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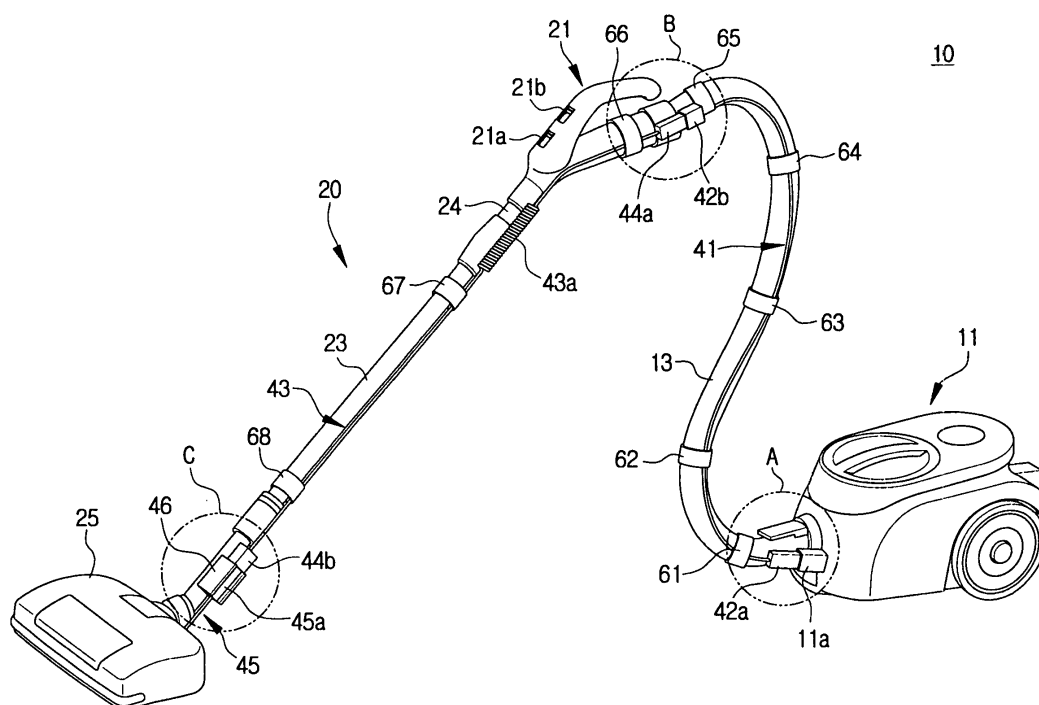
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### (54) Vacuum cleaner having steam cleaning function

(57) The present invention relates to a vacuum cleaner having a steam cleaning function. The vacuum cleaner includes a cleaner body (11) having a suction motor and a dust collecting apparatus; a flexible hose (13) connected to the cleaner body (11); and a cleaning unit (20) hav-

ing a steam generator and at least one dust-cloth. The cleaning unit (20) is detachably connected to the cleaner body (11) and can be supplied with an electric power from a different power source so as to individually perform the steam cleaning.

**FIG. 1**



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## Description

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

**[0001]** The present invention relates to a vacuum cleaner. More particularly, the present invention relates to a vacuum cleaner having a steam cleaning function.

#### 2. Description of the Related Art

**[0002]** Generally, a vacuum cleaner, especially, a canister type vacuum cleaner has a cleaner body, and a brush separated from the cleaner body. The cleaner body and the brush are connected via a connecting pipe and a flexible hose. The vacuum cleaner draws-in and collects dust or other foreign matters through the brush connected by the connecting pipe and flexible hose by the operation of a suction motor and a filter disposed in the cleaner body.

**[0003]** In the conventional vacuum cleaner, the suction motor inside the cleaner body draws-in dust or other foreign matters from a surface to be cleaned with air, and the filter filters the dust or other foreign matters from the drawn-in air so that cleaned air is discharged to the outside.

**[0004]** Because the conventional vacuum cleaner performs the cleaning work by the filtering operation that the filter filters the dust or other foreign matters from the drawn-in air, it cannot remove embedded dirt or grime on a floor, a tiled floor, edges of a window, and so on. Therefore, for performing a complete cleaning work, users remove the dust or other foreign matters from the surface to be cleaned using the conventional vacuum cleaner, and then, wipe the surface to be cleaned out using a damp cloth.

**[0005]** For solving the problem, Korean Patent No. 194379 discloses a vacuum cleaner having a steam cleaning function. The conventional vacuum cleaner having a steam cleaning function includes a water tank, a water feed pump, and a heater which are disposed at a brush body of the vacuum cleaner or at a side of a brush connecting pipe. The heater is connected to a steam pipe extending to a side of a rotating brush disposed in the brush body. When cleaning, steam is jetted to the surface to be cleaned beside the rotating brush through the steam pipe so that high temperature steam resolves grime or dirt embedded on the surface to be cleaned. As a result, the conventional vacuum cleaner having a steam cleaning function can separate and draw-in grime or embedded dirt which the conventional vacuum cleaner only having a suction function cannot remove.

**[0006]** However, the conventional vacuum cleaner having a steam cleaning function has a problem that, even when users want to use only the steam cleaning function, they have to pull the heavy cleaner body that is not related to the steam cleaning function around. Due

to the problem, it is inconvenient to use the conventional vacuum cleaner, and the marketability of the conventional vacuum cleaner is decreased.

