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(54) **HOOVER AND METHOD FOR CLEANING A PLURALITY OF FILTER ELEMENTS**

(57) A hoover 1 comprises two or more suction units 3 each configured to generate a vacuum and suck an airflow from an environment; two or more filter elements 4, each of which is operatively associated with a corresponding suction unit 3 and is configured to retain dust particles on a retention surface 40 thereof; an electronic control unit connected to said suction units 3 for cyclically and selectively reducing or eliminating said vacuum on each suction unit 3; a support structure 5 configured to support said filter elements 4; vibrating means 6 selectively activatable by said control unit and mechanically connected to said support structure 5 to vibrate said support structure 5 so as to simultaneously shake said filter elements 4 to implement a detachment of the dust particles from the retention surface 40 of the filter element associated with the suction unit 3 for which the vacuum is reduced or eliminated.

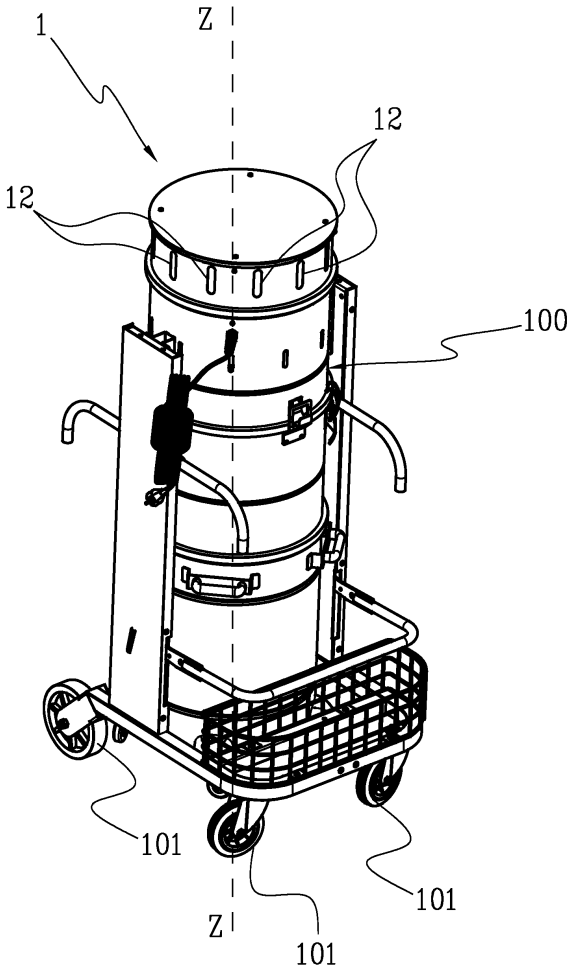

Fig.1

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Description

Technical field

[0001] The present invention concerns a hoover and a method for cleaning a plurality of filter elements.

[0002] The invention finds particular and advantageous use in the field of cleaning environments of various type, such as commercial establishments (e.g., offices, shops and the like), production plants (e.g., machine shops, industrial warehouses and the like) and more generally environments intended for non-residential use.

Prior art

[0003] The use of hoovers for cleaning industrial environments is known in the technical field of reference.

[0004] The known hoovers typically comprise at least one filter for retaining dust, dirt, particles and generally materials with different granulometry characteristics (e.g., shape and size).

[0005] In general, such machines are commonly equipped with a plurality of filters and impellers driven by corresponding electric motors, and are therefore commonly referred to as "multi-filter" (or "pluri-filter") and/or "multi-motor" in the technical jargon of the field.

[0006] In more detail, hoovers are known which are provided with various filter-motor (and related impeller) configurations; for example, there are machines commonly referred to as multi-motor and multi-filter machines, in which a filter is associated with a related motor.

[0007] In order to clean an environment, in particular an industrial environment, it is essential to prevent dust/particles from escaping from the hoover and returning to the environment, e.g., by means of an airflow out of the machine, i.e., having a direction which goes from the inside towards the outside of the machine itself.

[0008] Therefore, during the use of a hoover, the sucked dust/dirt particles are deposited on the surfaces of the aforesaid filters, and accumulate over time during the operating hours of the machine itself.

[0009] This causes, in particular after a certain amount of time varying from a few minutes up to an hour of operation of the hoover, an excessive accumulation of dust, causing an obstruction/occlusion of the aforesaid filters, with consequent loss of filtering capacity by the filters themselves.

[0010] To date, several devices, in particular of pneumatic and electromechanical type, are known for cleaning filters. For example, such known devices comprise striking heads configured to exert an impulsive mechanical action against the machine's filters in order to produce an impact such as to detach dust/dirt particles from the filters.

[0011] In more detail, such striking heads are electromechanically driven and have a striking mass adapted to impact against the filters in order to exert an impulsive mechanical action capable of removing the dust covering the surface of the filters.

[0012] An example of a hoover of known type with a striking head cleaning device is described in European Patent EP2749193. The device illustrated in such a document envisages that each filter is fitted with an independent striking head. In other words, in accordance with EP2749193, each filter is associated with a striking head thereof, whereby the number of striking heads is equal to the number of filters.

[0013] The hoovers of known type such as those briefly described have in practice proved to include drawbacks.

[0014] The main drawback is that the hoovers of known type are not very durable over time. Indeed, a striking head exerts considerable mechanical stresses. Such mechanical stresses, or blows, can damage the filter, impairing the functionality thereof.

[0015] A further drawback is that the hoovers of known type are expensive and complex. In fact, such machines are provided with a number of striking head cleaning devices equal to the number of filters mounted on the machines themselves. Furthermore, each striking head device comprises numerous components, such as valves, solenoid valves, magnets, solenoids and dedicated piping/ducts. This translates into a high number of components, which leads to high assembly times by an operator and thus high costs of the final hoover.

Objects of the invention

[0016] The technical task of the present invention is to propose a hoover which allows to overcome, at least in part, the above-mentioned drawbacks of the prior art.

[0017] In particular, an object of the invention is to provide a hoover which allows the filters, mounted on the machine itself, to be cleaned continuously, i.e., without interrupting the operation of the hoover.

