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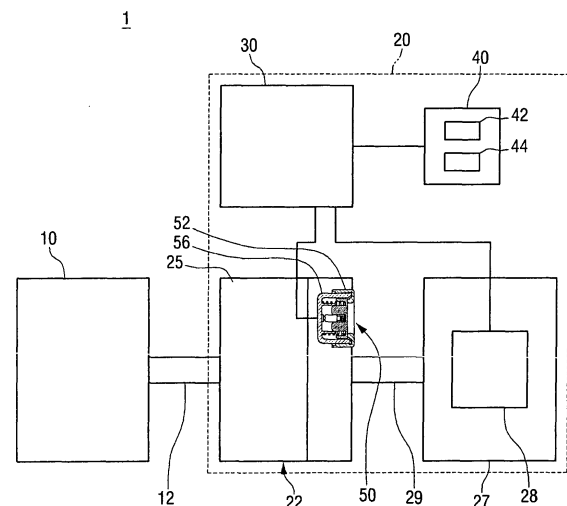
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(54) **A damper assembly for a vacuum cleaner**

(57) A damper assembly for a vacuum cleaner, and a motor protection and dust emptying time-notification method using the damper assembly, which introduce air into a dust separating chamber to increase a pressure in the dust separating chamber when a sub-atmospheric pressure is increased above a certain level in the dust separating chamber and which notifies a user of the exceedance of a limit, are disclosed. The damper assembly includes a casing having an air inflow port; a damper body coupled with the casing and having an air outflow port; a piston disposed in the damper body to be movable between a first position and a second position, the piston being movable towards the second position by a change in air pressure in the damper body; a resilient member for resiliently pressing the piston towards the first position; and a detection sensor to generate a signal when the piston is in the second position. The piston blocks fluid communication between the air inflow port and the air outflow port when in the first position, and permits fluid communication between the air inflow port and the air outflow port when in the second position.

FIG. 1



Description

[0001] This invention relates to a vacuum cleaner, and in particular to a damper assembly for a vacuum cleaner. This invention also relates to a motor protection and dust emptying time-notification method using the damper assembly, which introduces air into a dust separating chamber to increase the pressure in the dust separating chamber when a sub-atmospheric pressure is increased beyond a certain level in the dust separating chamber, as is the case, when a dust separating unit is filled with a dust, dirt or other contaminants (hereinafter referred to as dust), and which notifies a user if this happens.

[0002] In general, a vacuum cleaner generates a strong suction force by using a suction motor, so that it draws in dust from a surface to be cleaned, thereby cleaning the surface. Such a vacuum cleaner generally includes a dust separating unit having a dust bag or a cyclone, a dust receptacle and a filter, this unit separating and collecting the dust from the air. Thus, the dust drawn in by the suction force of the suction motor is removed from the air while passing through the dust separating unit and the air is discharged to the outside.

[0003] However, such a conventional vacuum cleaner may present a problem in that, when the dust is accumulated in the dust bag or the dust receptacle of the dust separating unit during continuous cleaning, the suction force of the suction motor is reduced, thereby causing the dust separating efficiency to deteriorate. Particularly, if the dust bag or the dust receptacle of the cyclone is filled with the dust or the filter is choked with the dust, the suction motor may be overloaded, thereby reducing the lifetime of the motor.

[0004] To address such a problem, a conventional vacuum cleaner includes a dust indication unit installed in the vicinity of the dust separating unit, so that, when a sub-atmospheric pressure in the dust separating unit is increased beyond a certain level, a dust indicator (to which a dust empty sign is marked) is moved by the sub-atmospheric pressure. The dust indicator is usually pressed and supported in a direction opposite to the direction of the sub-atmospheric pressure, by a resilient spring.

[0005] However, the dust indication unit should be installed so that the dust indicator is exposed to the outside. Thus, there is a problem in that the dust indicator needs a dust indication window or the like, thereby causing the installed structure to be complicated. Also, since the dust indicator does not have a damping function which introduces external air into the dust separating unit, there is a problem in that the suction motor is continuously overloaded until the dust collected in the dust bag or the dust receptacle of the cyclone is emptied, or the dust accumulated in the filter is cleaned or removed therefrom.

[0006] An aim of the present invention is to address at least the above problems and/or disadvantages, and to provide at least the advantages described below. Accordingly, an aim of the present invention is to provide a damp-

er assembly for a vacuum cleaner, and a motor protection and dust emptying time-notification method using the damper assembly, which introduces air into a dust separating chamber to increase the pressure in the dust separating chamber when a sub-atmospheric pressure is increased beyond a certain level in the dust separating chamber, as is the case when a dust separating unit is filled with a dust, and which notifies a user if this happens.

[0007] The present invention provides a damper assembly of a vacuum cleaner, the damper assembly comprising: a casing having an air inflow port; a damper body coupled with the casing and having an air outflow port; a piston disposed in the damper body to be movable between a first position and a second position, the piston being movable towards the second position by a change in air pressure in the damper body; a resilient member for resiliently pressing the piston towards the first position; and a detection sensor to generate an electric signal when the piston is in the second position, wherein the piston blocks fluid communication between the air inflow port and the air outflow port when in the first position, and permits fluid communication between the air inflow port and the air outflow port when in the second position.

