



(11) **EP 2 455 675 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
23.05.2012 Bulletin 2012/21

(51) Int Cl.: **F24F 3/16** (2006.01) **B08B 15/00** (2006.01)

(21) Application number: **11188403.7**

(22) Date of filing: **09.11.2011**

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

(71) Applicant: **Korvent Oy**
01730 Vantaa (FI)

(72) Inventor: **Vilhunen, Juhani**
FI-02340 Espoo (FI)

(74) Representative: **Tanhua, Pekka Vilhelm Berggren Oy AB**
P.O. Box 16
00101 Helsinki (FI)

(30) Priority: 17.11.2010 FI 20100491 U

(54) **Apparatus for generating negative pressure in a space**

(57) The invention relates to an apparatus for generating negative pressure in a space, especially in a work space designated for construction and/or renovation. According to the invention, the apparatus (1) comprises a chamber (3) and a radial fan (4), said chamber (3) having at least one first opening (31) for introducing air into the chamber (3) from a space (T), said opening being fitted

with a first filter (5), and a second opening (32) for expelling air from the chamber, said second opening being connected to an inlet duct (41) of the radial fan (4), in connection with said second opening (32) being a second filter (6), and an outlet duct (42) of said radial fan (4) being connectible to an exhaust duct (7) and outside the space (T).

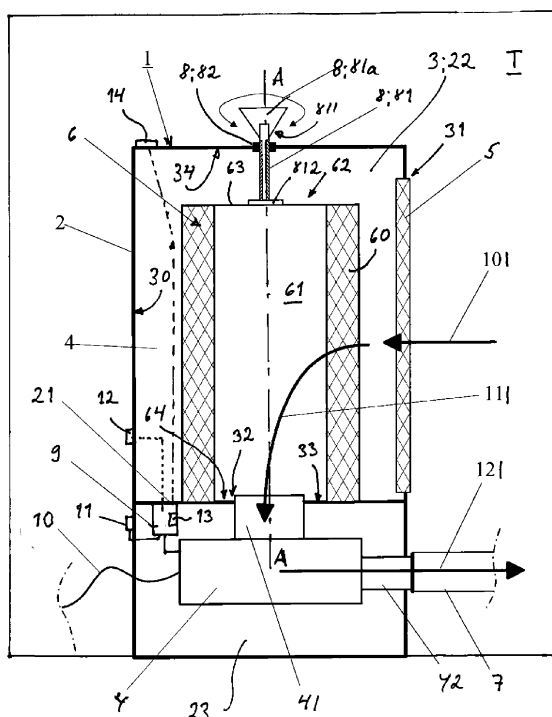


FIG.1

Description

[0001] This invention relates to an apparatus for generating negative pressure in a space. More specifically, it concerns an apparatus for generating negative pressure in a work space that constitutes a repair building or renovation project, and its primary objective is to prevent construction and/or demolition dust from spreading to immediate surroundings.

[0002] Vacuum fans are in general use at construction and renovation sites to prevent the spread of harmful dust elsewhere from the work project. This is of particular importance in bathroom renovations with work-generated dust tending to spread all over the residence. The resulting dust tends to spread in the residence even if the work project is sealed off its surroundings with plastic covers. This results in a necessity of cleaning the entire residence after renovation. The vacuum fan is used for creating in the work space a negative pressure, whereby air and dust tend to flow through openings in the plastic cover towards the working space, not the other way round.

[0003] Currently employed solutions involve setting up a bulky vacuum fan in a work space that has been sealed off the surroundings. The vacuum fan is used in an effort to maintain a sufficient negative pressure at the work site in order to prevent dust from escaping the work space. The vanes of such a fan rotate around the axis perpendicularly to the air duct and produce air flow in the axial and air duct direction. The axial fan's outlet is typically in the order of 20-40 cm because of a large diameter of the fan vanes.

