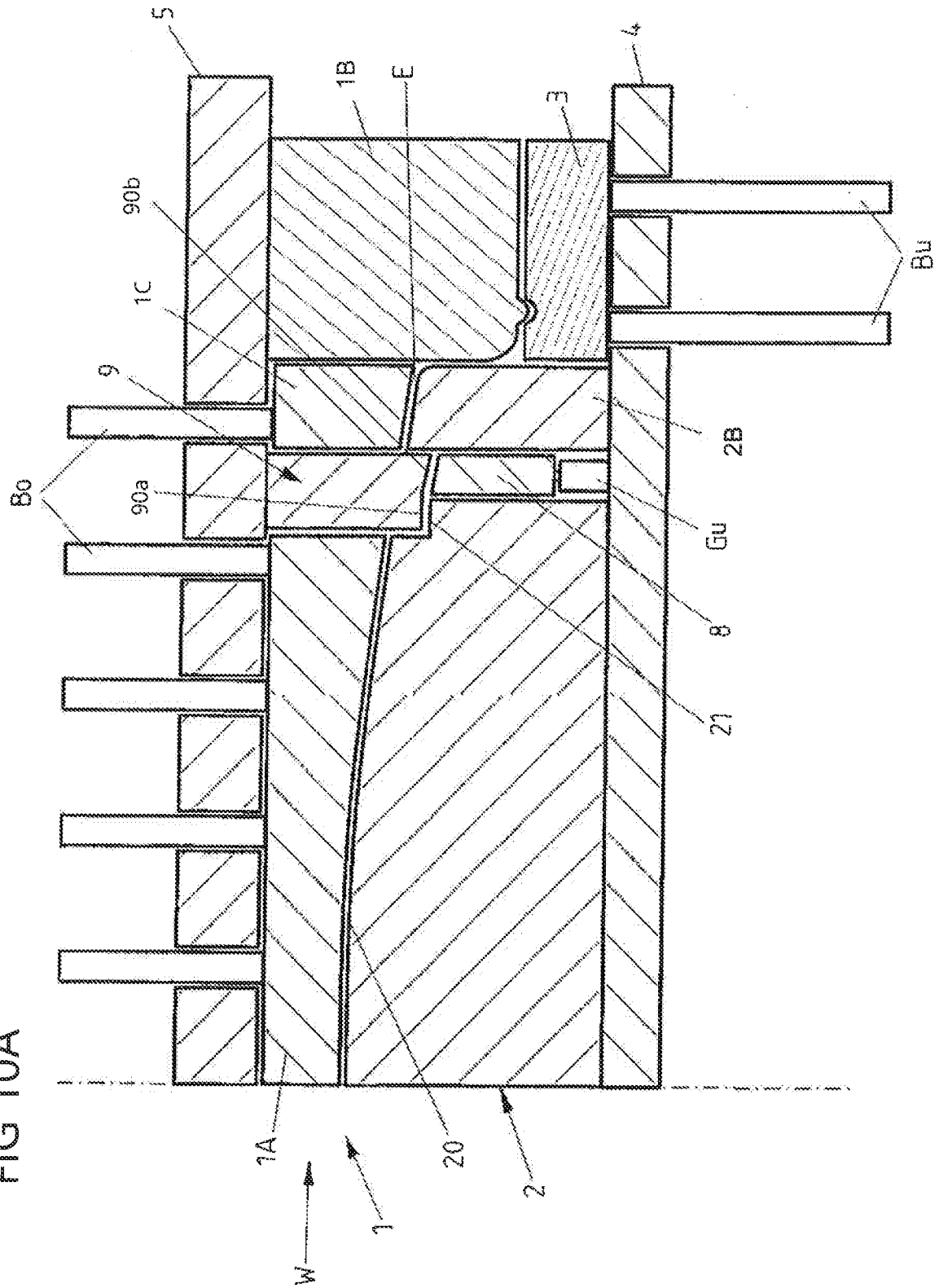


FIG 10B

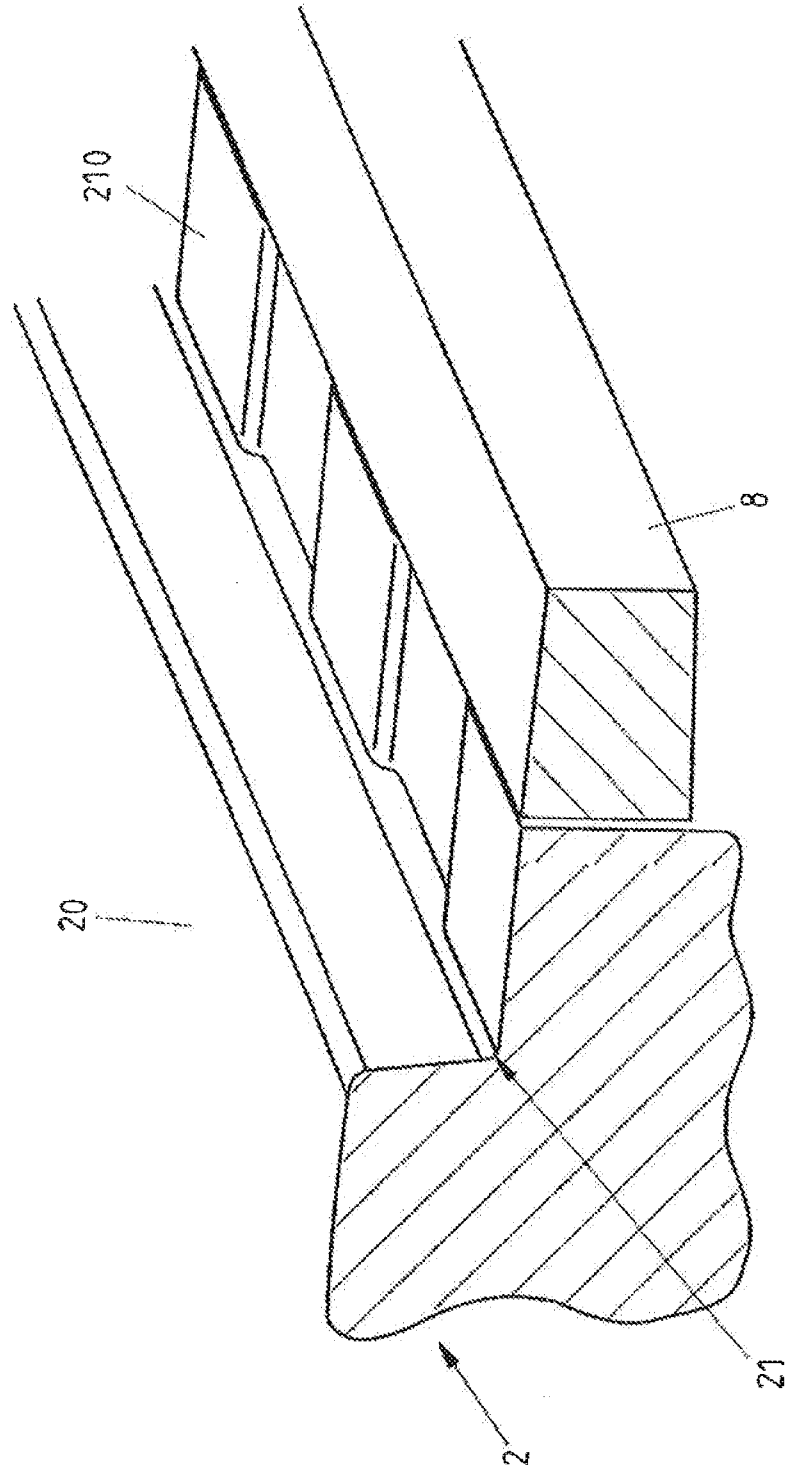
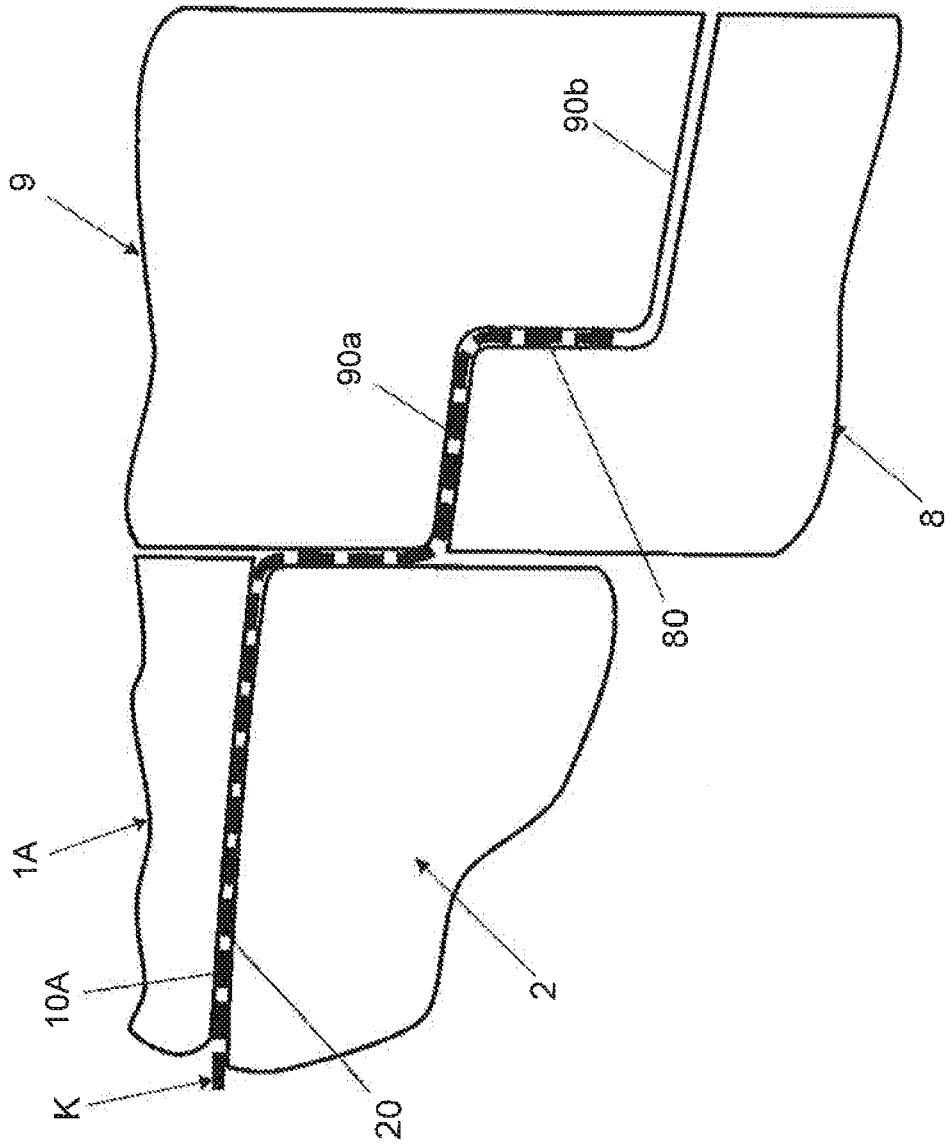


