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Dimensionally stable ring element for a heat exchange jacket

The present invention relates to a dimensionally stable ring element for a heat exchanger casing, to a heat exchanger casing having a plurality of such ring elements, and to an agitator ball mill having such a heat exchanger casing.

Agitator ball mills have applications in many fields, but especially in those fields in which a material is to be ground especially finely, such as, for example, in the case of pigment processing in the paints and coatings industry. With the aid of an agitator ball mill, colour pigments and fillers are comminuted therein to a very small particle size (for example nanoparticles) and dispersed. The grinding process generates heat in the grinding container of the agitator ball mill. In order to achieve the best possible grinding result it can be advantageous to be able to dissipate or recover excess heat or to enable a desired temperature regime to be implemented for the grinding process. For that reason, agitator ball mills can be provided with a heat exchanger casing through which a heat transfer medium is able to flow, with the result that a desired temperature regime can be implemented for the grinding process. A controlled temperature regime for processes in containers can also be desirable in many other applications and is therefore not limited to grinding processes or agitator ball mills.

DE-202015101859-U1 discloses a fluid guiding mat for the directed guidance of a fluid flow in an agitator ball mill. In an agitator ball mill known from DE-2920758-B1, the heat exchanger casing is in the form of a one-piece hollow-cylindrical sleeve (for example made of stainless steel) which extends over the entire length of the grinding container and encompasses the latter. The inner wall of the hollow-cylindrical sleeve is provided with a groove which runs helically from one end of the sleeve to the other. A flexible dividing wall is secured in the groove, the inner end of which dividing wall rests against the grinding container so that a channel running helically around the grinding container is formed. Both the

introduction of the helical groove and the attachment of the flexible dividing wall is laborious and requires cost-intensive manufacturing processes.

5 Since, during cooling or heating, a heat transfer medium (for example water) flows through the helical channel, over time deposits may be formed which can have an adverse effect on the temperature regime and therefore have to be removed. The dividing wall can also undergo wear over time, so that it needs to be exchanged, because otherwise the heat transfer medium will no longer flow uniformly through the helical channel around the grinding container. Both the removal of such
10 deposits and the exchange of the dividing wall are very laborious, because for that purpose first the hollow-cylindrical sleeve extending over the entire length of the grinding container has to be completely stripped off the grinding container, which can be a difficult procedure because the deposits make it more difficult or even impossible to strip off the hollow cylinder without at the same time causing
15 damage to the dividing wall. Exchanging the dividing wall is very labour-intensive, because for that purpose the new dividing wall needs to be laboriously pressed into the helical groove over its entire length along the inner wall of the hollow cylinder, which, on the one hand, is a difficult manual task and, on the other hand, is extremely time-consuming.

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The invention is to provide a remedy in this regard and to eliminate the disadvantages mentioned above.

25 This object is achieved by the dimensionally stable ring element for a heat exchanger casing according to the invention, as it is defined by the features of independent claim 1. Advantageous aspects of the dimensionally stable ring element according to the invention are apparent from the features of the corresponding dependent claims.

30 According to the invention there is proposed a dimensionally stable ring element for a heat exchanger casing which comprises the following:

- a cylindrical sleeve having a cylinder axis, a first end and a second end remote from the first end, and having an inner wall,
- a dividing wall which projects inwards from the inner wall of the sleeve and extends helically around the cylinder axis along the inner wall from the first end of the sleeve to the second end of the sleeve.

At its first end the sleeve comprises a projection extending parallel to the cylinder axis, which projection is arranged in a predetermined circumferential position on the sleeve. At its second end the sleeve comprises a recess extending parallel to the cylinder axis, which recess has a shape complementary to the projection and is arranged on the sleeve in the same predetermined circumferential position as the projection.

The term "dimensionally stable" in relation to the ring element means that the ring element as a whole, that is to say considered as a complete component, does not change its external shape when the ring element is used as intended, that is to say its shape is stable. That does not mean that individual parts of the ring element cannot be deformable (for example the dividing wall can have a flexible and therefore deformable sealing lip, but it need not; see discussion hereinbelow), but the ring element as a whole is stable in external shape when the ring element is used as intended.

Such a dimensionally stable ring element allows particularly simple assembly and disassembly of a quasi-modular heat exchanger casing which is formed from a plurality of individual dimensionally stable ring elements arranged one after the other in a row, and, in addition, renders the laborious replacement of the dividing wall obsolete. The projection and the recess provide a positioning aid during assembly. Such a positioning aid allows simple, error-free, quick and positionally correct assembly of a plurality of such ring elements one after the other in a row in order to form a heat exchanger casing. Moreover, because they are complementary in shape, the projection and the recess allow interlocking engagement

between a plurality of such ring elements arranged one after the other in a row. As a result, the individual ring elements of the heat exchanger casing can be prevented from twisting relative to one another. In the event of the dividing wall of an individual ring element being damaged, only the damaged ring element needs
5 to be replaced during maintenance of the heat exchanger casing, thus rendering the manually laborious and time-consuming exchange of the dividing wall obsolete. Maintenance is accordingly limited to the replacement of the particular ring elements that are damaged, which can be done easily without requiring a large amount of time.

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In accordance with one aspect of the dimensionally stable ring element according to the invention, the projection at the first end of the sleeve has a tooth having a tooth length and a tooth width, and the recess at the second end of the sleeve has a notch having a notch depth and a notch width. The tooth has a shape
15 complementary to the notch; the tooth length corresponds to the notch depth and the tooth width corresponds to the notch width.

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The tooth and the notch complementary thereto allow simple and reliable interlocking engagement of ring elements arranged one after the other in a row. In that way, two ring elements arranged one after the other in a row are prevented from twisting relative to one another. The dimensions of the notch are such that the tooth can be inserted into the notch during assembly and removed from the notch during disassembly. Moreover, the combination of tooth and notch allows simple and quick identification of the correct assembly position.

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In accordance with a further aspect of the dimensionally stable ring element according to the invention, the projection at the first end of the sleeve comprises an overhang extending along the circumference of the sleeve, which overhang has an overhang length in the direction of the circumference of the sleeve and an
30 overhang width in the direction of the cylinder axis. The recess at the second end of the sleeve comprises a cutaway extending in the direction of the circumference

of the sleeve, which cutaway has a cutaway length in the direction of the circumference of the sleeve and a cutaway depth in the direction of the cylinder axis. The overhang has a shape complementary to the cutaway, and the overhang length corresponds to the cutaway length and the overhang width corresponds to the cutaway depth.

