

(19)



(11)

**EP 2 749 193 A1**

(12)

**EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**02.07.2014 Bulletin 2014/27**

(51) Int Cl.:  
**A47L 9/12 (2006.01) A47L 9/20 (2006.01)**

(21) Application number: **13199322.2**

(22) Date of filing: **23.12.2013**

(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**

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(30) Priority: **27.12.2012 IT CR20120026**

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(54) **Multi-filter vacuum cleaner with independent shaker cleaning device for each filter**

(57) The invention relates to the sector of industrial vacuum cleaners. In particular the invention concerns a multi-filter vacuum cleaner (100) with independent shaker cleaning device for each filter comprising shaker means (9) with striking head, which can be selectively activated and are adapted to act on each filter.

Said vacuum cleaner comprises:

- at least a suction turbine (1, 1a, 1b, 1c) for sucking a primary flow of dusty air (F), associated with a vacuum chamber (2, 2a, 2b, 2c);
- a plurality of cartridge filters (6) for cleaning said primary flow (F), each one connected to said vacuum chamber;
- containment means (7) for containing the dust sucked

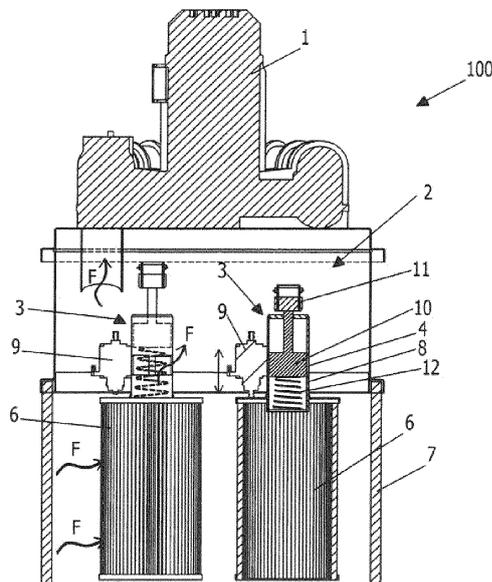
- and retained by said cartridge filters (6);
- an electrical control unit.

Said shaker cleaning device comprises:

- a plurality of connecting ducts (8) each interposed between one of said filters (6) and said vacuum chamber (2, 2a, 2b, 2c);
- valve means (3), which can be selectively activated and are adapted to reversibly close said connecting ducts (8).

Said control unit controls at least indirectly said valve means (3) and directly activates said shaker means (9), so that said shaker means (9) are active on a given filter (6) only when the corresponding connecting duct (8) is closed.

Fig. 2



**EP 2 749 193 A1**

## Description

**[0001]** The invention relates to the sector of industrial vacuum cleaners. In particular the invention concerns a multi-filter vacuum cleaner with independent shaker cleaning device for each filter.

**[0002]** One problem of industrial vacuum cleaners is that the inner filters clog rapidly, and this requires frequent interventions to remove the solid deposits from the filters and restore their efficiency as far as possible.

**[0003]** The filters are arranged between a chamber in which a vacuum is created by a suction turbine and a chamber for inlet of the dusty air and collection and accumulation of said dust once separated from the flow sucked in.

**[0004]** The filters normally comprise one or more cartridges positioned parallel to one another, each of cylindrical shape, with the lateral surface consisting of a sheet of pleated porous material, the lower base closed and the upper base having a circular opening through which the air flows, said air having been previously filtered by passing through said porous material.

**[0005]** In order to remove the solid deposits of dust from the filters, some vacuum cleaners are provided with a cleaning device, of electromechanical or pneumatic type, comprising a striking head adapted to perform a mechanical shaking action on the vacuum cleaner filters.

**[0006]** In multi-filter vacuum cleaners, each filter is always cleaned, disadvantageously, while the vacuum cleaner is operating and the filter is in use, and therefore the cloud of dust dislodged from the walls of the filter shaken by the action of the striking head is immediately re-deposited on the surface of said filter, sucked in by the suction turbine.

