(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 008 562 A2

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
31.12.2008 Bulletin 2009/01

(51) Int Cl.:
***A47L 7/04** (2006.01)*

(21) Application number: **08011110.7**

(22) Date of filing: **19.06.2008**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

(30) Priority: **29.06.2007 IT MI20071306**

(71) Applicant: **GISOWATT S.P.A. Industria Elettrodomestici**
21055 Gorla Minore (Varese) (IT)

(72) Inventor: **Sozzi, Gianfranco**
21055 Gorla Minore
Varese (IT)

(74) Representative: **Coloberti, Luigi**
Via E. de Amicis No. 25
20123 Milano (IT)

(54) **Method and vacuum cleaner apparatus with germicidal action**

(57) The vacuum cleaner apparatus comprises a chamber (11) for collecting the dust provided with a mechanical filtering system, an irradiation chamber containing a source of UV-C radiation, and an aspirator between the dust collection chamber and the irradiation chamber (13); the irradiation chamber (13) is in the form of an annular chamber disposed coaxially to the impeller of the aspirator, in which the suctioned stream of air with a microbial load, is made to re-circulate in a vortical state, subjecting the microbial load to the repeated action of UV-C radiations.

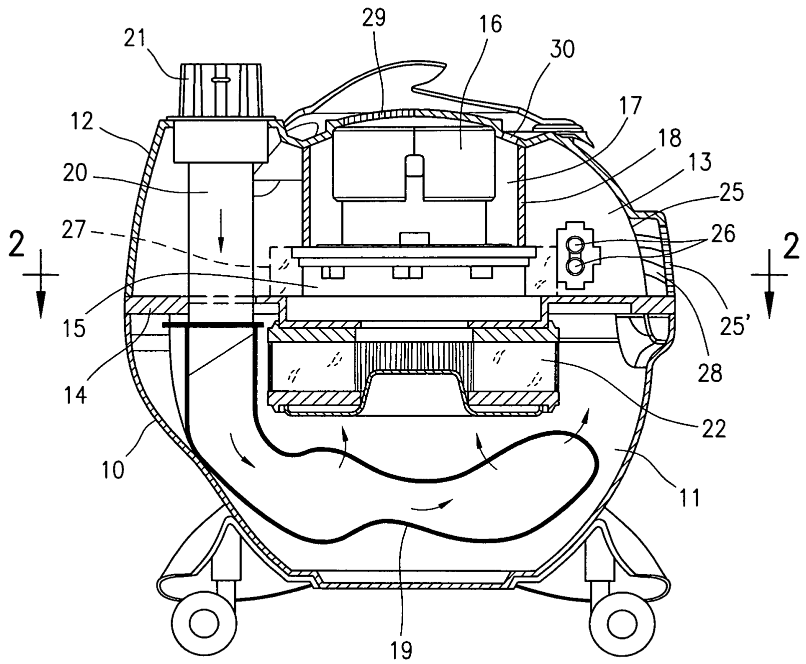

Fig. 1

EP 2 008 562 A2

Description

BACKGROUND OF THE INVENTION

[0001] This invention refers to a method and a vacuum cleaner apparatus for domestic appliance or semi-professional use, capable of performing an intense mechanical and/or chemical filtering action, and an intense germicidal action capable of destroying the microbial load contained in the sucked air stream, before it is returned to the external environment.

STATE OF THE ART

[0002] Most of the vacuum cleaners presently existing on the market are provided exclusively with mechanical filters, consisting of various filtering materials having a high porosity degree, capable of filtering and retaining both the dust and the impurities contained in the sucked air stream; in combination with mechanical filters, use may sometimes be made of so-called chemical filters, for example, active carbon filters, capable of absorbing odours. The sucked air, appropriately filtered and ridded of dust and impurities, is subsequently returned to the outside environment with a high content of bacteria and/or microorganisms, which may prove harmful to people.

[0003] In order to improve the functioning of the vacuum cleaner apparatuses of the aforementioned type, and in order to make an attempt to reduce the bacterial load returned with the air stream into the external environment, it has variously been suggested to provide the vacuum cleaners with an ultraviolet radiation source, adopting particular precautionary measures to prevent the radiations from escaping and causing irritation and/or physical damage to people.

[0004] For example, GB-A-648,967 and US-A-2,590,152 illustrate a vacuum cleaner with air sterilising means, in which a source of ultraviolet radiations is disposed in the air intake nozzle to generate a germicidal action, both in the sucked air stream upstream a dust collection chamber, and directly on the surface to be cleaned.

