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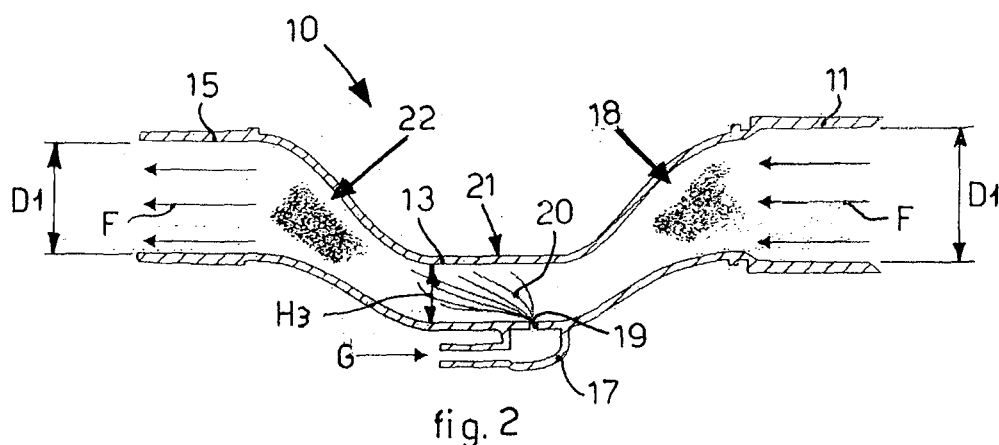
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(54) **Pre-filter device for a cleaning apparatus, suction device comprising said filter device and relative pre-filtering method**

(57) Pre-filter device for air and dust for a cleaning apparatus, able to be positioned at the entrance to a filter unit (12) of a suction device for air and dust. The pre-filter device comprises a shaped hollow body having a first portion (11) for the entrance of a stream of air and dust, a second treatment portion (13), disposed downstream of the first portion (11) and a third portion (15) disposed downstream of the second portion (13), through which the stream of air and dust exits. The second portion

(13) is provided with introduction means (17) to introduce a jet (20) of gas or steam suitable to hit the stream of air and dust. The second portion (13), at least in correspondence with the introduction means (17, 19), has a passage section bigger than the passage section of the first portion (11), so as to determine, during normal use, a slowing down of the speed of the stream of air and dust and so as to increase the contact time between the jet (20) and the stream of air and dust.



Description

FIELD OF THE INVENTION

[0001] The present invention concerns a pre-filter device and the relative method, usable for example in a filter unit of a vacuum cleaner or machine for sucking up liquids that uses a liquid bath to filter the dust.

[0002] The present invention also concerns the suction device comprising said filter device.

BACKGROUND OF THE INVENTION

[0003] It is known that traditional vacuum cleaners, with a sack or other means to collect the dust, allow a considerable quantity of dust to exit from the collection means; the dust must be filtered by other filter means, usually high-efficiency filters of the HEPA type, located downstream of the collection means.

[0004] Such known vacuum cleaners have the following disadvantages:

- with time there is a reduction in the suction capacity;
- the speed at which the air exits does not allow optimum efficiency of HEPA filters;
- the filters need frequent maintenance if they are to be efficient.

[0005] Many of these disadvantages of such known vacuum cleaners have been solved with liquid bath filters, typically based on processes to pulverize the water.

[0006] Vacuum cleaners that use the liquid bath filter have the advantage that they capture a greater quantity of dust in the collection means and do not lose their suction capacity over time.

[0007] However, even vacuum cleaners with liquid bath filters have a limited capacity for capturing the dust, especially fine dust, belonging to inhalable and breathable fractions.

[0008] This limitation is due to the fact that dust is hydro-repellent, and therefore does not bind easily with the water particles that are found in suspension in the filter means, and also due to the fact that when considerable quantities of dust are introduced into a vacuum cleaner in a very short period of time, the filter means tend to lose efficiency.

[0009] In practice, due to the size and speed of the particles and the chemical incompatibility between particles of dust and filter liquid, the filter means are not fully effective, or are not so in particular situations.

[0010] For this reason, also vacuum cleaners with a liquid bath filter are generally provided with another filter at exit (usually of the HEPA type), to allow to abate the fine dust, which otherwise would be re-introduced into the air.

[0011] However, despite the theoretical high efficiency of such filters, the air actually introduced into the environment can contain moderate quantities of fine dust, for

the reasons set out above concerning the limits of usability of these filters.

[0012] The filter capacity is reduced by the high outlet speed of the air and the lack of maintenance to which the filters are subjected.