#### 5 SUMMARY OF THE INVENTION

**[0007]** The present invention has been developed in order to overcome the above drawbacks and other problems associated with the conventional arrangement. An aspect of the present invention is to provide a vacuum cleaner having a steam cleaning function, in which a brush, a connecting pipe, and a handle that are capable to perform steam cleaning are formed in a single unit so that, when performing the steam cleaning, the single unit can be easily separated from a cleaner body. The above aspect and/or other feature of the present invention can substantially be achieved by providing a vacuum cleaner having a steam cleaning function, which includes: a cleaner body having a suction motor and a dust collecting apparatus; a flexible hose connected to the cleaner body; and a cleaning unit having a steam generator and at least one dust-cloth. When performing steam cleaning or vacuum cleaning, the cleaning unit is connected to the flexible hose, or when performing the steam cleaning, the cleaning unit is separated from the flexible hose and individually performs the steam cleaning. Therefore, in the vacuum cleaner according to an embodiment of the present invention, the cleaning unit can be separated from the cleaner body and individually used so that, when only using the steam cleaning function, users can simply separate the cleaning unit from the flexible hose of the cleaner body, and then, perform the steam cleaning using the separated cleaning unit. As a result, the users may not apply much force to easily perform the steam cleaning.

**[0008]** Furthermore, the vacuum cleaner according to an embodiment of the present invention further includes: a first electric wire connected to the cleaner body; and a second electric wire connected to the first electric wire.

**[0009]** Each of the first and second electric wires further includes connectors disposed at opposite ends thereof; wherein the female connector is disposed at the rear end of each of the first and second electric wires in the direction, in which an electric power is applied from the cleaner body to the cleaning unit. The cleaner body further includes a female connector into which a male connector of the first electric wire is inserted. Therefore, users are prevented from receiving an electric shock by the live connectors of the vacuum cleaner.

**[0010]** The first electric wire is fixed at the flexible hose in a longitudinal direction of the flexible hose, and the second electric wire is fixed at a connecting pipe in a longitudinal direction of the connecting pipe. Therefore, it prevents the first and second electric wires hanging down from obstructing the cleaning work, for examples, the first and second electric wires hanging down are stepped on or caught by other objects.

**[0011]** Furthermore, the vacuum cleaner according to

an embodiment of the present invention further includes a third electric wire connected to the second electric wire when the cleaning unit is separated from the flexible hose for the steam cleaning. Therefore, when only using the steam cleaning function, users can easily perform the steam cleaning with respect to a wide cleaning area using the third electric wire with the length capable to cover the cleaning area.

**[0012]** The cleaning unit includes a handle detachably connected to the flexible hose; a connecting pipe connected to the handle; and a brush connected to the connecting pipe. The brush include a steam generator storing water and generating steam; and at least one cloth rotating part rotating the at least one cloth.

**[0013]** Furthermore, the cleaning unit may further include an extension pipe extractably disposed inside the connecting pipe, wherein the extension pipe connects the handle with the connecting pipe.

**[0014]** The second electric wire preferably has a coil part formed in a coil shape so as to be extended according to the extracted length of the extension pipe.

**[0015]** Other objects, advantages and salient features of the invention will become apparent from the following detailed description, which, taken in conjunction with the annexed drawings, discloses preferred embodiments of the invention.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0016]** These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings of which:

**[0017]** Fig. 1 is a perspective view illustrating a vacuum cleaner having a steam cleaning function according to an embodiment of the present invention;

**[0018]** Fig. 2 is a partially enlarged perspective view illustrating area A in Fig. 1;

**[0019]** Fig. 3 is a perspective view illustrating a cleaning unit separated from the vacuum cleaner having a steam cleaning function of Fig. 1;

**[0020]** Fig. 4 is a schematic view illustrating a selection switch and a control switch disposed on a handle of Fig. 3;

**[0021]** Fig. 5 is a partially enlarged perspective view illustrating area B in Fig. 1;

**[0022]** Fig. 6 is a perspective view illustrating the vacuum cleaner having a steam cleaning function of Fig. 1 with an extension pipe extracted from a connecting pipe;

**[0023]** Figs. 7a and 7b are a plan view and a bottom view illustrating a brush of the vacuum cleaner of Fig. 1; and

**[0024]** Fig. 8 is a partially enlarged perspective view illustrating area C in Fig. 1.

**[0025]** Throughout the drawings, like reference numerals will be understood to refer to like parts, components and structures.

#### DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

**[0026]** Hereinafter, certain exemplary embodiments of the present invention will be described in detail with reference to the accompanying drawings.

**[0027]** The matters defined in the description, such as a detailed construction and elements thereof, are provided to assist in a comprehensive understanding of the invention. Thus, it is apparent that the present invention may be carried out without those defined matters. Also, well-known functions or constructions are omitted to provide a clear and concise description of exemplary embodiments of the present invention.

**[0028]** Fig. 1 is a perspective view illustrating a vacuum cleaner having a steam cleaning function according to an embodiment of the present invention, and Fig. 2 is a partially enlarged perspective view illustrating a first connector disposed at a cleaner body.

**[0029]** Referring to Fig. 1, a vacuum cleaner 10 having a steam cleaning function includes a cleaner body 11, a flexible hose 13, a cleaning unit 20, a first electric wire 41, and a second electric wire 43.

**[0030]** Inside the cleaner body 11 are disposed a suction motor (not shown) generating suction force and a dust collecting apparatus (not shown). Outside the cleaner body 11 is disposed a first connector 11a electrically connected to an inner electric wire (not shown) disposed inside the cleaner body 11. The first connector 11a is preferably formed as a female connector having joining holes H (see Fig. 2) so that, when users incautiously touch the first connector 11a of the vacuum cleaner 10 connected to an electric power source, they do not receive an electric shock. Therefore, a second connector 42a of the first electric wire 41 connected to the first connector 11a is preferably formed as a male connector having joining pins P (see Fig. 2) inserted into the joining holes H of the first connector 11a.

