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(54) Domestic vacuum cleaner

(57) The present invention relates to a vacuum cleaner for domestic cleaning of the type comprising a body (2) adapted to comprise suction means (5) in fluid communication with an air intake opening (8), filtering means (6A, 11) to filter the particles contained in the suctioned air, these filtering means (6A, 11) being interposed between the intake (8) and the suction means (5), an air discharge path to convey a flow of air suctioned by the suction means (5) to an outlet opening (21) and a tank (3, 3A, 3B) for a fluid (20) associated with the body (2) in order to be interposed in fluid communication between the suction means (5) and the outlet (21). The vacuum cleaner has the characteristic feature that it comprises a first air discharge path (7A) in order to convey a first flow of air discharged by the suction means (5) to an outlet opening (21), a second air discharge path (7B) in order to convey a second flow of air discharged by the suction means (5) to means (27) for generating an atomised flow (M), so that the first flow of air suctioned by the suction means (5) is intercepted by the atomised flow (M) in the first air discharge path (7A) so as to extract the particles contained in the suctioned air.

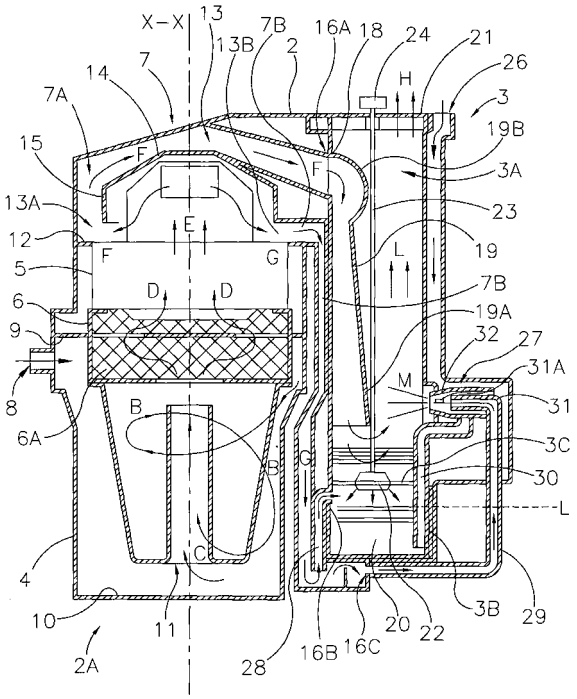

FIG. 1

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Description

[0001] The present invention relates to an improved domestic vacuum cleaner.

[0002] Vacuum cleaners comprising a box-shaped body associated with a tank containing a fluid are known. The vacuum cleaner comprises, within the box-shaped body, a fan coupled to an electric suction motor connected to an intake duct for air containing dust and dirt. For domestic cleaning, therefore, a vacuum cleaner may be used in which the flow of air containing dust, brought about by the motor/suction unit, firstly passes through a filter, for instance a diaphragm filter (normally in the form of a bag) able to retain and separate the solid particles contained in the suctioned flow of air, then flows along a discharge path into a tank containing a fluid, generally water, so that the dust contained in the suctioned flow of air can be extracted.

[0003] Although vacuum cleaners of the above-mentioned type are satisfactory from a practical point of view, they have the drawback that the purification fluid may clog the filters for the removal of the residual dust to an extent that may compromise their operational efficiency.

[0004] These filters, conventionally of the "HEPA" type, are in practice disposed along the intake path upstream of the tank, generally in the vicinity of the air outlet slots provided in the body of the vacuum cleaner.

[0005] Known vacuum cleaners, in order to obtain an adequate filtration action, also need to use a substantial quantity of fluid, making the use of the vacuum cleaner difficult as a result of its weight and the volume needed to contain the fluid. In view of the prior art described above, the object of the present invention is to provide a vacuum cleaner having structural and operational features able to obviate the drawbacks described above with reference to vacuum cleaners of the prior art. A further object of the present invention is to provide a vacuum cleaner in which the tank for the fluid responsible for extracting the dirt is separate from the motor/suction unit and which is therefore easier and more practical for the user to handle. A further object of the present invention is to provide a vacuum cleaner which is economical and functional, which enables efficient filtration of the suctioned air, separating it from dust and dirt particles and from droplets of fluid prior to its discharge, and which uses a smaller quantity of fluid for that purpose.

