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(54) **VACUUM PUMP**

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WO-A2-2009/044197 GB-A- 2 489 248

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Description

[0001] The invention relates to a vacuum pump, in particular a multi-stage vacuum pump and a stator of such a pump.

[0002] A vacuum pump may be formed by positive displacement pumps such as roots or claw pumps, having one or more pumping stages connected in series. Multi-stage pumps are desirable because they involve less manufacturing cost and assembly time compared to multiple single stage pumps in series.

[0003] Multi-stage roots or claw pumps may be manufactured and assembled in the form of a clamshell. As shown in Figure 1, the stator 100 of such a pump comprises first and second half-shell stator components 102, 104 which together define a plurality of pumping chambers 106, 108, 110, 112, 114, 116. Each of the half-shells has first and second longitudinally extending faces which mutually engage with the respective longitudinally extending faces of the other half-shell when the half-shells are fitted together. Only the two longitudinally extending faces 118, 120 of half-shell 102 are visible in the Figure. During assembly the two half shells are brought together in a generally radial direction shown by the arrows R.

[0004] The stator 100 further comprises first and second end stator components 122, 124, also known as head plates. When the half-shells have been fitted together, the first and second end components are fitted to respective end faces 126, 128 of the joined half-shells in a generally axial, or longitudinal, direction shown by arrows L. The inner faces 130, 132 of the end components mutually engage with respective end faces 126, 128 of the half-shells.

[0005] Each of the pumping chambers 106-116 is formed between transverse walls 134 of the half-shells. Only the transverse walls of half-shell 102 can be seen in Figure 1. When the half-shells are assembled the transverse walls provide axial separation between one pumping chamber and an adjacent pumping chamber, or between the end pumping chambers 106, 116 and the end stator components. The present example shows a typical stator arrangement for a roots or claw pump having two longitudinally extending shafts (not shown) which are located in the apertures 136 formed in the transverse walls 134 when the half-shells are fitted together. Prior to assembly, rotors (not shown) are fitted to the shafts so that two rotors are located in each pumping chamber. Although not shown in this simplified drawing, the end components each have two apertures through which the shafts extend. The shafts are supported by bearings in the end components and driven by a motor and gear mechanism.

[0006] The multi-stage vacuum pump operates at pressures within the pumping chamber less than atmosphere and potentially as low as 10^{-3} mbar. Accordingly, there will be a pressure differential between atmosphere and the inside of the pump. Leakage of surrounding gas into the pump must therefore be prevented at the joints between the stator components, which are formed between the longitudinally extending surfaces 118, 120 of the half-shells and between the end faces 126, 128 of the half-shells and the inner faces 130, 132 of the end components.

[0007] A known alternative sealing arrangement is disclosed in US2002155014 providing a one piece sealing member comprising two longitudinal portions and two annular portions. The sealing member is however generally quite intricate to fit in place and expensive to manufacture.

[0008] The document GB 2 489 248 is considered as being the closest prior art and discloses the features of the preamble of the independent claims.

[0009] The present invention provides in the embodiments an improved seal arrangement for sealing a clam shell pump.

[0010] The present invention provides a multi-stage vacuum pump comprising a stator comprising: first and second half-shell stator components and first and second end stator components which when assembled define a plurality of pumping chambers; the half-shell components being assembled together along respective pairs of mutual engaging longitudinal faces and the end stator components being assembled at the ends of the half-shell components at respective pairs of mutual engaging end faces; a longitudinal channel counter-sunk in at least one longitudinal face of each pair of mutual engaging longitudinal faces for receiving respective longitudinal sealing members for sealing between the half-shell components; an annular channel counter-sunk in at least one end face of each pair of mutual engaging end faces for receiving respective sealing members for sealing between the half-shell components and the end stator components; recesses counter-sunk at the end portions of the longitudinal faces for receiving a sealant for sealing between the longitudinal sealing members and the annular sealing members, supports for supporting the annular sealing members at the recesses when the annular sealing members are received in the annular channels to resist protrusion of the annular sealing members into the recesses when compressed between mutually engaging end faces.

[0011] The present invention also provides multi-stage vacuum pump comprising a stator comprising: first and second half-shell stator components and first and second end stator components which when assembled define a plurality of pumping chambers; the half-shell components being assembled together along respective pairs of mutual engaging longitudinal faces and the end stator components being assembled at the ends of the half-shell components at respective pairs of mutual engaging end faces; a longitudinal channel counter-sunk in at least one longitudinal face of each pair of mutual engaging longitudinal faces for receiving respective longitudinal sealing members for sealing between the half-shell components; an annular channel counter-sunk in at least one end face of each pair of mutual engaging end faces for receiving respective sealing members for sealing between the half-shell components and the end stator components; shallow recesses counter-sunk at the end portions of the longitudinal faces for receiving a sealant for sealing between the longitudinal sealing members and the annular sealing members, wherein the depth of the shallow recesses is less than the depth of the longitudinal channels and counter-sunk into each recess is at least one deep pocket extending from the longitudinal channel for allowing sealant to flow around a longitudinal sealing member received in the longitudinal channel for preventing the formation of a leakage path.

[0012] Other preferred and/or optional features of the invention are defined in the accompanying claims.

[0013] In order that the present invention may be well understood, an embodiment thereof, which is given by way of example only, will now be described in more detail, with reference to the accompanying drawings, in which:

Figure 1 shows generally the components of a clam shell stator;
Figure 2 shows a plan view and section of part of a half shell stator component without adequate sealing and the formation of a leakage path;
Figure 3 shows one example of a half shell stator component with adequate sealing;
Figure 4 is an enlarged view of an end portion of the half shell stator component shown in Figure 3;
Figure 5 is a section taken through a recess at the end portion shown in Figure 4;
Figure 6 is a plan view of a longitudinal face of another example of a half shell stator component with adequate sealing;
Figure 7 is an enlarged view of an end portion of the half shell stator component shown in Figure 6; and
Figure 8 is a section taken through a recess and deep pockets at the end portion shown in Figure 7.

[0014] By way of background to the invention, US2002155014 discusses the problem of sealing a clam shell stator. In particular, it indicates that leakage lines exist between a longitudinal gasket providing peripheral radial sealing and O-rings providing axial sealing at the ends, which results in unsatisfactory sealing. As a consequence the patent proposes a one-piece three-dimensional sealing member as discussed above. This three-dimensional sealing member is expensive to manufacture and intricate to fit in place.