**[0031]** An end of the flexible hose 13 is connected to the dust collecting apparatus (not shown) of the cleaner body 11, and the other end of the flexible hose 13 is detachably connected to an end of the cleaning unit 20, in detail, an end of a handle 21 described below. The first electric wire 41 is fixed along an outer side of the flexible hose 13 in a longitudinal direction of the flexible hose 13 by a plurality of fixing members 61, 62, 63, 64, and 65 so that the first electric wire 41 does not hang down from the flexible hose 13. Therefore, when performing a cleaning work, the first electric wire 41 is prevented from hanging down to obstruct the cleaning work.

**[0032]** The cleaning unit 20 includes the handle 21 detachably connected to the other end of the flexible hose 13, an extension pipe 24 connected to the other end of the handle 21 with a predetermined length, a connecting pipe 23 inside which the extension pipe 24 is extractably disposed, and a brush 25 connected to the other end of the connecting pipe 23.

**[0033]** Hereinafter, the structure of the cleaning unit

20 is described in detail with reference to Figs. 3 to 8. Fig. 3 is a perspective view illustrating the cleaning unit separated from the cleaner body for a steam cleaning and having the brush, the connecting pipe, and the handle. Fig. 4 is a schematic view illustrating a selection switch and a control switch disposed on the handle. Fig. 5 is a partially enlarged perspective view illustrating a connecting part of the handle and the flexible hose. Fig. 6 is a perspective view illustrating the vacuum cleaner with the extension pipe extracted from the connecting pipe.

**[0034]** Referring to Fig. 3, the handle 21 includes a selection switch 21a (see Fig. 4) that is disposed at a side of the handle 21, and selects one function among a vacuum cleaning function, a steam cleaning function, and a vacuum and steam cleaning function. Here, the vacuum and steam cleaning function means that the vacuum cleaner 10 simultaneously performs the vacuum cleaning and the steam cleaning. The selection switch 21 a can select one of the three functions when the cleaning unit 20 is separated from or connected to the cleaner body 11. Also, the handle 21 includes a control switch 21b that turns on or off the vacuum cleaning function and adjusts the strength of suction force. Operations of both the selection switch 21a and the control switch 21b are described in detail hereinafter. The other end of the flexible hose 13 is detachably connected to an end of the handle 21 as shown in Fig. 5. As long as a connecting method has an airtightness not to lower the suction force of the vacuum cleaner 10, there are various methods of connecting the handle 21 with the flexible hose 13. For examples, any one of a snap connecting method, a screw connecting method, and so on can be used.

**[0035]** On the other hand, a third connector 42b of the first electric wire 41 is connected with a fourth connector 44a of the second electric wire 43 nearby where the flexible hose 13 is connected to the handle 21 as shown in Fig. 5. At this time, the third connector 42b is disposed at a rear end of the first electric wire 41 and is preferably formed as a female connector with joining holes H (see Fig. 5). Here, the rear end of the first electric wire 41 means an ending point of the first electric wire 41 in the direction, in which an electric power is applied from the cleaner body 11 to the cleaning unit 20. The object of the above-described structure of the third connector 42b is the same as that of the first connector 11a (see Fig. 2). In other words, it is to prevent users from receiving an electric shock when users incautiously touch the third connector 42b of the turned-on vacuum cleaner 10.

**[0036]** Furthermore, the fourth connector 44a connected with the third connector 42b is disposed at a front end of the second electric wire 43, and is formed as a male connector with projecting joining pins P inserted into the joining holes H (see Fig. 5). Here, the front end of the second electric wire 43 means a starting point in the direction, in which the electric power is applied from the cleaner body 11 to the cleaning unit

20 via the first and second electric wires 41 and 43 connected with each other so that the electric power is supplied to a steam generator 61 and a plurality of driving motors 63a and 63b as described below.

**[0037]** The extension pipe 24 is extractably inserted into the connecting pipe 23 as shown in Fig. 6 so that the length of the connecting pipe 23 can be extended for the convenience of the cleaning work. An end of the extension pipe 24 is connected to the handle 21, and the other end thereof is slidably inserted inside the connecting pipe 23. Therefore, the connecting pipe 23 can be extended from an initial status as shown in Fig. 1 to an extended status in that the connecting pipe 23 is slid along the extension pipe 24 in the direction of arrow A as shown in Fig. 6. For the extension of the connecting pipe 23, the second electric wire 43 has a coil part 43a, in which at least a portion of the second electric wire 43 is formed in a coil shape by a predetermined length, approximately at the boundary between the handle 21 and the connecting pipe 23. The coil part has elasticity so that, when the connecting pipe 23 is slid along the extension pipe 24 in the direction of arrow A, the coil part 43a is extended in a substantially straight line according to the extended length of the connecting pipe 23. As a result, even when the connecting pipe 23 is extended, the electric power can be safely supplied to the brush 25. Also, the second electric wire 43 is fixed along an outer side of the connecting pipe 23 by a plurality of fixing members 66, 67, and 68 in the same way as the first electric wire 41 so that the second electric wire 43 does not hang down from the connecting pipe 23. Therefore, when performing the cleaning work, the second electric wire 43 is prevented from hanging down to obstruct the cleaning work. The second electric wire 43 according to this embodiment has the coil part 43a for extending the second electric wire 43; however this should not be considered as limiting. Various methods can be used for extending the second electric wire 43.

**[0038]** Figs. 7a and 7b are a plan view and a bottom view illustrating a brush of the vacuum cleaner, and Fig. 8 is a partially enlarged perspective view illustrating fifth and sixth connectors disposed behind the brush.