FIG 11



FILE

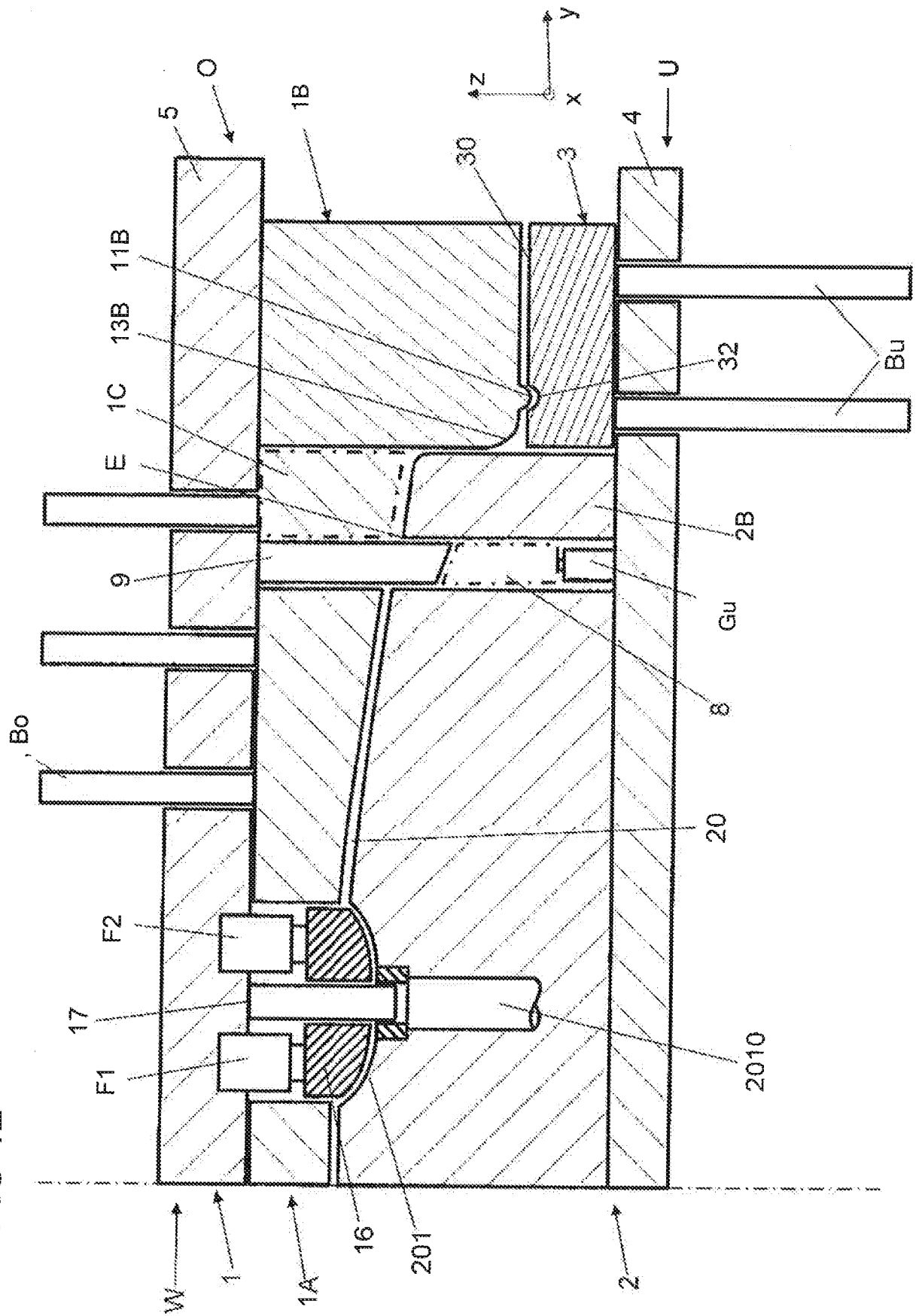


FIG 13A