The overhang, which extends along the circumference of the sleeve, and the cutaway, which is complementary in shape thereto and likewise extends along the circumference of the sleeve, likewise allow torsion-resistant interlocking engagement of ring elements arranged one after the other in a row and also fix the positionally correct arrangement of the individual ring elements relative to one another.

In accordance with a further aspect of the dimensionally stable ring element according to the invention, the dividing wall extends helically around the cylinder axis from the overhang at the first end of the sleeve to the cutaway at the second end of the sleeve, the dividing wall having a dividing wall width extending parallel to the cylinder axis, which dividing wall width is smaller than or equal to the overhang width.

A width of the dividing wall that is so predetermined relative to the width of the overhang (or correspondingly relative to the depth of the cutaway) enables the dividing wall of a ring element to rest with the beginning of the dividing wall that is located at the overhang congruently against the end of the dividing wall at the cutaway of a ring element arranged directly adjacent in the row, so that an as it were helical uninterruptedly continuous dividing wall is formed.

In accordance with a further aspect of the dimensionally stable ring element according to the invention, the dividing wall has a flexible sealing lip at its end remote from the inner wall of the sleeve.

During mounting of the ring element or the heat exchanger casing composed of a plurality of such ring elements, the flexible sealing lip is able to come to rest against the container wall of the processing container or grinding container, with the result that an optimum sealing action is achieved.

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In accordance with a further aspect of the dimensionally stable ring element according to the invention, the sleeve is made from a first material having a first modulus of elasticity and the dividing wall is made from a second material having a second modulus of elasticity, the first modulus of elasticity of the material of the sleeve being greater than the second modulus of elasticity of the material of the dividing wall.

This makes it possible for the dividing wall to be bent during mounting and thus to be able to rest firmly against the processing container or grinding container, while the sleeve, and accordingly the ring element considered as a whole, remains stable in respect of its external shape. For example, the first material, from which the sleeve is made, can be polyamide or fibre-reinforced polyamide. The second material, from which the dividing wall is made, can be, for example, a thermoplastic elastomer. Both the first material, from which the sleeve is made, and the second material, from which the dividing wall is made, are, for example, injection-mouldable materials.

For example, in accordance with a further aspect of the dimensionally stable ring element according to the invention, the sleeve made from the first material with the dividing wall made from the second material is manufactured by a two-component injection-moulding process. A dividing wall manufactured in that way has a contour matched to the contour of the container wall of the processing container or grinding container. As a result of being produced by means of an injection-moulding process, the contact surface of the dividing wall which comes into contact with the container wall of the processing container or grinding container remains free of folds, so that the heat transfer medium flows uniformly through the

channel around the processing container or grinding container, while in the case of pressed-in dividing walls, as known from the prior art, such fold formation can occur.

- 5 With the aid of a two-component injection-moulding process it is possible to manufacture the dimensionally stable ring element according to the invention in an economical, reliable and time-saving way. Accordingly, the dividing wall need not be incorporated into the sleeve in a separate working step, but instead, with the aid of such a two-component injection-moulding process, the ring element can be
- 10 manufactured immediately as a complete component. Accordingly, when exchange is necessary, only the ring element according to the invention that needs to be exchanged is replaced by a new ring element, which is cost-efficient (advantageous production of the ring element; time-saving and manually simple replacement of a worn ring element by a new ring element). Moreover, the amount
- 15 of time required for exchange, during which time the processing container is idle, is also comparatively short.

- In accordance with another aspect of the dimensionally stable ring element according to the invention, the dividing wall is in the form of a dimensionally stable
- 20 bead running helically around the cylinder axis, which bead projects inwards from the inner wall of the sleeve. The term "dimensionally stable" in relation to the bead again means that when the ring element is used as intended, the bead does not change its shape, that is to say its shape is stable.

- 25 A dividing wall having such a dimensionally stable bead is robust and resistant to wear. On the other hand, the dimensionally stable bead needs to be produced so that it is not able to rest against the container wall but instead a small radial gap remains between the container wall and the dividing wall. Otherwise the dimensionally stable bead can be damaged during mounting (for example it can
- 30 break).

In accordance with a further aspect of the dimensionally stable ring element according to the invention, in such a case the sleeve and the dividing wall can be made from the same material with the aid of a one-component injection-moulding process.

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The one-component injection-moulding process is an especially economical, reliable and time-saving way of producing the dimensionally stable ring element according to the invention.

10 According to the invention there is further proposed a heat exchanger casing in which a plurality of dimensionally stable ring elements according to the invention, as described above, are arranged one after the other in a row, wherein the projection of a ring element that is arranged subsequently in the row engages interlockingly in the recess of the respective preceding ring element in the row.

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In such a heat exchanger casing, the ring elements arranged one after the other in a row cannot twist relative to one another, they are accordingly arranged so as to be torsion-resistant. This is achieved by interlocking engagement between the projection of a forward ring element in the row and the recess of the respective
20 subsequent rear ring element. Furthermore, such a heat exchanger casing is economical to maintain, because it may not be necessary to exchange all the ring elements of the heat exchanger casing, but rather it is possible to exchange only ever those ring elements that actually need replacement. Moreover, such a heat exchanger casing is quick to assemble, because the dividing wall of the ring
25 elements does not need to be laboriously inserted into the heat exchanger casing, but is already integrated in the ring elements.

As already mentioned, application is possible in principle for many types of processing containers, but especially for agitator ball mills. According to the
30 invention there is therefore also proposed an agitator ball mill which comprises
- a grinding container having a cylindrical container wall and

- a heat exchanger casing according to the invention as described above.

The heat exchanger casing is arranged around the container wall, so that a helical channel is formed by the dividing walls of the ring elements of the heat exchanger casing extending helically around the cylinder axis and by the container wall.

The agitator ball mill according to the invention further comprises
- an inlet and an outlet for a heat transfer medium, the inlet being connected to a first end of the helical channel and the outlet being connected to a second end of the helical channel of the heat exchanger casing, which second end is remote from the first end.

Such an agitator ball mill has the advantage that it is simple to assemble and maintain. Furthermore, such an agitator ball mill allows an efficient temperature regime for the process in the grinding container. During assembly, the heat exchanger casing can be mounted on the grinding container in a simple way by inserting the grinding container into the heat exchanger casing, which is composed of the assembled ring elements arranged one after the other in a row, or by pushing the heat exchanger casing over the grinding container. For maintenance, the heat exchanger casing can be demounted from the grinding container in reverse order (withdrawal of the grinding container from the heat exchanger casing or removal of the heat exchanger casing from the grinding container). The arrangement of the heat exchanger casing around the container wall allows an optimum exchange of heat between the grinding container and a heat transfer medium flowing through the heat exchanger casing, because the channel for conducting the heat transfer medium is formed in such a way that the heat transfer medium comes directly into contact with the container wall of the grinding container. Depending upon the application, the heat transfer medium can serve as a cooling medium or as a heating medium.

