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DESCRIPTION

[0001] The present invention relates to a bearing for linear guide rails for mold boxes for injection moulding processes.

Background of the invention

[0002] In injection moulding machines comprises an injection unit and a clamping unit for operating a mould box. In injection moulding machines, mould boxes typically comprises two mould half plates, or simply mould plates, arranged moveably relative to each other and guided by a set of guide rails. A clamping unit further comprises an actuator in the form of a linear drive mechanism for pressing at least one of the mould plates against one or more other mould plates, during injection of molten plastic performed by the injection unit. Typically, one mould plate is fixed relative to an injection moulding machine and the set of guide rails, and the other mould plate is slideable along the set of guide rails. Four cylindrical guide rails are commonly arranged in parallel and intersecting the four corners of the half plates. An actuator, the linear drive mechanism, drives the sliding of moveable half-plate/mould plate along the set of guide rails, between a position, where the half-plates closes to form a mould, and a position, where the half-plates are separated from each other, so that a moulded item may be removed from the mould box.

[0003] The use of a set of four cylindrical guide rails, or main guide rail pillars, provides for making a very stable construction. It is however a disadvantage that such mould box constructions are very complicated and expensive to manufacture due to the high precision needed for making the half-plates/mould plates slide on the set of parallel guide rails, driving tight tolerance demands. Further, during use mould boxes are subject to uneven temperature distribution, causing uneven wear on the mould box parts. It is also a problem that the guide rails makes it difficult to design for auxiliary functions for example ejection pins, extraction arms etc.

[0004] For this purpose it is suggested to provide a mould box where the half plates/mould plates are guided by a single linear guide rail, or at least a reduced number of guide rails. Below it is proposed to provide a mould box with one (or more) guide rails, which has/have a cross sectional shape perpendicular to a longitudinal axis of the guide rail(s), wherein the cross-section forms a polygon, such as a rectangular cross section. Such a guide rail will have at least two, three or more planar surfaces extending in the longitudinal direction of the guide rail, which planar surfaces needs to be supported by a bearing on any part - such as a half plate - movably arranged on the guide rail. Bearings for cylindrical guide rails are well known. DE 298 02 231 U1 discloses a device for injection molding with at least two guide rods for two plates, the plates having bores through which a guide rod extends, wherein at least one bore has two inner surfaces arranged parallel to one another, and where each guide rod has mating outer surfaces arranged parallel to one another. EP 2 607 044 A2 discloses an injection

molding tool comprising a molding insert with molding insert halves, and having cross-sectionally rectangular guiding profiles protruding forward in the direction of the first, nozzle-side tool half. US 4 718 845 discloses a stack mold comprising a center mold part, first and second outside mold parts moveable at both sides of the center mold part, and a rack and pinion gear arrangement to move the outside mold parts as well as a guide rod.

[0005] However, providing a bearing for a planar surface presents some unexpected trouble. A bearing needs to have a certain contact area. However, contact between planar surfaces of a guide rail as proposed and entirely planar bearing surface of a bearing element will result in problems at the edges, where the contact surface ends. When the guide rail and/or the half plate (mould plate) moving on the guide rail is subjected to uneven load distribution causing torsional forces, such an edge will cause increased wear on the guide rail/and or the bearing. In theory, such an effect may be alleviated by "rounding" the edge, or at least making a ledge in an angle to the bearing surface.

[0006] However, if the stability of the contact in the bearing is to be maintained, it is necessary to provide such a rounding with a very small angle. It is expected that - over the width of a typical half plate - it is not possible to make such a low angle rounding. This could in theory be alleviated by increasing the length of the bearing, e.g., by increasing the thickness off the half plates/mould plates. However, this would be undesirably at least for space saving reasons.

[0007] Another problem, which would not be solved even with an increased length of the bearing, is that - in practice - it is generally very difficult to make a small angle "rounding" without introducing a (microscopic) edge between the planar surface and the rounded surface of the bearing. Even such a very small edge may break the oil film on thee bearing surfaces and increase wear or cause the bearing surfaces to lock.

[0008] Therefore, there is a need for an alternative bearing for polygonal cross section guide rails for mould boxes.

Summary of the invention

[0009] It is therefore an object of the invention to solve the disadvantages of the prior art systems, and to increase the variety of options.

[0010] The objects of the invention are - in a first aspect of the invention obtained by a bearing between planar guide surfaces of a guide rail pillar of a mould box and a mould plate of the mould box, the mould plate being moveably arranged on the guide rail, the guide rail having a longitudinal axis, the bearing comprising a bearing element,

wherein the bearing element has a main body part with a first end and a second end and a through-going opening for receiving said guide rail pillar, the through-going opening extending from said first end to said second end through said body part, and the through-going opening

having one inner surface for each planar guide surface of the guide rail pillar,

wherein, for at least one of the guide surfaces of the guide rail pillar, the bearing element comprises a first planar bearing surface and a second planar bearing surface arranged in a common plane and parallel to the planar guide surface, and spaced apart in the direction of the longitudinal axis, the first bearing surface arranged at the first end and the second bearing surface arranged at the second end of the bearing element,

wherein the first and second bearing surfaces are elevated above the corresponding inner surface of the through-going opening,

wherein the first and second bearing surfaces are separated by an intermediary surface portion being retracted from the common plane of the two bearing surfaces, and

wherein, below each of the first and second bearing surfaces, a cavity is formed in the bearing element, such that a portion of the bearing element is provided with a resilience relative to the main body part of the bearing element.

[0011] Preferably, the bearing element comprises two planar bearing surfaces arranged as described above for each inner surface of the through-going opening.

[0012] The cavity below (under) the first bearing surface allows the portion (on which the first bearing surface is formed) to flex relative to the main body part proper, thereby providing the mentioned resilience. Similarly, the cavity below the second bearing surface allows the portion (on which the second bearing surface is formed) to flex relative to the main body part proper, thereby providing the mentioned resilience.

[0013] In an embodiment the cavity below the first bearing surface comprises a primary cavity extending into the main body part of the bearing element from an end surface at the first end, and wherein the cavity below the second bearing surface comprises a primary cavity extending into the main body part of the bearing element from an end surface at the second end.

[0014] In a further embodiment the cavity below each of the first and second bearing surfaces is formed as a ledge.

[0015] The ledges' may be formed with surfaces angled relative to the inner surface.

[0016] In a further embodiment the first and the second bearing surfaces and the intermediary surface portion are formed on a detachable plate member, wherein the detachable plate member is arranged in an elongate depression formed in the inner surface of the through-going opening through the bearing element, which elongate depression extends from said first end to said second end of the bearing element.

[0017] In this embodiment, the portions of the bearing element provided with a resilience

relative to the main body part by the cavities formed in the bearing element form part of the detachable plate member.

[0018] The reverse side of the detachable plate member, relative to the first and the second bearing surfaces may be formed with a single planar surface. In other embodiments however, the detachable plate member, on a reverse side relative to the first and the second bearing surfaces comprises

- a first abutment surface;
- a second abutment surface; and
- an intermediary surface portion being retracted from a common plane of the two abutment surfaces.

[0019] In a further embodiment, the elongate depression formed in the inner surface of the through-going opening through the bearing element comprises

- a first abutment plateau at the second first end of the bearing element;
- a second abutment plateau at the second end of the bearing element, and
- an intermediary depression formed between the first and second abutment plateaus.

[0020] Thus, in embodiments where the elongate depression formed in the inner surface is formed with an even bottomed surface, the retracted surface portion forms a void or space between the even bottomed surface and the detachable plate member, thereby increasing the flexibility of the bearing.

[0021] In embodiments, where the elongate depression formed in the inner surface is formed with the first and second abutment plateaus separated by the intermediary depression, and the reverse side of the detachable plate member, relative to the first and the second bearing surfaces is formed with a single planar surface, a similar void or space is formed between the single planar surface of the detachable plate member and the intermediary depression between the abutment plateaus whereby a similar increased flexibility of the bearing may be achieved.

[0022] In embodiments, where the elongate depression formed in the inner surface is formed with the first and second abutment plateaus separated by the intermediary depression, and where the reverse side of the detachable plate member, relative to the first and the second bearing surfaces, is formed with retracted surface portion between the first and second abutment surfaces, an increased size void or space is formed between the elongate depression and the detachable plate member, whereby an increased flexibility of the bearing may be achieved.

[0023] It is noted that in embodiments, where the elongate depression formed in the inner surface is formed with the first and second abutment plateaus separated by the intermediary depression, and where the reverse side of the detachable plate member, relative to the first and the second bearing surfaces, is formed with retracted surface portion between the first and second abutment surfaces, the abutment surfaces and the abutment plateaus re configured for abutting on each other.

[0024] Not shown locking means may keep the detachable plate member locked in the correct position in the elongate depression 57.

[0025] In a further embodiment, the cavity below the first bearing surface comprises a secondary cavity extending into the main body part of the bearing element from the inner surface of the through-going opening from a position adjacent to the first bearing surface; and wherein the cavity below the second bearing surface comprises a secondary cavity extending into the main body part of the bearing element from the inner surface of the through-going opening from a position adjacent to the second bearing surface.

[0026] In an embodiment hereof the secondary cavity adjacent to the first bearing surface and the secondary cavity adjacent to the second bearing surface each comprise one first cavity portion extending in a direction perpendicular to a plane of the inner surface of the through-going opening and one second cavity portion extending from the first cavity portion in a direction parallel to the inner surface of the through-going opening.

[0027] In a further embodiment, the portions of the bearing element provided with a resilience relative to the main body part by the cavities formed in the bearing element are formed integral with the main body part of the bearing element.

[0028] For example the main body part of the bearing element may be formed in one piece and the cavity portions may be shaped by milling the cavity in the main body part. In other embodiments, the bearing element may be formed in one piece in an additive manufacturing process.

[0029] In such embodiments, the cavity forms a bridge between the main body part as such and the portion on which the first bearing surface is formed. This bridge thereby has a diminished material thickness, which will provide a desired resilience. Similarly, the cavity forms a bridge between the main body part as such and the portion on which the second bearing surface is formed.

[0030] In a further embodiment, wherein two separations are provided in the bearing element adjacent to each of the first and the second bearing surface, the separations extending along a direction parallel to the longitudinal axis, and in an entire length of the bearing surface, and the separations extending from the inner surface of the through-going opening into the main body part.

[0031] In embodiments thereof, where the portions of the bearing element provided with a resilience relative to the main body part by the cavities formed in the bearing element are formed integral with the main body part of the bearing element the main body part of the bearing element may be formed in one piece and the portions may be shaped by milling the cavity and/or the separations in the main body part.

[0032] In further embodiment, the guide rail pillar comprises two parallel planar guide surfaces and where the bearing element comprise two opposed parallel inner surfaces corresponding to the two parallel planar guide surfaces, and where each of the two opposed parallel inner surfaces comprises at least one set of first and second bearing surfaces.

[0033] In further embodiment, the guide rail pillar comprises a first two parallel planar guide surfaces and a second two parallel planar guide surfaces perpendicular to the first two parallel planar guide surfaces, and where the bearing element comprise a first two opposed parallel inner surfaces corresponding to the first two parallel planar guide surfaces, and a second two opposed parallel inner surfaces corresponding to the second two parallel planar guide surfaces, and where each of the parallel inner surfaces comprises at least one set of first and second bearing surfaces.

[0034] In a further embodiment, the bearing element is arranged in an opening through the moveable mould plate of the mould box.

[0035] The objects of the invention may - in a second aspect - be obtained by a mould box for an injection moulding machine, the mould box comprising

- a first mould plate;
- a second mould plate movably arranged relative to the first mould plate; and
- a guide rail system configured for guiding the second mould plate linearly away from and towards the first mould plate,

wherein the guide rail system comprises a guide rail pillar,

wherein the guide rail pillar has a longitudinal axis and a cross sectional shape perpendicular the longitudinal axis, and wherein the cross-section forms a polygon,

wherein the guide rail pillar comprises planar guide surfaces equivalent to the number of sides in the polygonal cross-sectional shape of the guide rail pillar; and

wherein a bearing according to any one of the embodiments of the first aspect described above, is arranged between the planar guide surfaces of the guide rail pillar and the second mould plate.

[0036] In an embodiment also the first mould plate may be moveably arranged on the guide rail pillar wherein a bearing according to any one of the embodiments of the first aspect

described above, is arranged between the planar guide surfaces of the guide rail pillar and the first mould plate.

[0037] In further embodiments, the guide rail system comprises a single guide rail pillar only.

[0038] In a further embodiment, the single guide rail pillar extends through a second opening in the second mould plate and first opening in a first mould plate and further, the second opening in the second mould plate is formed centrally in the second mould plate and the first opening in the first mould plate is formed centrally in the first mould plate.

[0039] In a third aspect of the invention the objects may be obtained by an injection moulding machine comprising a mould box according to the first aspect of the invention.

[0040] More particularly, in the third aspect, the objects of the invention are achieved by an injection moulding machine comprising

- a mould box comprising a first mould plate and a moveable second mould plate;
- a linear drive mechanism for moving the second mould plate; and
- an injection unit,

the mould box further comprising

- a base plate connected to the frame of the injection machine and to the first mould plate; and
- a guide rail system configured for guiding the second mould plate linearly away from and towards the first mould plate,

wherein the second mould plate is movably arranged relative to the first mould plate, and driven by the linear drive mechanism,

wherein the guide rail system comprises a guide rail pillar,

wherein the guide rail pillar has a longitudinal axis and a cross section perpendicular the longitudinal axis, where the cross-section forms a polygon;

wherein the guide rail pillar comprises planar guide surfaces equivalent to the number of sides in the polygonal cross-sectional shape of the guide rail pillar; and

wherein a bearing according to any one of the embodiments of the first aspect described above is arranged between the planar guide surfaces of the guide rail pillar and the second mould plate.

