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(54) **Washing machine**

(57) The invention relates to a washing machine comprising a tub (2), a draining circuit (16) fluidly connected to the tub (2) for draining fluid from the tub (2), a recirculation circuit (10) fluidly connected to a lower portion of the tub (2) for recirculating fluid from the lower portion of the tub (2) into the tub, and a filter element (28, 28', 28'') at an inlet (14) of the recirculation circuit (10) for preventing foreign objects to enter the recirculation

circuit, wherein the filter element (28, 28', 28'') comprises at least one filter aperture for letting pass fluid, and wherein the at least one filter aperture extends to a lateral border of the filter element (28, 28', 28''), such that the at least one filter aperture comprises an opening in its perimeter and/or the at least one filter aperture (34a-e) forms a at least two filter fingers (35a-d, 35a'-d', 35a''-f'') spaced one another.

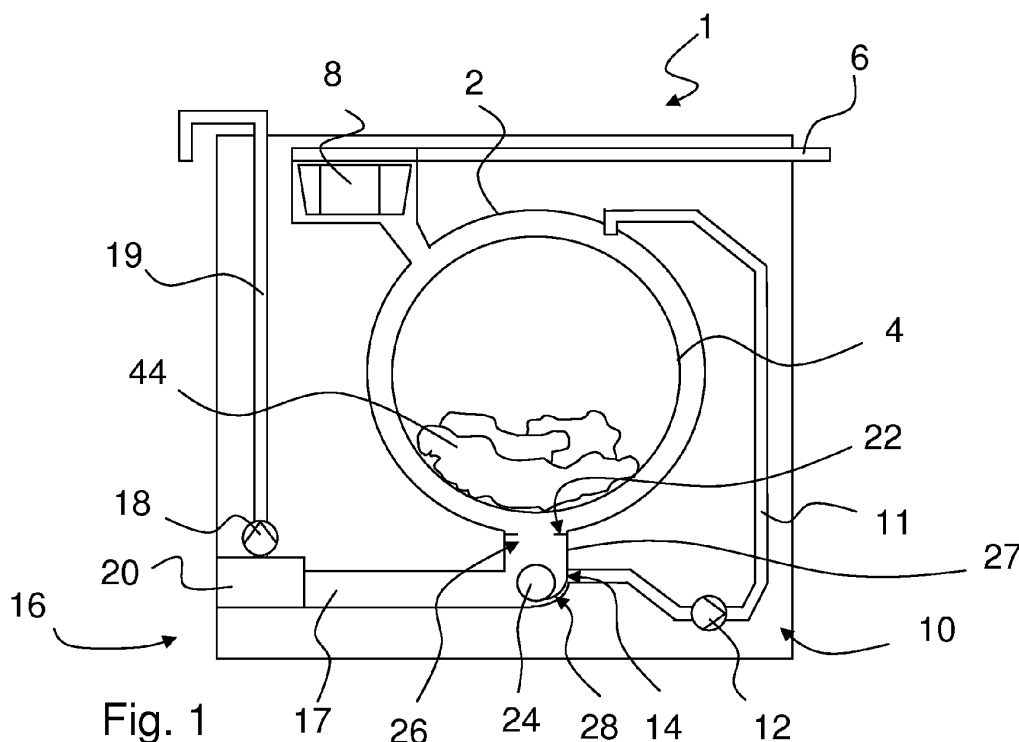


Fig. 1

Description

[0001] The invention relates to a washing machine (this expression including also a washing machine having dryer function), comprising a filter element for a recirculation circuit thereof.

[0002] DE 100 46 349 A1 discloses a washing machine having a draining circuit and a recirculation circuit for circulating washing water from a lower portion of a tub to an upper portion thereof. A fine mesh filter is spanned across the inlet of the recirculation circuit to prevent fluff to enter the recirculation circuit. The filter element is cleaned by a backflow of water through the recirculation circuit, wherein removed fluff is washed away by water flowing past the mesh filter during a draining phase.

[0003] EP 0 240 911 B1 discloses a removable filter for a washing machine. The washing machine comprises a recirculation circuit and a draining circuit fluidly connected to a tub via a conduit. The filter is placed at the outlet of the conduit such that washing water which is drained from the tub or which is circulated back into the tub passes through the filter. During a draining phase of a washing cycle the fluff fibers caught at a surface of a fine filter portion of the filter are removed by water flowing past the surface of the fine filter portion.

[0004] It is an object of the invention to provide a washing machine comprising an improved filter element for a recirculation circuit.

[0005] The invention is defined in claim 1. Particular embodiments are set out in the dependent claims.

[0006] In the following, when reference is made to 'water', the term 'water' may denote water as such, washing water, washing liquid, washing liquor or the like.

[0007] In the following, when reference is made to "washing machine", the term "washing machine" can denote a front-loading type or a top-loading type washing machine, both having or not also a dryer function.

[0008] According to claim 1, a washing machine comprises a tub and a draining circuit fluidly connected to the tub for draining water from the tub during at least one draining phase of a washing cycle. E.g. the draining circuit is connected or attached to the tub or the tub may comprise a sump and the draining circuit is attached or connected to the sump. A recirculation circuit is provided, which is fluidly connected to the tub for recirculating fluid from a lower portion of the tub to an upper or middle portion of the tub in at least one recirculation phase of a washing cycle. By recirculating the water repeatedly to the laundry it is not required to use a water level in the tub which is high enough to fully cover the laundry within the tub. Consequently the amount of water to be heated is reduced, whereby the energy consumption of the washing machine is reduced. A filter element of the washing machine is located upstream of an inlet of the recirculation circuit for preventing foreign objects (e.g. fluff, buttons, coins, etc.) to enter the recirculation circuit. Thus a clogging or blocking of the recirculation circuit and/or of a recirculation pump thereof is prevented by the filter

element. At least one filter aperture of the filter element to let pass water extends to a lateral border or perimeter (which may be a circumference if the filter has a circular shape) of the filter element. Thus the at least one filter aperture comprises an interrupted perimeter or an opening like a gap in its perimeter. Thereby the at least one filter aperture forms a spacing between at least two filter fingers, or stings forming filter or rake pins. When recirculating water through the recirculation circuit, fluff and other foreign objects are caught in the at least one aperture of the filter element or the at least two fingers of the filter element. When using a mesh filter element as described with respect to DE 100 46 349 or EP 0 240 911 B1, fluff and foreign objects might get entangled in the mesh, such that water flowing past or through the mesh filter cannot remove the entangled fluff any more. In this case the only possibility to clean the mesh filter is to replace it or to clean it mechanically or by hand. In contrast thereto, the opening in the perimeter of the at least one filter aperture or the filter fingers of the filter element prevent that fluff/foreign objects get entangled in the filter element. Thus the opening in the perimeter of the at least one filter aperture or the filter fingers assist in washing away fluff/foreign objects from the filter element, e.g. during a draining phase of the washing machine.

[0009] According to a preferred embodiment the filter element extends or protrudes at least partially or with a main section thereof into the draining circuit, the tub, or a sump of the washing machine. Thus the filter element is preferably attached to the washing machine in a cantilevered manner. I.e. only one part of the filter element is advantageously fixed or attached to the washing machine, such that the filter element is a self supporting or free-standing element. Consequently the filter element preferably does not extend across the entire cross-section of the drain circuit or sump of the washing machine. The cantilevered attachment, which results in a free end of the filter element, assists in washing fluff off the filter element into the draining circuit, tub or sump.

[0010] Preferably a gap is provided at least over a portion of an area between a lower surface of the filter element and the upper surface of a region below the filter element. This gap assists in washing away deposits and fluff from the filter element and the recirculation circuit when the draining circuit is operated and water is drained out of the washing machine.

[0011] In a preferred embodiment the filter element, at least a portion of the filter element, or a main section thereof, is adapted to deflect water flowing from the tub, in particular during a draining phase. Thus the filter element is adapted to redirect the drain water flow. E.g. water flowing from the tub in a draining phase hits the filter element or a portion thereof at an acute angle and is redirected by the filter element in direction to the draining circuit. Due to the impact of the water on the filter element or the water flowing onto or past the filter element fluff and foreign objects are effectively washed away from the filter element. Alternatively, if the filter element is ar-

ranged in the tub, in particular between a tub and a drum rotationally supported in the tub, a water flow in the tub, which may be caused by the rotation of the drum within the tub, flows past the filter element and assists thereby in washing away fluff from the filter element.

[0012] Preferably at least a portion of the filter element which is attached to or at the inlet, in particular to the draining circuit, the tub and/or sump, comprises a closed surface. Thus no opening or aperture is provided proximate to an attached portion of the filter element. The closed portion of the filter element can efficiently deflect water e.g. to the draining circuit. A free end of the filter element, which extends into the draining circuit, tub and/or sump preferably comprises the at least one filter aperture. Thus the filter element advantageously comprises a fork-like or rake-like shape, whereby the washing away of fluff from the filter element is facilitated.

[0013] Preferably the filter fingers or rake pins are aligned parallel to or are partially extending into a flow direction of water flowing from the tub to the draining pump when the draining pump is operating. Consequently, in a draining phase fluff and foreign objects are washed in direction of the opening in the at least one filter aperture or in direction of the free end of the at least two filter fingers. Thus the washing away of fluff is further facilitated. Preferably, but not necessarily, the opening in the perimeter of the at least one filter aperture takes up at least 1/16, 1/10, 1/5 or 1/4 of the perimeter of the at least one filter aperture. Thereby the gap is sufficiently large to allow e.g. fluff to be readily washed away from the filter element.

[0014] According to a preferred embodiment, the at least one aperture comprises a shape which is tapered from the opening in the at least one aperture to a base of the at least one aperture opposite to the opening. Thus the base of the at least one aperture is narrower than the opening in the perimeter of the at least one aperture. Or each of the at least two filter fingers are advantageously tapered from a base to the free end thereof. The narrowing of the cross-section of the at least one aperture in direction to the base of the at least one aperture assists in catching or trapping of fluff and foreign objects in the at least one aperture. In turn, the widening of the cross-section of the aperture from the base to the gap assists the removal or washing away of fluff or foreign objects which are caught in the aperture. For example the at least one filter aperture comprises a shape selected from rectangular, substantially rectangular, triangular, substantially triangular, semicircular or substantially semicircular.

[0015] Preferably the filter element comprises at least four filter fingers, preferably at least six filter fingers. However any number of filter fingers (odd or even, but clearly equal to or greater than two) may be provided. The apertures are preferably arranged parallel or substantially parallel to each other, such that the apertures form a rake-like filter element.