**[0007]** The cleaning effect is therefore annulled or in any case rendered ineffective.

**[0008]** Alternatively, the suction would have to be interrupted every time a filter is cleaned.

**[0009]** At industrial level, a solution of this kind could never be applied as it would mean continuously stopping the vacuum cleaners and compromising the productivity of the work process.

**[0010]** It is therefore necessary to provide a temporary isolation system for each filter so that mechanical cleaning can be performed, for example, by a striking head during temporary interruption of the suction.

**[0011]** The aim of the invention is therefore to provide a multi-filter vacuum cleaner with independent shaker cleaning device for each filter which has a particularly efficient mechanical cleaning effect, without affecting the general operation of the vacuum cleaner and in particular without interrupting the work thereof.

**[0012]** A further aim of the invention is to provide a cleaning device which is easy and inexpensive to produce, that can be combined with any type of vacuum cleaner, and can also be used in environments with the risk of explosion, in full compliance with the relevant safety regulations.

**[0013]** Said aims are achieved by a multi-filter vacuum cleaner with independent shaker cleaning device for each filter comprising shaker means with striking head, which can be selectively activated and are adapted to act on each filter, wherein said vacuum cleaner comprises:

- at least a suction turbine for sucking a primary flow of dusty air, associated with a vacuum chamber;
- a plurality of cartridge filters for cleaning said primary flow of dusty air, each one connected to said vacuum chamber;
- containment means for containing the dust sucked and retained by said cartridge filters;
- an electrical control unit;

characterized in that said shaker cleaning device comprises:

- a plurality of connection ducts each interposed between one of said cartridge filters and said vacuum chamber;
- valve means, which can be selectively activated and are adapted to reversibly close said connection ducts,

wherein said control unit controls at least indirectly said valve means and directly activates said shaker means, so that said shaker means are active on a given cartridge filter only when the corresponding connecting duct is closed.

**[0014]** According to a first embodiment of the invention, said connection ducts comprise a plurality of openings adapted to connect the inside of the corresponding filter to said vacuum chamber to ensure suction of the primary flow of dusty air.

**[0015]** In particular, said valve means comprise:

- a piston;
- means for actuating said piston controlled by said control unit;
- elastic return means;

wherein said piston slides in said duct controlled by said activating means against the action of elastic return means so as to cause, through the alternating movement thereof, the opening and closing of said openings.

**[0016]** Advantageously, said activating means of said piston comprise a solenoid or a pneumatic actuator.

**[0017]** Even more advantageously, said elastic return means comprise a helical spring coaxial to said duct, arranged between the base of said piston and a ring fixed to a terminal section of said duct.

**[0018]** According to a preferred embodiment of the invention, said activating means cause the movement of said piston to close said duct, while said elastic return means cause the inverse movement of said piston to open said duct.

**[0019]** According to a further embodiment of the invention, said vacuum cleaner comprises a plurality of turbines, each independently connected to a vacuum chamber.

**[0020]** In particular, between each vacuum chamber and each filter a connection duct is interposed provided with an outlet adapted to connect the inside of the corresponding filter to said vacuum chamber to ensure suction of the primary flow of dusty air by activating each turbine.

**[0021]** Furthermore, in said embodiment, said valve means comprise:

- a diaphragm,
- elastic return means,

wherein said diaphragm slides in said vacuum chamber due to the suction force of said turbine against the action of elastic return means so as to cause, by means of its alternating movement, the opening and closing of said outlet.

**[0022]** Advantageously, said elastic return means comprise a helical spring positioned in said vacuum chamber, between said diaphragm and said turbine.

**[0023]** According to a preferred embodiment of the invention, the activation of one of said turbines causes the movement of said diaphragm to open the respective duct, while said elastic return means cause the inverse movement of said diaphragm to close said duct.

**[0024]** According to a further embodiment of the invention, said shaker means comprise a striking head, electromechanically activated by a solenoid or by a cam vibrator, adapted to strike said filter to exert a mechanical vibrating action to perform effective cleaning.

