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(54) Separation system for wet vacuum cleaners

(57) The invention relates to a canister wet vacuum cleaner comprising a cyclonic separation system for separating solids and/or liquids from a suctioned air flow, which has a total volume of from 2000 to about 7000 cm^3 and comprises two or more cyclonic units and a collection chamber. The radial distance between the outer wall and the inner wall of the first cyclonic unit is of from 20 mm to 40 mm. A toroidal partition wall partially separates said collection chamber from the first cyclonic unit, extending radially from an inner wall toward a side wall, without contacting it, and identifying an annular space between the perimeter of the toroidal partition wall and said side wall, through which liquids and/or solids separated in the first cyclonic unit fall into the collection chamber.

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Description

Field of the invention

[0001] The invention relates to a canister wet vacuum cleaner, preferably for domestic use, comprising a cyclonic separation system for separating solids and/or liquids from a suctioned air flow, which cyclonic separation system has a total volume of from 2000 to 7000 cm^3, preferably of from 3000 to 6000 cm^3 and which is designed to collect significant amounts of liquids, preferably at least 200 cm^3, more preferably at least 400 cm^3, most preferably at least 600 cm^3, of liquids.

[0002] In particular, the canister wet vacuum cleaner of the invention comprises a cyclonic separation system comprising at least two cyclonic separation units; the radial distance between the outer wall and the inner wall of the first cyclonic unit is comprised between 20 mm and 40 mm, preferably between 25 mm and 35 mm. The cyclonic separation system further comprises a collection chamber, which is preferably located below the first cyclonic unit. Said collection chamber collects the heavy solids and/or liquids which are separated from the air flow in the first cyclonic unit. According to the invention, said collection chamber is partially separated from the first cyclonic unit by means of a toroidal partition wall, which extends radially, from an inner wall toward a side wall, without contacting said outer wall, so that an annular space is identified between the perimeter of said toroidal partition wall and said side wall, through which the liquids and/or heavier solids, separated from the suctioned air flow in the first cyclonic unit, fall into the collection chamber.

[0003] Preferably, the cyclonic separation system comprises a dust collection bucket; preferably the outer wall of the first cyclonic unit is formed by a portion of the side wall of said dust collection bucket, so that the first cyclonic unit is preferably defined by a portion of said dust-collection bucket, comprising a tangential air inlet for entry of suctioned air flow. Suctioned air enters through said tangential inlet so that a cyclonic air flow is generated in said portion of the dust collection bucket.

[0004] Preferably, the first cyclonic unit is formed by an annular separation chamber which is outwardly delimited by the side wall of the dust collection bucket and internally by an inner wall substantially concentric to said side wall. The bottom of said annular separation chamber is preferably formed by the toroidal partition wall, which partially

[0005] separates the first cyclonic unit from the collection chamber. According to said preferred embodiment, said toroidal partition wall extends radially, parallel to the bottom of said dust-collection bucket, toward the side wall of said dust-collection bucket, without contacting it.

[0006] Preferably, the canister wet vacuum cleaner of the invention has both vacuum and steam cleaning functionality. More preferably, said canister wet vacuum cleaner is a canister steam and vacuum cleaner having a main body, wherein said separation system is housed, which has width, length and height dimensions such that at least one of said dimensions is equal to or less than 300 mm, preferably equal to or less than 280 mm, more preferably equal to or less than 270 mm.

Background of the invention

[0007] When operated, domestic vacuum cleaners suction air and dirt particles, generally through a nozzle, then separate said dirt particles from said suctioned air by means of filtering means, providing a flow of clean exhausted air, which exits the vacuum cleaner. The suctioned air flow is generated by means of a motor-driven fan. The dirt particles, separated through a filtering path, are generally collected in a dust collector which can either comprise a bag or be a bag-less collector.

[0008] At the present, canister vacuum cleaners are preferred compared to conventional upright vacuum cleaners. The basic design of canister vacuum cleaners comprises a long, flexible hose and a main body (canister) which generally houses the motor and the separation system. Canister vacuum cleaners are much handier than upright vacuum cleaners, thus their marketability is greater. In particular, it is desirable that said canister vacuum cleaners are as small as possible.

[0009] Wet vacuum cleaners have also been developed, which are capable of suctioning both solids and liquids.

[0010] A further class of vacuum cleaners are the so called "wet and dry vacuum cleaners", which, according to the European Regulations, are defined as vacuum cleaners designed to remove a volume of more than 2.5 litres of liquid, in combination with the functionality of a dry vacuum cleaner.

[0011] Both wet vacuum cleaners and wet and dry vacuum cleaners require collectors having very big volume. As an example, EP 1584278 discloses a bag-less wet and dry vacuum cleaner comprising two separated compartments, of which at least one is designed for collecting liquids. The separate compartments, which are alternatively connected to the suction hose, have the aim of avoiding the mixing of aspirated solids and liquids. As a consequence, said vacuum cleaner has very big size.

[0012] US 3896521 discloses a large apparatus for wet and dry vacuum cleaning, whose size is 50,8 x 45,7 x 35,6 cm. It comprises a vacuum tank with a layer of water at the bottom, within which suctioned dirt and foreign objects are trapped.

[0013] The water filtration system is a bag-less separation system, wherein the suctioned air is forced through water, entrapping the removed material as it passes through. Dirt thus remains bound to the water and clean exhausted air is provided.

[0014] A further water filtration system is described in EP 1112712 by the present Applicant.

[0015] The present Applicant also commercializes a canister vacuum cleaner, having steam functionality,

which comprises a water filtration system. Said canister steam and vacuum cleaner has size (L x W x H) of 49 x 32 x 33 cm.

[0016] Water filtration systems require frequent maintenance: the systems must be in fact cleaned after each use, to avoid growth of bacteria and mold.

[0017] More easy to be maintained are the cyclonic separation systems. Cyclonic separation systems typically consist of substantially cylindrical or frustoconical units with a tangential air inlet and an upper outlet. The centrifugal air movement that is generated inside the cyclone, makes dirt and debris falling due to gravity, while exhausted air exits the cyclones outlet. Frequently, several cyclonic units in series are employed, optionally comprising also filter elements, in order to separate dirt particles of different size.

[0018] Although cyclonic filtration systems are very efficient in separating dirt from suctioned air, compact cyclonic systems disclosed in the prior art are unsuitable for separating liquids. In particular, in order to draw in and separate a significant amount of liquids, devices of big size are required, which can collect said liquids in separate portions of the device, avoiding the liquid to flow backward to the separation system.

[0019] As an example, WO 2011/132323 discloses a wet and dry vacuum cleaner with cyclonic separation system, capable of separating dust and water. The device is however of very big size.

[0020] WO 2012/171005 discloses a canister wet and dry vacuum cleaner, whose separation system comprises two cyclonic stages. The separation system comprises a collection chamber which is preferably provided with a bag, such as a garbage bag, for collecting wet or dry dirt. The collection chamber and the cyclonic separation elements are both of big volume.

[0021] It was thus not available so far a canister wet vacuum cleaner, comprising a cyclonic separation system, capable of drawing significant amounts of water and still maintaining a compact size.

[0022] The present invention provides a canister wet vacuum cleaner comprising a cyclonic separation system, which separation system is of small size and can separate great amounts of liquids. The separation system of the invention, despite being capable of collecting significant amounts of liquids, is in fact suitable for been located within the main body of a small domestic vacuum cleaner.

[0023] Furthermore, the separation system of the invention is particularly suitable when comprised in domestic vacuum cleaners with steam functionality.

[0024] Steam and vacuum cleaners are capable of drawing and filtering dirt and dust from suctioned air, while providing steam for removing embedded dirt and grime on the surfaces. The use of high temperature steam results thus in deeper and more hygienic cleaning. However, when in contact with the surfaces to be cleaned, such as windows, floors, etc., the steam condense; therefore, it is highly desirable to have the possibility of easily and rapidly suctioning said condensed steam. The separation system of the invention, which is capable of collecting both solids and liquids is thus very advantageous for use in vacuum cleaners with steam functionality. Furthermore, its compact size is very convenient when it is associated to a vacuum cleaner with steam functionality, as the steam generator usually occupies much room.

Summary of the invention

[0025] The present invention relates to a canister wet vacuum cleaner, preferably for domestic use, which comprises a cyclonic separation system of reduced size and which is capable of collecting significant amounts of liquids.

