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(54) **Shock absorber with improved piston architecture.**

(57) A shock absorber comprises a cylinder and a piston dividing the cylinder in first and second cylinder chambers, the piston being movable within the cylinder. The piston comprises a first main channel and a first main non-return valve allowing a first main fluid flow from the second to the first chamber; and a second main channel and a second main non-return valve allowing a second main fluid flow from the first to the second chamber. Further the piston comprises a connecting member comprising a part of the first main channel and a part of the second main channel; a first central member comprising another part of the first main channel and received into the connecting member such that the parts of the first main channel in the connecting member and the first central member are in line; and a second central member comprising another part of the second main channel and received into the connecting member such that the parts of the second main channel in the connecting member and the second central member are in line. The connecting member seals against the cylinder wall.

SHOCK ABSORBER WITH IMPROVED PISTON ARCHITECTURE

FIELD OF THE INVENTION

The invention relates to a shock absorber comprising a cylinder having a cylinder wall, and a piston sealing against the cylinder wall and dividing the cylinder in first and second cylinder chambers, the piston being movable within the cylinder along the cylinder wall in inward and outward directions upon inward and outward movement, respectively, of the piston inside the cylinder. A first side of the piston is associated with the first cylinder chamber and a second side of the piston is associated with the second cylinder chamber, being associated meaning that the first side points in the direction of the first cylinder chamber and that the second side points in the direction of the second cylinder chamber. The piston comprises a first main channel and a first main non-return valve associated with the first main channel such that the first main channel and first main non-return valve allow a first main fluid flow from the second side to the first side of the piston; and a second main channel and a second main non-return valve associated with the second main channel such that the second main channel and second main non-return valve allow a second main fluid flow from the first side to the second side of the piston.

BACKGROUND OF THE INVENTION

[01] Dampers, or shock absorbers, are well known and widely applied in, for instance, a variety of vehicles like cars, truck, buses and trains. The dampers are designed to provide a desired damping behavior between parts moving with respect to one another. Damping can be chosen to be stiff or soft by the specific design of the damper. More complex dampers have been proposed, which are, for instance, stiff dampers but soft at the start of a motion to be damped or provide a frequency selective damping behavior. Each such damper will have its own damper architecture dedicated to the functioning of the damper. Each architecture requires its own specific parts. Any required changes in the damping requirements may require a redesign of the damper and amendments of quite a few if not all parts of the damper. Each damper design and damper characteristics will requires their own dedicated parts.

[02] The damper characteristics are generally implemented in the design of the piston. The various requirements will yield complex piston designs with a considerable building height. The larger building height of the piston will result in a reduced working stroke of the damper at a same height of the damper or to a longer damper at a same working stroke. Preferably one would like to have a piston with a small building height to have to longest possible working stroke at a given height of the damper. Present piston designs of complex dampers generally require longer damper heights or

provide a shorter working stroke.

[03] Currently, various different design concepts are required to obtain dampers or pistons with a linear damping behavior, blow-off type dampers or pistons, dampers or pistons requiring only rebound forces, etcetera, whereas it would be very advantageous to have a piston architecture concept that allows incorporating various, including even the most difficult damping characteristics, which is not feasible at all with known piston architectures.

SUMMARY OF THE INVENTION

[04] It is an objective of the invention to provide a damper (shock absorber) having a simple design architecture.

[05] It is another or alternative objective of the invention to provide a damper having a design architecture using standard parts that can be used in other designs as well.

[06] It is yet another or alternative objective of the invention to provide a damper having a flexible design architecture allowing implementation of complex damping characteristics.

[07] It is yet another or alternative objective of the invention to provide a damper having a design architecture providing a short building height.

[08] At least one of the above objectives is achieved by a shock absorber comprising a cylinder having a cylinder wall, and a piston sealing against the cylinder wall and dividing the cylinder in first and second cylinder chambers, the piston being movable within the cylinder along the cylinder wall in inward and outward directions upon inward and outward movement, respectively, of the piston inside the cylinder, a first side of the piston being associated with the first cylinder chamber and a second side of the piston being associated with the second cylinder chamber, the piston comprising

- a first main channel and a first main non-return valve associated with the first main channel such that the first main channel and first main non-return valve allow a first main fluid flow from the second side to the first side of the piston;
- a second main channel and a second main non-return valve associated with the second main channel such that the second main channel and second main non-return valve allow a second main fluid flow from the first side to the second side of the piston;
- a connecting member comprising a part of the first main channel and a part of the second main channel;
- a first central member comprising another part of the first main channel and received into the connecting member at a first side of the connecting member

associated with the first side of the piston such that the parts of the first main channel in the connecting member and the first central member are in line; and

- a second central member comprising another part of the second main channel and received into the connecting member at a second side of the connecting member associated with the second side of the piston such that the parts of the second main channel in the connecting member and the second central member are in line.

[09] The piston design architecture with the connecting and first and second central members is very flexible in implementing various damping characteristics, even complex damping characteristics, at a very short building height of the piston. Various parts of the design can be used in different designs having different damping characteristics

[10] In an embodiment the connecting member is configured for movement along and sealing against the cylinder wall.

[11] In an embodiment the connecting member comprises a ring-shaped connecting member.

[12] In an embodiment the first main non-return valve is provided on the first central member.

[13] In an embodiment the second main non-return valve is provided on the second central member.

[14] In an embodiment the part of the first main channel in the connecting member has opposing ends, one end being in line with the part of the first main channel in the first central member and the other end being in fluid connection with the second side of the piston.

[15] In an embodiment the part of the second main channel in the connecting member has opposing ends, one end being in line with the part of the second main channel in the second central member and the other end being in fluid connection with the first side of the piston.

[16] In an embodiment of the shock absorber

- a first central member channel is provided on a side of the first central member associated with the second side of the piston, the first central member channel being in fluid communication with the second side of the piston,

- a second central member channel is provided in a side of the second central member associated with the first side of the piston, the second central member channel being in fluid communication with the first side of the piston, and

- an auxiliary valve is provided in between the first and second central member channels such as to influence a fluid flow between the first and second sides of the piston.

[17] The auxiliary valve provides an additional damping characteristic to the

shock absorber. An additional soft damping characteristic can be provided at the onset of a damping stroke to provide a more comfortable damping character. The additional damping may also be made frequency-dependent. The shock absorber and especially the piston architecture allows to integrate such additional damping behaviour.

The central member channels allow for an auxiliary flow to provide additional damping characteristics to the damper.

[18] In an embodiment the first central member channel comprises a first central member groove provided at the side of the first central member associated with the second side of the piston.

[19] In an embodiment the second central member channel comprises a second central member groove provided at the side of the second central member associated with the first side of the piston.

[20] In an embodiment the first central member groove comprises an annular groove, the second central member groove comprises an annular groove, and the auxiliary valve comprises an annular plate valve.

[21] In an embodiment the first central member channel is in fluid connection with the part of the first main channel in the first central member, especially a first auxiliary channel being provided in the first central member, which extends from the first central member channel to a side of the first central member opposing the side comprising the first central member channel, so to provide for a fluid connection between the first central member channel and the part of the first main channel in the first central member.

[22] In an embodiment the second central member channel is in fluid connection with the part of the second main channel in the second central member, especially a second auxiliary channel being provided in the second central member, which extends from the second central member channel to a side of the second central member opposing the side comprising the second central member channel, so to provide for a fluid connection between the second central member channel and the part of the second main channel in the second central member.

[23] In an embodiment the auxiliary valve comprises

- a controlled flow channel, the controlled flow channel comprising the first and second central member channels;
- a controlled valve assembly provided in the controlled flow channel such as, in operation, to allow influencing a controlled fluid flow in the controlled flow channel in a controlled flow direction from the first valve side to the second valve side;
- a movable valve body being movable with respect to a wall of the controlled flow channel and acting on the controlled valve assembly so as to allow changing a flow resistance for the controlled fluid flow by the controlled valve assembly; and

- a variable volume chamber, the movable valve body interacting with the variable volume chamber such that movement of the movable valve body and a change in volume of the variable volume chamber are interrelated, wherein the variable volume chamber comprises an outlet opening, in operation, downstream of the controlled valve assembly and does not comprise an opening upstream of the controlled valve assembly with respect to the controlled fluid flow in the controlled flow channel, the outlet opening providing a flow resistance, and a fluid pressure upstream of the controlled valve assembly with respect to the controlled fluid flow acting on the movable valve body so as to induce a force on the movable valve member in a direction to increase a fluid pressure in the variable volume chamber and to decrease a volume of the variable volume chamber by fluid flow from the variable volume chamber through the outlet opening, which allows an interrelated movement of the movable valve body.

[24] In an embodiment the controlled valve assembly is configured such that at least one of an effective opening and a closing force of the controlled valve assembly is changed upon movement of the movable valve body so as change the flow resistance for the controlled fluid flow by the controlled valve assembly.

[25] In an embodiment the controlled valve assembly is configured such that the flow resistance for the controlled fluid flow by the controlled valve assembly increases with decreasing volume of the variable volume chamber.

[26] In an embodiment the controlled valve assembly is configured such as to have spring-like behaviour and to exert a force on the movable valve body in a direction to move the movable valve body back to a neutral position when the movable valve body has moved from the neutral position.

[27] In an embodiment the controlled valve assembly comprises a controlled valve plate, especially a ring-shaped controlled valve plate.

[28] In an embodiment the controlled valve plate comprises opposing edges, especially opposing internal and external perimeters of a ring-shaped controlled valve plate, one or both opposing edges being restricted in movement with respect to one or both of a wall of the controlled flow channel and the movable valve body, respectively, especially one or both opposing edges being clamped by one or both of a wall of the controlled flow channel and the movable valve body, respectively.

[29] In an embodiment the controlled valve assembly comprises a controlled valve plate interacting with at least one curved surface upon movement of the movable valve body with decreasing volume of the variable volume chamber so as to gradually decrease an effective surface area of the controlled valve plate in the controlled flow channel.

[30] In an embodiment the controlled valve plate comprises at least one

opening.

[31] In an embodiment the controlled valve plate comprises at least one opening positions and configured such as to gradually close against the at least one curved surface upon movement of the movable valve body with decreasing volume of the variable volume chamber.

[32] In an embodiment the movable valve body comprises a curved surface interacting with the controlled valve plate.

[33] In an embodiment the movable valve body comprises first and second movable valve body members, and the controlled valve plate is clamped between the first and second valve body members, especially at least one of the first and second valve members comprising a curved surface interacting with the controlled valve plate.

[34] In an embodiment the wall of the controlled flow channel comprises a curved surface interacting with the first valve plate.

[35] In an embodiment the controlled valve assembly comprises a controlled valve plate closing against a valve seat and of which a closing force against the valve seat is changed upon movement of the movable valve body, especially the valve seat being provided on the movable valve body and the controlled valve plate being fixed with respect to the wall of the controlled flow channel.

[36] In an embodiment the controlled valve assembly is bidirectional acting for first and second flows in opposite directions in the controlled flow channel, and comprises first and second controlled valve plates associated with the first and second flows, respectively, each of the first and second controlled valve plates closing against a respective valve seat and of which a closing force against the respective valve seat is changed upon movement of the movable valve body, especially the respective valve seats being provided on the movable valve body and the first and second controlled valve plates being fixed with respect to the wall of the controlled flow channel.

[37] In an embodiment the controlled valve assembly comprises a third controlled valve plate configured such as to have spring-like behaviour and to exert a force on the movable valve body in a direction to move the movable valve body back to a neutral position when the movable valve body has moved from the neutral position, especially the third controlled valve plate being arranged in between the first and second controlled valve plates

[38] In an embodiment the variable volume chamber comprises a non-return valve associated with an opening of the variable volume chamber downstream of the controlled valve assembly, the non-return valve being closed upon the controlled fluid flow and opening for a fluid flow in a direction opposite to the controlled fluid flow.

[39] In an embodiment the connecting member comprises one of a slot and projection at its internal perimeter, and at least one of the first and second central

members comprises the other one of the projection and the slot at its external perimeter, the slot and projection being configured to cooperate such as to align the connecting member and the at least one of the first and second central members with respect to one another.

[40] In an embodiment the connecting member and at least one of the first and second central members are fitted, especially press-fitted, into one another such as to provide a sealing fit.

[41] In an embodiment the piston comprises more than one first main channel, the connecting member comprising a part of each first main channel in line with another part of each first main channel comprised in the first central member.

[42] In an embodiment the piston comprises more than one second main channel, the connecting member comprising a part of each second main channel in line with another part of each second main channel comprised in the second central member.

[43] In an embodiment the parts of the first and second main channels in the connecting member are provided alternately in the connecting member.

[44] In yet another aspect the invention provides a piston for use in a shock absorber according to any one of the preceding claims, the piston comprising

- a first main channel and a first main non-return valve associated with the first main channel such that the first main channel and first main non-return valve allow a first main fluid flow from the second side to the first side of the piston;
- a second main channel and a second main non-return valve associated with the second main channel such that the second main channel and second main non-return valve allow a second main fluid flow from the first side to the second side of the piston;
- a connecting member comprising a part of the first main channel and a part of the second main channel, especially a ring-shaped connecting member;
- a first central member comprising another part of the first main channel and incorporated into the connecting member at a first side of the connecting member associated with the first side of the piston such that the parts of the first main channel in the connecting member and the first central member are in line; and
- a second central member comprising another part of the second main channel and incorporated into the connecting member at a second side of the connecting member associated with the second side of the piston such that the parts of the second main channel in the connecting member and the second central member are in line.

BRIEF DESCRIPTION OF THE DRAWINGS

[45] Further features and advantages of the invention will become apparent from the description of the invention by way of non-limiting and non-exclusive embodiments. These embodiments are not to be construed as limiting the scope of protection. The person skilled in the art will realize that other alternatives and equivalent embodiments of the invention can be conceived and reduced to practice without departing from the scope of the present invention. Embodiments of the invention will be described with reference to the accompanying drawings, in which like or same reference symbols denote like, same or corresponding parts, and in which

Figure 1 shows a first embodiment of a damper (shock absorber) according to the invention;

Figure 2 shows the piston of the shock absorber of figure 1 in cross-section;

Figures 3, 4 and 5 show the first central member, the connecting member and the second central member, respectively, of the piston of figure 2 in cross-sectional perspective views; and

Figure 6 shows a second embodiment of the piston of the shock absorber of figure 1 in cross-section;

Figure 7 shows the first central member of the embodiment of figure 6 in cross-sectional perspective view;

Figures 8a and 8b shows the second central member of the embodiment of figure 6 in cross-sectional perspective views;

Figure 9 shows a variant of the second embodiment of figure 6;

Figure 10 shows the first central member of the variant of figure 9 in cross-sectional perspective view;

Figure 11 shows the second central member of the variant of figure 9 in cross-sectional perspective view;

Figures 12a and 12b shows two embodiments of an auxiliary valve of the second embodiment of figures 6 and 9;

Figures 13a and 13b show a detail of the auxiliary valve of figures 6 and 9 in a neutral and a deformed state, respectively;

Figures 14a and 14b show a variant of a detail of the auxiliary valve of figures 6 and 9 in a neutral and a deformed state, respectively;

Figure 15 shows yet another embodiment of the piston of the shock absorber of figure 1, the piston comprising a frequency-selective damper valve;

Figure 16 shows the damper valve of figure 15 in more detail;

Figure 17 shows a detail of figure 16;

Figure 18 shows the controlled valve plate of the embodiments of figures 15 to 4;

Figure 19 shows yet another embodiment of the piston of the shock absorber of figure 1, the piston comprising another embodiment of a frequency-selective damper valve;

Figure 20 shows a detail of yet another embodiment of the piston of the shock absorber of figure 1, the piston comprising yet another embodiment of a frequency-selective damper valve; and

Figure 21 shows a detail of yet another embodiment of the piston of the shock absorber of figure 1, the piston comprising yet another embodiment of a frequency-selective damper valve.

DETAILED DESCRIPTION OF EMBODIMENTS

[46] Figure 1 schematically shows a shock absorber or damper 10 according to the invention. The damper comprises a cylinder 12 and a piston 11 that can move within the cylinder in inward and outward directions with respect to the cylinder. The direction of movement of the inward and outward strokes of the piston are indicated by the arrows labeled Mi and Mo, respectively. The piston seals against the cylindrical wall 12.1 of the cylinder and divides the cylinder in a first or upper cylinder chamber 10.1 and a second or lower cylinder chamber 10.2. A piston rod 13 attached to the piston 11 is in a sealing fashion guided through a top wall of the cylinder 12. The damper can be attached by its piston and cylinder attachment arrangements 14, 15 to, for instance, parts of a car to damp relative movements. Damping is achieved by influencing a fluid flow in between first and second cylinder chambers by an arrangement in the piston 11.

[47] The piston according to a first embodiment is shown in more detail and in cross-section in figure 2. A top or first side 11.1 of the piston is directed towards and associated with the first cylinder chamber 10.1, and a bottom or second side 11.2 of the piston is directed towards and associated with the second cylinder chamber 10.2.