[0006] This object is achieved, in accordance with the present invention, by a vacuum cleaner as claimed in claim 1.

[0007] As a result of the present invention, it is therefore possible to provide a highly efficient domestic vacuum cleaner with a minimum absorbed power and a high particle accumulation capacity.

[0008] As a result of the present invention, moreover, it is possible to provide a vacuum cleaner of compact dimensions with respect to known vacuum cleaners since a smaller quantity of fluid is required to carry out filtration.

[0009] The characteristic features and advantages of the present invention are set out in the following detailed description of a practical embodiment thereof, shown by way of non-limiting example in the accompanying drawings, in which:

Fig. 1 is a diagrammatic view, in section, of an embodiment of the vacuum cleaner of the present invention;

Fig. 2 is a diagrammatic side view of a detail of the vacuum cleaner of the present invention.

[0010] In the accompanying drawings, a device, for domestic use, for cleaning by suction of dust, or a vacuum cleaner, is shown overall by 1.

[0011] The vacuum cleaner 1 comprises a body 2 with which a tank 3 is associated.

[0012] The body 2 of the vacuum cleaner 1 comprises a filtration suction unit 2A comprising a container 4 which may be removed by extraction from the body 2, a motor/suction unit 5, a filter-holder 6 disposed downstream of the motor/suction unit 5 and an air discharge path 7 disposed upstream of the motor/suction unit 5.

[0013] In the following description, in order to ensure an improved and constant dust capture efficiency and ability, even of very fine dust, which is very often the cause of allergies, the embodiment provided with an axial cyclone or volute is proposed as the best embodiment of the filtration suction unit 2A.

[0014] Alternatively, it is possible to use any other type of known filtration suction unit.

[0015] The container 4 takes the form, in a preferred embodiment, such as the embodiment of Fig. 1, of a body with a section of frustoconical type: it is provided laterally with an inlet opening 8 to which dirt and dust collection tools (tubes, brushes, crevice tools, etc.), of known type and not shown in the drawings, are adapted to be connected, comprises a top 9 adapted to divide the container 4 from the motor/suction unit 5 and also comprises, at the bottom, a base 10 adapted to collect the dust residues.

[0016] A generically cylindrical duct 11 (which is in practice slightly conical to facilitate moulding operations) which is connected in a known manner with the filter-holder 6 extends coaxially to and within the container 4.

[0017] The motor/suction unit 5, of substantially known type, comprises an electric motor adapted to cause the rotation of a fan adapted to generate the vacuum within the container 4 which gives concrete shape to the operation of the vacuum cleaner 1. The motor/suction unit 5 is supported by a base 12 which acts as a dividing wall between this motor/suction unit 5 and the discharge path 7.

[0018] The filter-holder 6 internally comprises a filter 6A which, in a preferred embodiment, takes the form of a filtration member of star-shaped type. This filter 6A may be readily removed by extraction from the filter-holder 6 so as to enable periodic cleaning operations.

[0019] A person skilled in the art may of course sub-

stitute other filters equivalent in structural and/or operational terms for this star-shaped filter 6A.

[0020] The air suctioned by the motor/suction unit 5 therefore enters the container 4 in a tangential direction (arrow A) via the inlet opening 8 and descends with a swirling movement (arrow B) into the frustoconical body of the container 4. In this way, the coarser particles contained in the suctioned air are deposited on the base 10 of the container 4 and the partially purified air rises back towards the centre (arrow C) of the frustoconical body in order to flow into the central duct 11.

[0021] A volute or cyclone (not shown), which provides the essentially axial flow of air in the duct 11 with a swirling movement, is rigidly housed in the central duct 11 and secured, for instance, by plastic thermowelding, adhesion or simply by pressure.

[0022] As a result of this swirling movement, the residual dust contained in the flow of air suctioned by the motor/suction unit 5 is centrifuged outwardly in a peripheral ring.

[0023] The separation of the peripheral portion of the flow of air from the central portion takes place within the duct 11, more particularly downstream of the cyclone, this central portion thus being able to flow freely through the star-shaped filter 6A. The dust contained in the peripheral portion of the flow of air gradually accumulates on the walls of the cyclone and tends to collect, under the effect of gravity, towards the bottom of the cyclone, and is deposited on the base 10 of the container 4. It will be appreciated that this container 4 has to be emptied periodically by the user.

