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(54) LAUNDRY WASHING MACHINE

(57) A laundry washing machine (1) having an outer casing (2) and comprising, inside said outer casing (2): a washing tub (3) adapted to contain the washing liquid; a rotatable drum (4) which is fitted in axially rotatable manner inside the washing tub (3) and is adapted to contain the laundry to be washed; and at least one ball balancing ring (13) which is rigidly secured to the rotatable drum (4) for reducing the vibrations of the drum (4); said at least one ball balancing ring (13) comprises: a nearly toroidal, annular housing (15) which is rigidly secured to the drum (4) and has a tubular structure with a substantially polygonal-shaped, transversal cross-section, so as to delimit a closed annular inner cavity (16) with a substantially polygonal-shaped cross-section; and a number of balancing masses (17) accommodated in free movable manner inside said annular inner cavity (16) together with a dumping liquid that damps out the movement of the balancing masses (17) inside the same annular inner cavity (16); the polygon defining/resembling the shape of the transversal cross-section of the annular housing (15) having a first (25) and a second (26) consecutive sides that are located substantially astride of a midplane (P) of the annular housing (15), opposite to a central axis (B) of the annular housing (15), are inclined to one another and are both non-perpendicular to the same midplane (P).

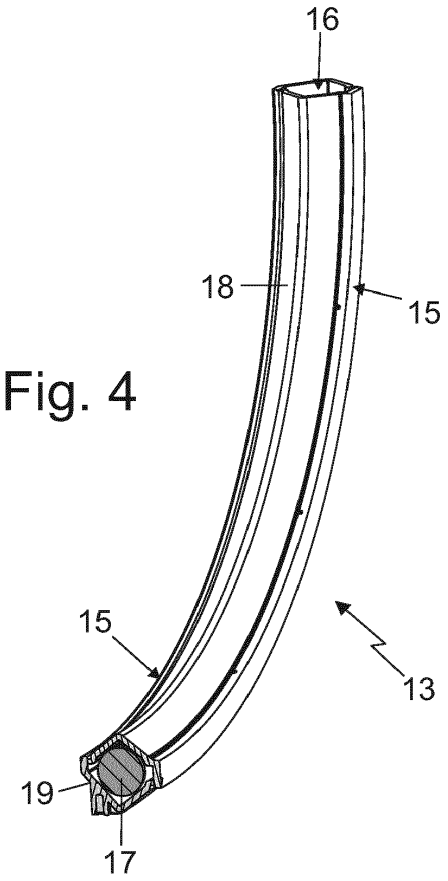

Fig. 4

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Description

[0001] The present invention relates to a laundry washing machine.

[0002] More in detail, the present invention relates to a front-loading home laundry washing machine, to which the following description specifically refers purely by way of example without this implying any loss of generality.

[0003] As is known, a front-loading home laundry washing machine generally comprises: a substantially parallelepiped-shaped, self-supporting boxlike outer casing structured for resting on the floor; a substantially horizontally-oriented and nearly cylindrical, cup-shaped washing tub which, in use, contains the washing liquid and is suspended in floating manner inside the casing, with the front mouth directly facing a laundry loading-unloading through opening formed in the front wall of the casing; a substantially cylindrical, cup-shaped rotatable drum which is structured for accommodating the laundry to be washed, and is fitted in axially rotatable manner inside the washing tub with the concavity facing the laundry loading-unloading opening, so as to be able to freely rotate inside the washing tub about its substantially horizontally-oriented, central axis locally coinciding with the longitudinal axis of the washing tub; an elastically-deformable bellows which watertight connects the front mouth of the washing tub to the laundry loading-unloading opening formed in the front wall of the casing; a porthole door which is hinged to the front wall of the casing to rotate to and from a closing position in which the door closes the laundry loading-unloading opening in the front wall of the casing for watertight sealing the washing tub; and an electrically-powered motor assembly which is structured for driving into rotation the rotatable drum about its longitudinal axis inside the washing tub.

[0004] To reduce vibrations of the drum during spin phases with unbalance loads, today's high end laundry washing machines are additionally provided with at least one and usually two ball balancing rings which are rigidly secured to the drum body perfectly coaxial to the drum rotation axis.

[0005] More specifically, each ball balancing ring is substantially circular in shape and is usually secured to the drum body, outside of the drum and adjacent to the front or rear rim of the drum cylindrical wall, coaxial to the drum rotation axis.

[0006] Each ball balancing ring moreover basically comprises: a rigid, hollow toroidal housing having inside a perfectly circular, closed annular inner cavity; and a number of heavy spherical masses accommodated in free movable manner inside the inner cavity of the toroidal housing together with a viscous liquid that damps out the movement of the spherical masses inside the inner cavity.

[0007] The toroidal housing is secured to the drum body perfectly coaxial to the drum rotation axis, so that the annular inner cavity lies/extends on a plane perfectly perpendicular to the drum rotation axis.

[0008] During spin phases, the spherical masses tend to group together and to move altogether inside the inner cavity so as to balance the unbalanced load (laundry) momentarily placed inside the drum.

[0009] EP1862577 A2 discloses a front-loading laundry wherein the annular inner cavity of the toroidal housing has a nearly rectangular, uniform cross-section, and wherein the hollow toroidal housing is divided into two discrete and complementary annular members that are made of plastic material and are fused together.

[0010] More in detail the first annular member has a nearly U-shaped cross section with the two opposite and concentric lateral walls extending perpendicular to the midplane of the toroidal housing (i.e. the plane perpendicular to the central axis of the torus and containing the geometric barycentres of all the transversal/poloidal cross-sections of the torus), whereas the second annular member has a nearly plate-like annular structure and is welded in abutment against the inner and outer annular rims/ edges of the first annular member, so as to fluid-tight close the annular opening of the circular groove delimited by the first annular member.

[0011] The first annular member therefore extends astride of the mid plane of the toroidal housing, whereas the second annular member lies/extends on a lying plane parallel and spaced apart from the midplane of the toroidal housing.

[0012] The main drawback of this structure is that, during spin phases, each spherical mass is allowed to freely move, on surface of the cylindrical outer wall of the first annular member, even in a direction parallel to the drum rotation axis. Therefore it may happens that, during a spin phase, the spherical masses group together while misaligning along the circumferential direction, with all problems that this entails.

[0013] The spherical masses, in fact, start moving on different orbital planes that are parallel and slightly spaced to one another, thus causing small mechanical vibrations that increases together with rotation speed and became extremely noisy when rotation speed rises above 1200 rpm.

[0014] Aim of the present invention is to realize a ball balancing ring capable of operating at high drum rotation speeds without the drawbacks referred above.