[48] A first main channel 301, 101 passes through the piston 11 to allow for a first main fluid flow F10 from the second side 11.2 to the first side 11.1 of the piston and therefore from the second cylinder chamber 10.2 to the first cylinder chamber 10.1. A first main non-return valve 111 is arranged at the piston first side 11.1 and is associated with the first main channel 301, 101 so as to open for fluid flow from the second cylinder chamber 10.2 through the first main channel towards the first cylinder chamber 10.1 and piston first side 11.1. The first main non-return valve 111 is closed for fluid flow in the opposite direction, although may allow for a small constant fluid flow in either direction by providing a relatively small constant opening. The first main fluid flow F10 flows through the first main channel 301, 101 upon inward movement Mi of the piston 11 within the cylinder 12. The first main fluid

flow and associated inward movement of the piston is damped by the first main channel and the first main non-return valve.

[49] In the same manner a second main channel 302, 202 passes through the piston 11 to allow for a second main fluid flow F20 from the piston first side 11.1 and first cylinder chamber 10.1 to the piston second side 11.2 and second cylinder chamber 10.2. A second main non-return valve 212 is arranged at the piston second side 11.2 and is associated with the second main channel 302, 202 so as to open for fluid flow from the first cylinder chamber 10.1 through the second main channel towards the second cylinder chamber 10.2 and piston second side 11.2. The second main non-return valve is closed for fluid flow in the opposite direction, but may also allow for a relatively small constant fluid flow in either direction by providing a constant opening. The second main fluid flow F20 flows through the second main channel 302, 202 upon outward movement Mo of the piston 11 within the cylinder 12. The second main fluid flow and associated outward movement of the piston is damped by the second main channel and the second main non-return valve.

[50] The piston body comprises first and second central members 100, 200 and a ring-shaped connecting member 300. The first (or top) central member 100 is received into the connecting member 300 at a top or first side of the connecting member, which is associated with the piston first side 11.1. The second (or bottom) central member 200 is received into the connecting member at a bottom or second side of the connecting member, which is associated with the piston second side 11.2. The first and second central members 100, 200 and the connecting member 300 are shown in more detail in figures 3, 4 and 5, respectively. The connecting member 300 seals against the cylinder wall 12.1 and is shaped to move along the cylinder wall. Both central members 100, 200 leave a clearance between them and the cylinder wall.

[51] The ring-shaped connecting member 300 comprises parts 301, 302 of both the first main channel and the second main channel, respectively. First main channel part 301 is in fluid connection with first main channel part 101 of the top (first) central member 100 to form the first main channel in between first and second sides 11.1, 11.2 of the piston. The part 301 of the first main channel in the connecting member has opposing ends. One end is in line with the part 101 of the first main channel in the top central member 100 and the other end is in fluid connection with the piston second side 11.2. Second main channel part 302 is in fluid connection with second main channel part 202 of the bottom (second) central member 200 to form the second main channel in between first and second sides 11.1, 11.2 of the piston. The part 302 of the second main channel in the connecting member 300 also has opposing ends. One end is in line with the part 202 of the second main channel in the bottom central member 200 and the other end is in fluid connection with the piston first side 11.1. The

clearances between the central members and the cylinder wall allow fluid to flow into the first and second main channel. The respective clearances may also be regarded as a part of the first and second main channels.

[52] Actually, the piston comprises more than one first main channel 301, 101 and more than one second main channel 302, 202 in the embodiment shown. This shows especially in figures 3, 4 and 5. The ring-shaped connecting member 300 comprises parts 301 for each first main channel and parts 302 for each second main channel. Each part 301 of each first main channel is in line with another part 101 of each first main channel comprised in the first central member 100. Correspondingly, each part 302 of each second main channel is in line with another part 202 of each second main channel comprised in the second central member 200. Figure 4 shows that the parts 301 and 302 are arranged alternately in the connecting member 300. The connecting member, and the first and second central members are fitted, especially press-fitted into one another so as to provide a sealing fit.

[53] The first main non-return valve 111 is provided on the top central member 100 and closes off the first main channel 301, 101. Likewise, the second main non-return valve 212 is provided on the bottom central member and closes of the second main channel 302, 202. As indicated above, one or both of the main non-return valves 111, 212 may provide for a constant opening to allow for a constant fluid flow across the respective valve in either direction. Such constant opening may, for instance, be provided in the valve or in the valve seat. One or both of the main non-return valves comprise one or more plates in the embodiment shown.

[54] Figures 6, 7, 8a and 8b shows a second embodiment of a piston 11 of a shock absorber 10 according to the invention. The second piston embodiment is largely identical to the first embodiment of figures 2-5, and additionally comprises central member channels 105, 205 in the first and second central members 100, 200, respectively, and an auxiliary valve 400 provided in between the first and second central member channels 105, 205.

[55] The first central member channel 105 is provided in the bottom side of the first central member 100 in figures 6 and 7. The bottom side of the first central member is associated with the second side 11.2 of the piston, meaning that both the bottom side of the first central member and the second side 11.2 of the piston are at corresponding sides. The second piston side 11.2 is also the bottom side of the piston in figure 6. The first central member channel 105 is in fluid communication with first main channel part 101 in the first central member 100 and is visible on the right-hand side in figures 6 and 7. Therefore, the first central member channel 105 is via the first main channel in fluid communication with the second side 11.2 of the piston and thus with the second cylinder chamber 10.2, which is visible at the right-hand side of

figure 6 as well. The first central member channel is shaped as a groove, especially an annular groove, arranged at the side of the first central member associated with the second side 11.2 of the piston.

[56] Correspondingly, the second central member channel 205 is provided in the top side of the second central member 200 in figures 6, 8a and 8b. The top side of the second central member is associated with the first side 11.1 of the piston, meaning that both the top side of the second central member and the first side 11.1 of the piston are at a corresponding sides. The first piston side 11.1 is also the top side of the piston in figure 6. The second central member channel 205 is in fluid communication with the second main channel part 202 in the second central member 200 and is visible on the left-hand side in figures 6, 8a and 8b. Therefore, the second central member channel 205 is via the second main channel in fluid communication with the first side 11.1 of the piston and thus with the first cylinder chamber 10.1, which is also visible at the left-hand side in figure 6. The second central member channel is also shaped as a groove, especially an annular groove, arranged at the side of the second central member associated with the first side 11.1 of the piston.

[57] Figures 9, 10 and 11 show a variant of the second embodiment. The variant of figures 9, 10 and 11 is largely identical to the second embodiment in figures 6, 7, 8a and 8b. However, the first central member channel in the form of annular first central member groove 105 is in a different manner in fluid connection with the second piston side 11.2. The first central member groove 105 is via first auxiliary channel 106 in fluid connection with first main valve chamber 101.1 between first central member 100 and main non-return valve 111. First main valve chamber 101.1 is in fluid connection with the second piston side 11.2 via first main channel 101, 301 so that first central member channel 105 is in fluid connection with the second piston side 11.2. In a corresponding fashion second central member channel in the form of annular second central member groove 205 is via second auxiliary channel 206 in fluid connection with second main valve chamber 202.1 between second central member 200 and the second main non-return valve 212. The second main valve chamber 202.1 is via second main channel 202, 302 in fluid connection with the first piston side 11.1.

[58] An auxiliary valve 400 in the form of an annular plate valve is provided in between the first and second central members 100, 200 in the second embodiment and its variant, such that fluid may flow past auxiliary valve 400 in a neutral or rest position thereof. The auxiliary valve 400 in this embodiment functions provides the shock absorber with a more comfortable damping behaviour and may also be referred to as a comfort valve 400. The neutral position of the comfort valve is shown in

figures 6 and 9. The annular plate valve 400 is clamped at its internal perimeter between first and second central members 100, 200. The external perimeter of auxiliary annular plate valve 400 is left free to move between the first and second central members. The auxiliary annular plate valve 400 is further provided with openings 401 to allow passage of fluid from first annular central member groove 105 to second annular central member groove 205, or vice versa. Figures 12a and 12b show top views on two embodiments of an annular plate valve 400. The embodiment of figure 12a has multiple round openings 401, while the embodiment of figure 12b has elongated openings. Various other embodiments may be conceived as well. One may vary in various parameters such as number, shape and locations of the openings 401 and thickness, shape and material of the plate valve 400. The auxiliary valve may also comprise more than one plate valve.

[59] Upon pressure build-up across auxiliary valve 400 upon fluid flow in either direction past the auxiliary/comfort valve, the auxiliary valve will move in the direction of the fluid flow and gradually deform against either the first or second central member 100, 200. Both the first and second central members 100, 200 have a rounded edge 110, 210 against which the auxiliary annular plate valve 400 deforms such as to gradually close off the openings 401 in the auxiliary valve. Figures 13a, 13b, 14a and 14b show a detail of the annular plate valve 400 clamped in between first and second central members 100, 200. A neutral or rest position of the plate valve 400 is shown in figures 13a and 14a, in which further a fluid flow F11 is depicted as an example fluid flow. Figures 13b and 14b show the plate valve 400 in a deformed state closing off the openings 401 against rounded edge 210. The figures 14a and 14b variant shows an additional stepped surface of the first and second central members 100, 200 at the position where the plate valve is clamped. The stepped surfaces allow for some additional fluid volume around the openings 401 and provide another parameter that can be varied to tune the damping characteristics. The auxiliary/comfort valve at its external perimeter will also close against either the first or second central member to close of fluid flow past the external perimeter. The auxiliary valve thus gradually closes of fluid flow upon pressure build up across the auxiliary valve 400.

[60] Upon inward movement Mi of the piston 11 inside the cylinder 12 a first main fluid flow F10 will pass through first main channel 301, 101 from the second cylinder chamber 10.2. A first auxiliary fluid flow F11 branches of from the first main fluid flow F10 to the first auxiliary annular groove 105 and flows past the auxiliary valve 400 into the second auxiliary annular groove 205 through second main channel 202, 302 towards the first cylinder chamber 10.1 with reference to figure 6. With reference to figure 9, the first auxiliary fluid flow F11 branches of from the first

main fluid flow F10 within the first main valve chamber 101.1 and passes through first auxiliary channel 106 into first central member groove 105 towards and past the auxiliary valve 400 into second central member groove 205 and subsequently into second auxiliary channel 206, second main valve chamber 202.1 and second main channel 202, 302 into first cylinder chamber 10.1. The first auxiliary fluid flow F11 is only present when the auxiliary valve is still close to its neutral position at the initial phase of the inward movement Mi. A pressure difference will build up across the auxiliary valve 400 such that it gradually closes off the first auxiliary fluid flow F11, which will cause a further pressure build up inside first main valve chamber 101.1. At sufficient pressure difference across first main non-return valve 111, the first main non-return valve opens to allow first main fluid flow F10 into the first cylinder chamber 10.1.

[61] Correspondingly, upon outward movement Mo of the piston 11 within the cylinder 12 a second main fluid flow F20 will pass through the second main channel 302, 202 from the first cylinder chamber. A second auxiliary fluid flow F21 branches of from the second main fluid flow F20 to the second auxiliary annular groove 205 and flows past the auxiliary/comfort valve 400 into the first auxiliary annular groove 105 through first main channel 101, 301 towards the second cylinder chamber 10.2 with reference to figure 6. With reference to figure 9, the second auxiliary fluid flow F21 branches of from the second main fluid flow F20 within the second main valve chamber 202.1 and passes through second auxiliary channel 206 into second central member groove 205 towards and past the auxiliary valve 400 into first central member groove 105 and subsequently into first auxiliary channel 106, first main valve chamber 101.1 and first main channel 101, 301 into second cylinder chamber 10.2. The second auxiliary fluid flow F21 is also only present when the auxiliary valve 400 is still close to its neutral position at the initial phase of the outward movement Mo. A pressure difference will build up across the auxiliary valve 400 such that it gradually closes off the second auxiliary fluid flow F21, which will cause a further pressure build up inside second main valve chamber 202.1. At sufficient pressure difference across second main non-return valve 212, the second main non-return valve opens to allow second main fluid flow F20 into the second cylinder chamber 10.2.

[62] The gradual closing off of fluid flows F11, F21 by auxiliary/comfort valve 400 upon inward or outward piston movement Mi, Mo before opening of first or second main non-return valve 111, 212, respectively, provides comfort to persons travelling in a vehicle in which the damper having such piston is employed.

[63] Figure 8b shows a view on the top side of second central member 200. A projection 250 at the circumference of the second central member is configured to

cooperate with a slot 350.1 at the bottom side of the connecting member 300, as visible in figure 4. The slot 350.1 is actually a part of first main channel part 301 in the connecting member. Correspondingly, the first central member 100 may also have projections shaped for cooperation with mating slots in the connecting member 300, such as slots 350.1 that are part of the second main channel part 302. Multiple projections may be arranged around the circumference of first and/or second central members 100, 200 for cooperation with corresponding slots in the connecting member 300. The cooperating projections and slots on first and/or second central members and the connecting member can also be employed on the first embodiment of figures 2, 3, 4 and 5, and any other embodiment. In other embodiment the projection can be provided on the connecting member and the slot on the first and/or second central member.

[64] The piston according to an embodiment with an auxiliary valve embodied as a frequency-selective damper valve is shown in detail and in cross-section in figure 15. Further details are shown in figures 16 to 18. A top or first side 11.1 of the piston is directed towards and associated with the first cylinder chamber 10.1, and a bottom or second side 11.2 of the piston is directed towards and associated with the second cylinder chamber 10.2.

[65] A bi-directional frequency-selective damper valve is provided between the first and second central members 100, 200 and centrally in the connecting member 300. The frequency-selective damper valve comprises a controlled valve assembly 500, a movable valve body 600 and two variable volume chambers 701, 702, and acts in a controlled valve channel in between the first and second cylinder chambers 10.1, 10.2. The controlled valve channel comprises first and second central member annular grooves 105, 205 in sides of the first and second central members 100, 200 associated with the second and first sides 11.2, 11.1 of the piston, respectively. The annular groove 105 in the first central member 100 is in fluid connection with the first main channel 301, 101 end therefore with the second cylinder chamber 10.2. The annular groove 205 of the second central member 200 is in fluid communication with the second main channel 302, 202 and therefore with the first cylinder chamber 10.1.

[66] The controlled valve assembly 500 is provided in the controlled flow channel and comprises a controlled valve plate 550 clamped in between first and second movable valve body members 610, 620 of the movable valve body 600. The controlled valve plate 550 is ring shaped, and also the first and second movable valve body members 610, 620 are ring-shaped. A sleeve 650 keeps the first and second movable valve body members 610, 620 and the controlled valve plate 550 clamped together. The ring-shaped controlled valve plate 550 has a central opening and is at its

inner circumference clamped between the first and second movable valve body members 610, 620. The inner circumference of controlled valve plate 550 can move up and down together with the movable valve body 600. The first and second movable valve body members comprise curved edges 611, 621 facing towards the controlled valve plate 550, the curved edges each having a curved surface. The outer circumference of the connecting controlled valve plate 550 is provided in between protrusion members 510, 520 on the wall of the controlled flow channel. The protrusion members have curved surfaces 511, 521 facing towards the controlled valve plate 550. They are clamped between the first/upper and second/lower central members 100, 200 and fitted within the connecting member so as to form a wall part of the controlled flow channel. The protrusion members 510, 520 have a ring-shaped configuration. In the embodiment of figures 15 and 16 the curved surfaces 511, 512 are provided on protrusions of the protrusion members, the protrusion projecting into the controlled flow channel. In alternative embodiments the curved surfaces can be provided in another manner.

[67] The movable valve body 600 of first and second movable valve body members 610, 620 and sleeve 650 is movable up and down in an annular space provided between first and second central members 100, 200, connecting member 300 and intermediate member 350. Intermediate member 350 is clamped in between first and second central members 100, 200 together with non-return valve plates 712, 722 (that are clamped in between first central member 100 and intermediate member 350, and intermediate member and second central member 200, respectively). An upper variable volume chamber 710 is defined between first central member 100, intermediate member 350 and movable valve body 600, especially first movable valve body member 610. An outlet opening 711 of the upper variable volume chamber 710 is defined by a clearance between first movable valve member 610 and first central member 100. The outlet opening 711 has an annular slit shape that provides for a flow restriction for a fluid flow F31 from the variable volume chamber 710 through the outlet opening 711 to the controlled flow channel. A variable volume chamber non-return valve 712 with opening 713 is provided at the top of the upper variable volume chamber. The non-return valve 712 allows for a fluid flow F11 from the space 101.1 between the first main non-return valve 111 and the first central member 100 into the upper variable volume chamber 710, but prevents a fluid flow from the upper variable volume chamber into that space 101.1.

[68] Correspondingly, a lower variable volume chamber 720 is defined between second central member 200, intermediate member 350 and movable valve body 600, especially second movable valve body member 620. An outlet opening 721 of the lower variable volume chamber 720 is defined by a clearance between second

movable valve member 620 and second central member 200. The outlet opening 721 has an annular slit shape that provides for a flow restriction for a fluid flow F32 from the variable volume chamber 720 through the outlet opening 721 to the controlled flow channel. A variable volume chamber non-return valve 722 with opening 723 is provided at the bottom of the lower variable volume chamber. The non-return valve 722 allows for a fluid flow F21 from the space 202.1 between the second main non-return valve 212 and the second central member 200 into the lower variable volume chamber 720, but prevents a fluid flow from the lower variable volume chamber into that space 202.1.