[0026] In particular, the canister wet vacuum cleaner of the present invention comprises a cyclonic separation system for separating solids and/or liquids from a suctioned air flow, which cyclonic separation system is housed in the main body of said canister wet vacuum cleaner and has a total volume of from 2000 to 7000 cm^3, preferably of from 3000 to 6000 cm^3. The cyclonic separation system comprises two or more cyclonic units. The first cyclonic unit is defined by a portion of said cyclonic separation system and is delimited by an outer wall and an inner wall, wherein the radial distance between said outer wall and said inner wall is comprised between 20 mm and 40 mm, preferably between 25 mm and 35 mm.

[0027] In conventional cyclonic separation systems, the separation chamber is typically narrower, i.e. the distance between the outer wall and the inner wall of a conventional cyclonic unit is much narrower compared to the first cyclonic unit of the present invention. This is aimed to maximize the efficiency of the cyclone. However, said conventional cyclonic units are not suitable for separating liquids.

[0028] The radial distance between the outer wall and the inner wall of the first cyclonic unit of the present invention allows to efficiently separate both solids and liquids, still maintaining efficient and satisfactory cyclonic movement of air.

[0029] The cyclonic separation system according to the invention further comprises a collection chamber which is partially separated from the first cyclonic unit by a toroidal partition wall. The toroidal partition wall extends radially from an inner portion of the cyclonic separation system toward a side wall, without contacting it. An annular space is thus identified between the perimeter of the toroidal partition wall and said side wall, which annular space puts in fluid communication the collection chamber and the first cyclonic unit, allowing the liquids and/or solids, which have been separated from the suctioned air flow by the first cyclonic unit, to fall into the collection chamber.

[0030] Preferably, the radial distance between the perimeter of the toroidal partition wall and the outer wall is of from 1 mm to 9 mm, more preferably of from 1.5 mm

and 8 mm.

[0031] Said radial distance provides efficient fall of separated solids and liquids into the collection chamber, with substantially no deposition of dirt over the partition wall. Furthermore, it avoids the backflow of collected liquids to the first cyclonic unit.

[0032] According to a preferred embodiment, the shape of the toroidal partition wall is such that the perimeter of the toroidal partition wall comprises an indent, so that the portion of the toroidal partition wall comprising the indent is more distal to the side wall compared to the rest of the perimeter of the toroidal partition wall. Preferably, the portion of the toroidal partition wall comprising the indent extends for about one third of the perimeter of said toroidal partition wall.

[0033] Preferably, the radial distance between the perimeter of the partition wall and the side wall, measured at the level of the indent of the toroidal partition wall, measures from 6 mm to 9 mm, preferably from 7 mm to 8 mm, while the shortest radial distance, measured at the more proximal edge of the toroidal partition wall, measures from 1 mm to 3 mm.

[0034] Preferably, the cyclonic separation system further comprises a dust collection bucket. More preferably, the bottom of the dust collection bucket is shaped so as to define the collection chamber for collecting liquids and/or heavy solids separated from the suctioned air flow, which collection chamber is placed below the first cyclonic unit and partially separated from said first cyclonic unit by the toroidal partition wall.

[0035] Preferably, the side wall toward which the toroidal partition wall extends is the side wall of the dust collection bucket.

[0036] Preferably, the first cyclonic unit is identified by a portion of the dust-collection bucket, so that the outer wall of the first cyclonic unit is the side wall of the dust collection bucket, said side wall comprising a tangential inlet for entry of suctioned air. More preferably, the first cyclonic unit is identified by a portion of the dust-collection bucket which comprises an annular separation chamber; said annular separation chamber is laterally delimited by the side wall of the dust collection bucket and medially by an inner wall, which inner wall is substantially concentric to said side wall of the dust collection bucket.

[0037] Preferably, the toroidal partition wall extends parallel to the bottom of the dust-collection bucket, more preferably at a height of from 35 to 85 mm from the bottom of the dust-collection bucket, most preferably at a height of from 40 to 70 mm from the bottom of the dust-collection bucket.

[0038] Preferably, the collection chamber is designed to collect at least 200 cm^3, more preferably at least 400 cm^3, most preferably at least 600 cm^3, of liquids.

[0039] The collection of significant amounts of liquids, still maintaining reduced size of the separation system, is made possible by the toroidal partition wall, which avoids the backflow of the liquids to the cyclonic units.

[0040] In a preferred embodiment, the collection chamber is interrupted by a vertical radial baffle. The radial baffle prevents the formation in the collection chamber of rotating flows of air and liquids which could cause the liquids to flow over the toroidal partition wall, outside the collection chamber.

[0041] Preferably, the canister wet vacuum cleaner comprises an engine-activated fan for generating a suctioning air flow. Preferably, the engine and the fan are placed over the cyclonic separation system, along its longitudinal axis.

[0042] Preferably, the cyclonic separation system further comprises a filter element, which filter element preferably has a truncated conical shape, tapering downwardly. The outer wall of said filter element is provided with a plurality of lateral openings. According to a preferred embodiment, the filter element is contained in the dust-collection bucket, substantially concentric to the side wall of the dust-collection bucket itself, so that the outer wall of said filter element corresponds to the inner wall which medially limits the first cyclonic unit.

[0043] The radial distance between the outer wall of the filter element and the side wall of the dust collection bucket is preferably of from 20 mm and 40 mm, more preferably of from 25 mm to 35 mm.

[0044] Said radial distance is the minimal distance, measured at the closest point between the side wall of the dust-collection bucket and the outer wall of said filter element. For example, when the filter element has a truncated conical shape, tapering downwardly, said radial distance is measured at the top of the filter element.

[0045] The canister wet vacuum cleaner of the invention also comprises a second cyclonic unit positioned downstream of the first unit. In particular, the second cyclonic unit is preferably placed above the first cyclonic unit, along the prosecution of its longitudinal axis.

[0046] Preferably, the second cyclonic unit is placed within an upper portion of the dust-collection bucket.

[0047] In a preferred embodiment, the second cyclonic unit projects at least partially in the first cyclonic unit.

[0048] In another preferred embodiment, the second cyclonic unit does not extend into the first cyclonic unit.

[0049] In further embodiments, the cyclonic separation system comprises more than two cyclonic units; examples of separation systems comprising more than two cyclonic units are disclosed in EP1898768, US2011061351, EP1883336.

[0050] Preferably, the second cyclonic unit includes a drain connected to a conduit for the collection of finest particles.

[0051] Preferably, the drain of the second cyclonic unit is inserted inside the filter element, substantially concentric to the side wall of the filter element.

[0052] Preferably, the conduit for the collection of finest particle is substantially concentric to the side wall of the collection chamber, more preferably it is located at the bottom of the dust-collection bucket, substantially concentric to its side wall.

[0053] Preferably, the above-mentioned second cy-

clonic unit includes a plurality of second cyclone separators arranged in parallel. Each second cyclone separator includes an upper cylindrical portion, provided with an inlet in communication with the first cyclonic unit and an outlet in communication with the air outlet of the vacuum cleaner, and a lower frustoconical portion tapering downwards, with an opening at the lower free end, pointing towards the drain leading to the conduit for the collection of finest particles.

[0054] Preferably, each second cyclone separator is individually fed in parallel to the other second cyclones separators from an upper portion of the first cyclonic unit.

[0055] The upper part of the dust-collection bucket is preferably closed by an annular lid, which hermetically closes the dust-collection bucket around the outlet. More preferably a filter, such as a HEPA filter, is located between the dust-collection bucket and the lid.

[0056] Preferably, the main body of the canister wet vacuum cleaner of the invention, which main body houses said cyclonic separation system, has width, length and height dimensions such that at least one of said dimensions is equal to or less than 300 mm, preferably equal to or less than 280 mm, more preferably equal to or less than 270 mm.

[0057] According to a preferred embodiment, the wet vacuum cleaner of the present invention has both vacuum and steam cleaning functionalities.

[0058] Preferably, the wet vacuum cleaner of the present invention is a high power vacuum cleaner, having a total power ranging from 700 W to 3000 W, preferably from 1000 W to 3000 W.

Brief description of figures

[0059]

Figure 1: perspective view of a preferred embodiment of the wet vacuum cleaner of the invention.

Figure 2: side view of the apparatus of figure 1.

Figure 3: perspective view of the apparatus of figure 2, wherein the anterior case has been removed to show the cyclonic separation system of the apparatus. The walls of the dust-collection bucket (3) are marked with broken lines as to make the inside visible.

Figure 4: plan view in vertical section of the cyclonic separation system (2) of the vacuum cleaner of figure 1, comprising the dust-collection bucket (3).

Figure 5: plan view in horizontal section of the dust-collection bucket (3) of figure 4 in correspondence of the second cyclonic unit, according to a preferred embodiment of the invention.