[0024] The flow of air output from the apex of the cyclone 11 and which passes through the filter 6A is thus conveyed (arrows D) towards the motor/suction unit 5.

[0025] The air output from the motor/suction unit 5 (arrows E) is then deflected by a deflector 13 which is adapted to deflect the air discharged from the motor/suction unit 5 downwards, i.e. to convey the air discharged from the motor/suction unit along a first and a second air discharge path, respectively 7A and 7B. For this purpose, in the embodiment of Fig. 1, the deflector 13 comprises, in its peripheral area, a primary air intake 13A and a secondary air intake 13B. The primary air intake 13A conveys a portion of the air suctioned by the motor/suction unit 5 into the first air discharge path 7A (arrow F) while the secondary air intake 13B conveys a further portion of the air suctioned by the motor/suction unit 5 into a second air discharge path 7B (arrow G).

[0026] The tank 3 internally contains a first and a second container 3A and 3B, in fluid connection with one another by way of connection means 3C described in detail below. The first and second containers 3A and 3B are advantageously removable by extraction from the tank 3.

[0027] The container 3B is adapted to be filled to a predetermined level L with a fluid 20, for instance water, possibly mixed with deodorant, sanitising or like products.

[0028] The means 3C comprise a shutter 22 via which the containers 3A and 3B may be brought into fluid communication with one another. The shutter is in practice adapted to move from a first (Fig. 1) to a second operating position (Fig. 2) in which the shutter 22 enables and respectively prevents any fluid communication between the containers 3A and 3B.

[0029] In an embodiment, for instance as shown in Fig. 1, the shutter 22 may be manually controlled by the user by control means 23 taking the concrete form, for instance, of a rod having an end connected to the shutter and a free end terminating externally to the tank 3. The free end of the rod is provided with gripper means 24 which may be gripped by the user. As a result of these gripper means 24, it is possible to exert a substantially vertical pressure able to cause the shutter 22 to occupy one of its two operating positions.

[0030] Alternatively, the control means 23 may switch between the first and the second operating position automatically by means of appropriate electrical devices or by means of mechanical means, which are known per se and not therefore described.

[0031] The tank 3 is also provided with an outlet opening 21 via which it is possible to expel (arrows H) the air suctioned by the motor/suction unit 5. The tank 3 further comprises a supply duct 26 adapted to bring the fluid 20 into the second container 3B when filling or refilling operations of the second container are necessary.

[0032] The vacuum cleaner 1 further comprises means to generate an atomised flow 27 (arrows M). As a result of these means 27, the first flow of air expelled by the motor/suction unit 5 and flowing via the first discharge path 7A in the direction of travel of the flow of air is intercepted by the atomised flow generated by the means 27 at the first air discharge path 7A so as to extract the particles contained in the suctioned air.

[0033] For this purpose, the body 2 of the vacuum cleaner 1 comprises a first outlet opening 16A adapted to bring the motor/suction unit 5 into fluid communication with the container 3A via the first discharge path 7A. The body 2 further comprises a second outlet opening 16B adapted to bring the motor/suction unit 5 into fluid communication with the container 3B via the second discharge path 7B and a third outlet opening 16C adapted to bring the motor/suction unit 5 into fluid communication with the means for generating an atomised flow 27.

[0034] It should be noted that sealing gaskets, for instance of rubber, are advantageously mounted on the peripheral edge of the outlet openings 16A, 16B and 16C of the body 2 and are adapted to prevent the fluid from gaining access to the motor/suction unit 5 and escaping from the tank 3.

[0035] The container 3A is in direct fluid communication with the motor/suction unit 5 via the discharge path 7A, which comprises a diffusing or diverging duct 19. This duct 19 therefore comprises a smaller air inlet portion and a diverging outlet portion. The end portion 19A of the duct 19 is disposed above the dividing baffle 3C; the

fluid communication between the duct 19 and the motor/suction unit 5 takes place by means of a portion 19B folded as an elbow. The first air discharge path 7A (arrow F) is adapted to convey the flow of air suctioned by the motor/suction unit 5 via the diverging duct 19 to the outlet opening 21 (arrows L).

[0036] The second air discharge path 7B (arrow G), as shown in Fig. 1, comprises a first and a second duct 28 and 29 in the direction of travel of the flow of air. The first duct 28 is adapted to convey a portion of the second flow of air to the second container 3B, while the second duct 29 is in fluid communication with the means for generating an atomised flow 27.