[0005] WO-A-2006/015390 in turn describes a vacuum cleaner provided with UV lamps to destroy the microorganisms directly inside a dust collection container; the dust container has a transparent bottom wall to exert a germicidal action both against the surface to be cleaned, and inside the container itself.

[0006] Solutions of this kind however have proved to be somewhat unsuitable, and somewhat inefficient in destroying the microbial load, in that the air stream that is returned to the external environment still contains a large quantity of bacteria and/or contaminating microorganisms previously sucked in together with the dust, or developed inside the vacuum cleaner.

[0007] FR-A-1.280.952 in turn proposes a different solution, in which the vacuum cleaner is provided with a cylindrical irradiation chamber connected to a delivery side of an aspirator, by an intermediate duct for conveying the sucked air stream. UV lamps extend longitudinally within the cylindrical irradiation chamber, in such a way as to be lapped and irradiate the air stream conveyed towards an outlet grid.

[0008] A diffuser, in the form of a wire netting, or a fan drawn into rotation by the same air stream, at the inlet end of the irradiation chamber allows a uniform distribution of the air stream.

[0009] The principle, upon which the vacuum cleaner according to FR-A-1.280.952 is based, consists in causing the radiation source to be lapped by the stream of air containing the microbial load, and in regulating the length of time that the bacteria are exposed to the ultraviolet radiations, by simply adjusting the speed of the air flux along the irradiation chamber.

[0010] While on the one hand, a solution of this kind offers the possibility of improving the effect of destroying the microbial load, as compared to previous solutions, it nevertheless still does not make it possible to obtain satisfactory results, causing a detrimental of the functional capacity and efficiency of the vacuum cleaner itself. In fact, although it has not been disclosed, in order to increase the time length that the bacteria remain in the cylindrical irradiation chamber, in FR-A-1.280.952 it would be necessary to reduce the speed of the air stream and consequently the suction power; moreover, the diffuser at the inlet side of the irradiation chamber, will tend to create an air stream with a limited turbulence that progressively lessens towards the outlet, thereby strongly jeopardising the suction efficiency and germicidal action.

OBJECTS OF THE INVENTION

[0011] The main object of this invention is to provide a method and a vacuum cleaner apparatus provided with an irradiating device characterised by a high destruction degree of the microbial load, while at the same time maintaining a high air suction efficiency.

[0012] A further object of the invention is to provide a vacuum cleaner apparatus of the aforementioned kind, in which the irradiation chamber can be made with a comparatively limited volume, while nevertheless allowing a prolonged stay time of the contaminating load, and an irradiating action of such intensity as to ensure substantially its complete destruction.

BRIEF DESCRIPTION OF THE INVENTION

[0013] According to the invention, a method for irradiating by UV-C radiation a microbial load entrained by an air stream into a vacuum cleaner, according to claim 1 is thus provided, as well as a vacuum cleaner apparatus comprising a UV-C irradiating device for the destruction of a microbial load entrained by an air stream that is made to re-circulate within an annular chamber, according to claim 5.

[0014] According to the invention, a method is thus provided for irradiating a microbial load entrained by an air flow into a vacuum cleaner device, according to which a sucked air flow is made to flow through a mechanical filtering system, and into an irradiation chamber where the microbial load is irradiated by a UV-C radiation source before returning the air stream towards the outside, characterised by the steps of:

causing the air flow and the microbial load to circulate within an annular irradiation chamber;
generating a swirling action in the air flow flowing within said annular irradiating chamber; and
repeatedly irradiating the microbial load in the air flow as it is made to re-circulate in the swirling state within said annular irradiating chamber of the vacuum cleaner device.

[0015] According to the invention, a vacuum cleaner apparatus has been also provided, of the type comprising:

a hollow casing defining a dust collecting chamber, provided with a first filtering means, and an air intake for sucking air from the outside;
an air flow irradiation chamber comprising a UV-C ray source for irradiating a microbial load entrained by the sucked air flow;
a fan device comprising a vacuum chamber in fluid communication with the dust collecting chamber, and the irradiation chamber, characterised by comprising:

an annularly-shaped irradiation chamber coaxially arranged to the vacuum chamber; and
air whirling means conformed and arranged in the irradiation chamber to cause a recirculation of the air flow and the microbial load, as well as to generate a whirling action and a turbulent state in the air flow circulating within the annular irradiation chamber of the vacuum cleaner apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] These and further characteristics of the method and the vacuum cleaner apparatus according to the invention, and a preferential embodiment, will be more clearly evident from the following description, with reference to the drawings, in which:

Fig. 1 shows a partial cutaway and cross-sectional view of a vacuum cleaner apparatus according to the invention;
Fig. 2 shows a cross-sectional view along the line 2-2 of figure 1.