Figure 6: partially exploded perspective view of the dust-collection bucket (3) and of the filtering section of the apparatus of figure 1.

Figure 7: plan view in vertical section of a preferred embodiment of the cyclonic separation system (2).

Figure 8: plan view in horizontal section of the cyclonic separation system (2) of figure 7, in correspondence of the toroidal partition wall.

Detailed description of the invention

[0060] The canister wet vacuum cleaner of the present invention comprises a cyclonic separation system having a total volume of from 2000 to 7000 cm^3, preferably of from 3000 to 6000 cm^3, which cyclonic separation system comprises at least two cyclonic units. The first cyclonic unit is delimited by an inner wall and an outer wall. The radial distance between said inner wall and said outer wall is of from 20 mm to 40 mm, preferably of from 25 mm to 35 mm. The cyclonic separation system further comprises, preferably below said first cyclonic unit, a collection chamber for collecting solids and/or liquids separated from the air flow in the first cyclonic unit. Said collection chamber is partially separated from the first cyclonic unit by means of a toroidal partition wall, which extends radially, from an inner wall toward a side wall, without contacting said side wall, so that an annular space is identified between the perimeter of said toroidal partition wall and said side wall, through which the liquids and/or heavier solids, separated from the suctioned air flow in the first cyclonic unit, fall into the collection chamber.

[0061] According to a preferred embodiment, the cyclonic separation system further comprises a dust collection bucket. Preferably, the first cyclonic unit is identified by a portion of said dust collection bucket, comprising a tangential air inlet, preferably positioned in correspondence of a median portion of the side wall of said dust-collection bucket, for entry of suctioned air flow through the side wall of said dust collection bucket, and an outlet for exit of filtered air. More preferably, the first cyclonic unit is identified by a peripheral annular separation chamber, which is preferably delimited by the side wall of the dust collection bucket and by an inner wall concentric to said side wall. The radial distance between said side wall of the dust-collection bucket and said inner wall, delimiting the peripheral annular separation chamber, is preferably comprised between 20 mm and 40 mm, preferably between 25 mm and 35 mm.

[0062] In a preferred embodiment, the bottom of the dust collection bucket is shaped as to form the collection chamber for collecting solids and/or liquids. According to said embodiment, the toroidal partition wall extends parallel to the bottom of the dust-collection bucket, toward the side wall of the dust collection bucket.

[0063] Preferably, said toroidal partition wall is located at a height of from 35 to 85 mm over the bottom of the dust-collection bucket, more preferably at a height of from 40 to 70 mm over the bottom of the dust-collection bucket.

[0064] Preferably, the radial distance between the perimeter of the toroidal partition wall and the side wall to which it extends is of from 1 mm to 9 mm, more preferably of from 1.5 mm and 8 mm. More preferably, said side wall is the side wall of the dust collection bucket.

[0065] In a preferred embodiment of the invention, the perimeter of the toroidal partition wall comprises an indent, so that the annular space between said perimeter of the toroidal partition wall and the side wall is not uniform and comprises a first portion having a first radial distance to said side wall, which measures from 6 mm to 9 mm, preferably from 7 mm to 8 mm, and a second portion having a second radial distance to said side wall, which measures from 1 mm to 3 mm.

[0066] Preferably, the collection chamber is interrupted by a vertical radial baffle. The vertical radial baffle can prevent the formation of rotating flows of air and liquids within the collection chamber.

[0067] Preferably, the collection chamber has a capacity of at least 200 cm^3, preferably at least 400 cm^3, more preferably at least 600 cm^3, of separated liquids.

[0068] Preferably, the cyclonic separation system further comprises a separated portion or conduit for the collection of finer particulate. More preferably, said portion for the collection of finer particulate is located at the bottom of collection chamber, substantially concentric to the side wall of the collection chamber. Most preferably, the collection chamber is a portion of the dust collection bucket.

[0069] Preferably, the total height of the cyclonic separation system is comprised between 150 mm and 300 mm, more preferably between 170 mm and 250 mm.

[0070] Preferably, the canister wet vacuum cleaner comprises an engine-activated fan for generating a suctioning air flow. A path for filtration of solids and/or liquids is identified between an inlet and an outlet of the vacuum cleaner, which path comprises the cyclonic separation system, in fluid communication said inlet and outlet.

[0071] Preferably, the engine and the fan are placed over the cyclonic separation system, along its longitudinal axis.

[0072] Preferably, the two or more cyclonic units of the cyclonic separation system are located along the prosecution of the longitudinal axis of the dust-collection bucket, at least partially inserted inside the dust-collection bucket.

[0073] Preferably, the cyclonic separation system further comprises a filter element. The outer wall of said filter element is provided with a plurality of lateral openings. According to a more preferred embodiment, the filter element has a truncated conical shape, tapering downwardly. The filter element is preferably concentric to the outer wall of the first cyclonic unit, so that the outer wall of said filter element preferably corresponds to the inner wall of the first cyclonic unit.

[0074] The radial distance between the outer wall of the filter element and the outer wall of the first cyclonic unit is preferably of from 20 mm and 40 mm, more preferably of from 25 mm to 35 mm.

[0075] Said radial distance is the minimal distance, measured at the closest point between the outer wall of the filter element and the outer wall of the first cyclonic unit. Preferably, when the filter element has a truncated conical shape, tapering downwardly, said distance is measured at the top of the filter element.

[0076] According to the invention, the cyclonic separation system further comprises a second cyclonic unit positioned downstream of the first cyclonic unit, along the aforesaid path for filtration of solids and/or liquids.

[0077] Preferably, the second cyclonic unit is placed within an upper portion of the dust-collection bucket.

[0078] In a preferred embodiment, the second cyclonic unit projects at least partially in the first cyclonic unit.

[0079] In another preferred embodiment, the second cyclonic unit does not extend into the first cyclonic unit.

[0080] In further embodiments, the cyclonic separation system comprises more than two cyclonic units; examples of separation systems comprising more than two cyclonic units are disclosed in EP1898768, US2011061351, EP1883336.

[0081] In a preferred embodiment, the second cyclonic unit includes a drain connected to the conduit for the collection of finest particles.

[0082] Preferably, said conduit for the collection of finest particle is substantially concentric to the wall of the dust-collection bucket.

[0083] Preferably, the above-mentioned second cyclonic unit includes a plurality of second cyclone separators arranged in parallel. Each second cyclone separator includes an upper cylindrical portion, provided with an inlet in communication with the first cyclonic unit and an outlet in communication with the air outlet of the vacuum cleaner, and a lower frustoconical portion tapering downwards, with an opening at the lower free end, pointing towards the drain leading to the conduit for the collection of finest particles.

[0084] Preferably, said drain is inserted inside the filter element, substantially concentric to the outer wall of the filter element.

[0085] Preferably, each second cyclone separator is individually fed in parallel to the other second cyclones separators from an upper portion of the first cyclonic unit.

[0086] The upper part of the dust-collection bucket is preferably closed by an annular lid, which hermetically closes the dust-collection bucket around the outlet. More preferably a filter, such as a HEPA filter, is located between the dust-collection bucket and the lid.

[0087] According to a preferred embodiment, the canister wet vacuum cleaner of the invention also has steam cleaning functionality. In particular, the main body of the vacuum cleaner preferably comprises a steam generator.

[0088] In a preferred embodiment, the steam generator and the cyclonic separation system are located side-by-side, along a longitudinal direction, extending from the front to the rear side of the vacuum cleaner's body. In particular, the cyclonic separation system is preferably located in a frontal portion of the main body, while a steam generator is located in a rear portion of the main body.

[0089] Preferably, the main body of the canister wet vacuum cleaner has height, width and length dimensions

such that at least one of said dimensions is equal to or less than 300 mm, preferably equal to or less than 280 mm, more preferably equal to or less than 270 mm.

[0090] Preferred embodiments of the present invention will be now described in more details with reference to the drawings.

[0091] As shown in figures 1 and 2, illustrating a preferred embodiment of the present invention, the canister wet vacuum cleaner comprises a main body (1), comprising the cyclonic separation system (2). The cyclonic separation system (2) is preferably located in the frontal portion of said body (1) and comprises the dust-collection bucket (3). Two cyclonic units are present inside the dust-collection bucket, located along the prosecution of the longitudinal axis of the dust-collection bucket (3), (3), coaxial to it.

[0092] Air is preferably suctioned through a hose (not shown), connected to the main body at a hose inlet (31). Said hose inlet is preferably located in the rear portion of the main body (1), in fluid communication with the inlet (4) of the cyclonic separation system.

