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(71) Applicant: **S.I.EL S.r.l.**
25030 Castelcovati, Brescia (IT)

(72) Inventor: **Vecchiarino, Luigi**
20069 Vaprio d'Adda (Milano) (IT)

(74) Representative: **Marietti, Giuseppe**
Marietti, Gislon e Trupiano S.r.l.
Via Larga, 16
20122 Milano (IT)

(54) Cleaning apparatus comprising a liquid filtering element

(57) Cleaning apparatus including means (3) for the generation of a suction fluid flow and at least one external suction fitting (2), as well as at least one filtering element (6; 106) placed between the means for the generation of the suction and the external fitting. The filtering element includes a tank (11) for a liquid (14), preferably water, which houses an inflow conduit (9) which is fluid-connected to the external fitting and at least one outflow opening (16) of the sucked fluid which is in fluid communication with said means for the generation of the fluid flow. The outlet (15) of the inflow conduit is located above the free surface of the liquid (14) contained inside the tank and the filtering element comprises an impact surface (19; 119) located above the outlet of the inflow conduit, said impact surface being at least partially bounded by at least one deflection wall (12; 112).

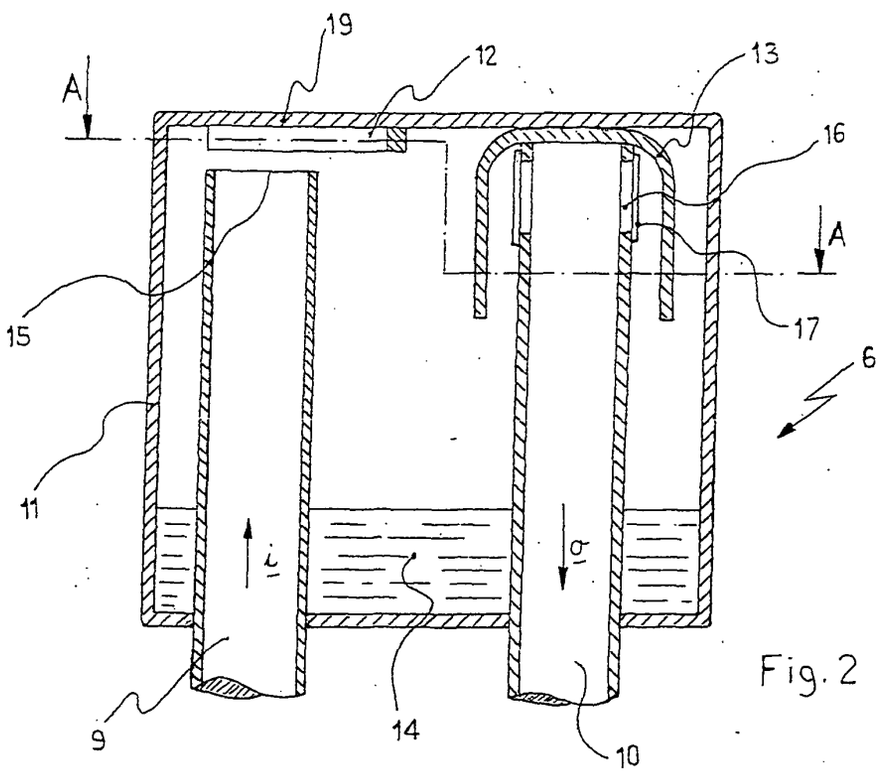

Fig. 2

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Description

[0001] This invention concerns a cleaning apparatus of the type comprising means for generating a suction (aspirated) flow and usually composed of a fan, an external fitting - such as a hose - for the suction of solids and/or liquids, and a filtering element located between the fan and the suction hose.

[0002] In case of cleaning apparatuses for the suction of solids as well as liquids, it is necessary to use one or several filtering elements to prevent sucked solid particles or liquids from reaching the fan. This would prejudice the efficiency of the rotor, of its drive motor and in general of the cleaning apparatus.

[0003] For this purpose, it's well known the use - as filtering element - of liquid filters which allow to accumulate liquids or solid and/or liquid particles, present in the sucked fluid, inside a collection tank. If only liquids are sucked by the user, it is enough to have such a suction power to cause the precipitation of the sucked liquid into the tank. On the contrary, if solid particles or liquid droplets are sucked into an air flow, it is necessary to favour the separation of particles or droplets from the aspirated air flow and consequently their precipitation into the tank.

[0004] The methods to drop down solid particles or liquid droplets in the suction air flow, or to separate them from the conveying fluid, include the humidification of the aspirated fluid and the reduction of the fluid velocity, in order to reduce the kinetic energy of the conveyed particles and favour their precipitation into the tank.