**[0039]** Referring to Fig. 7a, the brush 25 is provided with a steam generator 61 for generating and jetting steam inside the brush 25. The steam generator 61 stores water, and boils the stored water to steam so as to jet the steam through a plurality of steam jetting holes 25b formed at a bottom surface of the brush 25. In this embodiment, the steam generator 61 is disposed inside the brush 25; however, this should be not considered as limiting. The steam generator 61 may be disposed outside the brush 25, for an example, at the connecting pipe 23. Also, the brush 25 has in a bottom thereof a plurality of cloth rotating parts 25c and 25d for rotating dust-cloths (not shown) as shown in Fig. 7b. The plurality of cloth rotating parts 25c and 25d is driven by the plurality of driving motors 63a and 63b disposed inside the brush 25. In this embodiment, the cloth rotating parts 25c and

25d rotates the dust-cloths; however this should be not considered as limiting. The dust-cloths may be not rotated but fixed on the bottom surface of the brush 25.

**[0040]** The brush 25 has the sixth connector 45a connected with the fifth connector 44b of the second electric wire 43 behind itself as shown in Fig. 8 so that the electric power is supplied to the steam generator 61 and the plurality of driving motors 63a and 63b. The fifth connector 44b is formed as a female connector so as to prevent users from receiving an electrical shock just like the first connector 11a (see Fig. 2) and the third connectors 42b (see Fig. 5). On the other hand, the sixth connector 45a is fixed at a bottom end of the connecting pipe 23 by a fixing bracket 46 and is electrically connected to the steam generator 61 and the plurality of driving motors 63a and 63b inside the brush 25 via an electric wire 45. The reference numeral 25a in Fig. 7b represents a dust suction opening for guiding dust on a surface to be cleaned into the brush 25.

**[0041]** Hereinafter, operation of the vacuum cleaner 10 according to an embodiment of the present invention will be explained with reference to the accompanying drawings. Especially, the operation will be explained according to cleaning functions selected by the selection switch 21 a (see Fig. 4).

**[0042]** When the vacuum cleaning function is only used, the users connect the cleaning unit 20 to the flexible hose 13 of the cleaner body 11 as shown in Fig. 1 so that the cleaning unit 20 receives the electrical power from the cleaner body 11 via the first and second electric wires 41 and 43. In this state, the users set the selection switch 21a disposed at the handle 21 to be in the vacuum cleaning mode ("vacuum" position in Fig. 4), and then, move the control switch 21b from "weak" position to "strong" position so as to operate the suction motor of the cleaner body 11 (see Fig. 4). While the suction force is applied at the brush 25, the users move both the cleaning unit 20 and the cleaner body 11 along the surface to be cleaned to perform the vacuum cleaning.

**[0043]** When the vacuum cleaning function and the steam cleaning function are simultaneously used, the users connect the cleaning unit 20 to the flexible hose 13 of the cleaner body 11 as shown in Fig. 1 so that the cleaning unit 20 receives the electrical power from the cleaner body 11 via the first and second electric wires 41 and 43. In this state, when the users set the selection switch 21a disposed at the handle 21 to be in the vacuum and steam cleaning mode ("vacuum & steam" position in Fig. 4), the steam generator 61 (see Fig. 7a) begins to generate steam. Then, the plurality of driving motors 63a and 63b (see Fig. 7b) begins to rotate substantially when the steam generator 61 jets steam. Also, when moving the control switch 21b from "weak" position to "strong" position (see Fig. 4), the suction motor (not shown) of the cleaner body 11 operates.

**[0044]** Therefore, while the vacuum cleaning is performed by the suction force applied in the brush 25, the steam cleaning is performed so as to remove grime or

dirt embedded on the surface to be cleaned. The steam cleaning is that the steam generator 61 jets steam to the surface to be cleaned via the plurality of steam jetting holes 25b (see Fig. 7b), and the plurality of driving motors 63a and 63b rotates the dust-cloths via the plurality of cloth rotating parts 25c and 25d (see Fig. 7b) to wipe the surface to be cleaned.

**[0045]** When the steam cleaning is only used, as shown Fig. 3, users separate the cleaning unit 20 from the flexible hose 13 of the cleaner body 11, and then, separate the fourth connector 44a of the second electric wire 43 from the third connector 42b of the first electric wire 41. Then, the cleaning unit 20 is supplied with the electrical power by a third electric wire 47 having the longer length than the length of the first electric wire 41. In other words, a seventh connector 48a of the third electric wire 47 is connected to a wall socket (not shown) disposed at a wall and so on, and an eighth connector 48b is connected to the fourth connector 44a of the second electric wire 43.

**[0046]** In this state, when the users set the selection switch 21a to be in the steam cleaning mode ("steam" position in Fig. 4), the steam cleaning is only performed. In other words, the steam generator 61 jets steam to the surface to be cleaned via the plurality of steam jetting holes 25b, and the plurality of driving motors 63a and 63b at the same time rotates the dust-cloths via the plurality of cloth rotating parts 25c and 25d so that the dust-cloths remove grime or dirt embedded on the surface to be cleaned.

**[0047]** According to an embodiment of the present invention, the cleaning unit can be individually used when being separated from the cleaner body. When only using the steam cleaning function, users can separate the cleaning unit from the flexible hose of the cleaner body, and then, perform the steam cleaning using the cleaning unit so that the users are not required to pull the heavy cleaner body to perform the steam cleaning. Therefore, the users may not have to apply much force to perform the steam cleaning.

**[0048]** Furthermore, because female connectors are disposed at the rear end of each of the electric wires in the direction, in which the electric power is applied from the cleaner body to the cleaning unit, the vacuum cleaner according to an embodiment of the present invention prevents users from receiving an electric shock when users incautiously touch live connectors of vacuum cleaner.