[0093] After being filtered, exhausted air exits the outlet (5), preferably located at the top of the second cyclonic unit.

[0094] The fan (10) and the electric engine (11) operating the fan are preferably located above the dust-collection bucket, along a longitudinal axis extending upwards, as shown in figure 3.

[0095] The preferred longitudinal assembly of the cyclonic separation system shown in the drawings, extending upwards, favours the reduction of the body size and in particular of the body width of the vacuum cleaner.

[0096] The main body (1) preferably comprises wheels for the vacuum cleaner's movement.

[0097] A protective case preferably covers a major portion of the body (1).

[0098] Figure 6 shows a partially exploded perspective view of the dust-collection bucket (3) and of the cyclonic separation system (2) of the apparatus of figure 1. The first cyclonic unit is identified by a portion of the dust collection bucket (3), comprising a tangential air inlet (4) and an annular separation chamber (14).

[0099] As shown in figures 4 and 7, the tangential air inlet (4), which conveys the suctioned air flow, comprising dust and/or liquids, into the dust-collection bucket (3), is preferably located in correspondence of a median portion of the side wall of the dust-collection bucket (3).

[0100] The first cyclonic air flow is created in said annular separation chamber (14), which is laterally delimited by the side wall of the dust collection bucket (3) and medially delimited by an inner wall concentric to said side wall. The radial distance between said side wall and said inner wall is of from 20 mm to 40 mm, preferably of from 25 mm to 35 mm.

[0101] The bottom of the dust-collection bucket (3) is shaped as to form an annular relief (6) which defines the collection chamber (7), for the collection of suctioned liquids and/or heavier solids, and a central portion (8) for the collection of finer particulate.

[0102] Said collection chamber (7) is located below the first cyclonic unit, and it is partially separated from that by the toroidal partition wall (15), parallel to the bottom of said dust-collection bucket (3). The toroidal partition wall (15) extends radially from an inner wall toward the side wall of said dust-collection bucket (3) without contacting it, so that an annular space (28) is identified between the perimeter of the toroidal partition wall (15) and the side wall of the dust-collection bucket (3), which annular space (28) puts said collection chamber (7) in communication with said first cyclonic unit. Liquids and/or heavier solids, separated from the suctioned air flow in the first cyclonic unit, fall through said annular space (28) into the collection chamber (7).

[0103] The radial distance between the perimeter of said toroidal partition wall (15) and the side wall of the dust-collection bucket (3), defining the annular space (28) through which liquids and/or heavier solids fall into the collection chamber (7), is of from 1 mm to 9 mm, preferably from 1.5 mm to 8 mm. In particular, according to the preferred embodiment shown in figure 8, the perimeter of the toroidal partition wall (15) comprises an indent (29), so that the toroidal partition wall (15) comprises a first portion whose edge is more proximal to the side wall of the dust collection bucket (3) and a second portion, comprising the indent (29), whose edge is more distal to the side wall of the dust collection bucket. The radial distance, measured between the more distal edge of the toroidal partition wall (15) and the side wall of the dust-collection bucket (3), in the preferred embodiment shown in figure 8, is of about 7 mm, while the radial distance, measured between the more proximal edge of the toroidal partition wall (15) and the side wall of the dust-collection bucket (3), is of about 2 mm.

[0104] Preferably, the aforesaid collection chamber (7) is interrupted by a vertical radial baffle (9) which prevents the formation in said chamber of rotating flows of air and/or liquids and the consequent exit of the liquids and/or heavier solids collected therein. The radial baffle is shown in figures 4, 6 and 7.

[0105] Figures 4-8 show a preferred embodiment of the invention wherein the cyclonic separation system comprises a filter element (12), having an outer wall comprising a plurality of lateral filtering openings (13), through which the suctioned air flows. Preferably the surface of the wall comprising the lateral openings is smaller in correspondence of the tangential air inlet (4), in order to avoid that the suctioned air comprising dust and/or liquids is immediately filtered without a first separation of heavier solids and/or liquids performed by the first cyclonic unit. According to said preferred embodiment, the interspace between the wall of the filtering element and the side wall of the dust-collection bucket defines the peripheral annular separation chamber (14), extending along an axial portion of the dust-collection bucket, which identifies the first cyclonic unit. Said annular separation chamber (14) is positioned above said collection chamber (7), in fluid

communication with the outlet (5).

[0106] The annular peripheral separation chamber (14) has a closed upper end, which is preferably positioned above the tangential inlet (4) of the collection bucket (3).

[0107] The filter element (12) preferably has a frustoconical shape, tapering downwards, and is contained inside the dust-collection bucket (3), substantially concentric to the side wall of the dust-collection bucket itself.

[0108] The cyclonic separation system (2) according to the invention also includes a second cyclonic unit positioned downstream of the first unit. The air to be filtered by the second cyclonic unit is provided by the first cyclonic unit, preferably from the annular separation chamber (14). As shown in figures 4 and 6, this second cyclonic unit preferably includes a drain (18) extending into the filter element (12) and which is connected with the central portion (8) for the collection of the finest particles.

[0109] Preferably, the second cyclonic unit is further provided with an outlet (5) for the exit of exhausted air, in fluid communication with the outlet of the wet vacuum cleaner.

[0110] The above-mentioned second cyclonic stage preferably includes a plurality of second cyclone separators (19) arranged in parallel. Within the second cyclone separators (19) fine particles are separated from the air flow and are conveyed downward, descending by gravity, through the conduit of decantation or drain (18), into the central portion (8), located at the base of the dust-collection bucket (3). The conduit (18) for the draining the finest particle is preferably substantially concentric to the side wall of the filter element (12).

[0111] Each second cyclone separator (19) is preferably fed individually in parallel to the other second cyclones separators from an upper portion (20) of the filtering path, formed by the annular interspace identified between the filter element (12) and the conduit of decantation (18).

[0112] In particular, each second cyclone separator preferably includes an upper cylindrical portion (22), provided with an inlet in communication with the aforesaid upper portion (20), joined to a lower frustoconical portion (23), tapering downwards, provided with an opening at the lower free end of the frustoconical portion, pointing towards the conduit for the collection of finest particles (18).

[0113] Each second cyclone separator (19) preferably comprises a cylindrical duct (24), concentric to the cylindrical portion (22) of the cyclone separator, through which the filtered air is discharge to the opening (5) of the dust collection bucket, preferably with interposition of a filter (21).

[0114] The dust-collection bucket (3) is preferably closed at the top by an annular cover (26), which tightly closes the collection bucket (3) around the expulsion outlet (5), by interposition of sealing means (27).

[0115] With reference to the preferred embodiments described above and shown in the drawings, the dual-stage cyclonic separation, together with the filter element, is capable of separating solids and/or liquids from the aspirated air stream, with high efficiency. With the first cyclonic stage, liquids and heavier particles are precipitated into the collection chamber (7). The outgoing air from the first cyclonic stage, still containing fine particles, is conveyed, through the holes (13) of the filter element (12) and the annular gap identified between the filter element (12) and the decantation conduit (18), to upper portion of the first cyclonic unit (20). The air is thus conveyed upwards, entering the second cyclone separator stage (19), due to the suction flow. Once purified, exhausted air is expelled through the outlet (5), preferably after being transited through a further filter (21), more preferably a HEPA filter.

[0116] It should be noted that the preferred presence of a radial baffle (9) in the collection chamber (7) serves as a barrier, adapted to prevent rotating flows of air and/or liquids, in correspondence within the lower portion of the dust collection bucket (3).

[0117] The features of the wet vacuum cleaner of the invention participate in providing a cleaning device, capable of efficiently drawing in big volumes of liquids, still having a very compact size, highly desirable for canister vacuum cleaners. In particular, the toroidal partition wall which partially separates the collection chamber and the first cyclonic unit is capable of preventing the escape of heavier solids and/or liquids from said chamber to the cyclonic units, thus allowing to separate significant amounts of liquids in a separation system of reduced size.

[0118] Particularly preferred is the embodiment wherein the cyclonic separation system is comprised within the main body of a wet vacuum cleaner comprising steam functionality.