**[0025]** The main advantage of the invention is given by the fact that said shaker means are active on a given cartridge filter only when the corresponding connecting duct between the filter and the turbine is closed by respective valve means, so as to isolate each individual filter during its mechanical cleaning phase with respect to the remaining filters of the vacuum cleaner which remain active, thus optimising the cleaning action.

**[0026]** The valve means described do not require any additional motor for their activation, thus making the cleaning device, and the entire vacuum cleaner, lighter, cheaper and safer, as it can also be used in environments with the risk of explosion or in combination with operating machines that can generate sparks.

**[0027]** Even more advantageously, the embodiment of the invention that provides for each filter a single suction chamber directly connected to a single turbine, prevents the shaker means from being lapped by the flow of dusty air sucked and is even cheaper as the use of several turbines in one single vacuum cleaner significantly reduces the suction power required by each of them and therefore saves on the cost of the individual turbines which, in this way, can also be much smaller.

**[0028]** The lower electrical power requirement and the

very compact overall dimensions allow the cleaning device to be easily used on a wide range of vacuum cleaner models, which can also be used on building sites with low availability of electricity, such as civil domestic building sites.

**[0029]** These and further advantages of the invention will become clearer from the more detailed description given below, with the help of the drawings which show two embodiments thereof described and illustrated purely by way of non-limiting example, where:

Figure 1 illustrates, in a partially exploded perspective view, a vacuum cleaner with independent shaker cleaning device for each filter according to the invention;

Figure 2 illustrates, in axial section according to a vertical plane and in a schematic manner, the vacuum cleaner of fig. 1 provided with a first type of cleaning device;

Figures 3 and 4 illustrate, in a transparent front view, a detail of the cleaning device of Fig. 2, during the filter operating phase and during shaking of the same respectively;

Figure 5 illustrates, in axial section according to a vertical plane and in a schematic manner, the vacuum cleaner of Fig. 1 provided with a second type of cleaning device;

Figures 6 and 7 illustrate, in a transparent front view, a detail of the cleaning device of Fig. 5 during the filter operating phase and during shaking of the same respectively.

**[0030]** With reference to the details illustrated in Figures 1 and 2, the invention concerns a vacuum cleaner 100, particularly of industrial type, provided with a first type of independent shaker cleaning device for each filter.

**[0031]** The vacuum cleaner 100 comprises essentially a suction turbine 1 of a primary flow of dusty air F, associated with a vacuum chamber 2 and activated by a control unit (not illustrated), a plurality of cartridge filters 6 to clean said primary flow of dusty air F, each connected to said vacuum chamber 2, and containment means 7 for containing the dust sucked in and retained by said filters 6.

**[0032]** Said turbine 1 is adapted to create a vacuum in said chamber 2.

**[0033]** Said containment means 7 consist essentially of a tank provided with an outlet for disposing of the dust sucked, according to prior art.

**[0034]** Said filter cleaning device essentially comprises:

- electromechanical shaker means 9 with striking head to perform a vibration effect, which can be selectively activated and are adapted to act on each filter 6,
- a plurality of connecting ducts 8 each interposed be-

tween one of said cartridge filters 6 and said vacuum chamber 2;

- valve means 3, which can be selectively activated and are adapted to reversibly close said connecting ducts 8.

**[0035]** Said shaker means 9 with striking head comprise for each filter 6, in parallel to the respective valve means 3, an electromechanical solenoid filter shaker of known type.

**[0036]** Alternatively, said filter shaker can be of the cam vibrator type or of another per se known type.

**[0037]** Said shaker means 9 are controlled by the control unit of the vacuum cleaner 100, simultaneously with the respective valve means 3, and produce a mechanical cleaning action, thanks to the rapidly alternating vertical translation movement of a striking head 17 adapted to repeatedly strike the top surface of the respective filter 6 with which they are associated, causing the vibration thereof and contributing to detachment of the dust.

**[0038]** With particular reference to figures 3 and 4, each duct 8 comprises a plurality of lateral openings 4 adapted to connect the inside of the duct 8 to said vacuum chamber 2 to ensure suction of the primary flow of dusty air F.