[0015] Previous patent applications of the present applicant have proposed the use of four separate sealing components, namely two longitudinal sealing members, or gaskets, for sealing between the half-shell components 102, 104 in Figure 1 and two annular sealing members, or O-rings, for sealing between the end faces of the half-shell components and the end stator components 122, 124. Considerable difficulty was encountered when sealing at the interfaces between the longitudinal sealing members and the annular sealing members and the applicant's previous applications address a number of solutions to the difficulties. The present application differs from the previous applications in that rather than sealing the interfaces between the sealing members the present embodiments apply a sealant (which may be liquid or gel prior to curing to solid) to seal between the longitudinal sealing members and the half-shell components and between the annular sealing members and both the half-shell and end stator components. Therefore, the present embodiments do not have direct interfaces between sealing members. However, even without these interfaces, sealing is problematic particularly given that the differential pressure across the seal can be both positive and negative and vary by several bar. Early experiments conducted by the applicant and the attendant problems which arose are now described with reference to Figure 2. Figure 2 shows an end portion of longitudinal face 120 of a half shell component 102 and a portion of the end face 128. In this early arrangement, a longitudinal sealing member 140 is received in a counter sunk deep channel 142 which extends over the length of the longitudinal face leaving a space between the end of the longitudinal member, or channel, and an annular sealing member 146. The annular sealing member 146 is received in an annular channel 150 counter sunk in the end face 128. A shallow recess 144 is counter sunk in the longitudinal face surrounding the end of the deep channel 142 and in the space between this channel and annular channel 150. Sealant 152 is applied in the shallow recess for sealing between the longitudinal member 140 and the annular member 146. In this way, there is no direct interface between the longitudinal sealing member and the annular sealing member.

[0016] It was found however as shown in section A-A that the sealant 152 did not penetrate sufficiently into the channel 142 to provide an adequate seal between the longitudinal sealing member 140 and the half shell components. Spaces 154 in channel 142 are formed and as shown in the plan view in Figure 2 a leakage path 156 allows the flow of gas from atmosphere along one side of the sealing member around its tip and along the other side of the sealing member into the pump.

[0017] In order to increase penetration of the sealant around the longitudinal sealing member the depth of the recess 144 was increased so that it was approximately equal to the depth of the longitudinal channel 142. This arrangement provided adequate sealing about the longitudinal sealing member 140 but resulted in less than adequate sealing at the annular sealing member 146. In this regard, the sealant is fluid when applied until allowed to cure, and when the annular sealing member is compressed between the end faces of the half shell components and the internal face of the end components a kink is formed in the annular sealing member where it protrudes into the deep recess between the half shell components and displaces sealant which in its fluid state cannot provide sufficient resistance to kinking. Whereas the shallow recess shown in Figure 2 provided sufficient support for the annular sealing member to avoid significant kinking, by deepening the recess and solving the sealing problem around the longitudinal sealing member it created a different problem around the annular sealing member.

[0018] Embodiments of the invention provide a solution having adequate sealing at both the longitudinal sealing member and the annular sealing member.

[0019] A first embodiment of the invention is described with reference to Figures 3 and 4. Figure 3 shows a half shell stator component 10 similar in general structure to component 102 in Figure 1 having two longitudinal faces 12 located on either side of a series of pumping chambers shown generally at 14. Figure 4 is an enlarged view of an end portion of one of the longitudinal faces. In this first embodiment, one or both of the half shell stator components may be structured as shown. In this regard, Figures 3 and 4 show one half shell component and the other half shell component may correspond generally in structure or alternatively the other half shell component may comprise a planar longitudinal face for cooperating with the half shell component shown for sealing the pump.

[0020] Stator component 10 comprises a deep longitudinal channel 16 extending along a length of each of the longitudinal faces 12 for receiving a longitudinal sealing member (not shown in these Figures but see Figure 2). The ends of the deep channel are separated from the end face 18 of the half shell component by a deep recess 20. When the half shell components are assembled together they form an annular channel 22 which extends around the circumference of the pumping chambers 14 for sealing the end faces.

[0021] As previously discussed, a problem with such a deep recess as shown in Figure 3 is that it results in kinking of the annular sealing member received in channel 22. In the present arrangement, the annular sealing member is supported across the deep recess. In this way, sealant applied in the recess sufficiently seals around the longitudinal sealing member and also can seal adequately against the annular sealing member without kinking.

[0022] In more detail, a support 24 upstands from the counter sunk surface of recess 20 at the end face 18 for supporting the annular sealing member. As shown, the support is formed by a wall which is generally in line with the counter sunk surface of the annular channel 22. The annular channel has a width for receiving and locating the annular sealing member and the wall extends only partially over the width of the annular channel. On at least one side, and preferably on both sides as shown in Figure 4, is a space 26 between the wall and the end face so that sealant can flow and directly contact and seal against the annular sealing member in the annular channel. In this way, the arrangement supports the annular sealing member whilst also permitting adequate sealing between the sealant and the annular sealing member. In another example, the support 24 may extend from the opposing half-shell stator component with its end abutting or closely adjacent the counter-sunk surface of recess 20.

[0023] During assembly, a longitudinal sealing member is inserted in each of the longitudinal channels 16 shown in Figure 3. In order to locate the sealing member and provide a small tensile force the longitudinal channel has two pinch points 28 referenced in Figure 4 for applying pressure at respective end portions of the sealing member. Following location of the longitudinal sealing members in both channels 16, sealant is applied to the channels and recesses 20 prior to assembling the half shell components together or injected after the components are assembled together. At least one overflow path, or channel, 30 is provided at each end portion to allow sealant to escape either under compression of the half shell components together or following pressure from sealant injection.

[0024] The deep recess 20 is of comparable depth to that of the deep channel 16. Therefore, the sealant when applied can penetrate around the longitudinal sealing member when it is positioned in the longitudinal channel. Figure 5 shows a section through one of the deep recesses 20 counter sunk from longitudinal face 12. In Figure 5, the sealant 32 is shown penetrating and surrounding the end portion of one longitudinal member 34 thereby providing an effective seal. The depth of the recess allows the sealant to prevent the formation of a leakage path around the longitudinal sealing member. As shown in Figure 4, the supporting wall 24 supports the annular sealing member to resist kinking whilst allowing sealant to flow on either side of the wall to contact and seal against the annular sealing member. Therefore, the arrangement shown in Figures 3 to 5 provides adequate sealing between the sealant and the longitudinal sealing members and between the sealant and the annular sealing members to provide effective sealing of the pump.