[0041] In an embodiment also the first mould plate may be moveably arranged on the guide rail pillar wherein a bearing according to any one of the embodiments of the first aspect described above, is arranged between the planar guide surfaces of the guide rail pillar and the

first mould plate.

[0042] In further embodiments, the guide rail system comprises a single guide rail pillar only.

[0043] In a further embodiment, the single guide rail pillar extends through a second opening in the second mould plate and first opening in a first mould plate and further, the second opening in the second mould plate is formed centrally in the second mould plate and the first opening in the first mould plate is formed centrally in the first mould plate.

[0044] Above, and in the following, when referring to a guide rail system, a guide rail or guide rail pillar, reference may be made to any guide system, positioning system or alignment system of a mould box, a clamping unit or an injection moulding machine. However, a preferred use of the bearing is with polygonal cross-shape main guide rail pillars, i.e. the main guide rail system of a mould box, a clamping unit or an injection moulding machine. Main guide rail pillars, having a first end and a second, where the first end of the main guide rail pillar is connected to a fixed base plate, where the base plate is connected to an immobile relative to a frame of the injection moulding machine or at least a frame of the clamping unit of the injection moulding machine. Further, the second end of the main guide pillar(s) is/are connected to a second end structure of a clamping unit, which second end structure may be a plate and is arranged at a second end of the clamping unit frame. Further the second end structure is connected to an immobile relative to a frame of the injection moulding machine or at least a frame of the clamping unit of the injection moulding machine.

[0045] A main guide rail system and any main guide rail pillars, thereof, are separate from any alignment system, and different therefrom.

[0046] It should be emphasized that the term "comprises/comprising/comprised of" when used in this specification is taken to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

Brief description of the drawings

[0047] In the following, the invention will be described in greater detail with reference to embodiments shown by the enclosed figures. It should be emphasized that the embodiments shown are used for example purposes only and should not be used to limit the scope of the invention.

Fig. 1 schematically shows an outline of a prior art injection moulding machine;

Fig. 2, in a perspective view, shows components of a prior art mould box with two half-plates and a set of cylindrical guide rails;

Fig.3A, in a perspective view, shows a mould box according to one embodiment of the

invention in a first position;

Fig. 3B, in a front view, shows the mould box of Fig. 3A in a sectional side view, shows the mould box of Fig. 3A;

Fig. 3C, in a sectional side view, shows the mould box of Figs. 3A and 3B;

Fig. 4A, in a perspective view, shows the mould box of Figs. 3A-C in a second position;

Fig. 4B, in a front view, shows the mould box of Fig. 4A;

Fig. 4C, in a sectional side view, shows the mould box of Figs. 4A and 4B;

Fig. 5, in an exploded perspective view, shows the mould box of Figs. 3A-C and 4A-C; and

Fig. 6A, in a sectional view, shows a bearing between a guide rail with planar surfaces and a mould plate slidably arranged thereon, a bearing element arranged between the guide rail and the mould plate, in a situation where there are no torsional forces on the mould plate or the guide rail;

Fig. 6B shows the bearing of Fig. 6A in a situation where the guide rail or the mould plate is subjected to torsional forces;

Fig. 6C, show detail of Fig. 6B;

Fig. 7A, in a perspective view, shows a bearing element with separate bearing plate parts for a bearing according to a first embodiment of the invention;

Fig. 7B, in a perspective view, shows a bearing plate part for the bearing element of Fig. 7A;

Fig. 7C, shows a detailed view of the bearing plate part arranged in the bearing element of Fig. 7A;

Fig. 7D, in a rear view, shows the bearing element of Fig. 7A;

Fig. 7E shows a section A-A though the bearing element of Fig. 7D;

Fig. 7F shows a section B-B though the bearing element of Fig. 7D;

Fig. 8A, in a perspective view, shows a bearing element with integrated bearing surface parts for a bearing according to a second embodiment of the invention;

Fig. 8B, shows a detailed view of one integrated bearing surface part of the bearing element of Fig. 8A;

Fig. 8C in a rear view, shows the bearing element of Fig. 8A;

Fig. 8D shows a section A-A though the bearing element of Fig. 8C;

Fig. 8E shows a section B-B though the bearing element of Fig. 8C;

Fig. 9A, in a perspective view, shows a bearing element with alternatively shaped bearing surface parts for a bearing according to a third embodiment of the invention;

Fig. 9B, shows a detailed view of one integrated bearing surface part of the bearing element of Fig. 9A;

Fig. 9C in a rear view, shows the bearing element of Fig. 9A;

Fig. 9D shows a section A-A though the bearing element of Fig. 9C;

Fig. 9E shows a section B-B though the bearing element of Fig. 9C;

Fig. 10A, in a perspective view, shows a bearing element with profiled bearing surfaces for a bearing according to another aspect of the invention;

Fig. 10B shows a detailed view of one profiled bearing surface of the bearing element of Fig. 10A;

Fig. 10C, in a rear view, shows the bearing element of Fig. 10A;

Fig. 10D shows a section A-A though the bearing element of Fig. 10C;

Fig. 10E shows a section B-B though the bearing element of Fig. 10C;

Fig. 10F, in a side sectional view, shows a detail of a profile of a bearing surface of Figs.10E;

Fig. 11A, in a sectional view, shows a bearing between a guide rail with planar surfaces and a mould plate slidably arranged thereon, a bearing element according to yet another aspect of the invention arranged between the guide rail and the mould plate, in a situation where there are no torsional forces on the mould plate or the guide rail; and

Fig. 11B shows the bearing of Fig. 11A in a situation where the guide rail or the mould plate is subjected to torsional forces.

Detailed description of the embodiments

[0048] Fig. 1 illustrates schematically an injection moulding machine 200 as known in the art. The injection moulding machine 200 generally comprises an injection unit 210, shown in the left side of the figure, and a clamping unit 270, shown in the right side of the figure. The injection unit 210 handles injection of plastic material into a mould formed in the clamping unit 270 of the injection moulding machine 200. The injection unit 210 and the clamping unit 270 of the injection moulding machine 200 are attachable to a mount/frame 201.

[0049] Injection moulding machines 200 generally works in the following way: Plastic granules 105 are fed into the barrel 260 of a reciprocating screw 220 of the injection unit 210 via a

hopper 240. The reciprocating screw 220 is driven by a drive mechanism 230, such as an electrical motor. The plastic granules 105 fed through the hopper 240 are then transported towards the clamping unit 270 by the reciprocal screw, while being compacted and they are heated by heating devices 250 surrounding the reciprocating screw 220, until they melt and reach a suitable viscosity at a nozzle 225 at the entrance to the clamping unit 270 with the mould. The mould is formed in a mould box 1.

[0050] The fluid plastic material is fed from the nozzle 225 through sprue channels 226 in a base plate 10 of the mould box 1, and reaches a mould cavity 21 formed in a first mould plate 20 of the mould box 1. The first mould plate 20 of the mould box 1 is connected to the base plate 10. The base plate 10 is connected to the frame 201. A second mould plate 30 which may comprise a mould core and/or further portions of a mould cavity is arranged moveably relative to the first mould plate 20, such that the mould box may be completely closed (clamped together) to allow injection of the melted plastic, and such that the mould box 1 may be opened to extract a moulded object 100 (see Fig. 2).

[0051] In Fig. 1 the second mould plate 30 is attached to a moveable platen 290. The moveable platen 290 - and thereby the second mould plate 30 - is slideably arranged on a set of cylindrical guide rails 40". Typically, the clamping unit 270 of injection moulding machines 200 comprises four cylindrical guide rails 400 for guiding the movement of the moveable platen 290 with the second mould plate 30. The movement of the moveable platen 290 with the second mould plate 30 is performed by a linear drive mechanism 280, typically a hydraulic mechanism.

[0052] Each of the (main) guide rail pillars 40" of the (main) guide rail system of the mould box 1 of the clamping unit 270 has an elongate body, which is cylindrical, and has a first end 443 and a second end 444. The first end 443 is fixed to the base plate 10, which is fixed to a frame (not shown) of the clamping device 270. The frame of the clamping unit 270 may form part of the frame 201 of the injection moulding machine 200, or may be fixed thereto.

[0053] The opposite end, the second end 444, of the elongate body of each main guide rail pillars 40" is fixedly connected to a second end structure 15 of the clamping unit 270. The second end structure 15 of the clamping unit 270 is fixed to the frame (not shown) of the clamping device 270, which, as mentioned in the previous paragraph, may form part of the frame 201 of the injection moulding machine 200, or may be fixed thereto.

[0054] The second end structure 15 may also, as shown in Fig. 1, form a mount for the linear drive mechanism 280.

[0055] Now, returning to moveable platen 290 with the second mould plate 30, this moveable platen 290 comprises through-going slide bearings, or ball bearings, slidably receiving the cylindrical guide rails 40".

[0056] In an injection process, the linear drive mechanism 280 clamps the first mould plate 20

and the second mould plate 30 together, whereupon plastic is injected from the reciprocal screw 220 through the nozzle 225 and into the mould cavity 21. When the plastic has filled the mould cavity 21 completely, and has cooled sufficiently for the plastic to be in solid state, then the linear drive mechanism 280 moves the second mould plate 30 away from the first mould plate 20, and the moulded object is ejected from the mould cavity 21 in the first mould plate 20. The ejection of the moulded object 100 is typically done by ejector pins (not shown) formed in/through the base plate 10.

[0057] Fig. 2 shows a prior art mould box 1 for an injection moulding machine 200 (as outlined in Fig. 1), and a moulded object 100. The mould box 1 is shown in a separated state where the moulded object 100 is visible between two half plates, or mould plates 20, 30 of the mould box 1. Thus, the he mould box 1 comprises two mould plates 20, 30. A first mould plate 20, here shown to comprise a mould cavity 21 of a mould, is connected to a base plate 10 of the mould box 1. The first mould plate 20 and the base plate 10 may form one integrated part, or they may be formed as separate parts and joined subsequently by suitable means, e.g. bolts. A mould cavity 21 is formed as a depression in a surface of the first mould plate 20.

[0058] The first mould plate 20 is - via the base plate 10 -connected to an injection moulding machine 200, e.g. as described above. The base plate 10 may thus be connected to a frame 201 as shown in Fig. 1.

[0059] A second mould plate 30 is moveably arranged relative to the first mould plate 20 and the injection moulding machine 200. The second mould plate 30 is slideably arranged on a set of guide rails 40" of a guide rail system configured for guiding the second mould plate 30 linearly away from and towards the first mould plate 20.

[0060] The set of guide rails 40" comprises four cylindrical guide rails 40". The guide rails 40" are arranged to slide over bearings (not shown) provided through the second mould plate 30. In Fig. 2 only a portion of the guide rails 40" is seen.

[0061] The guide rails 40" are fixedly secured in the openings 24 provided in the first mould plate 20. There is one opening 24 per guide rail 40".

[0062] In Fig. 2 the cylindrical guide rails 40" extend through openings through the second mould plate 30 itself, as opposed to the version shown in Fig. 1, where the second mould plate 30 is connected to a moveable platen 290, which has bearings for the guide rails 40".

[0063] The second mould plate 30 is shown with a core 31 configured for mating with the mould cavity 21 in the first mould plate 20 to form a shape corresponding to the moulded object 100.

[0064] Figs. 3-5 shows a mould box 1 according to an embodiment of the invention. The mould box 1 comprises a base plate 10 and a first mould plate 20 connected thereto. During use in injection moulding processes, the first mould plate 20 is fixed in position relative to the

base plate 10. The base plate 10 is fixedly connectable to an injection moulding machine, e.g. as described in connection with the prior art injection moulding machine 200 shown in Fig. 1. The first mould plate may comprise one or more mould cavities (not shown) formed as depressions in a first surface 22 of the first mould plate 20. An opposite side, second side 23 of the first mould plate 20 faces the base plate 10, see e.g. Fig. 5.

[0065] The first mould plate 20 may be formed integrally with the base plate 10, or it may - as shown in Figs. 3-5 - be formed as individual/separate parts and subsequently be joined/connected, such that the first mould plate 20 is fixed to the base plate 10 at least during the injection moulding process. The first mould plate 20 may be connected to the base plate using for example bolts.

[0066] The not shown one or more mould cavities may - in also not shown - further embodiments be formed in one or more cassettes attachable on - or insertable in suitable recesses in - the first surface 22 of the first mould plate 20.

[0067] Further, the first mould plate and or the base plate may be equipped with sprue channels and runner channels necessary to connect the one or more mould cavities in the first mould plate 20 with an injection nozzle 225 of an injection moulding machine 200, such as an injection moulding machine as shown in Fig. 1.

[0068] The mould box 1 according to the invention - and as shown in Figs. 3-5 - further comprises a second mould plate 30.

[0069] The second mould plate 30 is movably arranged relative to the first mould plate 20. Thereby, the second mould plate 30 is also movably arranged relative to the base plate 10.

[0070] The mould box 1 according to the invention - and as shown in Figs. 3-5 - further comprises a guide rail system 40' configured for guiding the second mould plate linearly away from and towards the first mould plate 20.

[0071] The guide rail system 40' allows the second mould plate 30 to be movably arranged relative to the base plate 10.

[0072] In other not shown embodiments, the first mould plate 20 may also be movably arranged, relative to the base plate 10, the injection moulding machine 200 further comprising means for moving the first base plate 20 on the guide rail system 40'.

[0073] In yet other - not shown - embodiments, the mould box 1 may comprise a third plate (not shown) arranged between the first and second mould plates 20, 30, where for example runner channels are arranged in third plate. Such a third plate may be fixed relative to the base plate 10 or it may be moveable on the guide rail system 40' in order to facilitate de shaping of the runner channels.