[0008] Here, the piston may be configured to close the air inflow port and to define an air flow gap between an inner wall of the damper body and the piston member.

[0009] The resilient member may comprise a first resilient member disposed between the damper body and the piston.

[0010] The detector sensor may be disposed between the damper body and the piston, and may be operated by the piston.

[0011] The detection sensor may comprise a push switch. In this case, the resilient member may further include a second resilient member disposed inside the first resilient member between the damper body and the piston, and the damper assembly may further comprise a push member supported by the second resilient member for pressing and operating the push switch.

[0012] At this time, a resilient force (P1) of the first resilient member, a resilient force (P2) of the second resilient member and a pressing force (P3) operating the push switch may satisfy the following condition:

$$P1 > P2 > P3$$

[0013] The push member may be rod shaped or plate shaped. Here, the second resilient member may be disposed between the push member and the piston, and the push switch may be disposed on the bottom of the damper body. Alternatively, the second resilient member may be disposed on the bottom of the damper body, and the push switch may be disposed on an upper surface of the push member.

[0014] Also, the detection sensor may comprise a side push switch disposed on an inner wall of the damper body; or a magnetic element, and a magnetic proximity sensor to detect the magnetic element. Here, the magnetic element may be disposed on the piston, and the magnetic proximity sensor may be disposed on an inner

wall of the damper body.

[0015] The present invention also provides a vacuum cleaner comprising: a dust separating chamber having a dust separating unit disposed therein; a motor chamber having a suction motor disposed therein; a damper assembly as defined above, and disposed in the dust separating chamber to generate a signal while introducing air into the dust separating chamber to increase the pressure in the dust separating chamber when a sub-atmospheric pressure is increased in the dust collecting chamber; and a notification unit to notify the time when dust should be emptied from the dust separating chamber in response to the signal from the damper assembly,

[0016] Here, the notification unit may comprise at least one of a speaker to generate a sound, and a display unit for visually displaying a letter, a light or an image.

[0017] In accordance with further another aspect of the present invention, a motor protection and dust emptying time-notification method of a vacuum cleaner comprises causing a sub-atmospheric pressure in a dust separating chamber to increase; causing a piston of a damper assembly to move in a direction towards a dust separating chamber while pressing at least one resilient member; introducing air into the dust separating chamber through the damper assembly; causing the piston to operate a detection sensor; and notifying the time when dust should be emptied from the dust separating chamber in response to a signal generated according the operation of the detection sensor.

[0018] Preferably, the step of causing the piston to operate the detection sensor may comprise causing the at least one resilient member to press a push member, and causing the push member to operate the detection sensor.

[0019] Alternatively, the step of causing the piston to operate the detection sensor comprise causing the piston to operate a side push switch disposed on an inner wall of a damper body of the damper assembly. In another alternative, the step of causing the piston to operate the detection sensor comprises causing a magnetic proximity sensor disposed on an inner wall of a damper body of the damper assembly to detect a magnetic element disposed on the piston.

[0020] The invention will now be described in greater detail, by way of example, with the drawings, in which:

Figure 1 illustrates a block diagram of a vacuum cleaner having a damper assembly constructed according to the invention;

Figures 2A and 2B are cross-sectional views illustrates an operation of the damper assembly of Figure 1;

Figures 3 to 6 are cross-sectional views of modified examples of the damper assembly of Figure 2A;

Figure 7 is a flowchart illustrating a motor protection

and dust emptying time-notifying operation of the vacuum cleaner of Figure 1.

[0021] Throughout the drawings, the same reference numerals will be understood to refer to the same elements, features, and structures.

[0022] Referring to Figure 1, a vacuum cleaner 1 includes a nozzle unit 10 and a cleaner body 20.

[0023] The nozzle unit 10 is coupled to the cleaner body 20 through an air inflow passage 12, such as a suction hose (not shown), an extension tube (not shown) and the like.

[0024] The cleaner body 20 has a dust separating chamber 22 and a motor chamber 27 installed therein. A dust separating unit 25 is mounted in the dust separating chamber 22 to separate dust from the air drawn in through the nozzle unit 10. The dust separating unit 25 may be a dust bag to collect the dust from the drawn-in air, or a cyclonic dust separating unit having a cyclone or cyclones, a dust receptacle, and a filter.

[0025] A suction motor 28 is mounted in the motor chamber 27 to generate a suction force for drawing in the air through the nozzle unit 10. The motor chamber 27 is coupled to the dust separating chamber 22 through an air outflow passage 29.

[0026] A damper assembly 50 is disposed in the dust separating chamber 22. When the sub-atmospheric pressure in the dust separating chamber 22 is increased beyond a certain or predetermined level, corresponding to a time or state when the dust should be emptied from the dust separating chamber 22 (hereinafter referred to as a dust emptying time), by the suction force of the suction motor 28, as is the case when the dust bag or the dust-receptacle of the cyclone of the dust separating unit 25 is filled or choked with dust, the cleaner is within the dust emptying time. The damper assembly 50 then introduces external air into the dust separating chamber 22 to increase the pressure therein to atmospheric pressure, thereby allowing the suction motor 28 to alleviate an overload generated therein, and to notify a user of the dust emptying time. The damper assembly 50 is installed in the dust separating chamber 22, so that a portion thereof is exposed to the outside from the cleaner body 20.