[0005] In particular, it is a well-known technique to build up liquid filtering elements incorporating a tank that has been previously and partially filled with water or another liquid. The suction fluid passes through the tank via an inflow and outflow opening which are respectively connected with the external suction hose and to the fan and inside which the solid particles of the aspirated flow are dropped down and the liquid droplets, if any, escape.

[0006] As for some known cleaning apparatuses, the filtering element is designed so that the inflow opening of the sucked dirty fluid inside the tank is located below the free surface of the water held in the tank itself, with the purpose of obtaining the separation of the particles or the liquid droplets from the suction air flow by bubbling the fluid within the water. Although this is a highly effective solution, it implies the use of a fan which is able to generate a high suction power considering the significant pressure loss due to the water resistance when the air flow passes through the water. Thus, the efficiency of cleaning apparatuses with bubble type filtering elements is very limited and consequently energy consumption is very high. Moreover, the resistance to suction, peculiar to these filtering elements, may cause dangerous overheating of the fan rotor drive motor.

[0007] Instead of said bubble type filtering elements, water filtering elements in which the dirty fluid flow is first humidified by means of a water jet (taken from the tank), and then expanded inside the tank, may be used. Said expansion shall be large enough to favour the precipitation of any liquid droplets and the drop-off of humidified solid particles. As far as energy is concerned, said filtering element is more effective if compared to the bubble type filtering element above, but it is definitely less effective than this one and its structure is even more complex.

[0008] In order to improve said filtering elements, other water filtering elements have been constructed in which a tank incorporates some means for generating turbulence in the liquid in order to humidify the suction dirty fluid and meanwhile reduce the velocity of said suction fluid. More in detail, the European patent application EP 1.034.733-A1 describes a liquid filtering element where the sucked fluid passes through a Venturi tube located above the free surface of the liquid and between two separate chambers dividing the tank. The Venturi tube generates, inside the chamber where the feed inlet is located, some turbulence in the liquid contained inside it and it reduces the velocity of the sucked fluid in the chamber where the outlet is located, without any exaggerated pressure loss.

[0009] These filtering elements separate dusts or particles from the suction fluid in a very effective way and meanwhile they do not need to be very powerful, but they are quite complex and their designing shall be very accurate.

[0010] The present invention aims at supplying a suction cleaning apparatus comprising a new filtering element which has not the disadvantages of the previous known technique, and thus it effectively holds the sucked solid particles and liquid droplets, while it assures high energy efficiency.

[0011] In addition, the present invention aims at supplying a cleaning apparatus with a filtering element having an easy structure and which is thus easy to be constructed.

[0012] This and the other goals of the present invention will be clear when the technician reads the first independent claim and the following dependent claims.

[0013] The cleaning apparatus according to the present invention comprises means for generating a suction fluid flow and at least an external suction fitting and a filtering element located between the means for generating a suction fluid flow and the external fitting. The filtering element includes a tank for the liquid, preferably water, which houses an inflow conduit which is fluid-connected with the external fitting, and at least one outflow opening for the sucked fluid which is in fluid communication with said means for generating the fluid flow. The inflow conduit outlet is located above the free surface of the liquid held in the tank and the filtering element comprises an impact surface located above the inflow conduit outlet, said surface being partially bounded by at least one deflection wall.

[0014] The impingement of the sucked fluid on the impact surface located downstream of the conduit outlet,

inside the filtering element, and the deflection of the flow generated by the wall bounding the surface itself, were enough to effectively separate the solid particles and the liquid droplets from the conveying fluid and favour their precipitation into the tank liquid.

[0015] According to an advantageous aspect of the present invention, the deflection wall follows, in plan, a curved line with at least one concave section and its concavity can be directed towards the outflow opening.

[0016] Said configuration of the downflow wall defines a path for the sucked fluid which slows down the velocity of the sucked fluid, thus favouring the separation of solid particles or liquid droplets from the fluid and causing their fall into the tank liquid without excessive loss of pressure.

[0017] In a preferred embodiment of the present invention the wall can be spaced out above the inflow conduit outlet, so that a quite relevant expansion of the sucked fluid occurs inside the tank in correspondence with the inflow conduit outlet, in order to get a further reduction of the fluid velocity.

[0018] According to another particularly advantageous aspect of the present invention, the deflection wall is, in plan, substantially spiral-shaped, so that the sucked flow is forced to follow a path that allows to slow down its velocity for favouring the separation of conveyed solid particles. In this case, it is not necessary to space out the wall from the inflow conduit outlet, because the velocity and pressure loss generated in the suction fluid flow by the spiral path is enough to cause an effective separation of the solid particles.