[0013] A suction device is known from the European patent application EP-A-1.074.213, having a filter unit with a water filter and a pre-treatment region for the air entering, by means of steam.

[0014] However, the known device has the following disadvantages:

- only one point is provided for the introduction of the nebulized steam into a tubular chamber having a constant circular section. The speed of the air in said introduction point is such that the nebulized steam tends to be disposed in the upper part of the tubular chamber and therefore a large part of the dust is not hit by the jet, with a consequent poor pre-filtering effect;
- the device is installed near the recovery tank and therefore the steam introduced has no way of condensing and is expelled by the vacuum cleaner;
- the device requires a complex circuit and is difficult to access for cleaning;
- the device is inserted into the vacuum cleaner and cannot be removed therefrom nor applied to apparatuses that do not have one;
- the device requires activation by the user, or is always active. In this latter case it would be used even when it is not necessary (steam cleaning), thus reducing the cleaning performance of the steam.

[0015] One purpose of the present invention is to achieve a pre-filter device for a cleaning apparatus and a relative method that allows to filter with a high capacity of capturing the dust and hence a high filter efficiency of the dust, even the fine dust, considerably reducing if not eliminating the quantity of fine dust that is introduced into the environment after suction and filtering in the liquid bath.

[0016] Another purpose of the present invention is that the use of the pre-filter device allows to use liquid bath filters easily, so as to keep constant over time the suction capacity of the vacuum cleaner.

[0017] Another purpose of the present invention is to achieve a pre-filter device that will considerably reduce, if not eliminate, the need for maintenance interventions.

[0018] Another purpose of the present invention is to achieve a pre-filter device and a suction device comprising said pre-filter device, which has a simple circuit and is easily accessible and that can be removed and installed on vacuum cleaners that do not have one.

[0019] The Applicant has devised, tested and embodied the present invention to overcome the shortcomings of the state of the art and to obtain these and other purposes and advantages.

SUMMARY OF THE INVENTION

[0020] The present invention is set forth and characterized in the independent claims, while the dependent claims describe other characteristics of the invention or variants to the main inventive idea.

[0021] In accordance with the above purposes, a pre-filter device for air and dust according to the present invention is able to be positioned at the entrance of a filter unit of a suction device for air and dust.

[0022] According to a characteristic feature of the present invention, the pre-filter device for a cleaning apparatus is formed by a shaped hollow body having a first portion for the entrance of a stream of air and dust, a second portion, disposed downstream of the first portion and a third portion disposed downstream of the second portion, through which the air and dust exit.

[0023] The second portion is provided with introduction means to introduce a jet of gas or steam able to hit the stream of air and dust. Said second portion, at least in correspondence with the introduction means, has a wider passage section with respect to the passage section of the first portion, thus determining, under normal use, a slowing down of the stream of air and dust and increasing the contact time between the jet of gas or steam and the stream of air and dust.

[0024] This renders the treatment action more efficient, in particular the humidification, of the jet of steam or gas on the dust. In particular the fine dust and even the water-repellent dust is effectively captured. The slowing down of the stream of air is convenient even in cases where there is a considerable quantity of air taken in, which normally are not filtered well by the subsequent liquid bath filter.

[0025] The present invention therefore allows to filter with a high level of efficiency in capturing the dust, even the fine dust, considerably reducing, if not eliminating, the amount of fine dust which is released into the environment after suction and filtering in the liquid bath.

[0026] According to one embodiment of the present invention, the second portion is of a flattened shape, substantially U-shaped, with an area having a wider passage section than the passage section of the first portion.

[0027] Advantageously, the second portion is smaller transversally to the direction of advance of the stream of air and dust, advantageously also in the direction of exit of the jet of gas or steam, thus limiting the distance between the stream of air and said jet of steam or gas and consequently rendering the treatment of all the stream of air effective and homogenous.

[0028] Since it is able to use liquid bath filters efficiently without the need for further HEPA filters, the present invention is also economical and keeps the suction capacity of the vacuum cleaner to which it is possible applied constant over time.

[0029] Furthermore the need for maintenance interventions is considerably reduced, if not eliminated.

[0030] According to one form of embodiment, the in-

troducton means comprises a Venturi effect inlet and one or more inlet holes, provided substantially in correspondence with the region of maximum width of said second portion, thus determining a substantially uniform distribution of the jet in said region.

[0031] In practice, the exit holes of the steam or gas create a real and proper barrier to the stream of air and dust, so that the latter is forced to pass through the whole barrier, and thus subject to a uniform treatment.