[0015] In compliance with the above aims, according to the present invention there is provided a laundry washing machine having an outer casing and comprising, inside said outer casing: a washing tub adapted to contain the washing liquid; a rotatable drum which is fitted in axially rotatable manner inside the washing tub and is adapted to contain the laundry to be washed; and at least one balancing ring which is rigidly secured to the rotatable drum for reducing the vibrations of the drum;

said at least one balancing ring comprising: a substantially toroidal, annular housing which is rigidly secured to the drum and has a tubular structure so as to delimit a closed annular inner cavity with a substantially polygonal-shaped cross-section; and a number of balancing mass-

es accommodated in free movable manner inside said annular inner cavity;

the laundry washing machine being **characterized in that** the transversal cross-section of the annular inner cavity has, opposite to the central axis of said annular housing, a first and a second consecutive sides that are located substantially astride of a midplane of the annular housing perpendicular to the central axis, are inclined to one another and are both non-perpendicular to the same midplane.

[0016] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the axis around which the drum rotates is horizontal, or slightly inclined, with respect to the plane where the machine rests in its working position.

[0017] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the transversal cross-section of said annular inner cavity additionally has a third and a fourth consecutive sides which are located substantially astride of the midplane, opposite to said first and second consecutive sides, are inclined to one another and are both non-perpendicular to said midplane.

[0018] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the first and the second consecutive sides of the transversal cross-section of the annular inner cavity are inclined with respect to the midplane by an angle lower than 90°, and preferably ranging between 30° and 75°.

[0019] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the transversal cross-section of the annular inner cavity is substantially rhomboidal in shape.

[0020] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the transversal cross-section of the annular inner cavity has at least five sides.

[0021] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the transversal cross-section of the annular inner cavity has roughly the shape of an irregular hexagon.

[0022] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the annular housing has a tubular structure with a substantially polygonal-shaped, transversal cross-section.

[0023] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the annular housing includes an inner annular hemishell and an outer annular hemishell which are discrete and complementary to one another, extend astride of the midplane of the annular housing, are concentric to one another and are finally joined to one another so as to form/delimit the annular inner cavity of said annular housing.

[0024] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the transversal cross-section of the outer annular hemishell includes the first and second consecutive sides of the polygon defining/resembling the transversal cross-section of said annular housing.

[0025] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the transversal cross-section of the inner annular hemishell includes the third and fourth consecutive sides of the polygon defining/resembling the transversal cross-section of said annular housing.

[0026] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the transversal cross-section of said outer annular hemishell has a substantially C-shaped, curved polygonal-chain profile.

[0027] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the transversal cross-section of said inner annular hemishell has a substantially C-shaped, curved polygonal-chain profile.

[0028] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the curved polygonal chain has three or more straight line segments connected and inclined to one another.

[0029] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that said inner annular hemishell and said outer annular hemishell are stably joined/coupled to one another along corresponding first and second mating annular rims/edges.

[0030] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that said first and second mating annular rims/edges are arranged on opposite sides of midplane of said annular housing.

[0031] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that said inner and said outer annular hemishells are made of plastic material and are reciprocally welded along said first and second mating annular rims/edges.

[0032] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the outer annular hemishell has a first wall segment and a second wall segment nearly faced and non-parallel to one another, and a third wall segment connecting the first wall segment to the second wall segment; the first annular rim/edge of the outer annular hemishell edging the first wall segment of said outer annular hemishell; the second annular rim/edge of the outer annular hemishell edging the second wall segment of said outer annular hemishell.

[0033] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the inner annular hemishell has a first wall segment and a second wall segment nearly faced and non-parallel to one another, and a third wall segment connecting the first wall segment to the second wall segment; the first annular rim/edge of the inner annular hemishell edging the first wall segment of said first annular hemishell; the second annular rim/edge of the inner annular hemishell

edging the second wall segment of said inner annular hemishell.

[0034] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the outer annular hemishell is adapted to firmly abut on the drum.

[0035] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the outer annular hemishell is provided with a number of fixing protrusions which are angularly spaced about the central axis and extend outwards in a nearly radial direction so as to stably abut against the drum.

[0036] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the balancing ring includes, inside the annular inner cavity a dumping liquid that damps out the movement of the balancing masses inside the same annular inner cavity.

[0037] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the balancing ring is rigidly secured directly to the cylindrical wall of the drum.

[0038] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the balancing ring is located inside the drum.

[0039] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that the balancing masses are spherical in shape.

[0040] A non-limiting embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

- Figure 1 is a side view of a laundry washing machine realized in accordance with the teachings of the present invention, sectioned along the midplane of the washing machine and with parts removed for clarity;
- Figures 2 is an enlarged view of part of the laundry washing machine shown in Figure 1, with parts removed for clarity;
- Figures 3 is a front view of one of the balancing rings of the laundry washing machine shown in Figures 1 and 2;
- Figure 4 is an enlarged perspective view of a segment of the balancing ring shown in Figures 1, 2 and 3;
- Figures 5 is an enlarged side view of the balancing ring shown in Figures 3 and 4, sectioned along the midplane of the washing machine and with parts removed for clarity;
- Figure 6 is an exploded view of the toroidal hollow annular housing of the balancing ring shown in the preceding figures, sectioned along the midplane of the washing machine.

[0041] With reference to Figures 1 and 2, reference number 1 denotes as a whole a laundry washing machine 1 preferably suitable for domestic use.

[0042] The laundry washing machine 1 basically comprises: a preferably substantially parallelepiped-shaped, self-supporting boxlike outer casing 2 structured for stably resting on the floor; a preferably substantially cylindrical, washing tub 3 which, in use, contains the washing liquid and is arranged inside the casing 2 with its mouth directly facing a laundry loading-unloading opening formed on the casing 2; a substantially cylindrical, hollow rotatable drum 4 which is structured for accommodating the laundry to be washed, and is fitted in axially rotatable manner inside the washing tub 3 so as to be able to freely rotate about its longitudinal/central axis A inside the washing tub 3; a door 5 which is hinged to the outer casing 2 so as to be manually movable to and from a closing position (see Figure 1) in which the door 5 closes the laundry loading-unloading opening on the boxlike casing 2 for watertight sealing the washing tub 3; and an electrically-powered motor assembly 6 which is structured for driving into rotation the rotatable drum 4 about its longitudinal axis A inside the washing tub 3.

[0043] Moreover the laundry washing machine 1 comprises, inside the outer casing 2, a detergent dispenser 7 and a fresh-water supply circuit 8.

[0044] The detergent dispenser 7 is preferably located inside the outer casing 2 above the washing tub 3 and preferably, though not necessarily, immediately underneath an upper worktop or top wall of casing 2, and is structured for selectively feeding into the washing tub 3, preferably according to a washing cycle manually-selected by the user, a given amount of detergent, softener and/or other washing agent suitably mixed with water.