In accordance with a further aspect of the agitator ball mill according to the invention, the latter further comprises a cylindrical outer cover which encompasses the heat exchanger casing.

- 5 The cylindrical outer cover allows the stability of the heat exchanger casing to be additionally increased, because it encompasses the heat exchanger casing and therefore additionally holds the individual ring elements in position. There is preferably a small amount of radial play between the heat exchanger casing and the cylindrical outer cover, which allows the ring elements of the heat exchanger
- 10 casing to be pushed into the cylindrical outer cover, and subsequently allows the grinding container to be pushed into the heat exchanger casing with the encompassing cylindrical outer cover or allows the heat exchanger casing arranged in the cylindrical outer cover to be pushed over the grinding container.
- 15 In accordance with one aspect of the agitator ball mill according to the invention, the latter comprises a heat exchanger casing according to the invention composed of ring elements having a dividing wall with a flexible sealing lip as described above. The flexible sealing lip has an inner edge having an internal diameter and the container wall of the grinding container has an external diameter. The internal
- 20 diameter of the sealing lip is smaller than the external diameter of the container wall of the grinding container, so that the flexible sealing lip is bent and rests against the container wall of the grinding container.

- Preferably the sealing lip is bent in a direction opposite to the flow direction of the
- 25 heat transfer medium through the helical channel. As a result, during operation the sealing lip is pressed even more firmly against the container wall by the heat transfer medium, so that the helical channel is well sealed and, during operation, the heat transfer medium is accordingly able to flow uniformly through the helical channel without leakage, with the result, in turn, that a good and uniform exchange
- 30 of heat between the container wall and the heat transfer medium can take place.

In accordance with another aspect of the agitator ball mill according to the invention, the latter has a heat exchanger casing according to the invention composed of ring elements having a dividing wall with a dimensionally stable bead as described above. The dimensionally stable bead has an inner edge having an
5 internal diameter and the container wall of the grinding container has an external diameter. The internal diameter of the bead is larger than the external diameter of the container wall of the grinding container, so that a gap is formed between the inner edge of the bead and the container wall of the grinding container.

10 As a result of that difference in diameter between the bead and the container wall of the grinding container, the dimensionally stable bead does not rest against the container wall, otherwise the bead could be damaged during mounting of the heat exchanger casing (see discussion above). Accordingly, the heat exchanger casing can readily be removed from the grinding container during demounting.

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The mounting of the heat exchanger casing on the agitator ball mill can be carried out, for example, as follows: first of all, all the ring elements are aligned in the same circumferential position in relation to the cylindrical outer cover and inserted into the cylindrical outer cover interlockingly one after the other in a row. In that
20 procedure the projection and the recess of the respective ring element serve as positioning aids. After insertion of the ring elements into the cylindrical outer cover, the projection of a rear ring element in the row engages interlockingly in the recess of a respective forward ring element arranged immediately in front of that rear ring element in the row. The ring elements arranged in that way one after the other in
25 the row thus form the heat exchanger casing. Then the grinding container is inserted into the heat exchanger casing, which is surrounded by the cylindrical outer cover, or the heat exchanger casing arranged in the cylindrical outer cover is pushed over the grinding container. That means that in the case of ring elements having a dividing wall with a flexible sealing lip, the flexible sealing lip of the
30 respective ring element is bent and rests against the container wall of the grinding container, so that a sealed helical channel is formed. In the case of ring elements

having a dividing wall with a dimensionally stable bead, the bead does not touch the container wall, so that here a small radial gap remains between the container wall and the dividing wall, but likewise the helical channel is formed. For maintenance, the grinding container is withdrawn from the heat exchanger casing or the heat exchanger casing arranged in the cylindrical outer cover is removed from the grinding container. The ring elements of the heat exchanger casing are then taken out of the outer cover of the agitator ball mill and the worn ring elements are replaced by corresponding new ring elements (or, in principle, all ring elements are replaced during maintenance). Re-assembly is then carried out as already described.

The invention is described in greater detail below on the basis of exemplary embodiments and with reference to the accompanying drawings, wherein, in partly diagrammatic form:

Fig. 1 shows a longitudinal section through an agitator ball mill according to the invention having a heat exchanger casing according to the invention with dimensionally stable ring elements according to the invention;

Fig. 2 is a perspective view of a first exemplary embodiment of a dimensionally stable ring element according to the invention;

Fig. 3 is a side view of the dimensionally stable ring element from Fig. 2;

Fig. 4 shows a longitudinal section through the dimensionally stable ring element from Fig. 2;

Fig. 5 is an enlarged view of the detail V from Fig. 4;

Fig. 6 is a perspective view of the heat exchanger casing with a cylindrical outer cover;

Fig. 7 shows a longitudinal section through the heat exchanger casing with the cylindrical outer cover from Fig. 6 on a grinding container;

5 Fig. 8 is an enlarged view of the detail VIII from Fig. 7;

Fig. 9 shows a longitudinal section through a second exemplary embodiment of the dimensionally stable ring element according to the invention;

10 Fig. 10 is a side view of the second exemplary embodiment of the dimensionally stable ring element according to the invention, and

Fig. 11 shows a longitudinal section through a heat exchanger casing of the second exemplary embodiment of the dimensionally stable ring element
15 according to the invention on a grinding container.

The following considerations apply in respect of the description which follows: where, for the purpose of clarity of the drawings, reference symbols are included in a Figure but are not mentioned in the directly associated part of the description,
20 reference should be made to the explanation of those reference symbols in the preceding or subsequent parts of the description. Conversely, to avoid over-complication of the drawings, reference symbols that are less relevant for immediate understanding are not included in all Figures. In that case, reference should be made to the other Figures.

25

As can be seen in **Fig. 1**, an exemplary embodiment of an agitator ball mill 4 according to the invention comprises a grinding container 5, in which there is arranged an agitator for grinding the material to be ground. The agitator can be connected via a belt drive to a motor driving the agitator. The grinding container
30 has a material input for the material to be ground and a material output for the ground material. The agitator ball mill 4 also comprises a heat exchanger casing 3,

which is arranged around a cylindrical container wall 50 of the grinding container 5. The heat exchanger casing 3 comprises a plurality of dimensionally stable ring elements 1 (see Fig. 2-5) or a plurality of dimensionally stable ring elements 2 (see Fig. 9 and 10), which are arranged one after the other in a row in the direction of a cylinder axis 102 (see, for example, Fig. 3) or in the direction of a cylinder axis 202 (see, for example, Fig. 10), respectively. The heat exchanger casing 3 comprising the plurality of ring elements 1 or the plurality of ring elements 2 is shown in Fig. 6 to 8 and Fig. 11 and is described in greater detail hereinbelow. In addition, the agitator ball mill 4 has an inlet 40 and an outlet 42 for a heat transfer medium, for example water. The inlet 40 and the outlet 42 is described in greater detail hereinbelow in connection with the heat exchanger casing 3.