[0032] A filter unit for a suction device comprising a liquid bath filter and a pre-filter device as described above, placed upstream of the filter and fluidly connected to it, also comes within the scope of the present invention.

[0033] A suction device, for example a vacuum cleaner and/or a machine to suck up liquids, which comprises a filter unit as described above, also comes within the scope of the present invention.

[0034] Advantageously, in this suction device, the second portion of the pre-filter device of the filter unit is outside the body of the suction device, so as to be able to cool on contact with the outside environment. An increased condensation of the steam is thus achieved, before it reaches the dust collection tank.

[0035] Moreover, advantageously, the pre-filter device is independent of the main suction device and can be inserted or removed when necessary. In particular, it can be used only in the case of dry cleaning, being superfluous in steam cleaning.

[0036] Removability also ensures the accessibility of the second portion, or treatment chamber, of the pre-filter device, and facilitates the cleaning thereof.

[0037] The circuit necessary for the functioning of the suction device thus achieved is very simple and accessible compared to those in the state of the art.

[0038] According to an advantageous solution, the suction device comprises suction means able to be activated to suck air inside the filter unit, it comprises generator means able to generate a stream of steam or gas which is sent to the pre-filter device by means of an introduction line and automatic control means able to be influenced by the depression determined by the suction means so as to selectively command the opening/closing of the means to intercept the stream, disposed on the introduction line and upstream of the pre-filter device.

[0039] A selective activation of the suction device is thus achieved, advantageously only when suction occurs.

[0040] A method for the pre-filtering of air and dust for a filter unit of a suction device for air and dust also comes within the scope of the present invention. It provides to convey the stream of air entering the filter unit to a pre-filter device positioned at the entrance to the filter unit, to hit the stream of air and dust with a jet of steam or gas which is selectively introduced into at least a treatment portion of the pre-filter device and to determine a slowing of the speed of the stream of air and dust in order to increase the contact time between the jet and the stream of air and dust, at least in said treatment portion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] These and other characteristics of the present invention will become apparent from the following description of a preferential form of embodiment, given as a non-restrictive example with reference to the attached drawings wherein:

- fig. 1 is a schematic representation of a pre-filter device according to the present invention;
- fig. 2 is a sectioned lateral view of a pre-filter device according to the present invention;
- fig. 3 is a sectioned plane view of a pre-filter device according to the pre- sent invention;
- fig. 4 is another schematic representation of a pre-filter device according to the present invention;
- fig. 5 is a three-dimensional schematic view of a pre-filter device according to the present invention.

DETAILED DESCRIPTION OF A PREFERENTIAL FORM OF EMBODIMENT

[0042] With reference to the attached drawings, a pre-filter device 10 according to the present invention is usable in a filter unit 12 of a vacuum cleaner (not shown in the drawings).

[0043] The filter unit 12 comprises, in a traditional way, a liquid bath filter 14 and, downstream of this, an auxiliary filter 16. The auxiliary filter 16 is optional and not essential for the purposes of the present invention.

[0044] The device 10 is disposed upstream of the filter 14, as can be seen in fig. 1, in order to treat the dust, as is better described as follows.

[0045] The air sucked up, containing the dust, enters, as indicated by arrow I, into correspondence with the device 10 and is filtered along the unit 12, to then exit, as indicated by the arrow O.

[0046] In particular the device 10 is formed by a shaped hollow body, which can be seen in fig. 5, which has a first portion 11 with a tubular shape, having a circular section with an internal diameter D1 (fig. 2), for the entrance of the air, as indicated by the arrows F, a second portion 13 substantially U-shaped and with a flattened section, and a third portion 15 with a tubular shape, identical to the first portion 11. The third portion 15 conveys air toward the filter 14.

[0047] The second portion 13 has a section that widens and narrows in height, with respect to the sizes of the portions 11 and 15.

[0048] In particular the second portion 13 increases in width, with respect to the diameter D1 of the first portion 11, up to a maximum width L3, substantially in its central region 21, while it decreases its height with respect to the diameter D 1 of the first portion 11, to a minimum height H3, as can be clearly seen in figs 2, 3, 4 and 5.

[0049] The second portion 13 has at the lower part an inlet 17 with a Venturi effect, to introduce a jet 20 of water vapor, coming from a steam feeding line, as indicated by

the arrow G, which comes directly from the bottom toward the top inside the second portion 13.