[69] The controlled valve plate 550 is at its inner circumference clamped in between the first and second movable valve body members 610, 612 having the curved surfaces 611, 621 facing towards the controlled valve plate 550. At its outer circumference the controlled valve plate is provided, but not clamped, in between the protrusions of the protrusion members 510, 520, which have curved surfaces 511, 521 facing the controlled valve plate. The controlled valve plate has a large central opening 505.1, as shown in figure 18, to fit around the intermediate member 650 and allow clamping in between first and second movable valve body members. A detail showing the controlled valve plate clamped between the first and second movable valve members is shown in figure 17. The controlled valve plate further has openings 506.1 provided near its inner circumference, cut-out openings 506.2 at its inner circumference, and openings 506.3 near its outer circumference. The openings 506.1 and 506.2 cooperate with the curved surfaces 611, 621 of the movable valve body. Upon deformation of the controlled valve plate 550 when the movable valve body 600 moves up or down the openings 506.1 and 506.2 will be gradually closed off by the curved surfaces 621 and 611, respectively. The openings 506.3 cooperate with the curved surfaces 511, 521 of the protrusion members 510, 520. Upon deformation of the controlled valve plate 550 when the movable valve body 600 moves up or down the openings 506.3 will be gradually closed off by the curved surfaces 511 and 521, respectively. The gradual closing off of the openings 506.1, 506.2, 506.3 upon deformation of the controlled valve plate gradually shuts of a fluid flow F15, F25 past the controlled valve plate 550.

[70] Upon outward movement Mo the piston 11 moves upwards within the cylinder 12 and fluid flows F20, F21 and F25 enter from the first/upper cylinder chamber 10.1 into the second main channel 302, 202. The main fluid flow F20 passes to the second/lower cylinder chamber 10.2 when the second main non-return valve 212 opens. A fill flow F21 passes from the space in between second central member 200 and second main non-return valve into channels 220. The fill flow F21 will open the non-return valve 722 so that fill flow F21 passes through opening 723 in

the non-return valve 712 into lower variable volume chamber 720 to fill the lower variable volume chamber with fluid. Non-return valve 712 is configured such that opening 713 is normally closed, so closed in the absence of any fluid pressure on non-return valve 712. A controlled fluid flow F25 flows from first cylinder chamber 10.1 and second main channel 302, 202 into a space 205a at the first cylinder chamber side (second main channel side) of the controlled flow channel with respect to the controlled valve plate 550. The controlled fluid flow F25 may pass through the openings in the controlled valve plate towards the first cylinder chamber 10.1. The fluid pressures in lower variable volume chamber 720, in second main channel 302, 202, in the space 205a and in first cylinder chamber 10.1 are (about) equal. This fluid pressure acts in lower variable volume chamber 720 on a surface area A2 of the second movable valve body member 620. In space 205a this fluid pressure acts on a surface area A2-Ax of the second movable valve body member 620. The surface area Ax varies with movement of the movable valve member 600 and is dependent on the contact area of controlled valve plate 550 with second movable valve body member 620, especially with the curved surface 621 thereof. As the movable valve body moves upwards from the neutral middle position this surface area Ax becomes larger. The fluid pressure in lower variable volume chamber 720 therefore effectively acts on surface area Ax of the movable valve body 600 and the resulting force increases as the movable valve body moves upwards since the surface area Ax increases, which is a functional force transfer increase on the movable valve body with movement from the neutral position.

[71] At the same time the controlled valve plate 550 rolls over curved surface 511 of protrusion member 510 and curved surface 621 of the second movable valve body member 620 with movement away of the movable valve body 600 from the neutral position, which decreases a functional surface area of the controlled valve plate 550 for force transfer but at the same time increases its stiffness. Both characteristics can be tuned together with other parameters, such as increase of functional force on the movable valve body 600, to achieve a desired time and therefore frequency dependent behaviour of the damping valve. The controlled valve plate further acts like a spring exerting a force onto the movable valve body 600 to move it back to its neutral position.

[72] Space 105a of the controlled flow channel at the other side of the controlled valve plate 550 is in fluid connection with the first main channel 101, 301 and second cylinder chamber 10.2 and at (about) equal fluid pressure. Since the piston moves upwards the fluid pressure in second cylinder chamber 10.2 is considerably lower than the fluid pressure in first cylinder chamber 10.1. The fluid pressure in space 105a is thus considerably lower than the fluid pressure in

space 205a with outward piston movement Mo.

[73] At the start of the outward piston movement Mo the upper variable volume chamber 710 is filled with fluid. The fluid pressure (damping pressure) in the upper variable volume chamber acts on a surface area A1 of the first movable valve body member 610 of the movable valve body 600. Generally, the surface area A1 will be equal to the surface area A2 when the movable valve body 600 is symmetrical with respect to the controlled valve plate 550, as is the case in the embodiment shown in figures 15 and 16. The resulting force by the fluid pressure in upper variable volume chamber 710 is directed downwards and counteracts the upward force on the movable valve body by the fluid pressure in the lower variable volume chamber 720. A fluid flow F31 can escape from the upper variable volume chamber through the outlet opening 711 of the upper variable volume chamber. The outlet opening 711 is formed by a slit in between first/upper movable valve body member 610 and first/upper central member 100. The slit also presents a flow restriction to the fluid flow F31 from the upper variable volume chamber 710. Fluid can only escape from the upper variable volume chamber through outlet opening 711 that is in fluid connection with the controlled flow channel downstream of the controlled valve assembly with controlled valve plate 550 with respect to the controlled fluid flow F25 from upper/first cylinder chamber 10.1 to lower/second cylinder chamber 10.2. The non-return valve 712 with its opening 713 is closed for fluid flow from the upper variable volume chamber. The fluid pressure within upper variable volume chamber acts to close the non-return valve 712. The fluid pressure within upper variable volume chamber 710 and the fluid flow F31 act to damp the upward movement of the movable valve member 600. Fluid flow F31 can therefore be referred to as a damping fluid flow.

[74] The controlled fluid flow F25 is in parallel to the flow path of the second main fluid flow F20 upon outward movement Mo. The speed and therefore the time required for closure of the openings of the controlled valve plate 550 and therefore of the controlled valve assembly 500 determine the frequency-dependency of the damper valve. The frequency-selective gradual closing of the controlled valve assembly provides a frequency-selective damping of the controlled fluid flow and therefore of the piston movement with respect to the cylinder. One may like to have a proportional relationship between pressure increase in the upper variable volume chamber 710 and displacement of the movable valve body 600. The fluid pressure increase in the upper variable volume chamber is non-linear. This can be largely compensated by the change in effective surface area Ax on which the fluid pressure upstream of the controlled valve assembly 500 (in the lower variable volume chamber 720) acts. The curvatures and radiuses of the curved surfaces 511, 621 can be designed for obtaining a proportional relationship. One may further design the

number, position, shape and size of the openings in the controlled valve plate 550 for that purpose. A number of variables is therefore available to obtain a desired damping behaviour. The openings 506.1, 506.2 and 506.3 shown in figure 18 are only one example. The openings 506.1 allow for a fluid flow F25.1 that will be reduced as opening 506.1 will be gradually closed off upon displacement of the movable valve body. Cut-out openings 506.2 cooperate with annular chambers in the first and second movable valve body members 610, 620 as shown in figure 17 allow for a fluid flow F25.2 at a high frequent pressure increase.

[75] The frequency-selective damper valve shown in figures 15, 16, 17 and 18 acts bi-directional, so also at inward movement Mi of the piston 11. At inward movement a first main fluid flow F10 passes from the second cylinder chamber 10.2 to the first cylinder chamber through the first main channel when the first main non-return valve 111 opens. A fill fluid flow F11 will fill the upper variable volume chamber by passing opening 713 in non-return valve 712 and a controlled fluid flow F15 passes through the controlled flow channel from the second cylinder chamber to the first cylinder chamber when the controlled valve assembly 500 is not (yet) closed. A damping fluid flow F32 passes from the lower variable volume chamber 720 to what now is the downstream side of the controlled valve assembly with respect to the controlled fluid flow F15.

[76] Figure 19 shows another embodiment of a piston having a frequency-selective damper valve. The frequency selective damper valve of the figure 19 embodiment only acts in one direction, being the outward direction Mo. The various elements, parts and flows are largely identical as has been described with reference to the figures 15, 16, 17 and 18 for the outward movement of the bi-directional frequency-selective damper. However, the one-directional embodiment of figure 19 does not have a lower variable volume chamber. Instead a space 750 is provided below the movable valve body 600, which space 750 is in open fluid connection with the second main channel 302, 202, the space 202.1 between second central member 200 and second main non-return valve 212, and first/upper cylinder chamber 10.1 via passage 751. The passage 751 is provided in between second main channel part 202 and space 750 and between annular groove 205 and space 750 in the embodiment shown. The clearance between second/lower movable valve body member 620 is such that it does not present a flow restriction to fluid flow between channel 751 and space 750. Upon inward movement the fill flow F11 acts to reset upper/first variable volume chamber 710 to allow frequency-selective damping at a next outward movement of the piston.

[77] Yet another embodiment is shown in figure 20. Figure 20 also depicts a bidirectional frequency-selective valve inside piston 1. Parts and elements having the

same reference signs as parts and elements disclosed with reference to figures 15-19 have the same function as already disclosed. The controlled valve assembly shown in figure 20 comprises second and third valve plates 560, 570 acting on the one hand as non-return valve closing on valve seats 612, 622 of first and second movable valve body members 610, 620, respectively. The first and second controlled valve plates 560, 570 have inner slits 561, 571 at their inner circumference and outer slits 562, 572 at their outer circumference, respectively. The inner slits 561, 571 allow a fluid flow to pass the valve plates when lifted from their respective valve seat and further allow centering the valve plates on the movable valve body 600. At their outer circumference the first and second controlled valve plates 560, 570 rest against curved surfaces 531, 531, respectively, of protrusion member 530 that is part of the wall of the controlled flow channel 302, 202, 205, 205a, 105a, 105, 101, 301. Upon outward movement Mo of the piston controlled fluid flow F25 can pass the controlled valve assembly in two sub flows F25.7, F25.8. Sub flow F25.7 passes through slits 572 of third valve plate 570 and subsequently through slits 562 of second valve plate 560. The slits 572 are gradually closed off against curved surface 532 of protrusion member 530 as movable valve body 600 moves upwards. Second valve plate 560 then moves away from curved surface 531 so that slits 562 remain open to allow passing of any sub flow of controlled fluid flow F25. Another sub flow F25.8 may lift the third valve plate 570 from its valve seat 622 and pass the third vale plate across valve seat 622 and through outer valve plate slits 571. Subsequently, sub flow F25.8 passes through outer slits 562 of the second/upper valve plate 560 into space 105a and annular groove 105 and further towards lower/second cylinder chamber 10.2. The pretension on third valve plate increases as movable valve body 600 moves upwards, as has been described earlier with reference to figures 15-18. The characteristics of the damping behaviour of the valve plates is determined by the thickness and material of the valve plates, the curvature of the curved surfaces 531, 532, a pretension on the valve plates in the neutral position, etc. A desired behaviour can be obtained by careful design of the controlled valve assembly 500. Upon inward movement Mi of the piston the fluid flows and function of the second and third valve plates is inverted. The effective surfaces of the movable valve body 600 on which the fluid flow upstream of the controlled valve assembly acts are static in the figure 20 embodiment, meaning that they remain constant with movement of the movable valve body.

[78] Figure 21 shows yet another embodiment of a frequency-selective damping valve in a piston 11. The embodiment of figure 21 combines the embodiments of figures 15 and 20, providing an increased number of design parameters to tune the frequency-selective damping behaviour of the valve. The embodiment comprises first and second controlled valve plates 560, 570 embodied as

non-return valves and a third controlled valve plate 550. The third controlled valve plate 550 comprises openings and cooperates with curved surfaces as described earlier. The internal and external perimeters of the ring-shaped controlled valve plate 550 are restricted in their movement by the movable valve body 600 and the wall of the controlled flow channel, respectively. The internal perimeter is clamped between first and second members 610, 620 of the movable valve body. The third controlled valve plate comprises a chosen stiffness and acts like a spring exerting a force onto the movable valve body 600 to move it back to its neutral position.

[79] The first and second movable valve body members 610, 620 in this embodiment additionally comprise reset slits 615, 625 extending from the corresponding variable volume chambers 710, 720 towards the controlled valve assembly 500. The reset slits 615, 625 do not extend over the full available height of the members 610, 620 so as to still provide a flow resistance for fluid flow from the corresponding variable volume chambers 710, 720, respectively. The reset slits allow a fast movement back towards the neutral position of the controlled valve assembly when the piston reverses its movement from inwards to outwards or vice versa. Fluid can easily escape from a variable volume chamber through the reset slits after having been filled by a respective fill flow F11, F21.

[80] The embodiment of figure 21 further comprises various stepped and curved surfaces cooperating with the three valve plates 550, 560, 570 and their openings to achieve a desired frequency-dependent damping behaviour. The controlled flow channel comprises channel parts 106, 206 connecting to the spaces 101.1, 202.1 in between first/upper central member 100 and first main non-return valve 111, and second/lower central member 200 and second main non-return valve 212, respectively, which spaces are in fluid connection with the first main channel 301, 101 and second main channel 302, 202, respectively.

[81] A very important parameter to maintain a desired frequency-dependency is the preload generated on the first and second controlled valves 560, 570. The functional surface areas of these valves in relation to the pressure upstream of the controlled valve assembly results in a displacement of the first and second controlled valves 560, 570 at their circumference associated with the respective valve seats 612, 622. The fluid pressure upstream of the controlled valve assembly results in a displacement of the movable valve body 600 and its valve seats 612, 622, which is further governed by the stiffness of a respective controlled valve plate 560, 570 and the damping pressure in a variable volume chamber. The displacement of the movable valve body in an equilibrium position is predominantly given by the fluid pressure upstream of the controlled valve assembly and the stiffness of the respective controlled valve plate, which displacement should be equal or even larger than the

displacement of the respective controlled valve plate to result in closure of that valve plate on its associated valve seat. In such equilibrium position there should be a positive preload on the respective controlled valve plate 560, 570 in the order of, for instance, 0 to 50 N. At a next pressure pulse upstream of the controlled valve assembly the respective controlled valve plate 560, 570 will open from its valve seat. A corresponding displacement of the movable valve body is damped by a damping pressure in the respective variable volume chamber and will therefore lag behind a displacement of the controlled valve plate, during which fluid passes the controlled valve assembly through the controlled valve channel. In an next equilibrium position the respective controlled valve plate 560, 570 will close again on its associated valve seat 612, 622. The embodiment of figure 21 has element providing a degressive behaviour to the damping valve and elements providing progressive behaviour to the damping valve. By careful tuning of the various parameters available in the design one can obtain a desired damping behaviour of the damping valve.

[82] The bidirectional frequency-selective valve in the embodiments shown is configured symmetric for the inward and outward directions, but may generally also be configured asymmetrically. The valve plates of the controlled valve assembly may further be clamped or not, as would be desirable in a specific configuration to reach a required damping behaviour.

CONCLUSIES

1. Een schokdemper (10) omvattende een cilinder (12) met een cilinderwand (12.1), en een zuiger (11) die afdicht tegen de cilinderwand en de cilinder verdeelt in een eerste en een tweede cilinderkamer (10.1, 10.2), welke zuiger beweegbaar is binnen de cilinder langs de cilinderwand in een binnenwaartse en een buitenwaartse richting (Mi, Mo) bij respectievelijk een binnenwaartse en een buitenwaartse beweging van de zuiger binnen de cilinder, waarbij een eerste zijde (11.1) van de zuiger is geassocieerd met de eerste cilinderkamer (10.1) en een tweede zijde (11.2) van de zuiger is geassocieerd met de tweede cilinderkamer (10.2), welke zuiger omvat

- een eerste hoofdkanaal (101, 301) en een eerste hoofdterugslagklep (111) geassocieerd met het eerste hoofdkanaal zodanig dat het eerste hoofdkanaal en de eerste hoofdterugslagklep een eerste hoofdfluïdumstroom (F10) mogelijk maken van de tweede zijde (11.2) naar de eerste zijde (11.1) van de zuiger;
- een tweede hoofdkanaal (202, 302) en een tweede hoofdterugslagklep (212) geassocieerd met het tweede hoofdkanaal zodanig dat het tweede hoofdkanaal en de tweede hoofdterugslagklep een tweede hoofdfluïdumstroom (F20) mogelijk maken van de eerste zijde (11.1) naar de tweede zijde (11.2) van de zuiger;
- een verbindingsdeel (300) omvattende een deel (301) van het eerste hoofdkanaal en een deel (302) van het tweede hoofdkanaal;
- een eerste centraal deel (100) omvattende een ander deel (101) van het eerste hoofdkanaal en opgenomen in het verbindingsdeel (300) aan een eerste zijde van het verbindingsdeel geassocieerd met de eerste zijde (11.1) van de zuiger zodanig dat de delen (301, 101) van het eerste hoofdkanaal in het verbindingsdeel en het eerste centraal deel uitgelijnd zijn; en
- een tweede centraal deel (200) omvattende een ander deel (202) van het tweede hoofdkanaal en opgenomen in het verbindingsdeel (300) aan een tweede zijde van het verbindingsdeel geassocieerd met de tweede zijde (11.2) van de zuiger zodanig dat de delen (302, 202) van het tweede hoofdkanaal in het verbindingsdeel en het tweede centraal deel uitgelijnd zijn.