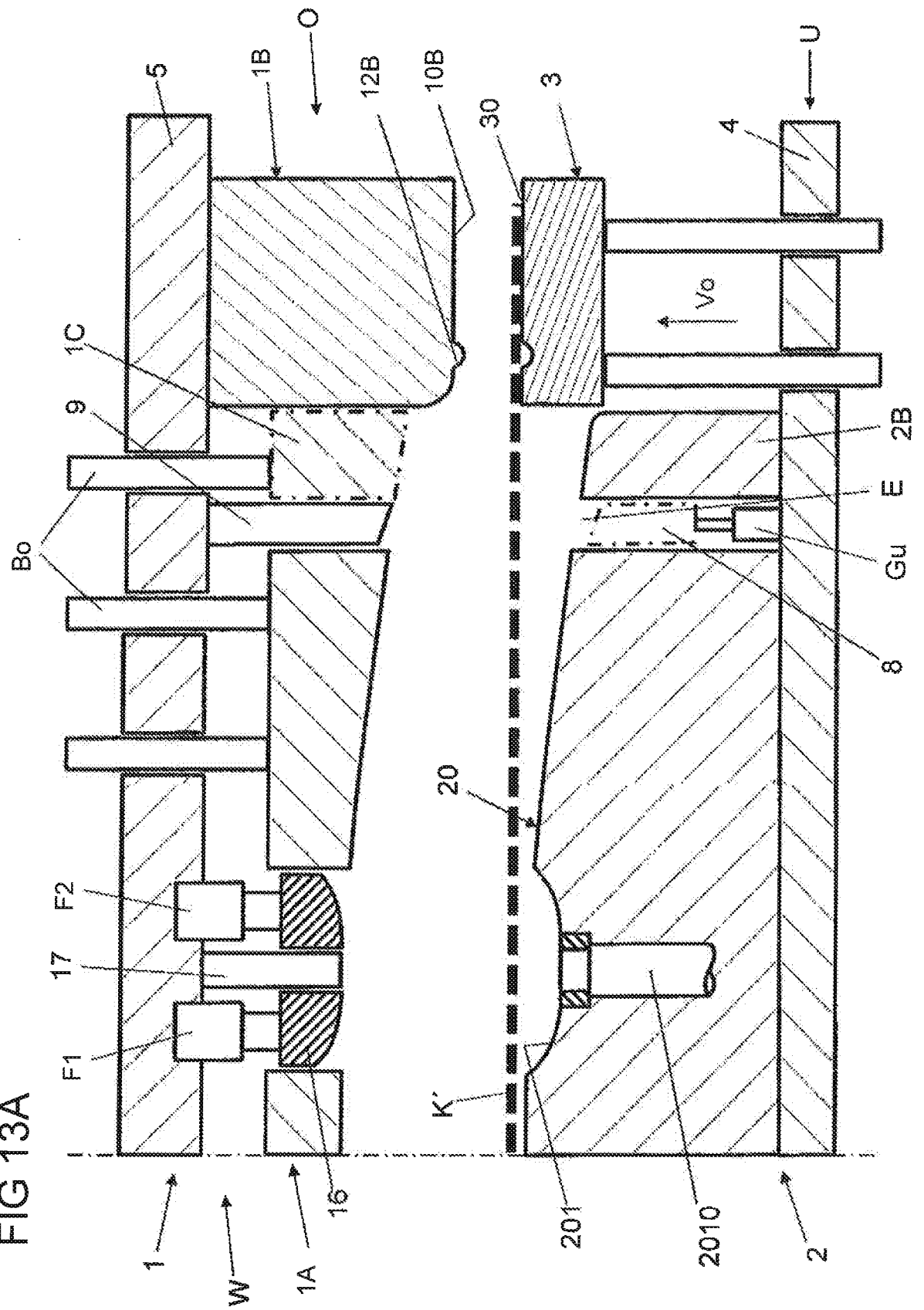


FIG 13B

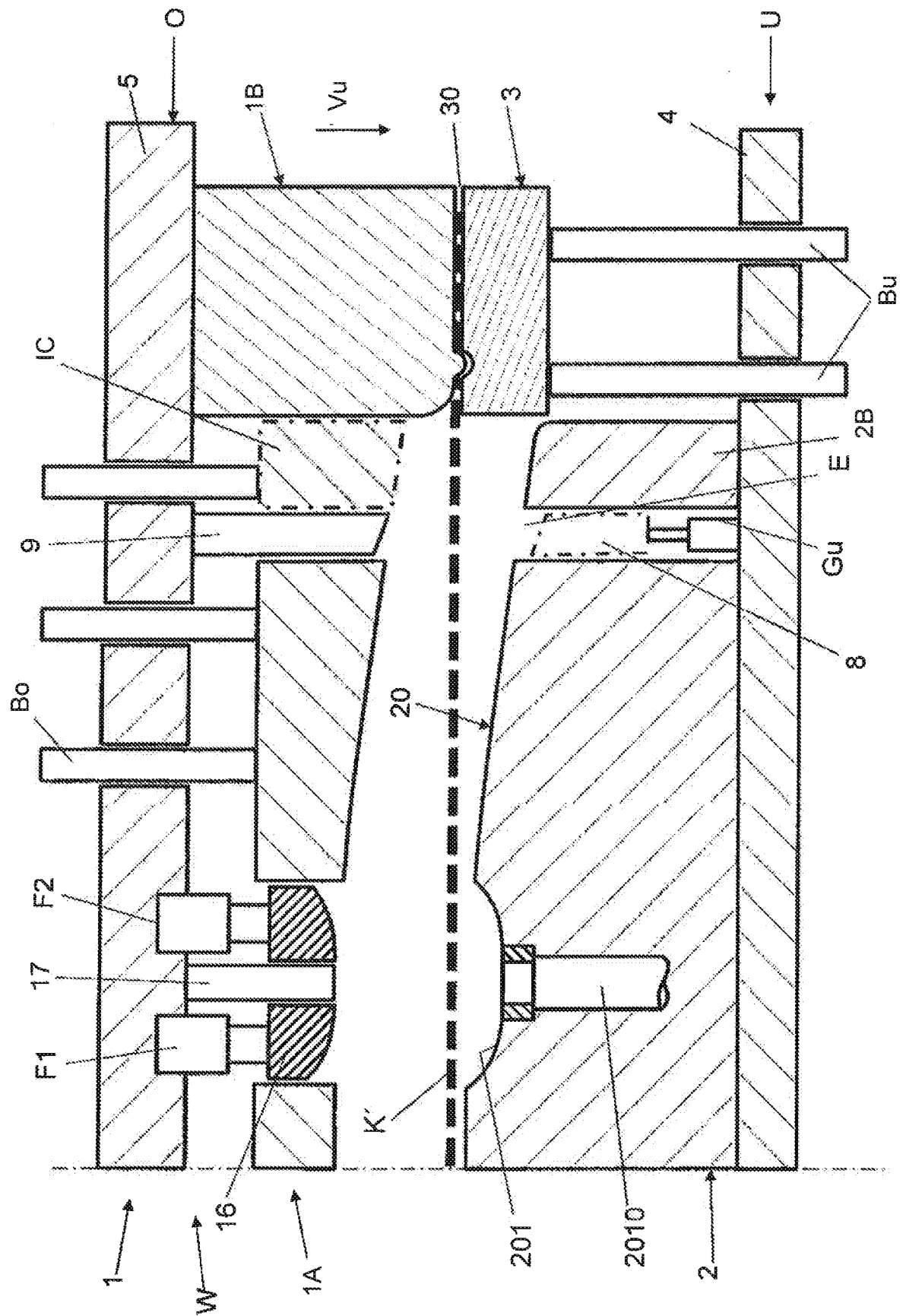