**[0039]** Each duct 8 is associated with said valve means 3, adapted to reversibly close said openings 4 during the mechanical cleaning phase of the corresponding cartridge filter 6.

**[0040]** Said valve means 3 comprise, for each filter 6, a piston 10, means for activating said piston 10 controlled by said control unit and elastic return means 12.

**[0041]** Said activating means comprise a solenoid 11 of known type.

**[0042]** Alternatively, said activating means comprise a pneumatic actuator provided substantially with a solenoid valve and a compressed air supply line.

**[0043]** Said piston 10 slides in said duct 8 controlled by said activating means against the action of corresponding elastic return means 12.

**[0044]** The alternating movement of said piston 10 causes selectively and reversibly the opening (Fig. 3) and closing (Fig. 4) of said openings 4.

**[0045]** The piston 10 slides with a slight play with respect to the inner surface of the duct 8, so that the alternating movement of the piston 10 can cause substantially airtight opening and closing of the openings 4.

**[0046]** Advantageously, the duct 8 is made of metal, while the piston is made of self-lubricating material, for example Teflon® or Nylon.

**[0047]** Said elastic return means 12 comprise a helical spring coaxial to said duct 8, arranged between the base of said piston 10 and a ring 13 fixed to a terminal section of said duct 8.

**[0048]** The helical spring has a frustoconical shape to self-centre and better adapt to the working conditions.

**[0049]** With reference to the details illustrated in Figure 5, the invention concerns a vacuum cleaner 100 provided

with a second type of shaker cleaning device independent for each filter.

**[0050]** In this embodiment, the vacuum cleaner 100 comprises a plurality of suction turbines, for example three, 1a, 1b, 1c, arranged according to the vertexes of an equilateral triangle, each one independently connected to its own vacuum chamber 2a, 2b, 2c.

**[0051]** In this case the turbines can be of the type with electric motor with collector.

**[0052]** In particular the figures show two cartridge filters 6, two corresponding vacuum chambers 2a, 2b connected in turn to two suction turbines 1a, 1b which can be activated by a control unit (not illustrated).

**[0053]** Between each vacuum chamber 2a, 2b and each filter 6, a connecting duct 8 is interposed provided with an outlet 5 adapted to connect the inside of the corresponding filter 6 to said vacuum chamber 2a, 2b to ensure suction of the primary flow of dusty air F by means of the activation of each turbine 1 a, 1 b.

**[0054]** With particular reference to the details of Figures 6 and 7, said valve means 3 comprise, for each filter 6, a diaphragm 14 and elastic return means 15.

**[0055]** Said diaphragm 14 slides in said vacuum chamber 2a, 2b due to the suction force of the corresponding turbine 1 a, 1 b against the action of elastic return means 15 so as to cause, also in this case, by means of its alternating movement, the opening (Fig. 6) and closing (Fig. 7) of said outlet 5.

**[0056]** Said diaphragm 14 has a circular shape and an area slightly larger than the area of the transverse section of the connecting duct 8 against which it has to abut.

**[0057]** Said diaphragm 14, on its face facing the turbine 1 a, 1b, 1c, is provided with a plurality of spacer teeth 16 adapted to define a plurality of openings for the flow of dusty air F even when the diaphragm 14 is sucked by the suction force of the turbine 1 a, 1 b and is positioned against it.

**[0058]** Said elastic return means 15 comprise a helical spring contained in said vacuum chamber 2a, 2b, arranged between said diaphragm 14 and said turbine 1 a, 1b.

**[0059]** Also in this second embodiment, said electromechanical shaker means 9 with striking head comprise for each filter 6, parallel to the respective valve means 3, an electromechanical filter shaker of known type with solenoid or cam.

**[0060]** According to the invention, during normal operation of the vacuum cleaner 100, the flow of dusty air F passes through the cartridge filters 6 and from here reaches the vacuum chamber 2, 2a, 2b, 2c from where it is emitted clean into the external environment via the turbine 1, 1 a, 1 b, 1 c.