[0037] In particular, the first duct 28 has its end portion disposed above the free surface L of the fluid 20 contained in the container 3B.

[0038] It should be noted that the means for generating an atomised flow (arrows M) are supplied by a supply duct 30 adapted to bring the fluid 20 contained in the container 3B to them. For this purpose, the duct 30 has its free end portion disposed below the free surface L of the fluid 20.

[0039] The means for generating an atomised flow 27 comprise an ejector 31 and an atomiser 32.

[0040] The ejector 31 uses the kinetic energy of the flow in the duct 29 to generate a vacuum, by means of which a certain quantity of fluid 20 is brought to the ejector itself-via the duct 30. In this way, air mixed with atomised water is discharged into the first discharge path within the first container 3A. For this purpose, the atomiser 32 is disposed immediately downstream of the ejector 31 so as to intercept the flow discharged by this ejector.

[0041] The task of the atomiser 32 is in particular to reduce the flow output from the ejector 21 into extremely minute droplets, for instance, by causing the flow output from the ejector 31 to pass through an appropriate spray nozzle. This spray nozzle atomises the flow by centrifugal force, discharging it into the first container 3A along the first discharge path 7A.

[0042] It should be noted that both the air discharge paths 7A and 7B comprise valve means adapted to enable the one-way passage of the air discharged by the motor/suction unit 5.

[0043] The description of the valve means cited above is set out in European Patent Application No. 04425538.8 filed on 20 July 2004 in the name of the Applicants. The description of these valve means is understood to be included here for reference.

[0044] It should also be noted that sensors of the level of fluid present may be provided within the container 3A and/or 3B, which sensors may be connected to a stop device, so as to discontinue the operation of the motor/suction unit 5 when the level of fluid in the container 3A and/or 3B exceeds or drops below a predetermined threshold.

[0045] The description of the sensors cited above is set out in European Patent Application No. 04425538.8 filed on 20 July 2004 in the name of the Applicants. The description of these sensors is understood to be included here for reference.

[0046] In operation, the user fills the container 3B with fluid 20 via the supply duct 27 up to a desired level L which can be checked by means of an appropriate graduated window 33. The container 3A is therefore initially empty.

[0047] Once the tank 3-is inserted, it is possible to start the motor/suction unit 5. This unit 5 suctions air towards the container 4 via the inlet aperture 8. The suctioned flow of air containing dust and/or solid particles passes firstly into the axial cyclone 11 where a first purification stage takes place and then flows through the star-shaped filter 6A where it is subject to a second filtration action, and lastly flows through the air discharge ducts 7A and 7B.

[0048] The flow of air suctioned by the motor/suction unit 5, flowing via the second path 7B, is in turn divided into two flows: the first of these flows reaches the second container 3B via the duct 28, while the second of these flows reaches the ejector 31 via the duct 29.

[0049] The ejector 31, using the kinetic energy of the flow in the duct 29, generates a vacuum by means of which a certain quantity of fluid 20 is brought to the ejector itself via the duct 30. The ejector 31 thus discharges air mixed with fluid which passes subsequently though the atomiser 32, as the latter is disposed immediately downstream of the ejector 31.

[0050] By means of the atomiser 32, therefore, the flow output from the ejector 31 is atomised into extremely fine droplets which are then discharged into the first container 3A along the first discharge path 7A. At the same time, the flow of air suctioned by the motor/suction unit 5 and flowing via the first path 7A, emerges from the diverging outlet section of the duct 19 and is conveyed towards the outlet 21 of the tank 3 (arrows L).

[0051] The atomised flow, from the atomiser 32, meets the flow of air from the diverging duct 19 and is mixed with it.

[0052] The dust contained in the flow suctioned by the motor/suction unit 5 and emerging from the diverging duct 19 is thus mixed with the atomised flow emerging from the means 27 so that the dust mixed with the fluid can be deposited, under the effect of gravity, on the base of the container 3A. After mixing has taken place in the container 3A, all of the particulate tends in practice to fall to the bottom of the container 3A.