[0018] A further object of the invention is to provide a hoover which allows the filters to be cleaned easily and thoroughly at the same time.

[0019] Another object of the invention is to provide a hoover which allows to clean the filters, mounted on the machine itself, fully automatically, i.e., without the need for human intervention.

[0020] A further object of the invention is to provide a hoover which allows to obtain a long service life of the filters mounted on the machine itself before they must be replaced.

[0021] Another object of the invention is to provide a hoover which is compact.

[0022] A further object of the present invention is to provide a hoover which is mechanically sturdy.

[0023] A further object of the present invention is to provide a hoover which is functionally and structurally safe and reliable.

[0024] A further object of the present invention is to provide a hoover which can be used in any type of environment, in particular any industrial environment.

[0025] All of these objects, either singly or in any com-

bination thereof, and others which will result from the following description are achieved, according to the invention, by a hoover and a method for cleaning a plurality of filter elements in accordance with the appended claims.

Brief description of the drawings

[0026] The present invention is hereinafter described in some of the preferred embodiments thereof, given for purely exemplary and non-limiting purposes with reference to the accompanying drawings, in which:

- figure 1 illustrates a perspective view of a hoover according to an embodiment of the present invention;
- figure 2 illustrates, according to a view from above, the hoover illustrated in figure 1;
- figures 3A and 3B illustrate, according to two longitudinal sectional views, the hoover illustrated in figure 1;
- figure 4 illustrates, according to a perspective view, the hoover illustrated in figure 1 with some parts removed to better highlight others thereof;
- figure 5 illustrates, according to a perspective view, an enlarged detail of the hoover illustrated in figure 4.
- figure 6 illustrates, according to a further longitudinal sectional view, the hoover illustrated in figure 1.

[0027] With reference to the figures, they serve solely to illustrate embodiments of the invention with the aim of better clarifying, in combination with the description, the inventive principles on which the invention is based.

Detailed description of the invention

[0028] With reference to the accompanying figures, a hoover for cleaning environments, in particular industrial environments, according to the present invention has been indicated overall with the number 1.

[0029] The invention is intended to be advantageously used in the field of the production and marketing of hoovers, in particular used for industrial environments. For example, the hoover 1 is advantageously usable in production plants, such as machine shops, assembly lines and the like, where work is carried out with the generation of dust and particles, as well as in plants where fine dust, such as cement, is treated, or in material removal processes with chip formation.

[0030] In the following, reference will be made in a non-limiting manner to a hoover provided with at least two filters mechanically associated with corresponding impellers each driven by a respective motor, e.g., an electric motor. As mentioned above, such a machine is called a multi-motor, multi-filter machine.

[0031] In addition, the connection between filter, impeller and motor is commonly referred to as the "suction unit or module" in industry jargon. In the following detailed description, reference will be made to a hoover with multiple suction units.

[0032] Furthermore, the term "dust" shall be understood in the present description to mean an agglomeration of solid particles having varying granulometry and size.

[0033] In addition, examples of solid particles present in industrial environments can be metal shavings, wood sawdust, cement dust and the like.

[0034] In accordance with an aspect of the invention, the hoover 1 comprises a containment frame 100, mainly extending along a longitudinal axis Z, preferably substantially orthogonal to the ground (i.e., substantially vertical). In accordance with an embodiment, the containment frame 100 defines a substantially cylindrical shape along the longitudinal axis Z, and is configured to house functional groups of the hoover 1, introduced and described in more detail below.

[0035] Advantageously, such a substantially cylindrical shape with vertical extension allows a quick and easy assembly, as well as giving the hoover 1 a compact and space-saving shape.

[0036] In more detail, the containment frame 100 further comprises an inlet mouth 11 configured to allow the connection, in particularly fluidic and mechanical, with at least one duct, e.g., a flexible duct.

[0037] Advantageously, an operator manually moves such a flexible duct to direct it at an area of the environment to be vacuumed, quickly and easily.

[0038] Advantageously, such a flexible duct allows access to hard-to-reach areas of the environment, such as edges and the like.

[0039] Preferably, the hoover 1 further comprises an interchangeable tool (not illustrated in the accompanying figures) configured to mechanically connect at one end of the flexible duct as a function of the type of surface of the environment to be cleaned.

[0040] Alternatively, the flexible duct can be partially constrained to a fixed station, e.g., to a work surface of a workshop or production line.

[0041] The hoover 1 further comprises at least one outlet mouth 12 configured to evacuate/discharge into the environment the airflow sucked in through the inlet mouth 11 and filtered by a plurality of filter elements 4 (introduced and described below in the description).

[0042] Preferably, there are several outlet mouths 12 made on the containment frame 100 and preferably arranged equally spaced around the longitudinal axis Y.

[0043] Advantageously, the containment frame 100 can be made of metal material, in particular steel or the like, to give the hoover 1 strength and rigidity during use.

[0044] In accordance with an aspect of the invention, the hoover 1 can comprise movement means, in particular wheels 101 or castors or the like, mechanically connected to the containment frame 100 and configured to be rested on the ground to allow a movement of the hoover 1 in an environment to be cleaned by an operator. If the hoover is intended for a fixed station, the movement

means can be eliminated and/or replaced by support feet constrained to the containment frame 100.

[0045] The hoover 1 comprises two or more suction units 3 configured to suck an airflow from an environment.

[0046] In more detail, each suction unit 3 comprises a motor 31, in particular an electric motor, such as an asynchronous or a permanent magnet type motor (e.g., brushless), and an impeller, or a fan or propeller or the like (not illustrated in the accompanying figures) mechanically connected to the motor 31 and configured to be rotated by the motor 31 itself to generate a vacuum such as to impose an airflow from the inlet mouth 11 to the outlet mouth 12.

[0047] In accordance with the figures, the hoover 1 comprises two filter elements 4 operatively associated with corresponding suction units 3.

[0048] That is, each filter element 4 is fluid-dynamically connected by piping (not illustrated) to a corresponding impeller, and thus to a motor 31. Thereby, the hoover according to the present invention defines a 1-to-1 correspondence between each filter element 4 and each suction unit 3. That is, each filter element is connected to an impeller and to the relative motor 31.