**[0049]** While the embodiments of the present invention have been described, additional variations and modifications of the embodiments may occur to those skilled in the art once they learn of the basic inventive concepts. Therefore, it is intended that the appended claims shall be construed to include both the above embodiments and all such variations and modifications that fall within the scope of the invention.

**Claims**

1. A vacuum cleaner having a steam cleaning function, the vacuum cleaner comprising:

a cleaner body (11) having a suction motor and a dust collecting apparatus;  
a flexible hose (13) connected to the cleaner body (11); and  
a cleaning unit (20) having a steam generator and at least one dust-cloth;

wherein, when performing steam cleaning and vacuum cleaning or vacuum cleaning alone, the cleaning unit (20) is connected to the flexible hose (13); and

wherein, when performing a steam cleaning function alone, the cleaning unit (20) is separated from the flexible hose (13) and individually performs the steam cleaning function.

2. The vacuum cleaner of the claim 1, further comprising:

a first electric wire (41) connected to the cleaner body (11); and  
a second electric wire (43) connected to the first electric wire (41) and the cleaning unit (20).

3. The vacuum cleaner of the claim 2, wherein each of the first and second electric wires (41, 43) further comprises a male connector (42a, 44a) and a female connector (42b, 44b) disposed at opposite ends thereof;  
wherein the female connector (42b, 44b) is disposed at a rear end of each of the first and second electric wires (41, 43) through which an electric power is applied from the cleaner body (11) to the cleaning unit (20).

4. The vacuum cleaner of claim 3, wherein the cleaner body (11) further comprises a female connector (11a) into which the male connector (42a) of the first electric wire (41) is inserted.

5. The vacuum cleaner of claim 2, wherein the first electric wire (41) is fixed at the flexible hose (13) in a longitudinal direction of the flexible hose, and the second electric wire (43) is fixed at a connecting pipe (23) in a longitudinal direction of the connecting pipe.

6. The vacuum cleaner of any of claims 2 to 5, further comprising:

a third electric wire (47) connected to the second electric wire (43) when the cleaning unit (20) is separated from the flexible hose (13) for the steam cleaning.

7. The vacuum cleaner of any of claims 1 to 6, wherein the cleaning unit (20) comprises:

a handle (21) detachably connected to the flexible hose (13);  
a connecting pipe (23) connected to the handle (21); and  
a brush (25) connected to the connecting pipe.

8. The vacuum cleaner of claim 7, wherein the brush comprises;  
a steam generator (61) storing water and generating steam; and  
at least one cloth rotating part (25c, 25d) rotating the at least one cloth.

9. The vacuum cleaner of claim 7 or 8, wherein the cleaning unit (20) further comprises;  
an extension pipe (24) extractably disposed inside the connecting pipe (23),  
wherein the extension pipe (24) connects the handle (21) with the connecting pipe (23).

10. The vacuum cleaner of claim 9, wherein the second electric wire (43) is extended according to an extracted length of the extension pipe (24).

11. The vacuum cleaner of claim 10, wherein the second electric wire (43) has a coil part (43a) formed in a coil shape.

12. A vacuum cleaner having a steam cleaning function, the vacuum cleaner comprising:

a dust collecting section (11);  
a cleaning section (20); and  
a removable connector (42b, 44a) between the dust collecting and cleaning sections,

wherein, the removable connector connects the sections when performing steam cleaning and vacuum cleaning or vacuum cleaning alone and the cleaning section (20) alone is used to individually perform a steam cleaning function.

13. The vacuum cleaner of the claim 12, further comprising:

a first electric wire (41) connected to the dust collecting section (11); and  
a second electric wire (43) connected to the first electric wire (41) and the cleaning section (20).

14. The vacuum cleaner of claim 13, further comprising:

a third electric wire (47) connected to the second electric wire (43) when the cleaning section (11) is separated from the connector for the steam

cleaning.

- 15.** The vacuum cleaner of any of claims 12 to 14, wherein the cleaning section (20) comprises:

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a handle (21) detachably connected to the connector (42b);

a connecting pipe (23) connected to the handle (21); and

a brush (25) connected to the connecting pipe (23). 10

- 16.** The vacuum cleaner of claim 15, wherein the brush (25) comprises:

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a steam generator (61) storing water and generating steam; and

at least one cloth rotating part (25c, 25d) rotating at least one cloth.

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- 17.** The vacuum cleaner of claim 15 or 16, wherein the cleaning section (20) further comprises:

an extension pipe (24) extractably disposed inside the connecting pipe (23), 25

wherein the extension pipe (24) connects the handle (21) with the connecting pipe (23).

- 18.** The vacuum cleaner of claim 17, wherein the second electric wire (43) is extended according to an extracted length of the extension pipe (24). 30

- 19.** The vacuum cleaner of claim 18, wherein the second electric wire (43) has a coil part (43a) formed in a coil shape. 35