[0045] The fresh-water supply circuit 8, in turn, is directly connected/connectable to the water mains, and is structured for selectively channelling, preferably according to the washing cycle manually-selected by the user, a flow of water from the water mains to the detergent dispenser 7 and/or directly to the washing tub 3.

[0046] In the example shown, in particular, the washing tub 3 is preferably substantially cup-shaped, is preferably arranged substantially horizontally inside the outer casing 2, and is preferably provided with a nearly circular front mouth that directly faces a complementary-shaped, laundry loading-unloading opening formed on a front wall 9 of casing 2.

[0047] With reference to Figure 1, the door 5, in turn, is preferably hinged to the front wall 9 so as to be manually movable, preferably about a nearly vertically-oriented rotation axis, to and from a closing position in which the door 5 closes the laundry loading-unloading opening on front wall 9 for watertight sealing the washing tub 3.

[0048] Furthermore, the washing tub 3 is preferably suspended in floating manner inside the boxlike casing 2 via a suspension system that preferably comprises at least one, and preferably a couple of coil springs 10 connecting the upper portion of washing tub 3 to the top of casing 2, and preferably at least one and more conveniently a couple of vibration dampers 11 connecting the bottom portion of washing tub 3 to the bottom of casing 2.

[0049] Preferably the laundry washing machine 1

moreover comprises an elastically-deformable tubular bellows 12 that watertight connects the front mouth of washing tub 3 to the laundry loading-unloading opening formed on the front wall 9 of boxlike casing 2.

[0050] The rotatable drum 4, on the other hand, is preferably substantially cup-shaped and is fitted in axially rotatable manner inside the washing tub 3 with its concavity facing the front mouth of washing tub 3. Preferably the rotatable drum 4 is furthermore arranged inside washing tub 3 with the drum rotation axis A locally substantially coaxial to the longitudinal axis of washing tub 3, and with its nearly circular front mouth directly aligned and faced to the front mouth of washing tub 3, so as to receive the laundry to be washed through the laundry loading-unloading opening present on front wall 9. In other words, the drum rotation axis A is preferably substantially horizontal.

[0051] With reference to Figures 1, 2 and 3, laundry washing machine 1 additionally comprises at least one balancing ring 13 which is discrete from rotatable drum 4, is rigidly secured to the rotatable drum 4 substantially coaxial to the drum rotation axis A, and is adapted to minimize/reduce the vibrations produced by drum 4 when rotating at high speed about the rotation axis A while accommodating an unbalance load of laundry.

[0052] More in detail, the/each balancing ring 13 is substantially circular in shaped, and is preferably accommodated inside of drum 4 coaxial to drum rotation axis A. Preferably the/each balancing ring 13 is furthermore rigidly secured directly to the cylindrical wall 14 of drum 4.

[0053] In the example shown, in particular, laundry washing machine 1 is preferably provided with two balancing rings 13 which are rigidly secured to the body of rotatable drum 4, preferably inside the drum 4 and preferably adjacent to the front and rear rims of the cylindrical wall 14 of drum 4.

[0054] With reference to Figures 2, 3, 4 and 5, the/each balancing ring 13 basically comprises: a substantially toroidal, rigid annular housing 15 which is adapted to be rigidly secured to the body of drum 4, or rather to the cylindrical wall 14 of drum 4, so that its central axis B substantially coincides with the drum rotation axis A, and has a tubular structure so as to delimit, inside itself, a closed annular cavity 16 which is circular in shape, is coaxial to central axis B and preferably has a substantially uniform cross-section; a number of heavy balancing masses 17 that are accommodated in free movable manner inside the inner cavity 16 of annular housing 15; and a dumbing liquid (not shown in the figures) that fills up, preferably completely, the inner cavity 16 of toroidal annular housing 15 for damping out the movement of the balancing masses 17 inside the annular inner cavity 16.

[0055] More in detail, the balancing masses 17 are preferably spherical in shape so as to roll on the inner surface of the hollow annular housing 15, and are preferably made of metal material. Preferably, the balancing masses 17 are moreover dimensioned so as to take up more than 50% of the transversal cross-section of the annular inner cavity 16. The dumbing liquid, in turn, is preferably a silicon-based liquid and/or preferably has a viscosity higher than 200 cSt.

[0056] It is to be understood that, in toroidal geometry, a transversal cross-section of the torus is a section of the torus according to a cutting plane which extends radially from the central axis of the torus and is, at same time, perpendicular to any plane perpendicular to the central axis of the torus, whereas the midplane or equatorial plane of the torus is the plane perpendicular to the central axis of the torus and containing the geometric barycentres of all the transversal cross-sections of the torus.

[0057] With particular reference to Figures 2, 4 and 5, the hollow annular housing 15, in turn, is shaped/structured so that the transversal cross-section of its annular inner cavity 16 is substantially polygonal in shape. Furthermore the preferably irregular, simple polygon defining/resembling the shape of the transversal cross-section of inner cavity 16 has at least a first and a second consecutive sides which are located substantially astride of the midplane P of the annular housing 15 (i.e. the plane perpendicular to central axis B and containing the geometric barycentres of almost all the transversal cross-sections of annular housing 15), opposite to the central axis B, are inclined to one another and are both non-perpendicular to the midplane P. Said first and second consecutive sides of the polygon therefore form, on the outer toroidal sector of the annular inner cavity 16, an annular race which has a nearly V-shaped cross-section and lies on a plane perfectly parallel to the midplane P.

[0058] In the example shown, furthermore the transversal cross-section of annular housing 15 is preferably substantially polygonal in shape and complementary to that of inner cavity 16.

[0059] In other words, the preferably irregular, simple polygon defining/resembling the shape of the transversal cross-section of annular housing 15 has at least a first and a second consecutive sides which are located substantially astride of the midplane P of the annular housing 15, opposite to the central axis B, are inclined to one another and are both non-perpendicular to the midplane P. Said first and second consecutive sides of the polygon therefore form, on the outer toroidal sector of the outer wall of annular housing 15, an annular race which has a nearly V-shaped cross-section and lies on a plane perfectly parallel to the midplane P.

[0060] More in detail, both said first and second consecutive sides of the polygon defining/resembling the transversal cross-section of annular inner cavity 16, or rather of annular housing 15, are inclined with respect to the midplane P by an angle lower than 90°, and preferably also ranging between 30° and 75°.

[0061] Preferably the polygon defining/resembling the transversal cross-section of inner cavity 16, or rather of annular housing 15, additionally has at least a third and a fourth consecutive sides that are located substantially astride of the midplane P, opposite to said first and second consecutive sides and thus directly faced to central

axis B, are inclined to one another and are both non-perpendicular to the midplane P.