[0053] Fluid mixed with dust therefore accumulates on the base of the container 3A. This accumulation may be discharged into the tank 3B by actuation of the shutter 22 by means of the manual command 24. This advantageously provides a fluid recovery action. Alternatively, when the quantity of fluid lying on the base of the container 3A exceeds a predetermined threshold value, the shutter 22 may automatically establish the fluid communication between the first and second container so that the fluid is able to flow from the first to the second container under the effect of gravity.

[0054] This therefore provides a filtration of the solid particles using a post-motor filtering design; in substance, the extraction of the dust residues takes place by mixing with the suctioned air which takes place upstream of the motor/suction unit 5.

[0055] It will be appreciated that these solid particles are the particles that have passed unchanged through the star-shaped filter 6A or which have not been trapped therein.

[0056] As mentioned above, in vacuum cleaners of the prior art, use is made of costly filters of the type commonly known as "HEPA" filters in order to filter these residues. These filters are disposed at the outlet of the vacuum cleaner.

[0057] Advantageously, the vacuum cleaner 1, in accordance with the present invention, does not require filters disposed at the outlet slots 21 of the container 3A as the residual solid particles discharged by the motor/suction unit 5 are retained by the filtering action exerted by the atomised flow output by the atomiser 32.

[0058] The vacuum cleaner of the present invention is therefore particularly efficient since it does not require the use of filters with pores of an extremely small diameter entailing substantial losses of load in the suction circuit and thereby reducing the suction vacuum in the take-up section of the external duct.

[0059] Moreover, this domestic vacuum cleaner is easy and economic to use, since it does not require complicated operations to remove the accumulated dust and does not require the regular replacement of spare parts.

[0060] A person skilled in the art could obviously, in order to satisfy contingent and specific requirements, make any modifications and variations to the embodiments described above, without thereby departing from the scope of protection of the invention as set out in the following claims.

Claims

1. A vacuum cleaner for domestic cleaning of the type comprising:

- a body (2) adapted to comprise suction means (5) in fluid communication with an air intake opening (8);
- filtering means (6A, 11) to filter the particles contained in the suctioned air, these filtering means (6A, 11) being interposed between the intake (8) and the suction means (5);
- a tank (3, 3A, 3B) for a fluid (20) associated with the body (2) in order to be interposed in fluid communication between the suction means and the outlet (21);

characterised in that it comprises a first air discharge path (7A) in order to convey a first flow of air suctioned by the suction means (5) to an outlet opening (21), a second air discharge path (7B) in order to convey a second flow of air suctioned by the suction means (5) to means (27) for generating an atomised flow (M), so that the first flow of air suctioned by the suction means (5) is intercepted by the atomised flow (M) in the first air discharge path (7A) so as to extract the particles contained in the suctioned air. -

2. A vacuum cleaner for domestic cleaning as claimed in claim 1, **characterised in that** the means (27) for generating an atomised flow (M) comprise an ejector (31).

3. A vacuum cleaner for domestic cleaning as claimed in claim 1 or 2, **characterised in that** the means (27) for generating an atomised flow (M) comprise an atomiser (32).

4. A vacuum cleaner for domestic cleaning as claimed in any one of the preceding claims, **characterised in that** the ejector (31) and the atomiser (32) are mutually connected to one another one after the other so that the atomiser (32) intercepts the flow ejected by the ejector (31) reducing the flow output from the ejector (31) into extremely minute droplets.

5. A vacuum cleaner for domestic cleaning as claimed in any one of the preceding claims, **characterised in that** the first air discharge path (7A) adapted to convey a first flow of air suctioned by the suction means (5) to an outlet opening (21) comprises a first duct (19) in the direction of travel of the flow of air.

6. A vacuum cleaner for domestic cleaning as claimed in claim 5, **characterised in that** the first diverging duct (19) has its diverging outlet section substantially perpendicular to the free surface (L) of the fluid (20).

7. A vacuum cleaner for domestic cleaning as claimed in any one of the preceding claims, **characterised in that** the second air discharge path (7B) adapted to convey to the tank (3, 3A, 3B) comprises a second (28) and a third (29) duct in the direction of travel of the flow of air, the second duct (28) being disposed above the free surface (L) of the fluid (20) in the tank (3, 3A, 3B) and the third duct (29) being in fluid communication with the means for generating an atomised flow (26).

8. A vacuum cleaner for domestic cleaning as claimed in any one of the preceding claims, **characterised in that** the means (27) for generating an atomised flow (M) are supplied via a supply duct (30) adapted to supply the fluid (20) contained in the tank (3, 3A, 3B).