[0004] To the axial fan's outlet is fitted a lightweight and thin exhaust duct of the plastic sleeve type, which in diameter is as extensive as the axial fan's outlet port. A problem is that such exhaust ducts of the plastic sleeve type easily become completely obstructed, especially in construction/renovation projects, as on top of the same are inadvertently laid for example building supplies or tools. In addition, exhaust ducts of the plastic sleeve type become obstructed as a result of folding the same (in corners).

[0005] Another problem is that axial fans operate at relatively low rotation speeds and are large in physical dimensions. Consequently, the overall fan assembly, along with its filter, is quite bulky and inconvenient to carry around. In addition, the large size causes trouble particularly in small renovation projects (for example small bathrooms and shower facilities), the bulky vacuum fan occupying a major portion of the effective work space.

[0006] Yet another drawback is the low power output of currently employed axial fans, which is accentuated as the performance of filters weakens. This results in an increasing need to clean or replace filters during ongoing construction/renovation activities in the work space.

[0007] An object of the invention is to eliminate the problems related, among others, to current vacuum fans. Another object of the invention is to provide a new im-

proved apparatus for generating negative pressure in a space, which apparatus is small in size, lightweight, and safe, and which is particularly, but not exclusively, suitable for use in construction and renovation projects.

[0008] An apparatus of the invention for generating negative pressure in a work space is characterized by what is presented in claim 1. Preferred embodiments of the invention are presented in dependent claims.

[0009] The invention relates to an apparatus for generating negative pressure in a space, especially in a work space designated for construction and/or renovation. According to the invention, the apparatus comprises a chamber and a radial fan, said chamber having at least one first opening for introducing air into the chamber from a space, said opening being fitted with a first filter, and a second opening for expelling air from the chamber, said second opening being connected to an inlet duct of the radial fan, in connection with said second opening being a second filter, and an outlet duct of said radial fan being connectible to an exhaust duct and outside the space.

[0010] A benefit of the invention is a small size, lightness, and high performance of the apparatus. The compact and lightweight apparatus is easy to bring to a project site and takes little space.

[0011] A benefit of the invention is that the generation of negative pressure is carried out by using a high performance radial fan. This enables, whenever necessary, the amounts of air expelled from a work space to be increased to a clearly higher-than-before level. As filters are gradually clogging, the axial fan quashes quite rapidly, nor is a sufficient negative pressure established in the work space. In an apparatus as set forth in the invention the radial fan continues to have enough strength to draw in air even through quite cloggy filters, nor does the negative pressure capacity decrease nearly as sharply as in prior known equipment making use of axial fans. In addition, if necessary, the suction performance of radial fans can be raised even more, because in a normal condition with the filters still mostly open (not clogged), the radial fan has just a small portion of its suction capacity in active service.

[0012] The invention and its other benefits will now be described in more detail with reference to the accompanying drawing, in which

fig. 1 shows one apparatus of the invention in a simplified cross-section view.

[0013] The apparatus 1 comprises a chamber 3 and a radial fan 4, which are most preferably accommodated in a common enclosure 2. The chamber 3 is conveniently airtight. The chamber 3 includes at least one first opening, i.e. an air inlet port, which is provided with a first filter 5. The chamber 3 has a second opening 32, i.e. an air outlet port, which is connected to an inlet duct 41 of the radial fan 4. Inside the chamber 3, between the first 31 and the second opening 32, is a second filter 6. An outlet duct 42 of the radial fan 4 is connectible to an exhaust duct 7 and

to the exterior of a space T. The exhaust duct 7, such as an exhaust pipe, is most preferably attachable to the outlet duct 42 in a removable manner.

[0014] The radial fan 4 comprises, housed inside the enclosure, an electric motor, such as an alternating current motor, and a vane unit driven rotationally by the electric motor (not shown in the drawing). The radial fan 4 is connectible with a power cord 10 to the mains electricity supply. Thus, air is displaced from the fan's and thereby the vane unit's central area radially outward from the fan.

[0015] The chamber 3 is most preferably a cylinder whose ends 33, 34 are e.g. circular or polygonal. The first opening 31 is provided most preferably in the chamber's shell 30 and the second opening 32 in its end, such as in the second end 34, and preferably in its mid-section.

