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(54) **A shaft sealing for use in a cryogenic freezer**

(57) A sealing device (300) for sealing an interface between a freezer wall and an axle (10), rotatable around its length axis and passing through the freezer wall, comprising: one or more insulating element(s) (1) adapted for accommodating the axle (10). The insulating element (s) (1) is/are made from a material, which is resilient at temperatures below -150 degrees C, preferably below -200 degrees C, so that it is able to compensate for changes in the position of the axle (10), and a contact surface (4) provided on an inside of the annular tube shaped insulation adapted for facing the axle (10), the contact surface (4) being wear resistant and non-abrasive, so that surface damage due to relative motion between the contact surface (4) and the axle (10) during the rotation of the axle (10) is avoided.

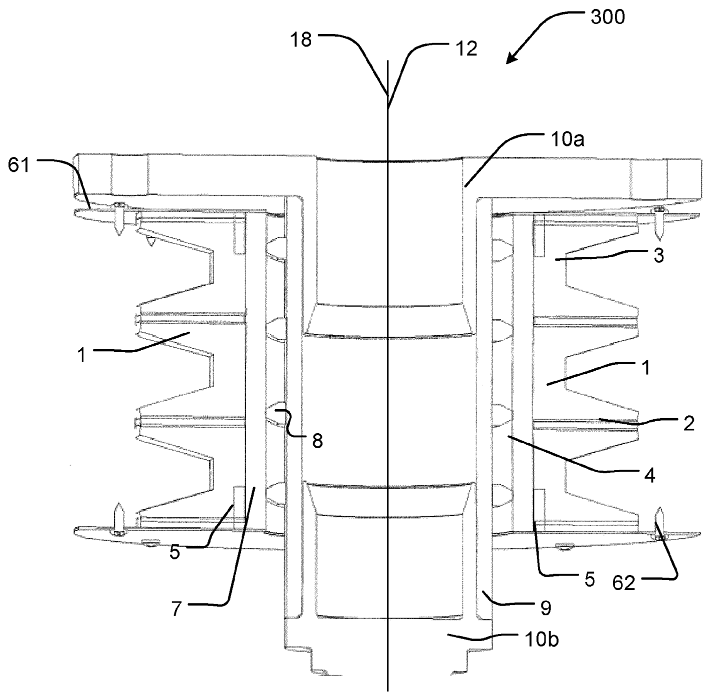

Fig. 3

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Description

[0001] The present invention relates to a sealing device for sealing an interface between a freezer wall and a through member, such as an axle, rotatable around its length axis and passing through the freezer wall between an interior of the freezer and the exterior.

[0002] The invention further relates to a system and a method of use of a sealing device.

[0003] In order to successfully preserve biomolecules, cells and biological tissue for extended periods of time, storage below -80 degrees Celcius (°C) is generally required. However, both shelf life and the ability to recover living cells are dramatically improved at even lower temperatures down to about - 196°C, which is the boiling point of liquid nitrogen. Therefore, liquid nitrogen is often used as a cooling agent for preservation of organic material.

[0004] Freezers operating at such low temperatures are generally known as cryogenic freezers, and the material stored therein is said to be cryo-preserved. There are different opinions on the upper temperature limit below which the term "cryogenic" should be applied to temperatures. The American National Institute of Standards and Technology has suggested an upper limit of -150°C, while some scientists regard the boiling point of oxygen (-183°C) as the upper limit. However, it is generally agreed, that a freezer refers to a storage device that operates from about -5°C to -20°C, an ultra low freezer operates from about -50°C to -90°C, and a cryogenic freezer operates from about -140°C to -196°C.

[0005] Hospitals, laboratories and research institutes all over the world experience an ever increasing need to be able to cryo-preserve, store and handle different types of organic material.

[0006] Many storage systems are arranged as ordinary laboratory freezers, where containers are stored in front of and on top of each other in order to maximize the use of the available space within the apparatus. Some freezers has been provided with paternosters in order to provide easy access to the stored samples and to reduce the time the access door is kept open such that only a small amount of heat from the ambient air is let in. An example of a cryogenic freezer provided with a paternoster is disclosed in WO2008/083685. Here, the motor is positioned outside the freezer and a drive axle passes through the wall of the freezer, but no explanation is given on the details of the interface between the axle and the wall of the freezer.

[0007] It is therefore the object of the present invention to provide a way of minimizing the thermal loss at the interface where a rotatable member enters the wall of a freezer.