[0019] According to another particular aspect of the present invention, the outflow opening is located, into the tank, inside a cup-shaped body which is placed above the free surface of the liquid. Said cup-shaped body has the function of defining a non-rectilinear path for the sucked fluid flow and protecting the outflow opening against any liquid droplets that raise inside the tank, when the sucked fluid passes through this latter.

[0020] There follows a description, provided purely by way of non-limiting example, of some preferred embodiments of the present invention with the aid of the attached figures, in which:

Figure 1 is a schematic cross-sectional side view of a cleaning apparatus comprising a water filtering element, according to a particular embodiment of the present invention;

figure 2 is a cross-sectional side view of the filtering element used for the cleaning apparatus of figure 1, according to a peculiar aspect of the present invention;

figure 3 is a cross-sectional top view of the filtering element of figure 2, taken from line A-A;

figure 4 is a cross-sectional top view of a filtering element, according to another preferred aspect of the present invention; and

figure 5 is a cross-sectional side view of the filtering element of figure 4, taken from line B-B.

[0021] With reference to figure 1, the cleaning apparatus 1 comprises a casing 5, advantageously assembled on wheels 18a, 18b, from which an external cleaning fitting branches off, such as a hose comprising a suction head connected with means 3 for generating a suction fluid flow, comprising, for instance, an electrically-driven fan. The casing 5 houses the means 3, a filtering element 6 incorporating a tank 11 for a liquid 14, preferably water, located between and in fluid communication with the means 3 and the external fitting 2.

[0022] The filtering element 6 includes inside an inflow conduit 9 which is in fluid communication with the external fitting 2 and an outflow opening 16 (see figure 2) fluid-connected with the fan 3. The conduit 9 and the opening 16 allow the sucked fluid to pass through the tank 11.

[0023] The inflow conduit 9 has, in correspondence of its end positioned inside the tank 11, an outlet 15, located above the free surface of the liquid 14, which directs the sucked fluid upwards to an impact surface 19 bounded by a flow deflection wall 12. The profile, in plan, of the deflection wall 12 is one of the critical factors affecting the efficiency and efficacy of the filtering element 6, as verified by the Applicant.

[0024] When the cleaning apparatus is in use (with a special reference to figure 1), the suction flow coming from the hose 2 passes through a transfer tube 7 and flows into the conduit 9 placed inside the tank 11 which contains the liquid 14, usually water.

[0025] Considering that the quantity of water 14, previously poured into the tank 11, is such that its free surface is always below the outlet 15 of the conduit 9, the sucked dirty fluid flows into the tank 11 above the liquid 14. In particular, the dirty fluid flowing out from the conduit 9, via the outlet 15, is first slowed down due to its expansion into the tank 11 and

[0026] it impinges directly on the impact surface 19 and indirectly on the deflection wall 12. This results in a first significant separation of the solid particles or the liquid droplets from the sucked air flow and their precipitation into the liquid 14.

[0027] The fluid flow, free of solid particles or liquid droplets, passes through the outflow opening 16, flows into a conduit 10 and then it comes to the fan 3 where it is ejected into the environment via an outlet funnel 4.

[0028] More in detail, as can be seen from figure 2 and 3, in the embodiment here described, the fluid flow coming from the hose 2, passes-following the direction marked with arrow i - through the conduit 9 which extends inside the tank 11 so that its fluid outlet 15 is above the free surface of the liquid 14.

[0029] In order to prevent that the quantity of liquid 14 inside the tank 11 increases too much, it is possible to provide for a level gauge (sensor) for the liquid 14, for instance a float gauge, that, connected with some means controlling the apparatus operation, can stop the

suction exerted by the means 3.

[0030] The sucked fluid is thus directed to impinge on the impact surface 19 that, in the illustrated embodiment, is a part of the inner surface of the tank ceiling 11. The distance between the impact surface 19 and the outlet 15 of the conduit 9 is suitably calibrated to favour the expansion of the sucked fluid inside the tank 11 and consequently to reduce its velocity. The impact surface 19 is at least partially limited by a deflection wall 12 that, in plan, develops forming a plane curve comprising at least a concave section.

[0031] In the embodiment described with reference to figures 2 and 3, said impact surface 19, that is advantageously (because it's easy to realise) plane and perpendicular to the flow coming from the outlet 15 of the conduit 9, serves for separating solid particles and/or any liquid droplets conveyed by the sucked fluid thanks to the kinetic energy loss that said particles or droplets suffer during the impingement. The loss of kinetic energy favours the gravity precipitation of said particles or droplets inside the liquid 14.