[0049] Advantageously, the hoover is both compact and efficient in terms of suction and in terms of cleaning the filters.

[0050] In accordance with the present invention, the term "filter element" means both a filter element made by means of a single filter (e.g., a cartridge filter), and a filter element made by means of multiple filter components (e.g., a plurality of cartridge filters) cooperating with each other to define a single filter element. Advantageously, the cartridge filters are simple, inexpensive and readily available on the market for a quick replacement thereof.

[0051] Preferably, the filter elements 4 and suction units 3 extend along a substantially longitudinal axis, in particular substantially parallel to the longitudinal axis Z.

[0052] In accordance with an aspect of the invention, the filter elements 4 are arranged in a substantially annular manner on a support structure 5, in particular on a plate 50 (introduced and described in more detail below), around a longitudinal axis Y.

[0053] In accordance with an aspect of the invention, the support structure 5 is operatively associated with the suction units 3 and configured to support the plurality of filter elements 4. In more detail, the support structure 5 is arranged hanging below the suction units 3.

[0054] In accordance with another aspect of the invention, the plate 50 has a substantially planar shape and is preferably counter-shaped to a transverse section of the containment frame 100.

[0055] Preferably, the plate 50 is made of metal material, e.g., steel or the like, to give the plate 50 itself strength and rigidity.

[0056] The hoover 1 comprises selectively activatable vibrating means 6 mechanically connected to the support structure 5 (i.e., to the plate 50 according to the embodiment illustrated) to vibrate it so as to simultaneously shake the plurality of filter elements 4 to implement a detachment of the dust particles from the retention surface 40.

[0057] In particular, to obtain an effective detachment of dust particles from the retention surface 40, vacuums inside the plurality of filter elements 4 must be reduced, and preferably avoided.

[0058] In accordance with the illustrated embodiment, i.e., two filters 4 and two suction units 3, this is achieved by interrupting/reducing (and subsequently switching on, e.g., at predetermined time intervals) the operation of one suction unit 3, while keeping the other suction unit 3 operating. Thereby, the suction capacity of the suction unit 3 corresponding to the filter to be cleaned is eliminated. In addition, at the same time as the aforesaid interruption/reduction of operation of the selected suction unit 3, a control unit activates the vibrating means 6 to shake the filters 4.

[0059] That is, to obtain an effective cleaning it is important to eliminate/reduce the vacuum inside the filters 4, and this is achieved by cyclically switching off or reducing the power of one of the motors 31 of the plurality of suction units 3, and simultaneously activating the vibrating means 6 so as to shake the filters and thus enable an effective detachment of dust particles. More specifically, the filters 4 not associated with the suction unit 3 for which the vacuum is reduced/eliminated are not affected by an effective cleaning of their retention surface 40. Therefore, such a cleaning will be activated at a later stage, at which point the electronic control unit will selectively and cyclically interrupt the operation of the corresponding motor 31 associated with the desired filter 4, or reduce the operating power of the aforesaid motor.

[0060] Advantageously, as a function of the type of environment to be cleaned, such a cyclic selection of suction units 3 to be switched off (or for which the operating power is reduced) associated with corresponding filters 4 to be cleaned allows the hoover 1 to operate continuously, thus avoiding interruptions in operation which lower the overall efficiency thereof. Thereby, the filters 4 maintain a longer service life relative to those fitted on standard hoovers, resulting in fewer, if any minimal, maintenance interventions by an operator.

[0061] In this regard, and in accordance with an aspect of the invention, the hoover 1 comprises an electronic control unit (not illustrated in the accompanying figures) configured to activate and deactivate the vibrating means 6 at preset time intervals. The electronic control unit can be connected by means of physical wiring, integrated circuits and/or wirelessly (e.g., via Bluetooth®) to the vibrating means 6. In more detail, the electronic control unit is configured to selectively deactivate each motor 31, e.g., in turn, associated with a corresponding filter element 4 to be cleaned. Thereby, the motor 31 which is deactivated does not generate any vacuum inside the corresponding filter element 4 to which it is connected. Alternatively, the electronic control unit can reduce the

operating power of the motor instead of shutting it off.

[0062] Subsequently, the electronic control unit drives the movement of the motor-vibrator 61 to shake the aforesaid filter element 4 associated with the deactivated/reduced suction unit and thus generate a detachment of dust from the filtering surface 40. The filter elements 4 not affected by the deactivation/reduction of the corresponding motor 31, i.e., with active motor 31, are shaken by the motor-vibrator 61 but do not undergo an effective detachment of the dust deposited on their filtering surface 40.

[0063] That is, the detachment of dust only occurs at the filter element 4 associated with the motor 31 which is deactivated by the electronic control unit. The remaining filter elements 4, although shaken by the motor-vibrator 61 do not undergo cleaning.

[0064] For example, an operator can set a desired time interval and after such a time interval has elapsed, the electronic control unit deactivates/reduces the operation of the selected motor and drives the motor-vibrator 61 to simultaneously shake the plurality of filter elements 4.

[0065] In accordance with a further aspect of the invention, the electronic control unit can be configured to control the electric motors of the suction units 3, for example to vary the power thereof and/or control the switching on and off thereof.

[0066] In more detail, according to an aspect of the invention illustrated in the appended figures, the vibrating means 6 is directly connected to the support structure 5, in particular by means of threaded connecting means, such as screws or rivets or the like.

[0067] As illustrated in the accompanying figures, the plurality of filter elements 4 is preferably mounted opposite the vibrating means 6 relative to the support structure 5. More specifically, the support structure 5 is arranged counter-faced to a base 30 for the suction units 3 so as to define a housing volume V for receiving the vibrating means 6. Preferably, the base 30 is substantially the same as the plate 50.

[0068] In more detail, the vibrating means 6 comprises a vibrator, in particular an electric motor-vibrator 61, configured to be housed inside the housing volume defined by the support structure 5 and by the base 30, in particular to rest on the support structure 5 (in the illustrated example it rests on the plate 50).

