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(54) Title: VACUUM CLEANER

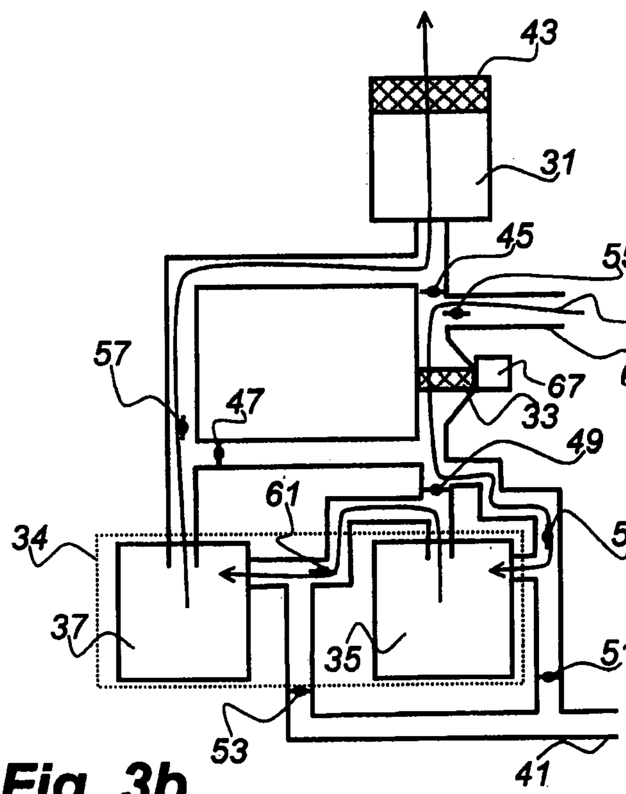

Fig. 3b

(57) Abstract: The present disclosure relates to a vacuum cleaner (1) comprising a separating unit (34), a vacuum source (31) for creating a negative air pressure, and a downstream filter (33). The vacuum cleaner is configured to operate in a vacuum cleaning mode, and is switchable to a filter cleaning mode, wherein the vacuum source is connected to the downstream filter to force an airstream therethrough in a reverse direction in order to remove dust from the downstream filter, and the separating unit is arranged to separate dust, released by the downstream filter, from the airstream. The separating unit has first and second sub-separators (35, 37), which are connected in parallel in the vacuum cleaning mode, and are connected in series in the filter cleaning mode. This provides convenient cleaning of the downstream filter.

WO 2008/091204 A1

VACUUM CLEANER

Technical field

The present disclosure relates to a vacuum cleaner comprising a separating unit, a vacuum source for creating a negative air pressure, and a downstream filter, the vacuum cleaner being configured to operate in a vacuum cleaning mode, wherein the vacuum source is connected to the separating unit to force a dust laden airstream therethrough in order to separate dust from the airstream, and the downstream filter is connected between the separating unit and the vacuum source to receive the airstream in a forward direction for filtering remaining dust therefrom, and the vacuum cleaner being switchable to a filter cleaning mode, wherein the vacuum source is connected to the downstream filter to force an airstream therethrough in a reverse direction in order to remove dust from the downstream filter, and the separating unit is connected between the downstream filter and the vacuum source to remove dust, released by the downstream filter, from the airstream. The present invention does also relate to a method for cleaning a downstream filter of a vacuum cleaner.

Background

Such a vacuum cleaner is disclosed in WO 2005/053497 A1. In that document two downstream filters are used, and when one is clogged by fine dust, the user is allowed to let the filters switch places and to clean the clogged filter using the separating unit and the other downstream filter. The cleaned filter is then ready for use when the other filter becomes clogged.

One problem with this vacuum cleaner is that the user may forget cleaning the filter or may find the process somewhat cumbersome.

Summary

An object of the present disclosure is to wholly or partly obviate this problem. This object is achieved by means of a vacuum cleaner according to claim 1 and by means of a method according to claim 9.