[0032] The deflection wall 12, for instance concave or spiral-shaped, has also the function to break the laminar flow of the sucked fluid and generate turbulence, although not excessive, into the suction fluid in order to interfere with said fluid and favour the further separation and precipitation of solid particles or liquid droplets still present inside the sucked fluid.

[0033] In a preferred embodiment of the present invention, the wall 12 extends towards the inflow conduit 9 in a very limited manner and so it is properly spaced out from the outlet 15 of said conduit 9. Said distance between the wall 12 and the outlet 15 prevents the formation of excessive turbulence into the liquid 14 and thus avoids significant pressure losses which are due to this last effect as well as the undesired humidification of the sucked flow.

[0034] In the embodiment shown, the wall 12 does not completely bound the impact surface 19, that is, it only extends for a limited angle around it, and the curve formed by said wall 12 presents (in plan) a concavity directed towards the outflow opening 16. This conformation revealed to be very effective for separating dusts or liquid droplets from the sucked fluid flow, without any significant pressure losses and without requiring a high suction power.

[0035] However, the wall 12 can develop along curves which are different from the illustrated curve; for instance it can be a spiral curve (as shown hereinafter by figure 4 and 5) or it can extend on the impact surface following joined or separated segments. Several deflection walls are likely to be present as well in proximity of the surface 19.

[0036] Another alternative embodiment of the deflection wall 12 is, for instance, a wall developing, in plan, along a plane curve with a concave section extending towards the outflow opening 16, but the concavity of which is not precisely directed towards the direction defined in plan by the outflow opening 16 and by the outlet 15 of the conduit 9. In particular, shaping the wall 12 according to a spiral curve with its concavity section directed towards the outflow opening 16 revealed to be effective (as it will be fully described below).

[0037] However, it is advantageous, for the ease of realization, for the effectiveness of the separation and for the high energy efficiency, that the impact surface 19 is substantially orthogonal to the flow coming from the outlet 15 and that the deflection wall 12, or possibly the walls, extend perpendicularly to said impact surface 19.

[0038] The fluid flow going out of the conduit 9 flows towards the outflow opening 16 of the conduit 10 and from there, following the direction of arrow o, towards the fan 3. On the way from the outlet 15 of the conduit 9 to the outflow opening 16, the sucked fluid may get in touch with liquid suspended particles, which are present above the free surface of the liquid 14 due to the turbulence inside the tank 11.

[0039] A cylindrical grid filter (or filtering net) 17 may be superposed on the outflow opening 16, which is obtained at an end portion of the conduit 10. Said filter can possibly be co-stamped with said conduit 10. The filter 17 has the function to hold back any fine dusts or liquid droplets not yet separated from the suction fluid.

[0040] In addition, the outflow opening 16 is inserted in a cup-shaped body 13 that is located above the free surface of the liquid 14. Said cup-shaped body defines a non-rectilinear path for the sucked fluid flow. Therefore the body 13 represents a further area in which the fluid slows down and it protects the outflow opening 16 from those liquid droplets that, due to the turbulence generated inside the tank 11, are raised by the liquid 14.

[0041] According to a further embodiment of the present invention (which is not illustrated) the side wall of the cup-shaped body 13 directed towards the outlet 15 of the conduit 9 can coincide with the deflection wall 12, that is said wall of the cup-shaped body 13 located in the proximity of the conduit 9 can be considered as a deflection wall for the flow coming out from the conduit itself and as a protection means for the outflow opening 16.

[0042] With reference now to figures 4 and 5, according to a particular aspect of the present invention, an embodiment of a filtering element 106 is described, in which the deflection wall of the sucked air flow i, flowing into the filtering element 106, becomes spiral-shaped. In figures 4 and 5, the elements corresponding to those described and regarding figures from 1 to 3 have the same reference numbers.

[0043] Like the above mentioned filtering element 6, said filtering element 106 comprises a tank 11 for a liquid 14 (preferably water), inside which there is an inflow conduit 9, in fluid communication with an external cleaning fitting, and an outflow conduit 10, fluid-connected with the means for generating a suction flow.

[0044] The inflow conduit 9 has an outlet 15, located inside the tank 11 above the free surface of the liquid

14, which is capable of directing the incoming fluid flow i, flowing from external and conveying solid particles and/or liquid droplets possibly sucked, towards an upper impact surface 119, bounded by a side deflection wall 112 for the flow.

[0045] Said deflection wall 112 is advantageously spiral-shaped and its concavity is directed towards the outlet 15 of the conduit 9, so that the sucked air flow i is forced - at least in part - to follow said path before continuing towards the outflow conduit 10.