[0050] The jet 20 of steam hits the stream of air F directly, thus subjecting the dust present in the air, above all the fine dust, to a treatment which renders it compatible with and suitable for the subsequent liquid bath filter 14.

[0051] The air sucked in enters full of dust from the first portion 11 and crosses the jet 20 of steam in the second portion 13 (figs. 2 and 3).

[0052] The combined effect of the pressure and temperature of the jet 20 of steam allows the dust particles present in the air to be treated and renders them chemically compatible with the liquid of the filter.

[0053] The dust is therefore made heavier and is more easily captured by the subsequent filter, thus preventing it from entering the environment.

[0054] The second portion 13 is connected to the first portion 11 and the second portion 15 and, as we said, has a flattened section which allows the steam to treat the dust better during its passage.

[0055] In correspondence with the inlet 17, the steam is introduced in a direction transverse to the stream of air F, and is distributed, thanks to one or more openings 19, made transversally along the whole width L3, in such a way as to cross it completely.

[0056] Therefore, with a section of width L3 bigger than the diameter D1 of the portions 11 and 13, a reduction in speed of the air coming in is obtained and, in consequence, an increase in the time of contact between the dust and the water vapor, with consequent optimization of the efficiency of the device 10. Moreover, by adopting a reduced height H3, less than the diameter D1, the distance of the stream of air F with respect to the jet 20 of steam is minimized, thus obtaining a homogenous treatment.

[0057] The development of the stream of air F in the second portion is well illustrated in fig. 3, where a widening of the stream lines corresponds to a slowing down of their speed.

[0058] In particular, therefore, the opening 19 is made precisely in correspondence with the maximum width L3 of the second portion, where we have the minimum speed of the stream F.

[0059] The second portion 13 thus functions as a treatment chamber for the air and the dust, to prepare them for the subsequent liquid filter, so as to have a higher efficiency of the filtering and a reduced, or nil, emission of fine dust into the environment.

[0060] The air and the dust thus treated are then conveyed toward the filter 14, to be filtered in a liquid bath, and they cross the third portion 15, identical to the first portion 11, so as to recover the speed of the stream and the initial pressure.

[0061] In this case, the device 10 is part of the filter unit 12 of a vacuum cleaner/machine to suck up liquids with water filtering, as described above.

[0062] In particular we have a vacuum cleaner provid-

ed with a steam boiler 24 (fig. 4) which generates steam and sends it, as indicated by arrow G, to the inlet 17 of the device 10, through a dedicated introduction line 27.

[0063] The device 10 uses this steam generated for the treatment of the dust before the entrance into the filter 12.

[0064] In this case, the device 10 is provided with a pressure switch 28, which automatically activates the introduction of the steam.

[0065] When the user activates the aspirator 30, the depression which it creates activates (closes) the pressure switch 28 which, in turn, drives an electromagnetic valve 26, mounted on the introduction line 27, which allows the passage of the steam.

[0066] In this way, an automatic activation of the steam jet is achieved only when it is necessary for the suction, and without any further intervention from the user, other than switching on the suction.

[0067] Moreover, thanks to this, the device 10 can also be supplied as a separate accessory for existing suction devices and does not require any modifications to be made to them.

[0068] It is clear that modifications and/or additions of parts and/or steps may be made to the pre-filter device 10 for a cleaning apparatus and suction device comprising said filter device and relative pre-filtering method as described heretofore, without departing from the field and scope of the present invention.

[0069] It is also clear that, although the present invention has been described with reference to specific examples, a person of skill in the art shall certainly be able to achieve many other equivalent forms of pre-filter device for a cleaning apparatus and suction device comprising said filter device and relative pre-filtering method, having the characteristics as set forth in the claims and hence all coming within the field of protection defined thereby.

Claims

1. Pre-filter device for air and dust for a cleaning apparatus, able to be positioned at the entrance to a filter unit (12) of a suction device for air and dust, **characterized in that** it comprises a shaped hollow body having a first portion (11) for the entrance of a stream of air and dust, a second treatment portion (13), disposed downstream of the first portion (11) and a third portion (15) disposed downstream of the second portion (13), through which the stream of air and dust exits, the second portion (13) being provided with introduction means (17) to introduce a jet (20) of gas or steam able to hit the stream of air and dust and having, at least in correspondence with the introduction means (17, 19), a passage section bigger than the passage section of the first portion (11), so as to determine, during normal use, a slowing down of the speed of the stream of air and dust and so as to increase the contact time between the jet (20) and

the stream of air and dust.