More specifically, in a vacuum cleaner of the initially mentioned kind the separating unit then comprises a first and a second sub-separator, wherein in the vacuum cleaning mode, the first and second sub-separators are connected in parallel, and in the filter cleaning mode, the first and second sub-separators are connected in series.

The use of two series connected sub-separators in the filter cleaning mode allows cleaning of a clogged downstream filter without the use of another downstream filter, as the series connected separator configuration has a much better separation performance. This configuration may be used, since a much higher separator flow resistance may be allowed in the filter cleaning mode. The auxiliary filter need not be moved every time the filter is cleaned, and the process may be simpler from the user's point of view. It may even be carried out automatically.

Each sub-separator may comprise a cyclone separator. A sub-separator may comprise several cyclone separators of equal or different vortex diameter. The several cyclones may be connected in series and/or in parallel.

The downstream filter may be a micro pore filter as it is not required to carry a lot of dust, since the filter may be cleaned regularly.

The vacuum cleaner may be a stationary vacuum cleaner or a moveable vacuum cleaner such as of the canister or the upright type.

The vacuum cleaner may further comprise means for rapping or vibrating the downstream filter in the filter cleaning mode.

Brief description of the drawings

Fig 1 shows a vacuum cleaner.

Fig 2 illustrates schematically a cyclone.

Fig 3a illustrates a vacuum cleaner operating in a vacuum cleaning mode.

Fig 3b illustrates the vacuum cleaner of fig 3a in a filter cleaning mode.

Figs. 4a and 4b illustrates schematically a valve for switching between the vacuum cleaning mode and the filter cleaning mode.

Detailed description

Fig 1 shows a vacuum cleaner 1 of the canister or cylinder type. The vacuum cleaner comprises a main part 3, having a vacuum source and a separating unit (not shown). The main part may comprise wheels 5 to provide improved moveability, and may, via a flexible tube 7 and a stiff tube 9, be connected to a nozzle 11 that is capable of picking up dust from floors and carpets, etc.

The present disclosure is relevant also for upright types of vacuum cleaners, where the main part is provided integrated with the stiff tube, and for stationary vacuum cleaners which may be provided as fixed installations in buildings.

Fig 2 illustrates schematically a cyclone 13 which may be used as a separating unit in the vacuum cleaner of the present disclosure. The cyclone 13 has an inlet slot 15, through which dust laden air enters into a vortex chamber 17, which may have a substantially circular cross section perpendicularly to the vertical direction, as illustrated in fig 2. The dust laden air enters along a tangential direction at the periphery of the vortex chamber 17, and is sucked out of the vortex chamber 17 through an outlet tube 19, which is inserted in the centre of the vortex chamber 17. This makes the dust laden air flow in a vortex 21 through the vortex chamber 17. Dust particles 23 are therefore subjected to a centrifugal force depending on v^2/R, where v is the flow velocity and R is the diameter of the vortex chamber cross section, which forces the particles towards the vortex chamber side wall. Once a dust particle 23 reaches the wall, it is caught in a secondary airstream directed downwards in the figure, and falls through an opening 25 in the bottom part of the vortex chamber 17 and into a dust chamber 27.

The dust chamber 27 may be conveniently emptied by the user of the vacuum cleaner, and the use of a cyclone of this kind may obviate the need for conventional vacuum cleaner filter bags.

In the illustrated cyclone 13, the vortex chamber 17 has a cross-section which tapers in the downward direction and has a minimum cross section at the opening. More particularly, the vortex chamber has a frustoconical shape. However, it should be noted that other tapering forms as well as cylindrical, non-tapering forms may be considered in a cyclone.

Often, a cyclone or a separating unit of another type will have a trade-off between separation efficiency and flow resistance, the higher the efficiency the higher the resistance. Therefore, e.g. if a cyclone capable of providing a very high separation efficiency/ratio for a standard dust would be used, the flow resistance would be too high to provide an acceptable airflow in the nozzle (11, fig 1) of the vacuum cleaner with a regular vacuum source. Therefore the vacuum cleaner would not be capable of picking up dust from a floor or a carpet in an acceptable manner. An example of a standard dust is DMT TEST DUST TYPE 8® referred to in DIN IEC 60312.