DETAILED DESCRIPTION OF THE INVENTION

[0017] Figure 1 schematically shows a vacuum cleaner apparatus provided with a mechanical filter and an ultraviolet ray device for the destruction of a microbial load contained in the stream of sucked air.

[0018] The vacuum cleaner comprises a container 10 defining a dust collection chamber 11 provided with first filtering means for retaining the dust, and an upper cover 12 defining a vacuum chamber 17 and an irradiation chamber 13, as specified further on, separated from the dust collection chamber 11 by a cross partition wall 14.

[0019] An air sucking device comprising a centrifugal fan 15 connected to an electric motor 16, is supported by the wall 14 inside the vacuum chamber 17; the chamber 17 is delimited by a cylindrical wall 18 to form together with the cover 12 an annularly-shaped irradiation chamber 13 coaxially arranged to the vacuum chamber 17 and to the fan 15.

[0020] Reference number 19 in figure 1 has been used to indicate an interchangeable filter bag, for example a bag microfiber, inside the dust collecting chamber 11, removably fitted onto the internal end of a duct 20 for suctioning air from the outside, normally provided on its external end with an air intake fitting 21 for connection to a flexible pipe, in a per se known way.

[0021] Reference number 22 in figure 1 has been also used to indicate a mechanical filter, for example a filtering cartridge which extends inside the dust collecting chamber 11, underside the fan 15.

[0022] As shown in figure 2, the fan 15 is provided with an impeller having radial blades 15' inside a vacuum chamber 17 having a peripheral wall 23 to suck air from the dust collecting chamber 11 through the cartridge filter 22, and to convey it into the annular irradiating chamber 13 through a plurality of peripheral apertures 24, angularly spaced apart on the peripheral wall 23 which separates the vacuum chamber 17 from the irradiation chamber 13.

[0023] Although the apertures 24 for the passage of the air flow from the vacuum chamber 23 into the annular irradiation chamber 13 can be shaped and disposed in any way whatsoever, they must be made such as to generate a whirling action in the air stream circulating in a turbulent state within the annular irradiating chamber 13. According to a preferential embodiment, shown in figure 2, the air outlet apertures 24 are provided with fins 24' extending into the irradiation chamber 13, in such a way as to orient the outgoing air flow, angularly in the rotational direction of the impeller of the fan 15, compared to a radial direction, in order to generate within the annular chamber 13 a whirling air stream that is made to re-circulate and subsequently flow out into the external environment through a side aperture 25 of the cover 12, provided with a protective grille 25' .

[0024] Inside the annular chamber 13, in correspondence with the air outlet grille 25, and/or in another suitable position, is a UV irradiation source having a germicidal action; the irradiation source comprises, for example, two UV-C ray lamps 26 which extend in a substantially tangential direction to the air flow which recirculates in the annular chamber 13, that is to say, parallely arranged to a straight line tangent to the annular chamber 13 itself.

[0025] A possible air-permeable anti-noise ring 27 shown in figure 1, of sound-damping material, shaped in such a way as to allow the passage of the air stream flowing from the apertures 24, can be provided around the wall 23 of the vacuum chamber 17; moreover, reference number 28 in figure 1 has been used to indicate an opaque filter, for example, provided with slanted fins, to reflect back the ultraviolet rays of the lamps 26 towards the irradiation chamber 13, preventing the same rays from escaping to the outside.

[0026] In the case shown, the electric motor 16 of the fan 15 is cooled by a secondary air stream, which is sucked through a grille 29 in the upper side of the cover 12, and then flows into the vacuum chamber 17 towards the outside, through an aperture 30.

[0027] The internal surface of the lid 12 and the external surface of the cylindrical wall 18 that delimit the annular irradiation chamber 13 are preferably made reflecting so as to repeatedly reflect in all directions the ultraviolet rays emitted by the lamps 26, prevent their absorption.