[0016] According to a preferred embodiment, the

washing machine comprises a valve having a valve body arranged between the tub and the draining circuit. When the valve is closed during a heating phase of a washing operation, water within the draining circuit is not heated. Thus the energy consumption of the washing machine is reduced.

[0017] In an embodiment the valve body is formed by the sump container or a portion thereof or by a portion of a draining suction duct connecting the tub to a draining pump. Thus the number of elements for providing the valve is reduced as compared to a valve having a separate body. In case the inlet of the recirculation circuit is arranged at a bottom or lower region of the valve body, the recirculation circuit has an improved ability to suck in undissolved detergent that has collected at the lower region of the valve body (e.g. sump or draining suction duct) due to gravity.

[0018] Preferably the filter element or the inlet of the recirculation circuit is placed downstream of the valve. In other words, the inlet of the recirculation circuit is positioned, with respect to the flow of water which exits the tub through the valve and goes to the draining circuit, after the valve (i.e. the water exiting the tub meets the inlet of the recirculation circuit after passing the valve). It may occur that undissolved detergent has passed the valve (e.g. during the water filling process when detergent is flushed into the tub) due to a not perfectly water-tight sealing of the valve. This detergent collects in the draining circuit substantially below the valve seat around the valve opening in the tub. The next time when the recirculation circuit is operated, the detergent collected in this way below the valve seat will be sucked in through the inlet of the recirculation circuit below (or downstream as seen from the tub) the valve, and is circulated back into the tub. Thereby the washing effect is enhanced, as detergent is more efficiently used instead of being drained from the washing machine. In other words less detergent gets lost in the draining circuit of the washing machine and therefore less detergent has to be used to achieve the same washing result. Thus the washing machine provides an economical washing operation with respect to energy and detergent consumption.

[0019] Preferably the valve body has the valve seat and a movable closure element adapted to be releasably engaged with the valve seat for closing the valve opening through the valve seat. The valve is preferably automatically closed or opened in dependency of a water level in the draining circuit and/or tub. In other words the valve is preferably adapted to be self*-actuated in dependency of a water level, for example by a closure element which is adapted to float in or on the (washing) water. E.g. the closure element floats on the water gradually filling the draining circuit or sump and is eventually pressed towards the valve seat by the rising water level, i.e. by buoyant force, and seals thereby the valve opening in the valve seat. Thereby the tub is shut off from the draining circuit, wherein a simple and robust valve is provided which is maintenance-free or substantially maintenance-

free.

[0020] According to a preferred embodiment a surface of the filter element facing the valve is shaped to receive or support the movable closure element of the valve on or at the surface. In a preferred embodiment the filter element partially or totally receives the closure element on its surface when water level is low and when the closure element is not longer buoyant on the water or is pressed down by flowing water. Due to the water flowing past the closure element a (mainly rotational) movement of the closure element occurs on or above the filter element, wherein a vortex is created which helps in removing fluff or other foreign objects from the filter element.

[0021] Preferably the movable closure element has a spherical or substantially spherical shape, such that it is adapted to engage with the valve seat in any (rotated) position. This is advantageous when the closure element is freely floating within the sump or draining circuit. Alternatively the closure element is formed e.g. by a hinged flap, e.g. like in a swing check valve, which is closed by buoyant force and water pressure.

However other kind of valves (e.g. electrically controlled) may be used for allowing/impeding water to flow from the tub to the draining circuit.

[0022] According to a preferred embodiment the filter element comprises, in at least one cross-section plane, a totally or partially arched or bent or hemispherical cross-section, and/or it is totally or partially concave in drain flow direction or as seen from the tub side. E.g. the filter element comprises a bowl-like form which assists in catching foreign objects and/or in supporting the movable closure element.

[0023] According to an alternative embodiment of a washing machine according to the invention, the inlet of the recirculation circuit, for example a pipe thereof, is attached to a lower portion of the tub, i.e. upstream the valve. Thus the filter element, which is located upstream the inlet, in this case advantageously extends into the tub, in particular into a space between the tub and a drum of the washing machine mounted therein. Also in this embodiment the filter element is cleaned by the water flowing past the filter element during the at least one draining phase of a washing cycle. Additionally, a rotational movement of the drum causes a flow or stream of washing water past the filter element in the tub and assists thereby in washing fluff or foreign objects from the filter element.

[0024] For the embodiments of the washing machine each isolated feature of the claims or description can be added or any arbitrary combination of isolated or individual features can be added to the claims.

[0025] Reference is made in detail to preferred embodiments of the invention, examples of which are illustrated in the accompanying figures, which show:

Fig. 1 a schematic cross-sectional front view of a washing machine according to the invention,

Fig. 2

a schematic cross sectional front view of the washing machine of Fig. 1 during filling of water into a tub thereof,

5 Fig. 3

a schematic cross sectional view of the washing machine of Fig. 1, wherein the tub is partially filled with water,

10 Fig. 4

a schematic cross sectional front view of the washing machine of Fig. 1 during a recirculation phase,

Fig. 5

a schematic cross sectional front view of the washing machine of Fig. 1 during a draining phase,

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Fig. 6

a perspective, partially cross-sectional side view of a part of an exemplary internal structure of a washing machine according to the invention,

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Fig. 7

a perspective, partially cross-sectional side view of the internal structure of the washing machine shown in Fig. 6,

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Fig. 8

a partial cross-sectional view of a detail of the structure of the washing machine shown in Fig. 6,

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Figs. 9a-d

perspective views and cross sectional views of a valve as shown in Fig. 6,

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Fig. 10

a cross-sectional side view of the valve of Figs. 9a-d in a closed state,

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Fig. 11

a cross-sectional side view of the valve of Fig. 9a-d in an opened state,

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Figs. 12a-d

perspective views of a filter element as shown in Figs 9a-d,

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Fig. 13

a schematic cross-sectional front view of a washing machine according to an alternative embodiment of the invention,

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Figs. 14a-b

a perspective view of an alternative embodiment of a filter element and a sectional side view of a valve with such a filter element, and

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Figs. 15a-b

a perspective view of another embodiment of a filter element and a sectional side view of a valve with such a filter element.

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[0026] Fig. 1 depicts a schematic cross-sectional front view of a washing machine 1 comprising a tub 2 with a drum 4 rotatably arranged therein. A draining circuit 16

is provided, preferably comprising a draining pump 18, a draining suction pipe 17, a draining riser pipe 19 and a draining filter 20. The draining suction pipe 17 is fluidly connected to the tub 2 to drain water, washing water, or fluid from the tub 2 during a draining phase when the draining pump 18 is operated. A valve 26 is advantageously provided, advantageously comprising a valve body 27; the valve 26 preferably comprises a valve seat 22 in form of a diaphragm with an opening, arranged between the tub 2 and the draining circuit 16. Advantageously, a movable closure element 24, for example a ball, which is freely moveable or floatable in the valve body 27, is adapted to engage with the valve seat 22 to shut the tub 2 from the draining circuit 16. The movable closure element 24 is made of floatable material e.g. plastic and floats on the water depending on the water level in the draining suction pipe 17 or valve body 27. When the water level rises, the movable closure element 24 is raised towards the valve seat 22 until the surface of the movable closure element closes the opening at the valve seat 22. The valve seat may be formed in a diaphragm or plate as shown in Fig. 1. In the depicted embodiment the draining suction pipe 17 is pipe-shaped and forms (at least part of) the sump and the valve body 27 connected to the lowest point for the tub 2. However in other embodiments the draining suction pipe 17 may have different shapes, at least in the region directly below the opening of the tub.

[0027] In a heating phase of a washing cycle the water in the tub 2 is advantageously heated by a heating element (not shown) arranged in the tub. When the valve 26 is closed, only the water in the tub 2 is heated but not the water in the draining circuit 16, whereby the energy consumption of the washing machine is reduced.

[0028] A recirculation circuit 10 is provided to circulate water or washing water from a lower portion of the tub 2 to an upper portion of the tub 2 (as in the embodiment shown), or to a middle portion of the tub. The recirculation circuit 10 preferably comprises a suction pipe 13 preferably fluidly connected to the draining suction pipe 17 (forming the sump), a recirculation pump 12 and a recirculation pipe 11. When the recirculation pump 12 is operated, the laundry 44 in the tub 2 is efficiently wetted without having to provide an amount of water in the tub 2 which completely (or even partially) covers the laundry 44. I.e. on the one hand the water consumption during a washing cycle is reduced and on the other hand, due to reduced water consumption, less water has to be heated, whereby the energy consumption is reduced.

[0029] The recirculation pump 12 and the draining pump 18 may be not watertight. Thus the water level in the recirculation pipe 11 and the draining riser pipe 19 corresponds to the water level in the tub 2 or draining suction pipe 17 when the pumps 12 and 18 are not operated and the valve 26 is open.

[0030] A filter element 28 is advantageously arranged downstream the valve seat 22 in front of an inlet 14 of suction pipe 13 of the recirculation circuit 10. When the

recirculation pump 12 is operated, the water passes the filter element 28 before it enters the recirculation circuit 10. The filter element 28 prevents that fluff and foreign objects which may pass through the opened or partially opened valve 26 enter the recirculation circuit 10, where they might obstruct a nozzle at the outlet of the recirculation pipe 11 or the recirculation pump 12. When no water is in the draining circuit 16, and/or when the recirculation pump 12 is operated and/or when the water level is low, the movable closure element 24 rests on the bottom of the valve body 27 and/or on the filter element 28.

[0031] Fig. 2 depicts a schematic cross sectional front view of the washing machine of Fig. 1 at the beginning of a washing cycle. As depicted by arrows, tap water flows into the tub 2 via a water inlet 6. The tap water flows through a detergent drawer 8, from where it carries detergent into the tub 2 and drum 4 as indicated with the arrows. In this state the water level 42a is in a range where the movable closure element 24 is not abutting the valve seat 22 such that the valve 26 is open. Thus the water fills the draining circuit 16 and partially the recirculation circuit 10.

[0032] Fig. 3 depicts a schematic cross sectional view of the washing machine of Fig. 1 during a phase of the washing cycle when the tub 2 is filled with water up to the maximum water level 42b for the selected washing program. In this phase the draining pump 16 and the recirculation pump 12 are not activated. The washing water has reached maximum level 42b which partially covers the laundry 44 in the tub 2. While the water level was rising from level 42a to 42b and due to the hydrostatic buoyant force, the movable closure element 24 is pushed or pressed against the valve seat 22 and closes thereby the valve 26. The valve 26 provides a simple and robust way for automatically shutting off the tub 2 from the draining circuit 16 during those phases of the washing cycle, in which the pumps 12, 18 are not operated and in which the water level has a minimum height to press the movable closure element 24 against the valve seat 22. In particular the valve 26 is preferably closed during a heating phase when the water is filled to close the valve and when no pumps are operated.