[0069] According to a further aspect, the hoover 1 comprises connecting means 7 configured to distally connect the support structure 5 to the suction units 3 to allow a vibration of the support structure 5 relative to the suction units 3. In accordance with the illustrated embodiment, the connecting means 7 mechanically connects the plate 50 to the base 30 of the suction units 3.

[0070] In more detail, the connecting means 7 preferably comprises a rigid element 7a and a deformable element 7b. The rigid element 7a and the deformable element 7b are mechanically connected to each other to allow an oscillating connection of the support structure 5 relative to the suction units 3. Preferably, the connecting means 7 is arranged at respective edge portions of the support structure 5, preferably in an annular manner around said longitudinal axis Y along which the filter elements 4 and the suction units 3 extend.

[0071] In more detail, the connecting means 7 is arranged substantially at peripheral portions of the base 30 and are preferably arranged equally spaced around the longitudinal axis Y.

[0072] Preferably, the deformable element 7b is a damper, commonly referred to with the term "puffer" in the technical jargon of the field, and the rigid element 7a is preferably shaped so as to define a substantially C-shape. Preferably, the rigid element 7a is made of metal material, in particular steel or the like.

[0073] Advantageously, the rigid element 7a enables the fixing of the support structure 5 to the deformable element 7b, quickly and easily.

[0074] Alternatively to a combination of rigid element 7a and "puffer" 7b, and in accordance with an embodiment not illustrated in the accompanying figures, the connecting means 7 can also be made by means of a single rigid element configured to directly connect the support structure 5 (in particular, the plate 50) to the base 30. In this case, the rigid element is made of an elastic material with a yield strength of at least 1150 MPa and tensile strength comprised between 1300-1500 MPa, to allow a relative movement between the base 30 and the support structure 5 during a vibration of the latter. For example, the rigid element can be made of steel, particularly spring steel, such as harmonic steel.

[0075] Preferably, the hoover 1 further comprises a container 8 for collecting dust particles and a hopper 9 configured to convey dust particles which separate from the filter elements 4 following the shaking carried out by the vibrating means 6.

[0076] In accordance with the embodiment illustrated, the container 8 has a substantially cylindrical shape and is mechanically connected to the containment frame 100.

[0077] Preferably, the container 8 is arranged in a lower position relative to the filter elements 4, so as to receive the dust particles falling by gravity from the filter elements 4 themselves.

[0078] According to an embodiment, the hopper 9 extends along an axis substantially parallel to the longitudinal axis Z of the frame 100 and is arranged in an intermediate position between the container 8 and the plurality of filter elements 4.

[0079] According to a further embodiment, the container 8 is connected to the frame 100 by means of clamps so as to be hookable/unhookable to/from the frame itself. In particular, the container 8 can also have a hooking device, for example a hook 15, configured to engage a corresponding seat present on a lower part of the frame 100, for example a slotted body 16 or another hook complementary thereto. Thereby, the container can be kept in a suspended condition relative to the ground, facilitating maintenance and/or inspection activities by an operator.

[0080] According to an aspect of the invention not illustrated in the appended figures, the filter elements 4 and the vibrating means 6 are directly connected to the support structure 5, i.e., without the interposition of connecting means 7. Advantageously, the hoover 1 is very compact.

[0081] It is further an object of the present invention a method for cleaning a plurality of filter elements 4 of a hoover 1, i.e., for detaching dust particles from a retention surface 40 of said plurality of filter elements 4, of which the same numerical references will be retained for the sake of descriptive simplicity.

[0082] The method in question comprises the step of cyclically and selectively reducing or eliminating on each suction unit 3 the vacuum generated to suck an airflow from an environment.

[0083] The method in question further comprises the step of simultaneously shaking all the filter elements 4 to implement a detachment of said dust particles from said retention surface 40.

[0084] In accordance with a further aspect, the method comprises the preliminary step of mounting said plurality of filter elements on a support structure 5, and further the sub-step of vibrating said support structure 5 to simultaneously shake said filter elements 4.

[0085] Preferably, the step of shaking the filter elements 4 is implemented according to predetermined time intervals.

[0086] It is clear from what has been said that the hoover, according to the invention, is particularly advantageous in that it allows the filters to be cleaned in a continuous cycle, i.e., without the need to switch off the machine and thus keeping the suction function active.

[0087] Furthermore, the hoover according to the invention is reliable and preserves the life of the filters.

[0088] Advantageously, the hoover according to the invention is compact and simple to construct.

Claims

1. A hoover (1), comprising:

- two or more suction units (3) each configured to generate a vacuum and suck an airflow from an environment;
- two or more filter elements (4), each of which is operatively associated with a corresponding suction unit (3) and is configured to retain dust particles on a retention surface (40) thereof;
- an electronic control unit connected to said suction units (3) for cyclically and selectively reducing or eliminating said vacuum on each suction unit (3);
- a support structure (5) configured to support said filter elements (4);
- vibrating means (6) selectively activatable by said control unit and mechanically connected to said support structure (5) to vibrate said support structure (5) so as to simultaneously shake said filter elements (4) to implement a detachment of the dust particles from the retention surface (40) of the filter element associated with the suction unit (3) for which the vacuum is selectively and cyclically reduced or eliminated.

2. The hoover (1) according to claim 1, comprising connecting means (7) configured to distally connect said support structure (5) to said suction units (3) to allow a vibration of said support structure (5) relative to said suction units (3).

3. The hoover (1) according to claims 1 or 2, wherein said support structure (5) is arranged hanging below said suction units (3).

4. The hoover (1) according to one or more of the preceding claims, wherein said support structure (5) is arranged counter-faced to a base (30) of said suction units (3) so as to define a housing volume (V) for receiving said vibrating means (6).

5. The hoover (1) according to one or more of the preceding claims, wherein said filter elements (4) are of the cartridge type.

6. The hoover (1) according to one or more of the preceding claims, wherein said vibrating means (6) is directly connected to said support structure (5).

7. The hoover (1) according to one or more of the preceding claims, wherein said filter elements (4) and said suction units (3) extend along a substantially longitudinal axis (Y).

8. The hoover (1) according to one or more of the preceding claims, wherein said filter elements (4) and said suction units (3) are arranged substantially annularly around said longitudinal axis (Y).