[0074] As shown in Figs. 3-5, the guide rail system 40' comprises a single guide rail pillar 40, only. In principle, the guide rail system may 40' may comprise more than a single guide rail pillar, but only one is needed.

[0075] The guide rail pillar 40 is elongate, having a first end 43 and second end 44, an elongate body part 41 extending between the first end 43 and the second end 44, and a longitudinal axis A. The guide rail pillar 40 has a cross sectional shape perpendicular to the longitudinal axis A.

[0076] The cross-section/cross-sectional shape forms a polygon.

[0077] We note that by a polygon or polygonal shape we mean any 2-dimensional shape formed with straight lines. Triangles, quadrilaterals, pentagons, and hexagons are all examples of polygons.

[0078] There are two main types of polygon - regular and irregular. A regular polygon has equal length sides with equal angles between each side. Any other polygon is an irregular polygon, which by definition has unequal length sides and unequal angles between sides. In principle, the cross-section of the guide pillar according to the invention may have any polygonal shape.

[0079] However, as shown in Figs. 3-5, the polygonal shape may in some embodiments be rectangular.

[0080] In some embodiments a longer side length of the rectangular cross section/cross-sectional shape may be arranged vertically. Thus, the rectangular shape of the guide rail pillar 40 is oriented such that a longer side of the rectangular shape extends vertically and a shorter side of the rectangular shape extends horizontally.

[0081] In any case, the guide rail pillar 40 having a cross-section/cross-sectional shape forming a polygon will result in the guide rail pillar 40 having a set of planar guide surfaces 45', 45", 46', 46" for cooperating with a bearing element 51 arranged on the second mould plate 30. The number of planar guide surfaces on the guide rail pillar 40 will depend on the number of sides of the polygonal cross-section/cross-sectional shape of the guide rail pillar 40. The guide rail pillar 40 shown in Figs. 3-5 having a rectangular cross section has two wider planar guide surfaces 45', 45" and two narrower planar guide surfaces 46', 46". The two wider planar guide surfaces 45', 45" are parallel to each other and formed on opposed sides of the guide rail pillar 40. Similarly, the two narrower planar guide surfaces 46', 46" are parallel to each other and formed on opposed sides of the guide rail pillar 40, but perpendicular to the two wider planar guide surfaces 45', 45".

[0082] The second mould plate may comprise one or more mould cores (not shown) extending outward from a first surface 32 of the second mould plate 20, facing the first surface of the first mould plate 20. An opposite side, second surface 33 of the second mould plate 320 faces away

from the first mould plate 20 and the base plate 10, see e.g. Fig. 5. The second mould plate 30 is arranged moveably relative to the first mould plate 20, such that the mould box may be completely closed (clamped together) to allow injection of the melted plastic, and such that the mould box 1 may be opened to extract a moulded object, e.g. similar to the moulded object 100 shown in Fig. 2.

[0083] As is the case with the first mould plate 20, described above, the not shown one or more mould cores (and/or further portions of mould cavities) may - in also not shown - further embodiments be formed in one or more cassettes attachable on - or insertable in suitable recesses in - the first surface 32 of the second mould plate 30.

[0084] As is the case with the prior art examples described above, the mould box 1 according to the invention may form part of a clamping unit 270 of an injection moulding machine 200, in this case however with a single polygonal cross-section guide rail pillar 40 (instead of the four cylindrical guide rails 40", shown in Fig. 1) for guiding the movement of the second mould plate 30. The movement of the second mould plate 30 is performed by a linear drive mechanism 280, for example a hydraulic mechanism.

[0085] As shown in Figs. 3-5, the guide rail pillar 40 extends through a second opening 130 in the second mould plate 30. The first opening 130 in the second mould plate 30 is a through-going opening extending all the way through the second mould plate 30.

[0086] The second opening 130 in the second mould plate 30 preferably has a cross sectional shape corresponding to the cross-sectional shape of the guide pillar 40 such that the guide pillar 40 may be slidably arranged therein.

[0087] Preferably, the second opening 130 in second mould plate 30 is provided with a bearing 50, such as a slide bearing. In this case the second opening 130 in the second mould plate 30 is configured to receive the bearing 50.

[0088] The bearing 50 comprises a bearing element 51 with inner surfaces configured for contacting the planar surfaces of the guide rail pillar 40. The bearing element 51 may as shown in e.g. Fig. 5 have a main body part 52 and flange 53 having a larger cross sectional extent than that of the main body part 51, see e.g. Fig.5. In such cases the second opening 130 in the second mould plate 30 may comprise one first section 131 configured for receiving the main body part 52 of the bearing element 51, and another, second section 132 with a larger cross-sectional extend than the first section 131, and configured for receiving the flange 53 of the bearing element 51, see e.g. Fig. 4C.

[0089] As shown in Figs. 3-5, the guide rail pillar 40 extends through a third opening 150 formed in the bearing 50. The third opening 150 in the bearing element 51 is a through-going opening extending all the way through the bearing element 51. The third opening 150 in the bearing element 51 preferably has a cross sectional shape corresponding to the cross-sectional shape of the guide pillar 40 such that the guide pillar 40 may be slidably arranged

therein.

[0090] As shown in Figs. 3-5, the guide rail pillar 40 also may extend through a first opening 120 in the first mould plate 20. The first opening 120 in the first mould plate 20 is a through-going opening extending all the way through the first mould plate 20. The first opening 120 in the first mould plate 20 preferably has a cross sectional shape corresponding to the cross-sectional shape of the guide pillar 40 such that the guide pillar 40 may be received and fixedly anchored.

[0091] The guide rail pillar 40 may have a main body part 41 and flange or protrusion 42 having a larger cross sectional extent than that of the main body part 41, see e.g. Fig.5. In such cases, and as shown in e.g. Fig 4C, the first opening 120 in the first mould plate 20 may comprise one first section 121 configured for receiving the main body part 41 of the guide rail pillar 40, and another, second section 122 with a larger cross-sectional extend than the first section 121, and configured for receiving the flange 42 of the guide rail pillar 40, see e.g. Fig. 4C. The guide rail pillar 40 at a first end 43 thereof may thereby be provided with a protrusion 41 configured for cooperating with an enlargement 121 of the second opening 120 in the first mould plate 20.

[0092] Thus, the guide rail pillar 40 is anchored in first opening 120 through the first mould plate 20.

[0093] In either case, and as shown in Figs. 3-5, the second opening 130 in the second mould plate 30 is formed centrally in the second mould plate 30. In this case, it follows that the first opening 130 in the first mould plate 30 is also formed centrally in the second mould plate 30.

[0094] The one or more mould cavities may be formed around the first opening 130 in the first mould plate 20. Further, mating mould cores may be formed around the second opening in the movable, second mould plate 30.

[0095] Figs. 3A-C, in various views, show a mould box 1 according to one embodiment of the invention in a first position, where the first and second mould plates 20, 30 are in close contact and clamped together. This illustrates a position, where plastic may be injected into the (not shown) mould cavity formed between the first and second mould plates 20, 30. Correspondingly, figs. 4A-C show the mould box of Figs. 3A-C in a second position, where the first and second mould plates 20, 30 are separated from each other. This illustrates a position, where moulded objects may be removed from the mould cavity.

[0096] Figs.6A-C, in a sectional view, shows a guide rail pillar 40 and a second mould plate 30 slidably arranged thereon. The guide rail pillar 40 is of the type described above, having a polygonal cross section (perpendicular to the elongate axis of the guide rail pillar 40), such as a square or rectangular cross section. Thus, as shown in Figs. 6A-C, the guide rail pillar 40 has two parallelly arranged planar guide surfaces 45', 45".

[0097] A bearing 50 is formed between the second mould plate 30 and the guide rail pillar 40. The bearing comprises a bearing element 51 arranged in a second opening 130 through the second mould plate 30 as described above. The bearing element 51 may be fixedly mounted in the second opening 130.

[0098] The bearing element 51 has a through-going opening, third opening 150, formed there through. The third opening 150 is shaped and sized to mate at least with the has two parallel arranged planar guide surfaces 45', 45" of the guide rail pillar 40, and configured to allow the second mould plate 30 with the bearing element 51 to slide reciprocally and linearly on the guide rail pillar 40 in a direction parallel to the longitudinal direction of the guide rail pillar 40.

[0099] The third opening 150 for this purpose has two parallel internal bearing surfaces 155'. 155". As shown in Figs. 6A-C, the parallel internal bearing surfaces 155'. 155" in this case are formed across the entire width of the bearing element 51 and the second mould plate 30. Theoretically, this would be beneficial to take up any torsional forces on the second mould plate during the moulding process.

[0100] Fig. 6A shows a situation where there are no torsional forces on the second mould plate 30 or the guide rail pillar 40. However, especially if there mould box 1 guide rail system 40' has only a single guide rail pillar 40, there is a risk that an uneven pressure influences the second mould plate 30 relative to the guide rail pillar 40 such that the second mould plate 30 is forced to rotate slightly relative to the guide rail pillar 40. Such a situation is shown in Fig. 6B. The encircled area shown in dashed line in Fig. 6B is blown up in Fig. 6C. From Fig. 6C it is evident that torsion between the second mould plate and the guide rail pillar may result in two line contacts 155'", 155'''". Line contact increases contact pressure between the guide rail pillar 40 and the bearing element 51, and can cause the bearing 50 to lock, resulting in abrasive wear on both bearing element 51 and guide rail pillar 51. The bearing thus experiences both static loads and dynamic friction, making it difficult to design for optimum performance in all load cases.

[0101] As illustrated in Figs. 10A-F, of which Figs. 10A-E are not to scale, this problem may be overcome by removing a portion of material from the internal bearing surfaces 155'. 155" to form a ledge or "rounding" 156', 156" of the internal bearing surfaces 155'. 155", at each end of the third opening 150, i.e. in the longitudinal direction, A. The bearing element 51 shown in Figs. 10A-F may substitute the bearing element 51 shown in Figs. 6A-C or Figs 3-5. Such ledges 156', 156" will allow a slight rotation of the second mould plate 30 with the bearing element 51 relative to the corresponding parallel guide surfaces 45', 45" of the guide rail pillar 40 to accommodate for any asymmetrical loads on the second mould plate 30 to which the bearing element 51 is attached.

[0102] As can be appreciated from Fig. 10F, which is a detailed view of the ledge 156" of Fig. 10E, the removal of material is very minute. Thus, the ledge 156" only forms a very slight angle relative to the internal bearing surface 155".

[0103] In practice it has proven very hard to make such ledges 156', 156" or "roundings" without introducing a (microscopic) edge 157 at the boundary between the planar bearing surface 155', 155" and the ledge 156', 156". Even this very small edge 157 is expected to break the oil film between the bearing surfaces and to increase wear on the guide rail pillar 40 or cause locking there between.

[0104] Figs. 7-9 show embodiments according to a first aspect of the invention, which will alleviate the problems of the prior art (Figs. 6A-C) and of the aspect of the invention shown in Figs. 10A-F.

[0105] According to this aspect of the invention, the bearing element 51 comprises - for at least one of the guide surfaces 45', 45" of the guide rail pillar 40 - a first planar bearing surface 64 and a second planar bearing surface 65 arranged in a common plane P_1 (see e.g. Figs. 7E, 8D or 9E) and parallel to the corresponding planar guide surface 45', 45" of the guide rail pillar 40. The first planar bearing surface 64 and the second planar bearing surface 65 are spaced apart in the direction of the longitudinal axis A. The first bearing surface 64 is arranged at the first end 54 of the bearing element 51, and the second bearing surface 65 is arranged at the second end 55 of the bearing element 51. In order to provide a resilience of the first and second bearing surfaces 64, 65 relative to a main body part 52 of the bearing element 51, and thereby ensure that the first and second bearing surface 64, 65 will follow and remain parallel to the corresponding planar guide surface 45', 45" of the guide rail pillar 40 to avoid any edges being the sole contact between the guide rail pillar 40 and the bearing element 50, a cavity 74, 75; 74', 75'; 174, 175 is formed in the bearing element 51 at least partially below each of the first and second planar bearing surfaces 64, 65.

[0106] Returning now to Figs. 7A-E, these figures show a first embodiment of the invention. Fig. 7A, in a perspective view, shows a bearing element 50 according to the invention. The bearing element 51 comprises a main body part 52 with a first end 54 and a second end 55 and a through-going opening 150. The through-going opening 150 is configured for receiving the guide rail pillar 40.

[0107] The through-going opening 150 extends from the first end 54 to the second end 55 of the main body part 52, and all the way through the main body part 52.

[0108] Thereby, the longitudinal axis A of the guide rail pillar 40 extends in the same direction as the direction from the first end 54 to the second end 55 of the main body part 52.

[0109] The bearing element 51 is preferably arranged in an opening 130 through a mould plate, such as a second mould plate 30 of a mould box 1 of an injection moulding machine 200 as described above. For this purpose the bearing element 51 may comprise a flange 53 with an increased extent (perpendicular to the longitudinal axis A) relative to the extent of the main body part 52 of bearing element 51 as also mentioned above.

[0110] The bearing element 51 forms part of a bearing 50 between planar guide surfaces 45',

45" of a guide rail pillar 40 of a mould box 1, for example as shown in Figs. 6A- C, and a second mould plate 30 of the mould box 1, where the second mould plate 30 is moveably arranged on the guide rail 40.

[0111] The through-going opening 150 in the embodiment shown in Figs. 7A-F has four inner surfaces 151', 151", 152', 152", see e.g. Fig 7D.

[0112] Preferably, the number of inner surface 151', 151", 152', 152" corresponds to the number of planar guide surface 45'.45" of the guide rail pillar 40.