**[0061]** During cyclic cleaning of the filters 6, the control unit is pre-set to activate the respective shaker means 9 and simultaneously ensure that the valve means 3 close the connecting duct 8 between the filter 6 to be cleaned and the vacuum chamber 2, 2a, 2b, 2c to prevent passage of the flow of dusty air F sucked, so that said shaker

means are active on a given cartridge filter 6 only when the corresponding connecting duct 8 is closed.

**[0062]** Once the filter 6 has been cleaned, the control unit ensures that the valve means 3 re-open the connecting ducts 8 and the filter 6 is re-placed in a vacuum thanks to the restored connection to the vacuum chamber 2, 2a, 2b, 2c.

**[0063]** In the variation in which the valve means comprise a piston 10 activated by a solenoid or a pneumatic actuator, the control unit acts directly to control said piston, while in the embodiment in which the valve means comprise a diaphragm 14, the control unit acts indirectly to activate said diaphragm 14 by simply commanding the operation of said suction turbines 1a, 1b, 1c.

## Claims

1. Multi-filter vacuum cleaner (100) with independent shaker cleaning device for each filter comprising shaker means (9) with striking head, which can be selectively activated and are adapted to acting on each filter, wherein said vacuum cleaner comprises:

- at least a suction turbine (1, 1a, 1b, 1c) for sucking a primary flow of dusty air (F), associated with a vacuum chamber (2, 2a, 2b, 2c);
- a plurality of cartridge filters (6) for cleaning said primary flow of dusty air (F), each one connected to said vacuum chamber (2, 2a, 2b, 2c);
- containment means (7) for containing the dust sucked and retained by said cartridge filters (6);
- an electrical control unit;

**characterized in that** said shaker cleaning device comprises:

- a plurality of connecting ducts (8) each interposed between one of said cartridge filters (6) and said vacuum chamber (2, 2a, 2b, 2c);
- valve means (3), which can be selectively activated and are adapted to reversibly close said connecting ducts (8),

wherein said control unit controls at least indirectly said valve means (3) and directly activates said shaker means (9), so that said shaker means (9) are active on a given cartridge filter (6) only when the corresponding connecting duct (8) is closed.

2. Multi-filter vacuum cleaner (100) according to claim 1, **characterized in that** said connecting ducts (8) comprise a plurality of openings (4) adapted to connect the inside of the corresponding filter (6) to said vacuum chamber (2) to ensure suction of the primary flow of dusty air (F).

3. Multi-filter vacuum cleaner (100) according to claims 1 and 2, **characterized in that** said valve means (3) comprise:

- a piston (10),
- means for activating of said piston (10) controlled by said control unit;
- elastic return means (12);

wherein said piston (10) slides in said duct (8) controlled by said activating means against the action of elastic return means (12), so as to cause, through the alternating movement thereof, the opening and closing of said openings (4).

4. Multi-filter vacuum cleaner (100) according to claim 3, **characterized in that** said activating means of said piston (10) comprise a solenoid (11) or a pneumatic actuator.

5. Multi-filter vacuum cleaner (100) according to claim 3, **characterized in that** said elastic return means (12) comprise a helical spring coaxial to said duct (8), arranged between the base of said piston (10) and a ring (13) fixed to a terminal section of said duct (8).

6. Multi-filter vacuum cleaner (100) according to claim 3, **characterized in that** said activating means cause the movement of said piston (10) to close said duct (8), while said elastic return means (12) cause the inverse movement of said piston (10) to open said duct (8).

7. Multi-filter vacuum cleaner (100) according to claim 1, **characterized in that** it comprises a plurality of turbines (1a, 1b, 1c), each independently connected to a vacuum chamber (2a, 2b, 2c).

8. Multi-filter vacuum cleaner (100) according to claim 7, **characterized in that** between each vacuum chamber (2a, 2b, 2c) and each filter (6) a connecting duct (8) is interposed provided with an outlet (5) adapted to connect the inside of the corresponding filter (6) to said vacuum chamber (2a, 2b, 2c) to ensure suction of the primary flow of dusty air (F) by activating each turbine (1a, 1b, 1c).