9. The hoover (1) according to one or more of the preceding claims, wherein said filter elements (4) are mounted opposite said vibrating means (6) relative to said support structure (5).

10. The hoover (1) according to one or more of the preceding claims, wherein said connecting means (7) comprises a rigid element (7a) and a deformable element (7b) mechanically connected to each other to allow an oscillating connection of said support structure (5) relative to said suction units (3).

11. The hoover (1) according to one or more of the preceding claims, further comprising:

- a container (8) for collecting said dust particles

and;
- a hopper (9) arranged between said filter elements (4) and said container (8) and configured to convey the dust particles falling from the filter elements (4).

12. The hoover (1) according to one or more of the preceding claims, **characterised in that** said rigid element (7a) of said connecting means (7) is shaped so as to substantially define a C shape.

13. The hoover (1) according to any one of claims 2 to 12, wherein said connecting means (7) is arranged at respective edge portions of said support structure (5), preferably in an annular manner around said longitudinal axis (Y) along which the filter elements (4) and the suction units (3) extend.

14. The hoover (1) according to one or more of claims 2 to 13, wherein said filter elements and said suction units (7) are arranged substantially annularly around said longitudinal axis (Y).

15. The hoover (1) according to claim 1, wherein said two or more suction units (3) are connected to said support structure (5).

16. A method for cleaning a plurality of filter elements (4) in a hoover (1), wherein said hoover (1) comprises two or more suction units (3) and two or more filter elements (4) each of which is operatively associated with a corresponding suction unit (3) and is configured to retain dust particles on a retention surface (40) thereof, said method comprising the steps of:

- cyclically and selectively reducing or eliminating on each suction unit (3) the vacuum generated to suck an airflow from an environment;
- simultaneously shaking the filter elements (4) to implement a detachment of the dust particles from the retention surface (40) of the filter at the suction unit (3) for which the vacuum has been selectively reduced or eliminated.

17. The method according to claim 17, comprising the preliminary step of mounting the filter elements (4) on a support structure, and wherein the step of simultaneously shaking the filter elements comprises the sub-step of vibrating said support structure.

18. The method according to claim 16 or 17, wherein the step of shaking the filter elements (4) is implemented according to predetermined time intervals.