[0062] More in detail, both said third and fourth consecutive sides of the polygon defining/resembling the transversal cross-section of inner cavity 16, or rather of annular housing 15, are inclined with respect to the midplane P by an angle lower than 90°, and preferably also ranging between 30° and 75°.

[0063] Therefore, the polygon defining/resembling the transversal cross-section of inner cavity 16, or rather of annular housing 15, preferably has at least four sides which are consecutive in pairs and are inclined with respect to the midplane P by respective angles lower than 90°, and preferably also ranging between 30° and 75°.

[0064] In other words, the transversal cross-section of inner cavity 16, or rather of annular housing 15, is preferably substantially rhomboidal in shape.

[0065] Moreover, the polygon defining/resembling the transversal cross-section of inner cavity 16, or rather of annular housing 15, preferably has at least five sides.

[0066] Preferably each of the sides of polygon defining/resembling the shape of the transversal cross-section of inner cavity 16, or rather of annular housing 15, is furthermore non-perpendicular to the midplane P of the annular housing 15.

[0067] More in detail, in the example shown the transversal cross-section of inner cavity 16, or rather of annular housing 15, preferably has approximately the shape of an irregular hexagon.

[0068] In addition to the above, with reference to Figures 4, 5 and 6, the toroidal annular housing 15 is preferably divided into, or at least includes, two discrete and complementary annular hemishells 18 and 19 that are preferably substantially coplanar and concentric to one another, and are watertight joined/coupled to one another so as to form/delimit the annular inner cavity 16.

[0069] More specifically, both annular hemishells 18 and 19 preferably extend astride of the midplane P of annular housing 15 and the annular hemishell 19 surrounds the annular hemishell 18.

[0070] The transversal cross-section of outer annular hemishell 19, therefore, includes the first and second consecutive sides of the polygon defining/resembling the transversal cross-section of annular housing 15.

[0071] The transversal cross-section of inner annular hemishell 18, in turn, preferably includes the third and fourth consecutive sides of the polygon defining/resembling the transversal cross-section of annular housing 15.

[0072] More in detail, with reference to Figures 5 and 6, in the example shown the transversal cross-section of both annular hemishells 18 and 19 preferably has a substantially C-shaped, curved polygonal-chain profile.

[0073] In other words, the transversal cross-section of both annular hemishells 18 and 19 basically consists of a series of straight line segments connected and inclined to one another so as to resemble a C.

[0074] Preferably the straight line segments of said substantially C-shaped, curved polygonal-chain profile moreover have lengths different to one another.

[0075] In the example shown, in particular, the curved polygonal-chain profile of the transversal cross-section of outer annular hemishell 19 preferably includes three straight line segments connected and inclined to one another. Obviously the straight line segments of the curved polygonal-chain may include more than three straight line segments connected and inclined to one another.

[0076] Similarly the curved polygonal-chain profile of the transversal cross-section of annular hemishell 18 preferably includes three straight line segments connected and inclined to one another. Also in this case, the straight line segments of the curved polygonal-chain may include more than three straight line segments connected and inclined to one another.

[0077] Furthermore, with reference to Figures 2, 4, 5 and 6, the annular hemishells 18 and 19 are stably joined/coupled to one another along corresponding mating annular rims/edges 18a, 19a and 18b, 19b that are preferably located on opposite sides of the midplane P of annular housing 15.

[0078] In other words, the inner annular hemishell 18 preferably has an approximately C-shaped cross section with the concavity facing the annular hemishell 19, i.e. opposite to central axis B, and the two annular rims/edges 18a and 18b delimiting the annular groove/channel of hemishell 18 are located on opposite sides of the midplane P.

[0079] The outer annular hemishell 19, in turn, preferably has an approximately C-shaped cross section with the concavity facing the central axis B and the annular hemishell 18, and the two annular rims/edges 19a and 19b delimiting the annular groove/channel of hemishell 19 are located on opposite sides of the midplane P. The outer annular hemishell 19, furthermore, encircles the inner annular hemishell 18 so that its two annular rims/edges 19a and 19b area aligned and stably coupled/joined each to a respective facing annular rim/edge 18a, 18b of annular hemishell 18.

[0080] In addition to the above, the annular hemishells 18 and 19 are preferably made of plastic material and are stably fused/joined to one another preferably via vibration welding.

[0081] More in detail, the two annular rims/edges 18a and 18b of annular hemishell 18 are preferably stably joined/fused to the corresponding mating annular rims/edges 19a and 19b of annular hemishell 19 by vibration welding.

[0082] According to an alternative embodiment, however, the two annular rims/edges 18a and 18b of annular hemishell 18 may be stably joined to the mating annular rims/ edges 19a and 19b of annular hemishell 19 by gluing.

[0083] With reference to Figure 6, in the example shown, in particular, the inner annular hemishell 18 is preferably provided with a first wall segment 21 and a second wall segment 22 nearly faced and non-parallel to one another, and a third wall segment 23 connecting

the first wall segment 21 to the second wall segment 22.

[0084] The first annular rim/edge 18a of annular hemishell 18 edges the first wall segment 21 of annular hemishell 18, whereas the second annular rim/edge 18b of annular hemishell 18 edges the second wall segment 22 of annular hemishell 18.

[0085] Moreover the consecutive wall segments 21 and 23 of annular hemishell 18 are preferably arranged substantially astride of the midplane P of annular housing 15, are inclined to one another and are both non-perpendicular to the midplane P. The wall segments 21 and 23 of annular hemishell 18 therefore correspond to the third and fourth consecutive sides of the preferably irregular, simple polygon defining/ resembling the transversal cross-section of annular housing 15.

[0086] Similarly, the outer annular hemishell 19 is preferably provided with a first wall segment 24 and a second wall segment 25 nearly faced and non-parallel to one another, and a third wall segment 26 connecting the first wall segment 24 to the second wall segment 25.

[0087] The first annular rim/edge 19a of annular hemishell 19 edges the first wall segment 24 of annular hemishell 19, whereas the second annular rim/edge 19b of annular hemishell 19 edges the second wall segment 25 of annular hemishell 19.

[0088] Preferably, the first wall segment 24 of outer annular hemishell 19 is moreover faced to the second wall segment 22 of inner annular hemishell 18. The second wall segment 25 of outer annular hemishell 19 is preferably faced to the first wall segment 21 of inner annular hemishell 18. The first wall segment 24 of outer annular hemishell 19 is furthermore faced to the second wall segment 22 of inner annular hemishell 18

[0089] Moreover the consecutive wall segments 25 and 26 of annular hemishell 19 are preferably arranged substantially astride of the midplane P of annular housing 15, are inclined to one another and are both non-perpendicular to the midplane P. The wall segments 25 and 26 of annular hemishell 19 therefore correspond to the first and second consecutive sides of the preferably irregular, simple polygon defining/ resembling the transversal cross-section of annular housing 15.