[0025] A second embodiment of the invention is described with reference to Figures 6 to 8, in which like reference numerals are used to refer to like components of the first embodiment.

[0026] The principal difference between the second embodiment and the first embodiment is that a shallow recess, rather than a deep recess, connects the deep channels of the longitudinal sealing members with the annular channels of the annular sealing members. The reduced depth of the shallow recess reduces kinking of the annular sealing members since there is less space between the half shell stator components into which the annular sealing members can protrude when compressed. However, as previously indicated, a shallow recess around the deep channel of the longitudinal sealing members prevents or reduces penetration of the sealant around the longitudinal sealing members. Therefore, the second embodiment comprises a deep pocket in the shallow recess to permit adequate penetration of sealant.

[0027] In more detail, and referring to Figures 6 to 8, a shallow recess 36 is positioned between the deep channels 40 of the mutually engaging longitudinal faces 12 of the half shell stator components 102, 104 and the annular channels 22 in the end face of the half shell components. The shallow recess has insufficient depth in itself to allow penetration of the sealant 32 into the deep channel and around the end portions of the longitudinal sealing members for effective sealing. However, in this embodiment, deep pockets 38 extend outwardly from the deep channels for receiving a sealant so that it can penetrate more deeply into channels. In the Figures, the deep pockets are located at each of the longitudinal ends of the deep channels and extend transversely on both sides of the channels and generally perpendicularly to the deep channel into the shallow recess 36. Alternatively, there may be a single deep pocket.

[0028] The shallowness of the recess 36 means that the annular sealing member 42 may not require support across the gap between the half shell stator components 102, 104 to prevent significant kinking of the annular sealing member. Nevertheless, a support such as a wall 25 shown schematically may be provided upstanding from the counter sunk surface of the shallow recess to give additional support to the annular sealing members across the space between the half-shell components, , similarly to wall 24 of the first embodiment.

[0029] In assembly, the longitudinal sealing members 34 are positioned in the deep channels 40 and secured in tension between the pinch points 28. The two half shell stator components 182, 104 are brought together along their respective mutually engaging longitudinal faces 12 compressing the longitudinal sealing member and providing sealing along the length of the stator. Sealant 32 may be applied prior to assembling the half shell stator components or injected following assembly. If applied prior to assembly the overflow channels 30 allow excess sealant to escape or in the alternative the side channels 26 can be used to inject sealant under pressure into the assembled components. The deep pockets 38 allow sealant to flow from the shallow recesses 36 around the cross-section of the end portions of the longitudinal sealing members to provide adequate sealing as shown in Figure 8.

[0030] In both embodiments, bores 44 are provided in the half shell stator components for receiving fastening members such as bolts for fastening the components together.

[0031] When the half shell stator components are assembled together they define the annular channels 22 at each end of the assembly and following assembly the annular sealing members 42 are positioned in the annular channels. Assembly of the end stator components 122, 124 at the end faces of the assembled half shell components compresses the annular sealing members. This compression applies an axial force to the annular sealing members but as the gap between the half shell stator components is reduced by the shallow recess 36 the annular sealing members do not protrude into the recesses to affect adequate sealing, particularly if a supporting wall is provided.

[0032] The present description uses the terms 'deep' and 'shallow'. In the context of this description, 'deep' refers to the depth substantially equal to that of the longitudinal channels counter sunk into the end faces 12 for the longitudinal sealing members. The depth is required for receiving the longitudinal sealing members and to allow sealant to seal around the end portions of the longitudinal sealing members to prevent leakage. 'Shallow' refers to a depth counter sunk into the end faces 12 which is less than 'deep', preferably less than half of the depth and more preferably less than a quarter of the depth, and which in insufficient to allow sealant to penetrate around the longitudinal sealing members. The exact measurements of deep and shallow depend on the overall measurements of the stator and pump, however typically 'deep' may be 2 mm or more, and 'shallow' may be 1 mm or less or preferably 0.5 mm or less.

Claims

1. A multi-stage vacuum pump comprising a stator comprising:

   first and second half-shell stator components and first and second end stator components which when assembled define a plurality of pumping chambers;
   the half-shell components being assembled together along respective pairs of mutual engaging longitudinal faces and the end stator components being assembled at the ends of the half-shell components at respective pairs of mutual engaging end faces;
   a longitudinal channel counter-sunk in at least one longitudinal face of each pair of mutual engaging longitudinal faces for receiving respective longitudinal sealing members for sealing between the half-shell components;
   an annular channel counter-sunk in at least one end face of each pair of mutual engaging end faces for receiving respective sealing members for sealing between the half-shell components and the end stator components;
   recesses counter-sunk at the end portions of the longitudinal faces for receiving a sealant for sealing between the longitudinal sealing members and the annular sealing members,
   characterized by supports for supporting the annular sealing members at the recesses when the annular sealing members are received in the annular channels to resist protrusion of the annular sealing members into the recesses when compressed between mutually engaging end faces.

2. A multistage vacuum pump as claimed in claim 1, wherein the supports extend across respective recesses transverse to a plane of the longitudinal fac-

es.

3. A multistage vacuum pump as claimed in claim 1 or 2, wherein the supports are formed by walls extending from the counter sunk surfaces of respective recesses in alignment with the annular channels.

4. A multistage vacuum pump as claimed in any of the preceding claims, wherein the annular channels have a channel width for receiving the annular sealing members and the supports have a support width which is less than the channel width to allow sealant in the recesses to contact the annular sealing members.

5. A multistage vacuum pump as claimed in claim 4, wherein on both sides of each support a space 26 is provided between the support and the end face so that sealant can flow and directly contact and seal against an annular sealing member in the annular channel on both sides of the support.

6. A multistage vacuum pump as claimed in any of the preceding claims, wherein the depth of the recesses is approximately equal to the depth of the longitudinal channels to allow sealant to flow around the longitudinal sealing members to prevent the formation of a leakage path.