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FIG. 1

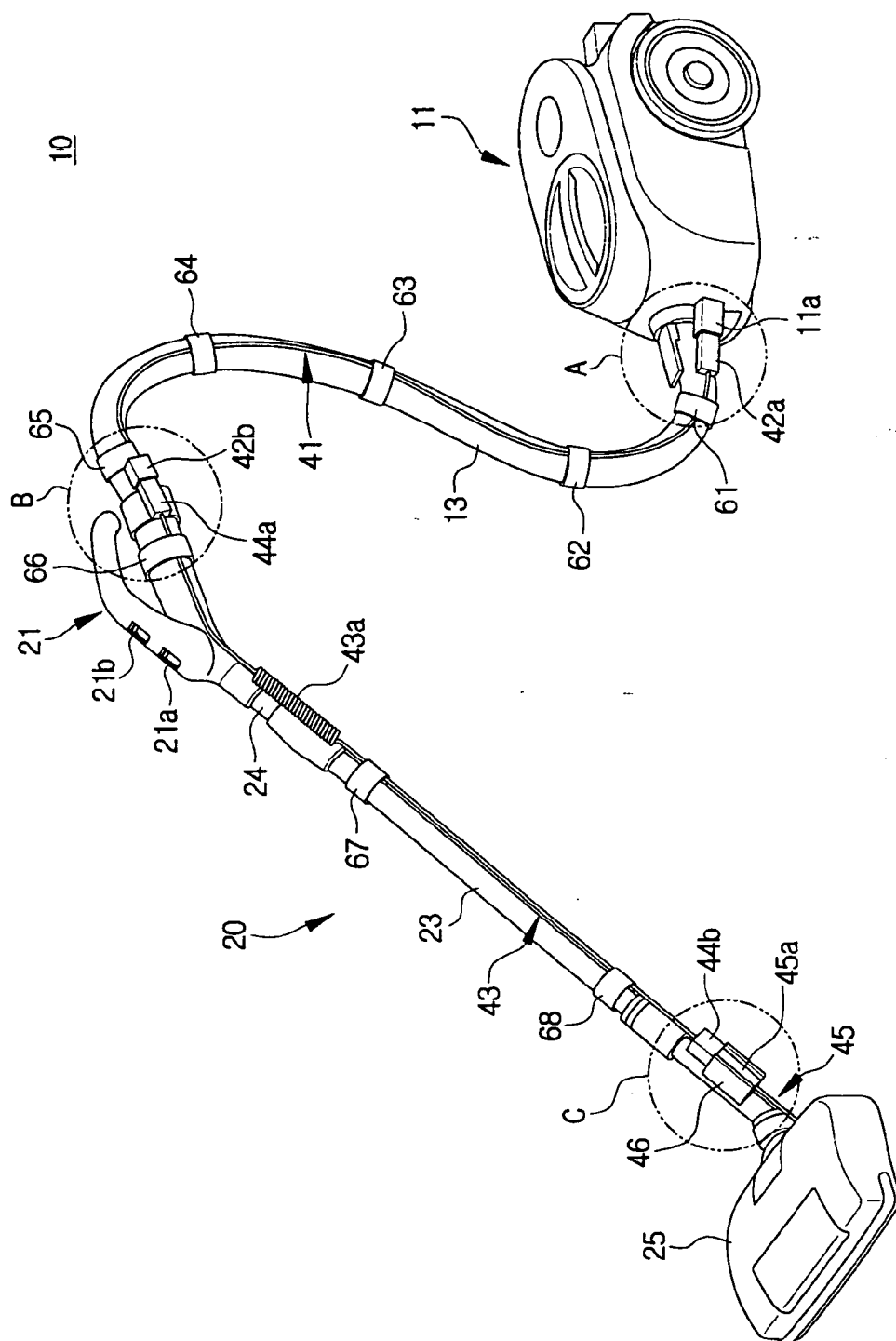




FIG. 2

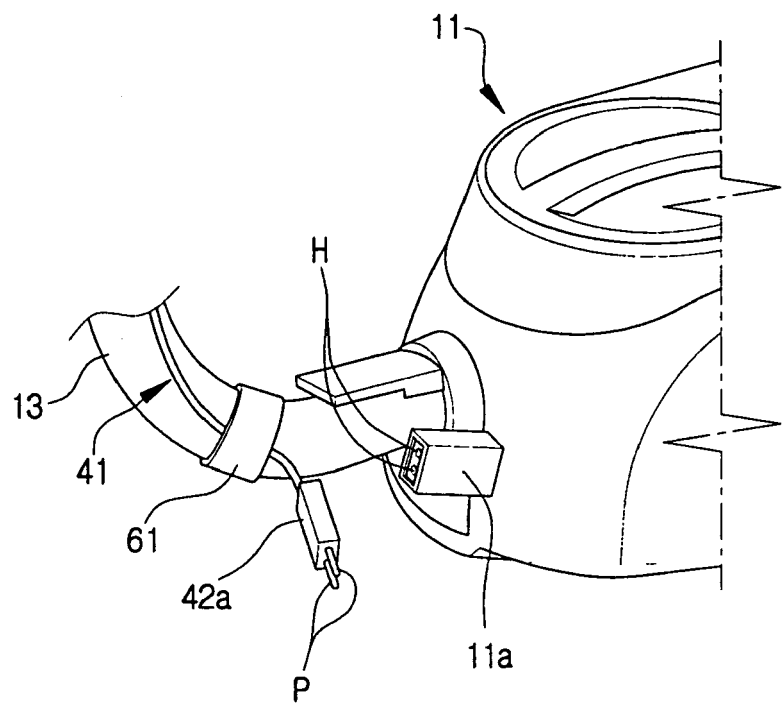