[0027] As shown in Figure 2A, the damper assembly 50 is provided with a casing 52 fixed to a frame 21 of the cleaner body 20, the casing having a portion exposed to the outside. The casing 52 is generally cylindrical, having an open lower part. An air inflow port 54 is formed in the centre of an upper part of the casing 52 to introduce the external air into the dust separating chamber 22 to increase the pressure in the dust separating chamber. The casing 52 has a circular groove 58 formed inside its upper part to fasten a circular fixing protrusion 57 of a damper body 56.

[0028] The damper body 56 is disposed inside the dust separating chamber 22, and is formed of a cylindrical body having an open upper part to form, together with the casing 52, a single cylinder. The damper body 56 has

a diameter smaller than that of the casing 52, so that its upper part is insertable into the casing. The circular fixing protrusion 57, which is fastened in the circular groove 58, is formed on, and projects from, an outer edge of the top of the damper body 56. In addition, a guide groove part 64 is formed in the bottom of the damper body 56 to guide movement of a guide protrusion 62 of a piston 60 to be described below. Also, an air outflow port 66 is formed at the bottom of the damper body 56 to discharge the external air drawn in through the air inflow port 54 into the dust separating chamber 22. The air outflow port 66 may be formed of a plurality of small holes.

[0029] The piston 60 is movably installed in the damper body 56, and is generally a cylindrical with a closed upper part. As shown in Figure 2A, the piston 60 is resiliently supported in a first position by a first resilient member 70 of a resilient device 68 to be described below. The first position is a closed position where the piston 60 is engaged with the air inflow port 54 of the casing 52 to close the air inflow port.

[0030] Also, to form an air flow gap 76 between the piston 60 and an inner wall of the damper body 56, the piston is configured to have a diameter smaller than that of the damper body 56. Accordingly, when the sub-atmospheric pressure in the dust separating chamber 22 increases to the predetermined level corresponding to the dust emptying time by the suction force of the suction motor 28, the sub-atmospheric pressure in the dust separating chamber is transmitted to the piston 60 through the air outflow port 66 of the damper body 56 and the air flow gap 76. As a result, as shown in Figure 2B, the piston 60 is moved from the closed position (see Figure 2A) blocking fluid communication between the air inflow port 54 and the air outflow port 66, to a second position allowing fluid communication between the air inflow port and the air outflow port, while compressing the first resilient member 70 by the sub-atmospheric pressure. Thus the external air is introduced into the dust separating chamber 22 through the air inflow port 54, the air flow gap 76 and the air outflow port 66. Here, the second position is a sensor operating position where a detection sensor 80 is operated, as described below. As the external air is introduced into the dust separating chamber 22, the pressure in the dust separating chamber increases to the atmospheric pressure removing any overload generated in the suction motor 28. The air introduced into the dust separating chamber 22 is discharged to the outside through the suction motor 28.

[0031] The guide protrusion 62 is formed on the centre of an inside part of the piston 60, and extends to the inside of the top of the guide groove part 64 to be guided along the guide groove part. A spring seating groove 78, on which a second resilient member 72 to be described below is installed, is formed in the guide protrusion 62.

[0032] The resilient device 68 includes the first resilient member 70 and the second resilient member 72. The first resilient member 70 is installed between the bottom of the damper body 56 and the piston 60, outside the

guide groove part 64 of the damper body 56 and the guide protrusion 62 of the piston, and resiliently supports the piston in the closed position (see Figure 2A). The first resilient member 70 may be a compression spring. Here, to enable the piston 60 to move to the sensor operating position (see Figure 2B) when the sub-atmospheric pressure in the dust separating chamber 22 is increased to the predetermined level corresponding to the dust emptying time, it is preferred that a resilient force P1 of the first resilient member 70 is set smaller than the sub-atmospheric pressure at the predetermined level.

[0033] The second resilient member 72 is installed in the spring seating groove 78 of the guide protrusion 62. The second resilient member 72 may be a compression spring. Not to restrict movement of the piston 60, it is preferred that the resilient force P2 of the second resilient member 72 is smaller than the resilient force P1 of the first resilient member 70.

[0034] A push member 74 is installed below the second resilient member 72 to press and operate the detection sensor 80. The push member 74 is rod shaped having a spring seating part at its upper end.

[0035] The second resilient member 72 and the push member 74 are installed to operate the detection sensor 80 and to establish a sufficient separation distance capable of introducing external air between an upper surface of the piston 60 and the air inflow port 54 when the piston moves to the sensor operating position operating the detecting sensor 80 due to sub-atmospheric pressure in the dust separating chamber 22.

[0036] To be more specific, if the second resilient member 72 and the push member 74 are not installed between the piston 60 and the detection sensor 80, the guide protrusion 62 of the piston should be designed for directly operating the detection sensor 80 when the piston is moved to the sensor operating position. In this case, if the guide protrusion 62 is formed too close to the detection sensor 80, and the detection sensor is operated by the movement of the piston 60, the separation distance may not be sufficient to introduce external air between the upper surface of the piston and the air inflow port 54. On the contrary, if the guide protrusion 62 is formed too far away from the detection sensor 80, a problem occurs in that the guide protrusion can not operate the detection sensor even if the piston 60 moves to the sensor operating position. Thus, if the second resilient member 72 and the push member 74 are installed between the piston 60 and the detection sensor 80, the separation distance between the upper surface of the piston and the air inflow port 54 and the sensor operating position of the push member 74 can be controlled by adjusting the resilient force of the second resilient member 72 and/or the length of the push member.