Claims

1. Canister wet vacuum cleaner comprising a main body (1), said main body (1) comprising a cyclonic separation system (2) for separating solids and/or liquids from a suctioned air flow, wherein said cyclonic separation system (2) has a total volume of from 2000 to about 7000 cm^3, preferably of from 3000 to 6000 cm^3 and comprises:

   two or more cyclonic units, wherein the radial distance between the outer wall and the inner wall of the first cyclonic unit is of from 20 mm to 40 mm, preferably of from 25 mm to 35 mm, and a collection chamber (7) for collecting liquids and/or solids separated from the suctioned air flow, wherein said collection chamber (7) is partially separated from the first cyclonic unit by a toroidal partition wall (15), which extends radially from an inner wall toward a side wall;

   wherein said toroidal partition wall (15) is not in con-

tact with said side wall, so that an annular space (28) is identified between the perimeter of the toroidal partition wall (15) and said side wall, which annular space (28) puts said collection chamber (7) in communication with said first cyclonic unit, so that liquids and/or solids separated from the suctioned air flow in the first cyclonic unit fall through said annular space into the collection chamber (7).

2. The canister wet vacuum cleaner of claim 1, further comprising a dust collection bucket (3), wherein the side wall, toward which the toroidal partition wall (15) extends, is the side wall of a dust-collection bucket (3).

3. The canister wet vacuum cleaner of claim 2, wherein the outer wall of the first cyclonic unit is the side wall of the dust collection bucket (3), and wherein the first cyclonic unit comprises a tangential air inlet (4) in the side wall of the dust collection bucket (3) for entry of suctioned air flow, an outlet for exit of exhausted air, and a peripheral annular separation chamber (14) where the cyclonic air flow is created.

4. The canister wet vacuum cleaner of any of the preceding claims, wherein the annular space (28) identified between the perimeter of the toroidal partition wall (15) and the side wall has a radial distance of from 1 mm to 9 mm, preferably from 1.5 mm to 8 mm.

5. The canister wet vacuum cleaner of any of the preceding claims, wherein the perimeter of the toroidal partition wall (15) comprises an indent (29), so that the annular space (28) between said perimeter of the toroidal partition wall (15) and the side wall is not uniform and comprises a first portion having a first radial distance to the side wall of from 6 mm to 9 mm, preferably of from 7 mm to 8 mm, and a second portion having a second radial distance to the side wall of from 1 mm to 4 mm, preferably of from 1.5 to 2.5 mm.

6. The canister wet vacuum cleaner of any of the preceding claims, wherein said collection chamber (7) further comprises a vertical radial baffle (9).

7. The canister wet vacuum cleaner of any of the preceding claims, wherein said collection chamber (7) for collecting liquids, and/or solids has a capacity of at least 200 cm^3, preferably of at least 400 cm^3, more preferably of at least 600 cm^3.

8. The canister wet vacuum cleaner of any of the preceding claims, wherein the main body (1) further comprises:

an engine (11), and
a fan (10) activated by said engine for suctioning outer air, wherein said fan (10) and the engine (11) are placed over the cyclonic separation system, along its longitudinal axis.

9. The canister wet vacuum cleaner of any of the preceding claims, wherein the cyclonic separation system further comprises a filter element (12), having an outer wall which comprises a plurality of lateral filtering openings (13), wherein said filter element (12) is placed inside a portion of the cyclonic separation system, substantially concentric to the outer wall of the first cyclonic unit, and wherein said outer wall of said filter element forms the inner wall of the first cyclonic unit.

10. The canister wet vacuum cleaner of any of the preceding claims wherein the second cyclonic unit is located downstream of the first cyclonic unit, along the prosecution of the longitudinal axis of the first cyclonic unit, and includes a drain (18) connected to a conduit (8) for the collection of finest particles, wherein said conduit (8) is substantially cylindrical and concentric to the side wall of the collection chamber (7).

11. The canister wet vacuum cleaner of claim 10, wherein the second cyclonic unit comprises a plurality of second cyclone separators (19) arranged in parallel.

12. The canister wet vacuum cleaner of claims 10-11, wherein the second cyclonic unit does not extend into the first cyclonic unit.

13. The canister wet vacuum cleaner of any of the preceding claims, wherein the total height of the cyclonic separation system (2) is comprised between 150 mm and 300 mm, preferably between 170 mm and 250 mm.

14. The canister wet vacuum cleaner of any of the preceding claims, wherein the main body (1) further comprises a steam generator, and wherein said main body (1) has height, width and length dimensions such that at least one of said dimensions is equal to or less than 300 mm, preferably equal to or less than 280 mm, more preferably equal to or less than 270 mm.

15. The canister wet vacuum cleaner of claim 14, wherein the cyclonic separation system (2) and the steam generator are located side-by-side, along a longitudinal direction, extending from the front to the rear side of the main body (1) of the canister wet vacuum cleaner.