Fig. 2, Fig. 3, Fig. 4 and Fig. 5 show a first exemplary embodiment of a dimensionally stable ring element 1 used in the heat exchanger casing 3 of the agitator ball mill 4. Such a dimensionally stable ring element 1 comprises a cylindrical sleeve 10 having the cylinder axis 102 and a first end 104 as well as a second end 106 remote from the first end 104. The dimensionally stable ring element 1 further comprises a dividing wall 11, which projects inwards from an inner wall 108 of the cylindrical sleeve 10 and extends helically around the cylinder axis 102 along the inner wall 108 from the first end 104 to the second end 106. The cylindrical sleeve 10 can be made, for example, from polyamide, which has a first modulus of elasticity. Good dimensional stability of the sleeve 10 can be achieved if fibre-reinforced, for example glass-fibre-reinforced, polyamide is chosen as material for the cylindrical sleeve 10.

At its first end 104 the cylindrical sleeve 10 has a tooth 109 extending parallel to the cylinder axis 102, as can be seen especially clearly in Fig. 4. Furthermore, at its second end 106 the cylindrical sleeve 10 has a notch 113 extending parallel to the cylinder axis 102 and complementary in shape to the tooth 109. The tooth 109 has a tooth length 112 and a tooth width 110, and the notch has a notch depth 115

corresponding to the tooth length 112 and a notch width 114 corresponding to the tooth width 110.

Furthermore, the cylindrical sleeve 10 has, at the first end 104, an overhang 116
5 extending along the circumference of the sleeve, as can readily be seen in
Fig. 3. The cylindrical sleeve 10 also has, at its second end 106, a cutaway 119
complementary in shape to the overhang, which cutaway is indicated in dashed
lines in Fig. 3. The overhang 116 has an overhang length 118 (see Fig. 2) in the
direction of the circumference of the sleeve and an overhang width 117 in the
10 direction of the cylinder axis 102 (see Fig. 3). The cutaway 119 has a cutaway
length 122 (see Fig. 2) corresponding to the overhang length 118 and a cutaway
depth 120 (see Fig. 3) corresponding to the overhang width 117.

Fig. 5 shows the detail V from Fig. 4 on a slightly enlarged scale, so that the
15 dividing wall 11 of the dimensionally stable ring element 1 can be seen more
clearly. The dividing wall 11 can extend helically around the cylinder axis 102 from
the overhang 116 at the first end 104 of the sleeve 10 to the cutaway 119 at the
second end 106 of the sleeve 10. The dividing wall 11 has a dividing wall
width 126, which is smaller than or equal to the overhang width 117 of the
20 overhang 116. Furthermore, the dividing wall 11 has a flexible sealing lip 128 at its
end remote from the inner wall 108 of the cylindrical sleeve 10, as can also be
seen in Fig. 8.

The flexible sealing lip 128 has an inner edge 130 which defines an internal
25 diameter 132 (see Fig. 4) of the dividing wall 11 which runs helically around the
cylinder axis 102. In the exemplary embodiment shown, that internal diameter 132
is smaller than the external diameter 500 of the cylindrical container wall 50 of the
grinding container 5. That difference in diameter has the result that when the
dimensionally stable ring element 1 is arranged around the container wall 50, the
30 flexible sealing lip 128 rests in a bent state against the container wall 50 of the
grinding container 5, as can be seen in Fig. 8.

The dividing wall 11 can be made from a thermoplastic elastomer which has a second modulus of elasticity, the second modulus of elasticity of the thermoplastic elastomer of the dividing wall 11 being smaller than the first modulus of elasticity of the polyamide of the sleeve 10. The sleeve 10 and the dividing wall 11 can have been made, for example, by a two-component injection-moulding process.

In such a two-component injection-moulding process, in a first step the sleeve 10 is injection-moulded from polyamide and then the dividing wall 11 is injection-moulded in a second step. Various measures can be taken to ensure that the dividing wall 11 is firmly seated in the sleeve 10. For example, the sleeve 10 can have a region of contact with the dividing wall 11, which region, after the injection-moulding of the dividing wall 11, forms an insoluble interlocking connection with the dividing wall 11.

15

A heat exchanger casing 3 is formed by a plurality of dimensionally stable ring elements 1 which are arranged one after the other in a row in the direction of the cylinder axis 102. This allows the tooth 109 and the overhang 116 of a ring element 1 arranged subsequently in the row to engage interlockingly in the notch 113 and in the cutaway 119, respectively, of the respective preceding ring element 1 in the row. **Fig. 6** shows such a row of inter-engaged dimensionally stable ring elements 1 which have been inserted into an outer cover 43. For that purpose, for the purpose of better understanding a "window" has been inserted in outer cover 43 in the drawing, through which the engagement of the teeth in the notches of the dimensionally stable ring elements 1 arranged one after the other in a row is visible. Fig. 6 also shows that the first dimensionally stable ring element 1 inserted into the outer cover 43 engages by means of its tooth 109 in an exactly fitting notch present in the outer cover 43 (or in a flange of the outer cover). Such engagement of the tooth 109 of the first dimensionally stable ring element 1 in the notch in the flange of the outer cover 43 enables the entire row of dimensionally stable ring elements 1 to be secured against twisting.

Furthermore, the outer cover 43 is screwed at its opposite ends to a first end ring 44 and a second end ring 45 (see **Fig. 7**), which seal the container wall 50 from the outside at the respective ends and accordingly ensure that the heat transfer medium flows through the inlet 40 into one end 101 of the helical channel 100, through the helical channel 100 and out of the outlet 42 again through the other end 103 of the helical channel 100. In addition, the dimensionally stable ring elements 1 of the heat exchanger casing 3 are held together in the axial direction by the second end ring 45 in order to ensure that they are secured against twisting (engagement of the tooth in the outer cover 43 at the other end).