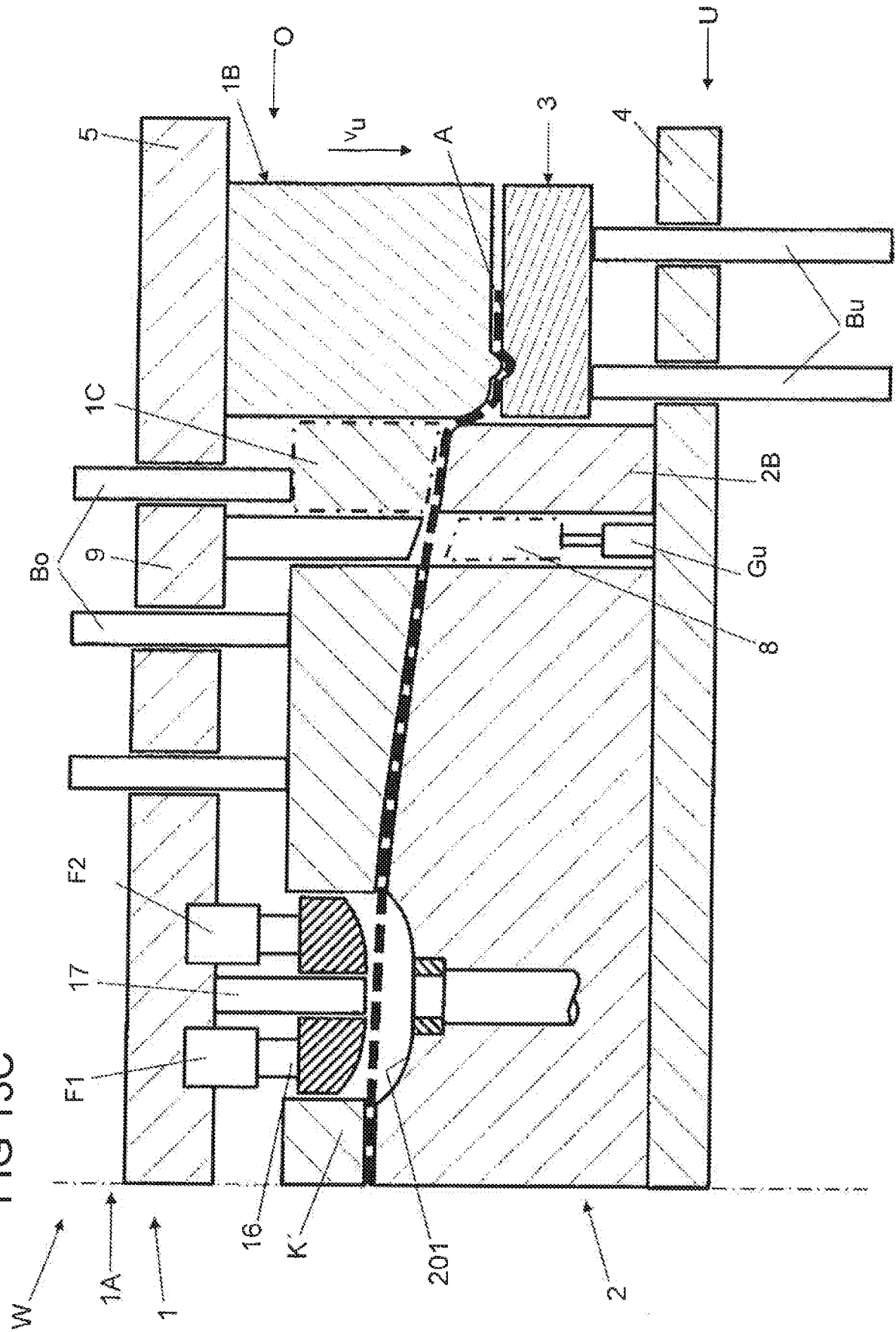
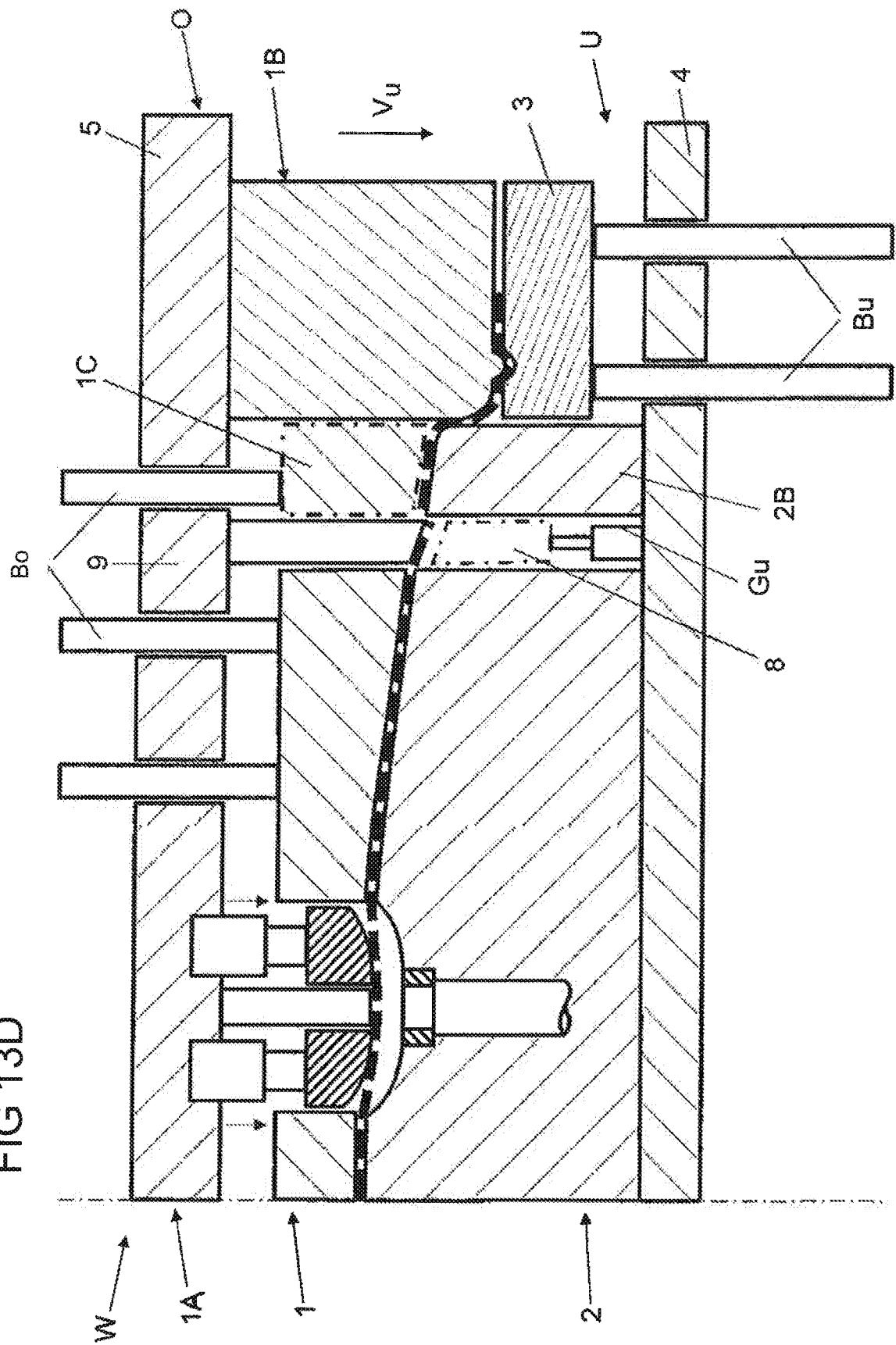