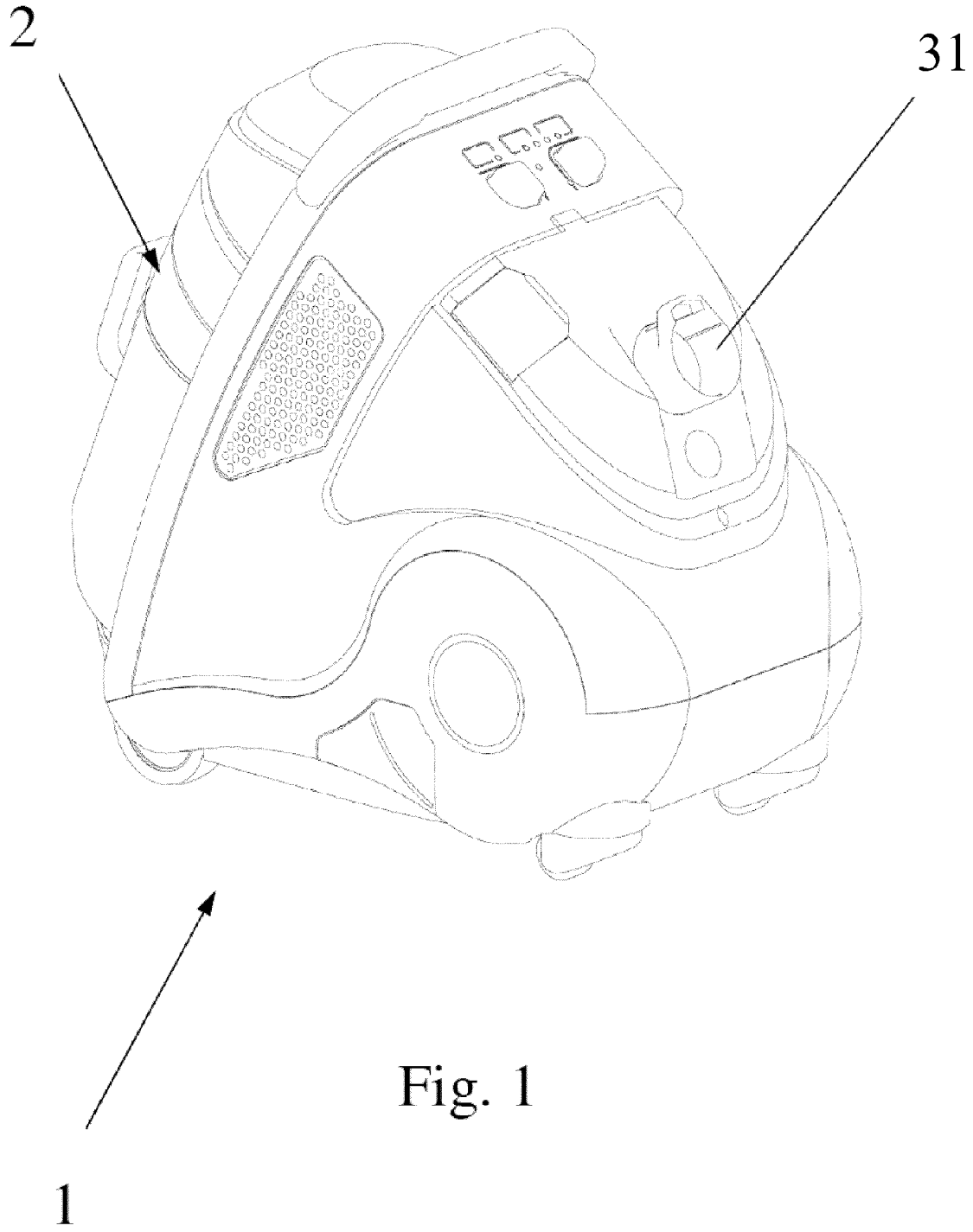

Fig. 1

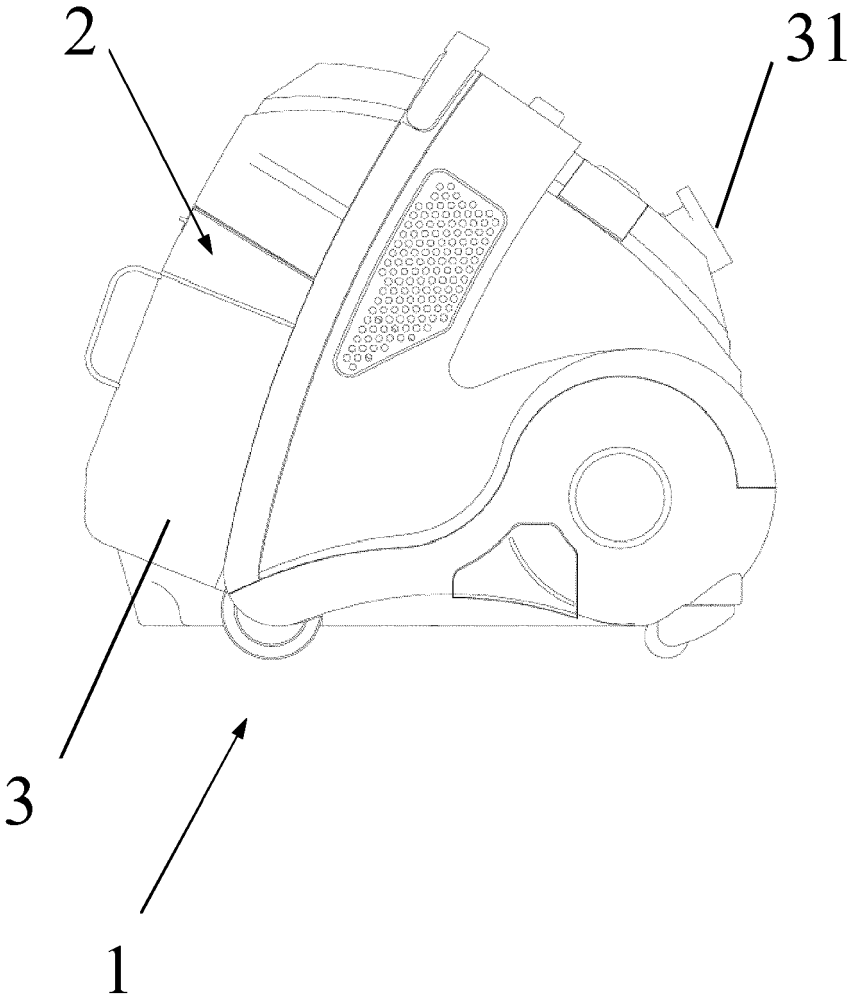

Figure 2

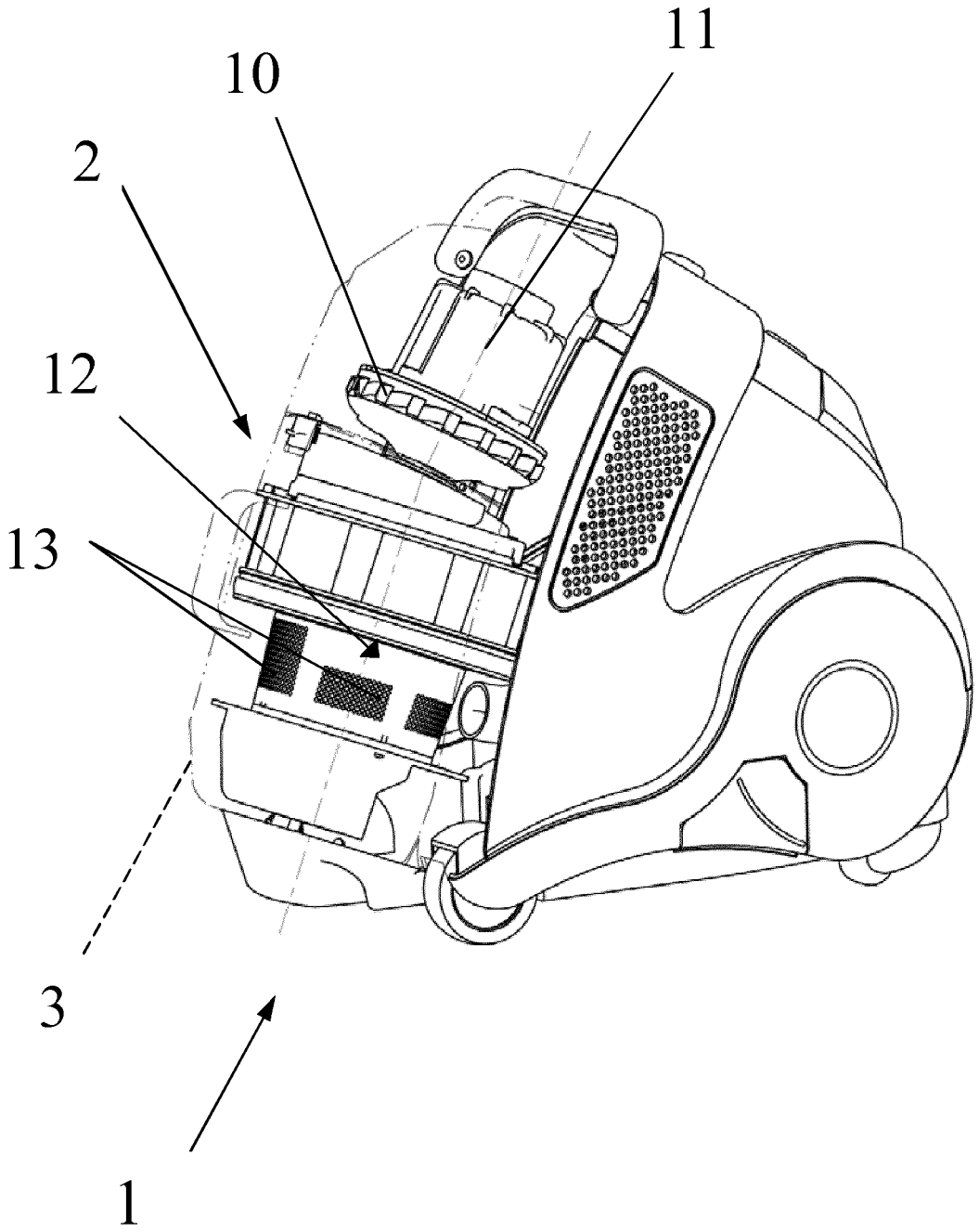

Figure 3

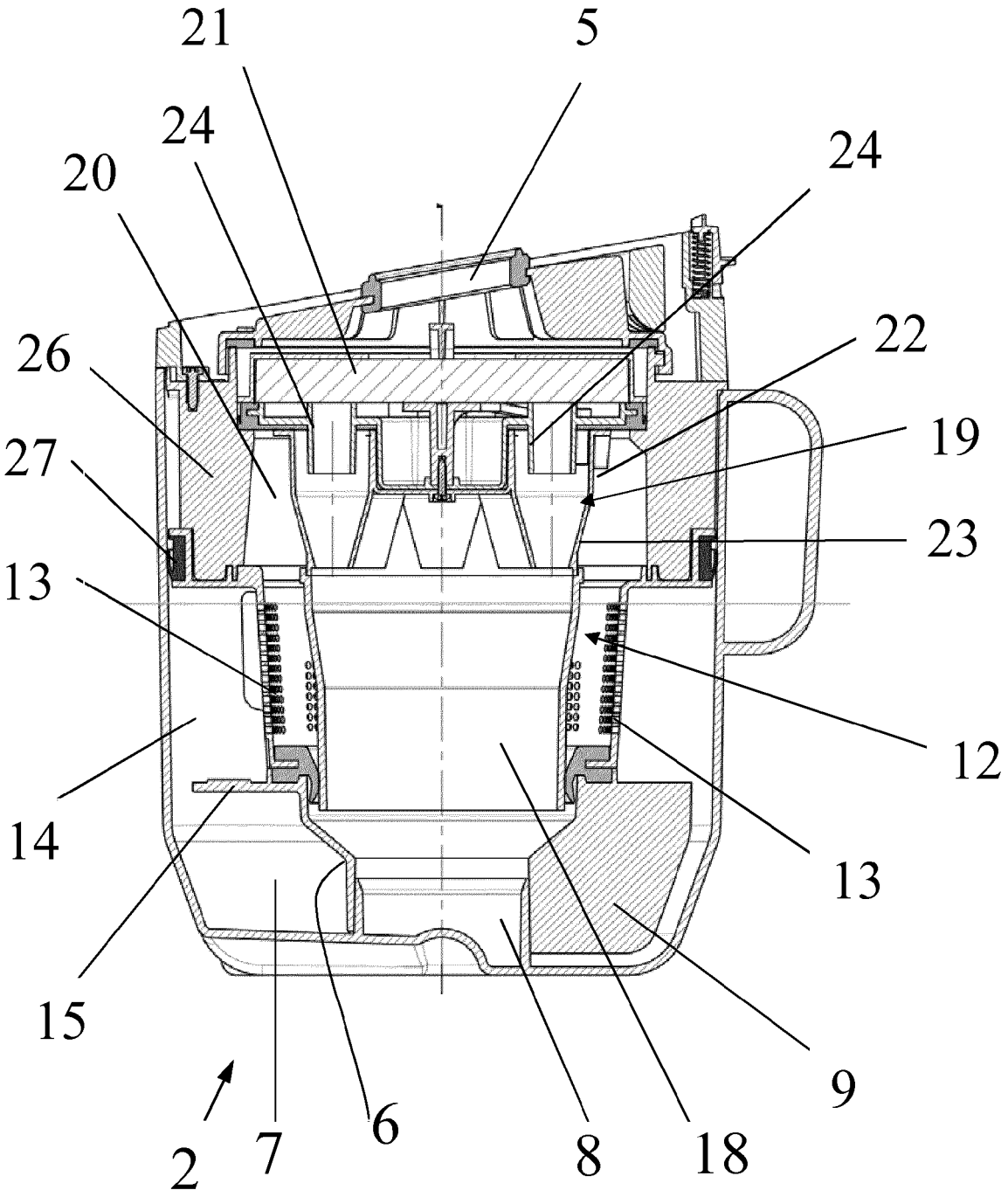

Figure 4

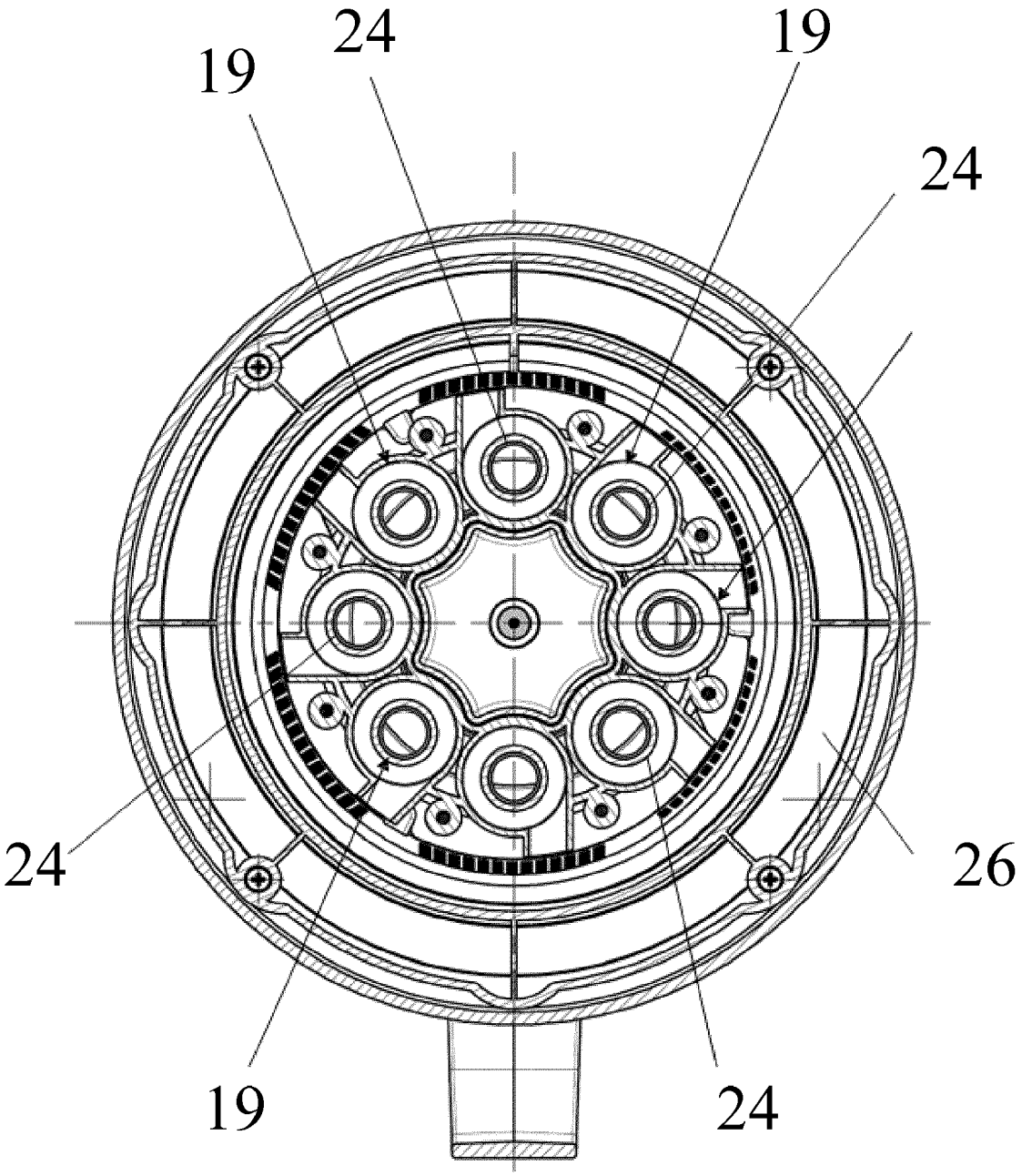