Fig. 7 and **Fig. 8** show that when the heat exchanger casing 3 is arranged around the container wall 50 of the grinding container 5, the dimensionally stable ring elements 1 with the dividing walls 11 extending helically around the cylinder axis, together with the container wall 50, form a helical channel 100. The helical channel 100 has a first end 101 and a second end 103 remote from the first end. The inlet 40 for the heat transfer medium of the agitator ball mill 4 is connected to the first end 101 of the helical channel 100, and the outlet 42 for the heat transfer medium is connected to the second end 103 of the helical channel 100. Accordingly, the heat transfer medium, for example water, is able to flow through the helical channel 100 from the inlet 40 to the outlet 42. The water is in direct contact with the container wall 50 of the grinding container 5, with the result that especially good heat exchange (for example cooling) of the container wall 50 can be achieved. The throughflow direction of the water through the helical channel 100 can be opposite to the bending direction of the flexible sealing lip 128. This has the result that the water flowing through the helical channel 100 in the opposite direction to the bending direction of the sealing lip 128 presses the flexible sealing lip 128 even more firmly against the container wall 50, thus further supporting the sealing tightness of the helical channel 100.

Fig. 9, Fig. 10 and **Fig. 11** each shows a second exemplary embodiment of the dimensionally stable ring element 2 and of a heat exchanger casing 3 having dimensionally stable ring elements 2 of the second exemplary embodiment of the invention. Some of the aspects already discussed in relation to the first embodiment apply likewise to the second embodiment, so that those aspects and their function will not be explained again here. In this regard reference is made to the corresponding parts of the description of the first exemplary embodiment.

In the second embodiment, the dimensionally stable ring element 2 comprises a cylindrical sleeve 20 having the cylinder axis 202 and a first end 204 as well as a second end 206 remote from the first end. The dimensionally stable ring element 2 comprises a (dimensionally stable) dividing wall 21 which projects inwards from an inner wall 208 of the cylindrical sleeve 20 and extends helically around the cylinder axis 202 along the inner wall 208 from the first end 204 to the second end 206. The cylindrical sleeve 20 can be made, for example, from polyamide. In particular, the sleeve 20 and the dividing wall 21 can both be injection-moulded from polyamide in a single step with the aid of a one-component injection-moulding process.

At its first end 204 the cylindrical sleeve 20 has a tooth 209 extending parallel to the cylinder axis 202. At its second end 206 the cylindrical sleeve 20 likewise has a notch 213 extending parallel to the cylinder axis 202 and complementary in shape to the tooth 209. The tooth 209 has a tooth length 212 and a tooth width 210, and the notch has a notch depth 215 corresponding to the tooth length 212 and a notch width 214 corresponding to the tooth width 210.

Furthermore, the cylindrical sleeve 20 comprises, at the first end 204, an overhang 216 extending along the circumference of the sleeve. The sleeve likewise has, at its second end, a cutaway 210 complementary in shape to the overhang. The overhang 216 has an overhang length 218 (see **Fig. 10**) in the direction of the circumference of the sleeve and an overhang width 217 in the

direction of the cylinder axis 202. The cutaway 219 has a cutaway length 222 (see **Fig. 10**) corresponding to the overhang length 218 and a cutaway depth 220 corresponding to the overhang width 217.

- 5 The dividing wall 21 extends helically around the cylinder axis 202 from the overhang 216 at the first end 204 of the sleeve 20 to the cutaway 219 at the second end of the sleeve 20 and has a dividing wall width 226 (see **Fig. 9**) that is smaller than or equal to the overhang width 217 of the overhang 216. Furthermore, the dividing wall 21 has a dimensionally stable bead 228 which projects
10 inwards from the inner wall 208 of the sleeve 20.

- The dimensionally stable bead 228 has an inner edge 230 having an internal diameter 232, that internal diameter 232 being larger than the external diameter 500 of the container wall 50 of the grinding container 5, so that a narrow gap
15 is formed between the inner edge 230 of the dimensionally stable bead 228 and the container wall 50 of the grinding container 5. The very slightly larger internal diameter 232 at the inner edge 230 of the dimensionally stable bead 228 prevents the (dimensionally stable and therefore inflexible) dividing wall 21 of the cylindrical sleeve 20 from being damaged during mounting on the grinding container 5.
20 Although the narrow gap formed in that way means that very slight leakage is possible, the heat transfer medium, apart from that very slight leakage, nevertheless flows through the helical channel similarly to the first exemplary embodiment, so that the mode of action is in principle the same as in the first exemplary embodiment.

25

The assembly of the heat exchanger casing 3 with dimensionally stable ring elements 2 in accordance with the second exemplary embodiment is identical to the assembly of the heat exchanger casing 3 with dimensionally stable ring elements 1 in accordance with the first exemplary embodiment.

30

The invention has been explained above with reference to exemplary embodiments. It will be clear, however, that the invention is not limited to those exemplary embodiments, but rather those exemplary embodiments serve merely for an understanding of the invention, so that modifications and/or additional aspects can
5 be provided without departing from the teaching of the invention. The scope of protection is therefore defined by the following patent claims.

PATENTKRAV

1. Formstabilt ringelement (1, 2) til et varmevekslerhus (3), omfattende:

5 - et cylindrisk hylster (10, 20) med en cylinderakse (102, 202), en første ende (104, 204) og en anden ende (106, 206), som vender bort fra den første ende, og med en indre væg (108, 208),

10 - en skillevæg (11, 21), der rager indad fra hylsterets (10, 20) indre væg (108, 208) og strækker sig spiralformet omkring cylinderaksen (102, 202) langs den indre væg (108, 208) fra den første ende (104, 204) af hylsteret (10, 20) til den anden ende (106, 206) af hylsteret (10, 20),

hvor hylsteret (10, 20) ved sin første ende (104, 204) omfatter et fremspring (109, 116, 209, 216), der strækker sig parallelt med cylinderaksen (102, 202), og som er anbragt i en forudbestemt omkredsposition på hylsteret (10, 20), og hvor hylsteret (10, 20) ved sin anden ende (106, 206) omfatter en udsparring (113, 119, 213, 219), der strækker sig parallelt med cylinderaksen (102, 202), og som har en form, der er komplementær til fremspringet (109, 116, 209, 216), og er arrangeret på hylsteret (10, 20) i den samme forudbestemte omkredsposition som fremspringet (109, 116, 209, 216).

20 2. Ringelement (1, 2) ifølge krav 1, hvor fremspringet ved den første ende (104, 204) af hylsteret (10, 20) har en tand (109, 209) med en tandlængde (112, 212) og en tandbredde (110, 210), og hvor udsparringen ved den anden ende (106, 206) af hylsteret (10, 20) har et hak (113, 213) med en hakkedybde (115, 215) og en hakkebredde (114, 214), hvor tanden (109, 209) har en form, der er komplementær til hakket (113, 213), og hvor tandlængden (112, 212) svarer til hakkedybden (115, 215), og tandbredden (110, 210) svarer til hakkebredden (114, 214).