[0028] The annular shape of the chamber 13 therefore contributes in providing differentiated irradiation areas, comprising at least one area A of direct irradiation in correspondence with the irradiation lamp or lamps 26, for example close to or in correspondence with the purified air outlet grille 25, and one or more indirect irradiation areas B, by repetitive ray reflections in the remaining portion of the chamber 13; in this way, thanks also to the recirculation and to the whirling state of the air stream in the annular chamber 13, it is possible to obtain a high irradiation degree and a substantially total destruction of the microbial load entrained by the stream of the circulating air flow.

[0029] The working method of the vacuum cleaner apparatus is briefly as follows: the fan 15 operated by the motor 16, sucks air through the radial filter 22 creating a vacuum in the dust collecting chamber 11 capable in turn of sucking an air stream from the outside, through the intake 21, the duct 20 and the filter bag 19.

[0030] The bag 19 is shaped in such a way as to retain most of the sucked dirt and to carry out a first filtering action, while allowing the fine dust and part of the microbial load present in the stream of air, to pass.

[0031] The air flow partially filtered by the bag 19 undergoes a second forced filtering action in the cartridge filter 22, before entering the vacuum chamber 17 from where, by the centrifugal action of the fan 15, it is ejected through the peripheral apertures 24.

[0032] The air that flows out of the apertures 24 and enters into the annular chamber 13 generates the circulation of a pressurised stream, still containing a greater part of the microbial load.

[0033] The whirling air stream generated by fins 24' in the annular chamber 13, its recirculation and the direct and indirect irradiation by UV-C rays of lamps 26, provide an intense bactericidal action capable of destroying the microbial load in the air stream that recirculates within the chamber 13, and which is made to return to the outside through the outlet grille 25'.

[0034] Using a vacuum cleaner apparatus according to the invention and of the previously described type, tests have been carried out in order to ascertain the level of microbiological contamination of the outgoing air, the results of which are given hereunder.

[0035] The tests were carried out to measure the level of residual contamination of artificially contaminated air, after its passage through a vacuum cleaner apparatus according to the invention.

[0036] The following tests were carried out:

A) the air contaminated with microorganisms of environmental origin was sucked and controlled at the outlet after its passage through a filter bag of certified L-category BGIA fibre, and subsequently through a filter cartridge of two bonded layers consisting of 10-micron cellulose and 0.3-micron HEPA;

B) contaminated air like in the previous case was sucked, subsequently controlling the outgoing air after it has passed through a filter bag and a cartridge filter identical to case A, and irradiated by a 9-Watt PL-S type UV-C lamp.

[0037] The various tests were repeated several times. In particular, the air was contaminated with known quantities of "Bacillus Atropheus" cells and mould of environmental origin, of the "Monilia" species.

[0038] The cell counts were carried out beforehand by the "count on plate" method, contaminating the air at the intake of the vacuum cleaner by atomisation.

[0039] For each test use was made of 20 ml of microbial suspension of a known strength, containing both "Bacillus Atropheus" and "Monilia" mould.

[0040] Recovery of the microorganisms from the air outgoing from the vacuum cleaner was carried out with an SAS instrument (Surfaces Air System) and "contact plates" containing specific culture media.

[0041] The count plates were sterilised in autoclave at a temperature ranging from 115° to 120° C for a period of time ranging from 10 to 15 minutes, with final pH ranging from 6.7 to 7.

[0042] The results of the "Bacillus Atropheus" and "Monilia" counts, relating to samples of outgoing air taken from the vacuum cleaner, are shown in table 1 for the tests A (with UV-C lamp switched OFF), and in table 2 for the tests B (with UV-C lamp switched ON).

TABLE 1

TEST N°	Number of *Bacillus Atropheus* cells atomised at the entrance UFC	Number of *Monilia* cells atomised at the entrance UFC	Number of outgoing *Bacillus atropheus* cells UFC	Number of outgoing *Monilia* cells UFC
1	22,700,000	13,100,000	10	17
2	22,700,000	13,100,000	17	13
3	22,700,000	13,100,000	10	23

TABLE 2

TEST N°	Number of *Bacillus atropheus* cells atomised at the entrance UFC	Number of *Monilia* cells atomised at the entrance UFC	Number of outgoing *Bacillus atropheus* cells UFC	Number of outgoing *Monilia* cells UFC
1	22,700,000	13,100,000	0	0
2	22,700,000	13,100,000	0	0
3	22,700,000	13,100,000	0	0

[0043] From table 1 it can be concluded that at the end of the first three tests, with the vacuum cleaner operating with the UV-C lamp switched OFF, a certain number of contaminating microbial cells were still found in the outgoing air.