In practice therefore, a cyclone with a lower flow resistance is used, and any remaining dust which is sucked out through the outlet tube 19 is instead removed with a downstream filter in order to protect the vacuum source. Usually it is the finer dust fraction that remains to be filtered, as heavier particles are subjected to greater centrifugal forces. The term downstream filter refers to the filter being placed after the main separator but before the vacuum source in a vacuum cleaning mode.

There will now be described a vacuum cleaner with means for cleaning such a downstream filter, whereby clogging of the filter can be avoided to a great extent.

The vacuum cleaner is then switched from the usual vacuum cleaning mode to a filter cleaning mode. This may be done manually or automatically.

Fig 3a illustrates a vacuum cleaner operating in a vacuum cleaning mode, where the vacuum cleaner is used for vacuum cleaning, while fig 3b illustrates the vacuum cleaner when switched to a filter cleaning mode.

With reference to both fig 3a and fig 3b, the vacuum cleaner has a vacuum source 31, typically comprising a fan driven by an electric motor. The vacuum source 31 creates a negative air pressure which makes the vacuum cleaner capable of collecting dust from floors and carpets, etc. Via a downstream filter 33, the vacuum source 31 is connected to a separating unit 34 which comprises a first 35 and a second 37 sub-separator. The first and second sub-separators 35, 37 are connected in parallel in the vacuum cleaning mode, such that they may each receive substantially half (50%) of a dust laden airflow 39, which is received through an inlet 41, which may typically be connected to the flexible tube 7 of fig 1. Of course it is possible to let the sub-separators receive different amounts of air (e.g. 60%-40%, 70%-30%, etc.). It would also be possible to use a three or more sub-separators connected in parallel.

The sub-separators 35, 37 separate most of the dust from the airstream 39. Any remaining dust is filtered by the downstream filter 33, through which the airstream passes in a forward direction, in order to protect the vacuum source 31 from the remaining dust, which typically consists of finer dust fractions. The airstream then passes through the vacuum source 31, and is finally filtered by a motor filter 43 to separate e.g. graphite particles released by the vacuum source 31. The configuration of fig 3a is accomplished by keeping a first set of valves 45, 47, 49, 51, 53 open, while a second set of valves 55, 57, 59, 61 are closed.

As the sub-separators are connected in parallel in the vacuum cleaning mode, the flow resistance of the separating unit in this case is low. This provides efficient collection of dust from carpets, floors, etc.

In fig 3b, the vacuum cleaner has been switched to a filter cleaning mode. In the filter cleaning mode, the downstream filter 33 is cleaned such that its flow resistance may be reduced by removing dust that may otherwise clog the filter. The vacuum cleaner is switched to the filter cleaning mode by closing the first set of valves 45, 47, 49, 51, 53 and opening the second set of valves 55, 57, 59, 61. Then an ambient air airstream 63 is drawn through a filter cleaning opening 65 and passes through the downstream filter 33 in a reverse direction, such that the downstream filter may release dust into the airstream 63. This process may optionally be enhanced by means of a rapper or vibrator 67, which vibrates or raps the downstream filter 33.

Note that the layout of figs 3a and 3b is only a schematic example. Other layouts are possible within the scope of the present disclosure and the functions of the valves may be achieved differently.

In Fig. 3b, an ambient air stream 63 is drawn through a filter cleaning opening 65. However, it is also possible to dispense with the filter cleaning opening 65 and to direct ambient air from the inlet 41 to the downstream filter 33 such that the air stream will pass the downstream filter 33 in a reversed direction. It would also be possible to shut all air inlets of the vacuum cleaner during the filter cleaning mode and to force air, which is already inside the vacuum cleaner, through the downstream filter 33 in the reversed direction.

The airstream then passes through the first sub-separator 35 and through the second sub-separator 37, which are now series connected, such that the released dust is again separated from the airstream. The airstream then passes through the vacuum source 31 and the motor filter.