2. De schokdemper volgens de voorgaande conclusie, waarbij het verbindingsdeel (300) is geconfigureerd voor beweging langs en afdichting tegen de cilinderwand (12.1).

3. De schokdemper volgens één of meer van de voorgaande conclusies, waarbij het verbindingsdeel omvat een ringvormig verbindingsdeel (300).

4. De schokdemper volgens één of meer van de voorgaande conclusies, waarbij de eerste hoofdterugslagklep (111) is verschaft op het eerste centraal deel (100).

5. De schokdemper volgens één of meer van de voorgaande conclusies, waarbij de tweede hoofdterugslagklep (212) is verschaft op het tweede centraal deel (200).

6. De schokdemper volgens één of meer van de voorgaande conclusies, waarbij het deel (301) van het eerste hoofdkanaal in het verbindingsdeel (300) tegenoverliggende uiteinden heeft, waarvan één uiteinde uitgelijnd is met het deel (101) van het eerste hoofdkanaal in het eerste centraal deel (100) en het andere uiteinde in fluïdumverbinding is met de tweede zijde (11.2) van de zuiger.

7. De schokdemper volgens één of meer van de voorgaande conclusies, waarbij het deel (302) van het tweede hoofdkanaal in het verbindingsdeel (300) tegenoverliggende uiteinden heeft, waarvan één uiteinde uitgelijnd is met het deel (202) van het tweede hoofdkanaal in het tweede centraal deel (200) en het andere uiteinde in fluïdumverbinding is met de eerste zijde (11.1) van de zuiger.

8. De schokdemper volgens één of meer van de voorgaande conclusies, waarbij

- een eerstecentraaldeelkanaal (105) is verschaft aan een zijde van het eerste centraal deel (100) geassocieerd met de tweede zijde (11.2) van de zuiger (11), welk eerstecentraaldeelkanaal in fluïdumverbinding is met de tweede zijde (11.2) van de zuiger,
- een tweedecentraaldeelkanaal (205) is verschaft aan een zijde van het tweede centraal deel (200) geassocieerd met de eerste zijde (11.1) van de zuiger (11), welk tweedecentraaldeelkanaal in fluïdumverbinding is met de eerste zijde (11.1) van de zuiger, en
- een hulpklep geconstrueerd en aangebracht tussen het eerste- en het tweedecentraaldeelkanaal (105, 205) teneinde een hulpfluïdumstroom te beïnvloeden tussen de eerst en de tweede zijde (11.1, 11.2) van de zuiger (11).

9. De schokdemper volgens de voorgaande conclusive, waarbij de hulpklep (400) is geconstrueerd en aangebracht in het comfortkanaal zodanig dat de hulpklep voorziet in een open verbinding voor de hulpfluïdumstroom door het eerste

en het tweede centraaldeelkanaal in een rustpositie van de hulpklep en de hulpfluïdumstroom geleidelijk afsluit bij toenemend drukverschil over de hulpklep bij zowel binnenwaartse als buitenwaartse beweging.

10. De schokdemper volgens één of meer van de voorgaande twee conclusies, waarbij het eerstecentraaldeelkanaal omvat een eerstecentraaldeelgroef (105) verschaft aan de zijde van het eerste centraal deel (100) geassocieerd met de tweede zijde (11.2) van de zuiger (11).

11. De schokdemper volgens één of meer van de voorgaande drie conclusies, waarbij het tweedecentraaldeelkanaal omvat een tweedecentraaldeelgroef (205) verschaft aan de zijde van het tweede centraal deel (200) geassocieerd met de eerste zijde (11.1) van de zuiger (11).

12. De schokdemper volgens één of meer van de voorgaande twee conclusies, waarbij de eerstecentraaldeelgroef (105) omvat een annulaire groef, de tweedecentraaldeelgroef omvat een annulaire groef, en de hulpklep (400) omvat een annulaire plaatklep.

13. De schokdemper volgens één of meer van de voorgaande vijf conclusies, waarbij het eerstecentraaldeelkanaal (105) in fluïdumverbinding is met het deel (101) van het eerste hoofdkanaal in het eerste centraal deel, waarbij in het bijzonder een eerste hulpkanaal (106) is verschaft in het eerste centraal deel (100), dat zich uitstrekt vanaf het eerstecentraaldeelkanaal (105) naar een zijde van het eerste centraal deel tegenover de zijde die het eerstecentraaldeelkanaal omvat, teneinde een fluïdumverbinding te verschaffen tussen het eerstecentraaldeelkanaal (105) en het deel (101) van het eerste hoofdkanaal in het eerste centraal deel.

14. De schokdemper volgens één of meer van de voorgaande zes conclusies, waarbij het tweedecentraaldeelkanaal (205) in fluïdumverbinding is met het deel (202) van het tweede hoofdkanaal in het tweede centraal deel, waarbij in het bijzonder een tweede hulpkanaal (206) is verschaft in het tweede centraal deel (200), dat zich uitstrekt vanaf het tweedecentraaldeelkanaal (205) naar een zijde van het tweede centraal deel tegenover de zijde die het tweedecentraaldeelkanaal omvat, teneinde een fluïdumverbinding te verschaffen tussen het tweedecentraaldeelkanaal (205) en het deel (202) van het tweede hoofdkanaal in het tweede centraal deel.

15. De schokdemper volgens conclusie 7, waarbij de hulpklep omvat

- een geregeldestromingskanaal (302, 205, 105, 301; 910), welk geregeldestromingskanaal omvat het eerste en het tweede centraaldeelkanaal;
- een geregeldeklepsamenstel (500) verschaft in het geregeldestromingskanaal teneinde, in gebruik, een geregelde fluïdumstroming (F15, F25) mogelijk te maken in het geregeldestromingskanaal in een geregeldestromingsrichting vanaf de eerste klepzijde naar de tweede klepzijde;
- een beweegbaar kleplichaam (600) dat beweegbaar is met betrekking tot een wand van het geregeldestromingskanaal en werkend op het geregeldeklepsamenstel teneinde veranderen mogelijk te maken van een stromingsweerstand voor de geregelde fluïdumstroming door het geregeldeklepsamenstel; en
- een variabelvolumekamer (710, 720), welk kleplichaam interacteerd met de variabelvolumekamer zodat beweging van het beweegbaar kleplichaam en een verandering in het volume van de variabelvolumekamer geïnterrelateerd zijn, waarbij de variabelvolumekamer een uitlaatopening (711, 721) omvat, in bedrijf, stroomafwaarts van het geregeldeklepsamenstel en geen opening omvat stroomopwaarts van het geregeldeklepsamenstel met betrekking tot de geregeldefluïdumstroming (F15, F25) in het geregeldestromingskanaal, welke uitlaatopening een stromingsweerstand verschaft, en een fluïdumdruk stroomopwaarts van het geregeldeklepsamenstel met betrekking tot de geregeldefluïdumstroming werkzaam is op het beweegbaar kleplichaam teneinde een kracht te induceren op het beweegbaar kleplichaam in een richting voor het doen toenemen van een fluïdumdruk in de variabelvolumekamer en een volume van de variabelvolumekamer te doen afnemen door fluïdumstroming vanuit de variabelvolumekamer door de uitlaatopening (711, 721), hetgeen een geïnterrelateerde beweging van het beweegbaar kleplichaam mogelijk maakt.

16. De demperklap volgens de voorgaande conclusie, waarbij het geregeldeklepsamenstel zodanig is geconfigureerd dat ten minste één van een effectieve opening en een sluitkracht van het geregeldeklepsamenstel wordt veranderd bij beweging van het beweegbaar kleplichaam teneinde de stromingsweerstand van de geregelde fluïdumstroming (F15, F25) door het geregelde klepsamenstel te veranderen.

17. De demperklep volgens één of meer van de voorgaande twee conclusies, waarbij het geregeldeklepsamenstel zodanig is geconfigureerd dat de stromingsweerstand voor de geregelde fluïdumstroming (F15, F25) door het

geregeldeklepsamenstel toeneemt bij afnemend volume van de variabelvolumekamer.

18. De demperklep volgens één of meer van de voorgaande drie conclusies, waarbij het geregeldeklepsamenstel zodanig is geconfigureerd teneinde veerachtig gedrag te vertonen en een kracht uit te oefenen op het beweegbaar kleplichaam in een richting om het beweegbaar kleplichaam terug te bewegen naar een neutrale positie wanneer het beweegbaar kleplichaam uit de neutrale positie is bewogen.

19. De demperklep volgens één of meer van de voorgaande vier conclusies, waarbij het geregeldeklepsamenstel omvat een geregeldeklepplaat, in het bijzonder een ringvormige geregeldeklepplaat.

20. De demperklep volgens één of meer van de voorgaande vijf conclusies, waarbij de geregeldeklepplaat omvat tegenover elkaar liggende randen, in het bijzonder tegenover elkaar liggende interne en externe perimeters van een ringvormige geregeldeklepplaat, en één of beide tegenover elkaar liggende randen in beweging beperkt zijn met betrekking tot één of beide van respectievelijk een wand van het geregeldestromingskanaal en het beweegbaar kleplichaam, waarbij in het bijzonder één of beide tegenover elkaar liggende randen ingeklemd worden door één of beide van respectievelijk een wand van het geregeldestromingskanaal en het beweegbaar kleplichaam.

21. De demperklap volgens één of meer van de voorgaande zes conclusies, waarbij het geregeldeklepsamenstel omvat een geregeldeklepplaat die interacteert met ten minste één gekromd oppervlak bij beweging van het beweegbaar kleplichaam met afnemend volume van de variabelvolumekamer teneinde een effectief oppervlaktegebied van de geregeldeklepplaat in het geregeldestromingskanaal geleidelijk te doen afnemen.

22. De demperklap volgens de voorgaande conclusie, waarbij de geregeldeklepplaat ten minste één opening omvat.

23. De demperklep volgens de voorgaande conclusie, waarbij de geregeldeklepplaat omvat ten minste één opening gepositioneerd en geconfigureerd teneinde geleidelijk te sluiten tegen het ten minste éne gekromde oppervlak bij beweging van het beweegbaar kleplichaam met afnemend volume van de variabelvolumekamer.

24. De demperklep volgens één of meer van de voorgaande drie conclusies, waarbij het beweegbaar kleplichaam omvat een gekromd oppervlak dat interacteert met de geregeldeklepplaat.

25. De demperklep volgens één of meer van de voorgaande vier conclusies, waarbij het beweegbaar kleplichaam omvat een eerste en een tweede beweegbarekleplichaamdeel, en de geregeldeklepplaat is ingeklemd tussen het eerste en het tweede kleplichaamdeel, en in het bijzonder ten minste één van het eerste en het tweede kleplichaamdeel een gekromd oppervlak omvat dat interacteert met de geregeldeklepplaat.

26. De demperklep volgens één of meer van de voorgaande vijf conclusies, waarbij de wand van het geregeldestromingskanaal een gekromd oppervlak omvat dat interacteert met de eerste klepplaat.

27. De demperklep volgens één of meer van de voorgaande conclusies 14-15, waarbij het geregeldeklepsamenstel omvat een geregeldeklepplaat die sluit tegen een klepzitting en waarvan een sluitkracht tegen de klepzitting wordt veranderd bij beweging van het beweegbaar kleplichaam, en in het bijzonder de klepzitting is verschaft op het beweegbare kleplichaam en de geregeldeklepplaat is gefixeerd met betrekking tot de wand van het geregeldestromingskanaal.

28. De demperklep volgens één of meer van de voorgaande conclusies 14-26, waarbij het geregeldeklepsamenstel bidirectioneel werkt voor een eerste en een tweede stroming in tegengestelde richtingen in het geregeldestromingskanaal, en omvat een eerste en een tweede geregeldeklepplaat respectievelijk geassocieerd met de eerste en tweede stroming, welke eerste en tweede geregeldeklepplaat elk sluiten tegen een respectieve klepzitting en waarvan een sluitkracht tegen de respectieve klepzitting wordt veranderd bij beweging van het beweegbaar kleplichaam, waarbij in het bijzonder de respectieve klepzittingen zijn verschaft op het beweegbaar kleplichaam en de eerste en de tweede geregeldeklepplaat zijn gefixeerd met betrekking tot de wand van het geregeldestromingskanaal.

29. De demperklep volgens de voorgaande conclusie, waarbij het geregeldeklepsamenstel omvat een derde geregeldeklepplaat geconfigureerd teneinde veergedrag te vertonen en een kracht uit te oefenen op het beweegbaar

kleplichaam in een richting om het beweegbaar kleplichaam terug te bewegen naar een neutrale positie wanneer het beweegbaar kleplichaam uit de neutrale positie is bewogen, waarbij in het bijzonder de derde geregeldeklepplaat is aangebracht tussen de eerste en de tweede geregeldekleplaat.

30. De demperklep volgens één of meer van de voorgaande conclusies 14-28, waarbij de variabelvolumekamer omvat een terugslagklep geassocieerd met een opening van de variabelvolumekamer stroomafwaarts van het geregeldeklepsamenstel, welke terugslagklep is geconfigureerd teneinde te sluiten bij de geregeldefluïdumstroming en te openen bij een fluïdumstroming in een richting tegengesteld aan de geregeldefluïdumstroming.

31. De schokdemper volgens één of meer van de voorgaande conclusies, waarbij het verbindingsdeel (300) omvat één van een sleuf en een uitsteeksel op de binnenomtrek daarvan, en ten minste één van het eerste en het tweede centraal deel (100, 200) omvat de andere van het uitsteeksel en de sleuf aan de buitenomtrek daarvan, welke sleuf en uitsteeksel zijn geconfigureerd teneinde samen te werken zodanig dat het verbindingsdeel en de ten minste ene van het eerste en het tweede centraal deel ten opzichte van elkaar uitlijnen.

32. De schokdemper volgens één of meer van de voorgaande conclusies, waarbij het verbindingsdeel (300) en ten minste één van het eerste en het tweede centraal deel (100, 200) in elkaar zijn gevat, in het bijzonder met een persvatting, zodanig dat een afdichtende vatting wordt verschaft.

33. De schokdemper volgens één of meer van de voorgaande conclusies, waarbij de zuiger (11) omvat meer dan één eerste hoofdkanaal (101, 301), en het verbindingsdeel (300) omvat een deel (301) van elk eerste hoofdkanaal uitgelijnd met een ander deel (101) van elk eerste hoofdkanaal omvat in het eerste centraal deel (100).

34. De schokdemper volgens één of meer van de voorgaande conclusies, waarbij de zuiger (11) omvat meer dan één tweede hoofdkanaal (202, 302), en het verbindingsdeel (300) omvat een deel (302) van elk tweede hoofdkanaal uitgelijnd met een ander deel (202) van elk tweede hoofdkanaal omvat in het tweede centraal deel (200).

35. De schokdemper volgens de voorgaande twee conclusies, waarbij de

delen (301, 302) van het eerste en het tweede hoofdkanaal in het verbindingsdeel (300) afwisselend in het verbindingsdeel zijn verschaft.

36. Een zuiger voor gebruik in een schokdemper volgens één of meer van de voorgaande conclusies, welke zuiger omvat

- een eerste hoofdkanaal (101, 301) en een eerste hoofdterugslagklep (111) geassocieerd met het eerste hoofdkanaal zodanig dat het eerste hoofdkanaal en de eerste hoofdklep een eerste hoofdfluïdumstroom (F10) mogelijk maken van de tweede zijde naar de eerste zijde van de zuiger;
- een tweede hoofdkanaal (202, 302) en een tweede hoofdterugslagklep (212) geassocieerd met het tweede hoofdkanaal zodanig dat het tweede hoofdkanaal en de tweede hoofdklep een tweede hoofdfluïdumstroom (F20) mogelijk maken van de eerste naar de tweede zijde van de zuiger;
- een verbindingsdeel (300) omvattende een deel van het eerste hoofdkanaal en een deel van het tweede hoofdkanaal, in het bijzonder een ringvormig verbindingsdeel;
- een eerste centraal deel (100) omvattende een ander deel (101) van het eerste hoofdkanaal en opgenomen in het verbindingsdeel (300) aan een eerste zijde van het verbindingsdeel geassocieerd met de eerste zijde (11.1) van de zuiger zodanig dat de delen (301, 101) van het eerste hoofdkanaal in het verbindingsdeel en het eerste centraal deel uitgelijnd zijn; en
- een tweede centraal deel (200) omvattende een ander deel (202) van het tweede hoofdkanaal en opgenomen in het verbindingsdeel (300) aan een tweede zijde van het verbindingsdeel geassocieerd met de tweede zijde (11.2) van de zuiger zodanig dat de delen (302, 202) van het tweede hoofdkanaal in het verbindingsdeel en het tweede centraal deel uitgelijnd zijn.