7. A multi-stage vacuum pump comprising a stator comprising:

first and second half-shell stator components and first and second end stator components which when assembled define a plurality of pumping chambers;
the half-shell components being assembled together along respective pairs of mutual engaging longitudinal faces and the end stator components being assembled at the ends of the half-shell components at respective pairs of mutual engaging end faces;
a longitudinal channel counter-sunk in at least one longitudinal face of each pair of mutual engaging longitudinal faces for receiving respective longitudinal sealing members for sealing between the half-shell components;
an annular channel counter-sunk in at least one end face of each pair of mutual engaging end faces for receiving respective sealing members for sealing between the half-shell components and the end stator components;
shallow recesses counter-sunk at the end portions of the longitudinal faces for receiving a sealant for sealing between the longitudinal sealing members and the annular sealing members,
characterized in that the depth of the shallow recesses is less than the depth of the longitudinal channels and counter-sunk into each recess is at least one deep pocket extending from the longitudinal channel for allowing sealant to flow around a longitudinal sealing member received in the longitudinal channel for preventing the formation of a leakage path.

8. A multistage vacuum pump as claimed in claim 7, wherein the deep pockets have a depth approximately equal to the depth of the longitudinal channels.

9. A multistage vacuum pump as claimed in claim 7 or 8, wherein the deep pockets are spaced from the annular channels so that the spacing between the half shell stator components at the annular channels is defined by the depth of the shallow recesses for resisting protrusion of annular sealing members received in the annular channels protruding between the half shell stator components.

10. A multistage vacuum pump as claimed in any of claims 7 to 9, wherein deep pockets extend laterally from both sides of respective longitudinal channels.

Patentansprüche

1. Mehrstufige Vakuumpumpe mit einem Stator, der umfasst:

eine erste und eine zweite Halbschalen-Statorkomponente und eine erste und eine zweite Endstatorkomponente, die, wenn sie zusammengebaut sind, eine Mehrzahl von Pumpenkammern bilden,
wobei die Halbschalenkomponenten entlang entsprechender Paare von gegenseitig zusammenwirkenden Längsflächen zusammengebaut sind und die Endstatorkomponenten an den Enden der Halbschalenkomponenten an jeweiligen Paaren von gegenseitig zusammenwirkenden Endflächen zusammengebaut sind;
eine Längsnut, die in mindestens einer Längsfläche jedes Paars von gegenseitig zusammenwirkenden Längsflächen eingesenkt ist, um jeweilige Längsdichtungsteile zum Abdichten zwischen den Halbschalenkomponenten aufzunehmen;
eine Ringnut, die in mindestens einer Endfläche jedes Paars von gegenseitig zusammenwirkenden Endflächen eingesenkt ist, um jeweilige Dichtungselemente zum Abdichten zwischen den Halbschalenkomponenten und den Endstatorkomponenten aufzunehmen;
an den Endbereichen der Längsflächen eingesenkte Aussparungen zur Aufnahme eines

Dichtmittels zum Abdichten zwischen den Längsdichtungselementen und den Ringdichtungselementen;

gekennzeichnet durch

Abstützungen zum Abstützen der Ringdichtungselemente an den Aussparungen, wenn die Ringdichtungselemente in den Ringnuten aufgenommen sind, um einem Vorspringen der Ringdichtungselemente in die Aussparungen entgegenzuwirken, wenn sie zwischen gegenseitig zusammenwirkenden Endflächen zusammengedrückt werden.

2. Mehrstufige Vakuumpumpe nach Anspruch 1, wobei die Abstützungen über entsprechende Aussparungen quer zu einer Ebene der Längsflächen verlaufen.

3. Mehrstufige Vakuumpumpe nach Anspruch 1 oder 2, wobei die Abstützungen durch Wände gebildet sind, die von den eingesenkten Oberflächen der jeweiligen Aussparungen fluchtend mit den Ringnuten verlaufen.

4. Mehrstufige Vakuumpumpe nach einem der vorhergehenden Ansprüche, wobei die Ringnuten eine Nutbreite zur Aufnahme der Ringdichtungselemente haben, und die Abstützungen eine Stützbreite haben, die kleiner als die Nutbreite ist, um den Dichtungsmittel in den Aussparungen das Berühren der Ringdichtungselemente zu ermöglichen.

5. Mehrstufige Vakuumpumpe nach Anspruch 4, wobei auf beiden Seiten jeder Abstützung ein Zwischenraum (26) zwischen der Abstützung und der Endfläche vorgesehen ist, so dass Dichtungsmittel fließen und ein Ringdichtungselement in der Ringnut auf beiden Seiten der Abstützung direkt berühren und gegen dieses abdichten kann.

6. Mehrstufige Vakuumpumpe nach einem der vorhergehenden Ansprüche, wobei die Tiefe der Aussparungen etwa gleich der Tiefe der Längsnuten ist, damit Dichtungsmittel um die Längsdichtungselemente fließen kann, um die Bildung von Leckpfaden zu vermeiden.

7. Mehrstufige Vakuumpumpe mit einem Stator, der aufweist:

eine erste und eine zweite Halbschalen-Statorkomponente und eine erste und eine zweite Endstatorkomponente, die, wenn sie zusammengebaut sind, eine Mehrzahl von Pumpenkammern bilden;

wobei die Halbschalenkomponenten entlang entsprechender Paare von gegenseitig zusammenwirkenden Längsflächen zusammengebaut sind und die Endstatorkomponenten an den Enden der Halbschalenkomponenten an jeweiligen Paaren von gegenseitig zusammenwirkenden Endflächen zusammengebaut sind;

eine Längsnut in mindestens einer Längsfläche jedes Paars von gegenseitig zusammenwirkenden Längsflächen zur Aufnahme jeweiliger Längsdichtungselemente zur Abdichtung zwischen den Halbschalenkomponenten eingesenkt ist;

eine Ringnut in mindestens einer Endfläche jedes Paars von gegenseitig zusammenwirkenden Endflächen zur Aufnahme jeweiliger Dichtungselemente zur Abdichtung zwischen den Halbschalenkomponenten und den Endstatorkomponenten eingesenkt ist;

flache Aussparungen an den Endbereichen der Längsflächen zur Aufnahme eines Dichtungsmittels zum Abdichten zwischen den Längsdichtungselementen und den Ringdichtungselementen eingesenkt ist;

dadurch gekennzeichnet, dass

die Tiefe der flachen Aussparungen kleiner als die Tiefe der Längsnuten ist und in jede Aussparung mindestens eine tiefe Tasche eingesenkt ist, die von der Längsnut aus verläuft, damit Dichtungsmittel um ein in der Längsnut aufgenommenes Dichtungselement zur Verhinderung der Bildung eines Leckpfads fließen kann.