In Figs. 4a and 4b, an example embodiment of a valve 70 for changing the connection of the sub-separators between a parallel and a serial when switching between the vacuum cleaning mode and the filter cleaning mode is shown. In the shown embodiment, each sub-separator comprises a cyclone separator, however, the skilled person realizes that also other kinds of sub-separators could be used. The cyclone separators can be of the type described above with reference to Fig. 2 and may comprise an inlet slot 15, a vortex chamber, an outlet tube 19 and an opening 25 in the bottom part for separated dust.

The valve 70 comprises a valve chamber, which is enclosed by a valve housing. The valve housing includes cylindrical wall portion 74. A cross wall 73 is arranged across the valve chamber such that the chamber is divided into two compartments 71, 72, wherein the compartments 71, 72 are sealed from each other by the cross wall 73 in an air tight manner. An air channel is provided in the cross wall, wherein the air channel extends from one end of the cross wall 73 to the other end of the cross wall 73. The cross wall 73 is rotatable arranged inside the valve chamber, wherein the cross wall 73 is in sliding contact with the inner side of the cylindrical wall portion 74 in order to keep the air tight seal between the compartments 71, 72.

The cylindrical wall portion 74 of the valve housing is provided with six air openings for leading an air stream in and out of the valve chamber. An air stream is fed to the valve 70 through a main entrance opening 75 and is released through a main outlet 80. Furthermore, a left outlet 76 is connected to the inlet 15 of a first sub-separator 35, and a left inlet 77 in connected to the outlet 19 of the fist sub-separator 35. Finally, a right outlet 78 is connected to the inlet 15 of a second sub-separator 37, and a right inlet 79 in connected to the outlet 19 of the second sub-separator 37.

In Fig. 4a the valve is shown in a position where the sub-separators are connected in parallel for operating the vacuum cleaner in a vacuum cleaning mode. The cross wall is positioned such that it extends from the cylindrical wall portion 74 at a location between the left outlet 76 and the left inlet 77 to an diametrically opposite location at the cylindrical wall portion 74 between the right outlet 78 and the right inlet 79. Thus, when a dust laden air stream enters the valve 70, it is received in the compartment 72 and is allowed to continue through both the right and the left outlets 76, 78 to both sub-separators 35, 37. The two air streams leaving the sub-separators are fed back to the valve chamber where they enter the compartment 71 through the left and right inlets 77, 79, respectively. Finally, a reunited air stream leaves the valve through the main outlet 80. Thereafter the air stream continues to the downstream filter (not shown) and further through the vacuum cleaner as describe above with reference to Figs. 1 – 3.

When the vacuum cleaner is switched to filter cleaning mode, the valve 70 is operated to rotate the cross wall 73 to the position shown in Fig. 4b, whereby the sub-separators 35, 37 become connected in series. The cross wall 73 is positioned such that the air channel thereof connects the right inlet 79 with the left outlet 76. Thus, when an air stream, which is laden with dust released from the down stream filter (not shown), arrives at the valve 70, it is fed into the compartment 72 through the main entrance opening 75. Thereafter, the air stream passes through the right outlet 78, through the second sub-separator 37, through the air channel of the cross wall 73, through the first sub-separator 35 and is finally received in compartment 71 of the valve chamber. Thereafter, the air stream leaves the valve camber through the main outlet 80 and continuous to vacuum source (not shown) as described above with reference to Figs. 1 – 3.

The process described with reference to Fig. 3a and 3b above cleans the downstream filter 33, such that it does not need to be replaced very often. As the sub-separators are now series connected, their separation ratio for a given dust (e.g. a standard dust) will be much higher than in the vacuum cleaning mode, which means that an additional downstream filter may not be needed, even though such a filter may optionally be provided. The higher separation ratio comes at the cost of a higher flow resistance, but in the filter cleaning mode this may be allowed, as there is no need to collect dust comprising heavier particles from a floor or carpet. This higher separation ratio makes it possible to efficiently separate the fine dust fractions released from the downstream filter.