[0037] As shown in Figure 2A, the detection sensor 80, which generates an electric detecting signal when the piston 60 is moved to the sensor operating position (see Figure 2B), is operated by the force exerted by the push member 74 when the piston 60 is moved to the

sensor operating position by the sub-atmospheric pressure of the dust separating chamber 22. For this, the detection sensor 80 is installed on the bottom of the damper body 56 below the push member 74. The detection sensor 80 may be a push switch, which is operable when it is pressed by a predetermined pressing force P3. Here, in order to operate the detection sensor 80 by the force of the push member 74 supported by the second resilient member 72, it is preferred that the pressing force P3 for operating the detection sensor is smaller than that of the resilient force P2 of the second resilient member. Also, in order to move the piston 60 to the sensor operating position when the sub-atmospheric pressure in the dust separating chamber 22 increases to the predetermined level corresponding to the dust emptying time, it is preferred that the sum of the pressing force P3 and the resilient force P1 of the first resilient member 70 is smaller than the sub-atmospheric pressure of the predetermined level corresponding to the dust emptying time.

[0038] A control unit 30 controls a notification unit 40 to notify a user that it is the dust emptying time in response to the signal generated when the detection sensor 80 is operated by the push member 74. The control unit 30 is installed in the cleaner body 20.

[0039] The notification unit 40 signals the dust emptying time by emitting a sound or the like, and/or by visually displaying the dust emptying time with a letter, a light, an image or the like. The notification unit 40 includes a speaker 42 to generate an alarm sound or the like, and/or a display unit 44 to visually display a letter, a light, an image or the like. Here, to allow the user to easily see a display, it is preferred that the display part 44 is installed so as to be exposed to the outside of the cleaner body 20.

[0040] As described above, the damper assembly 50 introduces external air into the dust separating chamber 22 to increase the pressure in the dust separating chamber when the sub-atmospheric pressure is increased to the predetermined level, and, at the same time, transmits a signal to indicate the dust emptying time to the notification unit 40, thereby notifying the user. Accordingly, the vacuum cleaner 1 having the damper assembly 50 does not present the problem of the structure being complicated by installation of a dust indication window or the like to expose the dust indicator to the outside as in the conventional dust indication apparatus. Also, since the vacuum cleaner 1 having the damper assembly 50 has the damping function which introduces external air into the dust separating unit in the dust separating chamber 22, the problem of reduced lifetime of the suction motor 28 due to overload, is prevented, even though the dust collected in the dust bag or the dust receptacle of the cyclone is not emptied immediately, or the dust accumulated in the filter is not cleaned and removed immediately.

[0041] In the above description, although the damper assembly 50 of the vacuum cleaner 1 is illustrated and explained as having the rod-shaped push member 74, the invention is not limited thereto. For instance, as in a damper assembly 50' or 50" shown in Figures 3 and 4,

a push member 74' or 74" may be plate shaped. In the damper assembly 50' shown in Figure 3, an upper part of a second resilient member 72' is supported on a support 63 of a piston 60', and is coupled and connected with a push member 74' at a lower part thereof. A detection sensor 80, such as a push switch, is installed on the bottom of a damper body 56. Also, in the damper assembly 50" shown in Figure 4, a second resilient member 72' is installed on the bottom of a damper body 56 with a push member 74" fixed on the upper part. A detection sensor 80, such as a push switch, is installed on the upper surface of the push member 74".

[0042] Also, although the damper assembly 50 of the vacuum cleaner 1 is illustrated and explained as including the second resilient member 72 and the push member 74, the invention is not limited thereto. For instance, as in a damper assembly 50''' shown in Figure 5, a resilient device 68' is formed of a single resilient member, and a detection sensor 80' is formed by a side push switch 80', which is installed on an inner wall of a damper body 56 and operated by a piston 60". In addition, as in a damper assembly 50'''' shown in Figure 6, a resilient device 68' is a single resilient member, and a detection sensor 80" includes a magnetic element 82, such as a circular magnet. A magnetic proximity sensor 84 then detects the magnetic element 82. Here, the magnetic element 82 is installed on a lower part of a piston 60'', and the magnetic proximity sensor 84 is installed on an inner wall of a damper body 56.

[0043] Hereinafter, a motor protection and dust emptying time-notification operation of the vacuum cleaner 1 having the damper assembly 50, 50', 50'', 50''', or 50'''' will be explained in detail with reference to Figure 7.

[0044] First, as the vacuum cleaner 1 is supplied with electric power, the suction motor 28 is operated. As a result, air along with dust picked up from a surface to be cleaned is drawn in into the dust separating unit 25 of the dust separating chamber 22 through the nozzle unit 10 and the air inflow passage 12. The dust is separated from the air drawn in into the dust separating unit, by the dust separating unit 25, and the air from which the dust has been separated is discharged through the suction motor 28 via the air outflow passage 29.