8. Mehrstufige Vakuumpumpe nach Anspruch 7, wobei die tiefen Taschen eine Tiefe haben, die ungefähr gleich der Tiefe der Längsnuten ist.

9. Mehrstufige Vakuumpumpe nach Anspruch 7 oder 8, wobei die tiefen Taschen von den Längsnuten beabstandet sind, so dass der Abstand zwischen den Halbschalen-Statorkomponenten an den Ringnuten durch die Tiefe der flachen Aussparungen bestimmt ist, um einem Vorspringen von in den Ringnuten aufgenommenen Ringdichtungselementen zwischen den Halbschalen-Statorkomponenten entgegenzuwirken.

10. Mehrstufige Vakuumpumpe nach einem der Ansprüche 7 bis 9, wobei die tiefen Taschen sich seitwärts von beiden Seiten der jeweiligen Längsnuten erstrecken.

Revendications

1. Pompe à vide à étages multiples comprenant un stator comprenant :

des premier et second composants de stator en demi-coque et des premier et second composants de stator d’extrémité qui lorsqu’ils sont assemblés définissent une pluralité de chambres de pompage ;

les composants en demi-coque étant assemblés l'un à l'autre le long de paires respectives de faces longitudinales s'engageant mutuellement et les composants de stator d'extrémité étant assemblés aux extrémités des composants en demi-coque au niveau de paires respectives de faces d'extrémité s'engageant mutuellement ;

un canal longitudinal fraisé dans au moins une face longitudinale de chaque paire de faces longitudinales s'engageant mutuellement destiné à recevoir des organes d'étanchéité longitudinaux respectifs pour assurer l'étanchéité entre les composants en demi-coque ;

un canal annulaire fraisé dans au moins une face d'extrémité de chaque paire de faces d'extrémité s'engageant mutuellement destiné à recevoir des organes d'étanchéité respectifs pour assurer l'étanchéité entre les composants en demi-coque et les composants de stator d'extrémité ;

des évidements fraisés au niveau des portions d'extrémité des faces longitudinales destinés à recevoir un produit étanchéifiant pour assurer l'étanchéité entre les organes d'étanchéité longitudinaux et les organes d'étanchéité annulaires,

caractérisée par

des supports destinés à supporter les organes d'étanchéité annulaires au niveau des évidements lorsque les organes d'étanchéité annulaires sont reçus dans les canaux annulaires afin de s'opposer à la protrusion des organes d'étanchéité annulaires dans les évidements lorsqu'ils sont comprimés entre des faces d'extrémité s'engageant mutuellement.

2. Pompe à vide à étages multiples selon la revendication 1, dans laquelle les supports s'étendent à travers des évidements respectifs transversalement à un plan des faces longitudinales.

3. Pompe à vide à étages multiples selon la revendication 1 ou 2, dans laquelle les supports sont formés par des parois s'étendant depuis les surfaces fraisées d'évidements respectifs en alignement avec les canaux annulaires.

4. Pompe à vide à étages multiples selon l'une quelconque des revendications précédentes, dans laquelle les canaux annulaires présentent une largeur de canal destinée à recevoir les organes d'étanchéité annulaires et les supports présentent une largeur de support qui est inférieure à la largeur de canal pour permettre au produit étanchéifiant dans les évidements de rentrer en contact avec les organes d'étanchéité annulaires.

5. Pompe à vide à étages multiples selon la revendication 4, dans laquelle des deux côtés de chaque support un espace 26 est prévu entre le support et la face d'extrémité afin de permettre à un produit étanchéifiant de circuler et d'entrer directement en contact avec et d'assurer l'étanchéité contre un organe d'étanchéité annulaire dans le canal annulaire des deux côtés du support.

6. Pompe à vide à étages multiples selon l'une quelconque des revendications précédentes, dans laquelle la profondeur des évidements est approximativement égale à la profondeur des canaux longitudinaux pour permettre au produit étanchéifiant de circuler autour des organes d'étanchéité longitudinaux afin d'empêcher la formation d'un chemin de fuite.

7. Pompe à vide à étages multiples comprenant un stator comprenant :

des premier et second composants de stator en demi-coque et des premier et second composants de stator d'extrémité qui lorsqu'ils sont assemblés définissent une pluralité de chambres de pompage ;

les composants en demi-coque étant assemblés l'un à l'autre le long de paires respectives de faces longitudinales s'engageant mutuellement et les composants de stator d'extrémité étant assemblés aux extrémités des composants en demi-coque au niveau de paires respectives de faces d'extrémité s'engageant mutuellement ;

un canal longitudinal fraisé dans au moins une face longitudinale de chaque paire de faces longitudinales s'engageant mutuellement destiné à recevoir des organes d'étanchéité longitudinaux respectifs pour assurer l'étanchéité entre les composants en demi-coque ;

un canal annulaire fraisé dans au moins une face d'extrémité de chaque paire de faces d'extrémité s'engageant mutuellement destiné à recevoir des organes d'étanchéité respectifs pour assurer l'étanchéité entre les composants en demi-coque et les composants de stator d'extrémité ;

des évidements de faible profondeur fraisés au niveau des portions d'extrémité des faces longitudinales destinés à recevoir un produit étanchéifiant pour assurer l'étanchéité entre les organes d'étanchéité longitudinaux et les organes d'étanchéité annulaires,

caractérisée en ce que

la profondeur des évidements de faible profondeur est inférieure à la profondeur des canaux longitudinaux et fraisée dans chaque évidement est au moins une poche profonde s'étendant depuis le canal longitudinal pour permettre au produit étanchéifiant de circuler autour d'un organe d'étanchéité longitudinal reçu dans le canal longitudinal pour empêcher la formation d'un chemin de fuite.

8. Pompe à vide à étages multiples selon la revendication 7, dans laquelle les poches profondes ont une profondeur approximativement égale à la profondeur des canaux longitudinaux.

9. Pompe à vide à étages multiples selon la revendication 7 ou 8, dans laquelle les poches profondes sont espacées des canaux annulaires de telle manière que l'espacement entre les composants de stator en demi-coque au niveau des canaux annulaires est défini par la profondeur des évidements de faible profondeur afin de s'opposer à la protrusion d'organes d'étanchéité annulaires reçus dans les canaux annulaires faisant saillie entre les composants de stator en demi-coque.