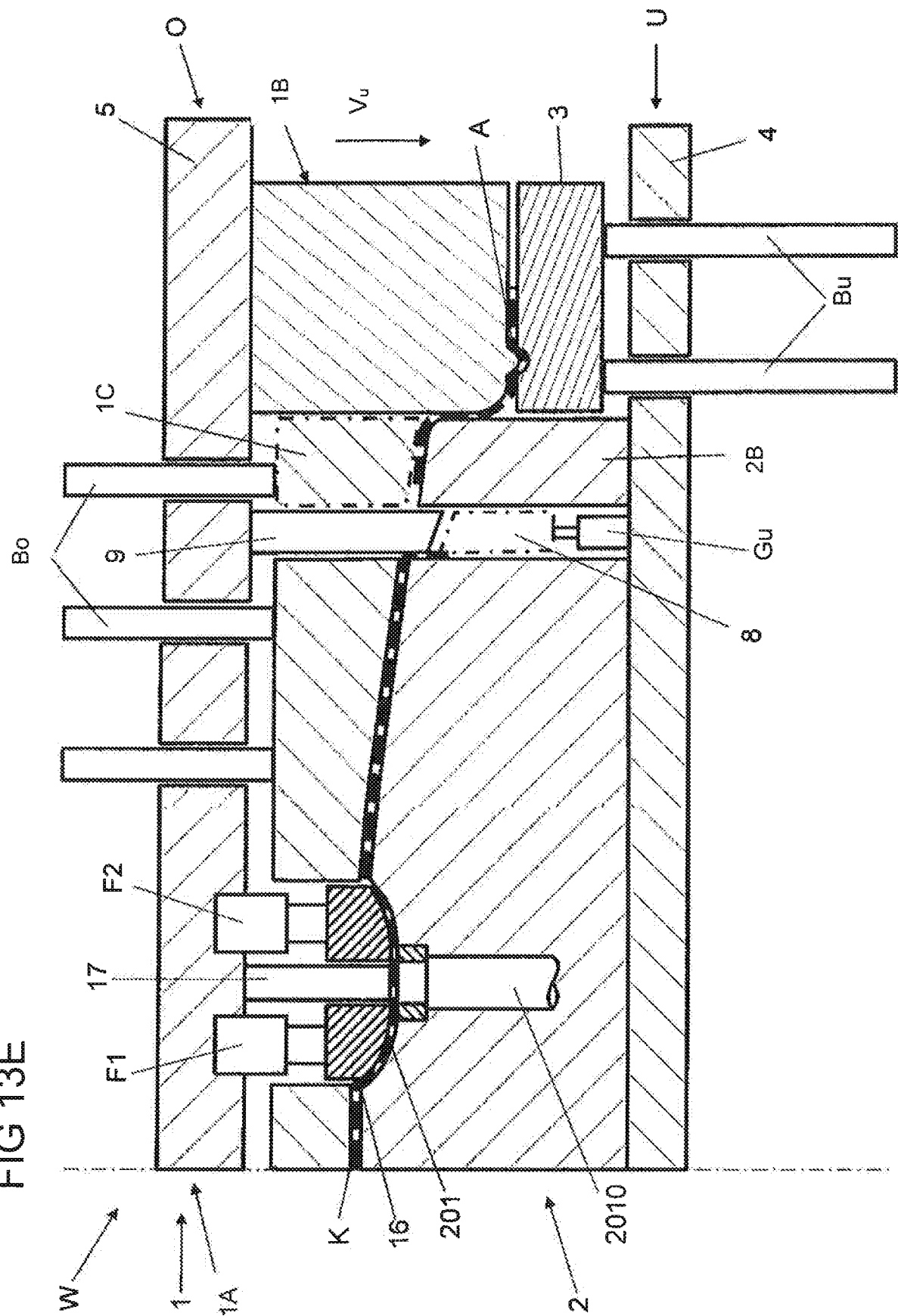
FIG 13C



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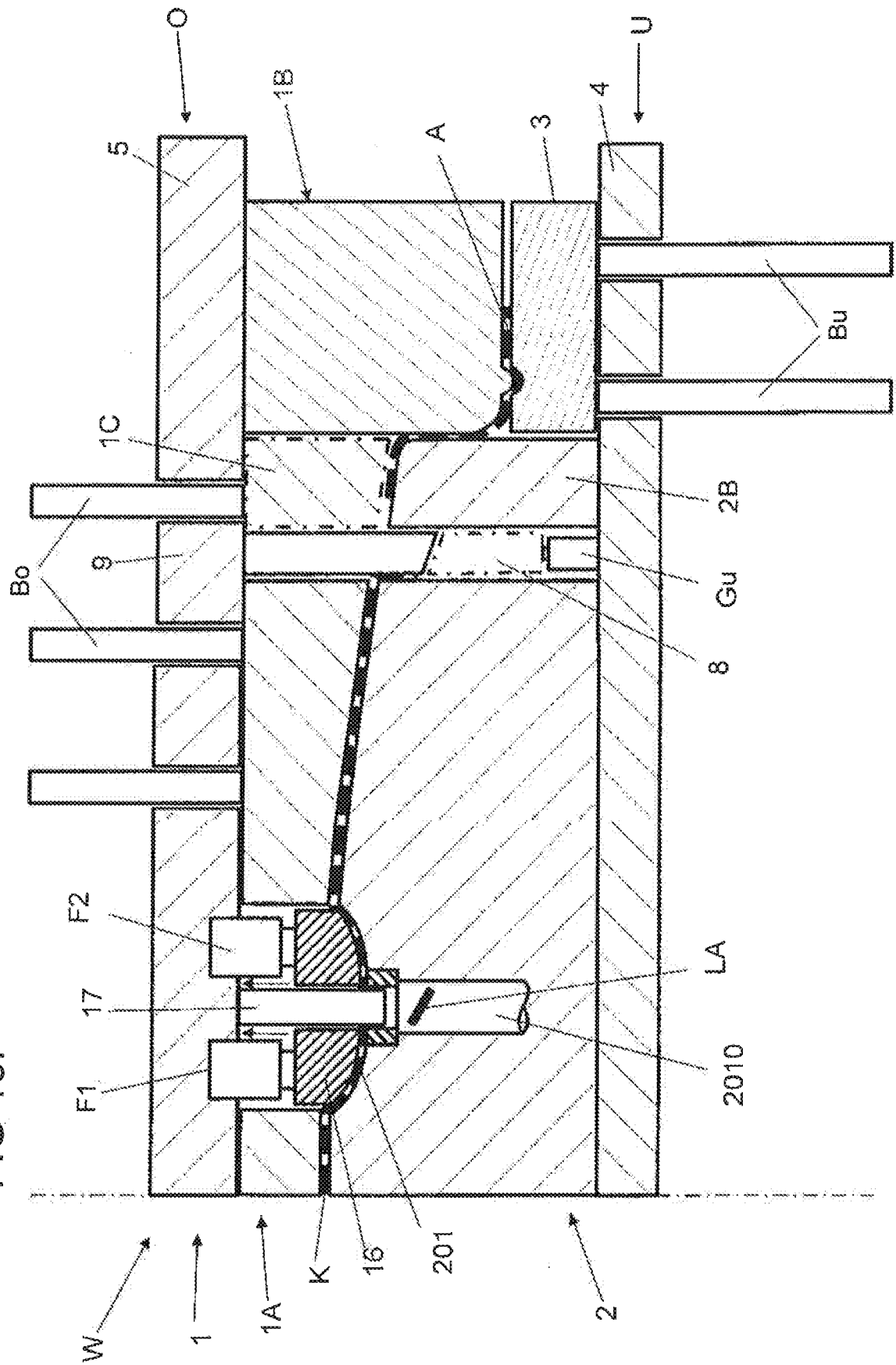