[0008] This object is achieved with a sealing device, comprising:

one or more insulating element(s) forming an annular tube shaped insulation with an inner space adapted for accommodating the through member, the inner space having a first opening intended to face the interior of the freezer and a second opening intended to face the exterior and a primary axis extending between the first and second openings, so that, in the mounted position, the length axis of the through member is parallel to the primary axis of the inner space of the insulation, where the insulating element(s) is/are made from a material, which is resilient at temperatures below -150 degrees C, preferably below -200 degrees C, so that it is able to compensate for changes in the position of the through member, and

a contact surface provided on an inside of the annular tube shaped insulation facing the through member in the mounted position, the contact surface being wear resistant and non-abrasive to prevent surface damage due to relative motion between the contact surface and the through member during the rotation of the through member.

[0009] Thereby the thermal loss at the interface is minimized, by completely surrounding the through member with insulating material. The insulating element may be in direct and close-fitting contact with the through member or intermediate members may be provided as will be explained later. In any event a close fit around the through member should be provided to avoid an air gap, which would influence the insulating properties negatively.

[0010] The seal is as such suitable to fit in a wall of a freezer, where the wall comprises a an outer and an inner wall in a rigid material, such as a polymer, and a insulating layer there between from a resilient material, such as foam or mineral wool. The sealing device may thereby be squeezed through a hole in the outer wall that has a smaller circumference than the sealing device in non-deformed state. When the sealing device is mounted it may return into its original shape in a non-deformed state.

[0011] In this context the term "resilient" covers materials which are able to absorb minor deflections of the through member at a temperature below - 150°C.

[0012] The term "wear resistant" means that there is no surface damage involving a substantial progressive loss of material, due to relative motion between a rotatable member and a contacting surface or substance and the term "non-abrasive" means it does not cause such surface damage on the contacting surface or substance during relative motion.

[0013] The contact surface may be formed on a separate receiving member adapted for receiving the through member and possibly also holding the insulating element(s), the receiving member preferably being a pipe made from a polymer. By using a receiving member the rotation is separated from the insulating elements and any translational deflection of the axle may still be absorbed in the insulating element, the receiving member compressing the insulating material when needed. This has the added advantage, that the insulating elements are affected in a more uniform manner than the local depressions, which might be the result of a direct contact with the axle.

[0014] It is noted that the contact surface is understood as any stationary surface of the sealing device being in contact with a moving surface on the through member itself or on additional elements provided thereon.

[0015] The annular tube shaped insulation may comprise two or more insulating elements positioned in series seen in the direction of the primary axis. By dividing the insulating element into smaller elements it is easier to adapt the thickness of the sealing to freezer walls of different thickness.

[0016] At least one insulating element may be provided with an annular recess encircling the primary axis. This ensures a greater flexibility in the insulating elements and they are thereby easier to manipulate and therefore easier to fit in an opening of a cryogenic freezer.

[0017] A textile web insert, such as felt, may be provided between insulating elements, preferably encircling the primary axis. By using a textile web such as felt or another material with insulating and resilient characteristics, a better insulation is provided by providing intermediate sections of different material across the length of the insulation sealing device, thus achieving well known advantages of layered materials. As an example some felts are substantially air-tight and hence will block any flow of air across the insulating elements.

[0018] The receiving member may also be formed as a mat made of a textile web, such as felt, which has both insulating qualities and is non-abrasive.

[0019] A textile web material may even constitute the contact surface, said textile web material possibly being in the form of several discrete bearing members such as such as rings encircling the primary axis or patches. The textile web material may be mounted on the receiving member, the insulating element(s) or the through member. The patches or rings or other shapes reduces the area of the contact surface and thereby any possible wear and contributes to the insulation.

[0020] As a further alternative, a textile web may be provided on the outside of the through member. This contributes to the insulation as well as absorbing minor temperature expansions of the through member or sealing device.

[0021] In addition to merely positioning the sealing device between an outer and an inner wall of a freezer, the device may further comprise attachment means for attaching the sealing device to the freezer wall in order to ensure a more stabile mounting of the device.

[0022] The sealing device may advantageously be adapted to be mounted from the exterior side of the freezer, as the space in a freezer is often limited.

[0023] The insulating element(s) may be made from a foam material, which has excellent properties both with regards to insulation and to absorbing temperature expansions and mutual changes of position of the through member and the different parts of the sealing device.

[0024] According to a second aspect of the invention a system comprising a sealing device, a rotatable through member, in the form of an axle, and a freezer wall forming a part of a freezer able to operate at temperatures below -150 degrees C, preferably below -200 degrees C is provided.