FIG. 3

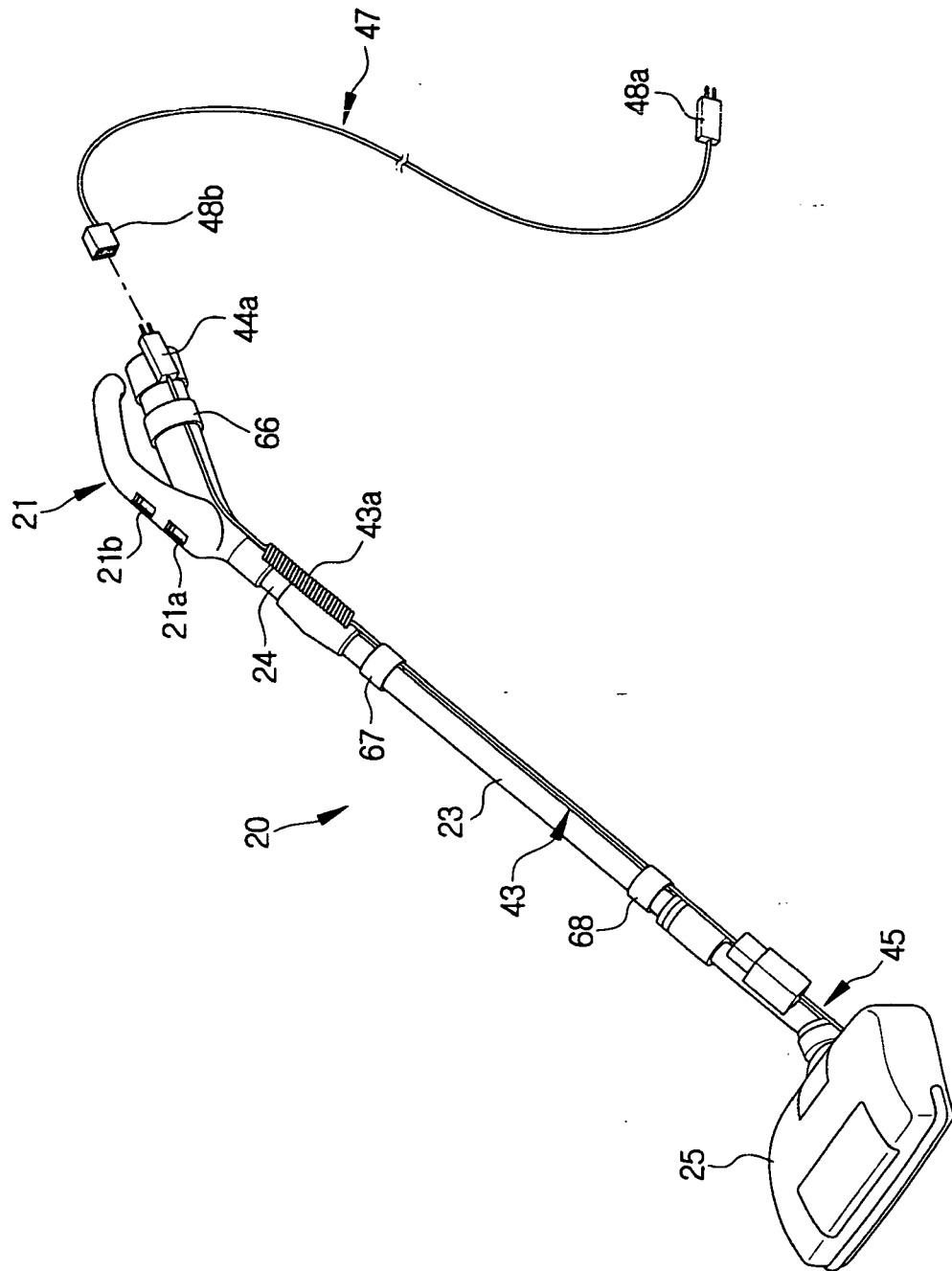


FIG. 4

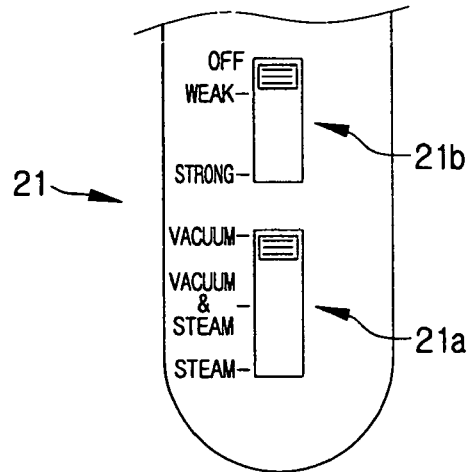


FIG. 5