2. Device as in claim 1, **characterized in that** the second portion (13) is shaped flat, substantially U-shaped, with a region (21) having a width (L3) at least greater than the width (D1) of the first portion (11) and a height (H3) at least less than the height (D1) of the first portion (11).
3. Device as in claim 2, **characterized in that** the introduction means comprises an inlet (17) with a Venturi effect and one or more entrance holes (19), provided in substantial correspondence with the region (21) of maximum width (L3) of said second portion (13), so as to determine a substantially uniform distribution of the jet (20) in the region (21).
4. Filter unit for a suction device comprising a liquid bath filter (14), **characterized in that** it also comprises a pre-filter device (10) as in any of the claims hereinbefore, connected upstream of the filter (14) and fluidly connected thereto.
5. Suction device **characterized in that** it comprises a filter unit (12) as in claim 4.
6. Suction device as in claim 5, **characterized in that** at least the second portion (13) of the device (10) of the filter unit (12) is outside the body of the suction device, so as to be able to cool down on contact with the outside environment.
7. Suction device as in claim 5 or 6, comprising suction means (30) able to be activated so as to suck in the air into the filter unit (12), **characterized in that** it comprises generator means (24) able to generate a stream of steam or gas (G) which is sent to the pre-filter device (10) through an introduction line (27) and automatic control means (28) able to be influenced by the depression determined by the suction means (30) so as to selectively command the opening/closing of stream interception means (26) disposed on the introduction line (27) upstream of the pre-filter device (10).
8. Method for pre-filtering air and dust for a filter unit (12) of a suction device for air and dust, **characterized in that** it provides to convey the stream of air (F) entering in the filter unit (12) into a pre-filter device (10) positioned at the entrance to the filter unit (12), in order to hit the stream (F) of air and dust with a jet (20) of steam or gas which is selectively introduced into at least a treatment portion (13) of the pre-filter device (10) and to determine a slowing down of the speed of the stream (F) of air and dust in order to increase the contact time between the jet (20) and the stream (F) of air and dust, at least in said treatment portion (13).