[0045] As the vacuum cleaner 1 is operated as described above, the dust accumulates in the dust bag or the dust receptacle of the cyclone. If the dust separating unit 25 is full, the air does not smoothly flow in to the dust separating unit due to the dust accumulated in the dust separating unit. As a result, the sub-atmospheric pressure is increased in the dust separating chamber 22 (step S1).

[0046] When the sub-atmospheric pressure in the dust separating chamber 22 increases to a predetermined level corresponding to the dust emptying time, the piston 60 is moved in a direction towards the dust separating chamber while compressing the first and the second resilient members 70 and 72 (step S2).

[0047] Thus, the piston 60 is moved from a closed po-

sition (see Figure 2A) blocking fluid communication between the air inflow port 54 and the air outflow port 66, to a sensor operating position (see Figure 2A), opening fluid communication between the air inflow port and the air outflow port. As a result, external air is drawn into the dust separating chamber 22 through the air inflow port 54, the air flow gap 76 and the air outflow port 66, and is then discharged to the outside through the suction motor 28 (step S3).

[0048] When the piston 60 moves to the sensor operating position, the detecting sensor 80 is operated by the piston and generates a detection signal (step S4).

[0049] That is, as the piston 60 moves, as shown in Figure 2B (or Figure 3), the push member 74 (or 74') is pressed by the second resilient member 72 (or 72') which is compressed by the piston 60 (or 60'), so that it operates the detection sensor 80.

[0050] Alternatively, in the damper assembly 50" shown in Figure 4, the piston 60" operates the detection sensor 80, which is installed on the upper surface of the push member 74" resiliently supported on the second resilient member 72".

[0051] In addition, in the damper assembly 50"" shown in Figure 5, the piston 60" operates the detection sensor 80', which is installed on the inner wall of the damper body 56.

[0052] Also, in the damper assembly 50"" shown in Figure 6, the magnetic element 82 installed on the piston member 60"" is detected by the magnetic proximity sensor 84 of the detection sensor 80" installed on the inner wall of the damper body 52, and thus the magnetic proximity sensor 84 generates a detection signal.

[0053] In response to the detection signal generated by the detecting sensor 80, 80' or 80", the control unit 30 controls the notification unit 40 to notify a user of the dust emptying time (step S5). The user sees that it is the dust emptying time, by a sound or the like, and/or by a letter, a light, an image or the like, which is generated from the notification unit 40, and empties dust accumulated in the dust separating unit 25 or cleans the filter.

[0054] It will be apparent that the vacuum cleaner 1 does not need to install a dust indicator exposed to the outside, or to install a dust indication window, so that the installed structure is not as complicated as in the conventional dust indication apparatus. Also, since the vacuum cleaner 1 has the damping function which introduces external air into the dust separating unit in the dust separating chamber, the problem of the suction motor overload, thereby causing the lifetime thereof to be reduced, is prevented, even though the dust collected in the dust bag or the dust-receptacle of the cyclone is not emptied immediately, or the dust accumulated in the filter is not cleaned and removed immediately.

[0055] Although representative embodiments of the present invention have been shown and described in order to exemplify the principle of the present invention, the present invention is not limited to the specific embodiments. It will be understood that various modifications

and changes can be made by one skilled in the art without departing from the scope of the invention as defined by the claims. Therefore, it shall be considered that such modifications, changes and equivalents thereof are all included within the scope of the present invention.

Claims

1. A damper assembly of a vacuum cleaner, the damper assembly comprising:

a casing having an air inflow port;
a damper body coupled with the casing and having an air outflow port;
a piston disposed in the damper body to be movable between a first position and a second position, the piston being movable towards the second position by a change in air pressure in the damper body;
a resilient member for resiliently pressing the piston towards the first position; and
a detection sensor to generate an electric signal when the piston is in the second position,

wherein the piston blocks fluid communication between the air inflow port and the air outflow port when in the first position, and permits fluid communication between the air inflow port and the air outflow port when in the second position.

2. A damper assembly as claimed in claim 1, wherein the piston is configured to close the air inflow port, and to define an air flow gap between an inner wall of the damper body and the piston.

3. A damper assembly as claimed in claim 1 or claim 2, wherein the resilient member comprises a first resilient member disposed between the damper body and the piston.

4. A damper assembly as claimed in claim 3, wherein the detection sensor is disposed between the damper body and the piston, and is operated by the piston.

5. A damper assembly as claimed in claim 4, wherein the detection sensor comprises a push switch.

6. A damper assembly as claimed in claim 5, wherein the resilient member further comprises a second resilient member disposed inside the first resilient member between the damper body and the piston, and wherein the damper assembly further comprises a push member supported by the second resilient member for pressing and operating the push switch.

7. A damper assembly as claimed in claim 6, wherein

a resilient force (P1) of the first resilient member, a resilient force (P2) of the second resilient member and a pressing force (P3) operating the push switch satisfy the following condition: $P_1 > P_2 > P_3$

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8. A damper assembly as claimed in claim 6 or claim 7, wherein the push member is rod shaped or plate shaped.

9. A damper assembly as claimed in any one of claims 6 to 8, wherein the second resilient member is disposed between the push member and the piston, and the push switch is disposed on the bottom of the damper body.

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10. A damper assembly as claimed in any one of claims 6 to 8, wherein the second resilient member is disposed on the bottom of the damper body, and the push switch is disposed on an upper surface of the push member.