[0113] At least one inner surface 151', 151", 152', 152" comprises a first planar bearing surface 64 and a second planar bearing surface 65 arranged in a common plane P_1 , as shown in Fig. 7E, and parallel to the planar guide surface (45', 45"). The first planar bearing surface 64 and the second planar bearing surface 65 are spaced apart in the direction of the longitudinal axis A. The first bearing surface 64 is arranged at the first end 54 and the second bearing surface 65 is arranged at the second end 55 of the bearing element 51.

[0114] In the embodiment, shown in Figs. 7A-F each of the two longer inner surfaces 151', 151" comprises two sets of such first and second planar bearing surfaces 64, 65, and each of the two shorter inner surfaces 152', 152" comprises a single set of such first and second planar bearing surfaces 64, 65.

[0115] In the shown embodiment the first and second planar bearing surfaces 64, 65 have a limited width, in a direction perpendicular to the elongate axis A. However, it will be appreciated that the width of the first and second planar bearing surfaces 64, 65 may be varied. Thus, instead of two set of first and second planar bearing surfaces 64, 65 on the two longer inner surfaces 151', 151", a single set of wider/broader first and second planar bearing surfaces 64, 65 may be used, for example extending the width of the inner surface 151', 151 ".

[0116] As shown in e.g. Fig. 7D, the first and second bearing surfaces 64, 65 are elevated above the corresponding inner surface 151', 151", 152', 152" of the through-going opening 150.

[0117] As shown in e.g. Figs. 7E and F, the first and second bearing surfaces 64, 65 are separated by an intermediary surface portion 66 being retracted from the common plane P_1 of the two bearing surfaces 64, 65.

[0118] As also mentioned above, a cavity 74, 75; 74', 75'; 174, 175 is formed in the bearing element 51, below each of the first and second bearing surfaces 64, 65, such that a portion 84, 85 of the bearing element 51 is provided with a resilience relative to the main body part 52 of the bearing element 51.

[0119] The cavity 74, 74', 174 below the first bearing surface 64 allows the portion 84 (on which the first bearing surface 64 is formed) to flex (at least slightly) relative to the main body

part 52 proper, thereby providing the mentioned resilience. Similarly, the cavity 75, 75', 175 below the second bearing surface 65 allows the portion 85 (on which the second bearing surface 65 is formed) to flex relative to the main body part 52 proper, thereby providing the mentioned resilience.

[0120] Generally, the cavity 74; 74'; 174 below the first bearing surface 64 may be formed as a primary cavity 74; 74' extending into the main body part 52 of the bearing element 51 from an end surface at the first end 54 of the bearing element 51. And, generally, the cavity 75; 75'; 175 below the second bearing surface 65 may be formed as a primary cavity 75; 75' extending into the main body part 52 of the bearing element 51 from an end surface at the second end 55 of the bearing element 51.

[0121] More specifically and as best illustrated in Figs. 7E and 7F, the cavity, or primary cavity 74, 75 below each of the first and second bearing surfaces 64, 65 is formed as a ledge 74', 75'.

[0122] The ledges 74', 75' may be formed with surfaces angled relative to the inner surface 151', 151", 152', 152".

[0123] As also shown in Figs. 7E and 7F, the first and the second bearing surfaces 64, 65 and the intermediary surface portion 66 are formed on a detachable plate member 56. One embodiment of the detachable plate member 56 as such is shown in Fig. 7B.

[0124] The detachable plate member 56 is arranged in an elongate depression 57 formed in the inner surface 151', 151", 152', 152" of the through-going opening 150 through the bearing element 51.

[0125] Preferably, and as shown in the Figs 7A-F, the elongate depressions 57 extends from said first end 54 to said second end 55 of the bearing element 51.

[0126] Preferably also the detachable plate member(s) 56 is/are configured such that it/they extend(s) from said first end 54 to said second end 55 of the bearing element 51 and fill out the entire length of the elongate depression(s) 57.

[0127] It will be appreciated, that in this embodiment, the portions 84, 85 of the bearing element 51 form part of the detachable plate member 56. It will also be appreciated that the portions 84, 85 of the detachable plate member 56 are provided with a resilience relative to the main body part 52 by being able to flex slightly due at least to the cavities 74, 75 formed as the ledges 74', 75' in the bearing element 51.

[0128] It will be appreciated that a reverse side of the detachable plate member 56 (reverse relative to the first and the second bearing surfaces 64, 65) may be formed with a single planar surface (not shown).

[0129] In other embodiments however, and as shown in e.g. Fig 7B, the detachable plate member 56, on the reverse side (relative to the first and the second bearing surfaces 64, 65) comprises

- a first abutment surface 64';
- a second abutment surface 65' formed in a common plane, P_2 , with the first abutment surface 64'; and
- an intermediary surface portion 66' being retracted from the common plane P_2 of the two abutment surfaces 64', 65'.

[0130] The intermediary surface portion 66 between the first and the second bearing surfaces 64, 65 on one side, and the intermediary surface portion 66' formed between the first and second abutment surfaces 64', 65' on the reverse side the detachable plate member 56, will - in combination allow for a reduced material thickness between the first and the second bearing surfaces 64, 65 which will increase the resilience of the portions 84, 85 of the detachable plate member 56 such that uneven load distribution on the second mould plate 30 will not cause an edge of the bearing element 51 to come into direct contact with the planar surfaces 45.' 45" of the guide rail pillar 40.

[0131] The elongate depression 57 formed in at least one of the inner surfaces 151', 151", 152', 152" of the through-going opening 150 through the bearing element 51 may in some (not shown) embodiments be formed with a planar bottom surface extending the entire length of the elongate depression.

[0132] However, as is evident from especially Figs. 7E and 7F, the elongate depression 57 formed in at least one of the inner surfaces 151', 151", 152', 152" of the through-going opening 150 through the bearing element 51, in a preferred embodiment, comprises

- a first abutment plateau 164 at the second first end 54 of the bearing element 51;
- a second abutment plateau 165 at the second end 55 of the bearing element 51, and
- an intermediary depression 166 formed between the first and second abutment plateaus 164, 165.

[0133] It will be appreciated that, in embodiments where the elongate depression 57 formed in the inner surface 151', 151", 152', 152" is formed with an even bottomed surface (entirely planar bottom surface), the retracted surface portion 66' forms a void or space between the even bottomed surface and the detachable plate member 56, thereby increasing the flexibility of the bearing 50.

[0134] In embodiments, where the elongate depression 57 formed in the inner surface 151', 151", 152', 152" is formed with the first and second abutment plateaus 164, 165 separated by

the intermediary depression 166, and the reverse side of the detachable plate member 56, relative to the first and the second bearing surfaces 64, 65, is formed with a single planar surface, a similar void or space is formed between the single planar surface of the detachable plate member 56 and the intermediary depression 166 between the abutment plateaus 164, 165, whereby a similar increased flexibility of the bearing 50 may be achieved.

[0135] In embodiments, where the elongate depression 57 formed in the inner surface 151', 151", 152', 152" is formed with the first and second abutment plateaus 164, 165 separated by the intermediary depression 166, and where the reverse side of the detachable plate member 56, relative to the first and the second bearing surfaces 64, 65, is formed with retracted surface portion 66' between the first and second abutment surfaces 64', 65', an increased size void or space is formed between the elongate depression 57 and the detachable plate member 56, whereby an increased flexibility of the bearing 50 may be achieved.

[0136] It is noted that in embodiments, where the elongate depression 57 formed in the inner surface 151', 151", 152', 152" is formed with the first and second abutment plateaus 164, 165 separated by the intermediary depression 166, and where the reverse side of the detachable plate member 56, relative to the first and the second bearing surfaces 64, 65, is formed with retracted surface portion 66' between the first and second abutment surfaces 64', 65', the abutment surfaces 64', 65' and the abutment plateaus 164, 165 are configured for abutting on each other.

[0137] It will further be appreciated that (not shown) locking means may keep the detachable plate member 56 locked in the correct position in the elongate depression 57.

[0138] Figs. 8A-E shows another embodiment of the bearing 50, in which the first and second bearing surfaces 64, 65 are not formed on a detachable plate member 56 arranged in an elongate depression 57 as shown in Figs. 7A-F. Instead, the first and second bearing surfaces 64, 65 are formed on portions 84, 85 formed in the sidewalls, inner surfaces 151', 151", 152', 152", of the bearing element 51. In principle the portions 84, 85 may be formed as (separate) attachable and/or detachable parts relative to the main body part 52 of the bearing element 51. However, in a preferred embodiment, the portions 84, 85 with the respective first and second bearing surfaces 64, 65 formed thereon, are integrated with the main body part 52 of the bearing element 51.

[0139] For example the main body part 52 of the bearing element 51 may be formed in one piece and the portions 84, 85 may be shaped by milling the cavity 74, 75 in the main body part 52. Alternatively, the main body part 52 of the bearing element 51 may be formed in one piece including the cavity 74, 75 defining the portions 84, 85 in an additive manufacturing process.

[0140] In such embodiments, the cavity 74 forms a bridge 84' between the main body part 52 as such and the portion 84 on which the first bearing surface 64 is formed. This bridge 84' thereby has a diminished material thickness, which will provide a desired resilience. Similarly, the cavity 75 forms a bridge 85' between the main body part 52 as such and the portion 85 on

which the second bearing surface 65 is formed.

[0141] In Figs. 8A-E, the cavity 74; below the first bearing surface 64 is formed as a primary cavity 74; extending into the main body part 52 of the bearing element 51 from an end surface at the first end 54 of the bearing element 51. Further, the cavity 75; below the second bearing surface 65 is formed as a primary cavity 75; 75' extending into the main body part 52 of the bearing element 51 from an end surface at the second end 55 of the bearing element 51.

[0142] The cavities 74, 75 extend in the same direction as the longitudinal axis A. The length (in the direction as the longitudinal axis A) of each of the cavities 74, 75 is preferably such that the cavity 74, 75 stretches under half of the first or second bearing surface 64, 65.

[0143] As was the case above, also in the Figs. 8A-E embodiment, the first and second bearing surfaces 64, 65 are separated by an intermediary surface portion 66 being retracted from the common plane P_1 of the two bearing surfaces 64, 65. In this case however, the intermediary surface portion 66 may form part of one of the inner surfaces 151', 151", 152', 152".

[0144] The first planar bearing surface 64 and the second planar bearing surface 65 are spaced apart in the direction of the longitudinal axis A. The first bearing surface 64 is arranged at the first end 54 and the second bearing surface 65 is arranged at the second end 55 of the bearing element 51.

[0145] Also in the embodiment shown in Figs. 8A-E, each of the two longer inner surfaces 151', 151" comprises two sets of such first and second planar bearing surfaces 64, 65, and each of the two shorter inner surfaces 152', 152" comprises a single set of such first and second planar bearing surfaces 64, 65.

[0146] In the shown embodiment the first and second planar bearing surfaces 64, 65 have a limited width, in a direction perpendicular to the elongate axis A.

[0147] It will however, be appreciated that the width of the first and second planar bearing surfaces 64, 65 may be varied. Thus, instead of two set of first and second planar bearing surfaces 64, 65 on the two longer inner surfaces 151', 151", a single set of wider/broader first and second planar bearing surfaces 64, 65 may be used, for example extending the width of the inner surface 151', 151".

[0148] As shown in e.g. Figs. 7D and 7E, the first and second bearing surfaces 64, 65 are elevated above the corresponding inner surface 151', 151", 152', 152" of the through-going opening 150.

[0149] The embodiment shown in Figs. 9A-E generally corresponds to the embodiments described in connection with Figs. 8A-E above. However, in the Figs. 8A-E embodiment, there is provided an additional secondary cavity 174 below the first bearing surface 64 and additional

secondary cavity 175 below the second bearing surface 65.

[0150] The additional secondary cavity 174 below the first bearing surface 64 extends into the main body part 52 of the bearing element 51 from the inner surface 151', 151", 152', 152" of the through-going opening 150 from a position adjacent to the first bearing surface 64.

[0151] Correspondingly, the additional secondary cavity 175 below the second bearing surface 65 extends into the main body part 52 of the bearing element 51 from the inner surface 151', 151", 152', 152" of the through-going opening 150 from a position adjacent to the second bearing surface 65.

[0152] In a further embodiment thereof, and as seen in e.g. Figs. 9D and 9E, the secondary cavity 174 adjacent to the first bearing surface 64 and the secondary cavity 175 adjacent to the second bearing surface 64 each comprise one first cavity portion 176 extending in a direction perpendicular to a plane of the inner surface 151', 151", 152', 152" of the through-going opening 150, and one second cavity portion 177 extending from the first cavity portion 176 in a direction parallel to the inner surface 151', 151", 152', 152" of the through-going opening 150.

[0153] Also in the latter case the portions 84, 85 of the bearing element 51 provided with a resilience relative to the main body part 52 by the cavities 74, 75 formed in the bearing element 51 are formed integral with the main body part 52 of the bearing element 51.

[0154] It will be appreciated that even though the Figs. 9A-E embodiment shows that there is both a primary cavity 74 and a secondary cavity 174 under/below the first bearing surface 74, and both a primary cavity 75 and a secondary cavity 175 under/below the second bearing, in (not shown) embodiment it will - in principle - be possible to have only cavities of the secondary type extending under first and second bearing surfaces 64, 65.

[0155] It will be appreciated that also in embodiments, where the portions 84, 85 of the bearing element 51 provided with a resilience relative to the main body part 52 by the secondary 174, 175 formed in the bearing element 51 are formed integral with the main body part 52 of the bearing element 51, the main body part 52 of the bearing element 51 may be formed in one piece and the portions 84, 85 may be shaped by milling the secondary cavity 174, 175. Alternatively, the main body part 52 of the bearing element 51 may be formed in one piece including the secondary cavities 174, 175 defining the portions 84, 85 in an additive manufacturing process.