[0025] The freezer wall may comprise an inner wall an outer wall and an insulation material there between. The sealing device may thereby be squeezed through a hole in the outer wall that has a smaller circumference than the sealing device in non-pressed state. When the sealing device is mounted it may expand into its original shape in a non-pressed state. Likewise, if used in a freezer with walls built from an inner and an outer wall, the total length of the insulating material seen in the direction of the primary axis is advantageously somewhat larger than the distance between the inner and outer wall. When the insulating material re-expands upon insertion, the sealing member becomes wedged between the walls and is thereby kept in place.

[0026] The sealing device is preferably the same length or longer in the direction of the primary axis than the distance between the inner wall and the out wall. Correspondingly, if using a freezer with only one wall, the sealing device advantageously extend from the interior to the exterior side of the wall of the freezer.

[0027] The through member may be a carbon fibre or glass fibre axle as this is easy to manufacture and is able to withstand cold temperatures without getting brittle. Other materials with a low brittle temperature (temperature at which a material becomes brittle) may also be used. Traditional axles made of metal are less preferred in this context due to their high thermal conductivity, but may of course be used.

[0028] The system may further comprise a paternoster system drivable via the rotatable through member and adapted for being positioned inside the freezer. As described in WO2008/083685 this makes it easier to withdraw a sample from the freezer without having to move samples around and take samples out in order to reach samples in the back.

[0029] According to a third aspect the sealing device is used for sealing an interface between a wall of a freezer operating at temperatures below - 150°C, preferably below -200°C, and a rotatable through member.

[0030] In the following, the invention will be described in further detail with reference to the drawings in which:

Fig. 1 is a perspective cross section of a first embodiment of the present invention,

Fig. 2 is a perspective cross section of a second embodiment of the present invention,

Fig. 3 is a cross section of a third embodiment of the present invention including an axle, and

Fig. 4 is a cross section of a fourth embodiment of the present invention mounted in a freezer wall.

[0031] Fig. 1 shows a basic version of the invention.

The sealing device 100 comprises three annular insulating elements 1a, 1b, 1c, (generally referred to as 1 in the following) each provided with an annular recess 3, which contributes to making the sealing device more flexible. The insulating elements forms an annular tube shaped insulation with a first opening 11a intended to face the interior of the freezer and a second opening 11b intended to face the exterior of the freezer and a primary axis 12 extending between the first 11a and second 11b openings. In use, the inner space formed between the first and second opening is housing a rotatable through member as will be described later.

[0032] The insulating elements 1 are preferably made from foam or another material with insulating and resilient properties at a temperature below - 150°C, preferably at a temperature below -200°C. Such materials are commercially available. Examples of suitable materials are textile, aerogel as described in W02007/044341 and polytetrafluoroethylene foam (PTFE foam). The resilience is suitable for compensating for any minor changes in the angle between the length axis 18 (see fig. 3) of the through member and the primary axis 12. More or less insulating elements may be used depending on the thickness of the freezer wall or the thickness of the insulating elements 1.

[0033] The recess(es) 3 may be dispensed with or the recess(es) 3 may be configured in a different way, e.g. such that several recesses are provided in each insulating element 1.

[0034] Between the insulating elements 1 a textile web inserts 2 such as felt is provided in order to enhance the insulating properties of the sealing device. The textile web may be woven or non-woven or made from wool, a polymer material or a mineral. The textile web inserts 2 is provided between the insulating elements 1 and at the ends of the insulating elements 1. The textile web inserts 2 may also be provided between only some of the elements 1 or be completely dispensed with.

[0035] On the inside of the annular tube shaped insulation a contact surface 4 is provided. The contact surface 4 is wear resistant and non-abrasive, so that surface damage due to relative motion between the contact surface and the through member during the rotation of the through member is avoided. This means that the contact surface 4 preferably has a low friction coefficient. The contact surface 4 may be formed by selecting a suitable parent material with a smooth surface, coating the surface or attaching an intermediate thin strip of suitable material on top of the insulating elements 1 and/or textile web inserts 2.

[0036] The contact surface is the surface which is in direct contact with the through member, such as a rotatable axle. It is not necessarily positioned directly on the annular tube shaped insulation or insulating elements but may be positioned on intermediate elements between the annular tube shaped insulation and the rotatable through member.

[0037] The sealing device 100 may be mounted from the exterior of the freezer, such that there is no need to access the interior of the freezer, when mounting the sealing device, or the through member for that matter.

[0038] The sealing device 100 is further provided with a sealing ring 5 between the contact surface 4 and the insulating elements 1 at the ends of the sealing device, in order to further sealing the interface between the through member and the wall of the freezer.