[0033] Fig. 4 depicts a schematic cross sectional front view of the washing machine 1 of Fig. 1 during a recirculation phase of a washing cycle. The recirculation pump 12 is activated and pumps the washing water from the sump or the draining suction pipe 17 to the outlet of the recirculation pipe 11 (which may have a nozzle) which is connected to the interior of the tub 2. While operating the recirculation circuit 10, recirculation pipe 11 is filled with water and the water level drops from maximum level 42b to an intermediate washing level 42c. As shown in the embodiment of Fig. 4, the recirculation circuit feeds the water into the tub 2 and onto the drum 4. The drum 4 comprises holes or perforations through which the washing water enters the drum 4 and wets the laundry 44. Alternatively the recirculation circuit 10 feeds the water directly into the drum 4 through an outlet at a rotational

axis of the drum 4 (Fig. 6). In another embodiment the outlet of pipe 11 or nozzle is arranged at a loading door of front-loader washing machine such that the recirculated water can be sprayed or sprinkled through the loading opening of the drum directly into the drum and the laundry 44 therein (not shown).

[0034] It may happen that detergent, in particular powder detergent, is not completely dissolved at the beginning of a washing cycle. For example at the beginning of flushing in the detergent by flowing tap water through the detergent drawer 8 and before the water level is high enough to close the valve 26 (see e.g. water level 42a), some detergent may remain undissolved and can be flushed along the tub inner wall through the opening in the seat 22 into the sump or draining suction pipe 17. There it may collect due to gravity. Additionally, even if the water level is high enough to close the valve 26, undissolved detergent collecting at the lowest point of the tub 2 may enter the draining circuit if valve 26 not perfectly closes the opening in the seat 22. E.g. during drum rotation operation of the washing machine.

[0035] As indicated in Fig. 4, the activated recirculation pump 12 creates a suction force on its suction side which opens or partially opens the valve 26 due to the pressure difference acting on the movable closure element from above and below and the movable closure element's buoyant force. The movable closure element 24 is moved away from its seat 22. Thereby water can be pumped from the tub 2 although the inlet 14 of the recirculation circuit 10 is placed downstream the valve seat 22. I.e. the valve 26 is automatically opened during a recirculation phase of a washing cycle by the suction force of the recirculation pump 12. Referring to the collection of detergent in the sump or the draining suction pipe 17 described before, as the inlet 14 of the recirculation circuit 10 is placed below or downstream the valve seat 22, any detergent deposited or collected in the sump or pipe 17 is recirculated back into the tub 2 when operating the recirculation circuit, whereby the detergent is effectively and efficiently used for the washing cycle.

[0036] Fig. 5 depicts a schematic cross sectional front view of the washing machine 1 of Fig. 1 during a draining phase of a washing cycle. The flow of the washing water is depicted with arrows. The suction force of the draining pump 18 on its suction side opens the valve 26 and the draining pump 18 pumps water from the tub 2 and also from the recirculation circuit 10 through the draining riser pipe 19 and out of the washing machine 1. The washing water exiting the tub 2 and flowing past the filter element 28 cleans the filter element 28, i.e. washes or flushes the filter element 28. Preferably the filter element 28 is arranged in the draining flow, draining circuit 16 or valve body, such that the water flowing from the tub 2 in a draining phase hits the filter element 28 at an acute angle with respect to the upper surface 30 of the filter element 28. In particular the water flow hits the portion of the filter element 28 which is close to the inlet 14 of the recirculation circuit at an acute angle. As described below, this

portion of the filter element 28 comprises a closed surface and forms thereby a deflecting portion or part of the filter element 28. The actual filtering portion of the filter element 28 which is formed by filter fingers 35a-d (e.g. Figs. 12a-d) is arranged at the free end of the filter element 28 which extends into the draining suction pipe 17. Thus the water flow from the tub 2 is deflected or redirected along the surface 30 of the filter element, i.e. substantially parallel to the surface 30 of the filter element 28, and fluff and foreign objects caught by the filter element 28 (i.e. filter fingers 35a-d) are washed away from the filter element 28 during the draining of water. In other words, the filter element 28 forms a deflector element which deflects or redirects the draining flow from the tub 2 to the draining circuit 16, in particular to the draining suction pipe 17. Further, in the flow or current of the washing water out of the tub 2, the movable closure element 24 moves mainly in a rotational movement (arrow). This movement of the movable closure element 24 creates a vortex which assists in removing fluff and foreign objects from the filter element 28. In other words a "self-cleaning" filter element 28 is provided. Additionally the backflow of water from the recirculation circuit 10 and out of the recirculation pipe 11 (as indicated by the falling water level 42d) assists in washing any caught foreign objects away from the filter element 28. Foreign objects which are washed from the filter element 28 or out of the tub 2 are subsequently caught in the draining filter 20, which is accessible from the outside for a user for cleaning. This is particularly advantageous if the filter element 28 itself is not accessible for a user from outside the washing machine.

[0037] Fig. 6 depicts a perspective, partially cross-sectional side view of a part of an exemplary internal structure of a washing machine 1 as schematically depicted in Fig. 1, which in this embodiment is a top-loading washing machine. The same reference signs are used for the same features of the washing machine 1 as described above. Relating to technical details and functional operation, full reference is made to the above embodiment schematically shown. The drum 4 is rotationally supported in the tub 2. Below the tub 2 the valve 26 is shown in a partial cross-sectional view. The movable closure element 24 (in this example ball-shaped) is engaged in the valve seat 22 and shuts the tub 2 from the draining circuit 16 in the state as depicted in Fig. 6. The inlet 14 of the recirculation circuit 10 is located below the valve 26, in particular below the valve seat 22. The suction side of the recirculation pump 12 is connected via suction pipe 13 to the sump or draining suction pipe 17. The output side of the pump 12 is advantageously connected via recirculation pipe 11 to a passage through and having an outlet at a rotational axis of the drum 4. The draining circuit 16 is fluidly connected to the tub 2 through the opening in the valve seat 22 (having the form of a diaphragm or plate) such that washing water can be drained from the tub 2 through pipe 17, draining filter 20, pump 18 and draining riser pipe 19 to the outside of the machine with the draining pump 18 operating.

[0038] Fig. 7 shows a perspective, partially cross-sectional side view of the structure of Fig. 6. In this partial cross-sectional view, the filter element 28 can be seen, which is arranged at the inlet 14 of the recirculation circuit 10. Fig. 8 shows a partial cross-sectional view of a detail of the structure of Fig. 6. The diaphragm or plate of the valve seat 22 is attached at the lower rim of an extension of the tub 2, extending at the bottom of the tub. The valve body 27 receiving the movable closure element 24 is preferably attached to the tub extension at the diaphragm and is forming part of the draining section pipe. Advantageously both the suction pipe 13 and the draining suction pipe 17 have sections formed as a bellows. The bellows serve for damping vibrations of the tub from being transferred to the pumps 12, 18.

[0039] Figs. 9a-d depict perspective, cross sectional views of the valve 26 as shown in Fig. 6. Fig. 9a shows a top view of the valve 26, wherein the diaphragm forming the valve seat 22 is shown from the tub side. A lug 29 is advantageously attached to and protruding from the valve body 27 which is used to attach one end of the suction pipe 13. The filter element 28 is advantageously attached to the lug 29; preferably, but not necessarily, the filter element 28 is made as a single or monolithic part with the lug. The lug 29 is preferably used to mount the filter element 28 at an outlet in the valve body 27, wherein the outlet forms the inlet 14 to the suction circuit 10.

[0040] Preferably, a further opening 37 (shown in Fig. 10) in the valve body 27 fluidly connects the interior of the valve body 27 to a duct 36 depicted in Fig. 9a-d. The duct is advantageously connected to a pressure control (pressostat; not shown) for detecting the water level 42 in the tub 2.

[0041] Fig. 9b shows a cross sectional view of the valve 26 along line A-A of Fig. 9a. The valve 26 is shut or closed by movable closure element 24 which rests in its seat 22 and blocks thereby the opening of the valve 26. The filter element 28 is attached to the inlet 14 of the recirculation circuit 10, preferably by the mounting portion or lug 29 which is connected to the recirculation circuit, advantageously by a plug connection.

[0042] The filter element 28 is preferably attached to the lug 29 forming the inlet 14 in a cantilevered manner, such that the main body of the filter element 28 extends into inner volume of the valve body 27 in a free-standing manner. A portion of the filter element 28 facing the inner space of the valve body 27 preferably has a shape which corresponds or basically corresponds to the shape of the movable closure element 24; for example, if the movable closure element 24 is spherical, the filter element 28 advantageously comprises a bent and/or hemispherical shape which substantially corresponds or partially corresponds to the shape of the movable closure element 24.

[0043] Fig. 9d shows a cross sectional view from below along the line B-B shown in Fig. 9c. In this embodiment the filter element 28 has advantageously a fork-like

shape and comprises fingers 35a-d with apertures 34a-e between the fingers having the open entrances 38a-e (or gaps) to the fingers. Advantageously the fingers of the filter form the teeth or pins of a rake. The fingers 35a-d are preferably parallel or essentially parallel to a flow path of water flowing from the tub through the valve body 27 to the draining pump 18 in draining phases. In particular the fingers 35a-d are advantageously parallel or essentially parallel to a flow path of water, which has been redirected or deflected by a closed portion or deflecting portion of the filter element 28. Thus the deflected water flow washes away fluff from the base of the fingers 35a-d to the gaps and assists thereby in cleaning the filter fingers 35a-d.

[0044] Fig. 10 shows a cross-sectional side view of the valve of Figs. 9a-d in a closed state, which has been described with respect to Fig. 3. Due to the water filling the tub 2, the draining circuit 16 and partially the recirculation circuit 10 the resulting buoyant force on the floatable movable closure element 24 presses the latter against the valve seat 22 (in this state both pumps 12, 18 are not operating).