[0046] In particular, the sucked fluid, entered into the filtering element 6 via the conduit 9, flows from the outlet 15 of said conduit 9 and impinges on the upper impact surface 119 and on the deflection wall 112, then it follows (at least partly) the spiral path defined by the same deflection wall 112.

[0047] The spiral deflection wall 112 extends advantageously beyond the output section which includes outlet 15 of the inflow conduit 9, thus reducing and substantially preventing the dispersion and expansion of the sucked fluid flow i within the tank 11, before this fluid flow i covers the spiral defined by said wall 112.

[0048] In a peculiar embodiment of this invention, the impact wall 119 can have a concave shape directed towards the outlet 15 of the inflow conduit 9 and preferably located just above said outlet 15.

[0049] Various tests carried out by the Applicant demonstrated that the spiral path defined by the deflection wall and schematically shown on figures 4 and 5, involves an excellent reduction of the sucked fluid velocity, which is capable of separating most of the solid particles or liquid droplets from the sucked fluid i and of favouring their fall within the liquid 14, without however bringing about excessive pressure losses (and therefore without causing a significant energy dissipation).

[0050] Like the embodiment shown in figures 1-3, the filtering element 106 also comprises, inside the tank 11, a cup-shaped body 13 located above the free surface of the liquid 14 and surrounding the inlet section of the outflow conduit 10, in order to further slow down the sucked fluid, as well as a grid filter 17 located in the same outflow conduit 10 so that the sucked fluid flow is forced to penetrate it.

[0051] The decreased velocity of the sucked flow and its pressure loss, due to the spiral path defined by the wall 112 and by the cup-shaped body 13; the presence - inside the tank 11 - of suspended liquid drops 14, generated by the air flow transiting inside the filtering element 6 and capable of humidifying any solid particles; the expansion suffered by the flow inside said tank 11 downstream of the deflection wall 112; and the additional cleaning action of the sucked flow due to the filtering element 17 allow to obtain an extremely effective filtering action of the sucked fluid, without however bringing about a high energy consumption.

[0052] The simple implementation of the invention, combined with its efficiency and efficacy, allows the use of rather low suction powers and makes its use particularly profitable in multi-function cleaning apparatuses which use means to supply steam and/or heated water and/or other detergent liquids.

[0053] In this case, the small size of the filtering element 6 according to this invention allows to reduce the total size of the apparatus, even if this is fitted, for instance, with a boiler and with means for the supply of steam.

Claims

1. Cleaning apparatus of the type including means (3) for the generation of a suction fluid flow and at least one external suction fitting (2), as well as at least one filtering element (6; 106) placed between said means (3) for the generation of a fluid flow and said suction fitting (2), the filtering element (6; 106) including a tank (11) for a liquid (14) which houses an inflow conduit (9) which is fluid-connected to said external fitting (2), and at least one outflow opening (16) for the sucked fluid which is in fluid communication with said means (3) for the generation of a fluid flow, the apparatus is **characterised in that** the outlet (15) of said inflow conduit (9) is located above the free surface of the liquid (14) contained inside the tank (11) and that said filtering element (6) comprises an impact surface (19; 119) located above said outlet (15) of the inflow conduit (9), said impact surface (19; 119) being at least partially bounded by at least one deflection wall (12; 112).

2. Apparatus according to claim 1, **characterized in that** said deflection wall (12, 112), in plan, is developed according to a curved line having at least one concave section.

3. Apparatus according to claim 2, **characterized in that** the concavity of said concave section is directed towards said outflow opening (16).

4. Apparatus according to any one of the preceding claims, **characterized in that** said deflection wall (12, 112) surrounds said impact surface (19,119) for a limited angle only.

5. Apparatus according to any one of the preceding claims , **characterized in that** said deflection wall (112) develops, in plan, according to a substantially spiral path.

6. Apparatus according to any one of the preceding claims, **characterized in that** said deflection wall (12) is located above the outlet (15) of the inflow conduit (9).

7. Apparatus according to any one of the preceding claims, **characterized in that** said impact surface

(19) is substantially plane and forms a right angle with the fluid flow flowing out of the outlet (15) of the inflow conduit (9).

8. Apparatus according to any of the claims from 1 to 6, wherein said impact surface (119) is concave in the direction of the outlet (15) of said inflow conduit (9).

9. Apparatus according to any one of the preceding claims, **characterized in that** it comprises at least one grid filter (17) located in correspondence of said outflow opening (16).