30 3. Ringelement (1, 2) ifølge et hvilket som helst af kravene 1 eller 2, hvor fremspringet ved den første ende (104, 204) af hylsteret (10, 20) omfatter et udhæng (116, 216), der strækker sig langs omkredsen af hylsteret, og som har en udhængslængde (118, 218) i retning af omkredsen af hylsteret og en udhængsbredde (117, 217) i retning af cylinderaksen (102, 202), og hvor udsparringen ved den anden ende (106, 206) af hylsteret (10, 20) omfatter en udskæring (119, 219), der strækker sig i retning af omkredsen af hylsteret (10, 20), og som har en udskæringslængde (122, 222) i retning af hylsterets

omkreds og en udskæringsbredde (120, 220) i retning af cylinderaksen (102, 202), hvor udhænget (116, 216) har en form, der er komplementær til udskæringen (119, 219), og hvor udhængslængden (118, 218) svarer til udskæringslængden (122, 222), og udhængsbredden (117, 217) svarer til udskæringsdybden (120, 220).

5

4. Ringelement (1, 2) ifølge krav 3, hvor skillevæggen (11, 21) strækker sig spiralformet omkring cylinderaksen (102, 202) fra udhænget (116, 216) ved den første ende (104, 204) af hylsteret (10, 20) til udskæringen (119, 219) ved den anden ende (106, 206) af hylsteret (10, 20), og hvor skillevæggen (11, 21) har en skillevæggsbredde (126, 226),
10 der strækker sig parallelt med cylinderaksen (102, 202), og som er mindre end eller lig med udhængsbredden (117, 217).

5. Ringelement (1) ifølge et hvilket som helst af de foregående krav, hvor skillevæggen (11) har en fleksibel tætningslæbe (128) ved den ende deraf, der vender bort fra den
15 indre væg (108) af hylsteret (10).

6. Ringelement (1) ifølge krav 5, hvor hylsteret (10) er fremstillet af et første materiale med et første elasticitetsmodul, og skillevæggen (11) er fremstillet af et andet materiale med et andet elasticitetsmodul, idet det første elasticitetsmodul af materialet i hylsteret
20 (10) er større end det andet elasticitetsmodul af materialet i skillevæggen (11).

7. Ringelement (1) ifølge krav 6, hvor hylsteret (10) er fremstillet af det første materiale med skillevæggen (11) af det andet materiale ved en tokomponent-sprøjttestøbningsproces.
25

8. Ringelement (2) ifølge et hvilket som helst af kravene 1 til 4, hvor skillevæggen (21) er udformet som en formstabil vulst (228), der løber spiralformet omkring cylinderaksen (202), og som rager indad fra den indre væg (208) af hylsteret (20).
30

9. Ringelement (2) ifølge krav 8, hvor hylsteret (20) og skillevæggen (21) er fremstillet af det samme materiale ved en énkomponent-sprøjttestøbningsproces.

10. Varmevekslerhus med et antal ringelementer (1, 2) ifølge et hvilket som helst af kravene 1 til 9, der er anbragt efter hinanden i en række i retning af cylinderaksen (102, 202), hvor fremspringet (109, 116, 209, 216) af et ringelement (1, 2), der efterfølgende
35

er anbragt i rækken, griber tætsiddende ind i udsparingen (113, 119, 213, 219) i det respektive foregående ringelement (1, 2) i rækken.

11. Omrørerkuglemølle (4), som omfatter:

- 5 - en formalingsbeholder (5) med en cylindrisk beholdervæg (50),
- et varmevekslerhus (3) ifølge krav 10,
- hvor varmevekslerhuset (3) er anbragt omkring beholdervæggen (50), således
- at der dannes en spiralformet kanal (100, 200) af skillevæggene (11, 21) af
- ringelementerne (1, 2) af varmevekslerhuset (3), hvilke skillevægge strækker
- 10 sig spiralformet omkring cylinderaksen og gennem beholdervæggen (50),
- et indløb (40) og et udløb (42) til et varmemædermedium, hvor indløbet (40) er
- forbundet til en første ende (101, 201) af den spiralformede kanal (100, 200), og
- udløbet (42) er forbundet til en anden ende (103, 203) af den spiralformede ka-
- nal (100, 200) af varmevekslerhuset (3), hvilken anden ende vender bort fra
- 15 den første ende.

12. Omrørerkuglemølle ifølge krav 11, som yderligere omfatter en cylindrisk ydre kappe (43), der omfatter varmevekslerhuset (3).

- 20 13. Omrørerkuglemølle ifølge et hvilket som helst af kravene 11 eller 12 med et varme-
- vekslerhus bestående af ringelementer (1) ifølge et hvilket som helst af kravene 5 til 7,
- hvor den fleksible tætningslæbe (128) har en indvendig kant (130) med en indvendig
- diameter (132), og beholdervæggen (50) af formalingsbeholderen (5) har en udvendig
- diameter (500), idet den indvendige diameter (132) af tætningslæben (128) er mindre
- end den udvendige diameter (500) af beholdervæggen (50) af formalingsbeholderen
- 25 (5), således at den fleksible tætningslæbe (128) er bøjet og ligger an mod beholder-
- væggen (50) af formalingsbeholderen (5).

- 30 14. Omrørerkuglemølle ifølge et hvilket som helst af kravene 11 og 12 med et varme-
- vekslerhus bestående af ringelementer (2) ifølge et hvilket som helst af kravene 8 eller
- 9, hvor den formstabile vulst (228) har en indvendig kant (230) med en indvendig dia-
- meter (232), og beholdervæggen (50) af formalingsbeholderen (5) har en udvendig dia-

meter (500), idet den indvendige diameter (232) af vulsten (228) er større end den udvendige diameter (500) af beholdervæggen (50) af formalingsbeholderen (5), således at der dannes en spalte mellem den indvendige kant (230) af vulsten (228) og beholdervæggen (50) af formalingsbeholderen (5).