[0045] Fig. 11 shows a cross-sectional side view of the valve of Figs. 9a-d in an opened state, which has been described with respect to Figs. 2, 4 and 5. Due to a low water level 42a (Fig. 2) or due to the suction force of the recirculation pump 12 (Fig. 4) or suction force of the draining pump 18 (Fig. 5) the valve 26 is opened. The movable closure element 24 is advantageously in close proximity to the filter element 28 or supported by the filter element, which advantageously comprises a shape which matches or substantially matches the shape of the movable closure element 24. In case the movable closure element 24 has a substantially spherical shape, a rotational movement of the movable closure element 24 due to the water flow during a draining phase crates a sort of vortex which assists the removal of e.g. fluff from the filter element 28 as described above.

[0046] Figs. 12a-d show perspective views of the filter element 28 as shown in Fig. 6. Fig. 12a shows the filter element 28 from above, i.e. the upper surface 30 of the filter element which faces the interior of valve body 27. The filter element 28 advantageously comprises a plurality of apertures 34a-e, which extend to a lateral border of the filter element 28 such that each aperture 34a-e has a laterally open side.

[0047] Fig. 12b shows the filter element 28 from below, i.e. it shows the surface 32 of the filter element 28 which faces away from the movable closure element 24 or valve 26. As described above, the filter element may advantageously be part of the lug 29 which forms at the same time a mounting portion for mounting the filter element 28 in the opening of the valve body 27. Thereby the filter element 28 is supported on one side in a cantilevered manner and the main body of the filter element 28 projects into the inner space of the valve body 27. The outer surface of the filter element 28 faces a portion of the inner surface of the valve body 27 and the filter ele-

ment 28 is preferably arranged such that there is a gap 33 between the outer or lower surface 32 of the filter element and the inner surface of the valve body.

[0048] Fig. 12c shows a side view of the filter element 28, wherein an arrow depicts the flow of water during a recirculation phase of a washing cycle. Fig. 12c also shows attachment of the recirculation pipe 11 on the lug 29. The water passes through the apertures 34a-e of the filter element from the upper side 30 to the lower side 32 of the filter element 28 and enters the recirculation circuit 10, advantageously through an opening in the mounting portion or lug 29.

[0049] The arrows in Fig. 12c and 12d indicate the water flow during a recirculation phase. Fluff or foreign bodies are retained at the fingers 35a-d or teeth of the filter 28 and are washed along the fingers to a base of the fingers opposite to the aperture openings 34a-e where the fluff and foreign bodies collect. In contrast thereto, during a draining phase of a washing cycle the washing water flows past the filter element 28 from above coming through the aperture in the valve seat 22 and also some water flows in reverse direction out of the circulation circuit 10. This water flow washes the fluff and foreign bodies in direction from the base of the fingers towards the aperture entrances 38a-e. Thereby any fluff or objects caught in the filter element 28 are easily washed out and are not permanently caught in the filter element 28 (i.e. in the filter apertures 34a-e or the fingers 35a-d of the filter). Further, preferably a portion of the filter element 28 in proximity to the recirculation circuit 10 has a closed surface. In other words the apertures 34a-e preferably do not extend across the entire surface of the part of the filter element 28 which extends into the draining circuit 16. The closed portion of the filter element 28 may catch larger foreign objects without the risk that these objects obstruct the apertures 34a-e of the filter element 28. Further, the closed portion of the filter element 28 assists the above described deflection of the drain water flow and assists thereby in efficiently cleaning the filter element 28. The filter element 28 with the filter fingers 35a-d preferably comprises a concave or hemispherical shape.

[0050] Fig. 13 depicts a schematic cross-sectional front view of a washing machine 1' according to an alternative embodiment. Elements corresponding to above described elements are designated with the same reference signs. Relating to technical details and functional operation of these elements full reference is made to the above described embodiments. In contrast to the above described embodiment of Fig. 1, an inlet 14' of the recirculation circuit 10 of the washing machine 1' of Fig. 13 is located upstream the valve 26, in particular the inlet 14' is connected to the tub 2. As the recirculation inlet 14' is located upstream the valve 26, the valve 26 remains shut or closed during a recirculation phase, i.e. only the water within the tub 2 is circulated. The filter element 28 corresponds to the above described embodiment and prevents that fluff and foreign objects enter the recircu-

lation circuit as described above. When the drum 4 rotates during a washing operation of the washing machine 1', the rotating drum causes a water flow in the tub 2 which flows past the filter element 28. In particular a water flow in direction of the end of fingers 35a-d washes fluff and other foreign objects caught in the apertures 34a-d of the filter element 28 out of the apertures 34a-d. Thus the filter element 28 is cleaned by the water flow in the gap between the tub 2 and the drum 4. In particular if the washing machine operates in a tumbling mode, i.e. when the rotation direction of the drum 4 is repeatedly changed during a washing operation, the filter element is repeatedly and therefore thoroughly cleaned. In a subsequent draining phase the washed of fluff and foreign objects are drained from the tub 2 into the draining circuit 16, as the suction force of the draining pump 18 opens the valve 26 as described with respect to Fig. 5. Fluff passes the draining filter 20 and larger foreign objects like coins are caught therein to prevent the foreign objects to reach and possibly damage or block the draining pump 18. Preferably the draining filter 20 is removable or at least accessible for a user to be cleaned, thus a user can remove foreign objects caught therein.

[0051] Fig. 14a shows a further embodiment of a filter element 28' in a perspective view. Similar or the same numerals are used for similar or the same elements as described above. In contrast to the above described filter element 28, the filter fingers 35a'-d' of Fig. 14a are differently shaped and oriented. Each filter finger 35a'-d' comprises at least one straight portion. In contrast to the above described filter 28, at least a portion of each of the fingers 35a'-d' of filter 28' is not curved or concave. When the filter element 28' of Fig. 14a is arranged in its operating position within the valve as shown in Fig. 14b, the filter fingers 35a'-d' are oriented such that water flow coming from the opening of the valve seat 22 (e.g. during a draining phase) hits the filter fingers 35a'-d' at a right angle or substantially right angle. In particular the water flow hits the straight portion of the fingers 35a'-d' at a substantially right angle. I.e. the (drain) water flow direction or force of the water flow is substantially perpendicular to the filter fingers 35a'-d'. Thus the water flow exerts its maximum force on the filter fingers 35a'-d' (which form the actual filtering area of the filter element) and therefore exerts maximum force on fluff and foreign objects caught in the apertures between the filter fingers 35a'-d'. Fluff and foreign objects are thereby efficiently loosened and washed away from the filter fingers 35a'-d'. Additionally, as described above, the closed upper surface 30' of the filter element 28' deflects or redirects the water flow from the opening of the valve seat 22 substantially parallel to the filter fingers 35a'-d', such that due to the combined water flow directions - perpendicular and parallel to the filter fingers 35a'-d' - loosened fluff and foreign objects are efficiently washed away from the filter element 28' into the drain suction pipe 17.

[0052] Fig. 15a shows a perspective view of just another embodiment of a filter element 28". Similar or the

same numerals are used for similar or the same elements as described above. In contrast to the above described filter elements 28, 28', filter element 28" comprises filter fingers 35a"-f" which are extending from a preferably substantially circular main body having a closed surface. The filter fingers 35a"-f" are formed preferably straight, i.e. not concave or curved, similarly as described with respect to filter 28' of Figs. 14a-b. Thus in operation of a valve with the filter element 28" and as shown in Fig. 15b, water flux coming from the opening of valve seat 22 hits the filter element 28", in particular the filtering area, i.e. the filter fingers 35a"-f", at a substantially right angle. Additionally the upper surface 30" of the filter 28" is preferably concave or hemispherical shaped and forms a deflection element for water flowing out of the tub 2 and into the valve as described above. Thus filter element 28" provides the same advantages as described with respect to Figs. 14a-b.

Claims

1. Washing machine (1, 1') comprising:

a tub (2),
a draining circuit (16) fluidly connected to the tub (2) for draining fluid from the tub (2),
a recirculation circuit (10) fluidly connected to a lower portion of the tub (2) for recirculating fluid from the lower portion of the tub (2) into the tub (2), and
a filter element (28, 28', 28") at an inlet (14, 14') of the recirculation circuit (10) for preventing foreign objects to enter the recirculation circuit,

characterized in that at least one filter aperture (34a-e) of the filter element (28, 28', 28") extends to a lateral border of the filter element (28, 28', 28"), such that the at least one filter aperture (34a-e) comprises an opening (38a-e) in its perimeter and/or the at least one filter aperture (34a-e) forms at least two filter fingers (35a-d, 35a'-d', 35a"-f") spaced one another.

2. Washing machine according to claim 1, wherein the main body and/or main area of the filter element (28, 28', 28") extends into the draining circuit (16), or into the tub (2) or into a sump of the washing machine as a free-standing element.

3. Washing machine according to claim 1 or 2, wherein a gap (33) is formed between the filter element (28, 28', 28") and an inner surface of the draining circuit (16), or of the tub (2) or of a sump of the washing machine and/or wherein the recirculation circuit inlet (14) is arranged at a backside (32) of the filter element (28, 28', 28").

4. Washing machine according to claim 1, 2 or 3, wherein the main body and/or main area of the filter element (28, 28', 28") forms a flow deflection element for deflecting and/or redirecting the water flowing from the tub (2) to the draining circuit (16) during a draining phase.

5. Washing machine according to any of the previous claims, wherein the free end of the filter element (28, 28', 28") extending into the draining circuit (16), or tub (2) or sump comprises the at least one filter aperture (34a-e) and wherein a portion of the filter element (28, 28', 28") attached to or at the draining circuit (16), or tub (2) or sump, comprises a closed surface.

6. Washing machine according to any of the previous claims, wherein the at least two filter fingers (35a-d, 35a'-d', 35a"-f") are aligned parallel or substantially parallel to a flow direction of fluid flowing from the tub (2) to the draining circuit (16).

7. Washing machine according to any of the previous claims, wherein the at least one filter aperture (34a-e) comprises a shape which is tapered from the opening (38a-e) to a base of the at least one aperture opposite to the opening and/or the at least two filter fingers (35a-d, 35a'-d', 35a"-f") are tapered from a base of each of the filter fingers to the free-end thereof.

8. Washing machine according to any of the previous claims, wherein the at least one filter aperture (34a-e) comprises and/or the at least two filter fingers (35a-d) comprise a shape selected from rectangular, substantially rectangular, triangular, substantially triangular, semicircular or substantially semicircular.

9. Washing machine according to any of the previous claims, wherein the filter element (28, 28', 28") comprises at least four filter fingers (35a-d, 35a'-d', 35a"-f"), preferably at least six filter fingers or eight filter fingers.