[0090] Additionally, with particular reference to Figure 6, the annular hemishells 18 and 19 are preferably shaped so that the two annular rims/edges 18a and 18b of annular hemishell 18 and the two annular rims/edges 19a and 19b of annular hemishell 19 are located/extend/lie on a same/common frustoconical surface which is coaxial to the central axis B of annular housing 15 and has an opening angle lower than 150°.

[0091] More in detail, the opening angle of said frustoconical surface preferably ranges between 20° and 70°. In other words, the generatrix f of the frustoconical surface makes an angle α with respect to central axis B preferably ranging between 10° and 35°.

[0092] In the example shown, in particular, the annular rims/edges 18a, 18b, 19a and 19b of the annular hemishells 18 and 19 are located/extend/lie on a frustoconical surface whose generatrix f is preferably inclined with respect to central axis B by an angle α roughly equal to 15°.

[0093] In other words, the opening angle of the frustoconical surface on which the annular rims/edges 18a, 18b, 19a and 19b of annular hemishells 18 and 19 lie is preferably equal to roughly 30°.

[0094] Finally, with reference to Figures 2, 3 and 5, the outer annular hemishell 19 of annular housing 15 is preferably structured to firmly rest/prop on the body of drum 4, or rather against the cylindrical wall 14 of drum 4, coaxial to drum rotation axis A.

[0095] More in detail, the outer annular hemishell 19 is preferably provided with a number of fixing protrusions 28 which are angularly spaced about the central axis B and extend outwards in a nearly radial direction so as to stably abut against the body of drum 4, or rather against the cylindrical wall 14 of drum 4.

[0096] Preferably, these fixing protrusions 28 are additionally coplanar to one another and substantially regularly spaced about the central axis B.

[0097] In the example shown, in particular, the fixing protrusions 28 are preferably regularly spaced about the central axis B and extend on a same/common reference laying plane which is substantially parallel to and offset from the midplane P of annular housing 15.

[0098] Preferably each fixing protrusion 28 is moreover adapted to be engaged by a preferably radially-extending, fixing screw 29 that extend in pass-through manner through the body of drum 4, or rather through the cylindrical wall 14 of drum 4.

[0099] More in detail, each fixing protrusion 28 is preferably provided with a radially-oriented, bling central hole adapted to be engaged by the threaded stem of the fixing screw.

[0100] Operation of laundry washing machine 1 is almost identical to that of any other laundry washing machine and therefore does not require further explanations.

[0101] As regards the balancing rings 13, during spin phases, the balancing masses 17 tend to group together and to move inside the annular inner cavity 16 of annular housing 15 so as to balance the unbalanced load, i.e. the laundry momentarily placed inside the drum 4.

[0102] The nearly v-shaped annular race formed on the outer toroidal sector of the wall of annular housing 15, in turn, keeps the balancing masses 17 perfectly coplanar to one another while they are moving at high speed along inside the annular inner cavity 16.

[0103] The advantages resulting from the particular structure of the toroidal hollow annular housing 15 are large in number.

[0104] First of all, the particular shape of the transversal cross-section of annular inner cavity 16 allows to keep the balancing masses 17 perfectly coplanar to one another while they are moving at high speed inside the toroidal hollow annular housing 15, thus avoiding all problems resulting from the misalignment long the circumferential

direction.

[0105] Moreover the particular shape of the transversal cross-section of annular housing 15 significantly increases the overall stiffness of the annular housing 15, thus minimizing the natural in-use deformations of annular housing 15, even when drum rotation speed rises far beyond 1000 rpm.

[0106] As a consequence, the laundry washing machine 1 is less noisy that today's laundry washing machines with traditional ball balancing rings.

[0107] Furthermore in balancing ring 13, each balancing mass 17 has now two spaced points of contact with the surface of annular hemishell 19, thus further reducing the noise of the balancing masses 17 rolling inside the inner annular cavity 16.

[0108] Finally, placing the first 18a, 19a and the second 18b, 19b mating annular rims/ edges of the annular hemishells 18 and 19 forming the toroidal annular housing 15 on opposite sides of the midplane of the annular housing 15 (i.e. on opposite sides of the midplane P) allows to greatly simplify the assembly process of the balancing ring 13 with the cost savings that this entails.

[0109] Clearly changes and modifications may be made to laundry washing machine 1 and to balancing ring 13 without, however, departing from the scope of the present invention.

[0110] For example, in a less sophisticated embodiment the balancing ring 13 may lack the dumbing liquid.

[0111] Moreover, the ball balancing ring or rings 13 may be firmly secured to the body of drum 4, outside of drum 4.

[0112] Furthermore, the front balancing ring 13 may be located/recessed into a specific annular seat formed in the front wall 30 of drum 4, obviously coaxial to drum longitudinal/rotation axis A.

[0113] Lastly, the fixing protrusions 28 may be replaced by a single outwards-protruding annular rib or ridge extending all around the annular hemishell 19.

Claims

1. A laundry washing machine (1) having an outer casing (2) and comprising, inside said outer casing (2): a washing tub (3) adapted to contain the washing liquid; a rotatable drum (4) which is fitted in axially rotatable manner inside the washing tub (3) and is adapted to contain the laundry to be washed; and at least one balancing ring (13) which is rigidly secured to the rotatable drum (4) for reducing the vibrations of the drum (4);
said at least one balancing ring (13) comprising: a toroidal annular housing (15) which is rigidly secured to the drum (4) and has a tubular structure so as to delimit a closed annular inner cavity (16) with a polygonal-shaped cross-section; and a number of balancing masses (17) accommodated in free movable manner inside said annular inner cavity (16);
the laundry washing machine (1) **being characterized in that** the transversal cross-section of the annular inner cavity (16) has, opposite to the central axis (B) of said annular housing (15), a first (25) and a second (26) consecutive sides that are located astride of a midplane (P) of the annular housing (15) perpendicular to the central axis (B), are inclined to one another and are both non-perpendicular to the same midplane (P).

2. Laundry washing machine according to Claim 1, wherein the transversal cross-section of said annular inner cavity (16) additionally has a third (21) and a fourth (23) consecutive sides which are located astride of the midplane (P), opposite to said first (25) and second (26) consecutive sides, are inclined to one another and are both non-perpendicular to said midplane (P).

3. Laundry washing machine according to Claim 1, wherein the first (25) and the second (26) consecutive sides of the transversal cross-section of the annular inner cavity (16) are inclined with respect to the midplane (P) by an angle lower than 90°, and preferably ranging between 30° and 75°.

4. Laundry washing machine according to Claim 2 or 3, wherein the transversal cross-section of the annular inner cavity (16) is rhomboidal in shape.

5. Laundry washing machine according to Claim 2, 3 or 4, wherein the transversal cross-section of the annular inner cavity (16) has at least five sides.