10. Pompe à vide à étages multiples selon l'une quelconque des revendications 7 à 9, dans laquelle des poches profondes s'étendent latéralement depuis les deux côtés des canaux longitudinaux respectifs.

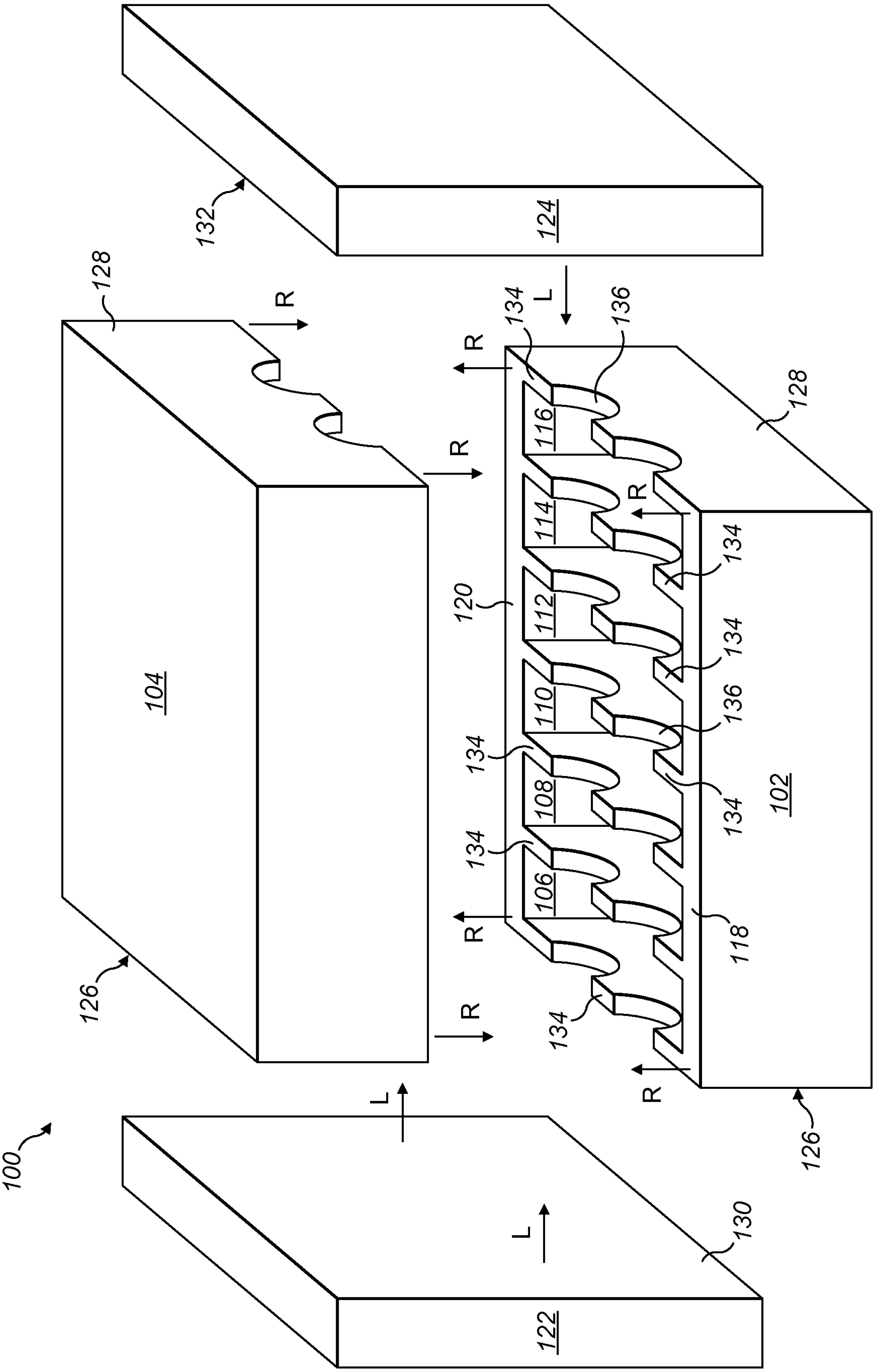
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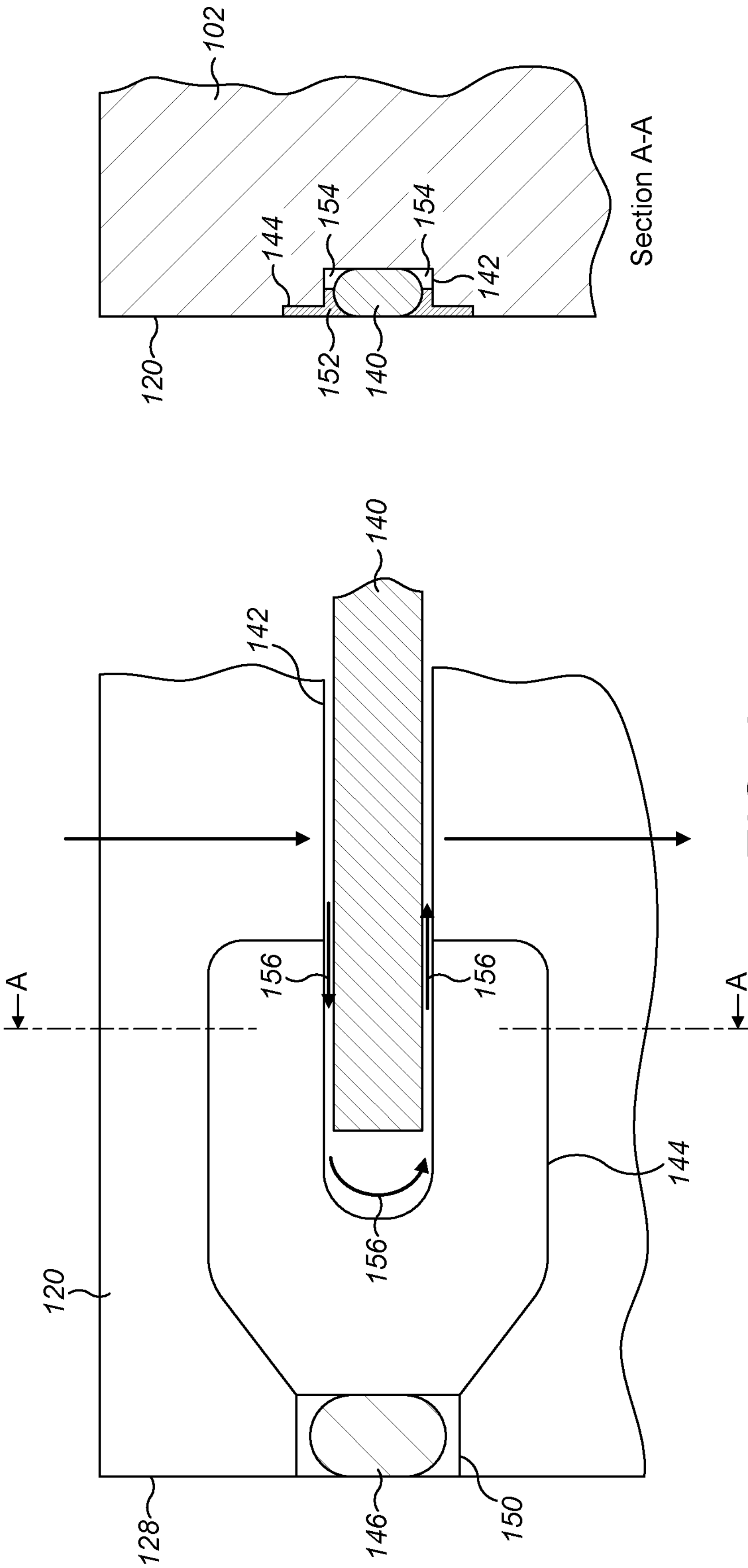
FIG. 1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150