[0156] As shown in Figs. 8A-E and 9A-E two separations 70', 70" are provided in the bearing element 51 adjacent to each of the first and the second bearing surface 64, 65. The separations 70', 70" extend along a direction parallel to the longitudinal axis A, and in an entire length of the bearing surface 64, 65, and the separations extends from the inner surface 151', 151", 152', 152" of the through-going opening 150 into the main body part 52. In principle the embodiments shown in Figs. 7A-F also comprises such separations 70', 70", but they are in the shape of the elongate depression 57.

[0157] In the latter cases, where the portions 84, 85 are integral with the main body part 53 the portions 84, 85 may be shaped by milling the separations 70', 70" in the main body part 52. Alternatively, the main body part 52 of the bearing element 51 may be formed in one piece including the separations 70', 70" in an additive manufacturing process.

[0158] As also mentioned above, a bearing element 51 according to any of the embodiments described may be arranged in an opening 130 through the mould plate 30 of the mould box 1, for example as shown in Figs 4B and 5.

[0159] Figs. 11A-B illustrates a bearing 50 according to another aspect of the invention. The bearing 50 comprises a bearing element 51. The bearing element 51 has a main body part 52 with a first end 54 and a second end 55. The bearing 50 also comprise two detachable bearing plates or portions 84, 85 for each planar surface 45' 45" of the guide rail pillar 40. In principle, the bearing plates or portions 84, 85 may be separate parts individually locked in position relative to the main body part 52 of the bearing element 51 (in the direction of the longitudinal axis A) by (not shown) locking means. However, the bearing plates or portions 84, 85 may also be connected to each other as one integrated part (not shown), for example as the detachable plate 56 described in connection with Figs. 7A-F. Also in this case the bearing plates or portions 84, 85 may be locked in the correct position relative to the bearing element 51 (in the direction of the longitudinal axis A) by (not shown) locking means. In either case, the bearing plates or portions 84, 85 are connected to the bearing element 51 via semi-cylindrical surfaces 194, 195, one semi-cylindrical surface 194 at the first end 54, and another semi-cylindrical surface 195 at the second end 55.

[0160] It is to be noted that the figures and the above description have shown the example embodiments in a simple and schematic manner. Many of the specific mechanical details have not been shown since the person skilled in the art should be familiar with these details and they would just unnecessarily complicate this description.

List of parts

[0161]

- 1 mould box
- 10 base plate
- 15 second end structure of the clamping part/clamping unit
- 20 first mould plate
- 21

- 22 mould cavity formed in the first mould plate
- 23 first surface/side of the first mould plate and facing toward the second mould plate
- 24 second surface/side of the first mould plate opposite to the first surface/side, and facing the base plate
- 25 upper edge of the first mould plate
- 26 lower edge of the first mould plate
- 30 openings through the first mould plate for receiving the cylindrical guide rails in prior art mould boxes
- 31 second mould plate
- 32 core formed on second mould plate, and configured for cooperating with the mould cavity of the first mould plate
- 33 first surface of the second mould plate and facing toward the first mould plate
- 40' second surface of the second mould plate opposite to the first surface, and facing away from the first mould plate and the base plate
- 40" guide rail system
- 40 cylindrical guide rail
- 40 guide rail pillar
- 41 elongate body part of guide rail pillar
- 42 protrusion at end of the elongate body part of the main guide rail pillar
- 43 first end of guide rail pillar
- 44 second end of guide rail pillar
- 45' surface of guide rail pillar
- 45" surface of guide rail pillar
- 46' surface of guide rail pillar
- 46" surface of guide rail pillar

- 50 surface of guide rail pillar
- 51 bearing between second mould plate and guide rail pillar
- 52 bearing element
- 53 main body part of bearing element
- 54 flange on main body part of bearing element
- 55 first end of the main body part of bearing element
- 56 second end of the main body part of bearing element
- 57 detachable plate member of bearing element
- 64 elongate depression formed in the inner surface of the through-going opening through the bearing element
- 64' bearing surface, first bearing surface
- 65 abutment surface on opposite side of first bearing surface of the detachable plate member of bearing element
- 65' bearing surface, second bearing surface
- 66 abutment surface on opposite side of second bearing surface of the detachable plate member of bearing element
- 66' intermediary surface portion being retracted from a common plane of the first and second bearing surfaces
- 70' intermediary surface portion being retracted from a common plane of the two abutment surfaces on the opposite sides of the first and the second bearing surfaces of the detachable plate member
- 70" separation provided in the bearing element adjacent to, and on one side of, each of the first and the second bearing surfaces
- 74 separation provided in the bearing element adjacent to, and on the other side of, each of the first and the second bearing surfaces
- 74 cavity, primary cavity formed in the bearing element at first end thereof (first end primary cavity)

- 74' ledge/angled surface forming the first end primary cavity
- 75 cavity, primary cavity formed in the bearing element at second end thereof (second end primary cavity)
- 75' ledge/angled surface forming the second end primary cavity
- 84 portion of the bearing element at second end thereof, defined by first cavity
- 85 portion of the bearing element at second end thereof, defined by second cavity
- 100 moulded object
- 105 plastic granules
- 120 first opening, opening in/through the first mould plate
- 121 first section of first opening in/through the first mould plate
- 122 second section of first opening in/through the first mould plate/enlargement
- 130 second opening, opening in/through the second mould plate
- 131 first section of the second opening in/through the second mould plate
- 132 second section of the second opening in/through the second mould plate
- 150 third opening, through-going opening/ formed through the bearing element
- 151' inner surface of through-going opening/third opening
- 151" inner surface of through-going opening/third opening
- 152' inner surface of through-going opening/third opening
- 152" inner surface of through-going opening/third opening
- 155' internal bearing surface
- 155" internal bearing surface
- 156' ledge or rounding
- 156" ledge or rounding

- ledge or rounding
- 157 edge
- 164 abutment plateau, first abutment plateau, formed in the elongate depression formed in the inner surface of the through-going opening at a first end of the bearing element
- 165 abutment plateau, second abutment plateau, formed in the elongate depression formed in the inner surface of the through-going opening at a second first end of the bearing element
- 166 intermediary depression formed between the first and second abutment plateaus in the elongate depression formed in the inner surface of the through-going opening through the bearing element
- 174 cavity, secondary cavity (first end secondary cavity) formed in the bearing element at first end thereof
- 175 cavity, secondary cavity (second end secondary cavity) formed in the bearing element at first end thereof
- 176 first cavity portion
- 177 second cavity portion
- 194 semi-cylindrical surfaces
- 195 semi-cylindrical surfaces
- 200 injection moulding machine
- 201 mount/frame of injection moulding machine
- 210 injection unit/injection part of injection moulding machine
- 220 reciprocating screw of injection moulding machine
- 225 nozzle at the entrance to the clamping part of injection moulding machine
- 226 sprue channels in the base plate of the mould box
- 230 drive mechanism for driving reciprocating screw of injection moulding machine
- 240 hopper of injection moulding machine

- 250 heating devices surrounding the reciprocating screw of the injection moulding machine
- 260 barrel surrounding reciprocating screw of injection moulding machine
- 270 clamping unit/clamping part of injection moulding machine
- 280 linear drive mechanism for linearly displacing the moveable platen and or the second mould plate 30
- 290 moveable platen
- A longitudinal axis of a guide rail pillar
- P₁ common plane of first and second bearing surfaces
- P₂ common plane of the two abutment surfaces plate member of bearing element

REFERENCES CITED IN THE DESCRIPTION

Cited references

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- [DE29802231U1 \[0004\]](#)
- [EP2607044A2 \[0004\]](#)
- [US4718845A \[0004\]](#)

Claims

1. Leje (50) mellem plane føringsflader (45', 45") af en føringsskinnesøjle (40) af en formkasse (1) og en formplade (30) af formkassen (1), idet formpladen (30) er
5 bevægeligt anbragt på føringsskinnen (40), idet føringsskinnen (40) har en langsgående akse (A), idet lejet (50) omfatter et lejeelement (51), hvor lejeelementet (51) har en hovedkropsdel (52) med en første ende (54) og en anden ende (55) og en gennemgående åbning (150) til modtagelse af føringsskinnesøjlen (40), idet den gennemgående åbning (150) strækker sig fra den
10 første ende (54) til den anden ende (55) gennem hoveddelen (52), og den gennemgående åbning (150) har en indre overflade (151', 151", 152', 152") for hver plan føringsflade (45'.45") af føringsskinnesøjlen (40),
kendetegnet ved, at lejeelementet (51) for mindst en af føringsskinnesøjlen (40) føringsflader (45', 45") omfatter en første plan lejeflade (64) og en anden plan
15 lejeflade (65), der er anbragt i et fælles plan (P_1) og parallelt med den plane føringsflade (45', 45") og har en indbyrdes afstand i den langsgående akse (A) retning, idet den første lejeflade (64) er anbragt i den første ende (54), og den anden lejeflade (65) er anbragt i den anden ende (55) af lejeelementet (51), hvor den første og anden lejeflade (64, 65) er hævet over den tilsvarende indre
20 overflade (151', 151", 152', 152") af den gennemgående åbning (150), hvor den første og anden lejeflade (64, 65) er adskilt af et mellemliggende overfladeafsnit (66), der er tilbagetrukket fra de to lejefladers (64, 65) fælles plan (P_1), og hvor der under hver af den første og anden lejeflade (64, 65) er udformet et hulrum
25 (74, 75; 74', 75'; 174, 175) i lejeelementet (51), således at en del (84, 85) af lejeelementet (51) forsynes med elasticitet i forhold til lejeelementets (51) hovedkropsdel (52).
2. Leje (50) ifølge krav 1, hvor hulrummet (74; 74'; 174) under den første lejeflade
30 (64) omfatter et primært hulrum (74; 74'), der strækker sig ind i lejeelementets (51) hovedkropsdel (52) fra en endeflade i den første ende (54), og hvor hulrummet (75; 75'; 175) under den anden lejeflade (65) omfatter et primært hulrum (75; 75'), der strækker sig ind i lejeelementets (51) hovedkropsdel (52) fra en endeflade i den

anden ende (55).

3. Leje (50) ifølge krav 2, hvor hulrummet (74, 75) under hver af den første og anden lejeblade (64, 65) er udformet som en afsats (74', 75').

5

4. Leje (50) ifølge et af kravene 1-3, hvor den første og den anden lejeblade (64, 65) og det mellemliggende overfladeafsnit (66) er udformet på et aftageligt pladeelement (56),

hvor det aftagelige pladeelement (56) er anbragt i en aflang fordybning (57), der er udformet i den indre overflade (151', 151", 152', 152") af den gennemgående åbning (150) gennem lejeelementet (51), hvilken aflang fordybning (57) strækker sig fra den første ende (54) til den anden ende (55) af lejeelementet (51).

5. Leje (50) ifølge krav 4, hvor det aftagelige pladeelement (56) på en bagside i forhold til den første og anden lejeblade (64, 65) omfatter

- en første anlægsflade (64');
- en anden anlægsflade (65'); og
- et mellemliggende overfladeafsnit (66'), der er tilbagetrukket fra et fælles plan (P_2) af de to anlægsflader (64', 65').

20

6. Leje (50) ifølge krav 4 eller 5, hvor den aflange fordybning (57), der er udformet i den indre overflade (151', 151", 152', 152") af den gennemgående åbning (150) gennem lejeelementet (51), omfatter

- et første anlægsplateau (164) i den anden første ende (54) af lejeelementet (51);
- et andet anlægsplateau (165) i den anden ende (55) af lejeelementet (51), og
- en mellemliggende fordybning (166), der er udformet mellem det første og andet anlægsplateau (164, 165).

7. Leje (50) ifølge krav 1 eller 2, hvor hulrummet (74; 74'; 174) under den første lejeblade (64) omfatter et sekundært hulrum (174), der strækker sig ind i

lejeelementets (51) hovedkropsdel (52) fra den indre overflade (151', 151", 152', 152") af den gennemgående åbning (150) fra en position ved siden af den første lejeblade (64); og

hvor hulrummet (75; 75'; 175) under den anden lejeblade (65) omfatter et sekundært

hulrum (75; 75'), der strækker sig ind i lejeelementets (51) hovedkropsdel (52) fra den indre overflade (151', 151", 152', 152") af den gennemgående åbning (150) fra en position ved siden af den anden lejeflade (65).

5 **8.** Leje (50) ifølge krav 7, hvor det sekundære hulrum (174) ved siden af den første lejeflade (64) og det sekundære hulrum (175) ved siden af den anden lejeflade (64) hver især omfatter et første hulrumsafsnit (176), der strækker sig i en retning vinkelret på et plan af den indre overflade (151', 151", 152', 152") af den gennemgående åbning (150), og et andet hulrumsafsnit (177), der strækker sig fra
10 det første hulrumsafsnit (176) i en retning parallelt med den indre overflade (151', 151", 152', 152") af den gennemgående åbning (150).

9. Leje (50) ifølge et af kravene 1, 2, 7 eller 8, hvor delene (84, 85) af lejeelementet (51), der er forsynet med en elasticitet i forhold til hovedkropsdelen (52) ved hjælp af
15 hulrummene (74, 75), der er udformet i lejeelementet (51), er udformet integreret med lejeelementets (51) hovedkropsdel (52).