The downstream filter 33 in this configuration may be cleaned regularly, either manually or automatically, e.g. when the user begins or finishes a vacuum cleaning. It is also possible to provide a pressure sensor that measures the pressure drop over the downstream filter in order to determine when filter cleaning is needed. The duration in which the vacuum cleaner is in the filter cleaning mode, or in other words, how long the filter is subjected to filter cleaning, can be a fixed time, decided on manually or depend on the pressure drop over the filter, for example.

Thus the downstream filter need not be able to carry a lot of dust. Micro pore filters such as filters made of expanded PTFE (polytetrafluorethylen), e.g. GORE-TEX (trademark) may be considered. On such filters the dust is collected on top of the filter surface, rather than in the depth of the filter as in a conventional filter. A micro pore filter may therefore be easily cleaned.

In summary, the present disclosure relates to a vacuum cleaner comprising a separating unit, a vacuum source for creating a negative air pressure, and a downstream filter. The vacuum cleaner is configured to operate in a vacuum cleaning mode, and is switchable to a filter cleaning mode, wherein the vacuum source is connected to the downstream filter to force an airstream therethrough in a reverse direction in order to remove dust from the downstream filter, and the separating unit is arranged to separate dust, released by the downstream filter, from the airstream. The separating unit has first and second sub-separators, which are connected in parallel in the vacuum cleaning mode, and are connected in series in the filter cleaning mode. This provides convenient cleaning of the downstream filter.

The invention is not restricted to the described embodiments, and may be varied and altered within the scope of the appended claims.

CLAIMS

1. A vacuum cleaner (1) comprising a separating unit (34), a vacuum source (31) for creating a negative air pressure, and a downstream filter (33);

the vacuum cleaner being configured to operate in a vacuum cleaning mode, wherein the vacuum source (31) is connected to the separating unit (34) to force a dust laden airstream (39) therethrough in order to separate dust from the airstream, and the downstream filter (33) is connected between the separating unit and the vacuum source to receive the airstream in a forward direction for filtering remaining dust therefrom; and

the vacuum cleaner being switchable to a filter cleaning mode, wherein the vacuum source (31) is connected to the downstream filter (33) to force an airstream therethrough in a reverse direction in order to remove dust from the downstream filter, and the separating unit (34) is connected between the downstream filter and the vacuum source to remove dust, released by the downstream filter, from the airstream; c h a r a c t e r i z e d in that

the separating unit comprises a first (35) and a second (37) sub-separator, wherein

in the vacuum cleaning mode, the first and second sub-separators are connected in parallel, and

in the filter cleaning mode, the first and second sub-separators are connected in series.

2. A vacuum cleaner according to claim 1, wherein each sub-separator comprises a cyclone separator (13).

3. A vacuum cleaner according to any of the preceding claims, wherein the downstream filter is a micro pore filter.

4. A vacuum cleaner according to any of the preceding claims, wherein the vacuum cleaner is a stationary vacuum cleaner.

5. A vacuum cleaner according to any of claims 1-3, wherein the vacuum cleaner is a moveable vacuum cleaner.

6. A vacuum cleaner according to claim 5, wherein the vacuum cleaner is of the canister type.

7. A vacuum cleaner according to claim 5, wherein the vacuum cleaner is of the upright type.

8. A vacuum cleaner according to any of the preceding claims, further comprising means (67) for rapping or vibrating the downstream filter in the filter cleaning mode.

9. Method for cleaning a downstream filter (33) of a vacuum cleaner, wherein

the vacuum cleaner comprises the downstream filter (33) and a separating unit (34),which comprises a first (35) and a second (37) sub-separator, and wherein

the downstream filter (33) is used during a vacuum cleaning method, comprising the steps of

- connecting the first and second sub-separators (35, 37) in parallel,
- forcing a dust laden air stream (39) through the separating unit (34) in order to separate dust from the air stream,
- forcing the air stream leaving the separating unit (34) through the downstream filter (33) in a forward direction for filtering remaining dust therefrom;

comprising the steps of

- connecting the first and second sub-separators (35, 37) in series,

- forcing an air stream (57) through the downstream filter (33) in a reverse direction in order to remove dust from the downstream filter,

-forcing the are stream (57) through the separating unit (34) in order to separate dust, released by the downstream filter, from the airstream.