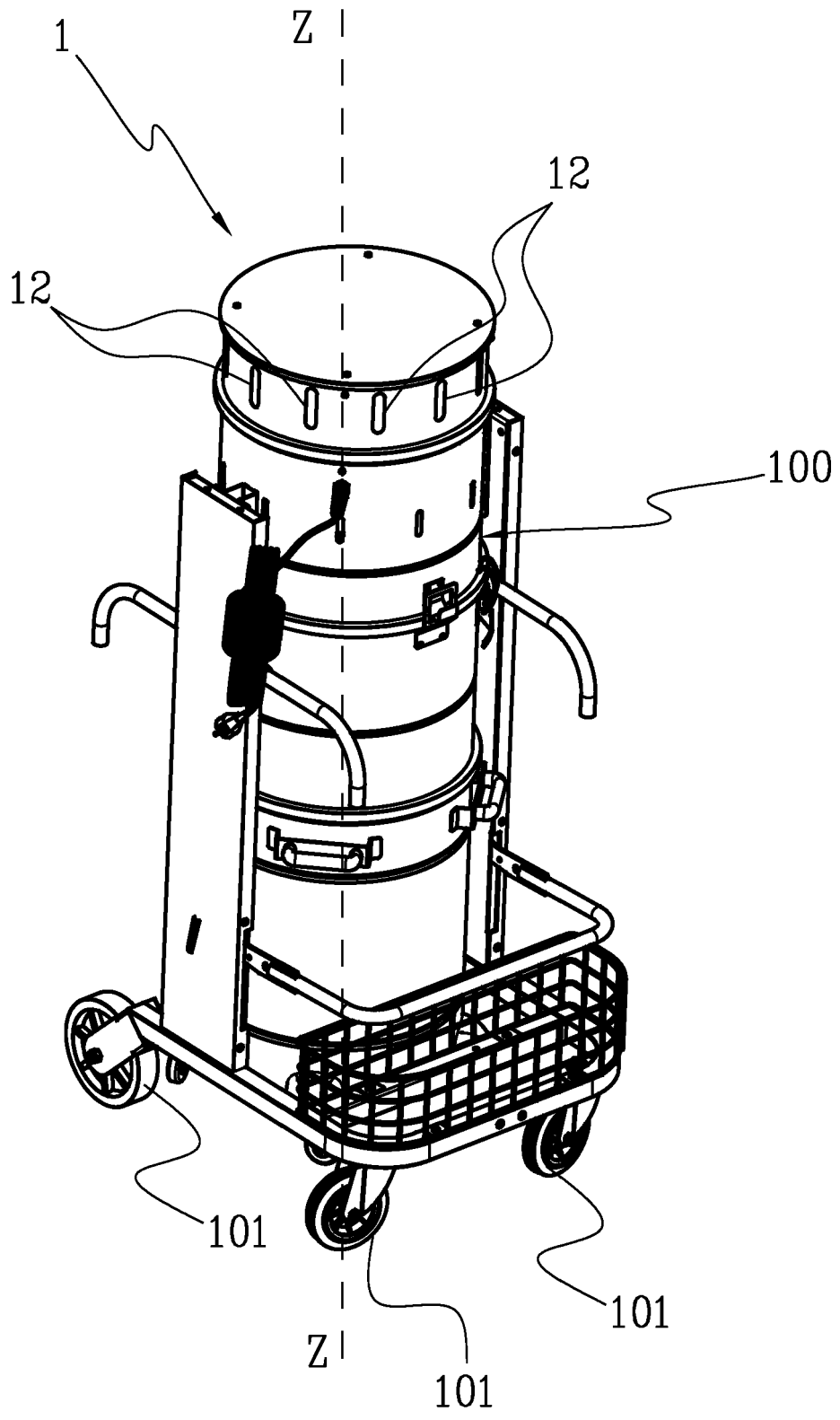

Fig.1

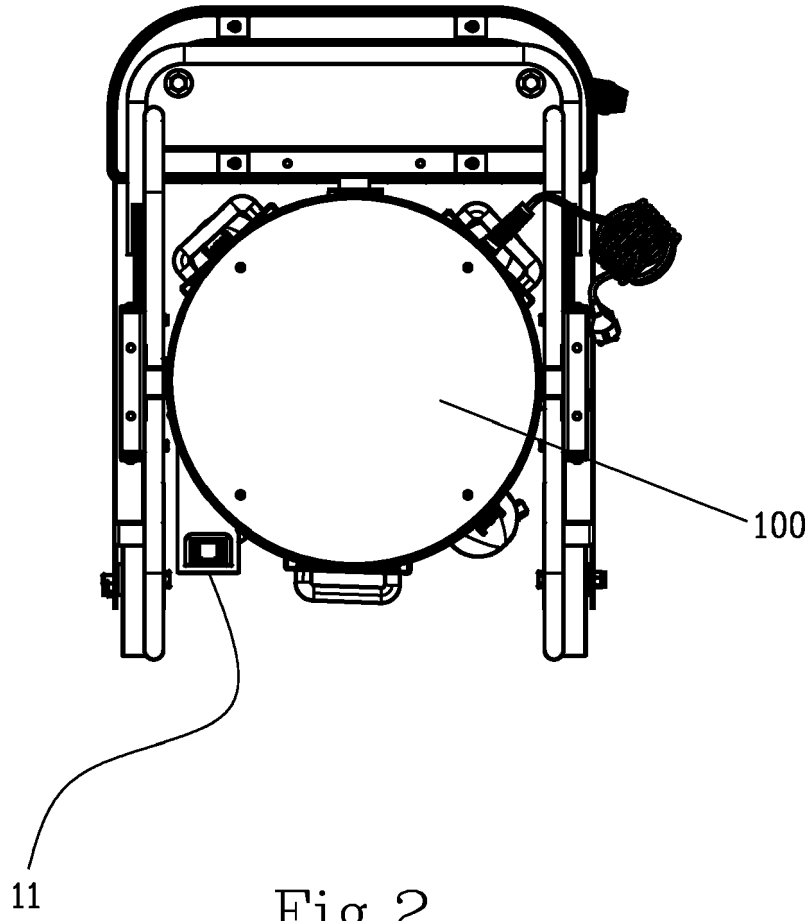

Fig.2

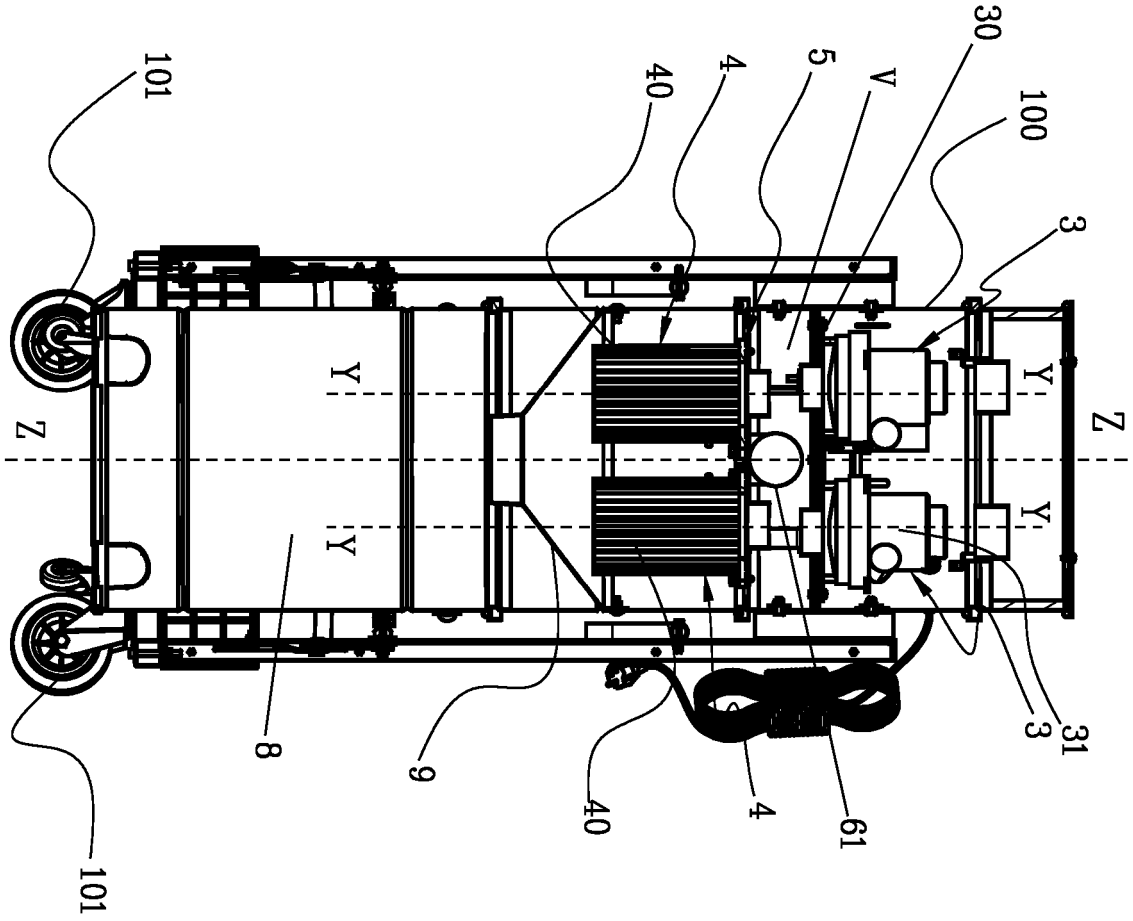
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Fig.3A