FIG 13G

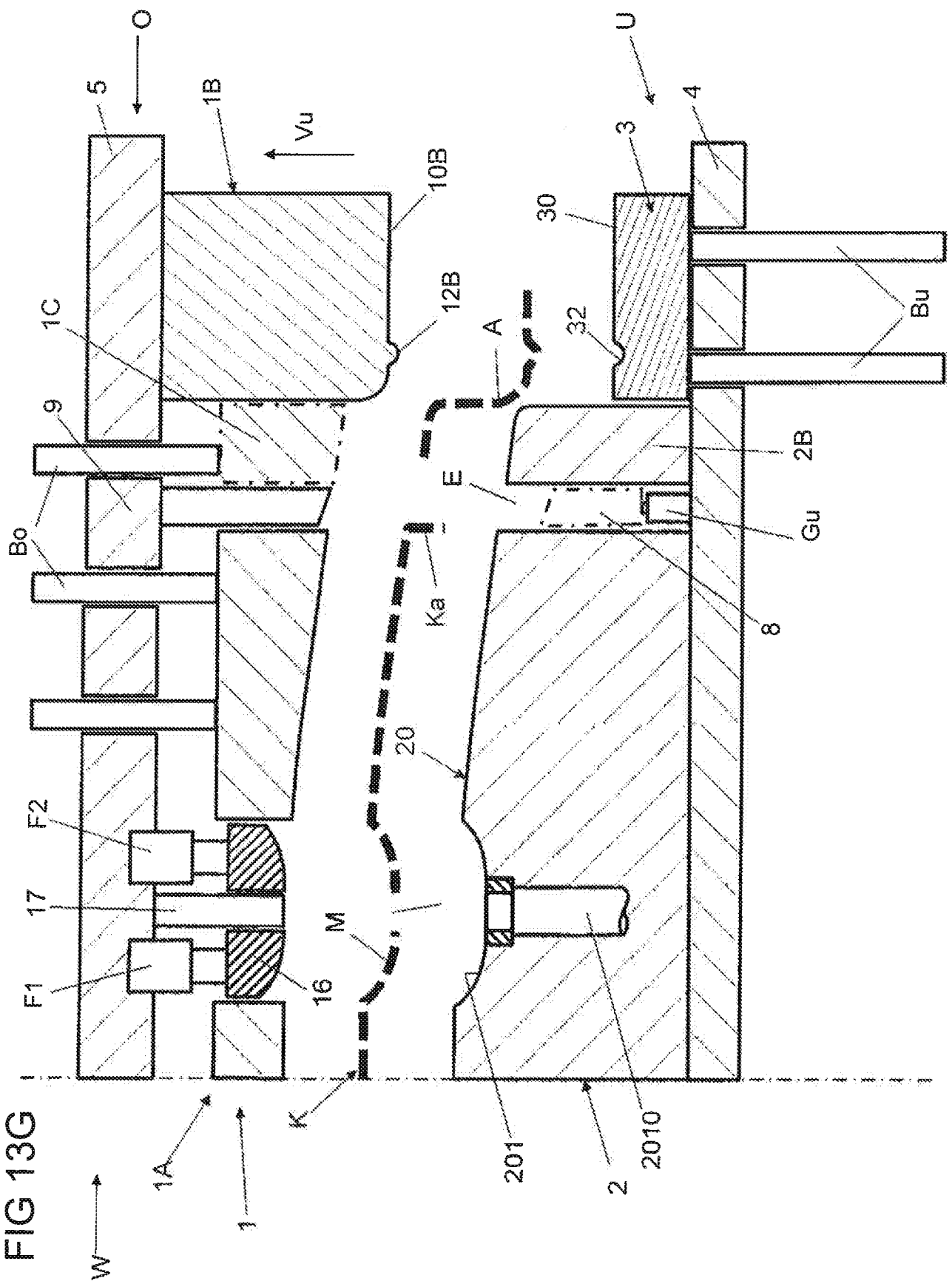
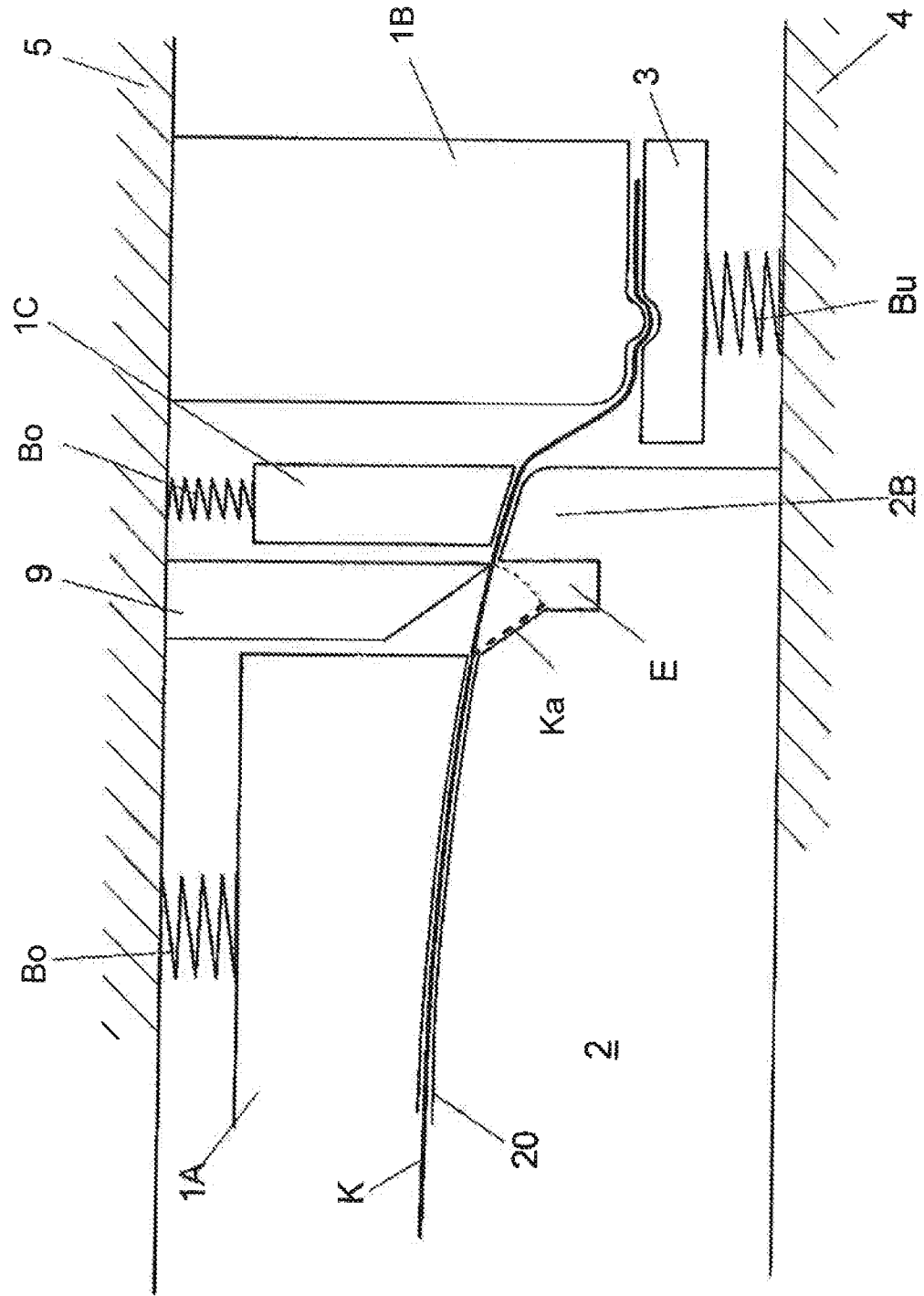