[0016] The chamber 3 has its first filter 5 as a prefilter capable of being removed, cleaned, and/or replaced as necessary. The first filter 5 is installed, preferably by a quick release attachment, in connection with the first opening 31 of the chamber 3.

[0017] The chamber 3 has its second filter 6 as a high performance filter, such as a HEPA filter (High Efficiency Particulate Air Filter), which is also capable of being removed and replaced as necessary.

[0018] In a preferred embodiment of the invention, the second filter 6 is preferably in the shape of a cylinder. The second filter 6 comprises a cylindrical protective jacket 60, which houses an open space 61 co-directional with a center axis A-A and extending through the filter. The second filter has its first end 62 closed with a flange 63 or the like plate. The second filter 6 is fitted in a central area of the chamber 3, such that there is vacant space around it within the chamber 3. The second filter has its second end 64, which is at least partly open, connected to the air outlet port 32 and further to the inlet duct 41 of the radial fan 4.

[0019] The apparatus 1 of the invention comprises attachment means 8 for fitting and sealing the second filter 6 inside the chamber 3 in connection with the air outlet port 32.

[0020] In a preferred embodiment of the invention, the attachment means 8 comprise a set screw 81 and a nut element 82. The nut element 82 is arranged in connection with the second end 34 of the chamber 3, preferably in the middle of it. The set screw 81 is fitted in the nut element 82. The set screw 81 is driven perpendicularly against the chamber's second end 34 by rotating it clockwise and/or counterclockwise from a first end, which extends outside the chamber and is provided with a suitable head 810 or the like. The set screw's second end is preferably provided with an end plate 811 or the like, which is to be set against the second filter's 6 flange 63 in the process of placing and securing the second filter in its position inside the chamber 3. When the set screw 81 is rotated from the head, 811 e.g. with a suitable implement, in one direction, most preferably clockwise, the second filter 6 is squeezed and thereby secured between the end plate 812 and the first end 33 of the chamber 3. Consequently,

the second filter has its second, at least partly open end 64 in alignment with the air outlet port 32. Respectively, when the set screw 81 is rotated from the head 811 in the other opposite direction, most preferably counterclockwise, the squeeze loosens and the second filter 6 is released from the grip.

[0021] In a preferred embodiment of the invention, the set screw 81 is a wing screw 81 a. In this case, the set screw is readily, even with bare hands, rotatable and enables the second filter 6 both to be secured in the chamber 3 and released from the chamber 3.

[0022] In a preferred embodiment of the invention, the apparatus 1 comprises the enclosure 2, housing both the chamber 3 and the radial fan 4. Hence, the apparatus 1 can be implemented as a relatively small size, compact, lightweight and easily portable unit.

[0023] In its most preferred embodiment, the enclosure 2 is provided with a partition 21, by means of which the chamber interior has been divided into two sections, a first and a second internal section 22 and 23. The first internal section 22 is configured as the chamber 3. The radial fan 4 is installed in the second internal section 23. Hence, the chamber's second opening 32 is provided in the partition 21. The radial fan 4 has its outlet duct 42 adapted to extend through the outer wall of the enclosure 2 and the second internal section 23.

[0024] The apparatus 1 according to the invention operates basically in such a way that the radial fan 4 draws in dusty air from the space T outside the apparatus, such that the air travels through the first filter 5 into the chamber 3 (a first arrow 101) and is cleaned of relatively large particles. From the chamber 3 the air passes through the second filter 6, such as a HEPA filter, and is cleaned of relatively small particles. The air proceeds onward from the second filter 6 by way of the second opening 32 into the radial fan's inlet duct 41 and into the radial fan 4 (a second arrow 111). After drawing it in, the radial fan 4 blows the air through the air exhaust duct 7 out of the apparatus 1 and along an exhaust hose 13 or the like, attached to the exhaust duct, out of the space T, such as a space under renovation/construction, preferably straight to the atmosphere (a third arrow 121).