[0039] The different parts of the sealing device 100 may be glued or in other ways fastened together by a suitable fastening material.

[0040] The sealing device 100 and its parts may be made from or impregnated with a flame-retardant material(s).

[0041] Fig. 2 shows a second embodiment of the sealing device 200. In addition to the features on Fig. 1, the sealing device 200 further comprises a receiving member 7 in the form of a polymer pipe suitable for temperatures below -150°C. The insulating elements 1 and textile web inserts 2 are attached to outside of the receiving member 7.

[0042] On the inside of the receiving member 7 discrete bearing members 8 are provided. In this configuration the discrete bearing members 8 form the contact surface as described under fig. 1. Instead of rings as shown in the figure, the contact surface 4 may be provided on patches or discrete bearing members 8 in other shapes. Instead of positioning the discrete bearing members 8 inside the receiving member 7, the discrete bearing members 8 may be positioned on the rotatable through member (not shown) such that the interface between the static sealing device 200 and the rotatable through member is between the receiving member 7 and the discrete bearing members 8. The receiving member 7 may instead be made from a felt mat, in which case the discrete bearing members 8 may be dispensed with.

[0043] The sealing device 200 further comprises attachment means in the form of plate segments 61, adapted to be mounted on the outside of the freezer wall, and screws 62 for fixing the sealing device 200 to the freezer wall. The sealing device 200 may be attached to a freezer wall by other means such as glue or another bonding material.

[0044] Fig. 3 is a third embodiment of the sealing device 300 according to the invention. In addition to the features on Fig. 2, Fig. 3 further discloses a rotatable through member 9, 10 comprising an axle 10 and an outer bushing 9. One end 10a of the axle part may be connected to a paternoster inside the freezer, while the other end 10b may be connected to a driving means, such as a motor, for providing the rotation of the axle. The axle 10 may be filled with an insulating material to minimize its thermal conductivity, such that heat from the surroundings is prevented from entering the freezer through the axle. The axle furthermore has a length axis 18, which, in a mounted position, is substantially coincident with the primary axis 12. Minor deflections may occur during rotation of the through member, which deflections are then absorbed by the insulating elements 1 and the textile web inserts 2.

[0045] The non-abrasive and wear resistant contact surface 4 is in this embodiment is on the receiving member 7, and the discrete bearing members 8 are provided on the bushing 9 of the axle.

[0046] Fig. 4 shows a fourth embodiment of the sealing device 400. The features present in Fig. 1 are also present in Fig. 4. Additionally Fig. 4 shows a sealing device 400 provided with an annular receiving member 7 upon which the contact surface 4 is provided. The sealing device 400 has been mounted in the wall of a freezer, between an inner wall 14 and an outer wall 13. Between the inner wall and the outer wall an insulation layer 15 is provided. Other insulation layers may be present than the ones shown in the figures. The inner wall 14 and outer wall 13 may be made from for example a polymer material. When mounting the sealing device 400 in a preformed hole in the freezer wall, the insulating elements 1 may either be squeezed together or they may bend or give in such that the sealing device 400 may enter an opening in the wall that is smaller than the diameter of the sealing device. When being positioned in the wall, the insulating elements 1 will return to their initial shape or position. The through member may then be positioned in the inner space of the sealing device from the exterior of the freezer wall. Plate members resembling those shown in Figs. 2 and 3 may optionally be attached to cover the joint between the exterior wall 13 and the sealing device 400.

[0047] The embodiments of invention described above comprise a number of features, which may be combined in different ways without departing from the scope of the invention as defined in the claims.

Claims

1. A sealing device (300) for sealing an interface between a freezer wall (13,14) and a through member (9,10), such as an axle (10), rotatable around its length axis and passing through the freezer wall (13,14) between an interior of the freezer and the exterior, comprising:

    one or more insulating element(s) (1) forming an annular tube shaped insulation with an inner space adapted for accommodating the through member (10), the inner space having a first opening (11a) intended to face the interior of the freezer and a second opening (11b) intended to face the exterior and a primary axis (12) extending between the first (11a) and second (11b) openings, so that, in the mounted position, the length axis of the through member (9,10) is parallel to the primary axis (12) of the inner space of the insulation, where the insulating element (s) (1) is/are made from a material, which is resilient at temperatures below -150 degrees C, preferably below -200 degrees C, so that it is able to compensate for changes in the position of the through member (9,10), and

    a contact surface (4) provided on an inside of the annular tube shaped insulation facing the through member (9,10) in the mounted position, the contact surface (4) being wear resistant and non-abrasive, to prevent surface damage due to relative motion between the contact surface (4) and the through member (9,10) during the rotation of the through member (9,10).