9. Multi-filter vacuum cleaner (100) according to claims 1, 7 and 8, **characterized in that** said valve means (3) comprise:

- a diaphragm (14),
- elastic return means (15),

wherein said diaphragm (14) slides in said vacuum chamber (2a, 2b, 2c) due to the suction force of said turbine (1a, 1b, 1c) against the action of elastic return

means (15), so as to cause, by means of its alternating movement, the opening and closing of said outlet (5).

10. Multi-filter vacuum cleaner (100) according to claim 9, **characterized in that** said elastic return means (15) comprise a helical spring positioned in said vacuum chamber (2a, 2b, 2c), between said diaphragm (14) and said turbine (1a, 1 b, 1c). 5
11. Multi-filter vacuum cleaner (100) according to claim 9, **characterized in that** the activation of one of said turbines (1a, 1b, 1c) causes the movement of said diaphragm (14) to open the respective duct (8), while said elastic return means (15) cause the inverse movement of said diaphragm (14) to close said duct. 10 15
12. Multi-filter vacuum cleaner (100) according to claim 1, **characterized in that** said shaker means (9) comprise a striking head (17), electromechanically activated by a solenoid or by a cam vibrator, adapted to strike said filter (6) to exert a mechanical vibrating action to perform effective cleaning. 20

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Fig. 1

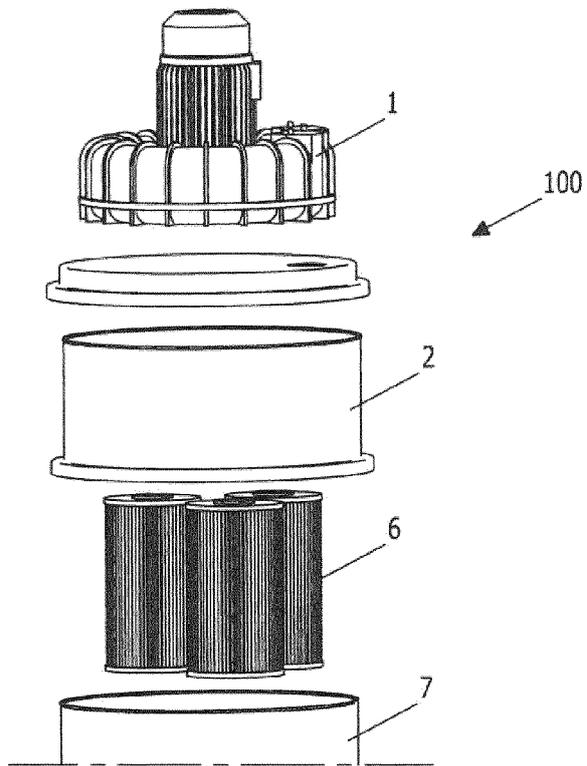


Fig. 2

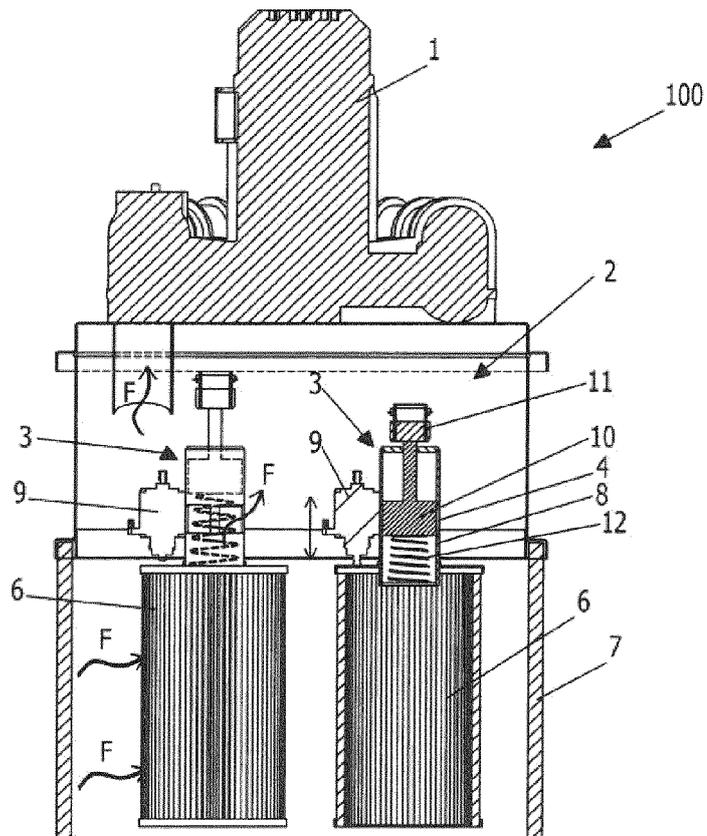


Fig. 3

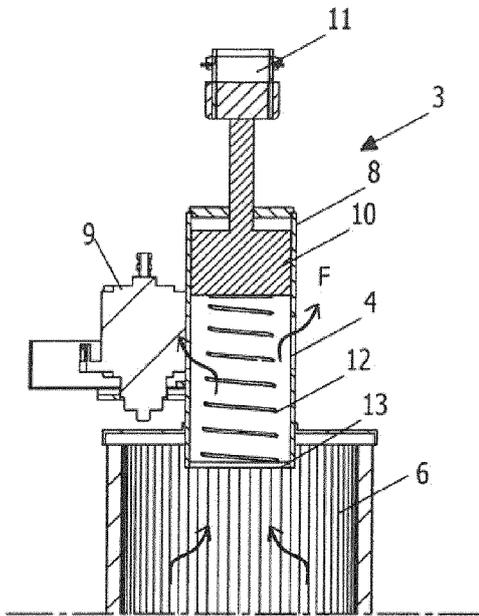


Fig. 4

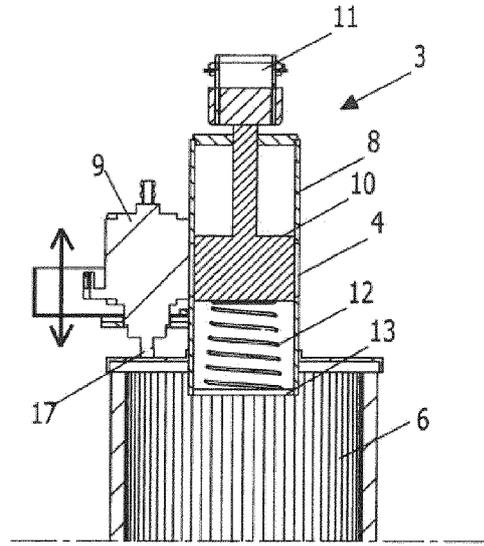


Fig. 5

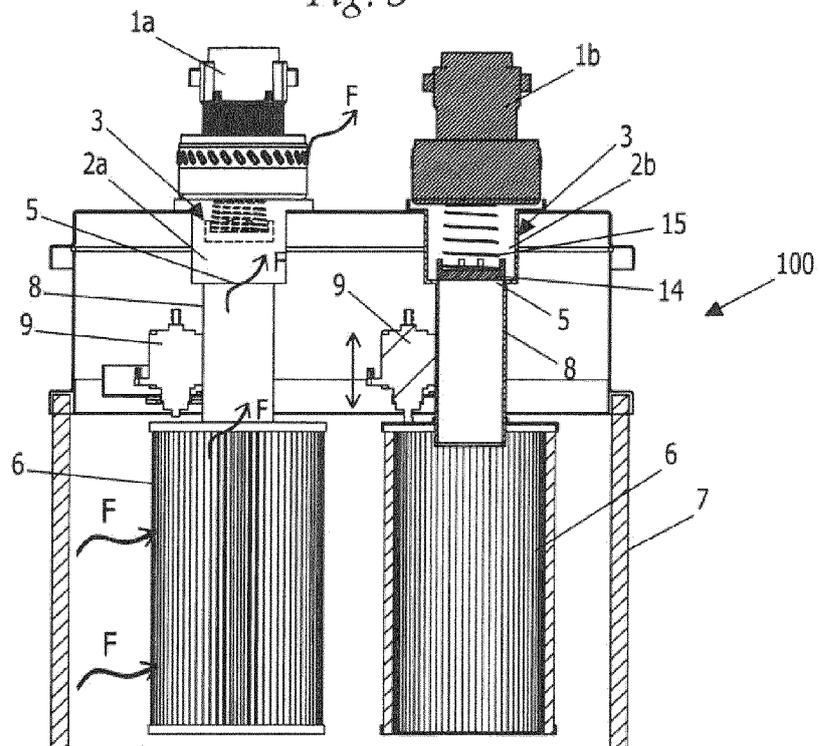


Fig. 6

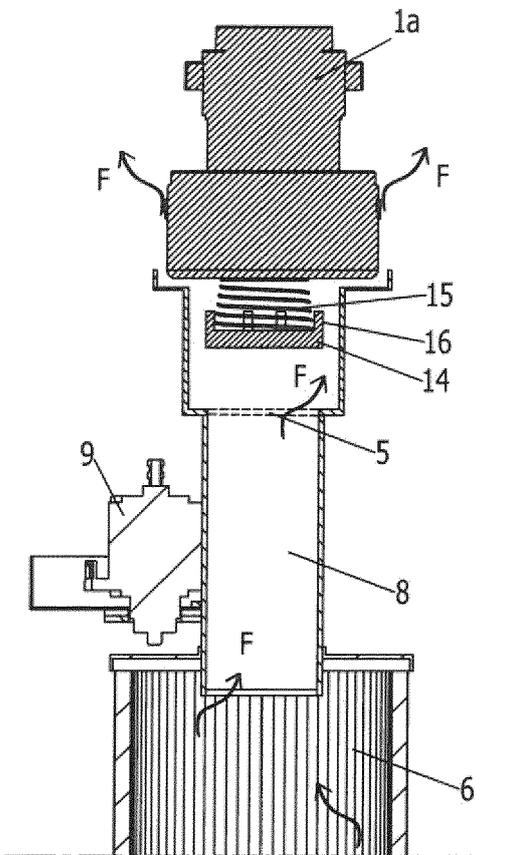
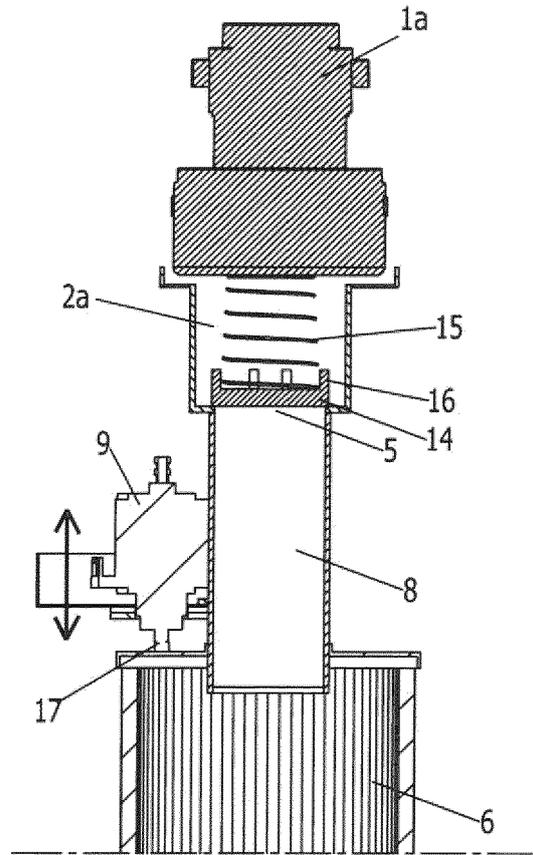


Fig. 7





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EP 13 19 9322

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EP 13 19 9322

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