9. A vacuum cleaner for domestic cleaning as claimed

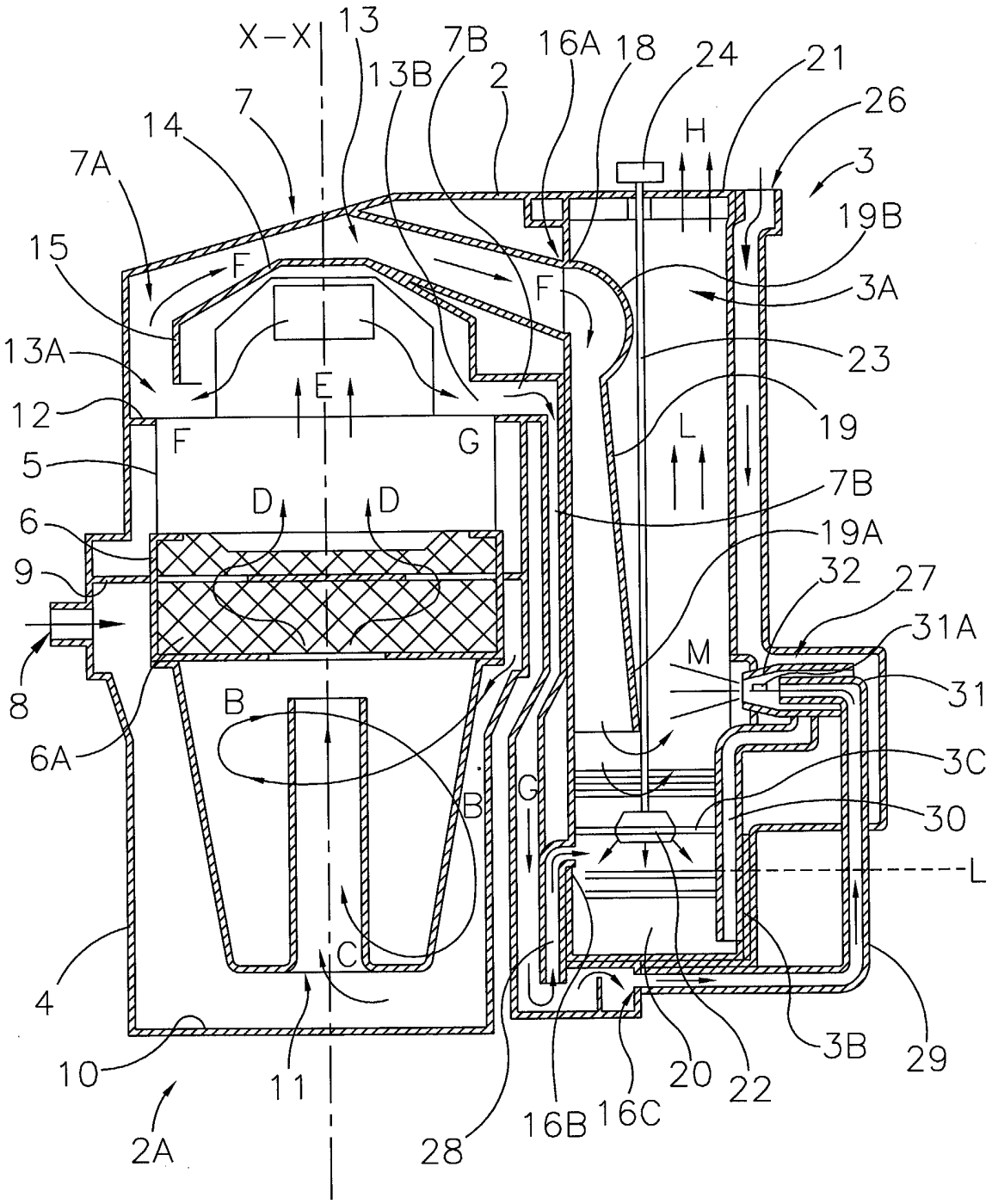
in any one of the preceding claims, **characterised in that** the tank (3, 3A, 3B) comprises a first container (3B) adapted to contain the fluid (20) and a second container (3A) in fluid communication with the first container (3B) by means of connection means (3C).