FIG. 2

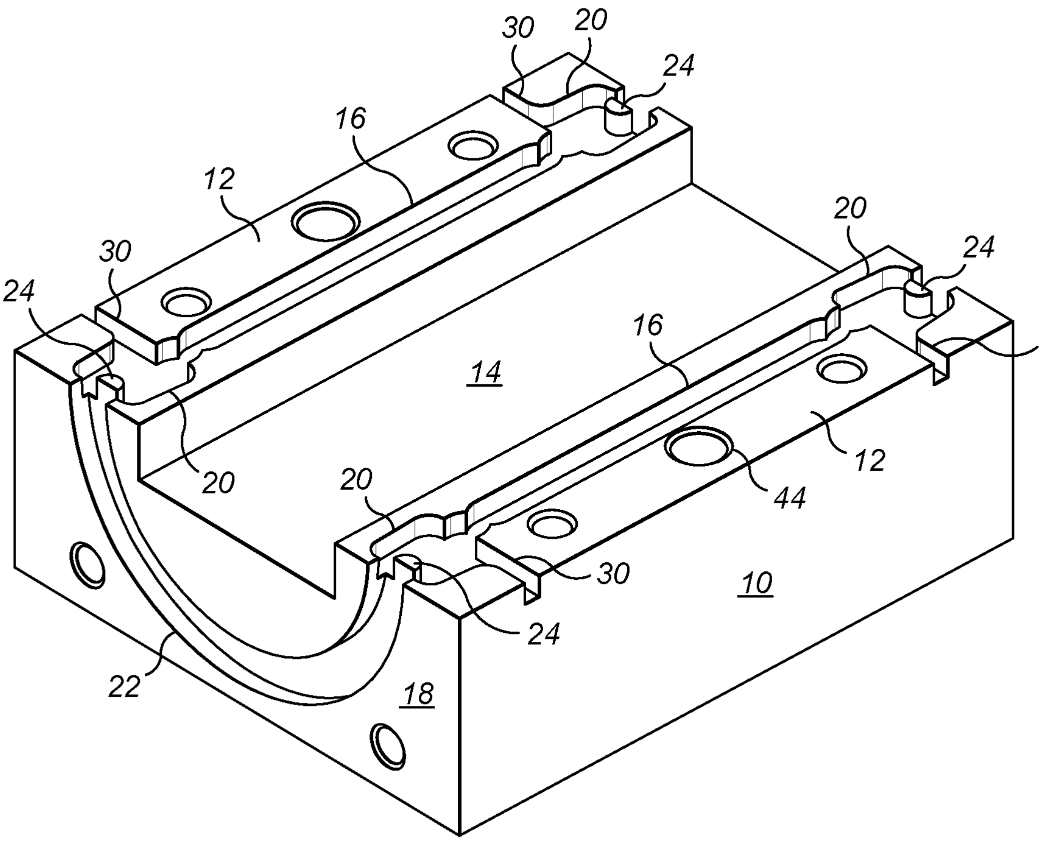
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FIG. 3

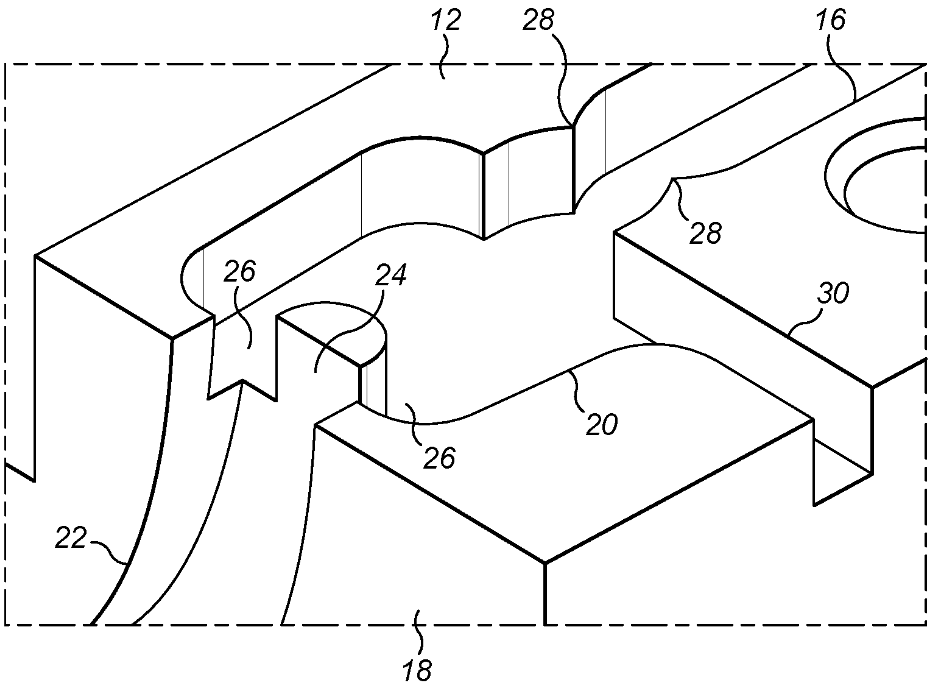
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FIG. 4