10. Leje (50) ifølge et af kravene 1-9, hvor der er tilvejebragt to adskillelser (70', 70") i lejeelementet (51) ved siden af hver af den første og den anden lejeflade (64, 65),
20 idet adskillelserne (70', 70") strækker sig langs en retning parallelt med den langsgående akse (A) og i en hel længde af lejefladen (64, 65), og adskillelserne strækker sig fra den indre overflade (151', 151", 152', 152") af den gennemgående åbning (150) ind i hovedkropsdelen (52).

25 **11.** Leje (50) ifølge krav 10, hvor føringsskinsøjlen (40) omfatter to parallelle plane føringsflader (45', 45"), og hvor lejeelementet (51) omfatter to modsatte parallelle indre overflader (151', 151"), der svarer til de to parallelle plane føringsflader (45', 45"), og hvor hver af de to modsatte parallelle indre overflader (151', 151") omfatter mindst et sæt første og andre lejeflader (64, 65).

30

12. Leje (50) ifølge krav 11, hvor føringsskinsøjlen (40) omfatter første to parallelle plane føringsflader (45', 45") og andre to parallelle plane føringsflader vinkelret på de første to parallelle plane føringsflader (45', 45"), og hvor lejeelementet (51) omfatter første to modsatte parallelle indre overflader (151',

151"), der svarer til de første to parallelle plane føringsflader (45', 45"), og andre to modsatte parallelle indre overflader (152', 152"), der svarer til de andre to parallelle plane føringsflader, og hvor hver af de parallelle indre overflader (151', 151", 152', 152") omfatter mindst et sæt første og andre lejeplader (64, 65).

5

13. Leje (50) ifølge et af kravene 1-12, hvor lejeelementet (51) er anbragt i en åbning (130) gennem formkassens (1) bevægelige formplade (30).

14. Formkasse (1) til en sprøjtestøbemaskine (200), hvilken formkasse (1) omfatter
10 - en første formplade (20);

- en anden formplade (30), der er anbragt bevægeligt i forhold til den første formplade (20); og

- et føringsskinnesystem (40'), der er udformet til føring af den anden formplade lineært væk fra og mod den første formplade (20),

15 hvor føringsskinnesystemet (40') omfatter en føringsskinnesøjle (40),

hvor føringsskinnesøjlen (40) har en langsgående akse (A) og et tværsnit vinkelret på den langsgående akse (A), og hvor tværsnittet danner en polygon,

hvor den enkelte føringsskinnesøjle (40) omfatter plane føringsflader (45', 45")

svarende til antallet af sider i føringsskinnesøjlen (40) polygonale tværsnitsform; og

20 hvor et leje (50) ifølge et af kravene 1-13 er anbragt mellem de plane føringsflader (45', 45") af føringsskinnesøjlen (40) og den anden formplade (30).

15. Sprøjtestøbemaskine (200) omfattende

25 - en formkasse (1) omfattende en første formplade (20) og en bevægelig anden formplade (30); og

- en lineær drivmekanisme (280) til bevægelse af den anden formplade (30); og

- en sprøjteenhed (210),

idet formkassen (1) endvidere omfatter

30 - et føringsskinnesystem (40'), der er udformet til føring af den anden formplade lineært væk fra og mod den første formplade (20),

hvor den anden formplade (30) er anbragt bevægeligt i forhold til den første formplade (20) og drives af den lineære drivmekanisme (280),

hvor føringsskinnesystemet omfatter en føringsskinnesøjle (40),

- hvor føringsskinnesøjlen (40) har en langsgående akse (A) og et tværsnit vinkelret på den langsgående akse (A), hvor tværsnittet danner en polygon;
- hvor føringsskinnesøjlen (40) omfatter plane føringsflader (45', 45") svarende til antallet af sider i føringsskinnesøjle (40) polygonale tværsnitsform; og
- 5 hvor et leje (50) ifølge et af kravene 1-13 er anbragt mellem de plane føringsflader (45', 45") af den enkelte føringsskinnesøjle (40) og den anden formlade (30).

DRAWINGS

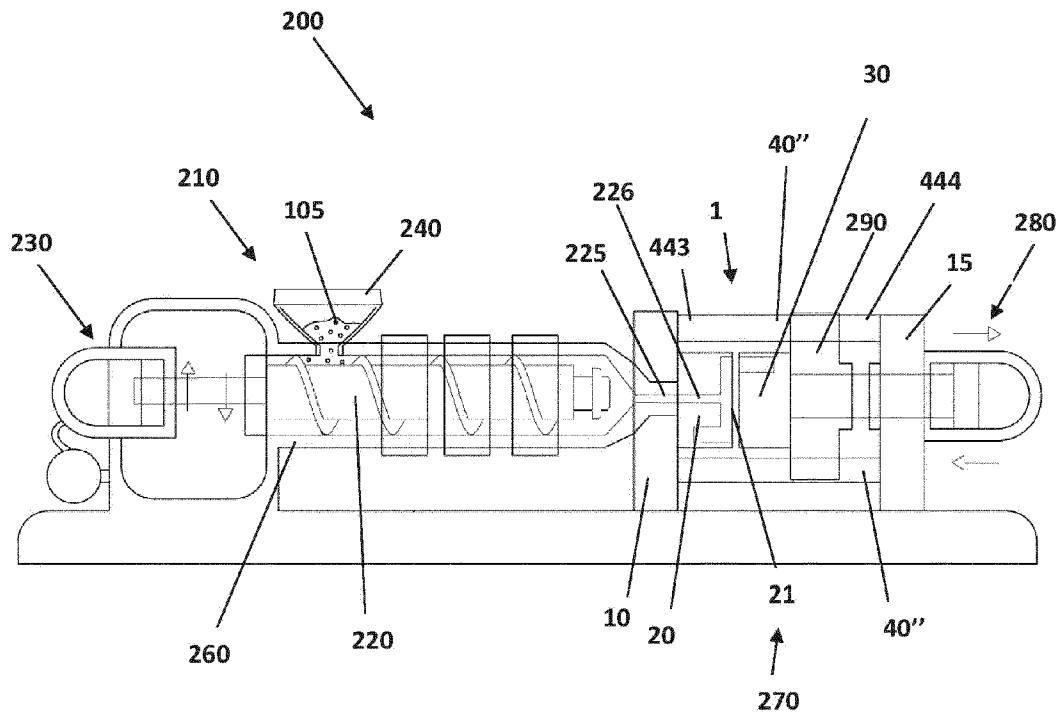


Fig. 1 (Prior art)

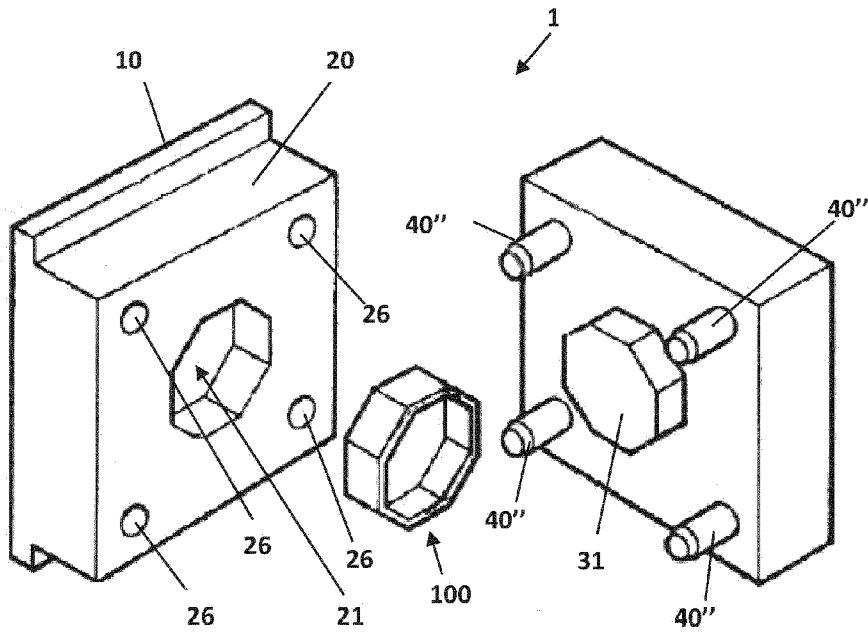


Fig. 2 (Prior art)