Fig. 1

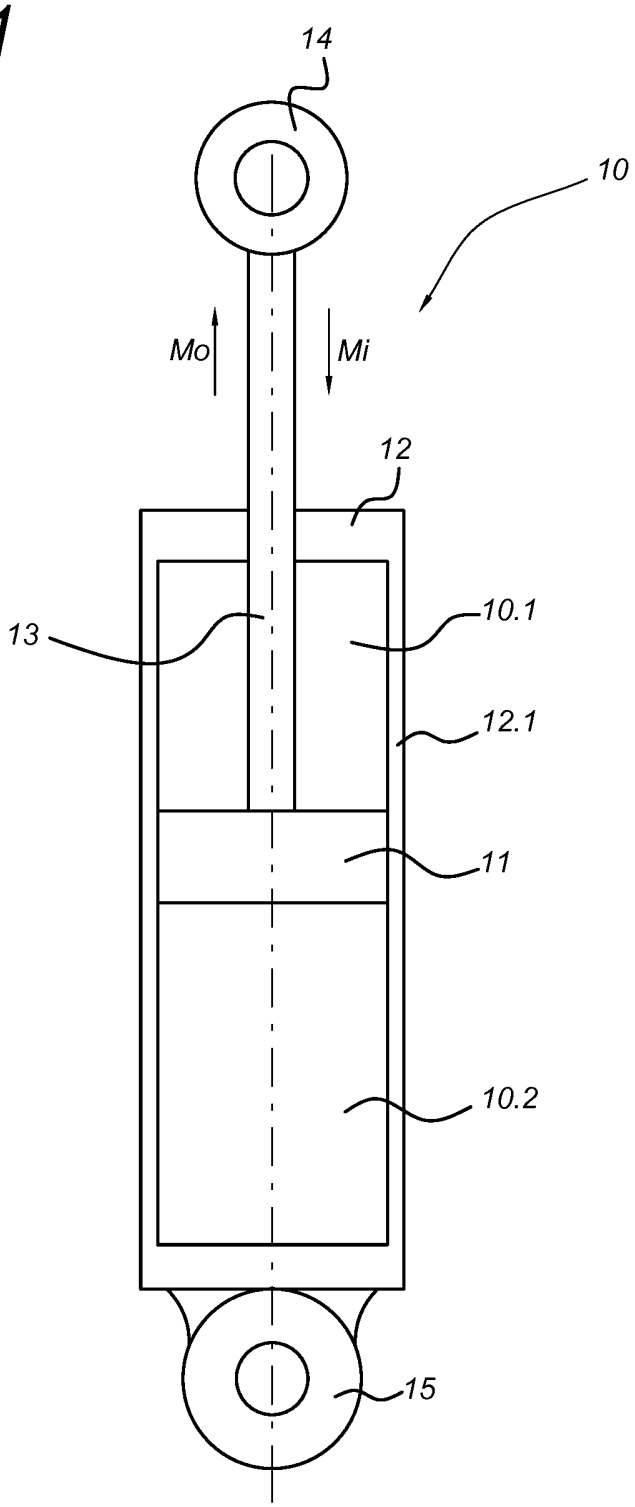
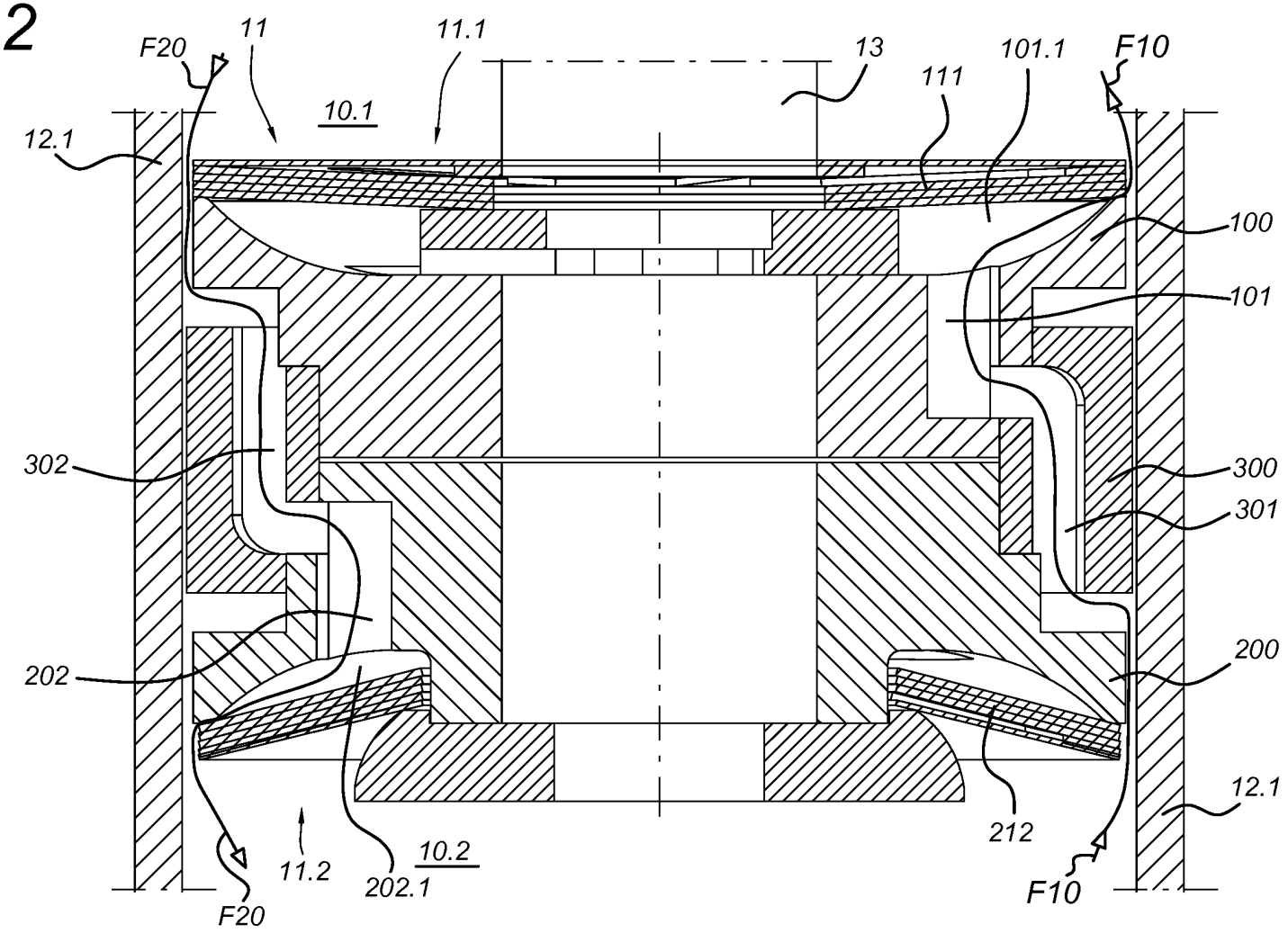


Fig. 2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101.1
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Fig. 3

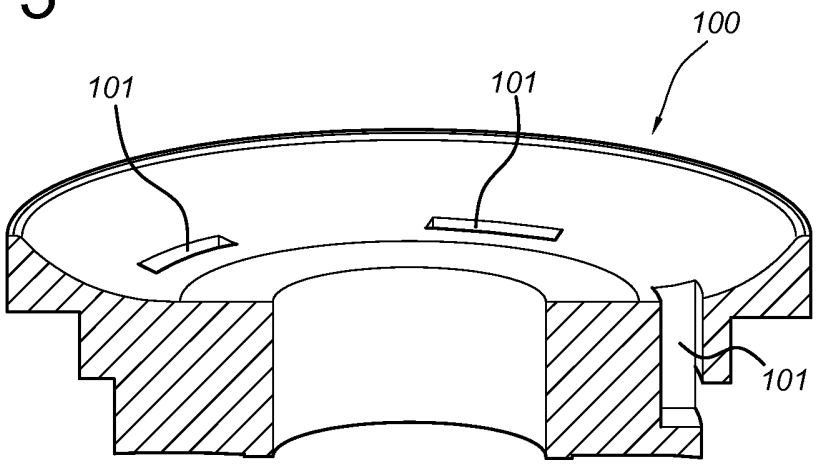
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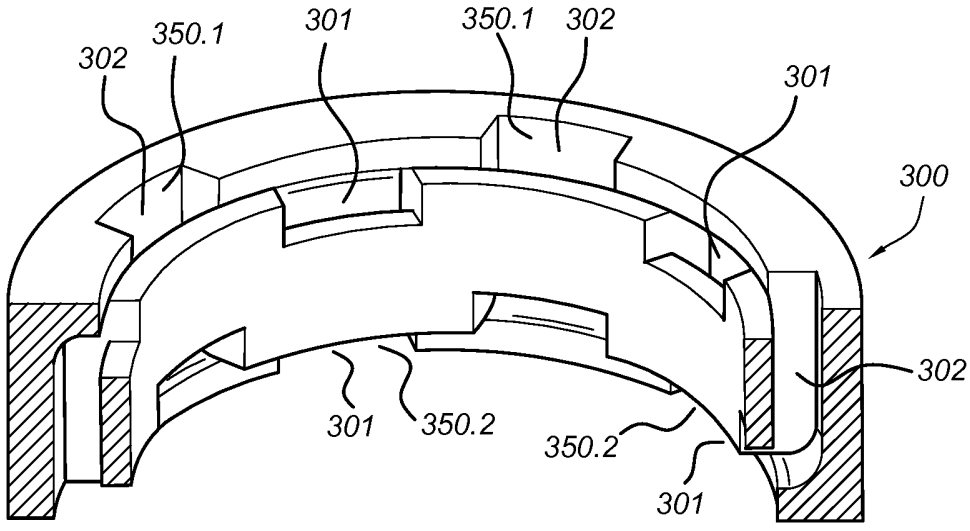
Fig. 4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301
350.2
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Fig. 5

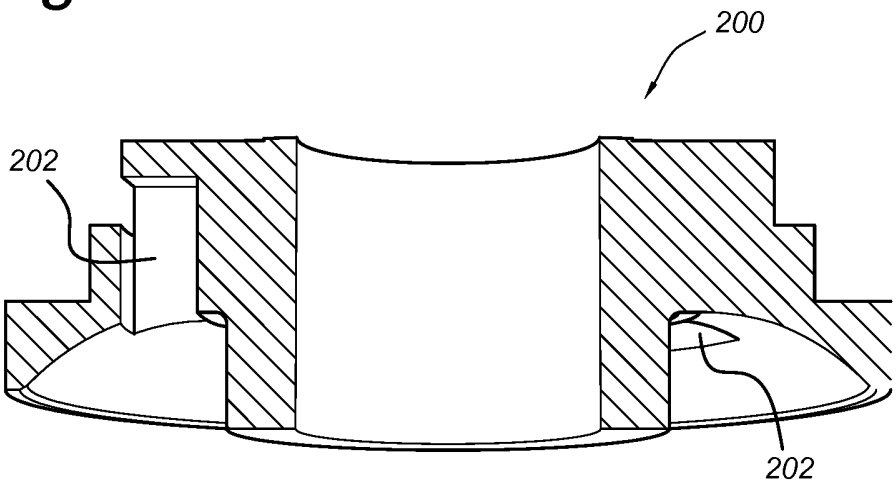

Fig. 7

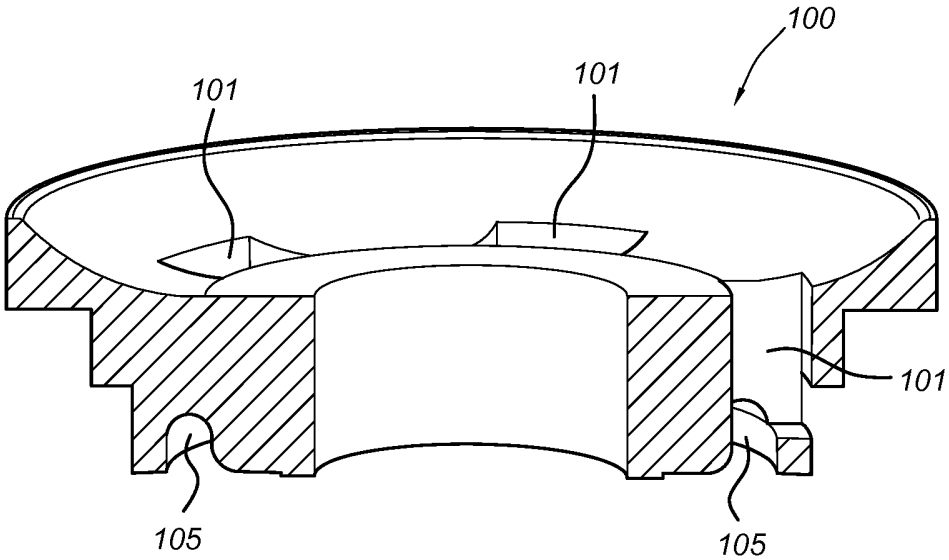

Fig. 6

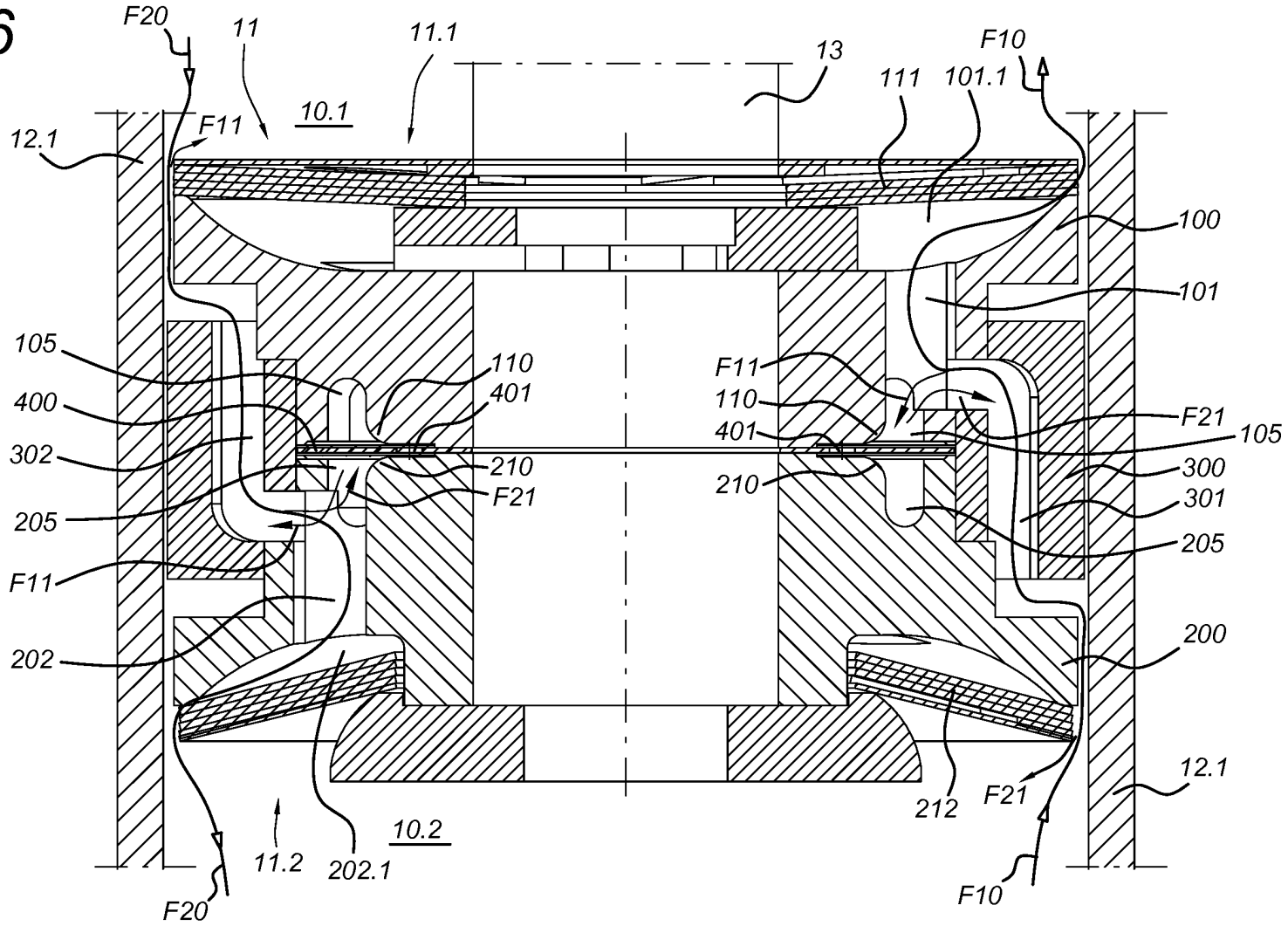
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Fig. 8a