Figure 5

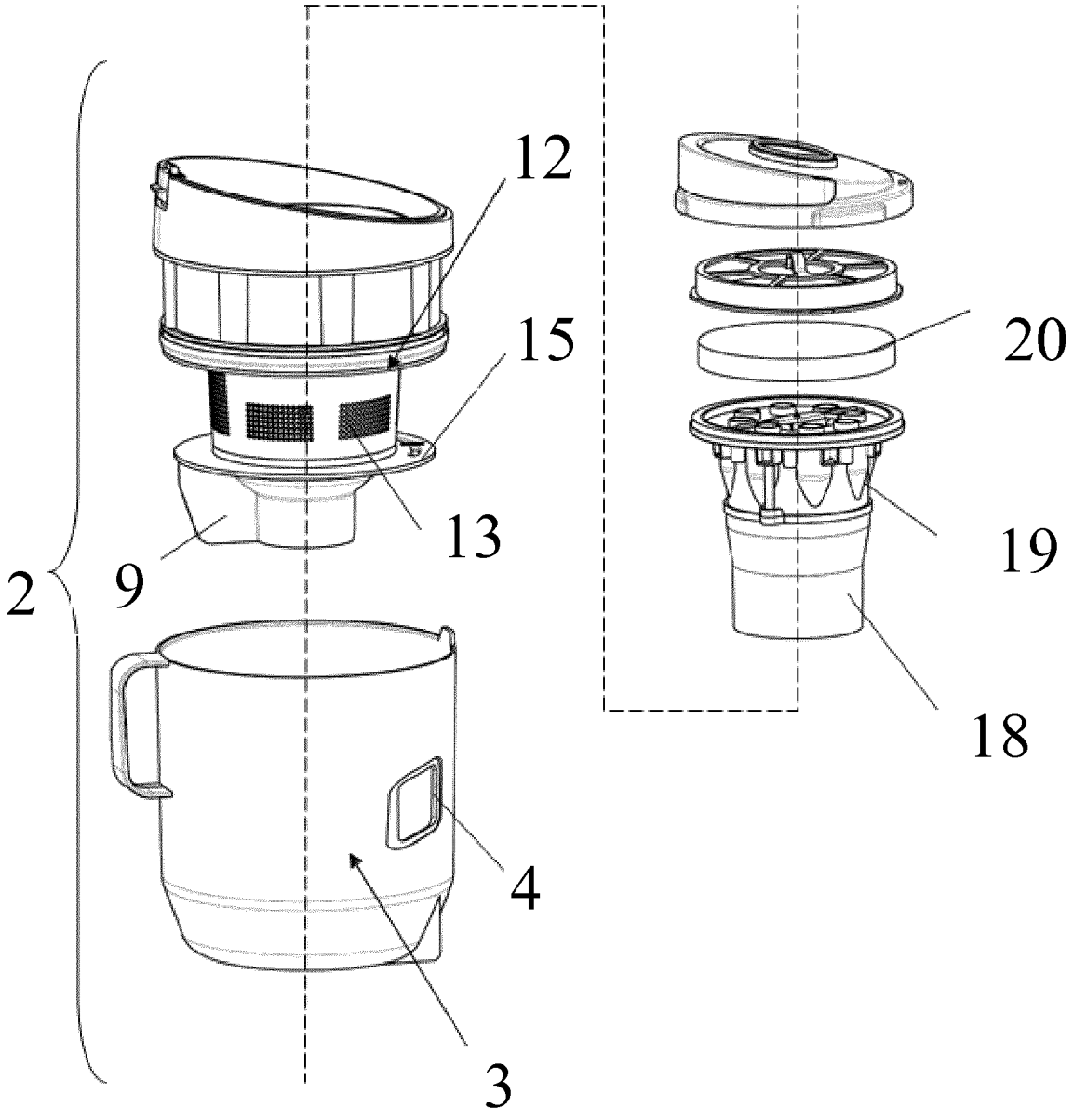

Figure 6

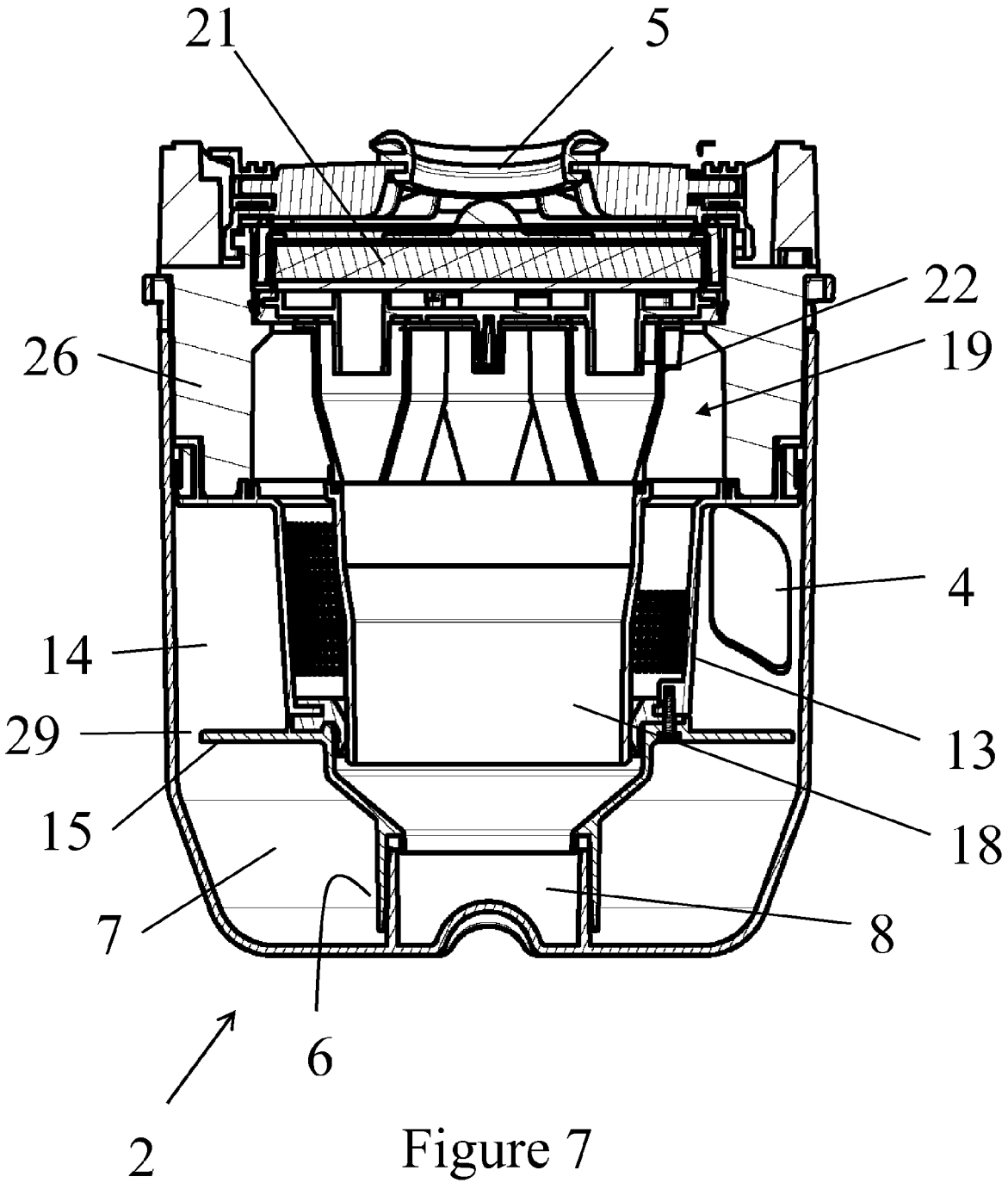

Figure 7

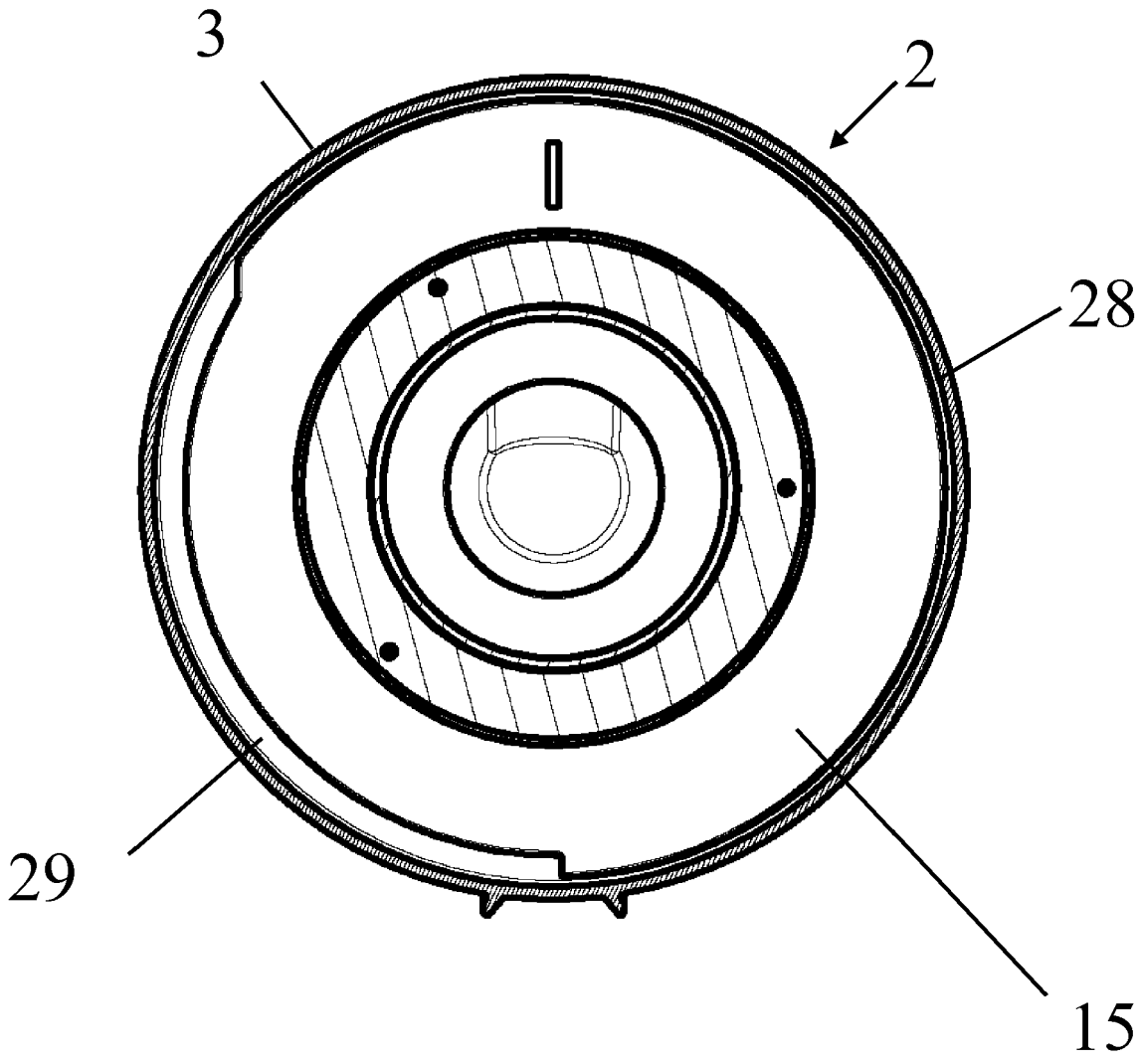

Figure 8

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EUROPEAN SEARCH REPORT

Application Number
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A47L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	4 December 2014	Blumenberg, Claus

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