FIG 14



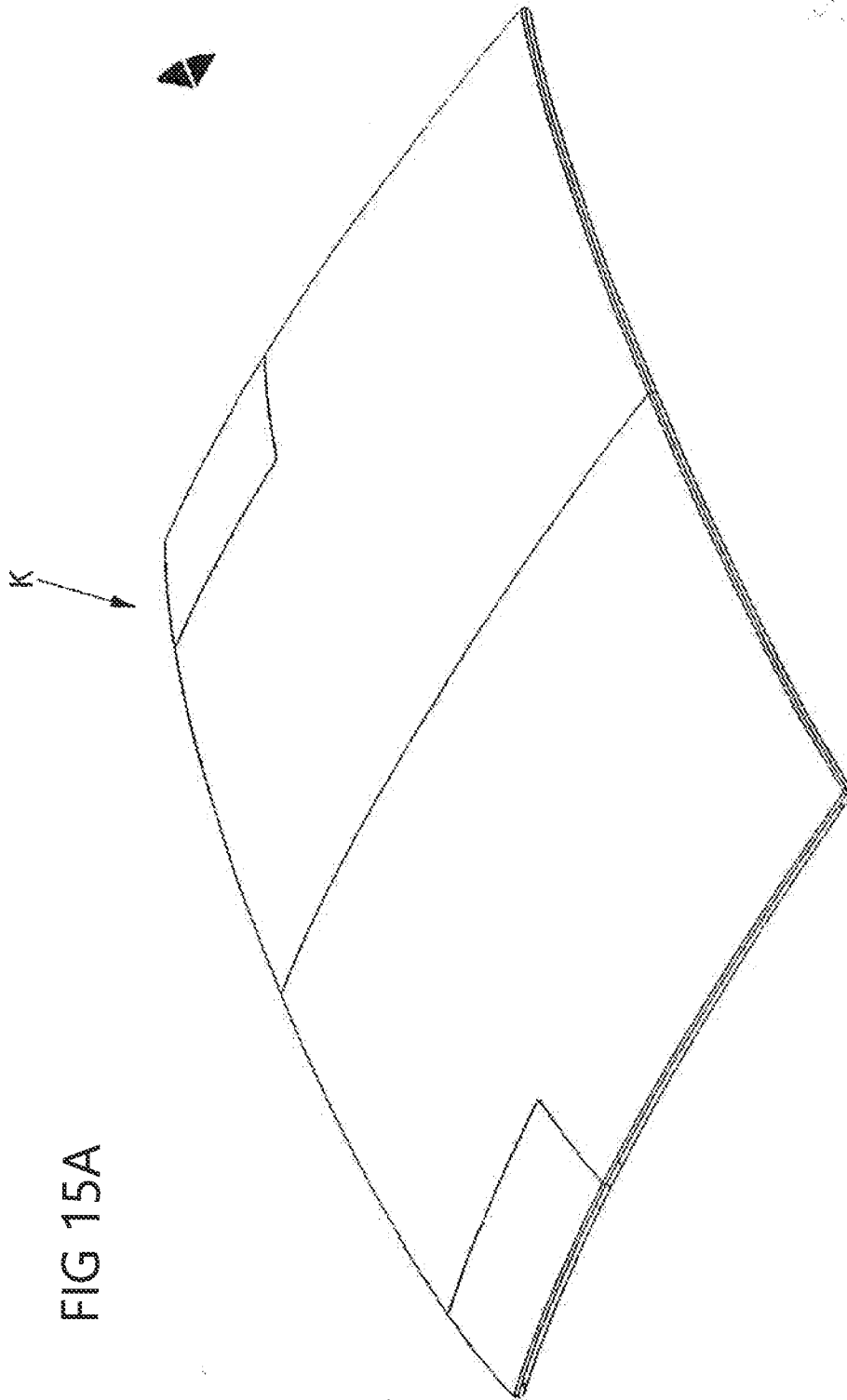


FIG 15A

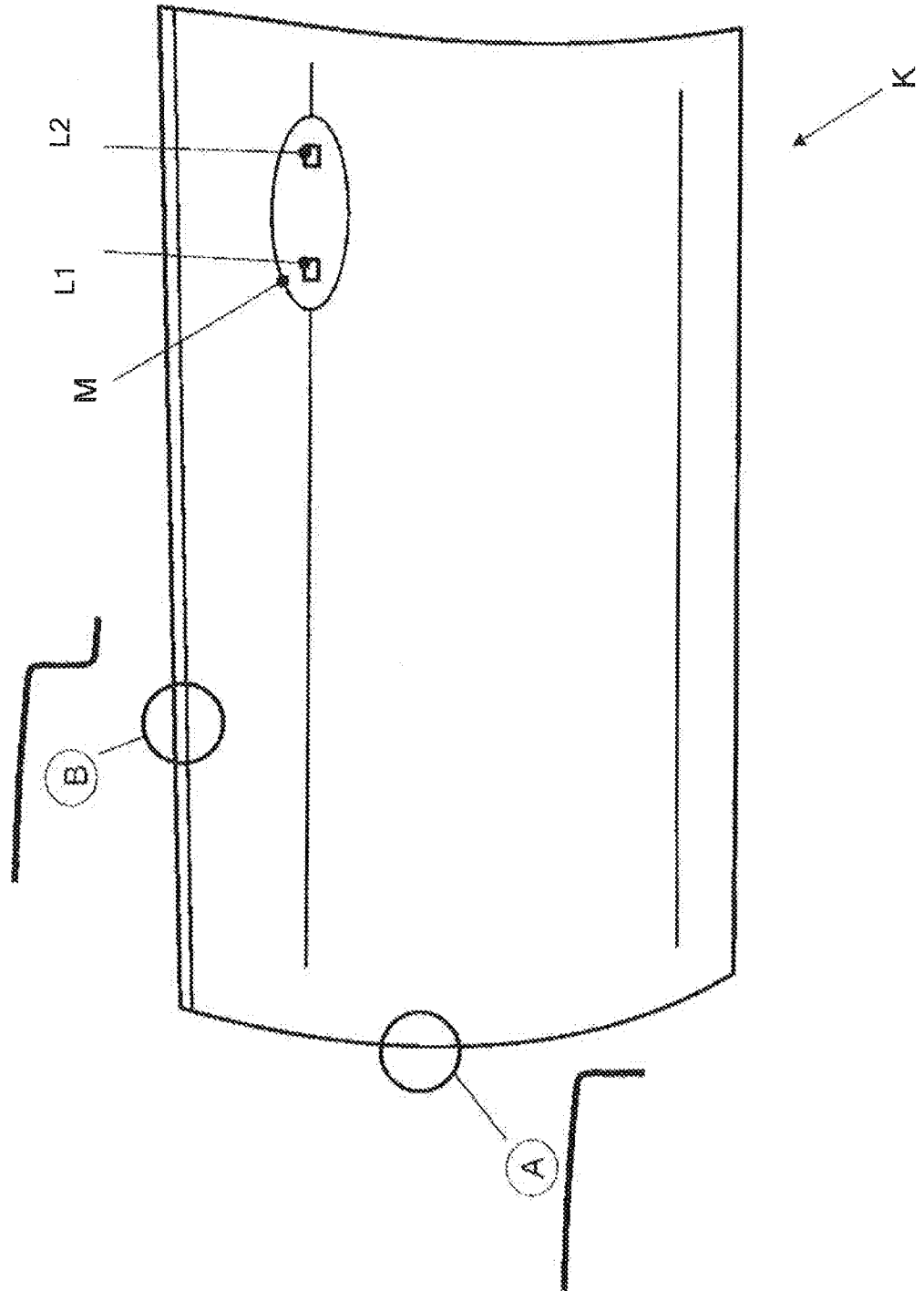


FIG 15B

FIG 16A
State of the art

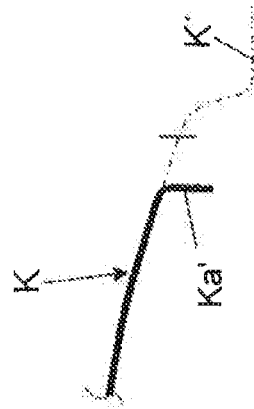


FIG 16B
State of the art

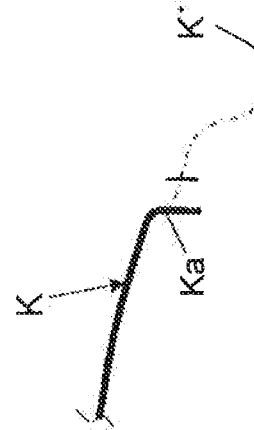


FIG 17A

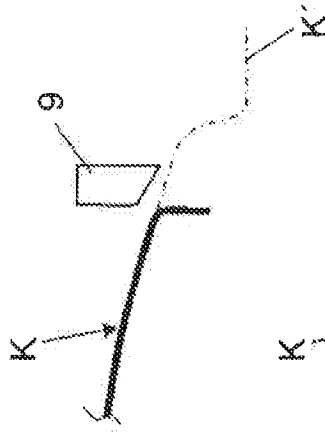


FIG 17B

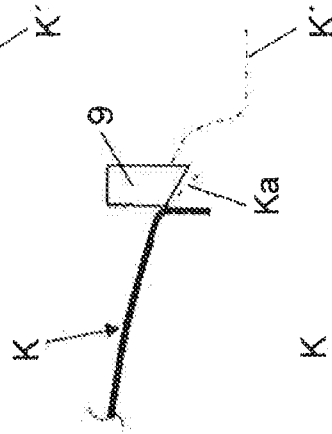
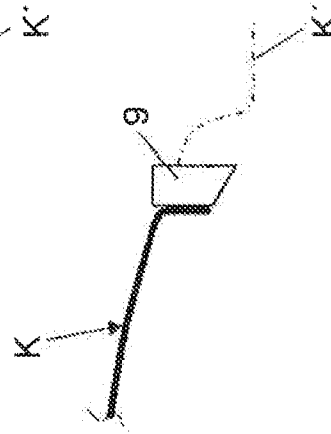