10. Washing machine according to any of the previous claims, wherein the washing machine comprises a valve (26) arranged between the tub (2) and the draining circuit (16), wherein the valve (26) comprises a valve body (27), a valve seat (22), and a movable closure element (24) adapted to be releasably engaged with the valve seat (22) to close or open the valve (26).

11. Washing machine according to claim 10, wherein the filter element (28, 28', 28") and/or the inlet (14) of the filter element is placed downstream a valve seat (22) of the valve (26).

12. Washing machine according to claim 10 or 11, wherein the valve is closed and opened in dependency of a water level (42a-d) and/or a pressure difference between the tub (2) and the valve body (27). 5
13. Washing machine according to claim 10, 11 or 12, wherein a surface (30) of the filter element (28, 28', 28'') facing the valve (26) is shaped to receive the movable closure element (24) on or at said surface (30). 10
14. Washing machine according to any of claims 10 to 13, wherein the movable closure element (24) comprises a spherical or substantially spherical shape. 15
15. Washing machine according to any of the previous claims, wherein the filter element (28, 28', 28'') comprises in at least one cross-section plane a totally or partially arched or bent or hemispherical cross-section, and/or it is totally or partially concave in drain flow direction or as seen from the tub side. 20

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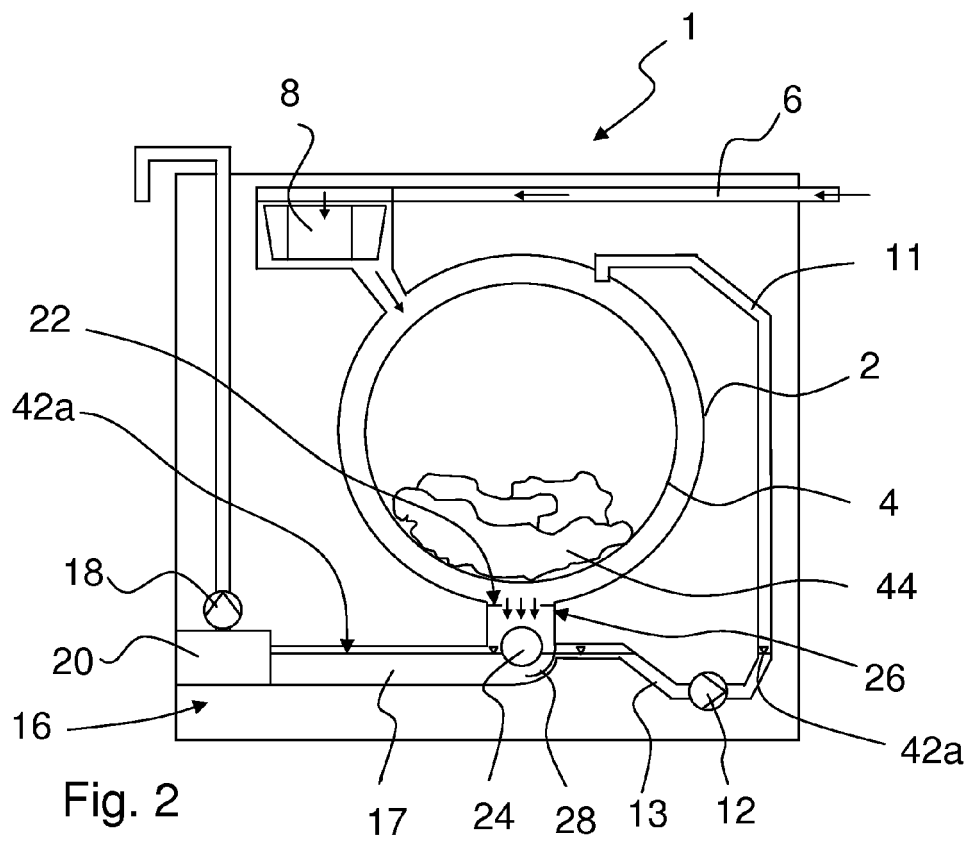
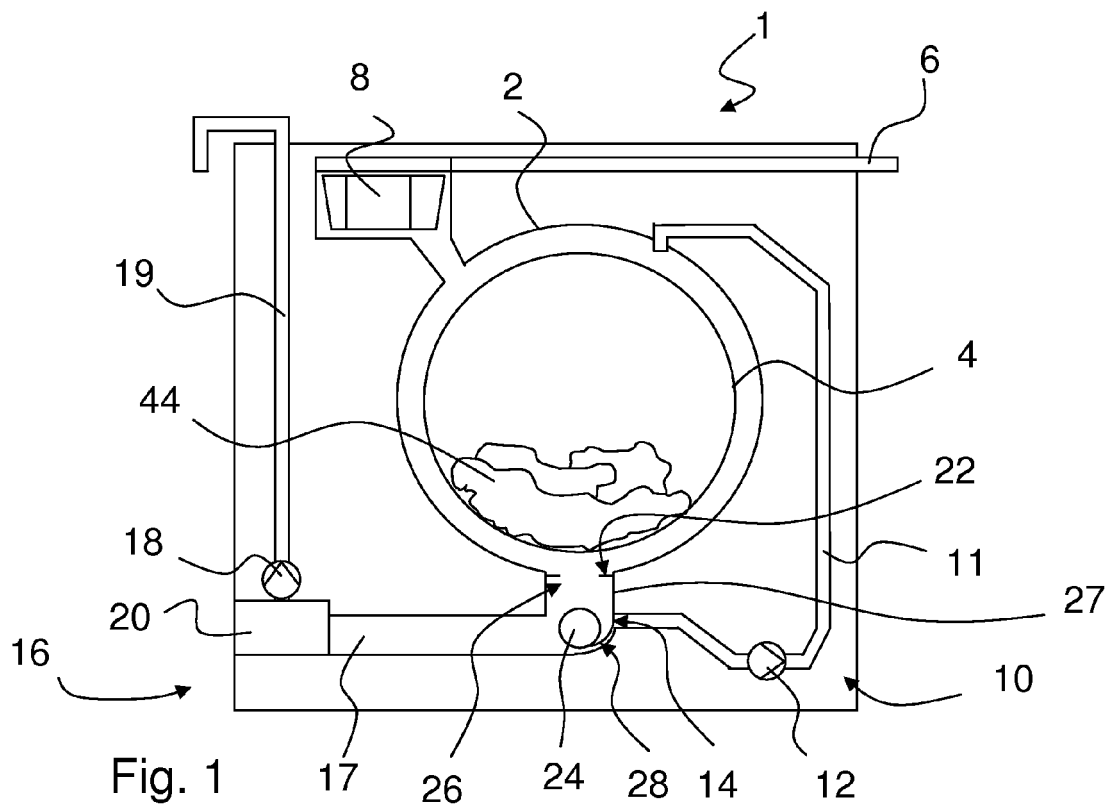
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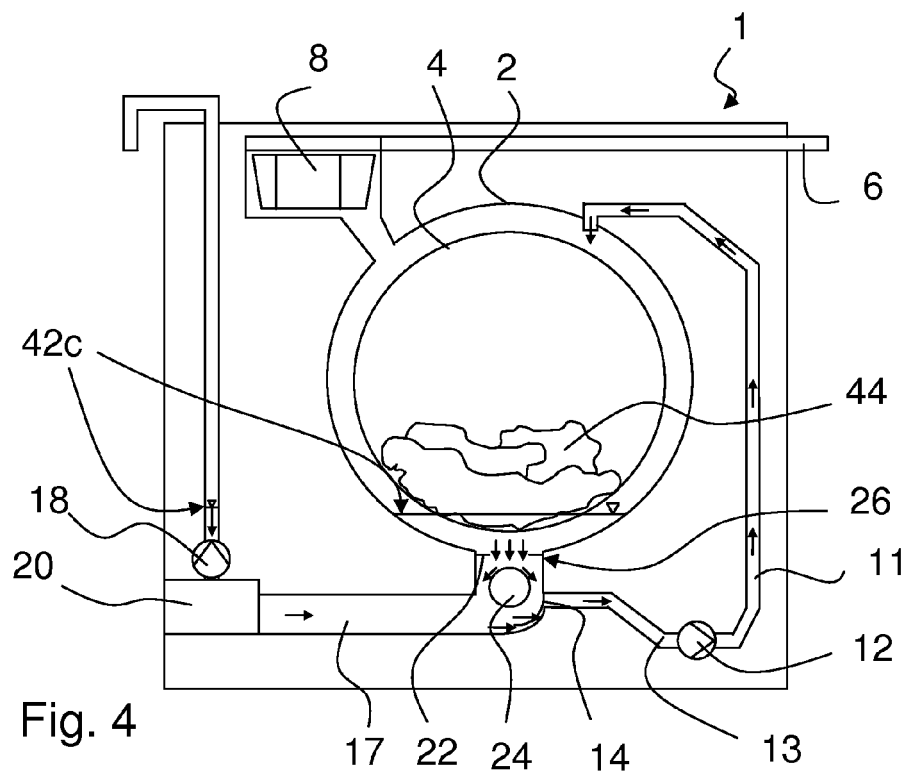
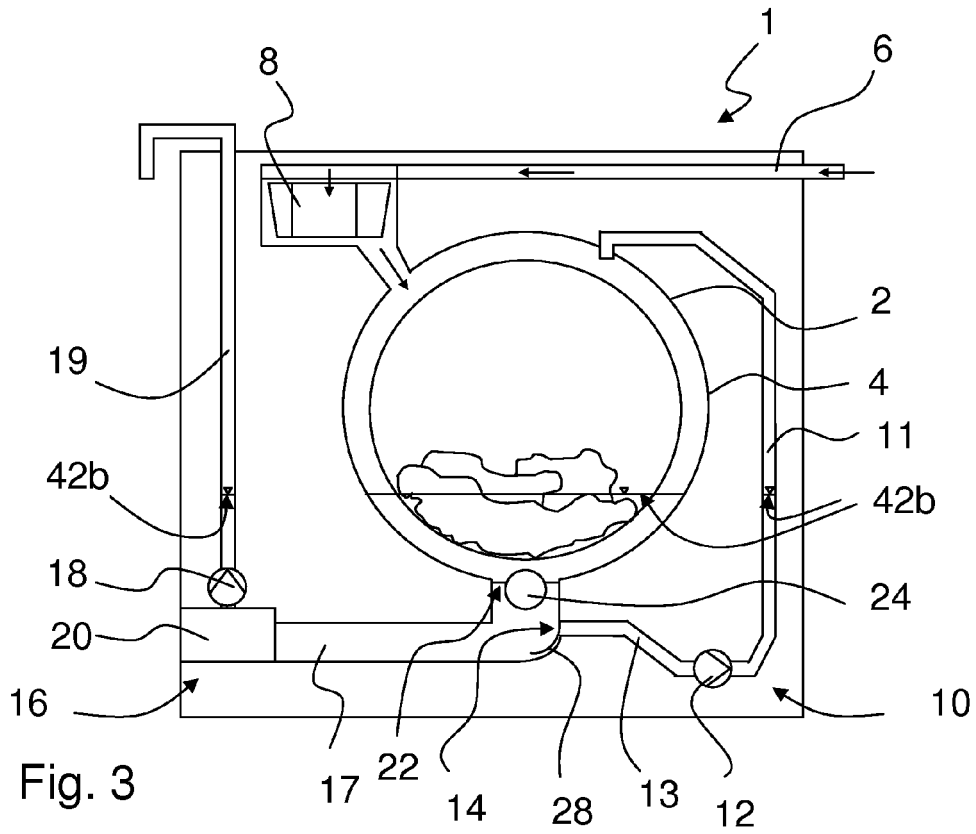
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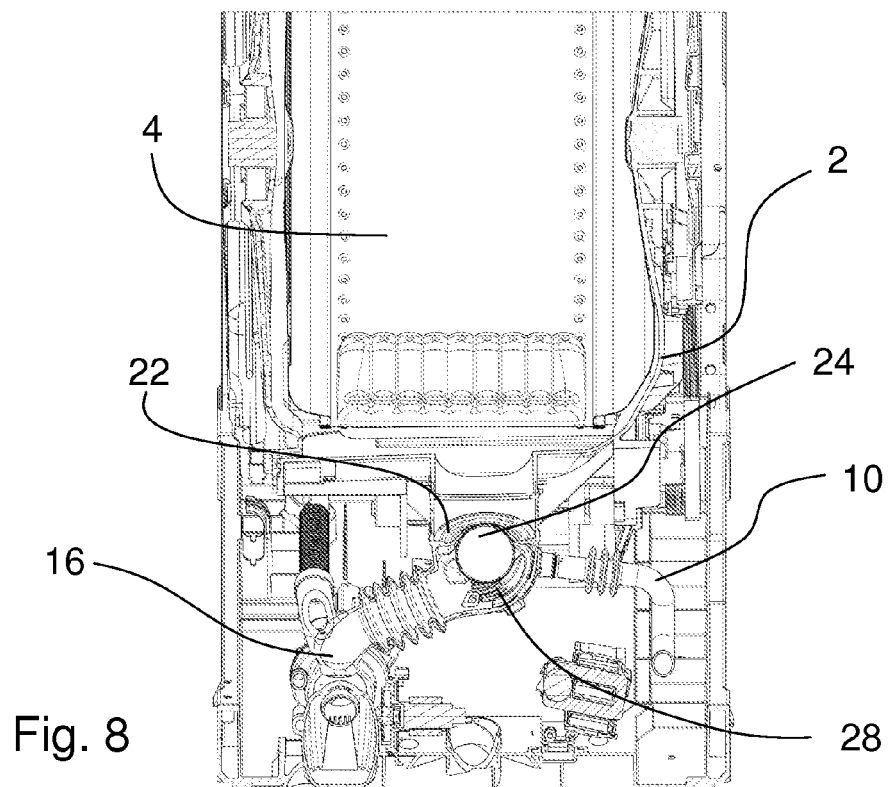
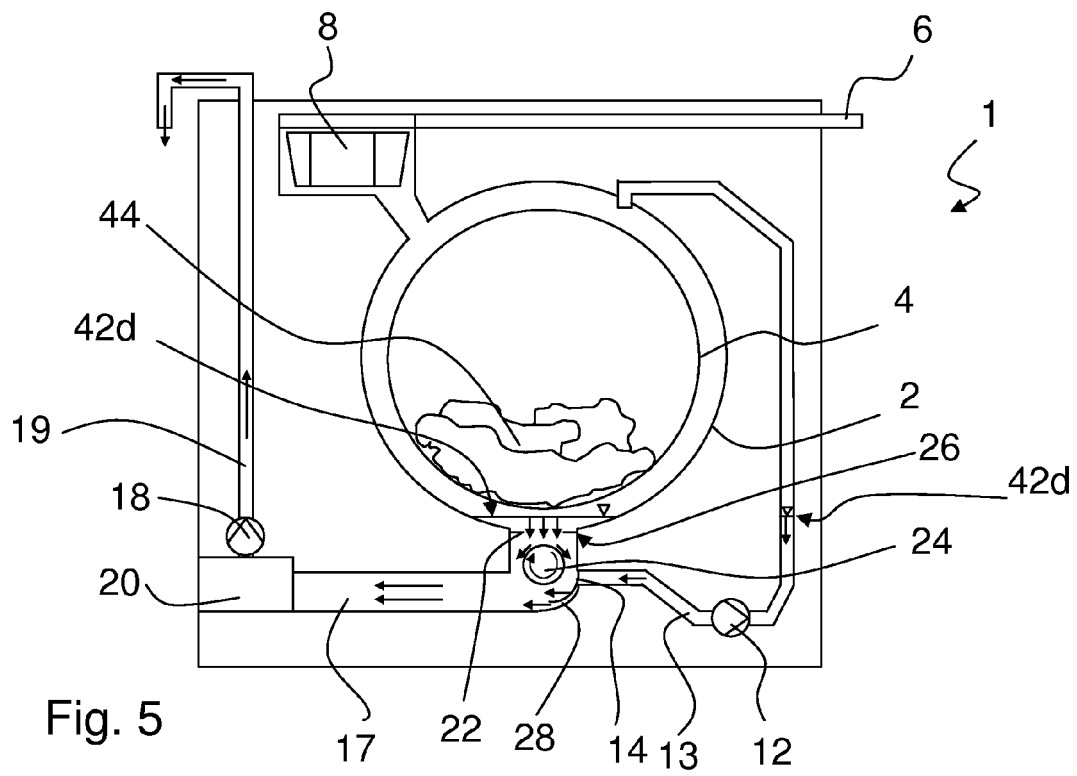