6. Laundry washing machine according to Claim 5, wherein the transversal cross-section of the annular inner cavity (16) has the shape of an irregular hexagon.

7. Laundry washing machine according to any one of the preceding claims, wherein the annular housing (15) has a tubular structure with a polygonal-shaped, transversal cross-section.

8. Laundry washing machine according to any one of the preceding claims, wherein the annular housing (15) includes an inner annular hemishell (18) and an outer annular hemishell (19) which are discrete and complementary to one another, extend astride of the midplane (P) of the annular housing (15), are concentric to one another and are finally joined to one another so as to form/delimit the annular inner cavity (16) of said annular housing (15).

9. Laundry washing machine according to Claim 8, wherein the transversal cross-section of the outer annular hemishell (19) includes the first (25) and second (26) consecutive sides of the polygon defin-

ing/resembling the transversal cross-section of said annular housing (15).

10. Laundry washing machine according to Claim 8 or 9, wherein the transversal cross-section of the inner annular hemishell (18) includes the third (21) and fourth (23) consecutive sides of the polygon defining/resembling the transversal cross-section of said annular housing (15).

11. Laundry washing machine according to Claim 8, 9 or 10, wherein the transversal cross-section of said outer annular hemishell (19) has a C-shaped, curved polygonal-chain profile.

12. Laundry washing machine according to Claim 8, 9, 10 or 11, wherein the transversal cross-section of said inner annular hemishell (18) has a C-shaped, curved polygonal-chain profile.

13. Laundry washing machine according to Claim 11 or 12, wherein the curved polygonal chain has three or more straight line segments connected and inclined to one another.

14. Laundry washing machine according to any one of Claim from 8 to 13, wherein said inner annular hemishell (18) and said outer annular hemishell (19) are stably joined/coupled to one another along corresponding first (18a, 19a) and second (18b, 19b) mating annular rims/edges.

15. Laundry washing machine according to Claim 14, wherein said first (18a, 19a) and second (18b, 19b) mating annular rims/edges are arranged on opposite sides of midplane (P) of said annular housing (15).