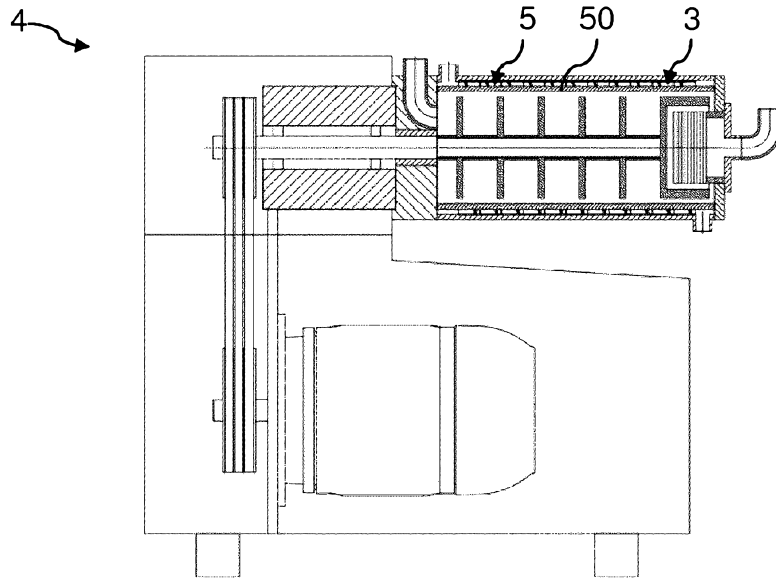


Fig. 1

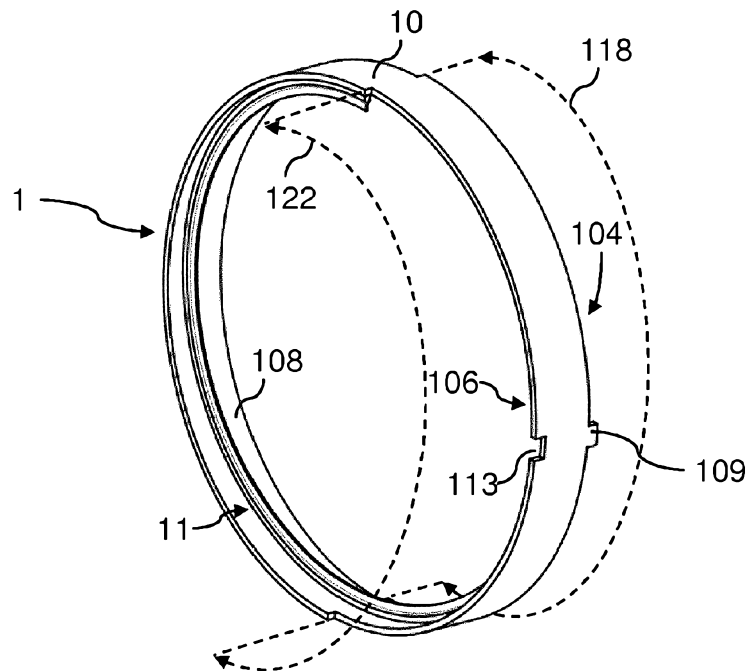


Fig. 2

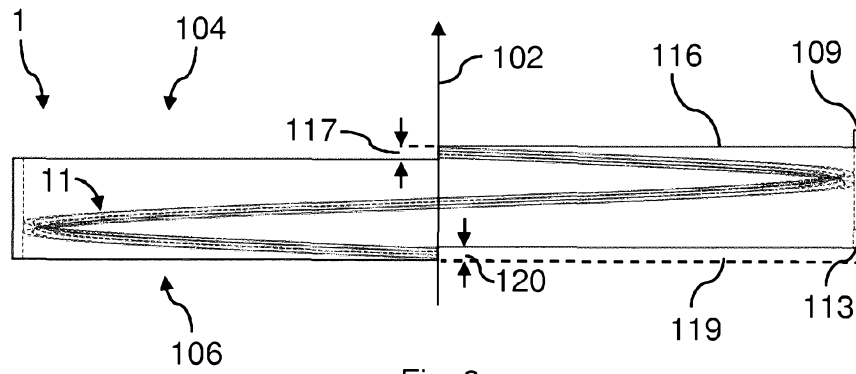


Fig. 3

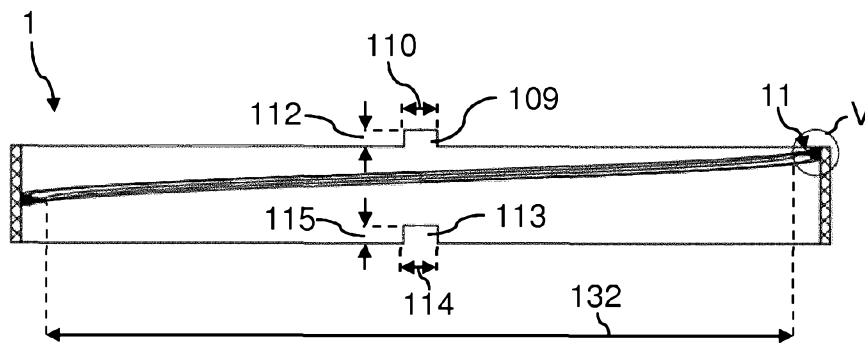


Fig. 4

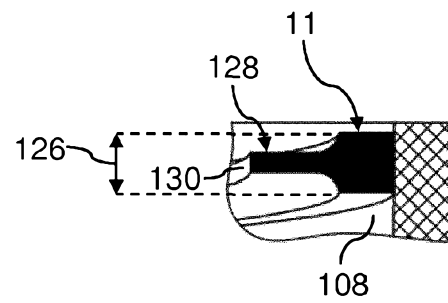


Fig. 5

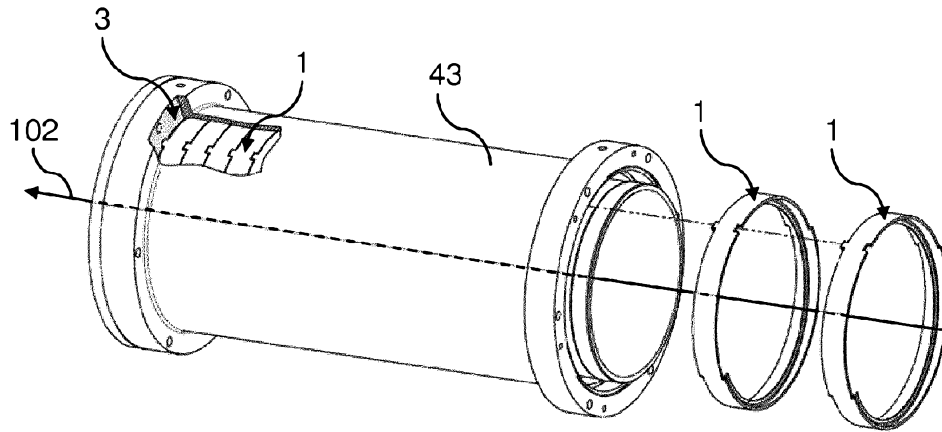