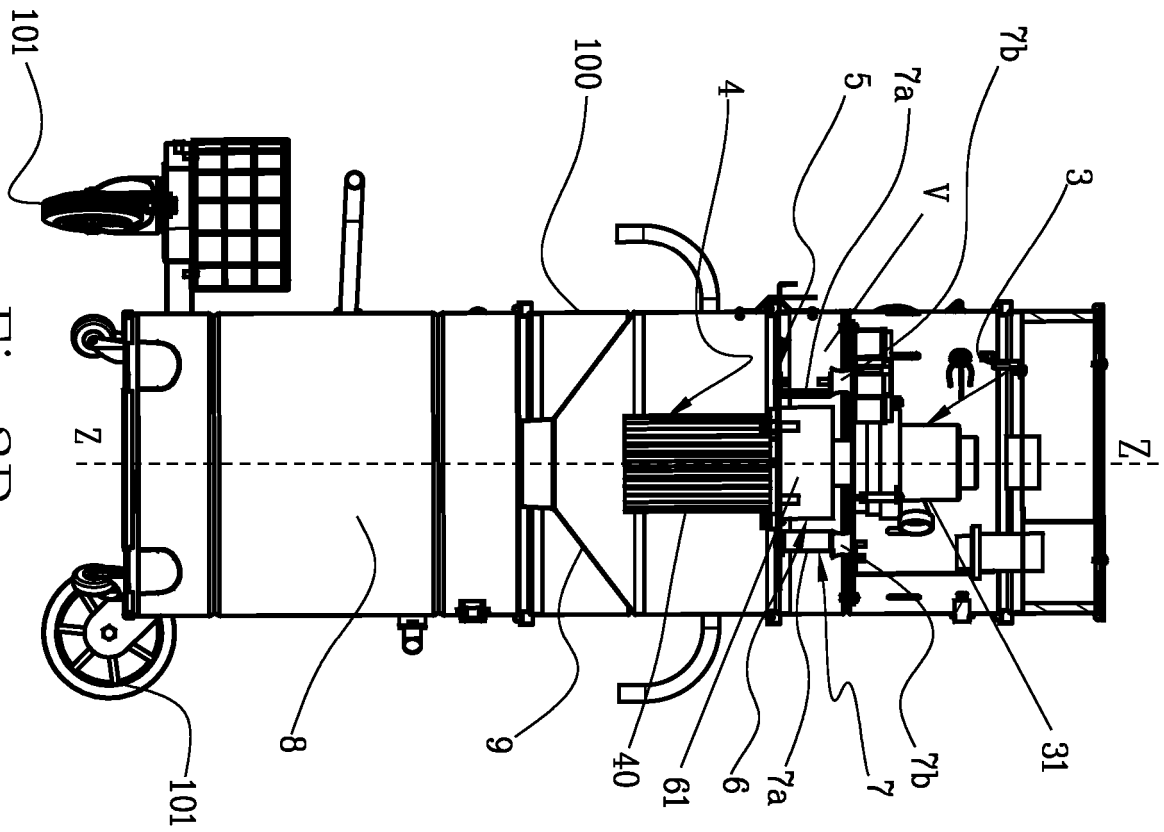
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Fig.3B