[0044] Conversely, at the end of the other three tests, with the vacuum cleaner operating with the UV-C lamp switched ON, from table 2 it can be seen that there is a total absence of contaminating microorganisms.

[0045] The tests carried out have consequently demonstrated that, in conformity with the method and by means of a vacuum cleaner apparatus according to the invention, the contaminating microorganisms contained in the stream of sucked air, already blocked to a great extent by the various filtering elements, were then totally eliminated by the direct and indirect radiating action of the germicidal lamp or lamps, while the stream of air was made to re-circulate in a swirling state, before being returned to the environment.

[0046] From what has been described and shown with reference to the example of figures 1 and 2, it will also be understood that a method and a vacuum cleaner apparatus equipped with a mechanical-type filtering system and a UV-C ray bactericidal system are provided, characterised by a particular configuration and disposition of the irradiation chamber, in which a swirling stream of air is made to re-circulate and is repeatedly irradiated until the complete elimination of the microbial load.

[0047] It is understood therefore that what has been described and shown in the accompanying drawings has been given purely in order to illustrate the general characteristics of the invention, and of a particular embodiment; consequently, other modifications or variations may be made both to the method and to the vacuum cleaner apparatus, without thereby deviating from the following claims.

[0048] For example, in place of the filter bag, use could be made of a water-type filter or other system for filtering and collecting the sucked dust.

[0049] The vacuum cleaner apparatus could also be structured differently compared to the type shown; for example, it could be of the upright or "broom" type, or have any other suitable configuration.

Claims

1. A method for irradiating a microbial load entrained by an air flow into a vacuum cleaner device, according to which the sucked air flow is made to flow through a mechanical filtering system (19, 22), and into an irradiation chamber (13) where the microbial load is irradiated by a UV irradiation source (26) before returning the air flow to the outside, **characterised by** the steps of:

   causing the air flow and the microbial load to circulate within an annular irradiation chamber (13); generating a swirling action in the air flow circulating within said annular irradiating chamber (13); and
   repeatedly irradiating the microbial load in the air flow while it is made to re-circulate in the whirling state within said annular irradiating chamber (13) of the vacuum cleaner.

2. The method according to claim 1, **characterised by** carrying out at least one irradiation step direct by said UV-C radiation source, along a first portion of the path inside the annular chamber (13), and at least one of indirect irradiation step by reflection of the rays along the remaining portion of the path in said annular irradiation chamber (13).

3. The method according to claim 2, **characterised by** carrying out one step of direct irradiation of the air stream close to the air outlet (25) of the annular irradiation chamber (13).

4. The method according to claim 1, **characterised by** maintaining the air flow within the irradiation chamber (13), in a pressurised state.

5. A vacuum cleaner apparatus of the type comprising: a hollow casing (10, 12) defining a dust collecting chamber (11) provided with an air intake (20, 21) for sucking air from the outside;
   a fan device (15) comprising a vacuum chamber (17) in fluid communication with the dust collecting chamber (11); and an air irradiation chamber (13) comprising a UV-C rays source (26) for irradiating a microbial load entrained by the sucked air;
   characterised by comprising:

   an annularly-shaped irradiation chamber (13), coaxially arranged to the vacuum chamber (17); and
   air whirling means (22, 24, 24') conformed and arranged in the irradiation chamber (13) to cause the recirculation of the air flow and the microbial load in a whirling condition in respect to the UV-C ray source (26).

6. The vacuum cleaner apparatus according to claim 5, **characterised in that** the UV-C radiation source (26) is positioned close to an outlet aperture (25) of the irradiation chamber (13) for the air stream.

7. The vacuum cleaner apparatus according to anyone of claims from 5 to 7, **characterised in that** the UV-C radiation source (26) extends parallely to a straight line tangent to the annular irradiation chamber (13).

8. The vacuum cleaner apparatus according to claim 5, **characterised by** comprising a filter (28) opaque to UV-C radiations, in correspondence with an air outlet aperture (25) of the irradiation chamber (13) for the air stream.

9. The vacuum cleaner apparatus according to claim 5, **characterised by** comprising a first filtering device (19) in the dust collection chamber (11), and a second filtering device (22) out the inlet side of the vacuum chamber (17), said second filtering device (22) extending into the dust collection chamber (11).