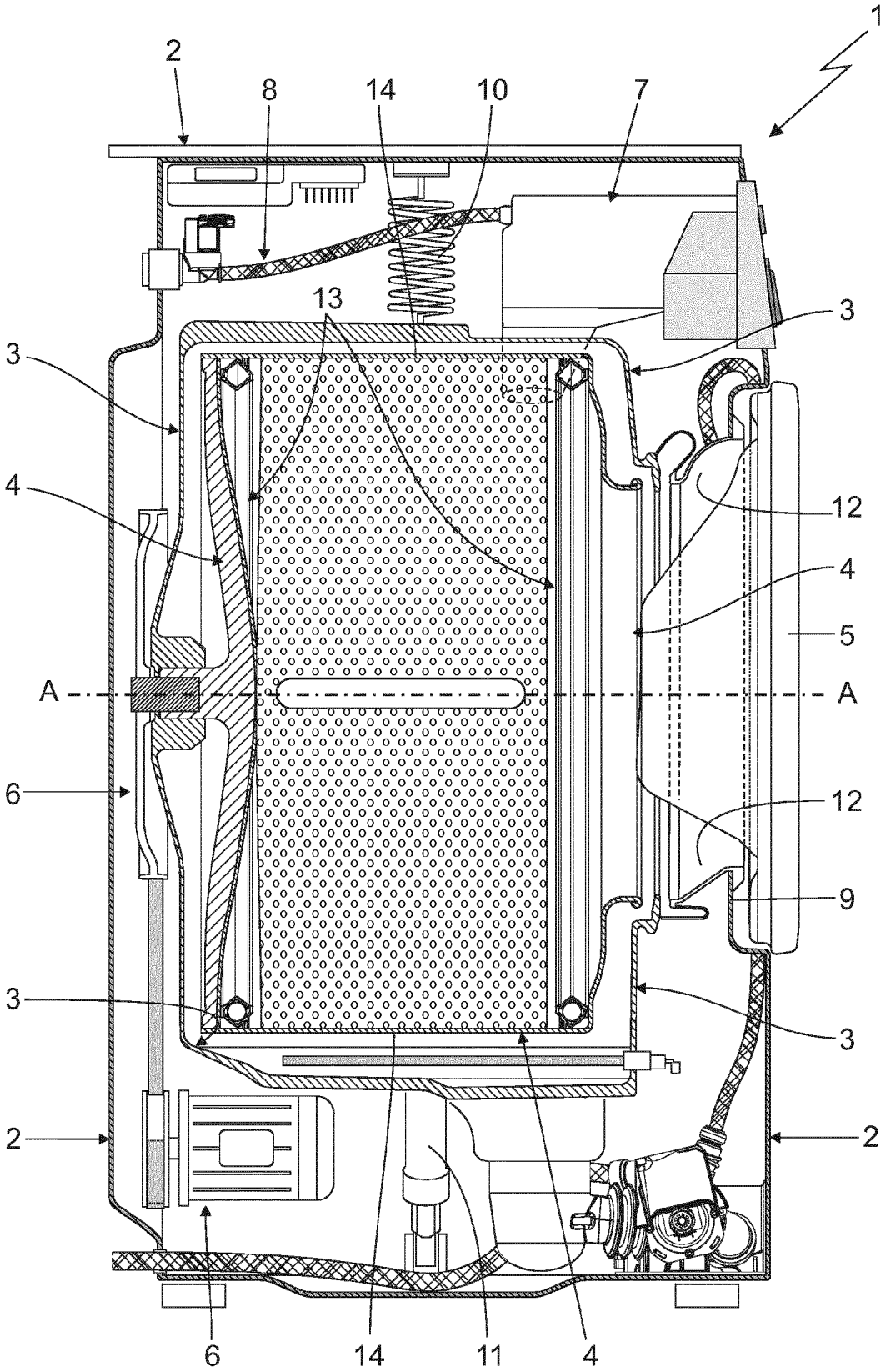

Fig. 1

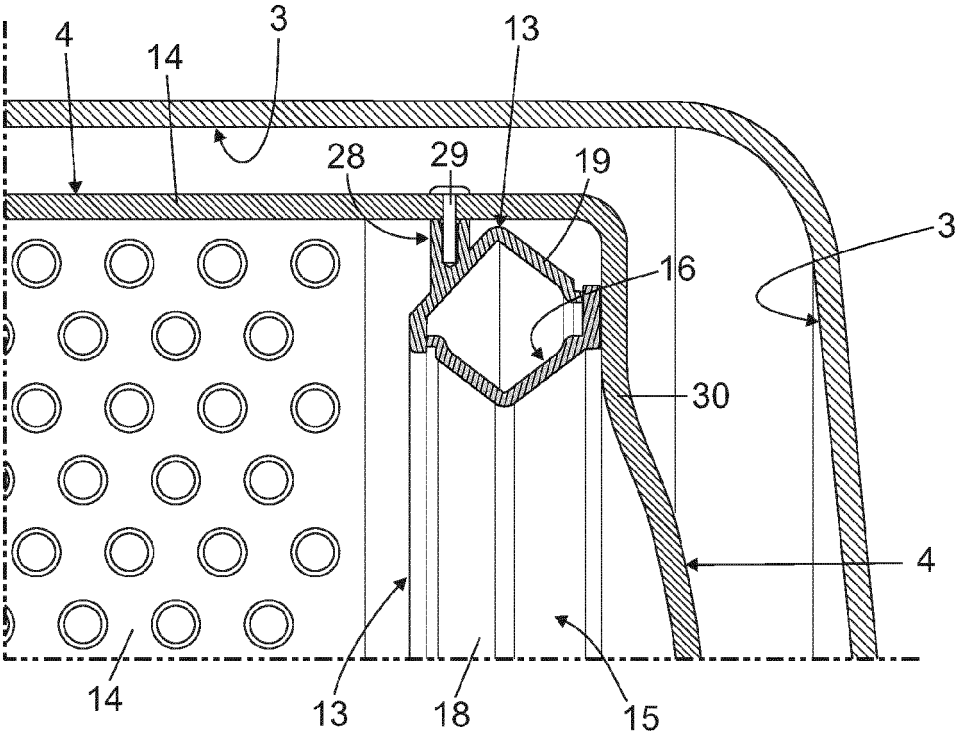
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Fig. 2

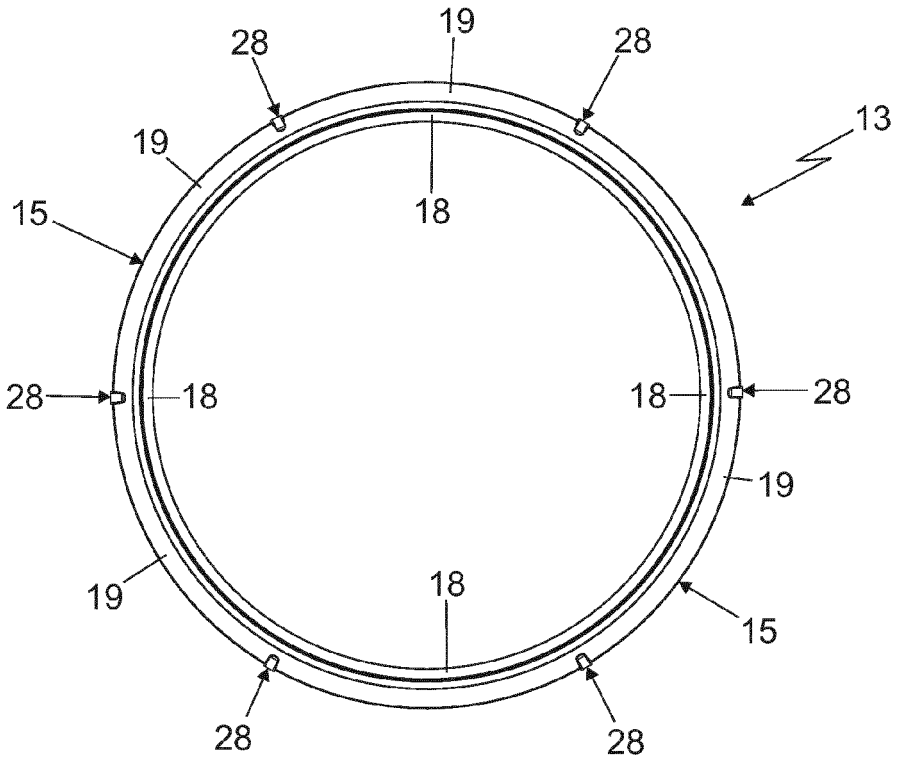
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Fig. 3