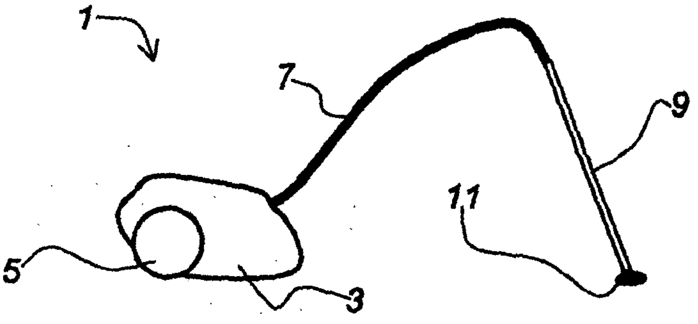

Fig. 1

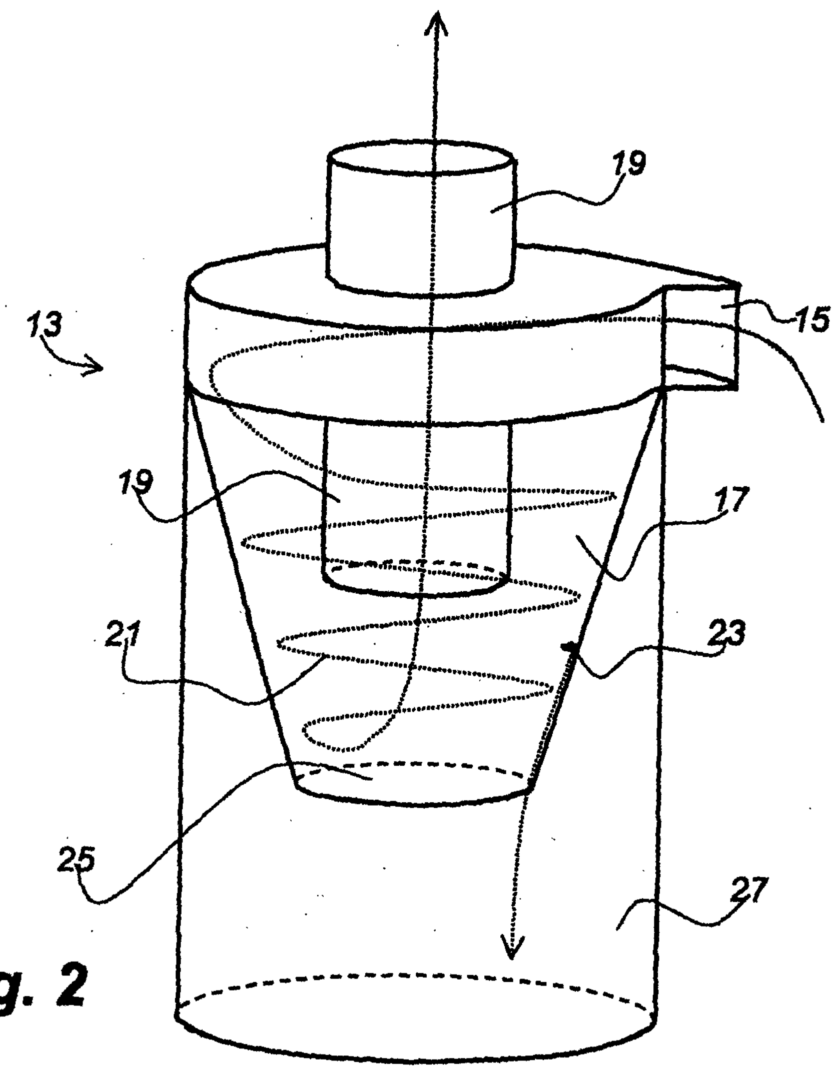

Fig. 2

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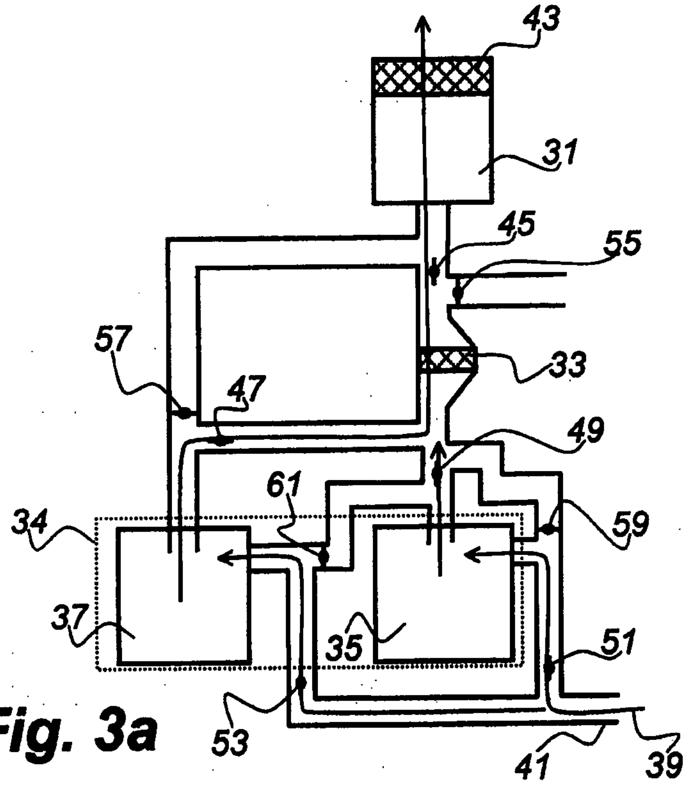