10. The vacuum cleaner apparatus according to claim 10, **characterised in that** said first filtering device (19) comprises a filter bag.

11. The vacuum cleaner apparatus according to claim 11, **characterised in that** the filter bag (19) is of microfiber type.

12. The vacuum cleaner apparatus according to claim 10, **characterised in that** said first filtering device (19) comprises a water-type filter.

13. The vacuum cleaner apparatus according to claim 5, **characterised in that** the air whirling means comprise a air outlet apertures (24) in a peripheral wall (23) of the vacuum chamber (17) and angularly orientated fins (24') extending into the irradiation chamber (13).

14. The vacuum cleaner apparatus according to claim 5, **characterised in that** the fan comprises a centrifugal fan and drive motor in a cooling chamber coaxially arranged to the annular irradiation chamber (13).

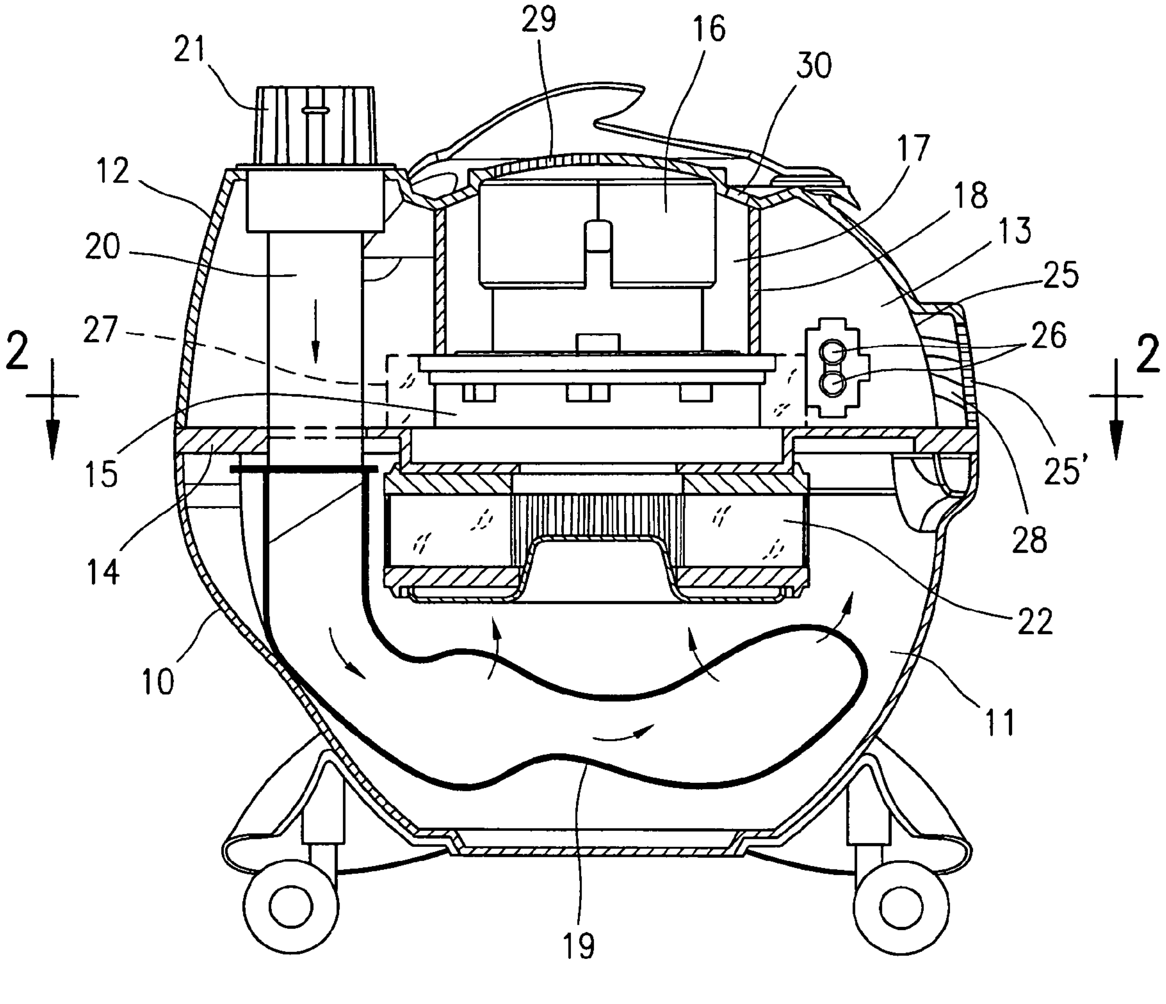

Fig. 1

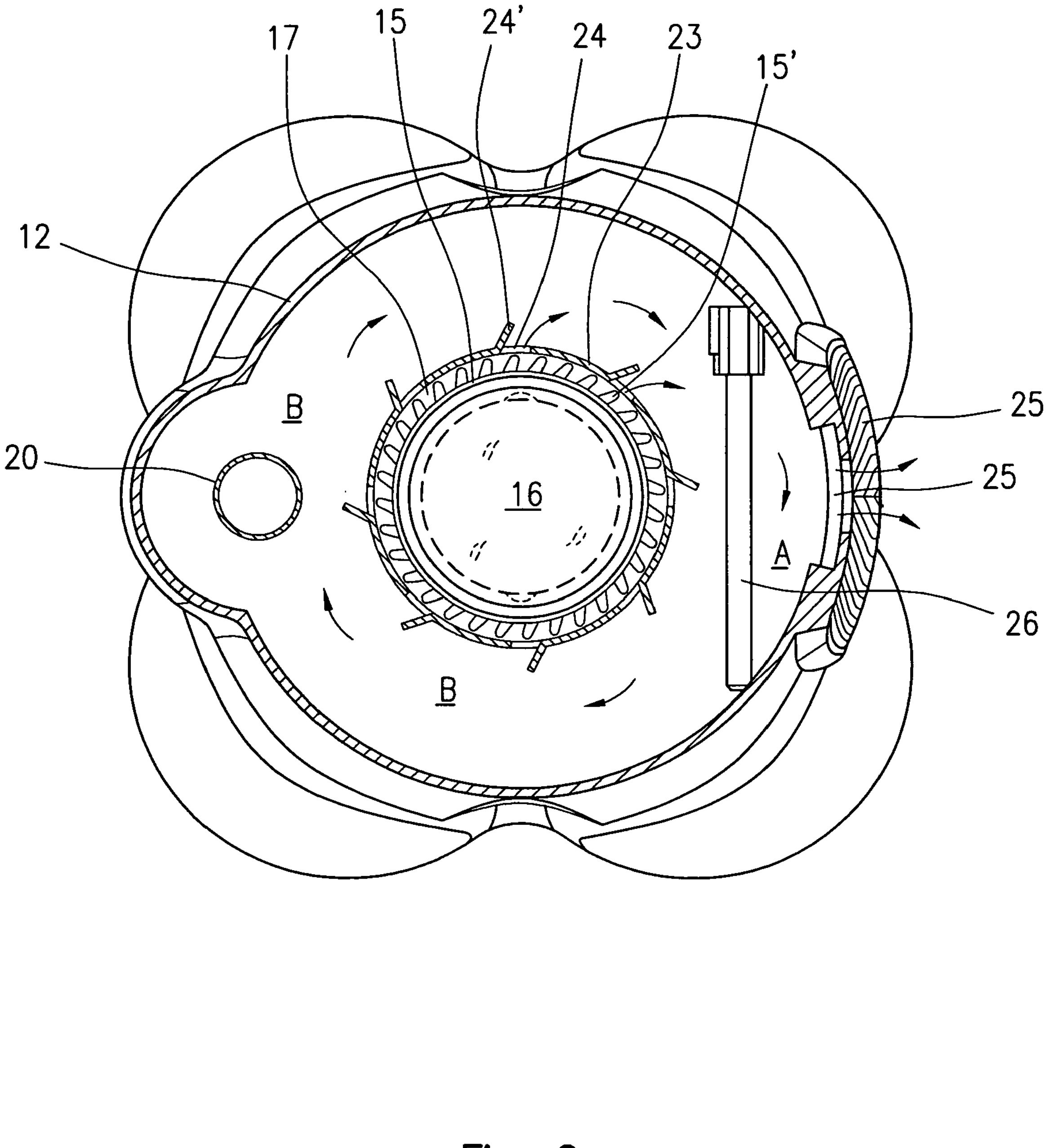

Fig. 2

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- GB 648967 A **[0004]**
- US 2590152 A **[0004]**
- WO 2006015390 A **[0005]**
- FR 1280952 A **[0007] [0009] [0010]**