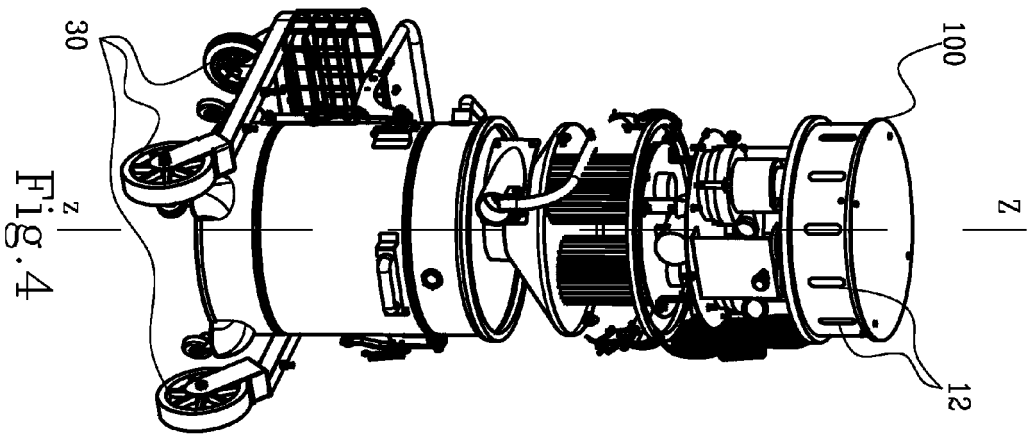

Fig.4

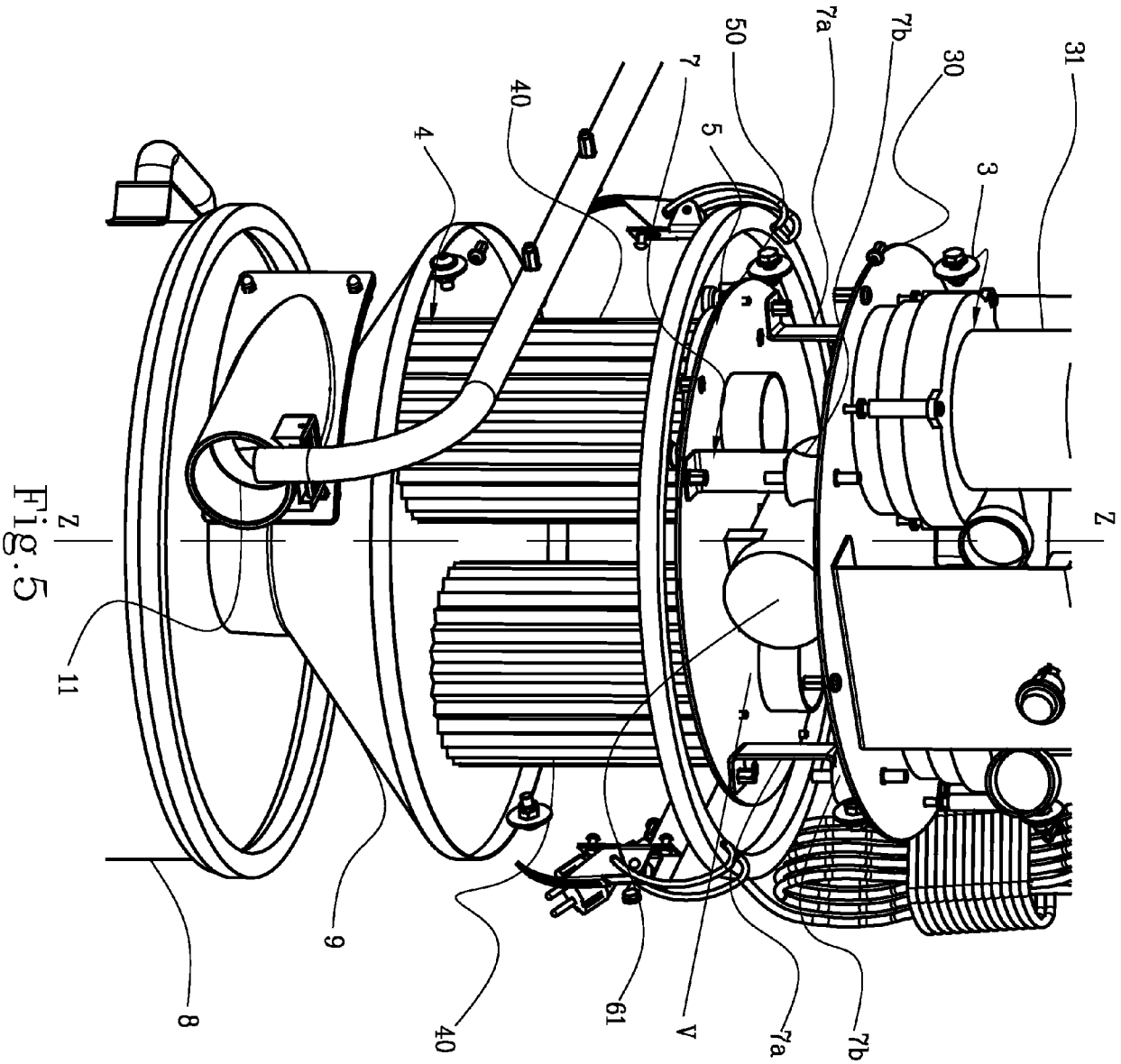

Fig.5

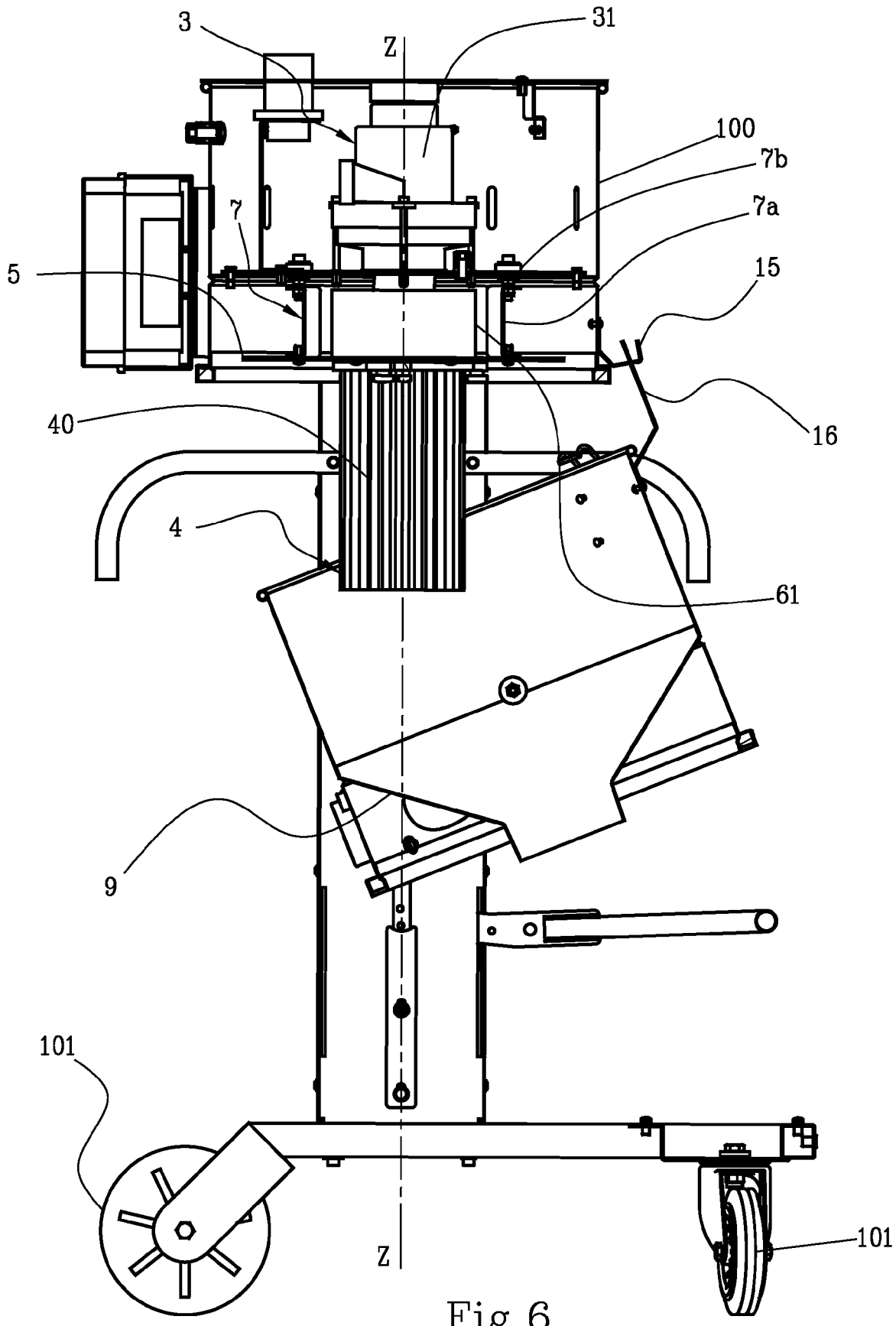

Fig.6

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EUROPEAN SEARCH REPORT

Application Number
EP 24 17 6978

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Place of search	Date of completion of the search	Examiner
Munich	17 September 2024	Jezierski, Krzysztof

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