10. Apparatus according to any one of the preceding claims, **characterized in that** said outflow opening (16) is located inside a cup-shaped body (13) located above the free surface of the liquid (14) thus defining a non-rectilinear path for the sucked fluid flow.

11. Apparatus according to any one of the preceding claims, also comprising at least one device for the supply of steam and/or hot water and/or detergent.

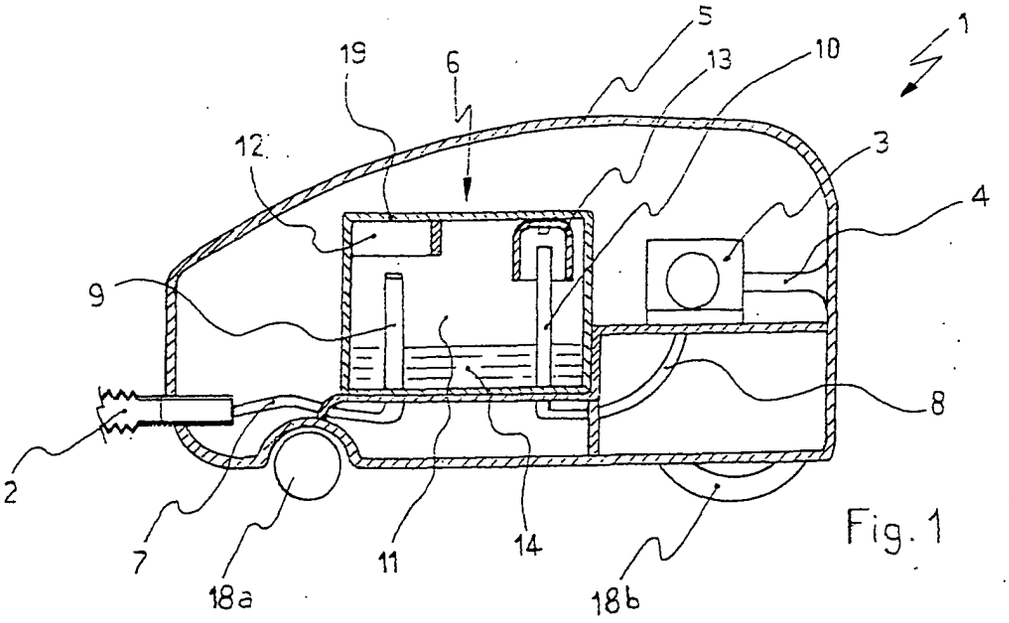

Fig. 1

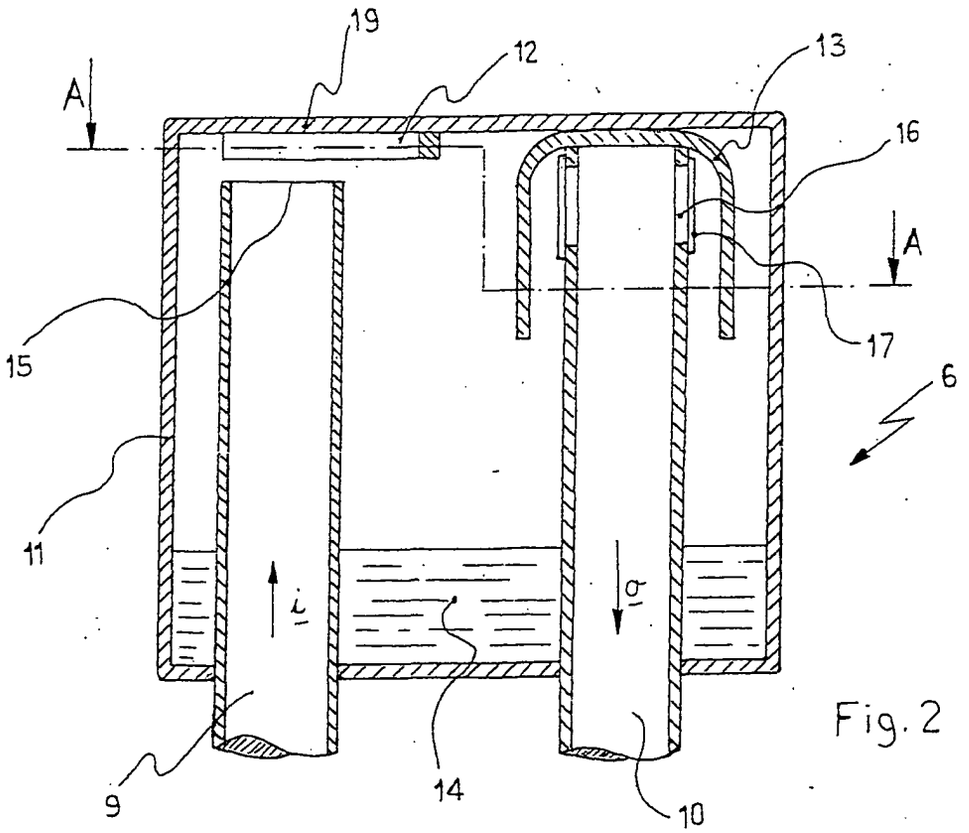

Fig. 2

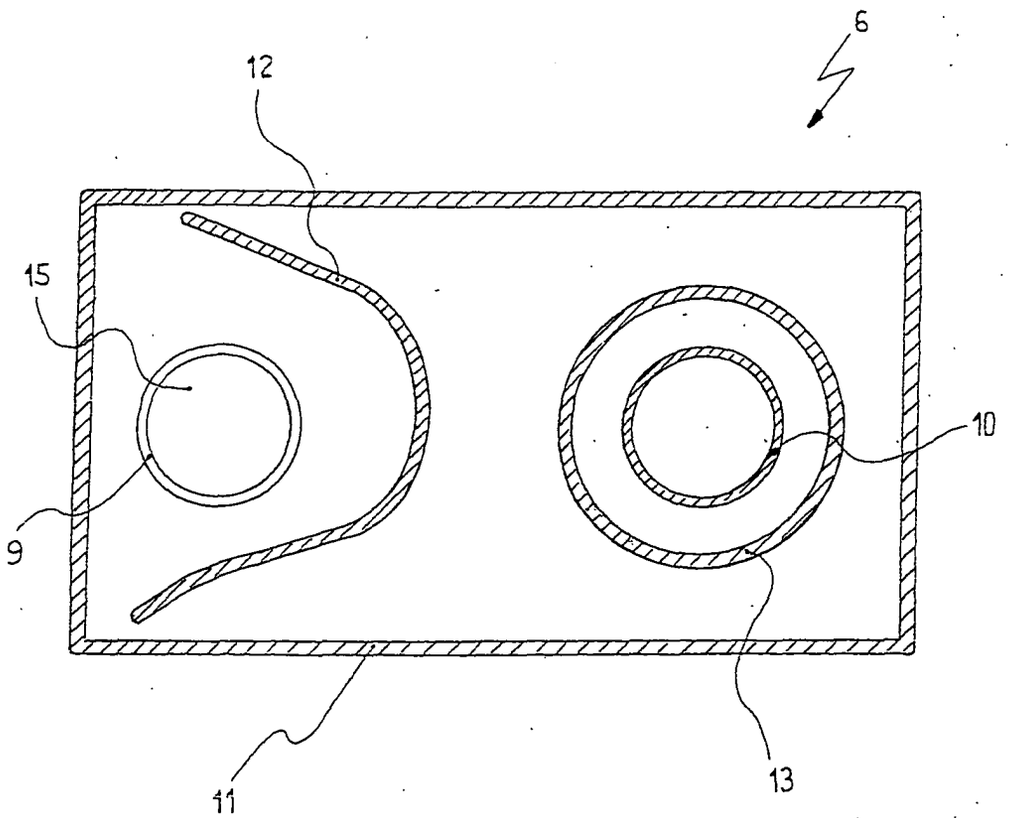

Fig. 3

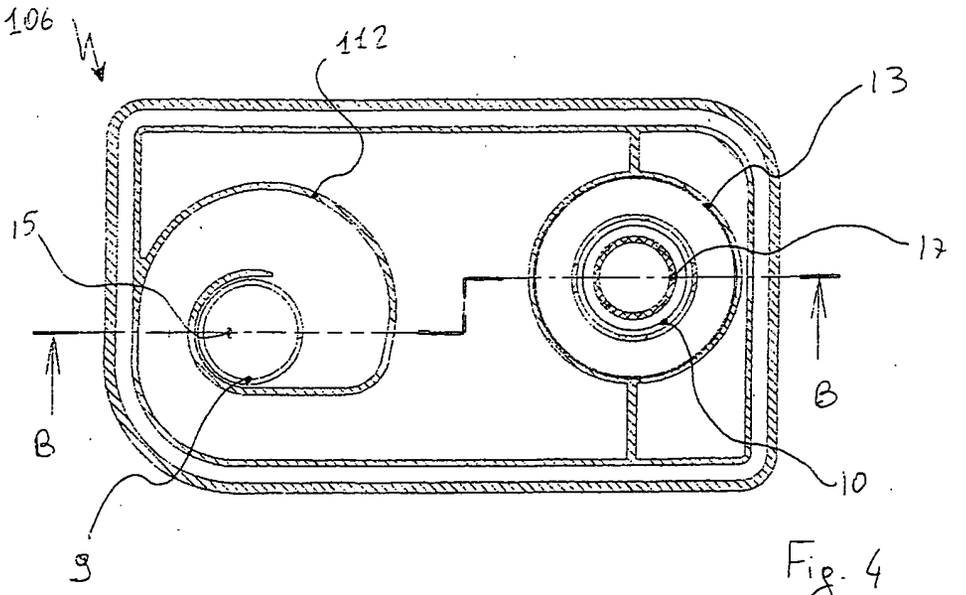

Fig. 4

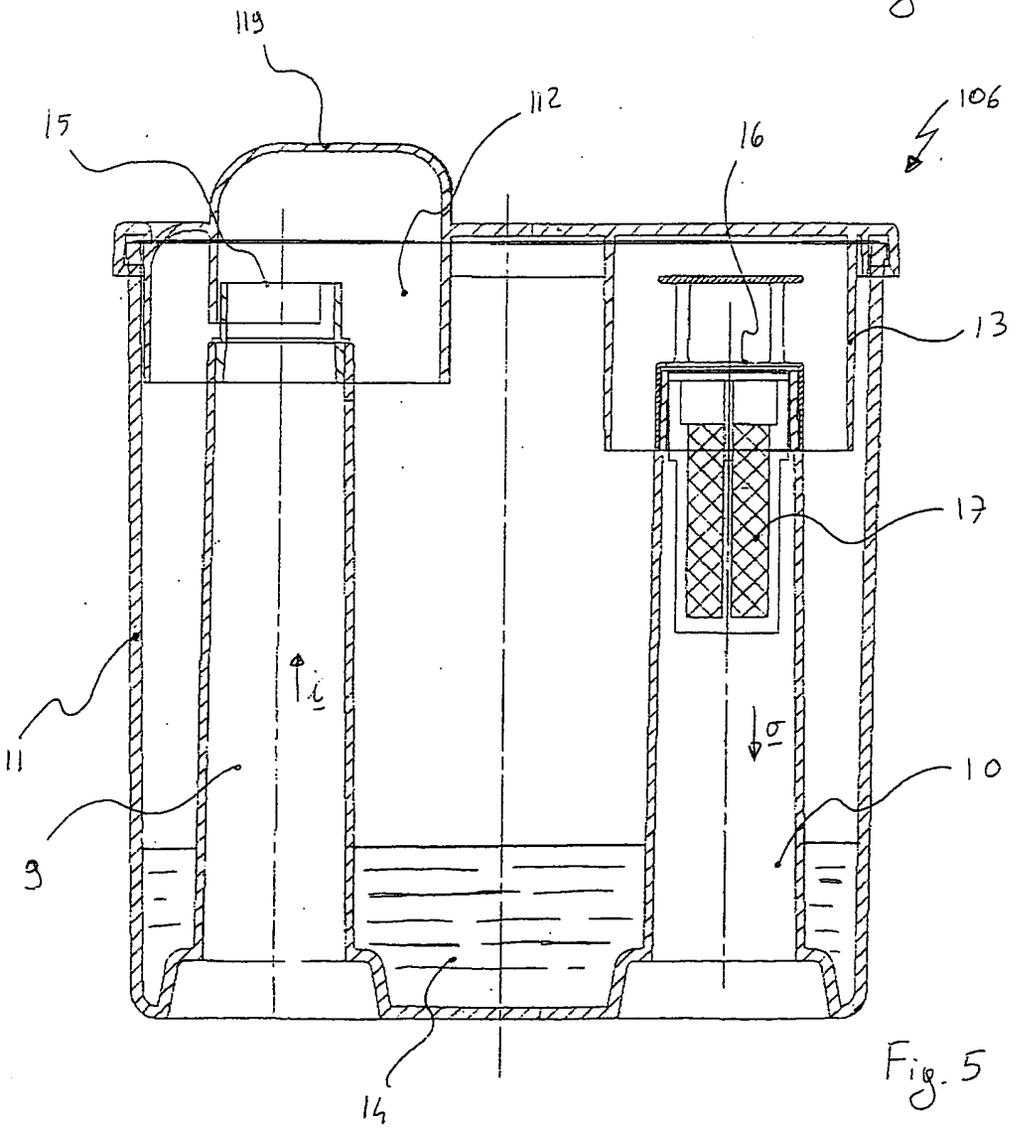

Fig. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 01 0580

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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	27 August 2003	MUNZER, E

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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