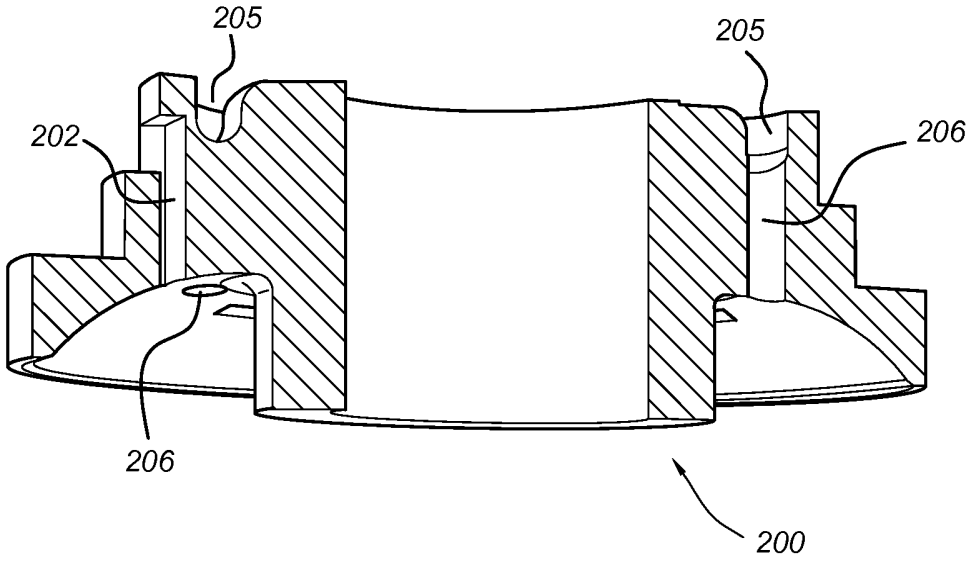

Fig. 8b

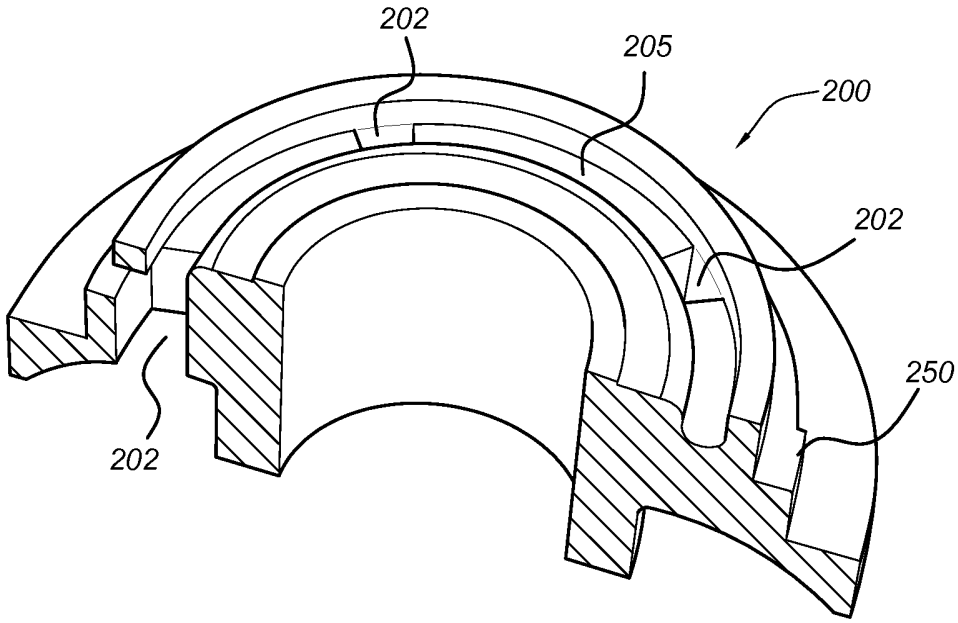

Fig. 9

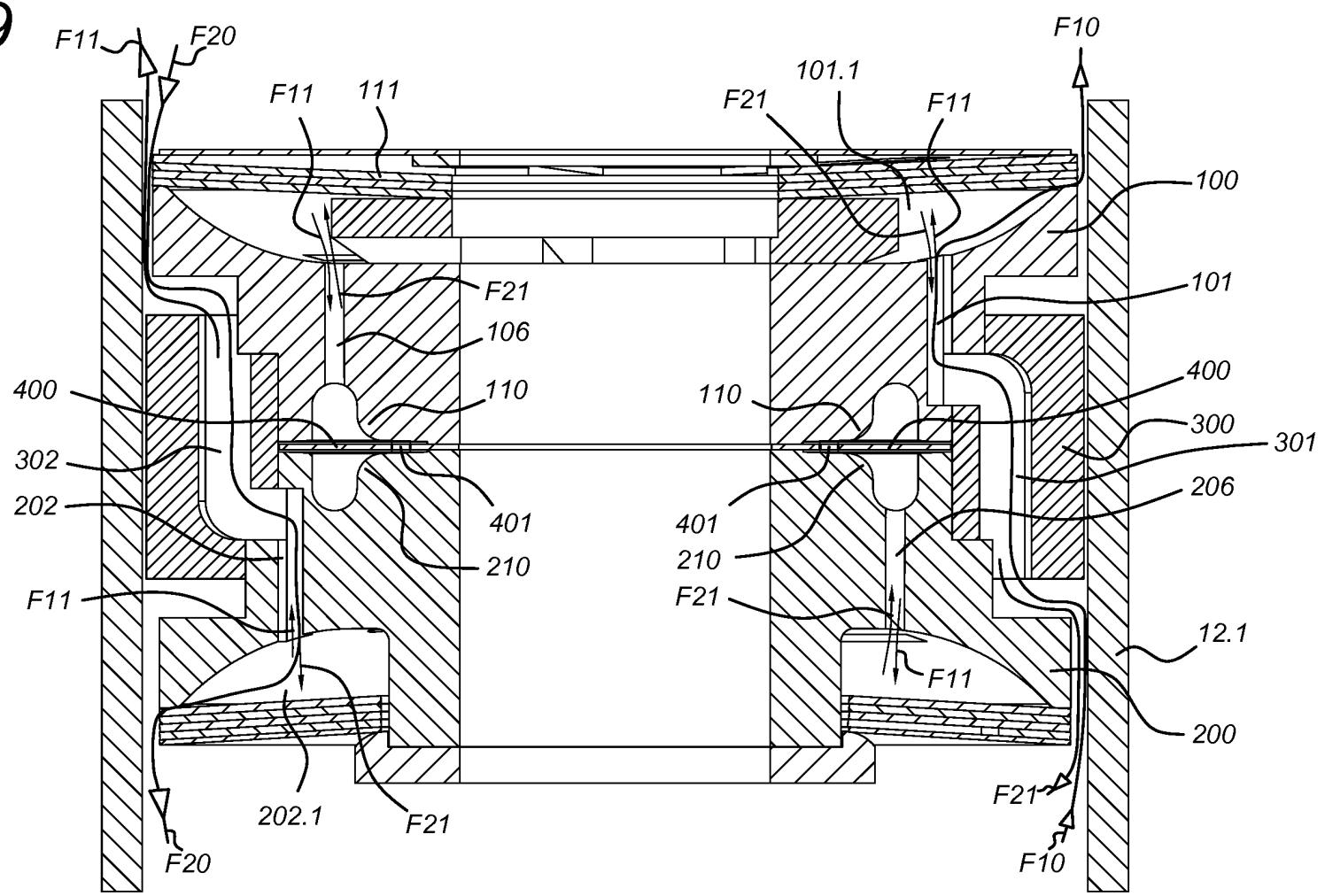
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Fig.10