[0025] The radial fan 4 has its outlet duct 42 small in diameter, typically in the order of 5-10 cm. Thus, the exhaust duct 7 to be attached to the outlet duct 42 is preferably a small-diameter, most preferably relatively rigid hose or tube, which is not easily collapsed. The above-mentioned exemplary diameter should by no means be construed a feature that would limit the invention.

[0026] The employed first filter or prefilter 5 is any prior known solution capable of filtering large particles from air passing therethrough. The employed prefilter 5 consists for example of some fabric type material. Such a prefilter 5 is quickly cleaned by detaching it from the first opening 31 and by shaking it to remove impurities or clogging particles therefrom. A benefit provided by using the prefilter 5 is that it prevents a rapid clogging of the second filter 6, such as a HEPA filter, and extends its longevity.

[0027] The second filter 6 is most preferably installed in its position by way of the first opening 31. Alternatively, the chamber 3 has its second end 34 removable from the shell 30, which operation is followed by installing the second filter 6 in position inside the chamber 3 and by securing the second end 34 back to its position. When the installation and removal of the second filter 6 are carried out by making use of the first opening reserved for the prefilter 5, there is no concern, after the above operations, regarding the sealing tightness of gaps between the removable components of the chamber 3.

[0028] In a preferred embodiment of the invention, the apparatus 1 further comprises a control unit 9, which is most preferably implemented by means of a microprocessor and suitable peripheral circuits. Hence, the control and regulatory functions of the apparatus are executed by means of computer programs stored in one or more memory units. Optionally, the control unit 9 is also achievable some other way, such as by means of suitable logic circuits or the like. The control unit 9 is fitted preferably in connection with the chamber 3 and/or the enclosure 2.

[0029] A pressure sensor 11 is connected to the control unit 9. The pressure sensor 11 is preferably mounted in contact with the chamber 3 and/or the enclosure 2 on its external surface, preferably at a distance from the first opening 31. The control unit 9 serves to regulate an air pressure p of the space T by regulating the radial fan 4 on the basis of pressure messages received from the pressure sensor 11 and the guideline value of a set air pressure, especially a negative pressure p_a .

[0030] The pressure sensor 11 serves to monitor air pressure in the work space T and this information is given to the control unit 9. When the apparatus 1 is placed in the work space T and the work space air pressure is to be dropped from a normal ambient air pressure to a predetermined air pressure, e.g. to an air pressure 1-10 pascals lower, i.e. to a negative pressure, the radial fan 4 is activated, the air pressure p in the work space T is monitored with the pressure sensor 11, and the pressure data is communicated to the control unit 9. Controlled by the control unit 9, by exploiting the air pressure data p that the pressure sensor 11 has provided, the radial fan 4 is first set to operate at full power in order to quickly reach a desired guideline value for an air pressure p_a in the work space T , after which the radial fan power can be adjusted lower. The pressure data p provided by the pressure sensor 11 is monitored continuously with the control unit 9. In case the pressure in the work space T rises, nor for one reason or another remains at a desired air pressure guideline value, specifically at the negative pressure p_a , a notification (or even an alarm) is given from the control unit 9 about the increase of air pressure and a transgression of the air pressure guideline value p_a .

[0031] In a preferred embodiment of the invention, the notification about a transgression of the set negative pressure guideline value p_a is given e.g. by means of a sound producing device 12, such as a speaker, a suitable sound signal or the like.

[0032] When a notification (or an alarm) is given regarding the rise of air pressure beyond the guideline value p_a , a person working in the work space T can immediately check the operation of the apparatus 1. The rise of air pressure beyond a desired guideline value of the negative pressure p_a is caused e.g. by a gradually developed obstruction of the first and/or the second filter 5, 6. In this case, cleaning the filters 5, 6 and/or replacing the same with a new matching filter is a procedure whereby the situation is rectified and the apparatus reset in flawless operation.