10. A vacuum cleaner for domestic cleaning as claimed in claim 9, **characterised in that** the connection means (3C) comprise a shutter (22).

11. A vacuum cleaner for domestic cleaning as claimed in claim 10, **characterised in that** the shutter (22) may be manually actuated.

12. A vacuum cleaner for domestic cleaning as claimed in claim 9, **characterised in that** the first container (3B) and the second container (3A) may be removed by extraction from the tank (3).

13. A vacuum cleaner for domestic cleaning as claimed in any one of the preceding claims, **characterised in that** the filter means (6A, 11) for retaining solid particles comprise a star-shaped filter member (6A) and an axial cyclone (11).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16C

FIG. 1

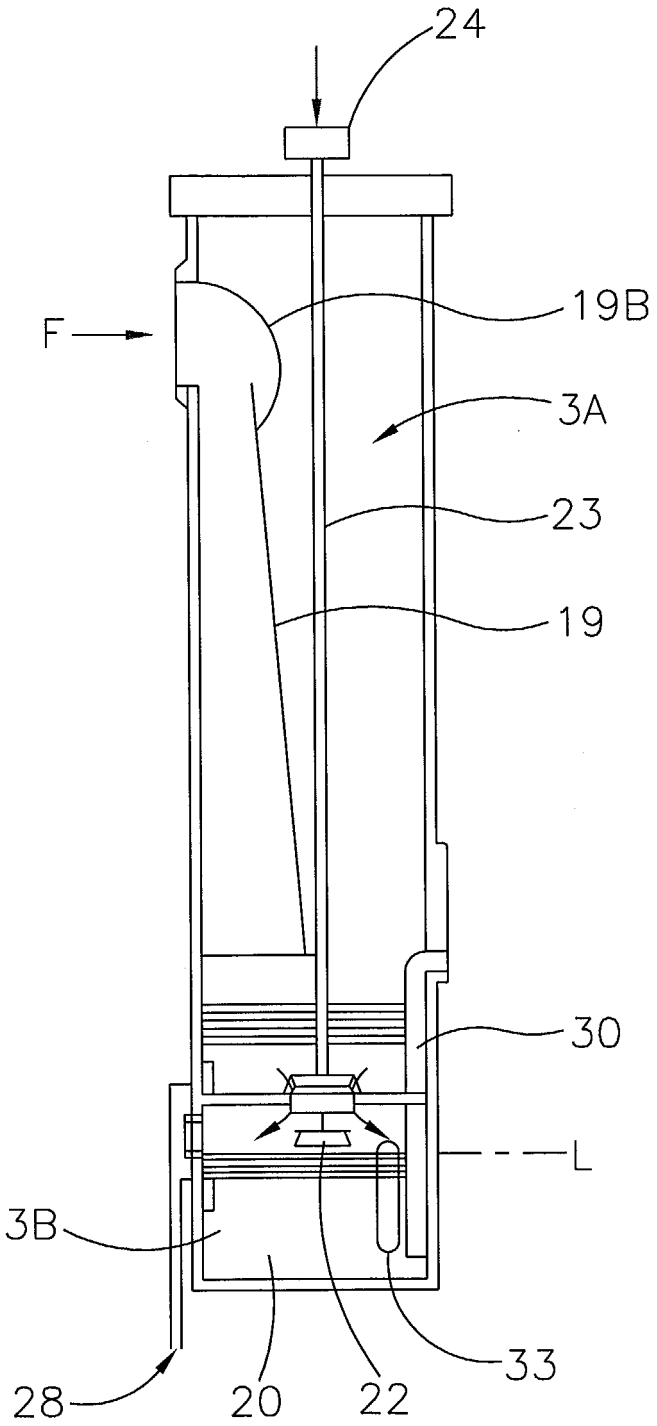

FIG.2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 42 5563

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	PATENT ABSTRACTS OF JAPAN vol. 2002, no. 02, 2 April 2002 (2002-04-02) -& JP 2001 286422 A (SHIMIZU YOSHIO), 16 October 2001 (2001-10-16) * abstract * * figures *	1	A47L9/18
A	EP 0 768 058 A (T.P.A. IMPEX S.P.A.) 16 April 1997 (1997-04-16) * abstract * * column 3, line 45 - column 4, line 6 * * figure 3 *	1	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	22 December 2004	Cabral Matos, A

CATEGORY OF CITED DOCUMENTS

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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