Fig. 6

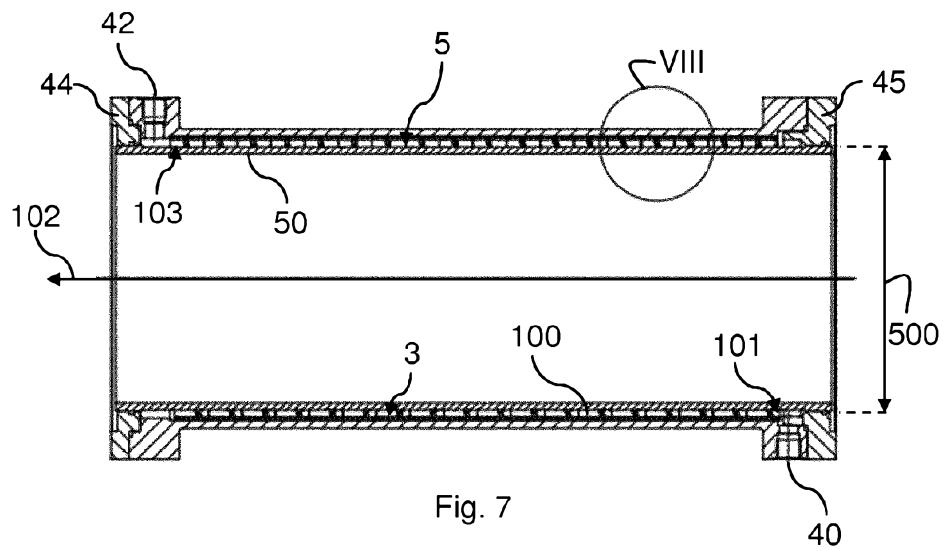


Fig. 7

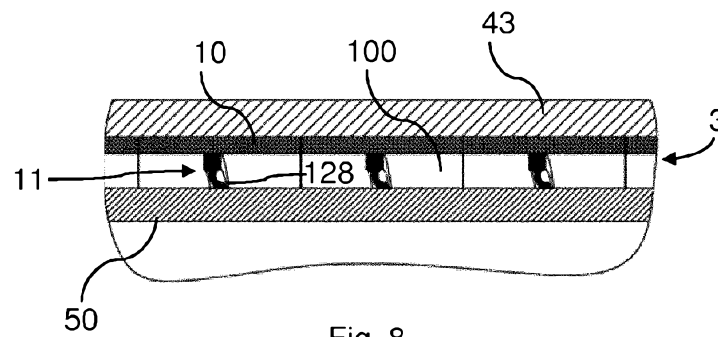


Fig. 8

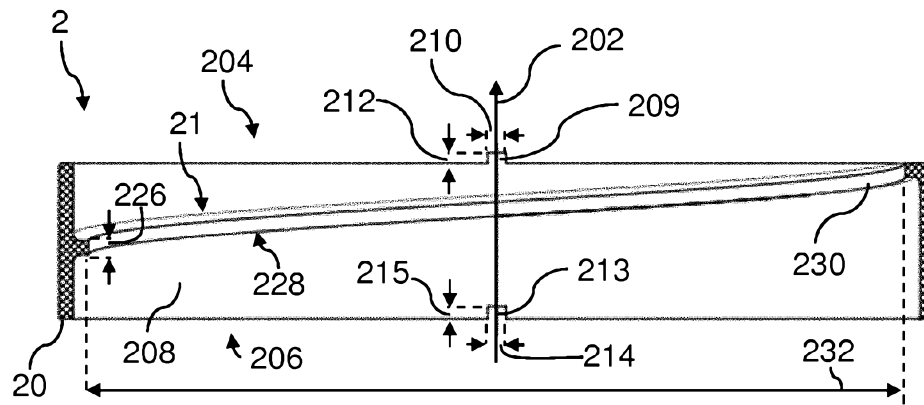


Fig. 9

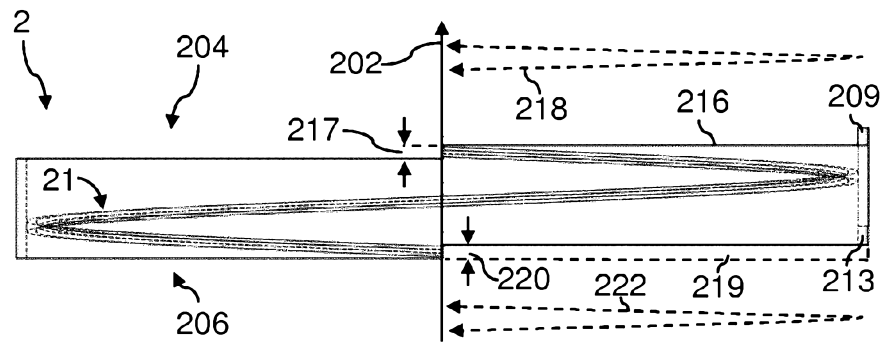


Fig. 10

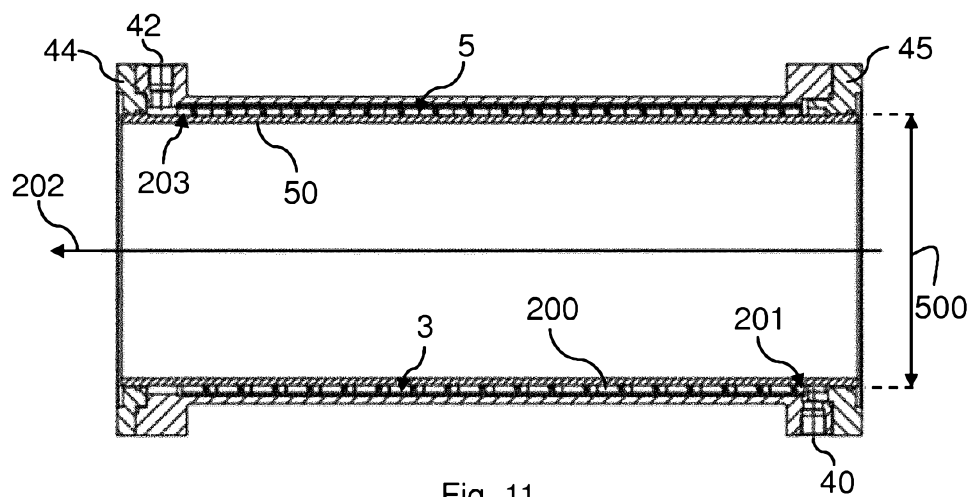


Fig. 11