Fig. 6

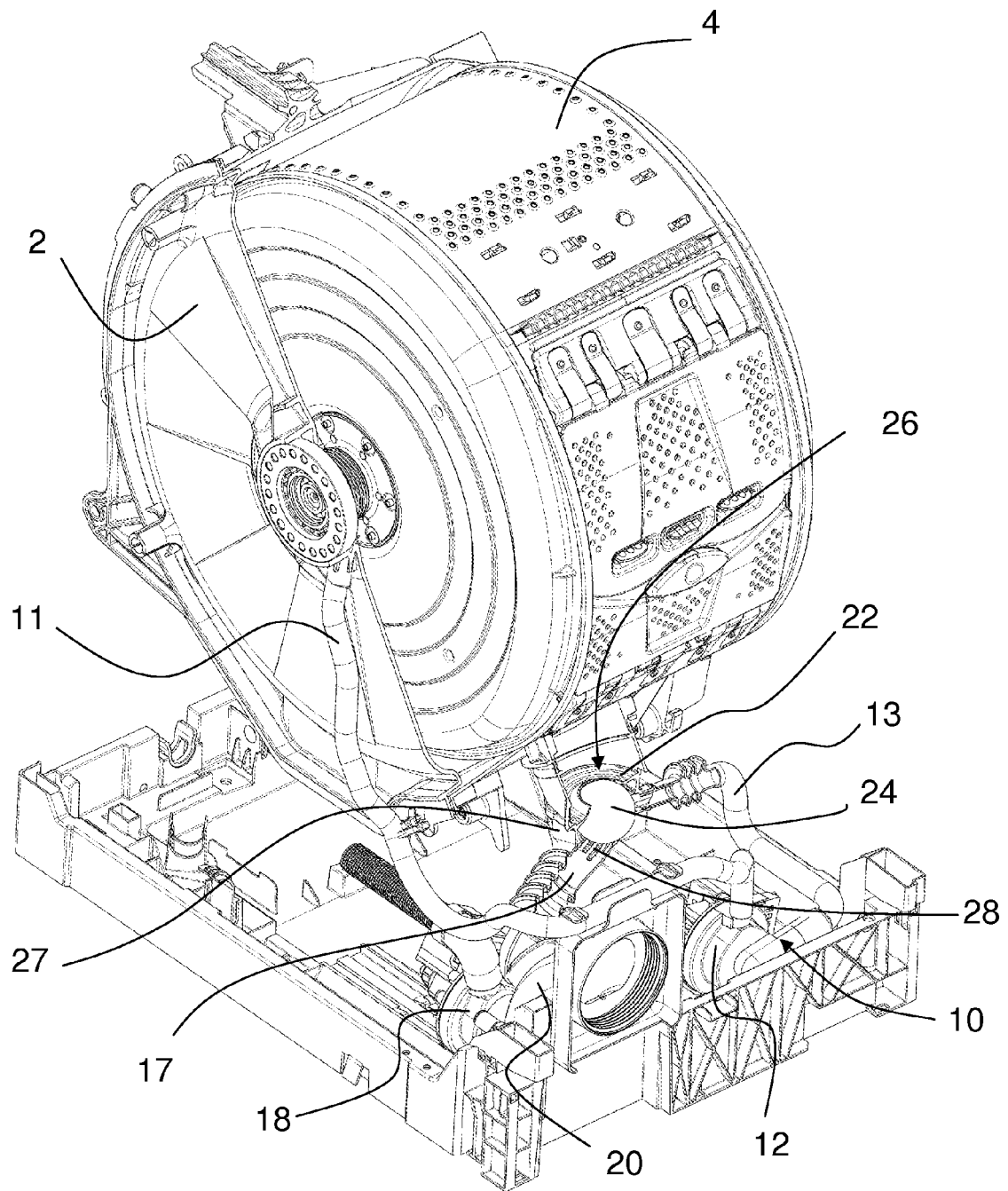
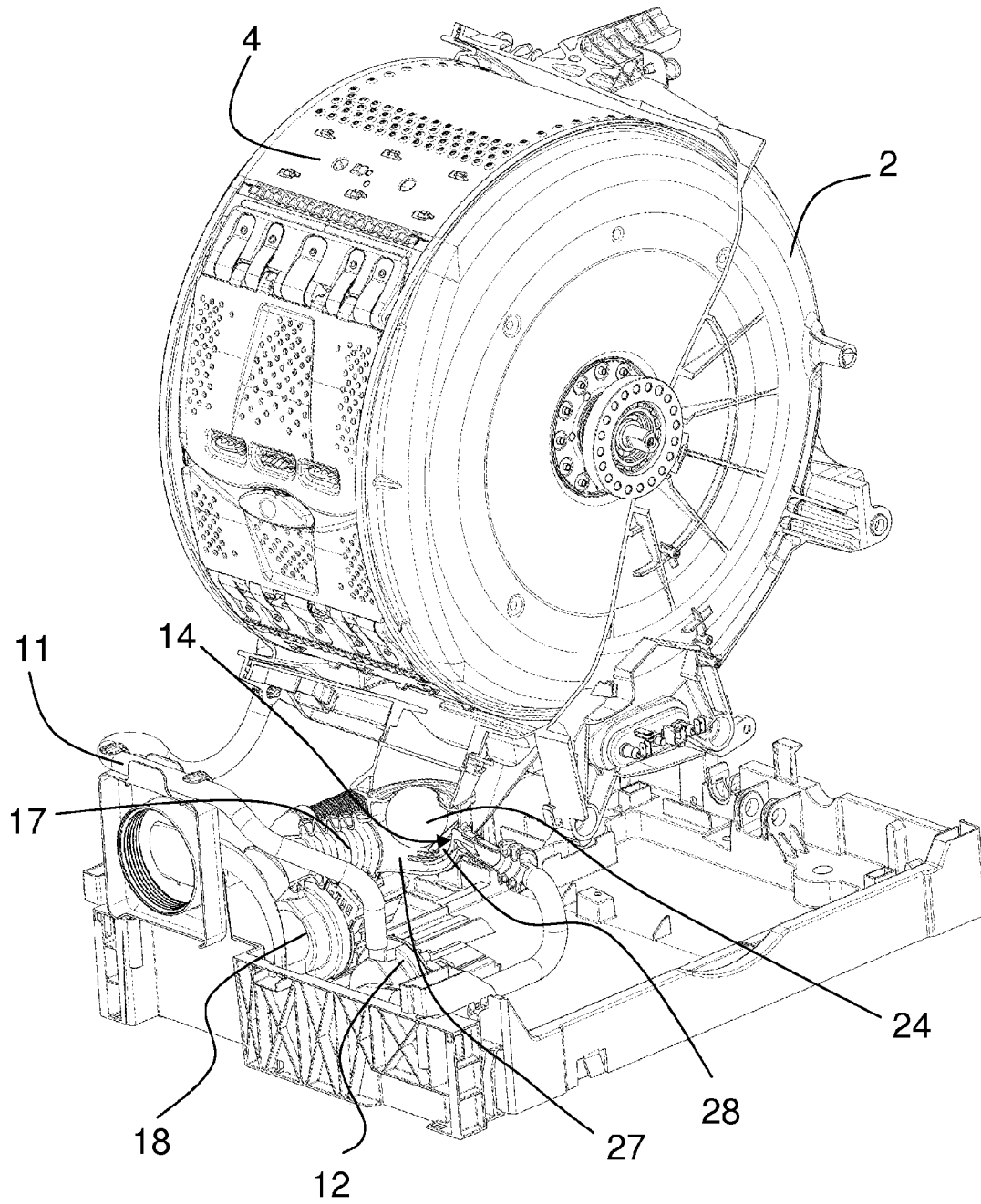
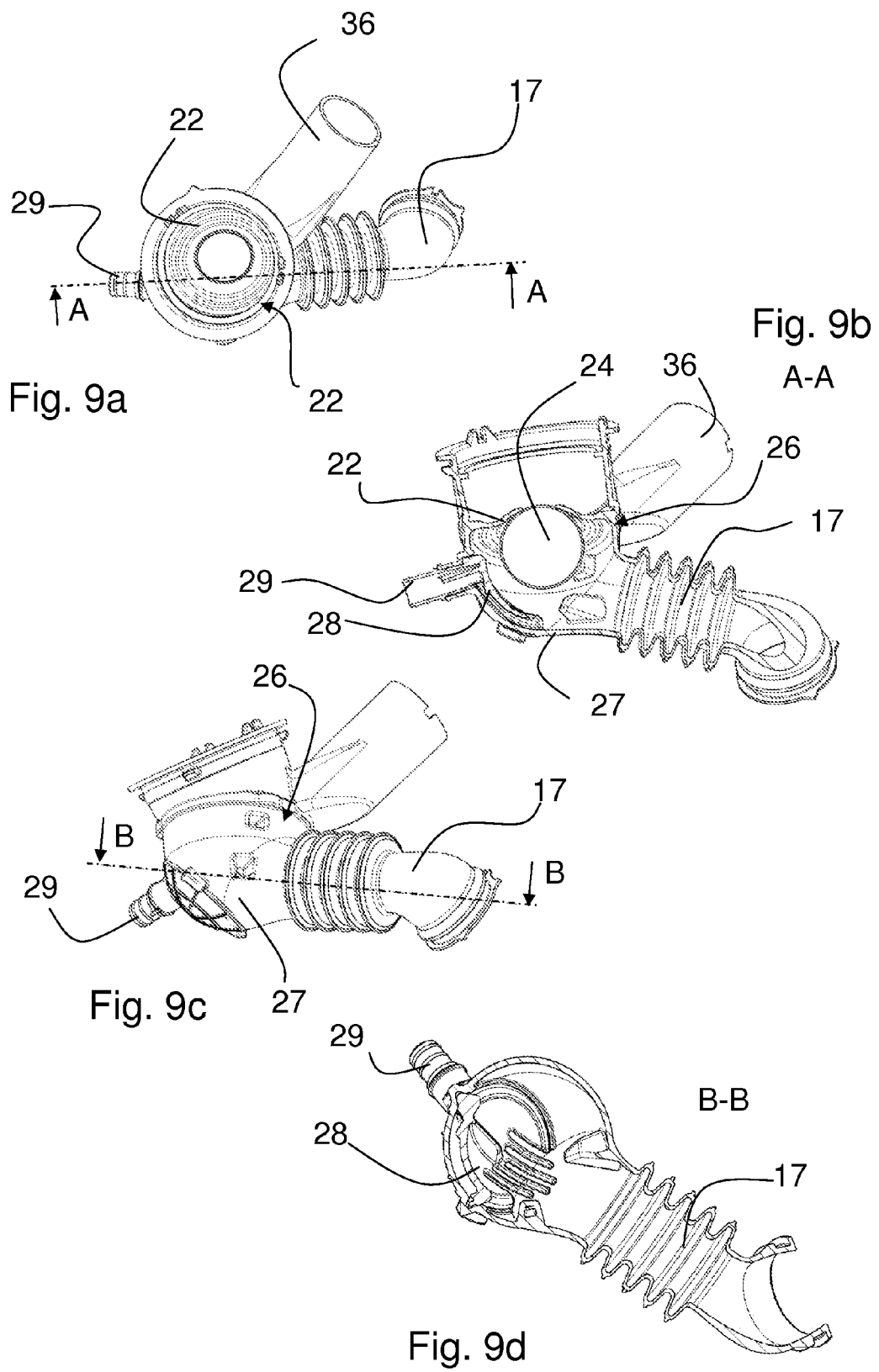