2. A sealing device (300) according to claim 1, wherein the contact surface (4) is formed on a separate receiving member (7) adapted for receiving the through member (9,10) and for holding the insulating element (s) (1), the receiving member (7) preferably being a pipe made from a polymer.

3. A sealing device (300) according to claim 1 or 2, wherein the annular tube shaped insulation comprises two or more insulating elements (1) positioned in series seen in the direction of the primary axis (12).

4. A sealing device (300) according to anyone of the preceding claims, wherein a textile web insert (2), such as felt, is provided between insulating elements (1).

5. A sealing device (300) according to anyone of the preceding claims, wherein the receiving member (7) is a formed as a mat made of a textile web.

6. A sealing device (300) according to anyone of the preceding claims, further comprising attachment means (61, 62) for attaching the sealing device (300) to the freezer wall.

7. A sealing device (300) according to anyone of the preceding claims, wherein the sealing device (300) is adapted to be mounted from the exterior side of the freezer.

8. A sealing device (300) according to anyone of the preceding claims, wherein a textile web material constitutes the contact surface (4), said textile web material possibly being in the form of several discrete bearing members (8) such as rings encircling the primary axis or patches.

9. A sealing device (300) according to anyone of the preceding claims, wherein the insulating element(s) (1) is/are made from a foam material.

10. A system comprising a sealing device (300) according to any one of claims 1-9,
a rotatable through member (9,10), in the form of an

axle, and
a freezer wall (13;14) forming a part of a freezer able to operate at temperatures below -150 degrees C, preferably below -200 degrees C.

11. A system according to claim 12, wherein the freezer wall comprises an inner wall (14) an outer wall (13) and an insulation material (15) there between.

12. A system according to anyone of claims 10 or 11, wherein a textile web (8) is provided on the outside of the through member (9, 10).

13. A system according to anyone of claims 10 to 12, wherein the through member (9, 10) is a carbon fibre axle.

14. A system according to claim 10 to 13, further comprising a paternoster system drivable via the rotatable through member (9, 10) and adapted for being positioned inside the freezer.

15. Use of a sealing device (300) according to any one of claims 1-9 for sealing an interface between a wall (13,14,15) of a freezer operating at temperatures below -150 degrees C, preferably below -200 degrees C, and a rotatable through member (9, 10).