[0033] In a preferred embodiment of the invention, the apparatus 1 comprises coupling elements 14 for linking the control unit 9 to a computer, a data network or the like extra-apparatus medium for outputting information, such as air pressure data, from the apparatus or for inputting information, such as a desired guideline value for the negative pressure p_a , into the apparatus, especially into the control unit 9. In addition, programs of the control unit 9 are capable of being updated and/or installed by way of the coupling elements 14 outside the apparatus. The coupling elements 14 are wired and/or wireless (e.g. an infrared or radio transceiver arrangement).

[0034] In a preferred embodiment of the invention, the apparatus 1 comprises a display unit 13 for presenting the air pressure prevailing in the vicinity, especially in the work space T , and other useful information, such as a piece of information regarding a transgression of the desired negative pressure p_a . The display unit 13 is preferably fitted in connection with the chamber 3 and/or the enclosure 2.

[0035] The invention is not limited to only concern the foregoing exemplary embodiment, but a multitude of variations are possible while remaining within the inventive concept defined by the claims.

Claims

1. An apparatus for generating negative pressure in a space, especially in a work space designated for construction and/or renovation, **characterized in that** the apparatus (1) comprises a chamber (3) and a radial fan (4), said chamber (3) having at least one first opening (31) for introducing air into the chamber (3) from a space (T), said opening being fitted with a first filter (5), and a second opening (32) for expelling air from the chamber, said second opening being connected to an inlet duct (41) of the radial fan (4), in connection with said second opening (32) being a second filter (6), and an outlet duct (42) of said radial fan (4) being connectible to an exhaust duct (7) and outside the space (T).
2. An apparatus according to claim 1 for generating negative pressure in a space, **characterized in that** the apparatus (1) comprises an enclosure (2), inside which the chamber 3 and the radial fan (4) are ac-

commodated.

3. An apparatus according to claim 1 or 2 for generating negative pressure in a space, **characterized in that** the first filter (5) is a prefilter and the second filter (6) is a high performance filter, such as a HEPA filter. 5
4. An apparatus according to claim 3 for generating negative pressure in a space, **characterized in that** the second filter (6) comprises a cylindrical filter jacket (60), housing an open space (61) which is co-directional with an axis (A-A) and extends through the filter, said filter being fitted in a mid-section of the chamber (3), and said filter having its first end (62) closed with a flange (63), and its second end (64) being at least partly open and connected to the air outlet port (32) and the radial fan's inlet duct (41). 10 15
5. An apparatus according to claim 4 for generating negative pressure in a space, **characterized in that** the apparatus (1) comprises attachment means (8) for fitting and sealing the second filter (6) inside the chamber (3) in connection with the air outlet port (32). 20
6. An apparatus according to claim 5 for generating negative pressure in a space, **characterized in that** the attachment means (8) comprise a set screw (81) and a nut component (82), said nut component (82) being disposed in connection with a second end (34) of the chamber (3), and by which set screw (81) the second filter (6) is to be squeezed from its first end flange (63) against a first end (33) of the chamber (3), such that the second filter's second, at least partly open end (64) is in alignment with the air outlet port (32). 25 30 35
7. An apparatus according to claim 6 for generating negative pressure in a space, **characterized in that** the set screw (81) is a wing screw (81 a). 40
8. An apparatus according to any of the preceding claims for generating negative pressure in a space, **characterized in that** the apparatus (1) further comprises a control unit (9) and a pressure sensor (11), said control unit being used for monitoring and regulating an air pressure (p) of the space (T) by adjusting the radial fan (4). 45
9. An apparatus according to claim 8 for generating negative pressure in a space, **characterized in that** the apparatus (1) comprises a sound producing device (12), by which a notification is given about a transgression of an air pressure guideline value (p_a) set for the work space (T). 50 55
10. An apparatus according to claim 8 or 9 for generating negative pressure in a space, **characterized in that** the apparatus (1) comprises coupling elements (13)

for linking the control unit (9) to a computer, a data network or the like.

11. An apparatus according to claim 8, 9 or 10 for generating negative pressure in a space, **characterized in that** the apparatus (1) comprises a display unit (14) for presenting the air pressure prevailing in the surroundings, especially in the work space (T).