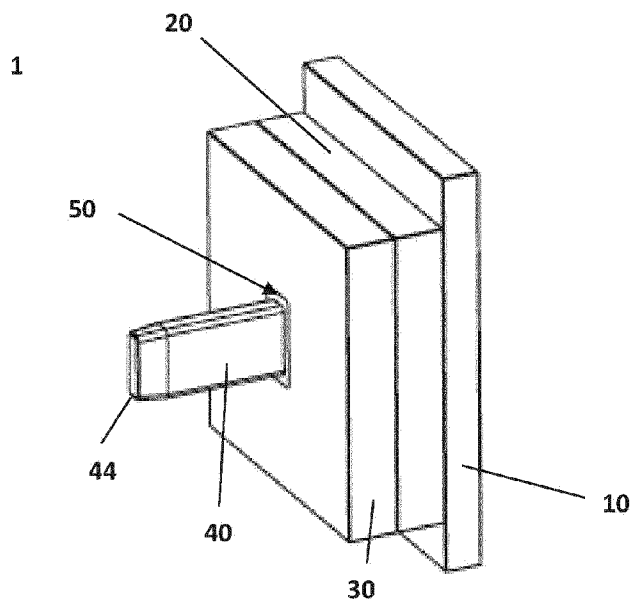


Fig. 3A

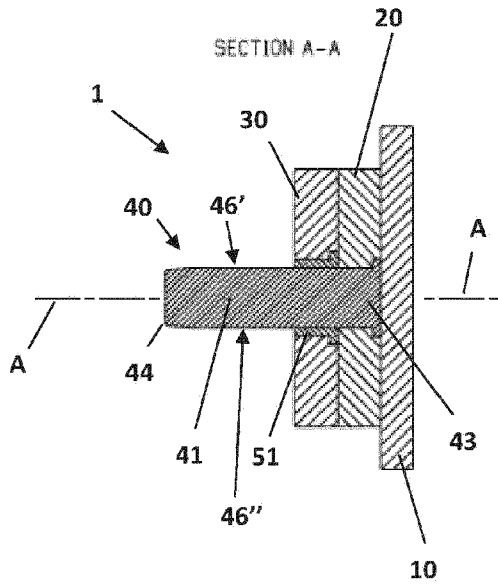


Fig. 3C

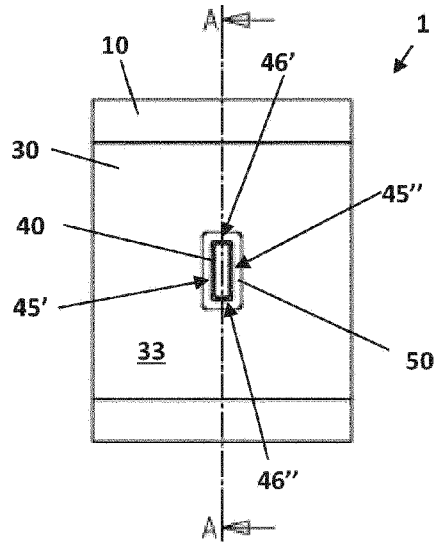


Fig. 3B

270

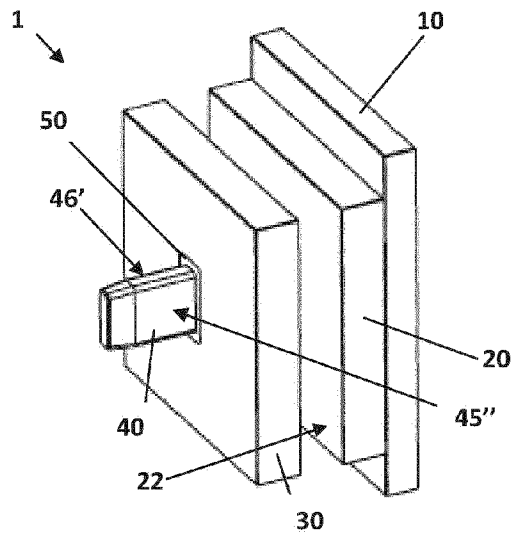


Fig. 4A

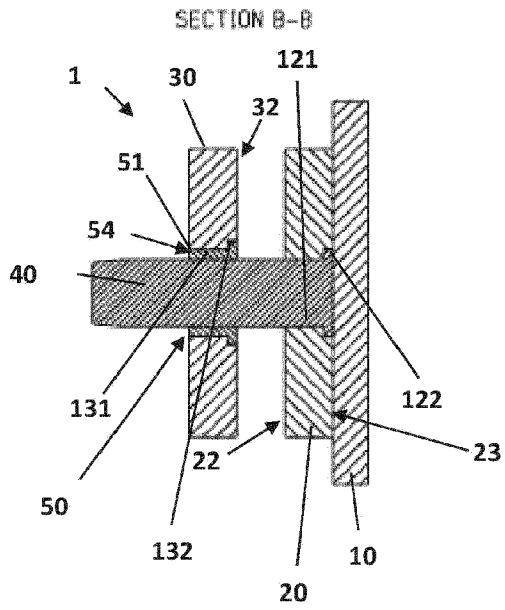


Fig. 4C

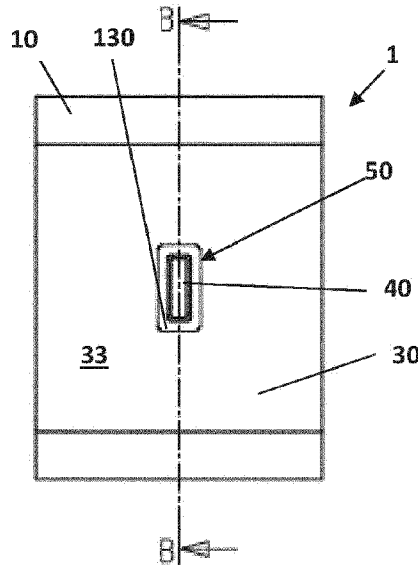


Fig. 4B

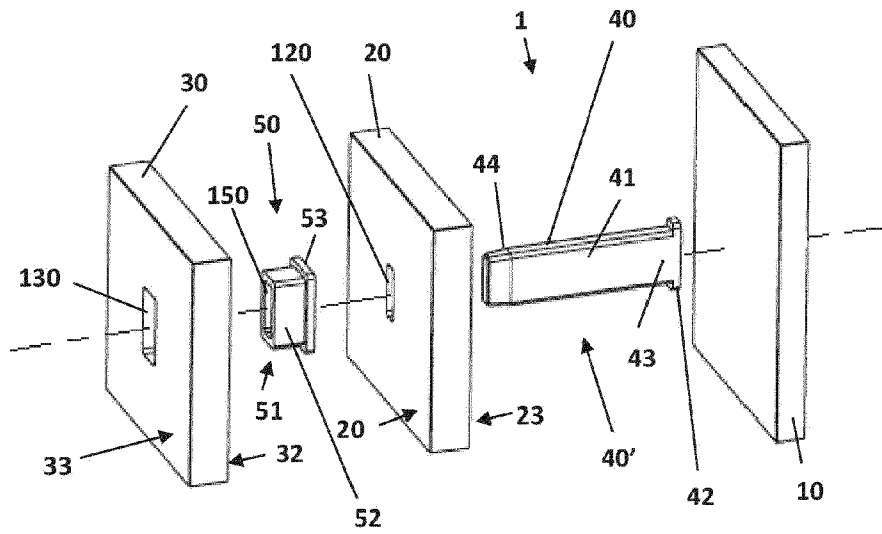


Fig. 5

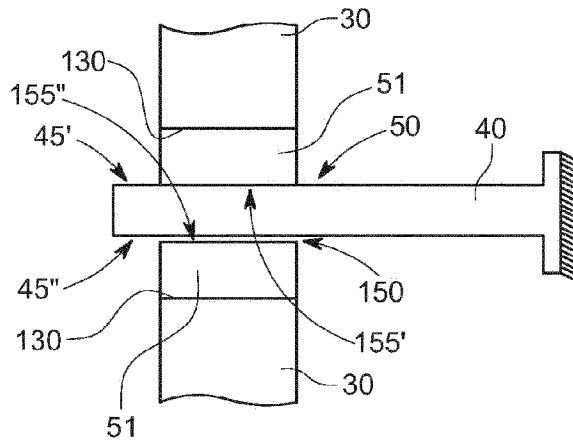


FIG. 6A

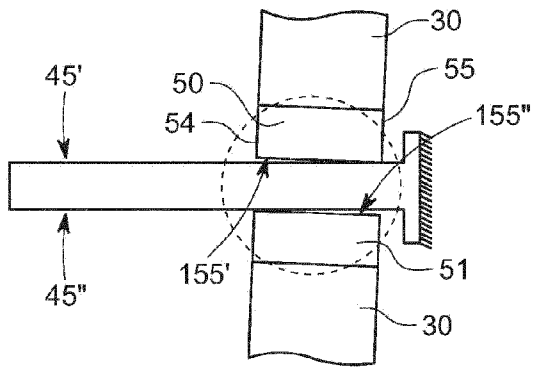


FIG. 6B

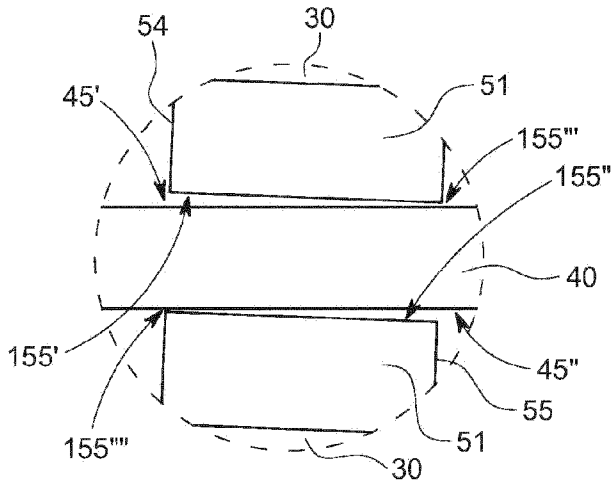


FIG. 6C

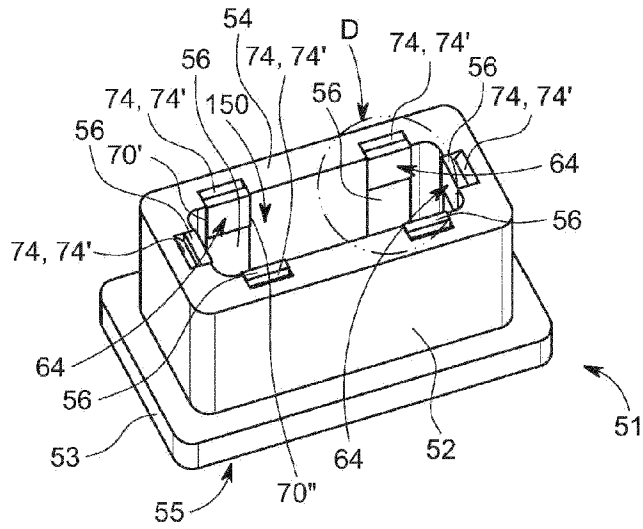


FIG. 7A

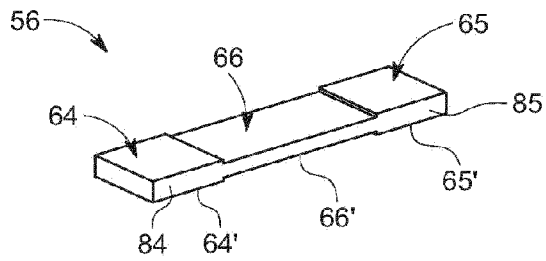


FIG. 7B

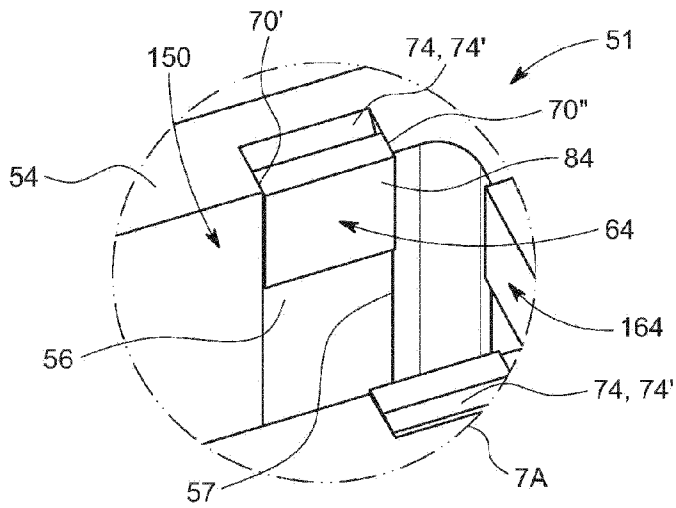


FIG. 7C