Fig. 3a

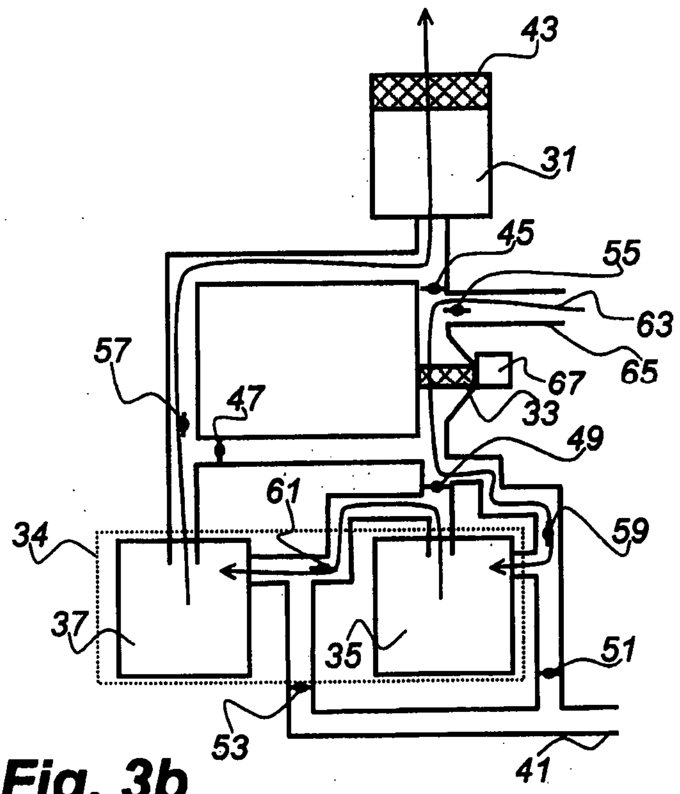

Fig. 3b

3/3

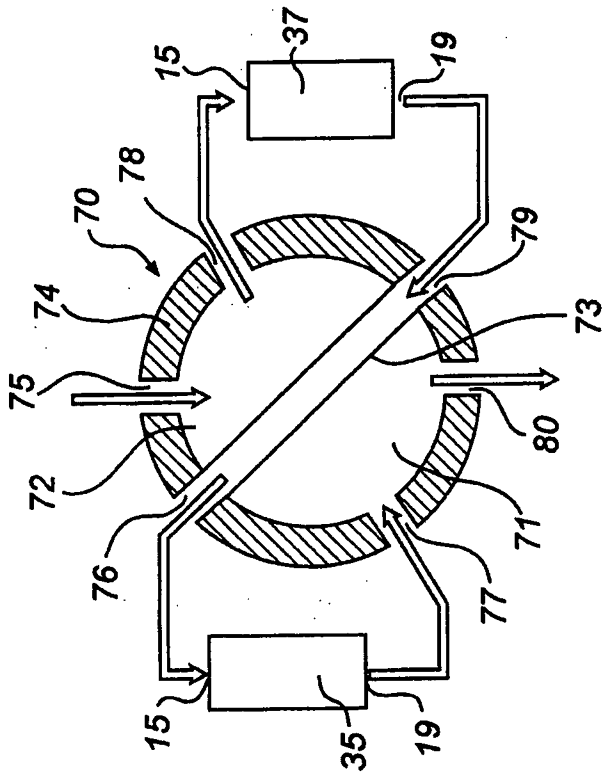

Fig. 4b

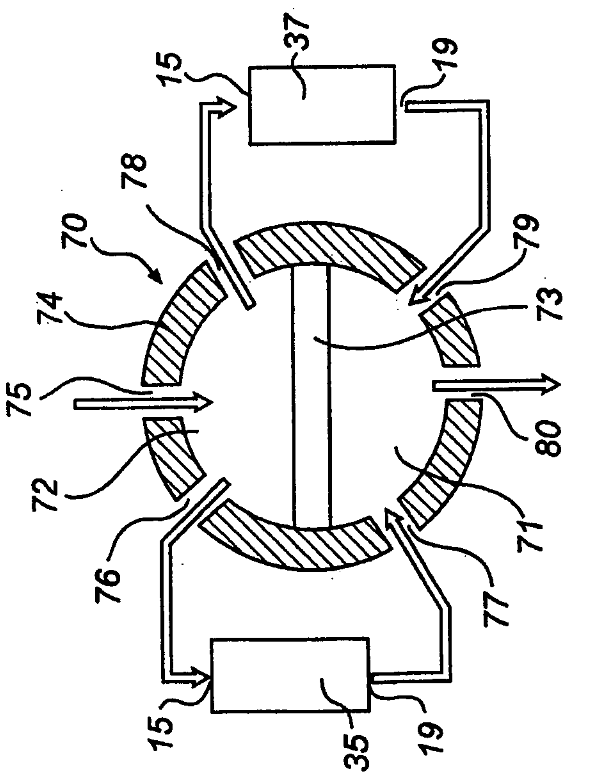

Fig. 4a

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2008/000071

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: A47L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WO 2004100752 A1 (BSH BOSCH UND SIEMENS HAUSGERÄTE GMBH), 25 November 2004 (25.11.2004), figure 1, abstract --	1-9
A	US 5951746 A (TREITZ ET AL), 14 Sept 1999 (14.09.1999), figures 1-4, abstract --	1-9
A	WO 2005053497 A1 (AKTIEBOLAGET ELECTROLUX), 16 June 2005 (16.06.2005), figures 1-9, abstract --	1-9
A	WO 8502528 A1 (OLLILA, MARTTI), 20 June 1985 (20.06.1985), figures 1-6, abstract --	1-9

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 March 2008	12 -03- 2008

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	DE 1001465 B (SIEMENS-SCHUCKERTWERKE AKTIENGESELLSCHAFT), 24 January 1957 (24.01.1957), figures 1-3	1-9
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International patent classification (IPC)

A47L 9/20 (2006.01)

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Use the application number as username.
The password is **DBCDRBXWVE**.

Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

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