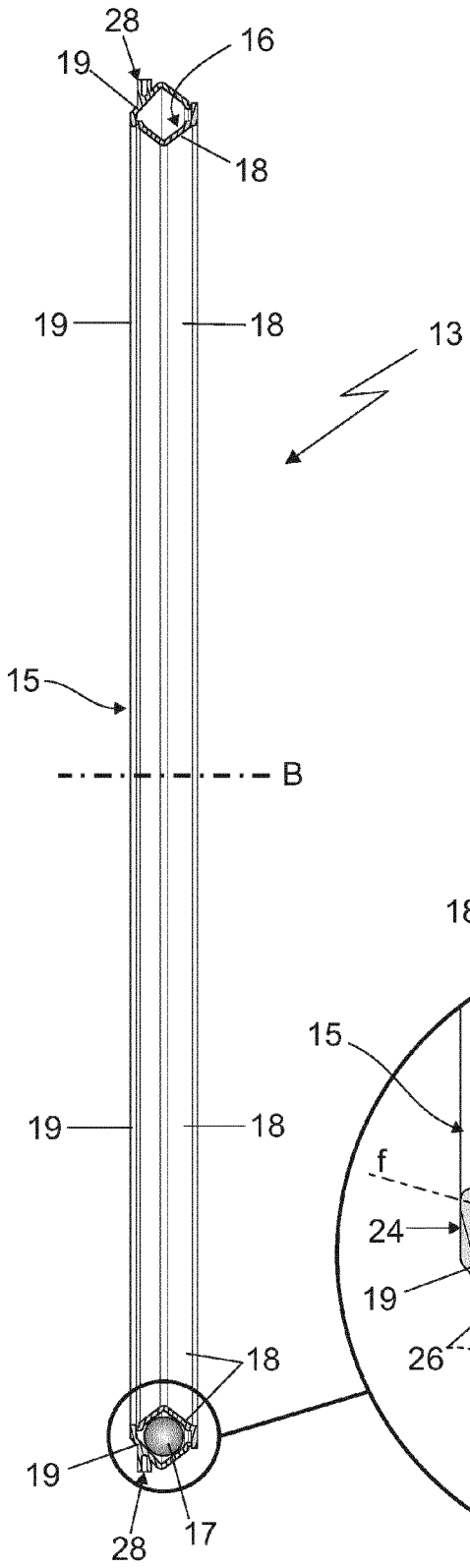
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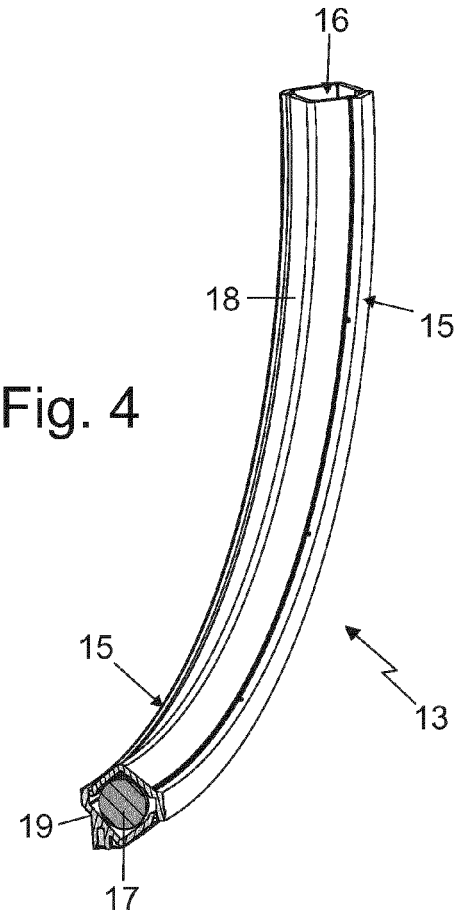
Fig. 4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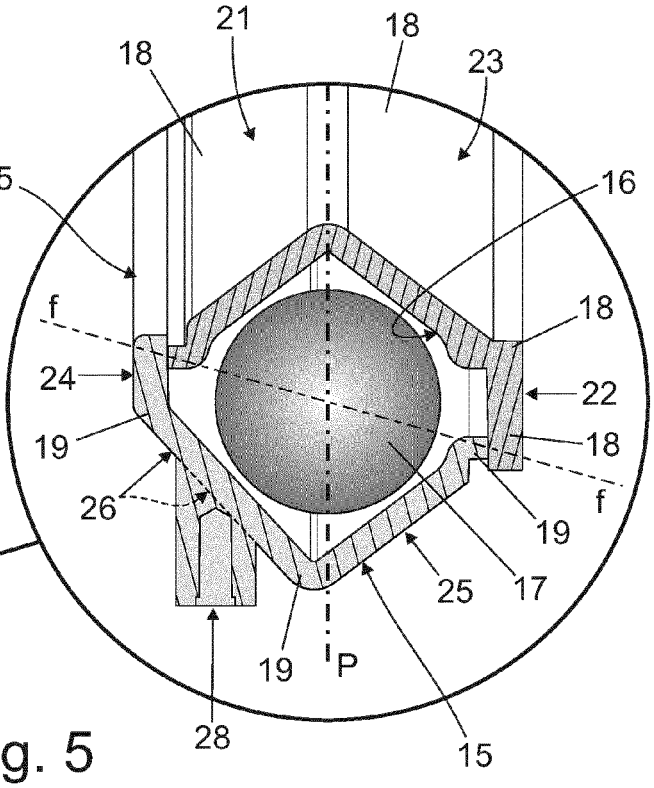
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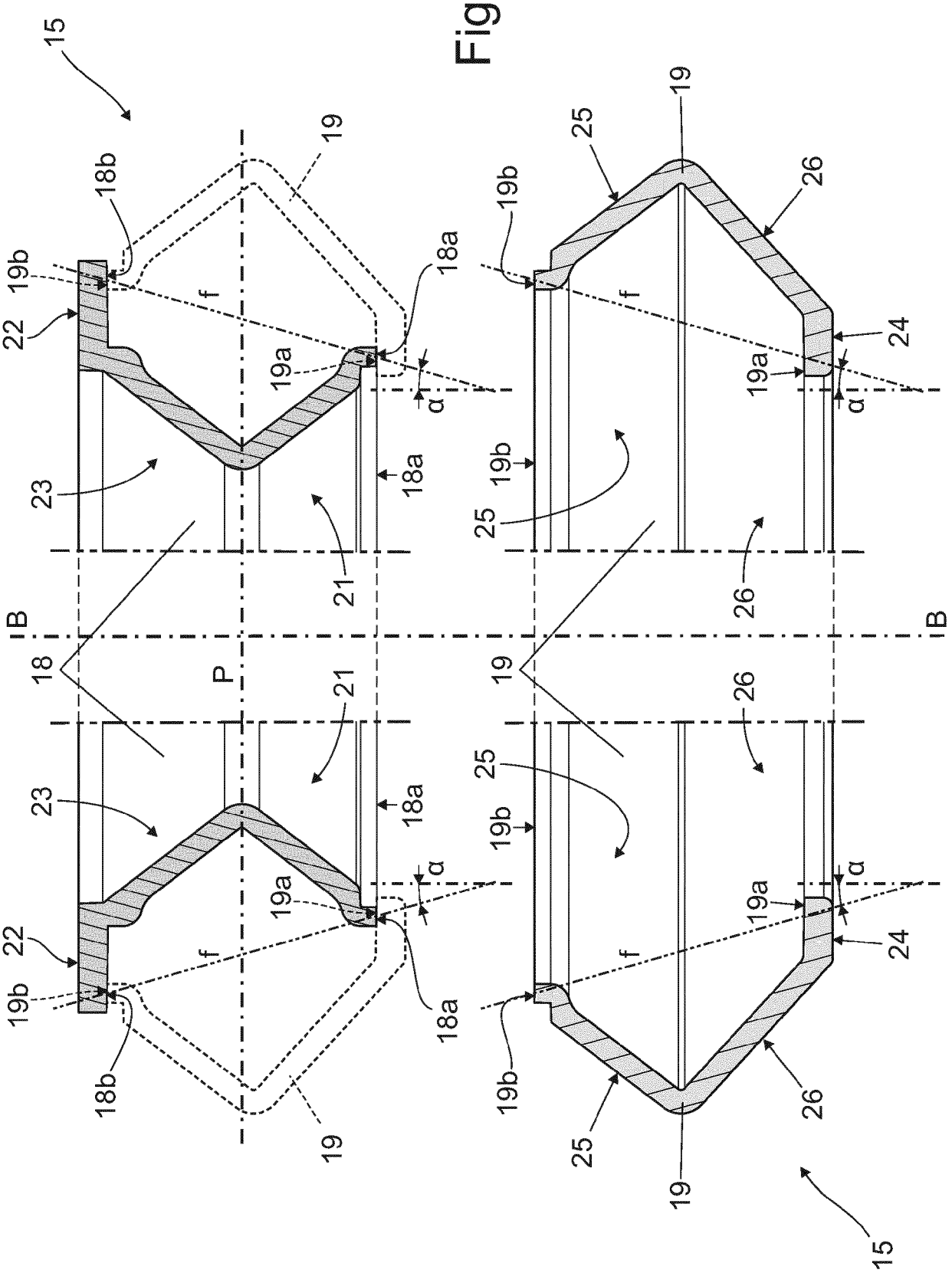
Fig. 5

Fig. 6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Application Number
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