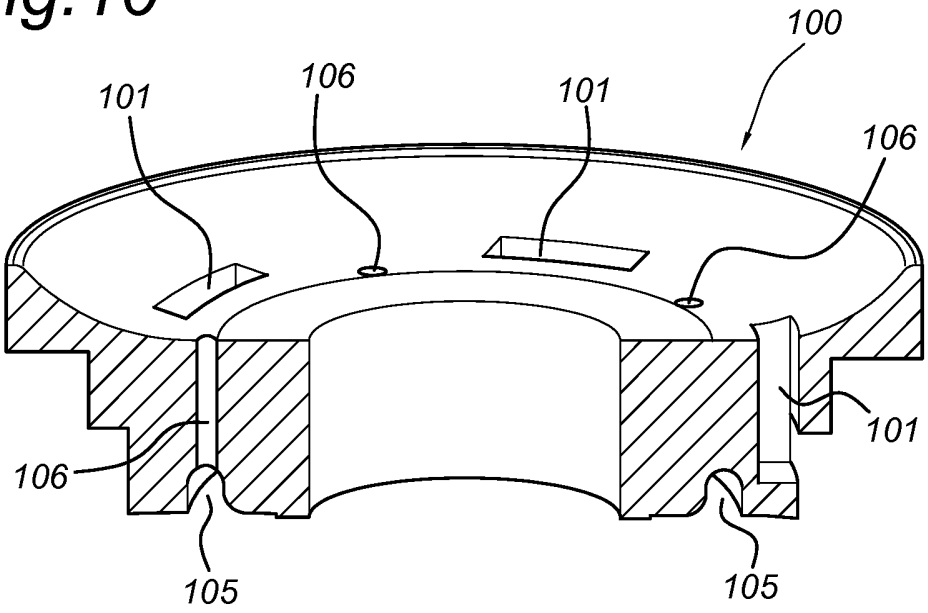

Fig.11

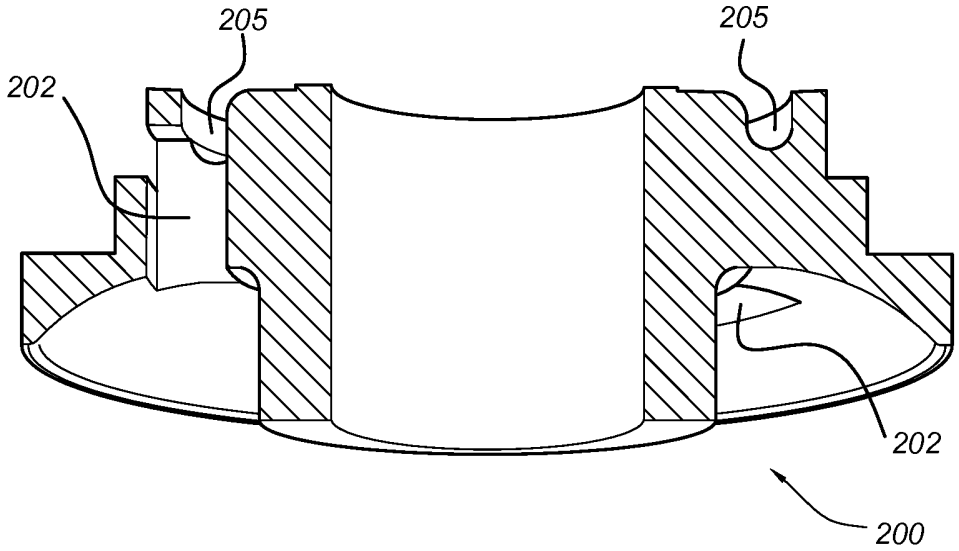

Fig.12a

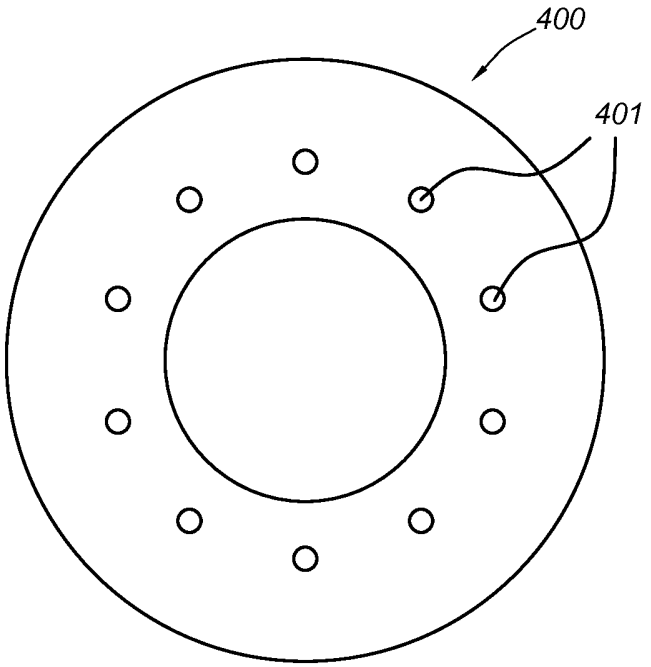

Fig.12b

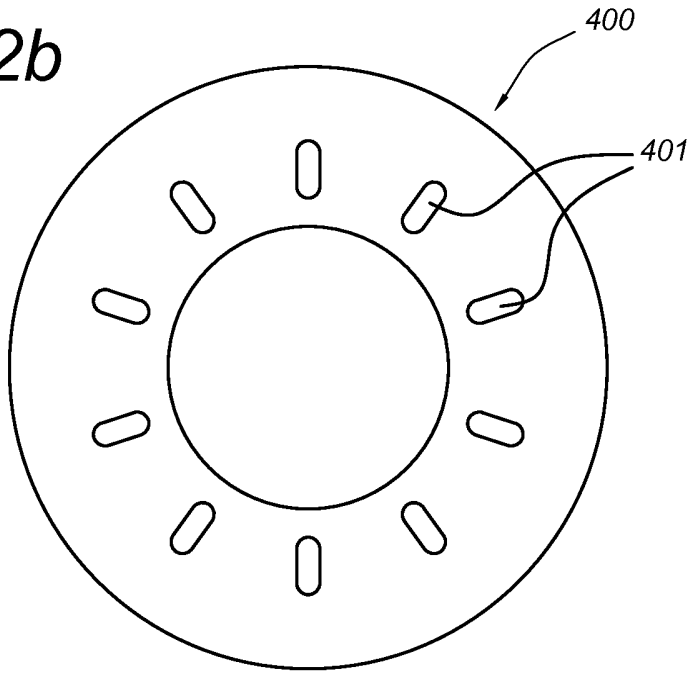

Fig. 13a

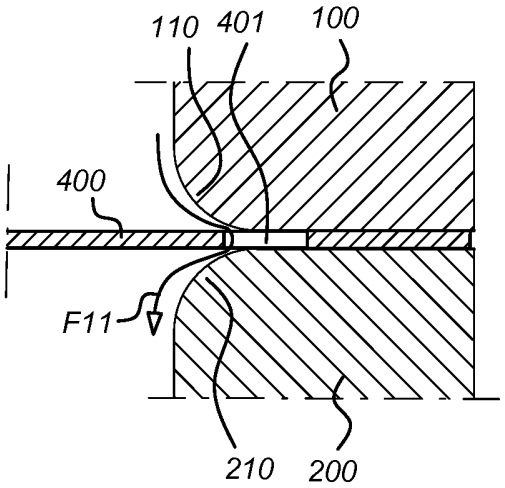

Fig. 13b

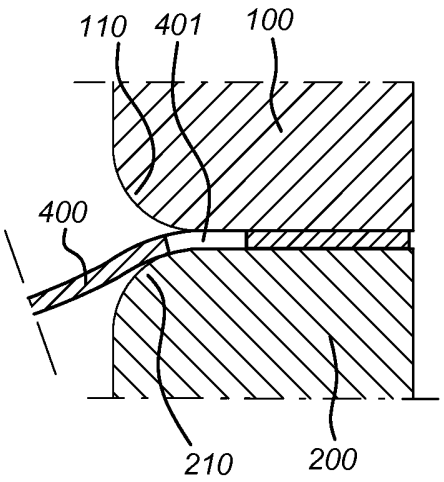

Fig. 14a

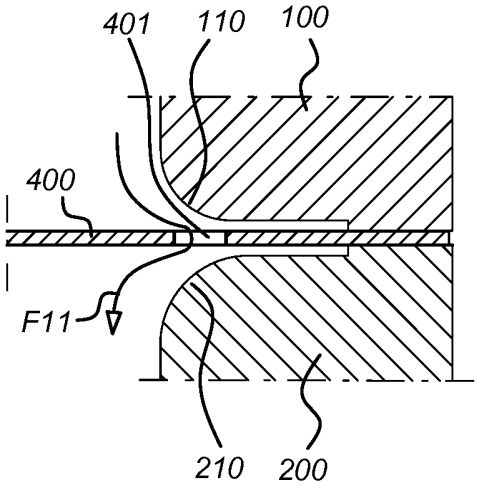

Fig. 14b

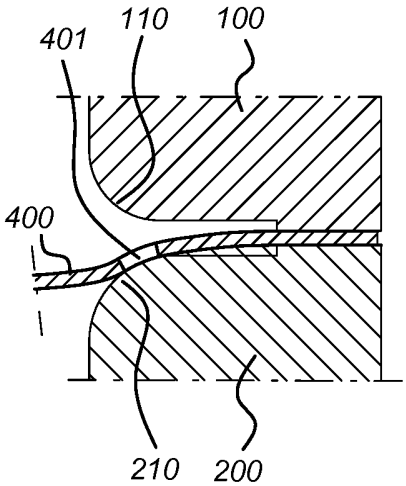

Fig. 15

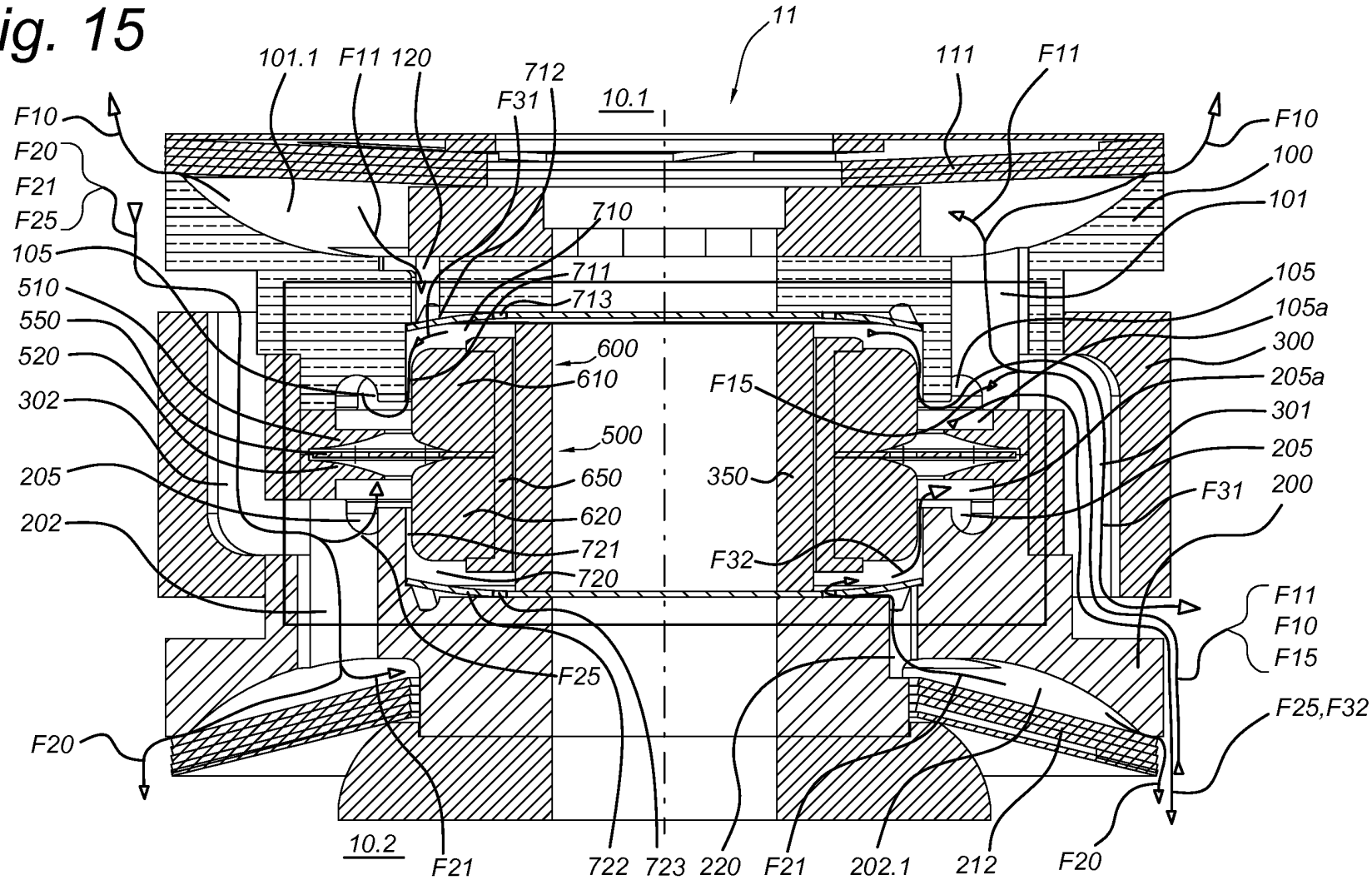
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Fig. 16

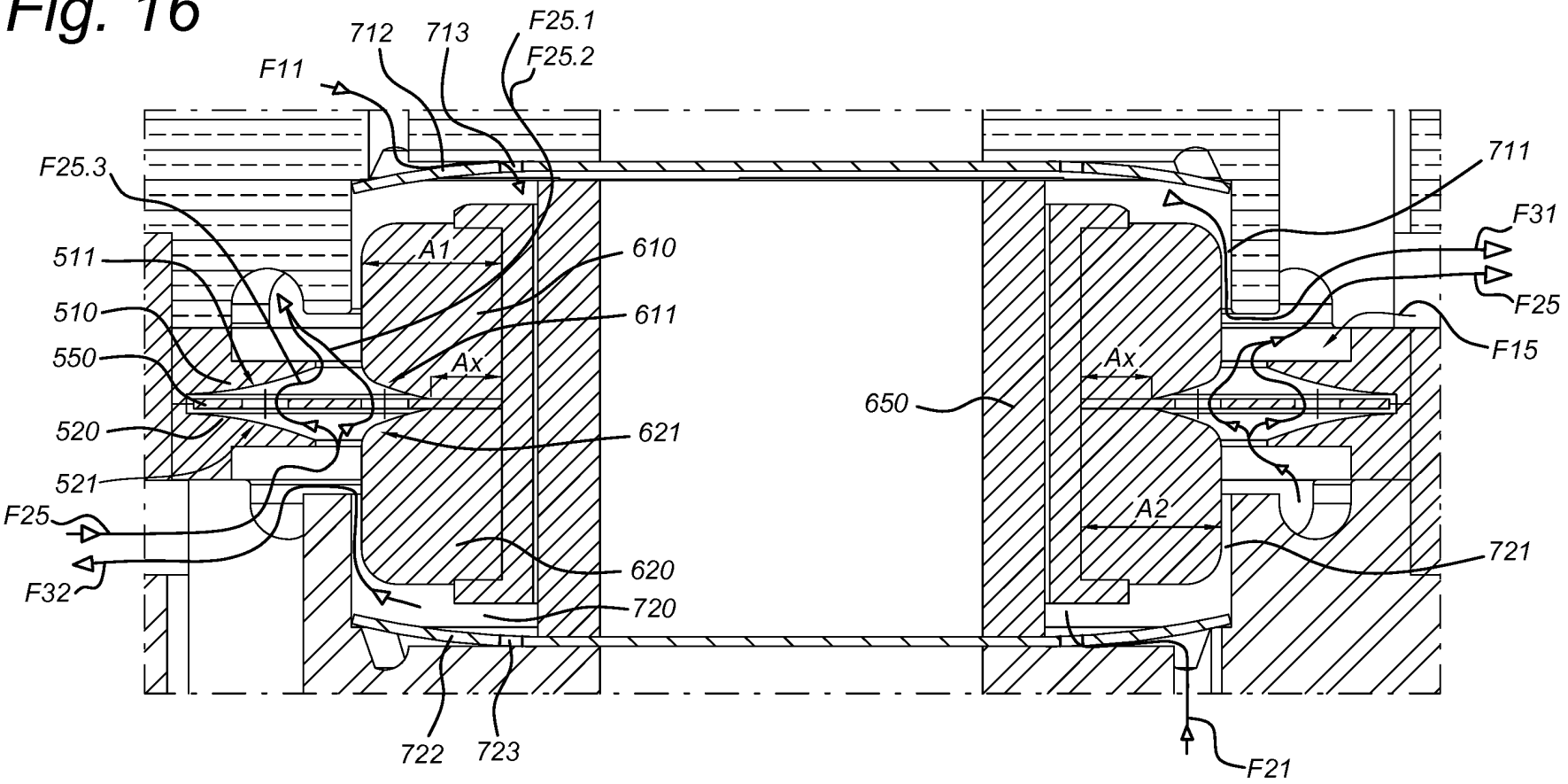
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Fig. 17

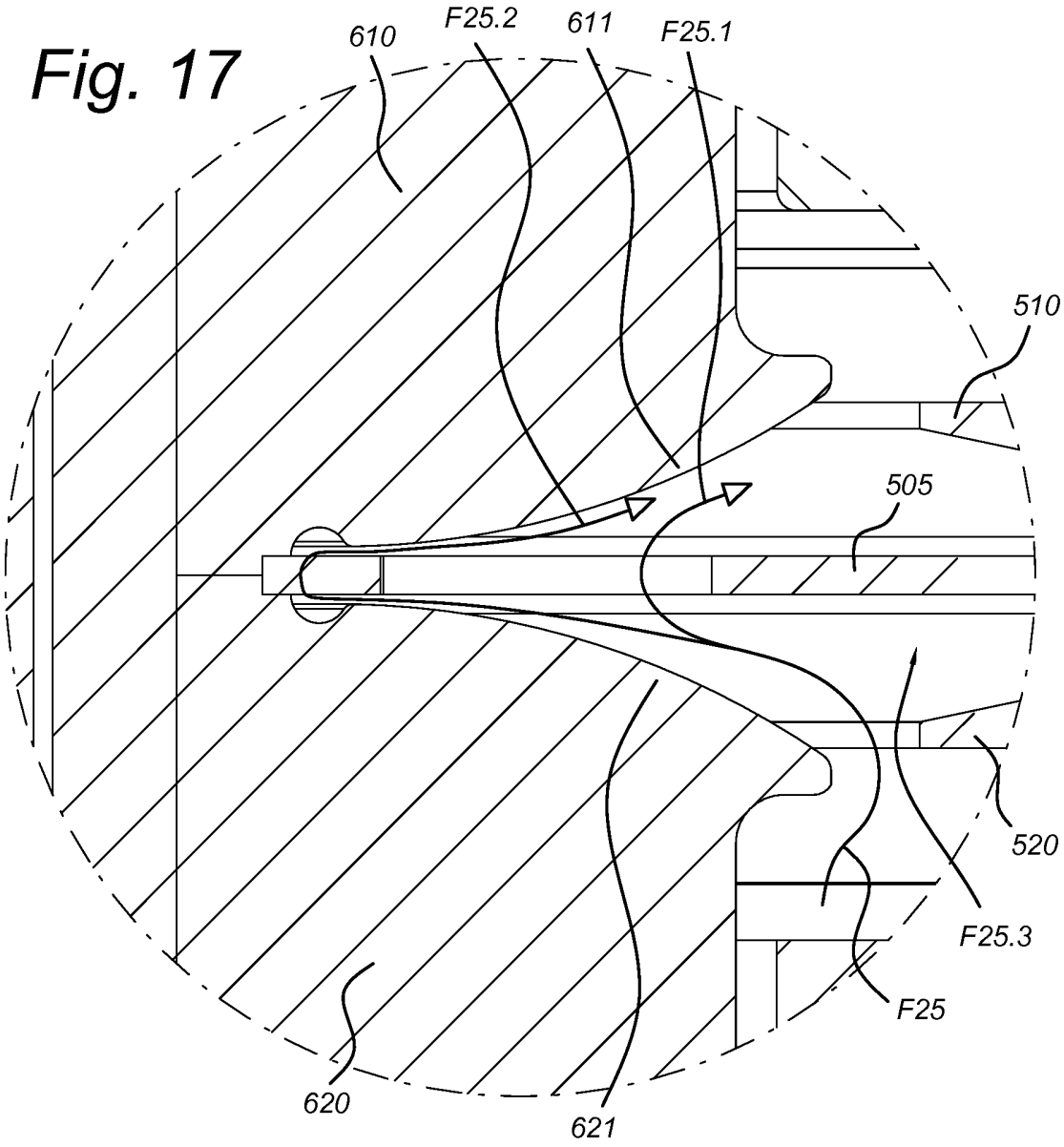
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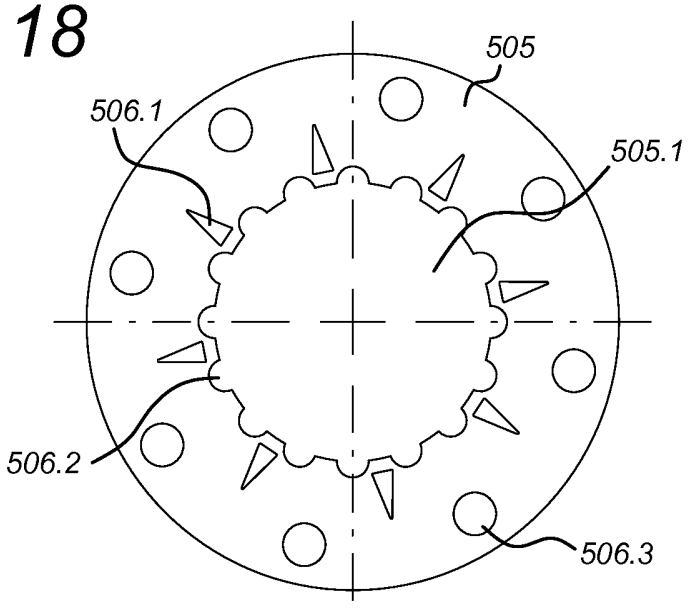
Fig. 18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505.1
506.2
506.3

Fig. 19

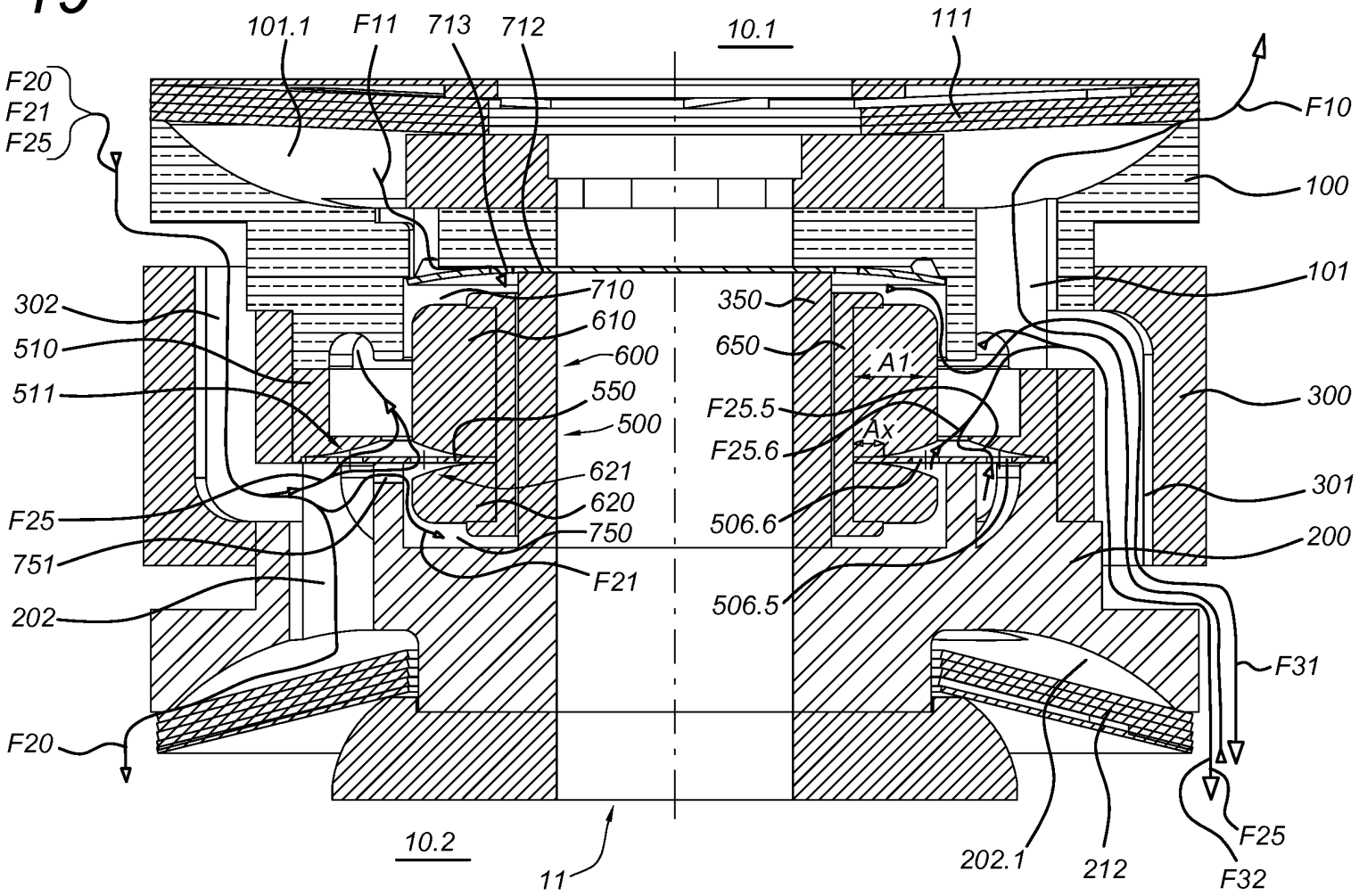
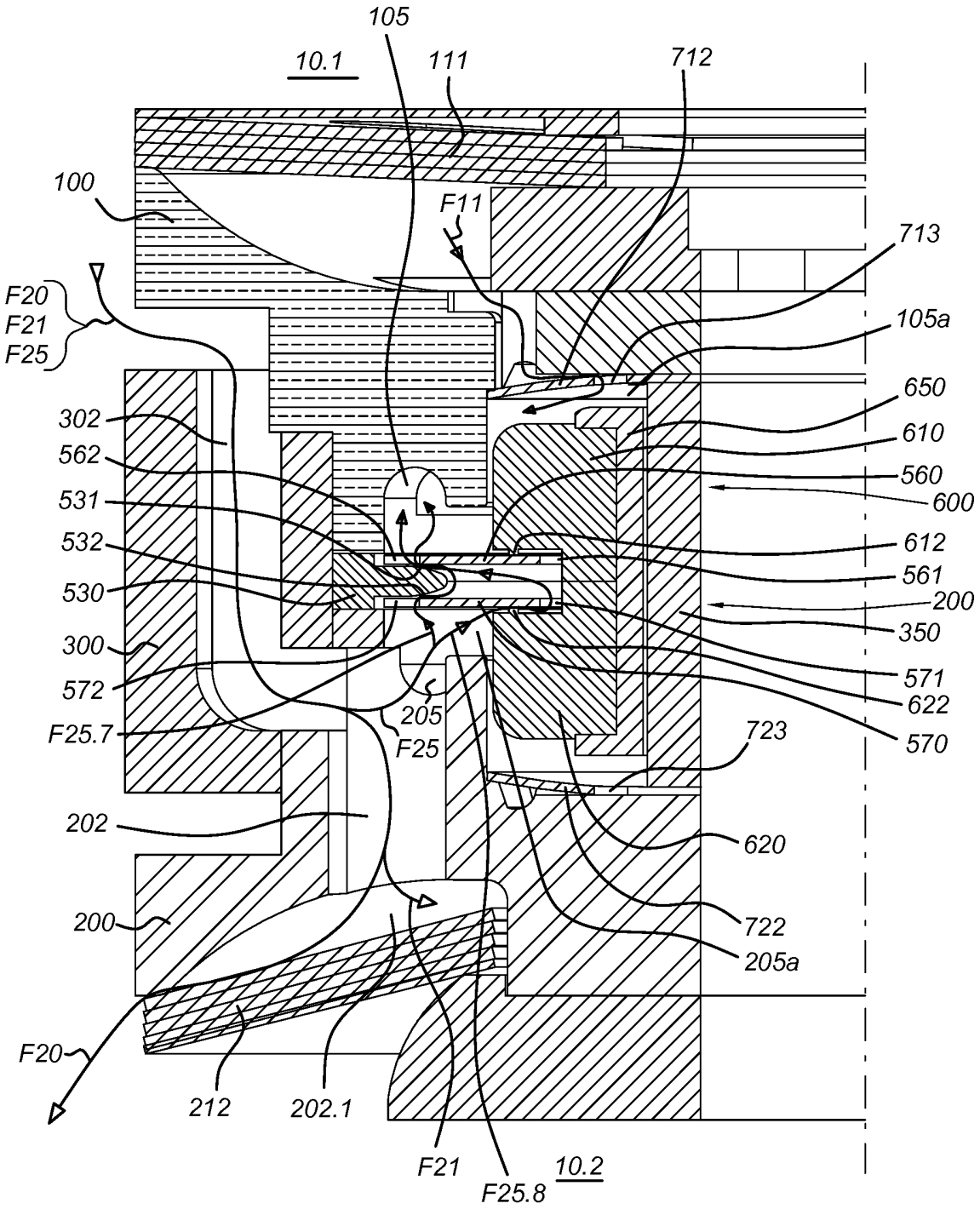