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11. A damper assembly as claimed in any one of claims 4 to 10, wherein the detection sensor comprises a side push switch disposed on an inner wall of the damper body.

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12. A damper assembly as claimed in any one of claims 4 to 10, wherein the detection sensor comprises:

a magnetic element; and
a magnetic proximity sensor to detect the magnetic element.

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13. A damper assembly as claimed in claim 12, wherein the magnetic element is disposed on the piston, and the magnetic proximity sensor is disposed on an inner wall of the damper body.

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14. A vacuum cleaner comprising:

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a dust separating chamber having a dust separating unit disposed therein;
a motor chamber having a suction motor disposed therein;
a damper assembly as claimed in any one of claims 1 to 13, and disposed in the dust separating chamber to generate a signal while introducing air into the dust separating chamber to increase the pressure in the dust separating chamber when a sub-atmospheric pressure is increased in the dust collecting chamber; and
a notification unit to notify the time when dust should be emptied from the dust separating chamber in response to the signal from the damper assembly,

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15. A vacuum cleaner as claimed in claim 14, wherein the notification unit comprises at least one of:

a speaker to generate a sound; and
a display unit for visually displaying a letter, a light or an image.

FIG. 1

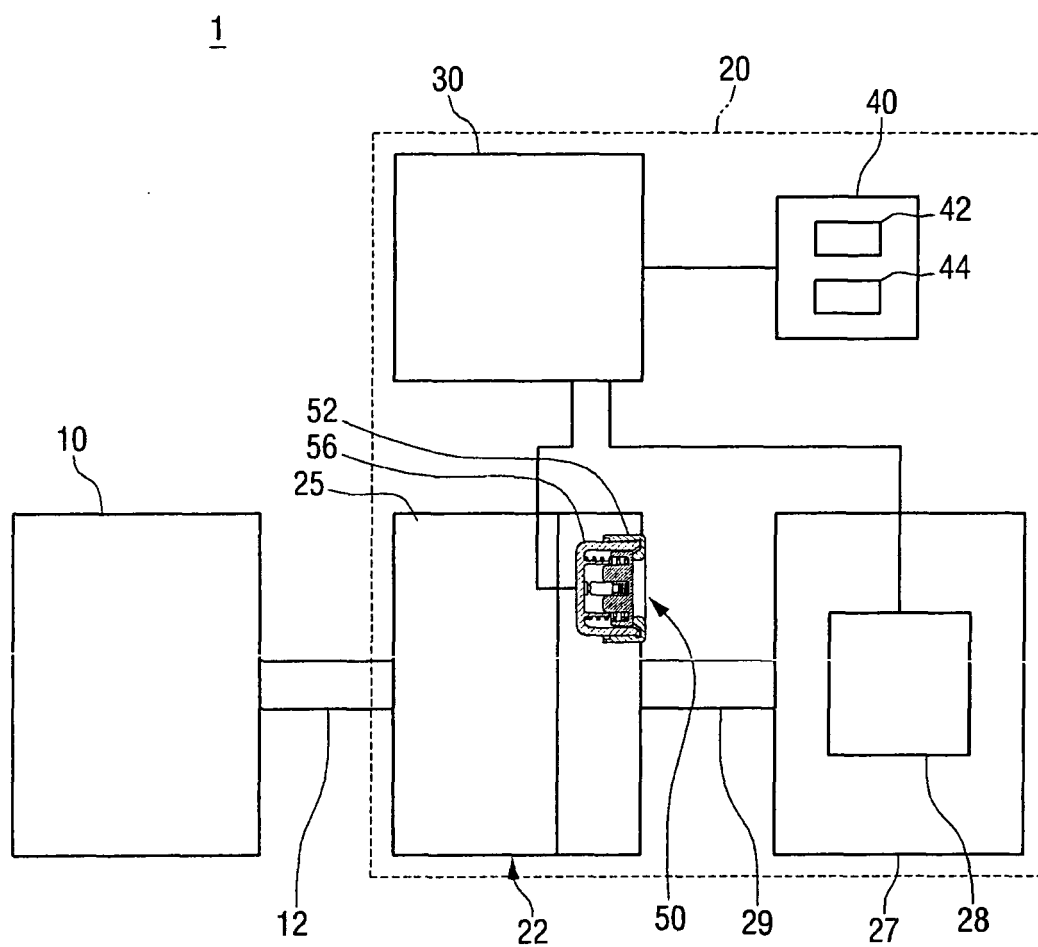


FIG. 2A

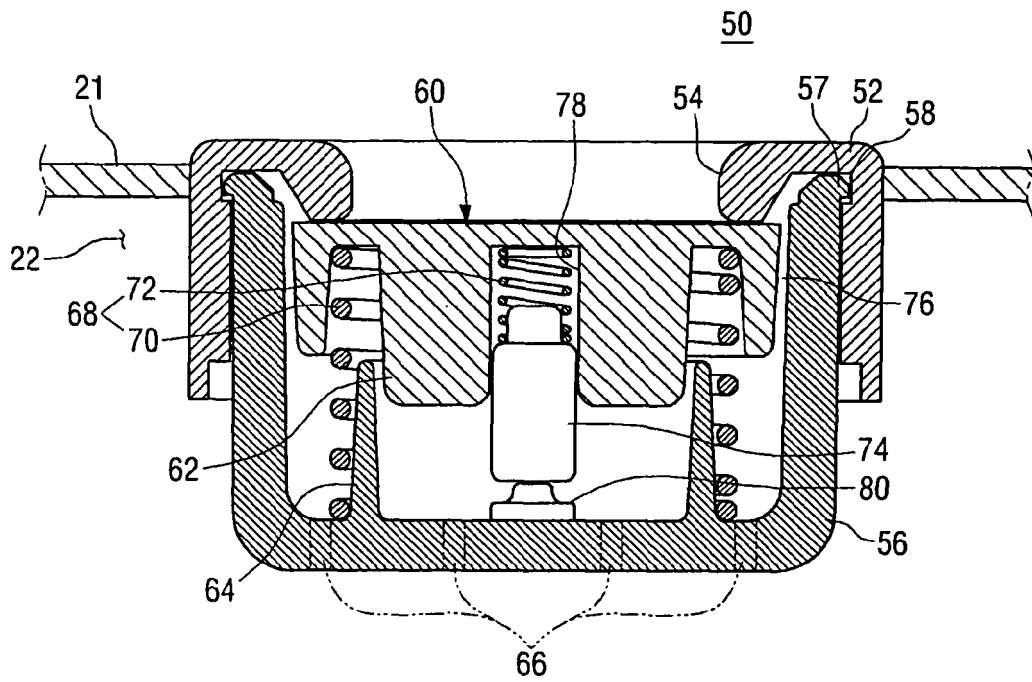


FIG. 2B

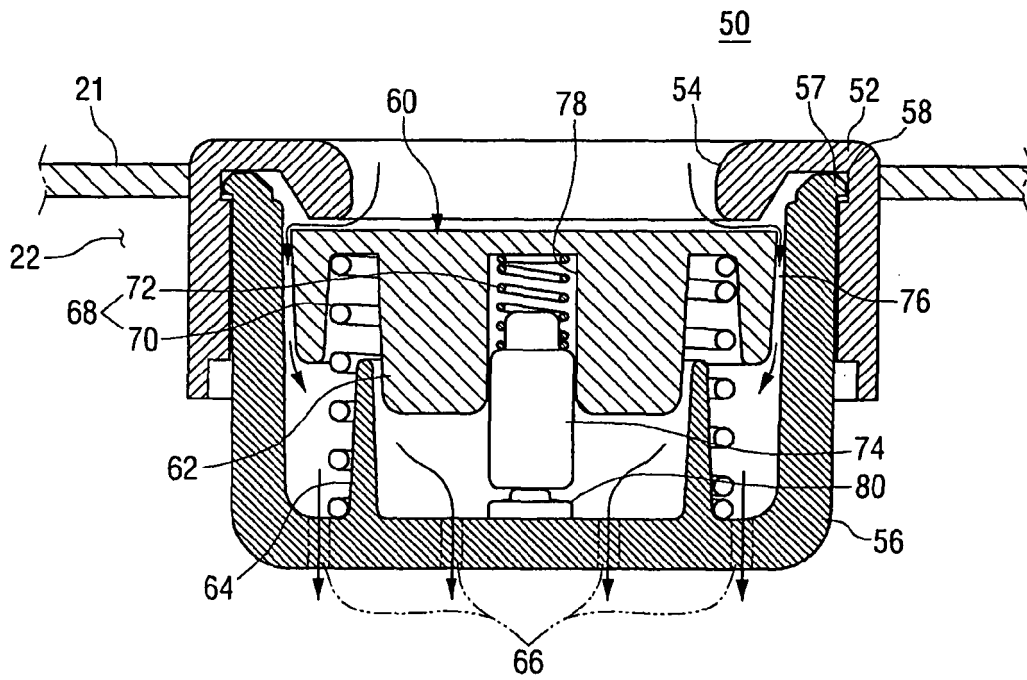


FIG. 3

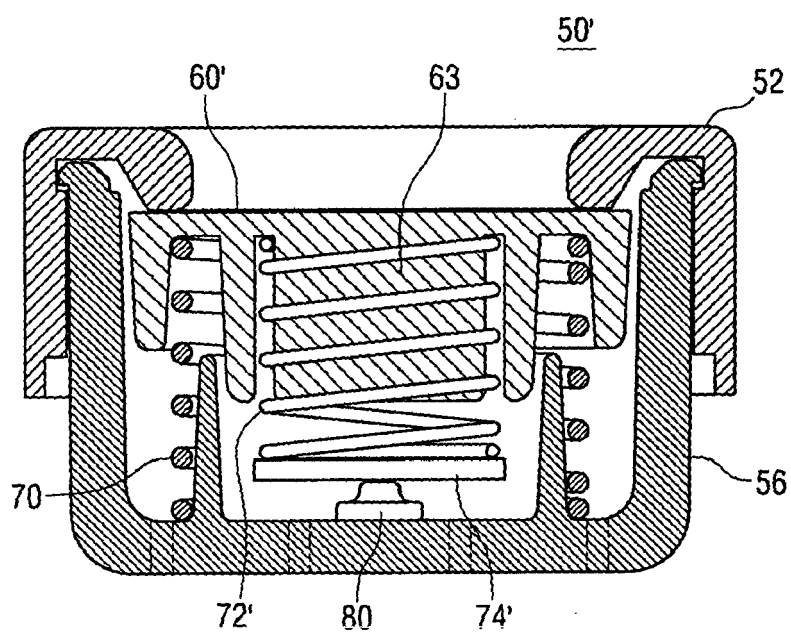


FIG. 4

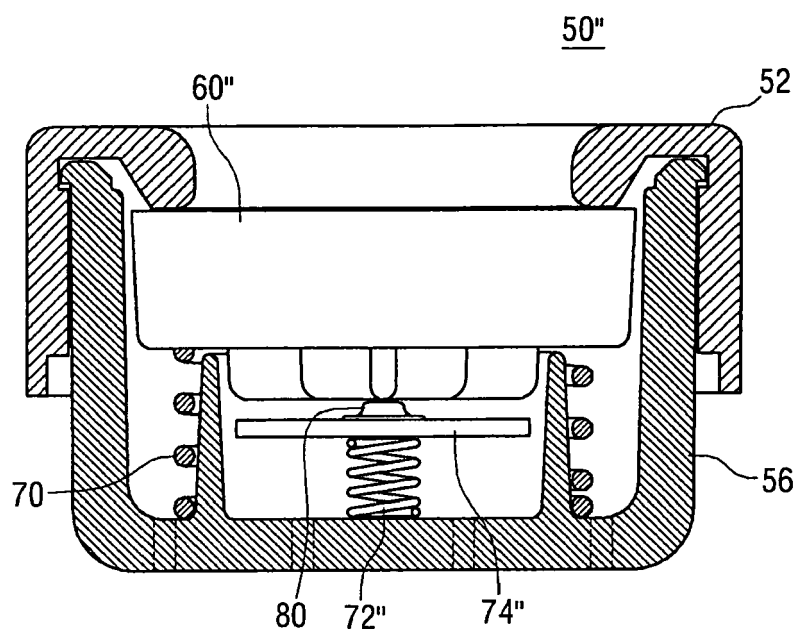


FIG. 5

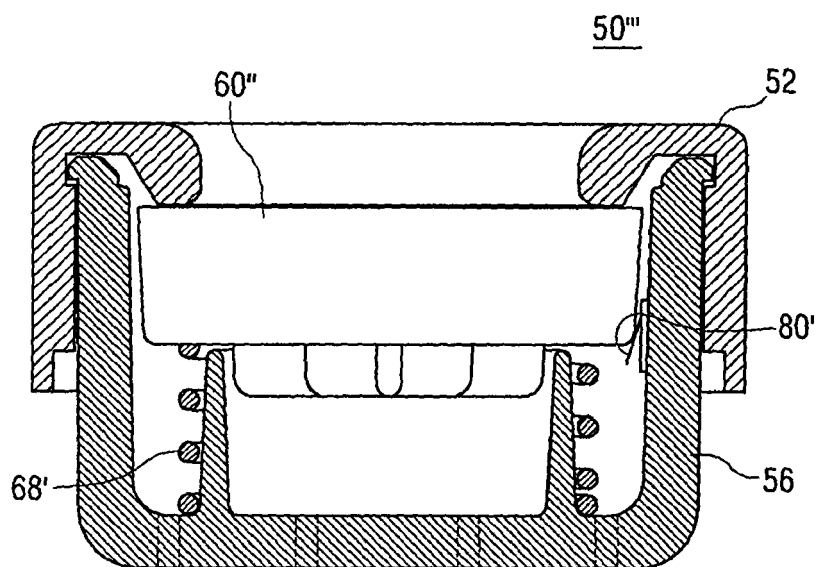


FIG. 6

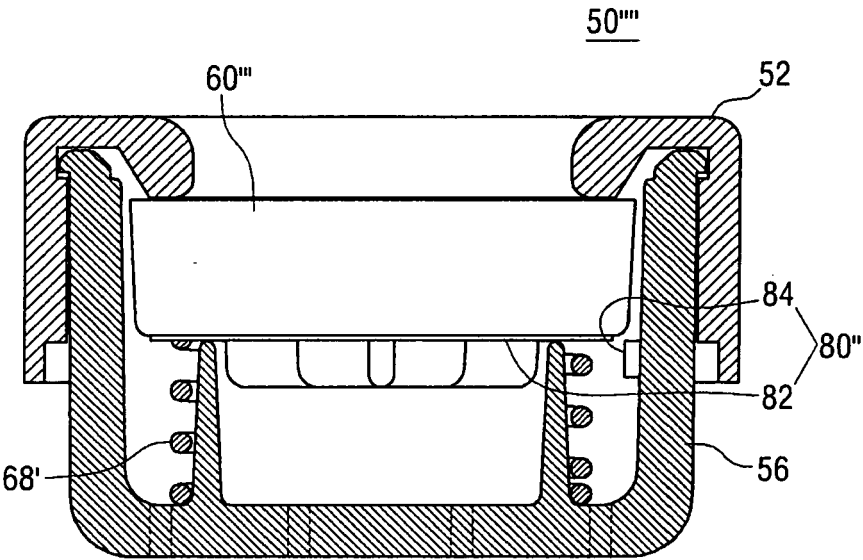


FIG. 7