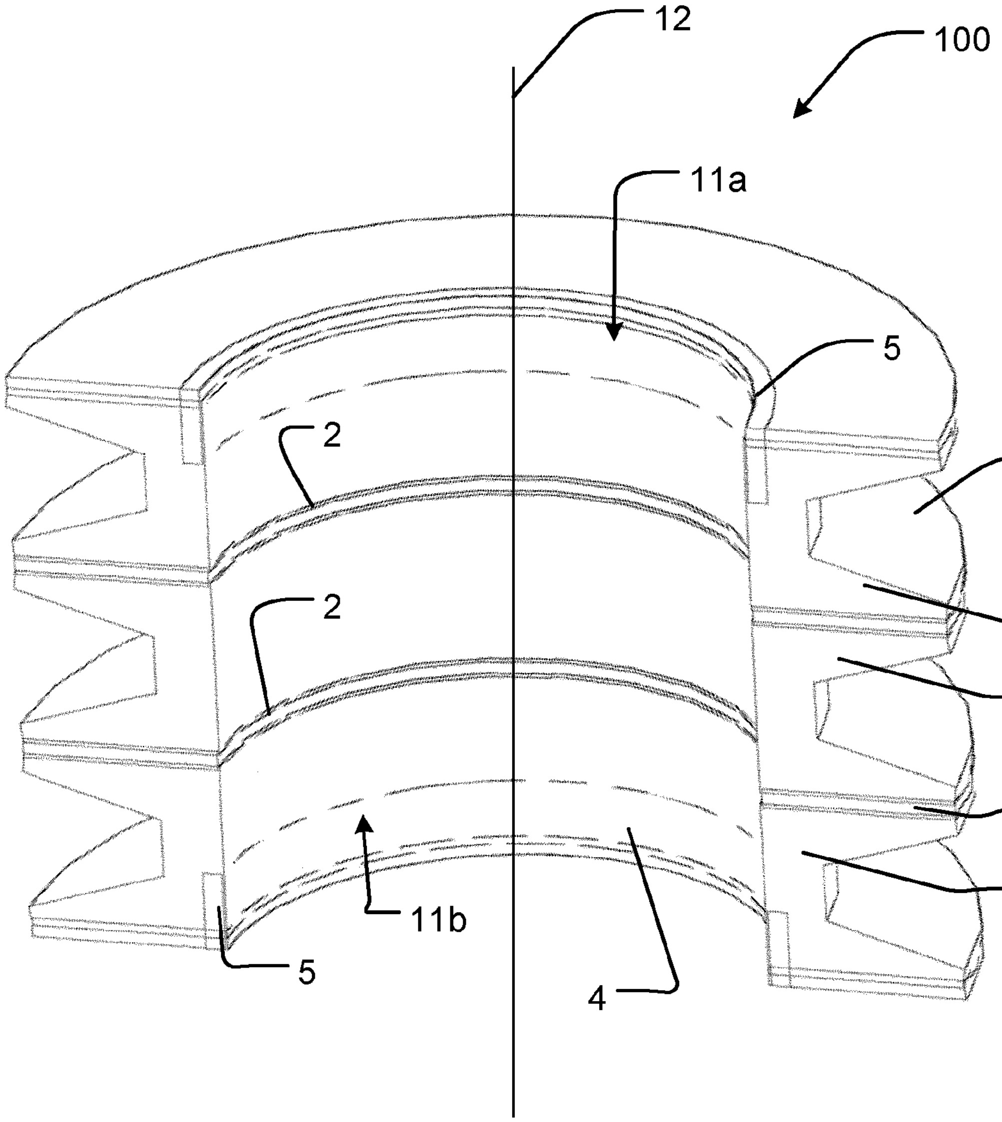

Fig. 1

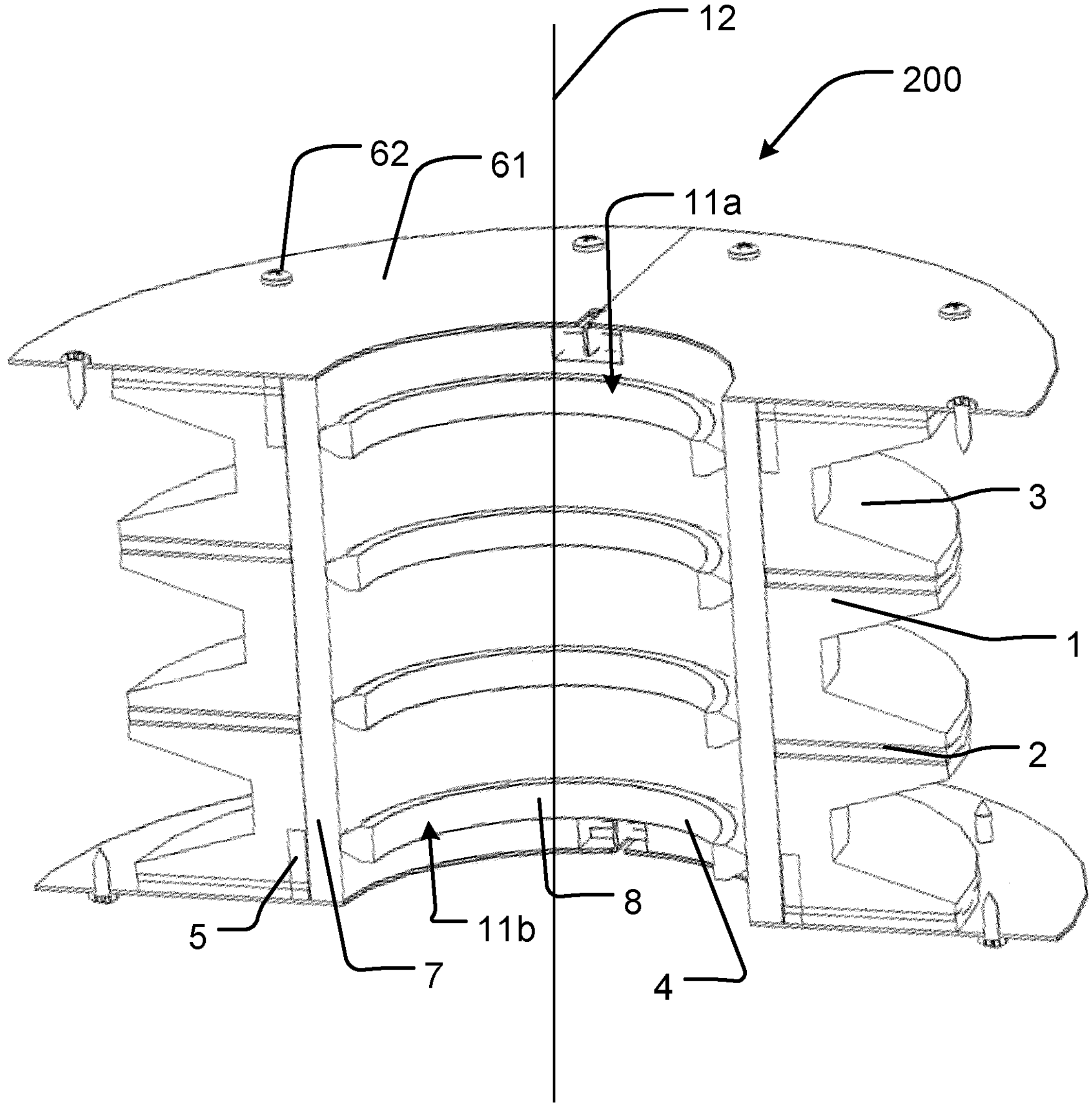

Fig. 2

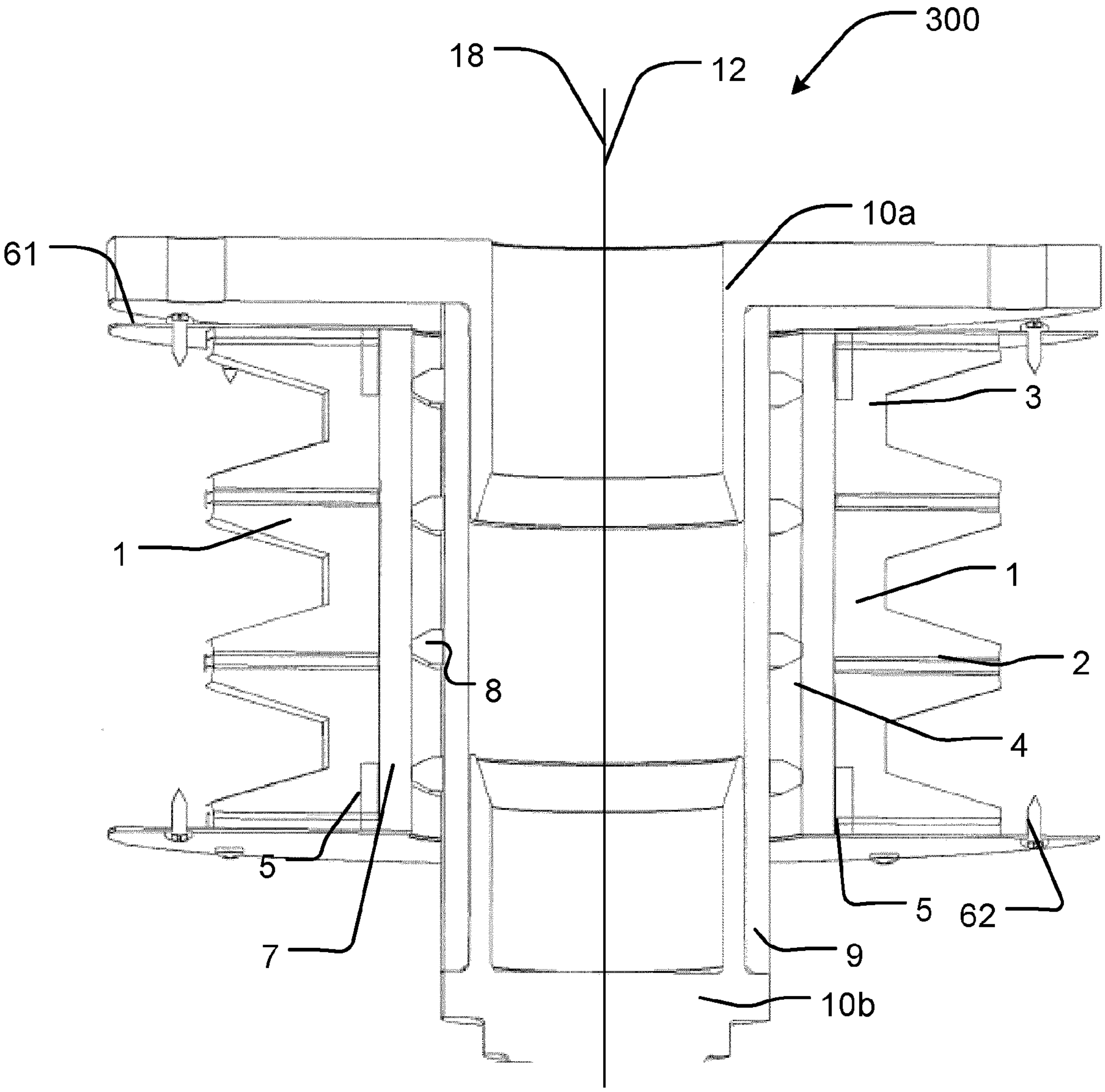

Fig. 3