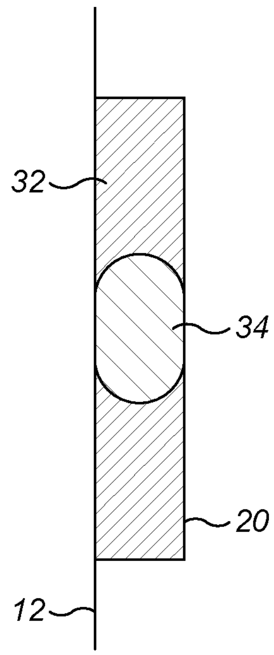

FIG. 5

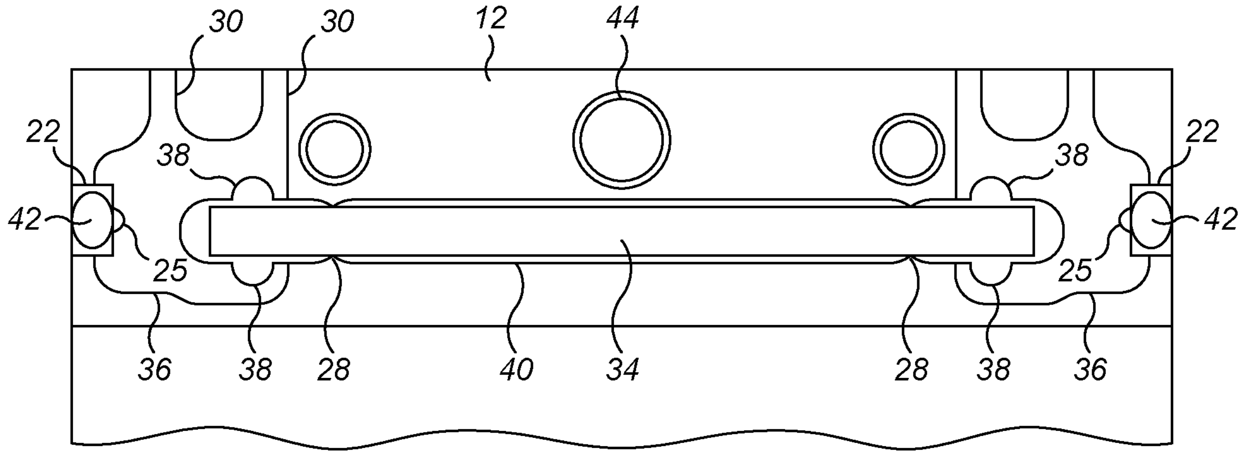

FIG. 6

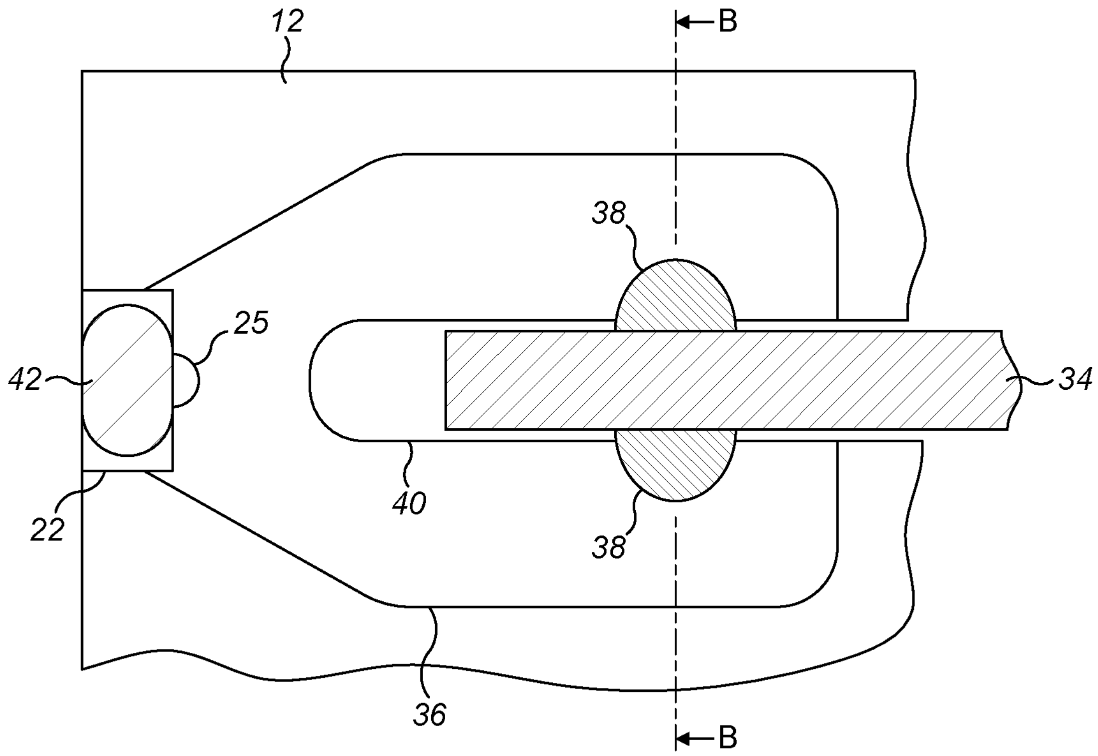

FIG. 7

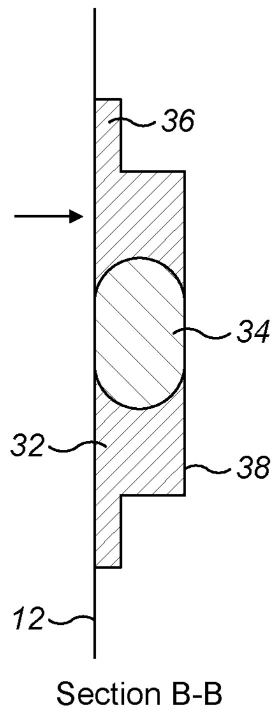

FIG. 8

REFERENCES CITED IN THE DESCRIPTION

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- GB 2489248 A **[0008]**