Fig. 7





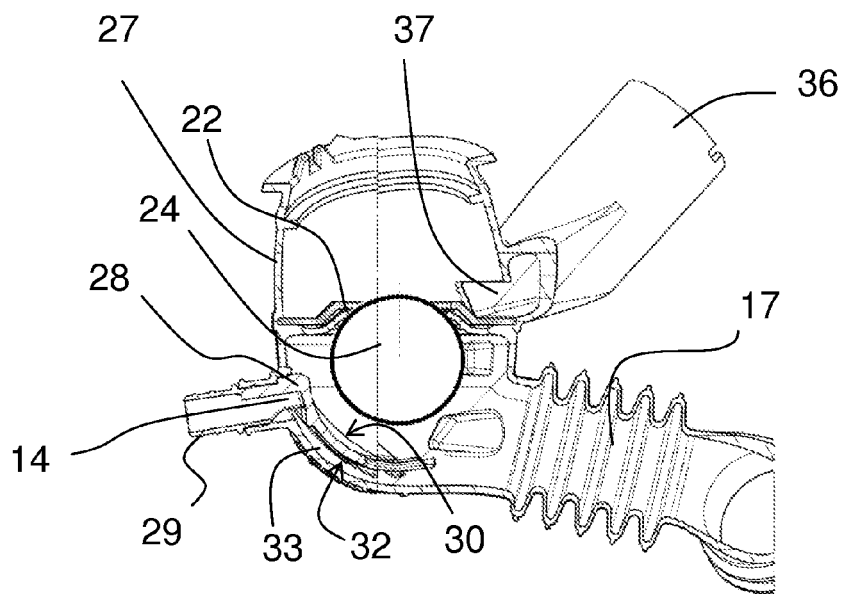


Fig. 10

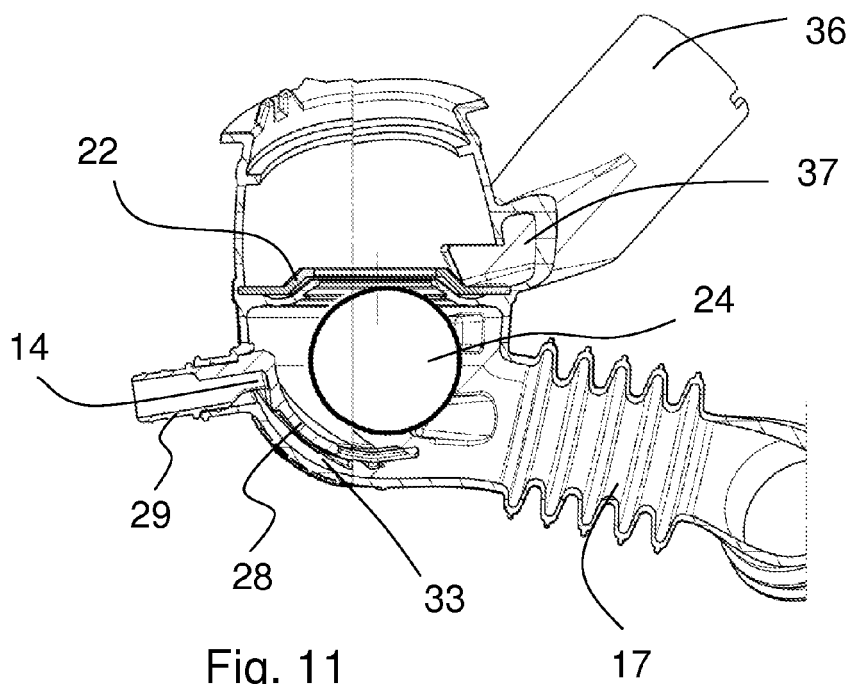


Fig. 11

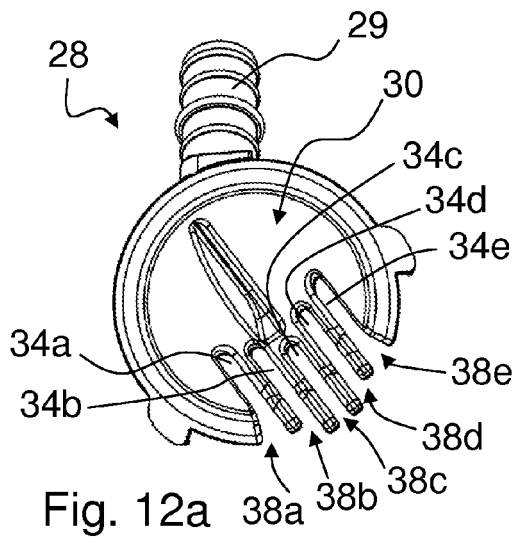


Fig. 12a

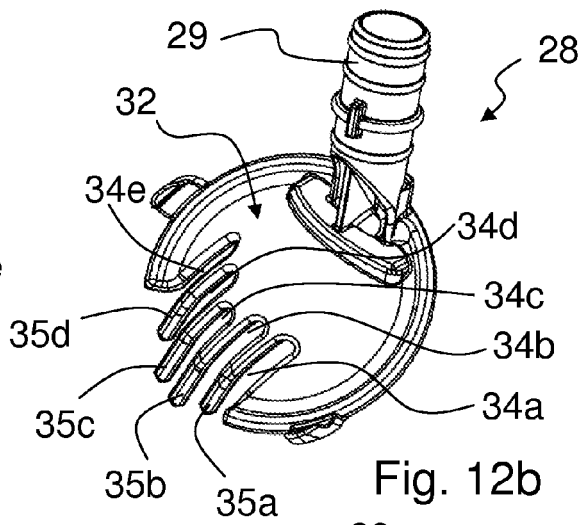


Fig. 12b

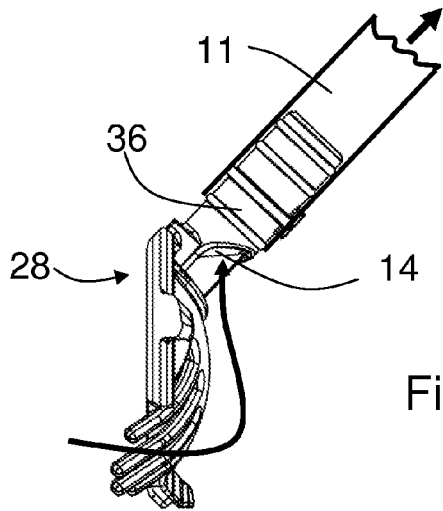


Fig. 12c

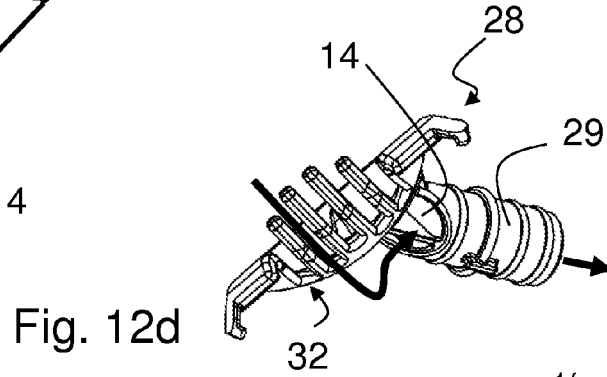


Fig. 12d

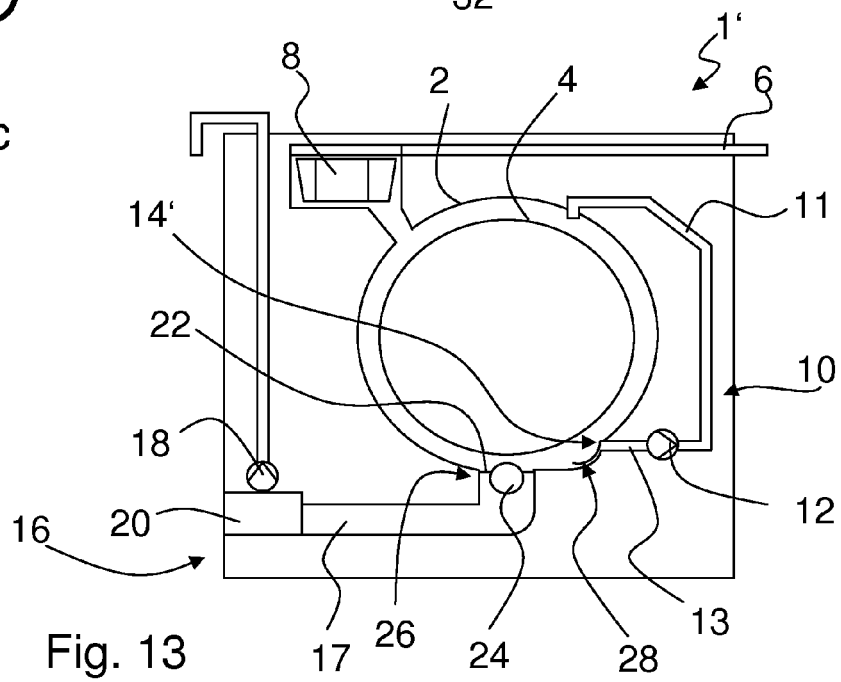


Fig. 13

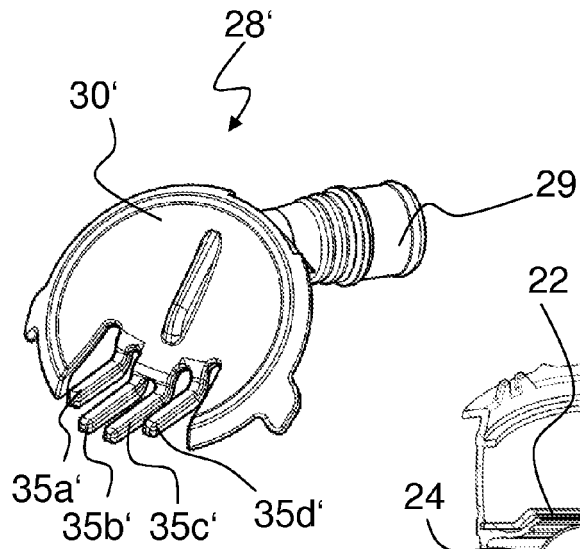


Fig. 14a

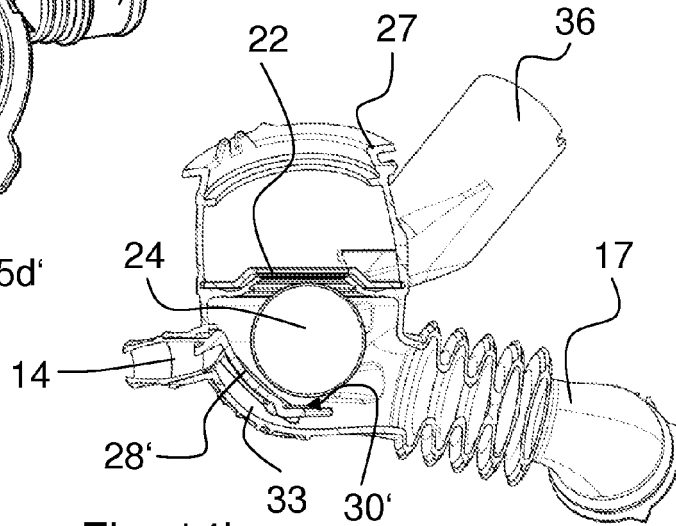


Fig. 14b

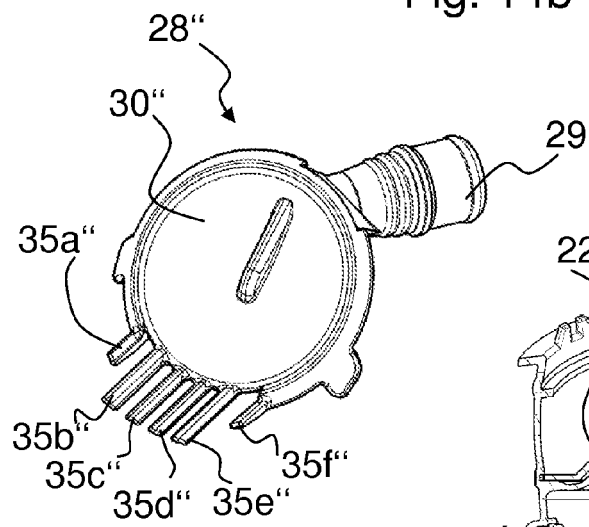


Fig. 15a

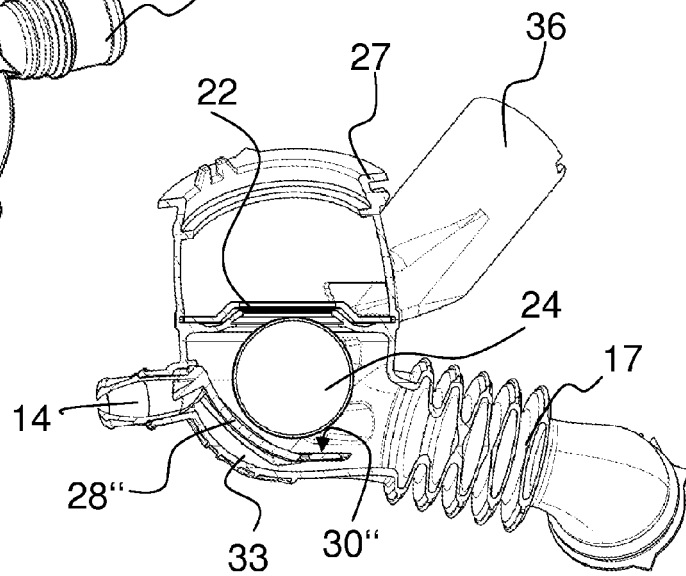


Fig. 15b



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 Application Number
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Place of search Munich		Date of completion of the search 27 May 2011	Examiner Kising, Axel
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