101.1
F11
713
712
10.1
111
F20
F21
F25
F10
100
101
302
710
610
600
350
650
A1
510
511
550
500
F25.5
Ax
F25.6
300
621
620
750
301
F25
751
F21
506.6
200
202
506.5
F31
F20
10.2
11
202.1
212
F25
F32

Fig. 20


105
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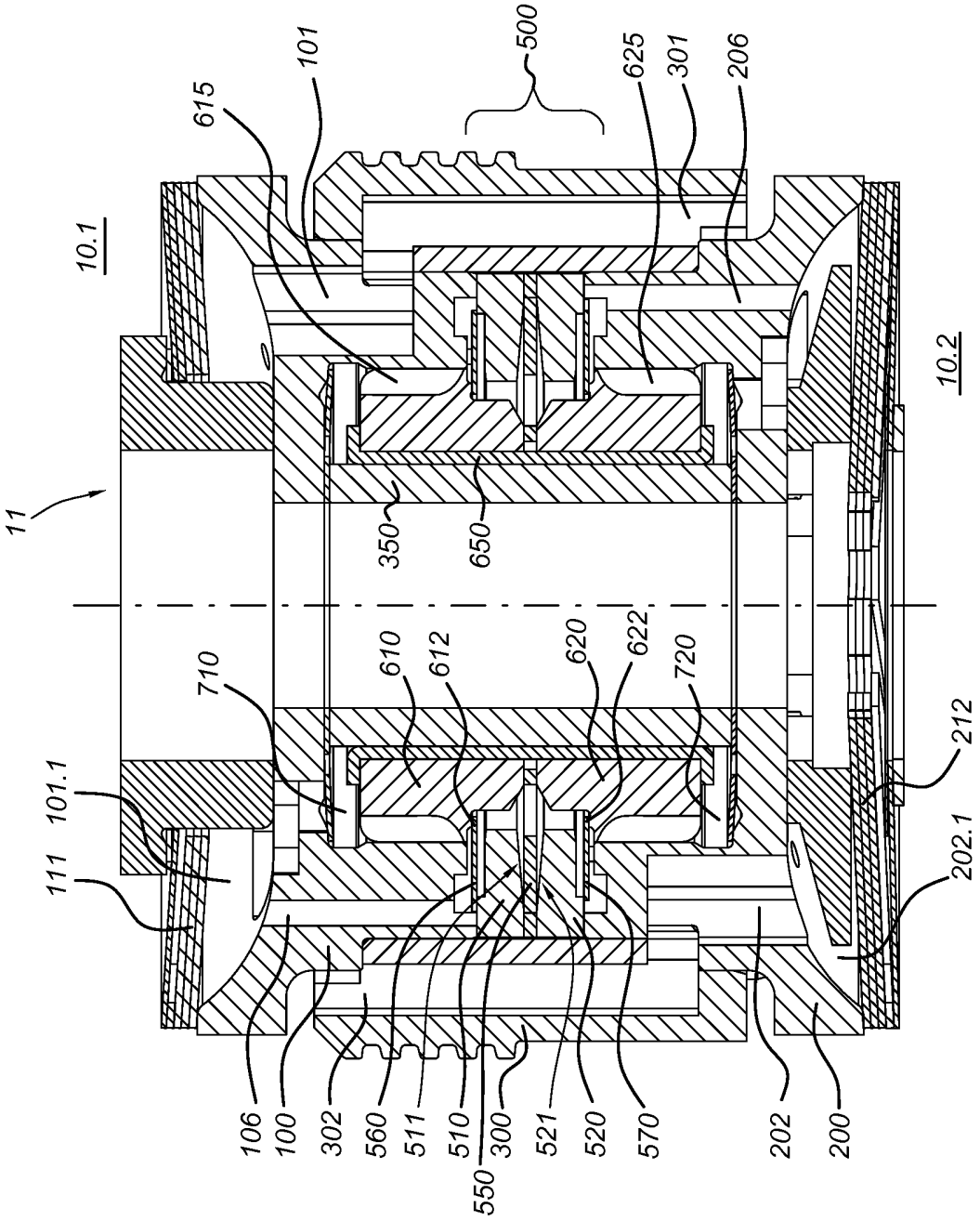
111
712
100
F11
713
F20
F21
F25
105a
650
302
610
562
560
531
600
532
612
530
561
200
350
300
571
572
622
205
F25.7
F25
570
723
202
620
200
722
205a
F20
212
202.1
F21
F25.8
10.2

Fig. 21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10.1
10.2
615
101
500
625
301
206
350
650
710
610
612
620
622
720
212
202.1
101.1
111
106
100
302
560
511
510
550
300
521
520
570
202
200

ABSTRACT

A shock absorber comprises a cylinder and a piston dividing the cylinder in first and second cylinder chambers, the piston being movable within the cylinder. The piston comprises a first main channel and a first main non-return valve allowing a first main fluid flow from the second to the first chamber; and a second main channel and a second main non-return valve allowing a second main fluid flow from the first to the second chamber. Further the piston comprises a connecting member comprising a part of the first main channel and a part of the second main channel; a first central member comprising another part of the first main channel and received into the connecting member such that the parts of the first main channel in the connecting member and the first central member are in line; and a second central member comprising another part of the second main channel and received into the connecting member such that the parts of the second main channel in the connecting member and the second central member are in line. The connecting member seals against the cylinder wall.

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
	P6056845NL
Nederlands aanvraag nr. **2015877**	Indieningsdatum **27-11-2015**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **Koni B.V.**	
Datum van het verzoek voor een onderzoek van internationaal type **09-07-2016**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN66767**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

F16F9/512

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC	**F16F**

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

III.	☐ **GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES**	(opmerkingen op aanvullingsblad)
IV.	☐ **GEBREK AAN EENHEID VAN UITVINDING**	(opmerkingen op aanvullingsblad)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2015877

A. CLASSIFICATIE VAN HET ONDERWERP
INV. F16F9/512
ADD.

Volgens de internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimum documentatie (classificatie gevolgd door classificatiesymbolen)
F16F

Onderzochte andere documentatie dan de minimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
EPO-Internal, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie *	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	EP 2 108 858 A2 (ZAHNRADFABRIK FRIEDRICHSHAFEN [DE]) 14 oktober 2009 (2009-10-14)	1-3, 8-14,31, 36
Y	* het gehele document *	15-30
A		4-7, 32-35

X	US 2015/152936 A1 (KIM HARK JOO [KR]) 4 juni 2015 (2015-06-04)	1-7, 31-36
A	* het gehele document *	8-30

Y	US 2005/056506 A1 (DEFERME STEFAN [BE]) 17 maart 2005 (2005-03-17)	15-30
A	* het gehele document *	1-14, 31-36

	-/--	

[X] Verdere documenten worden vermeld in het vervolg van vak C.

[X] Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

* Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid	Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type
31 oktober 2016	

Naam en adres van de instantie	De bevoegde ambtenaar
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Werth, Jochen

2

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2015877

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN

Categorie *	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
A	DE 103 21 351 A1 (THYSSEN KRUPP BILSTEIN GMBH [DE]) 9 december 2004 (2004-12-09) * het gehele document * -----	1-36
A	DE 10 2013 111502 A1 (THYSSEN KRUPP BILSTEIN GMBH [DE]) 23 april 2015 (2015-04-23) * het gehele document * -----	1-36
A	WO 2014/157041 A1 (KAYABA INDUSTRY CO LTD [JP]) 2 oktober 2014 (2014-10-02) * het gehele document * -----	1-36

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek: NL 2015877

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
EP 2108858 A2	14-10-2009	DE 102008001106 B3	18-06-2009
		EP 2108858 A2	14-10-2009
US 2015152936 A1	04-06-2015	CN 104696420 A	10-06-2015
		DE 102014009113 A1	11-06-2015
		KR 20150065058 A	12-06-2015
		US 2015152936 A1	04-06-2015
US 2005056506 A1	17-03-2005	BR PI0414445 A	14-11-2006
		CN 1871452 A	29-11-2006
		EP 1664578 A1	07-06-2006
		US 2005056506 A1	17-03-2005
		WO 2005036017 A1	21-04-2005
DE 10321351 A1	09-12-2004	GEEN	
DE 102013111502 A1	23-04-2015	DE 102013111502 A1	23-04-2015
		WO 2015055313 A1	23-04-2015
WO 2014157041 A1	02-10-2014	CN 105190083 A	23-12-2015
		DE 112014001675 T5	24-12-2015
		JP 5822359 B2	24-11-2015
		JP 2014190406 A	06-10-2014
		US 2016025180 A1	28-01-2016
		WO 2014157041 A1	02-10-2014

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN66767	27.11.2015		NL2015877

International Patent Classification (IPC)
INV. F16F9/512

Applicant
Koni B.V.

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the application
- ☐ Box No. VIII Certain observations on the application

Examiner
Werth, Jochen

Application number

WRITTEN OPINION

NL2015877

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	10-12, 15-30
	No:	Claims	1-9, 13, 14, 31-36
Inventive step	Yes:	Claims	
	No:	Claims	1-36
Industrial applicability	Yes:	Claims	1-36
	No:	Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 Reference is made to the following documents:

D1 EP 2 108 858 A2 (ZAHNRADFABRIK FRIEDRICHSHAFEN [DE]) 14 oktober 2009 (2009-10-14)

D2 US 2015/152936 A1 (KIM HARK JOO [KR]) 4 juni 2015 (2015-06-04)

D3 US 2005/056506 A1 (DEFERME STEFAN [BE]) 17 maart 2005 (2005-03-17)

D4 DE 103 21 351 A1 (THYSSEN KRUPP BILSTEIN GMBH [DE]) 9 december 2004 (2004-12-09)

D5 DE 10 2013 111502 A1 (THYSSEN KRUPP BILSTEIN GMBH [DE]) 23 april 2015 (2015-04-23)

D6 WO 2014/157041 A1 (KAYABA INDUSTRY CO LTD [JP]) 2 oktober 2014 (2014-10-02)

2 The present application does not meet the criteria of patentability, because the subject-matter of claim 1 is not new.

D1 discloses (cf. in particular Fig. 3):

Een schokdemper (1) omvattende een cilinder met een cilinderwand, en een zuiger (11) die afdicht tegen de cilinderwand en de cilinder verdeelt in een eerste en een tweede cilinderkamer (13, 15), welke zuiger beweegbaar is binnen de cilinder langs de cilinderwand in een binnenwaartse en een buitenwaartse richting bij respectievelijk een binnenwaartse en een buitenwaartse beweging van de zuiger binnen de cilinder, waarbij een eerste zijde van de zuiger is geassocieerd met de eerste cilinderkamer (13) en een tweede zijde van de zuiger is geassocieerd met de tweede cilinderkamer (15) welke zuiger omvat
- een eerste hoofdkanaal (91; also comprising the annular volume around the casing 11) en een eerste hoofdterugslagklep (87) geassocieerd met het eerste hoofdkanaal zodanig dat het eerste hoofdkanaal en de eerste hoofdterugslagklep een eerste hoofdfluidumstroom mogelijk maken van de tweede zijde naar de eerste zijde van de zuiger;
- een tweede hoofdkanaal (89; also comprising the annular volume around

the casing 11) en een tweede hoofdterugslagklep (85) geassocieerd met het tweede hoofdkanaal zodanig dat het tweede hoofdkanaal en de tweede hoofdterugslagklep een tweede hoofdfluidumstroom mogelijk maken van de eerste zijde naar de tweede zijde van de zuiger;
- een verbindingsdeel (the annular part enclosing casing 11) omvattende een deel van het eerste hoofdkanaal en een deel van het tweede hoofdkanaal (cf. Fig. 3);
- een eerste centraal deel (the upper part of casing 11 as shown in Fig. 3) omvattende een ander deel (the annular volume around the upper part of casing 11) van het eerste hoofdkanaal en opgenomen in het verbindingsdeel aan een eerste zijde van het verbindingsdeel geassocieerd met de eerste zijde van de zuiger zodanig dat de delen van het eerste hoofdkanaal in het verbindingsdeel en het eerste centraal deel uitgelijnd zijn; en
- een tweede centraal deel (the lower part of casing 11 as shown in Fig. 3) omvattende een ander deel (the annular volume around the lower part of casing 11) van het tweede hoofdkanaal en opgenomen in het verbindingsdeel aan een tweede zijde van het verbindingsdeel geassocieerd met de tweede zijdevan de zuiger zodanig dat de delen van het tweede hoofdkanaal in het verbindingsdeel en het tweede centraal deel uitgelijnd zijn.

In addition, also D2 discloses a damper with all features of claim 1.

3 The present application does not meet the criteria of patentability, because the subject-matter of claim 36 is not new in view of D1 and D2, see the according parts of claim 1 cited above.

4 Dependent claims 2-35 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of novelty and/or inventive step.

4.1 The additional features of claims 2-7 are already known at least from D2, such that the subject-matter of these claims ist not new.

4.2 The additional features of claims 8, 9, 13 and 14 are already known from D1, such that the subject-matter of these claims ist not new.

4.3 The features of dependent claims 10-12 have already been employed for the same purpose in D2. It would therefore be obvious to the person skilled in the art to apply this feature with corresponding effect to a damper according to D1.

4.4 The features of dependent claims 15-30 have already been employed for the same purpose in D3. It would therefore be obvious to the person skilled in the art to apply this feature with corresponding effect to a damper according to D1.

4.5 The additional features of claims 31-35 are already known at least from D2, such that the subject-matter of these claims ist not new.