FIG 17C



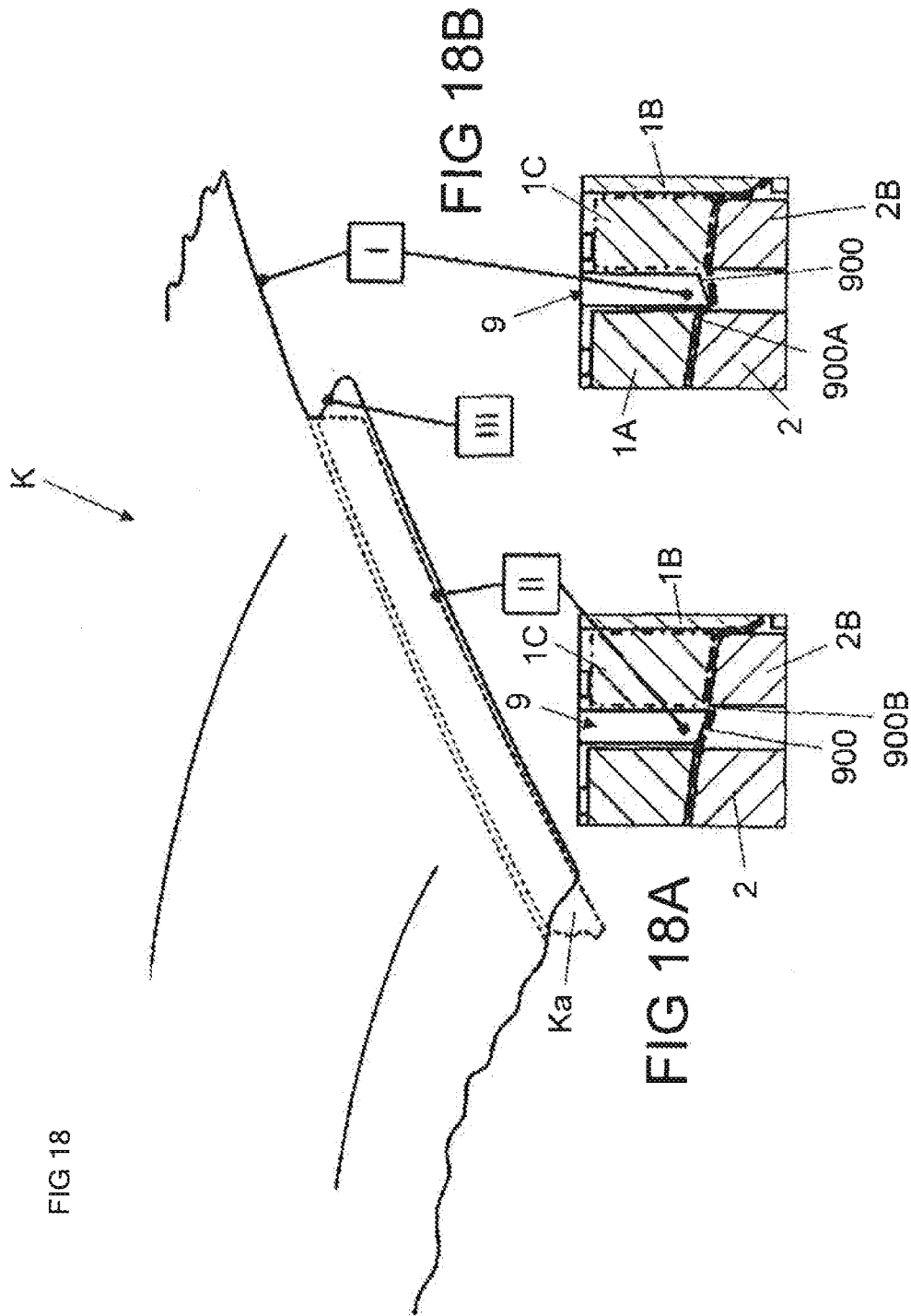


FIG 19

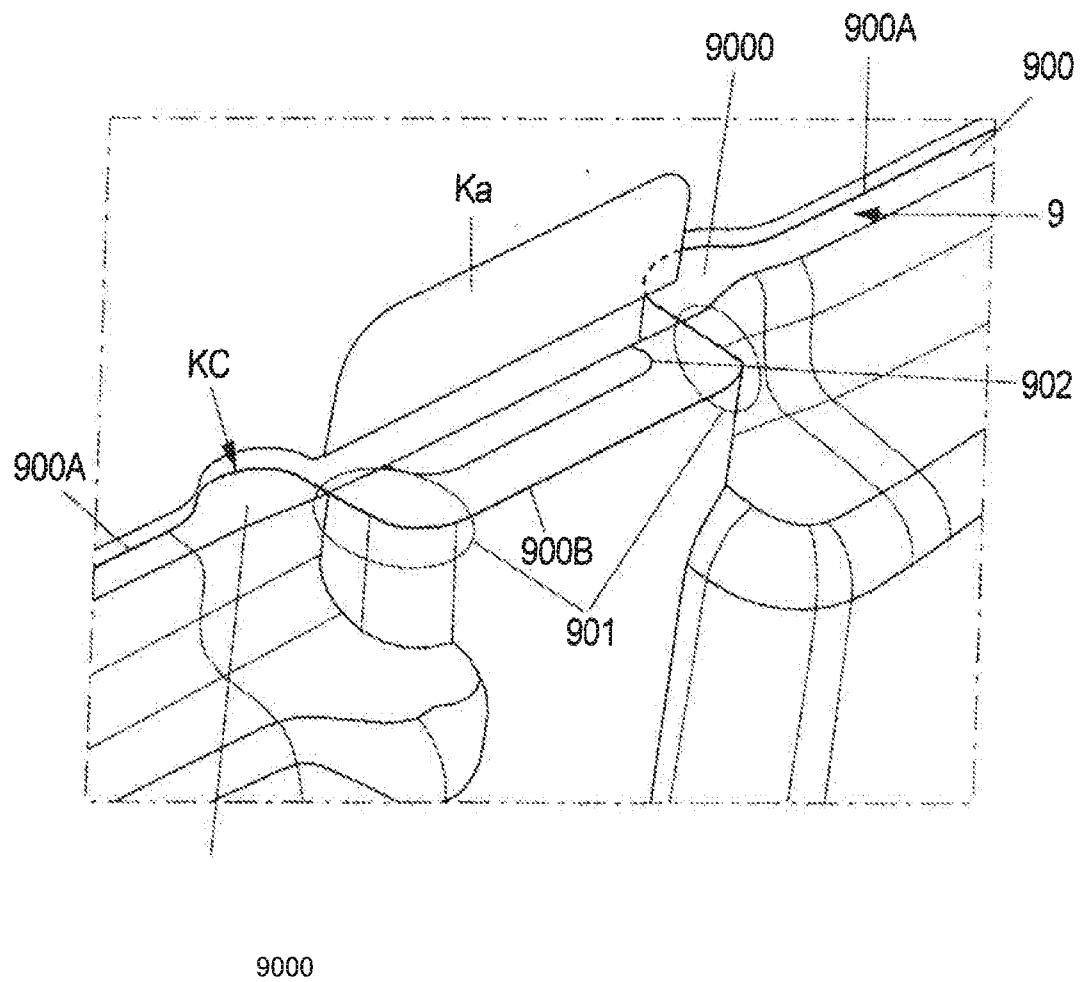


FIG 20