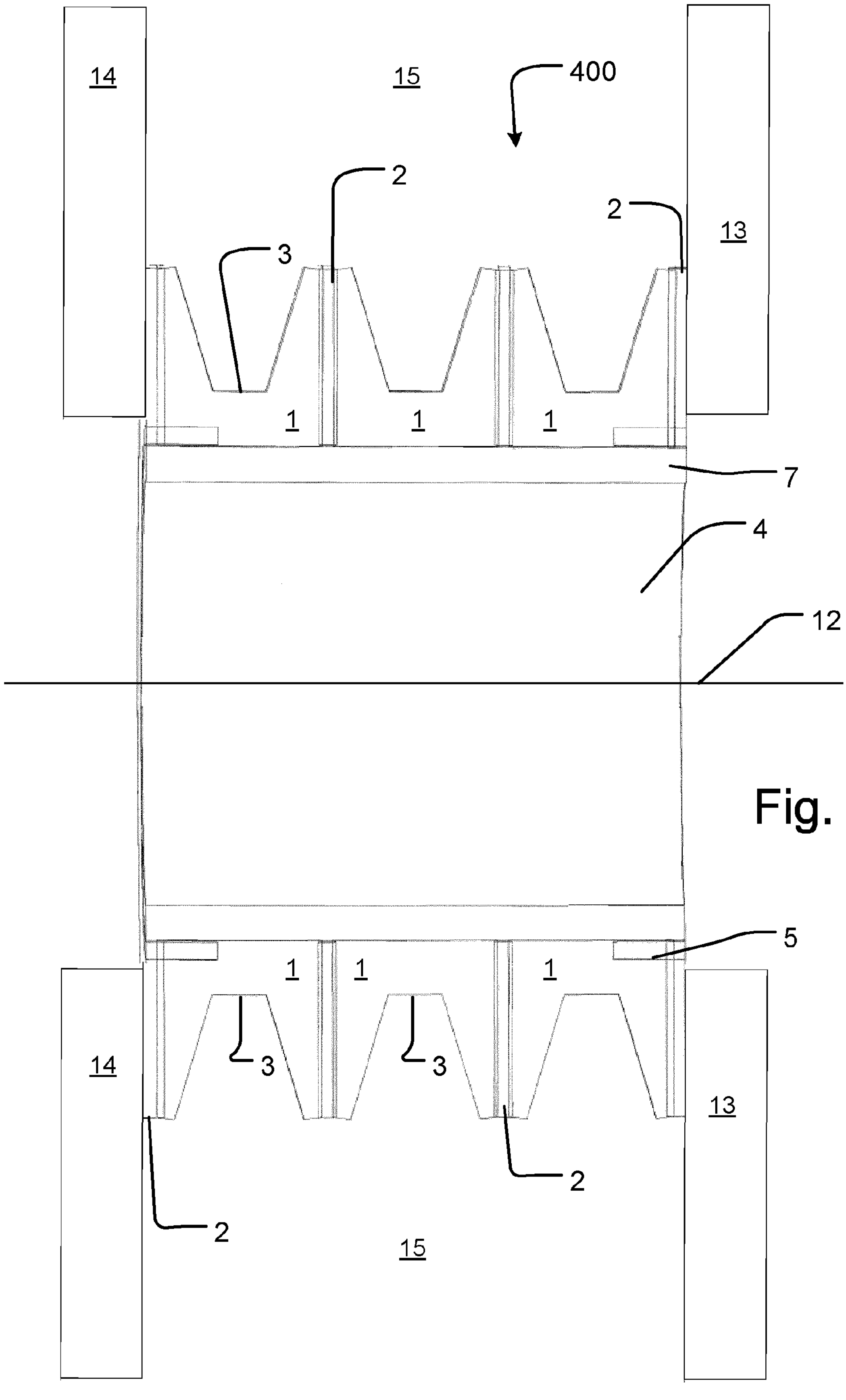

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 11 19 2563

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

F25D
F16L

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	19 April 2012	Amous, Moez

CATEGORY OF CITED DOCUMENTS

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