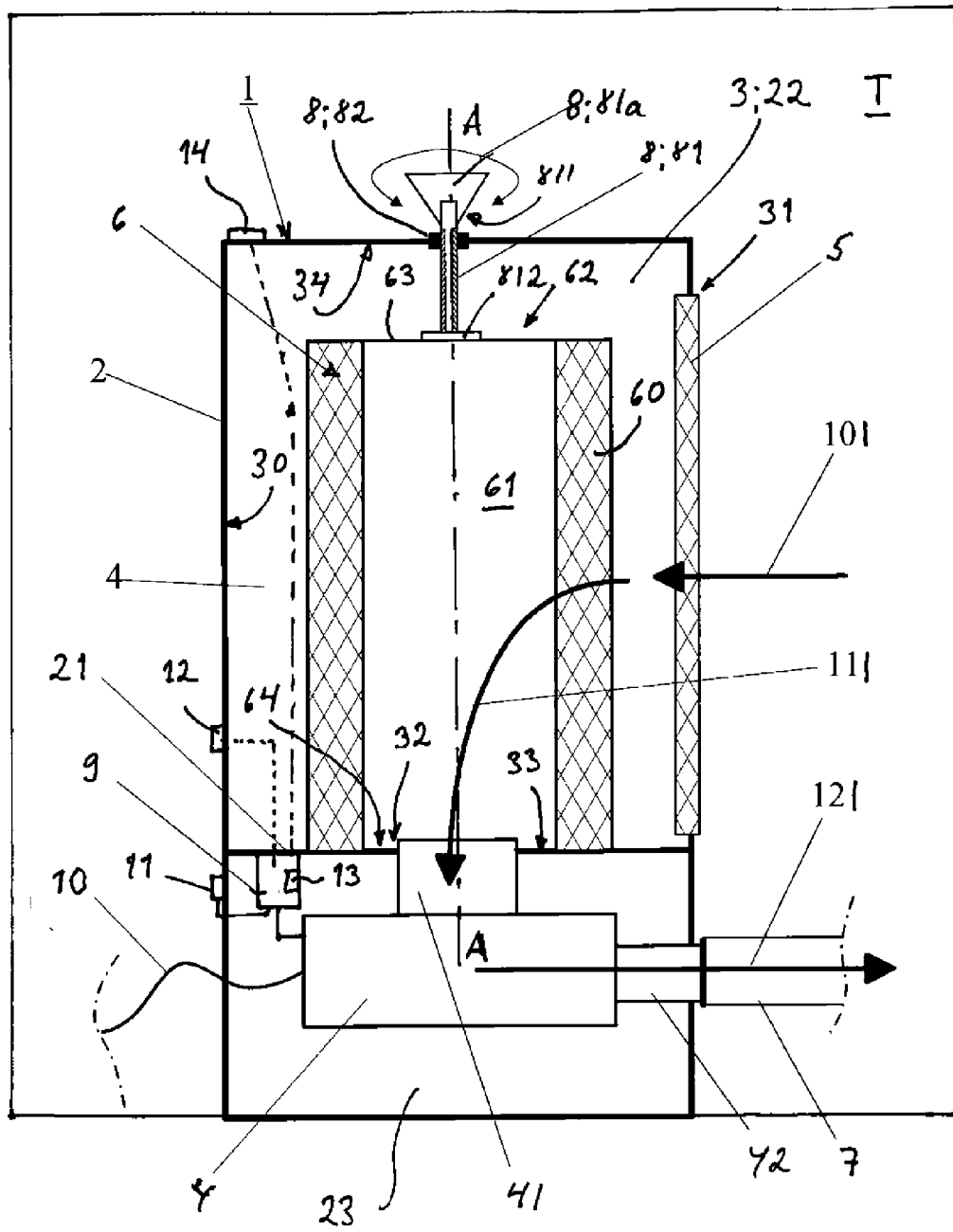


FIG.1