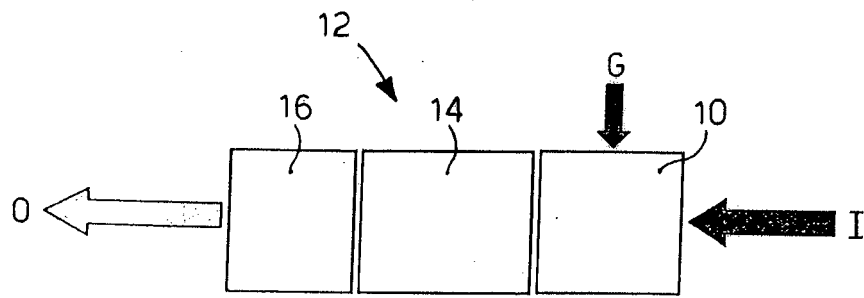


fig. 1

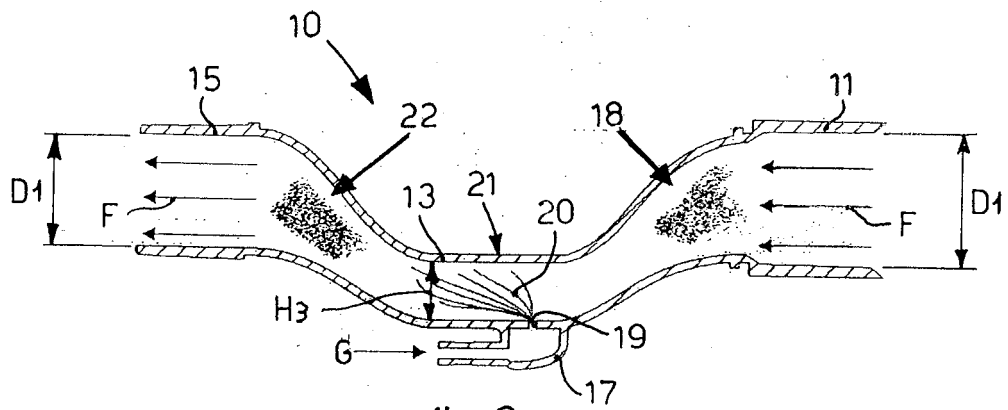


fig. 2

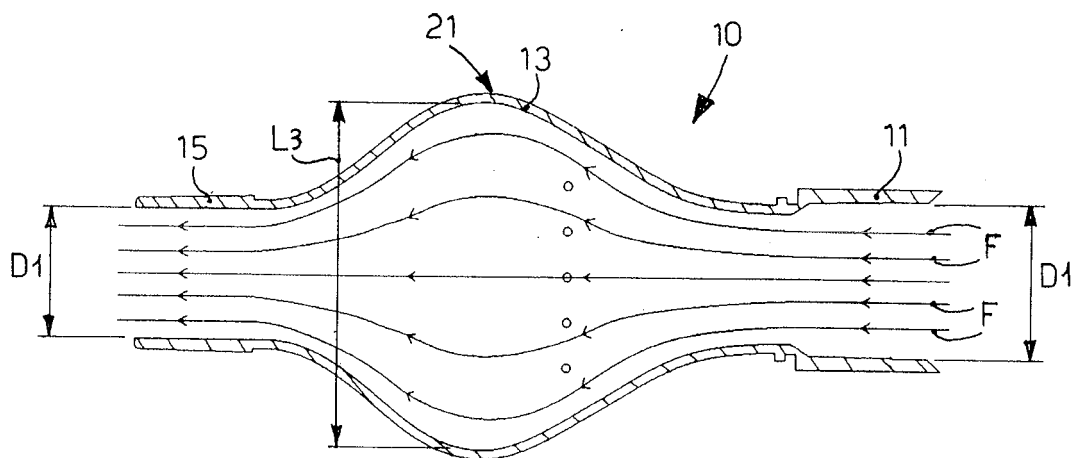


fig. 3

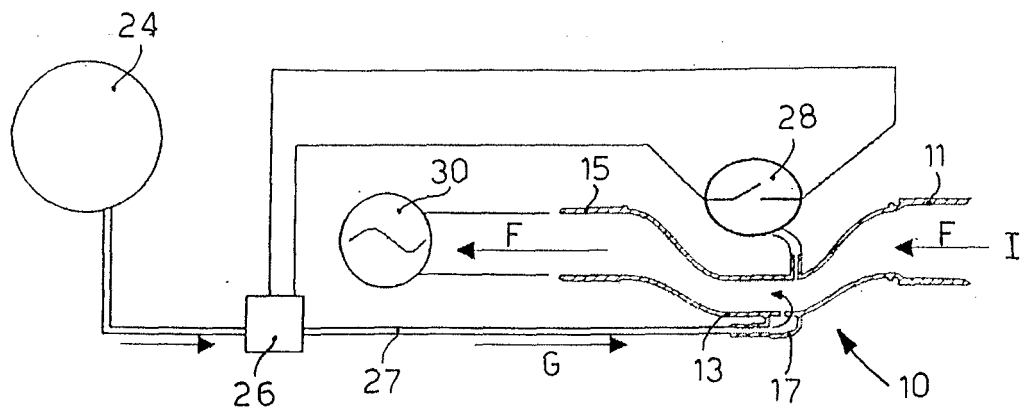


fig. 4

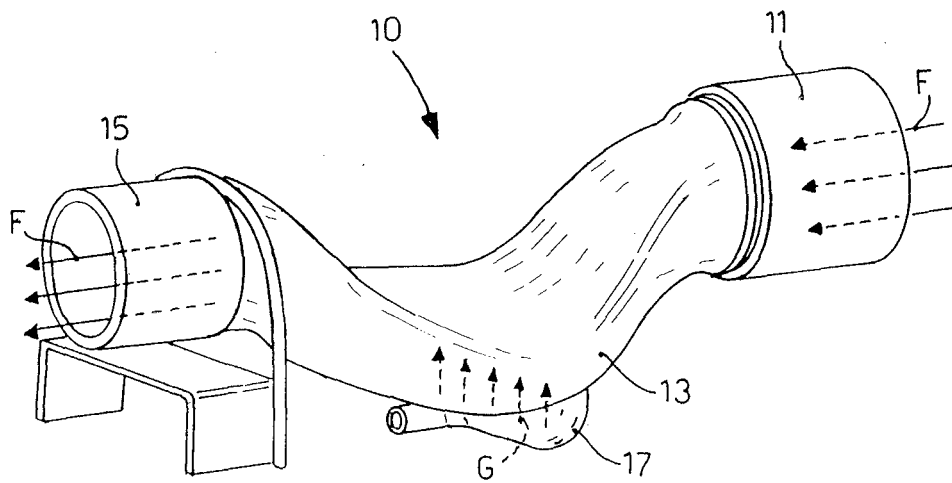


fig. 5



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EP 09 15 3729

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 09 15 3729

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