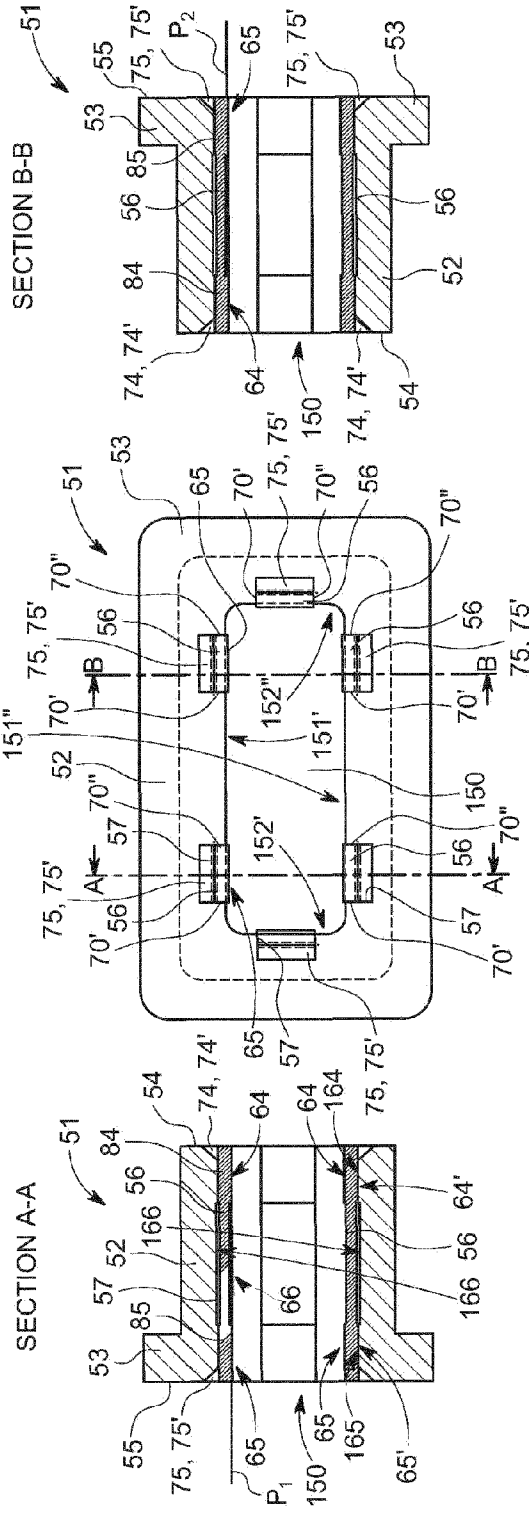


FIG. 7F

FIG. 7D

FIG. 7E

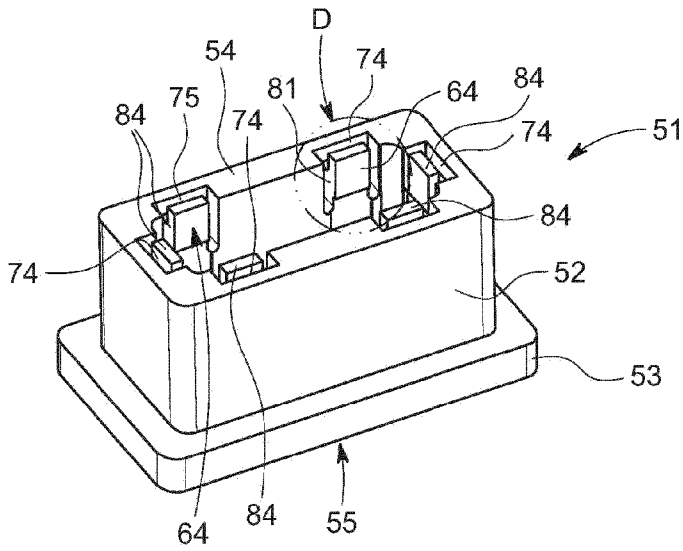


FIG. 8A

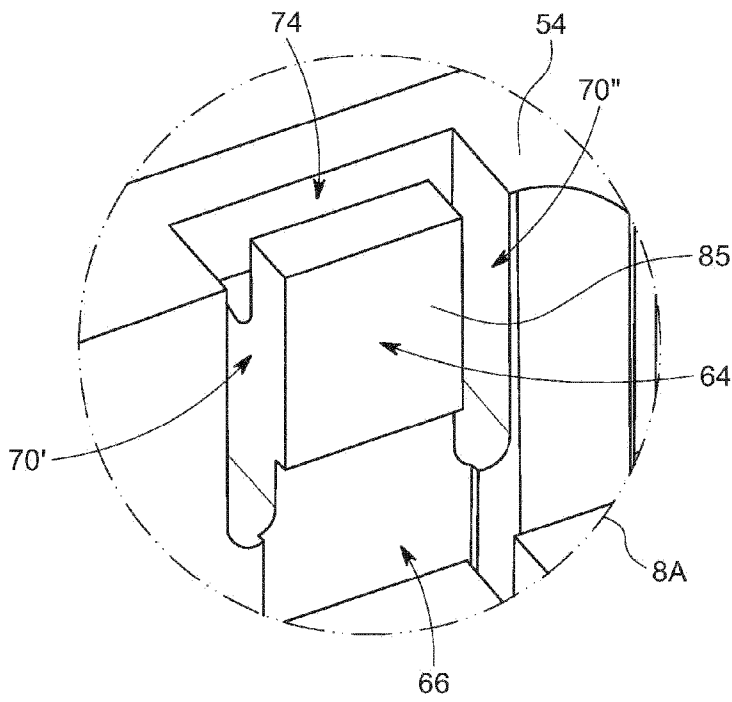


FIG. 8B

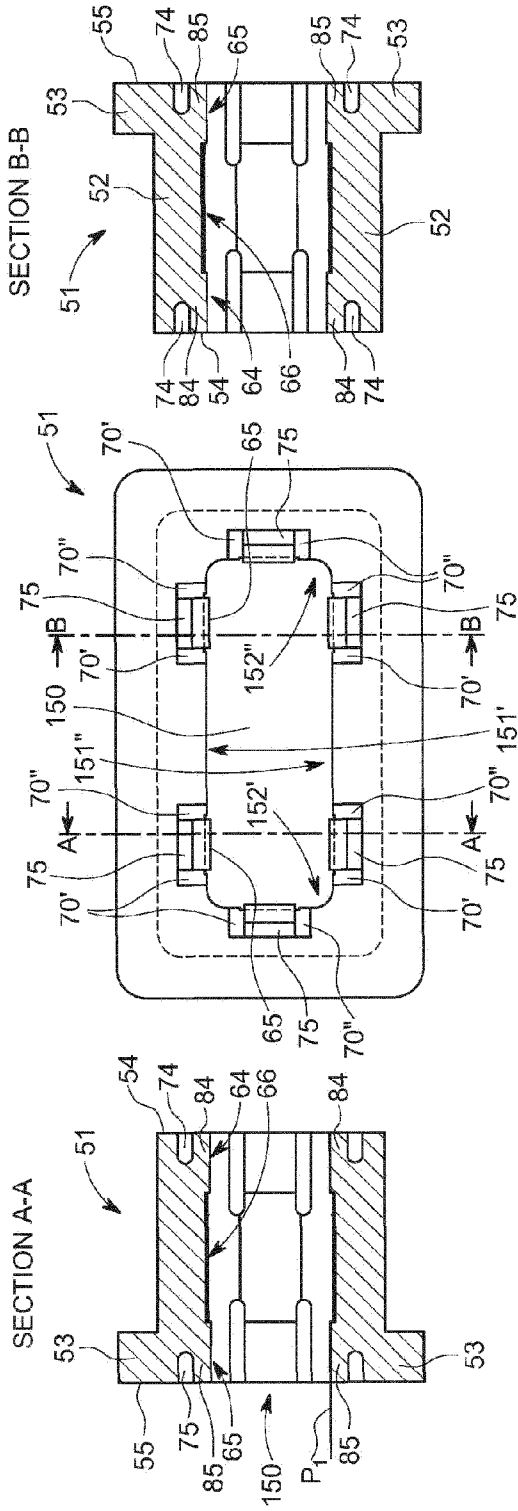


FIG. 8D

FIG. 8C

FIG. 8E

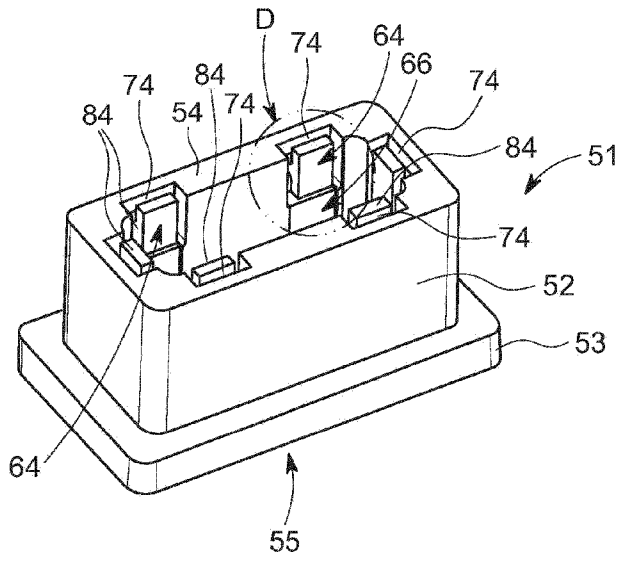


FIG. 9A

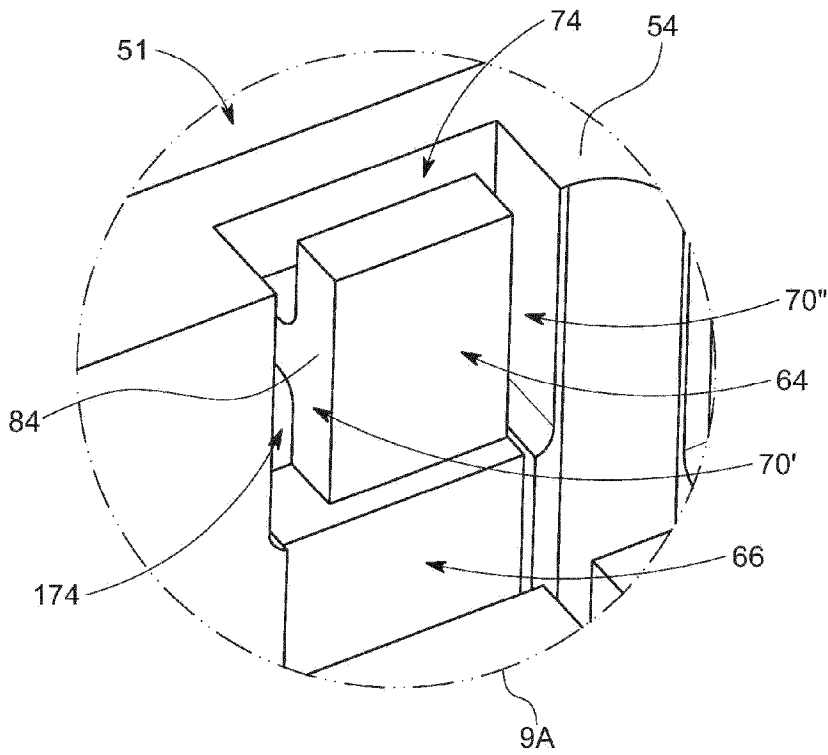


FIG. 9B

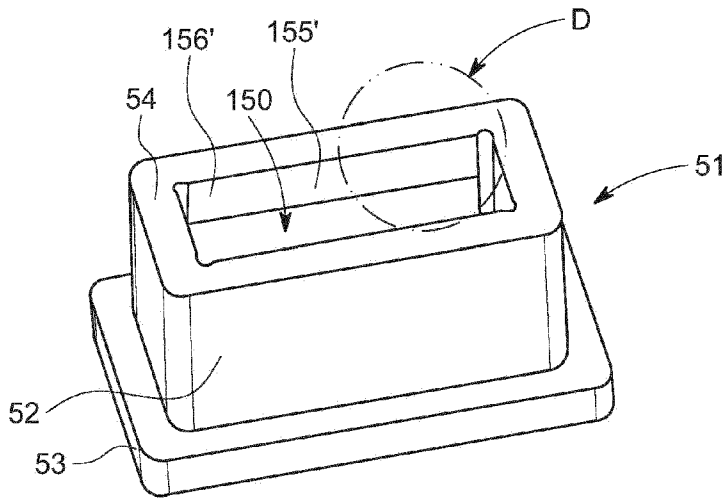


FIG. 10A

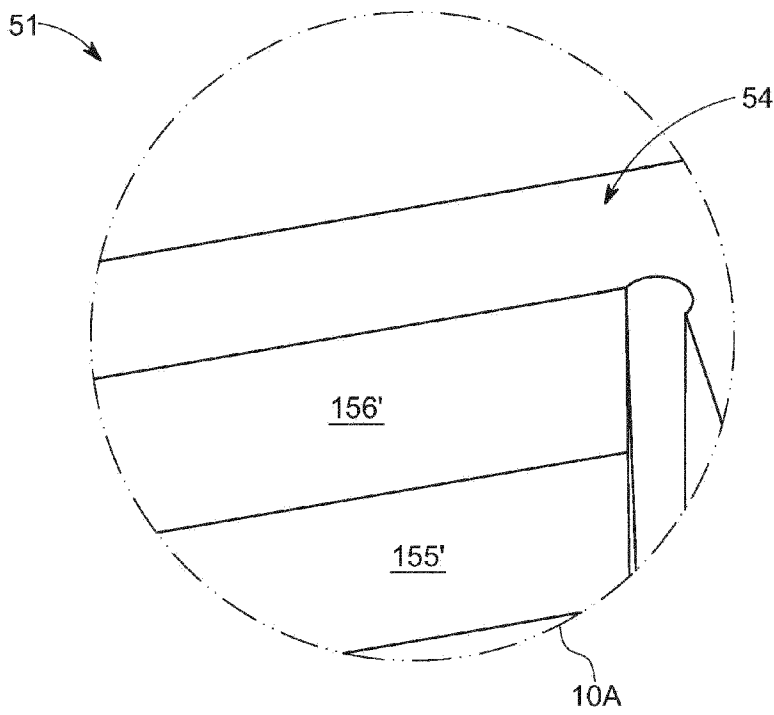


FIG. 10B

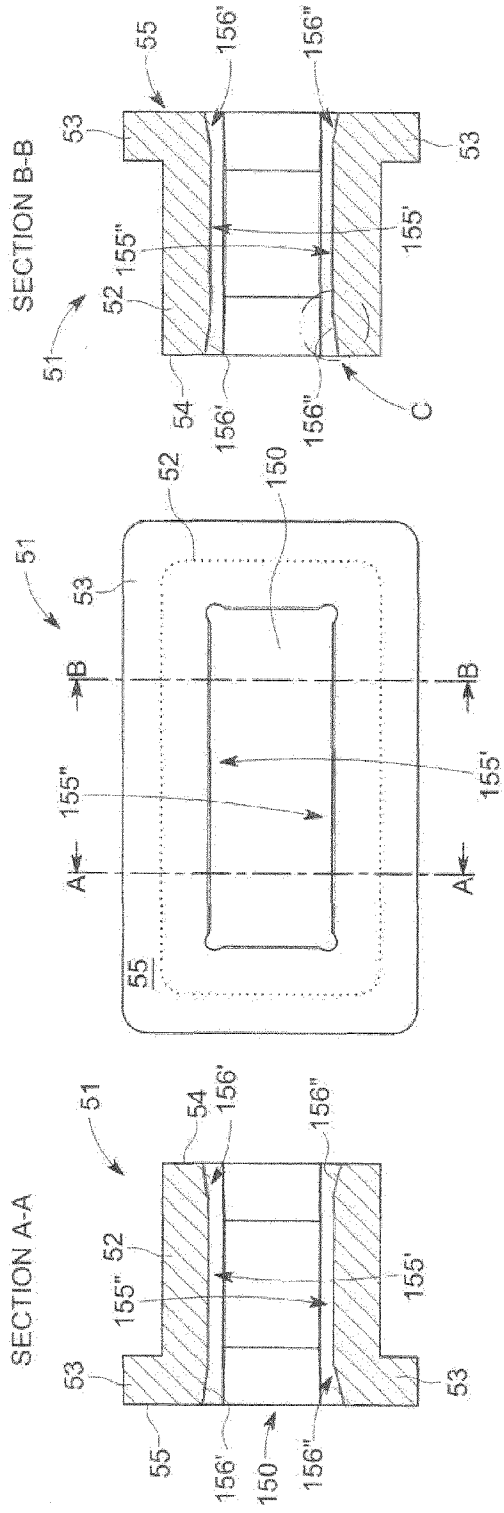


FIG. 10D

FIG. 10C

FIG. 10E

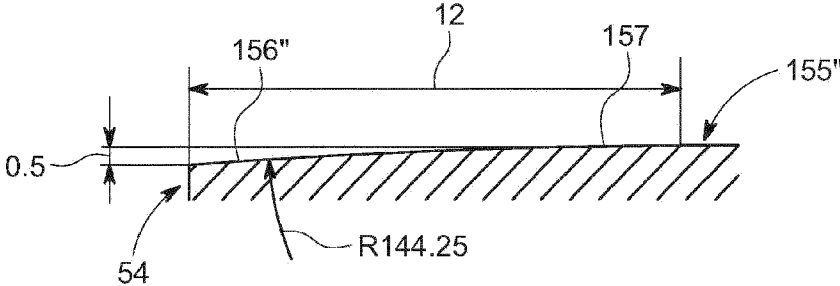


FIG. 10F

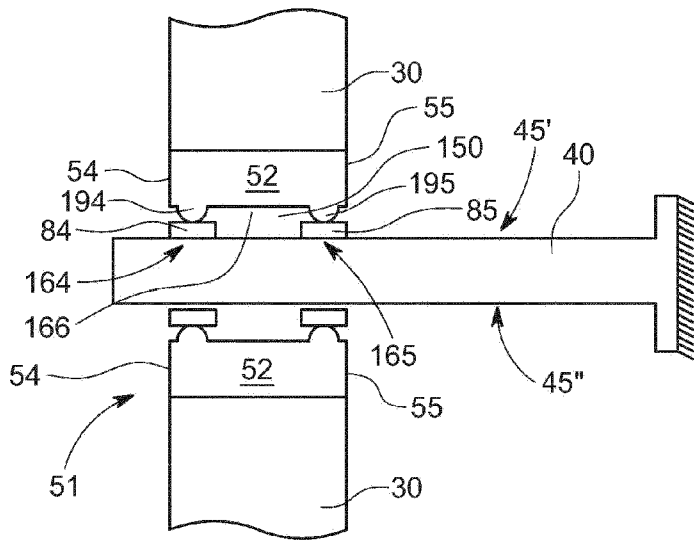


FIG. 11A

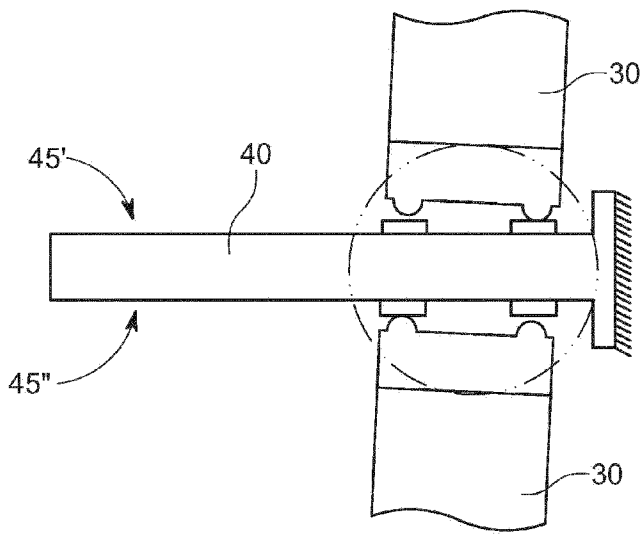


FIG. 11B