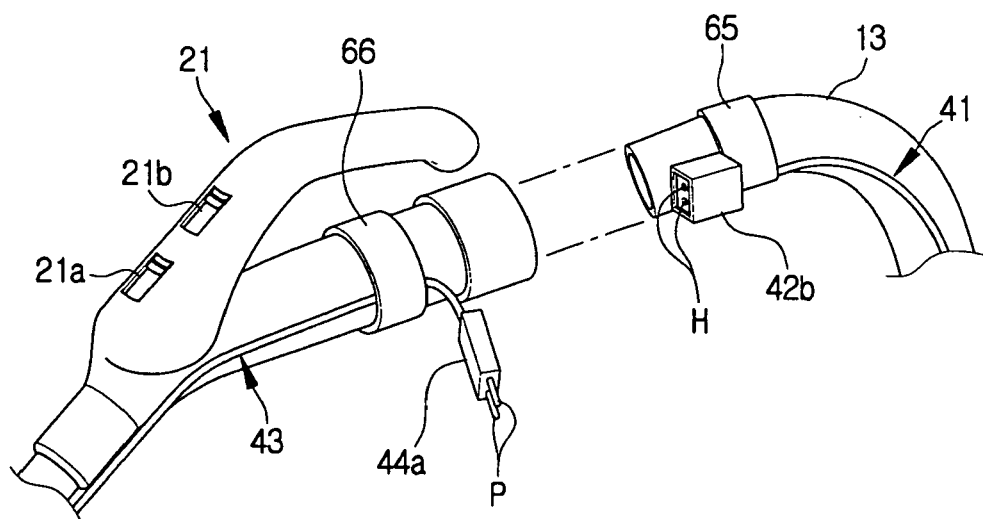


FIG. 6

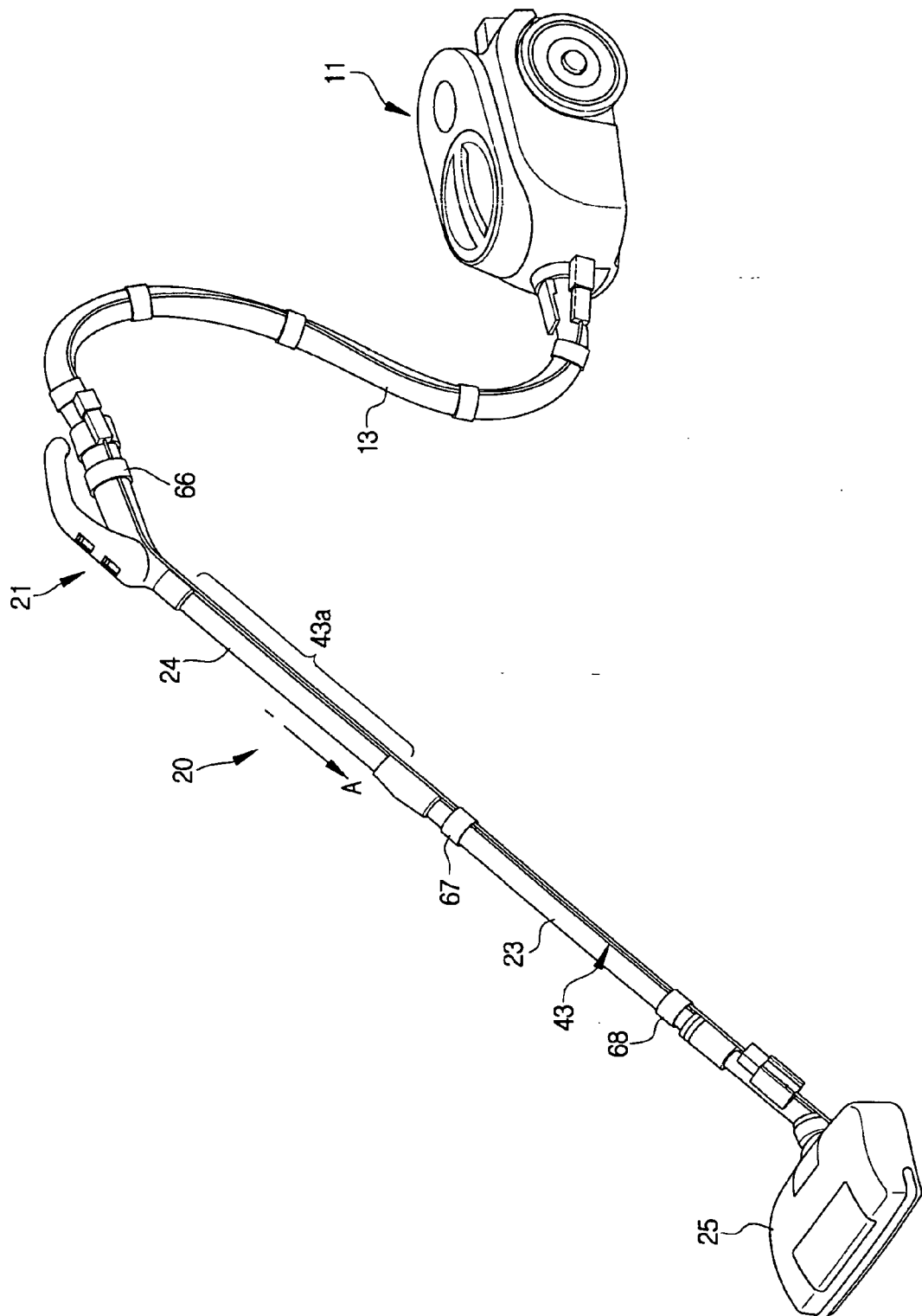


FIG. 7A

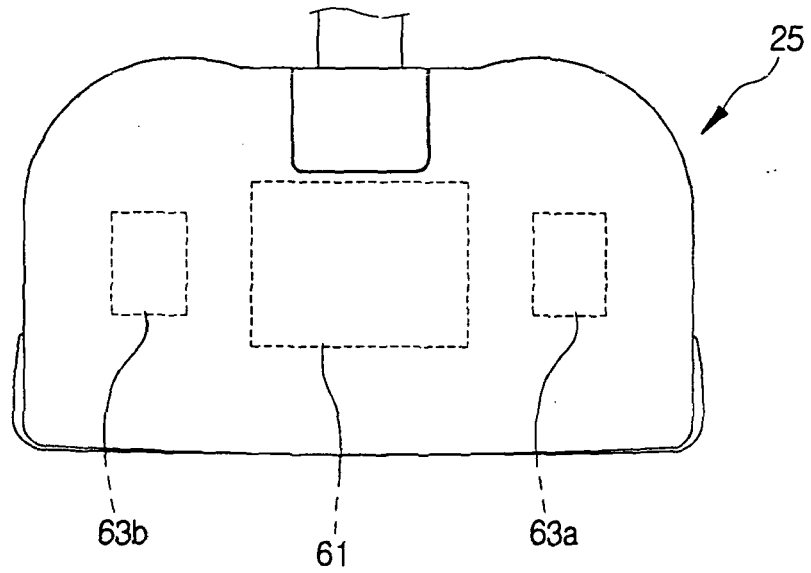


FIG. 7B

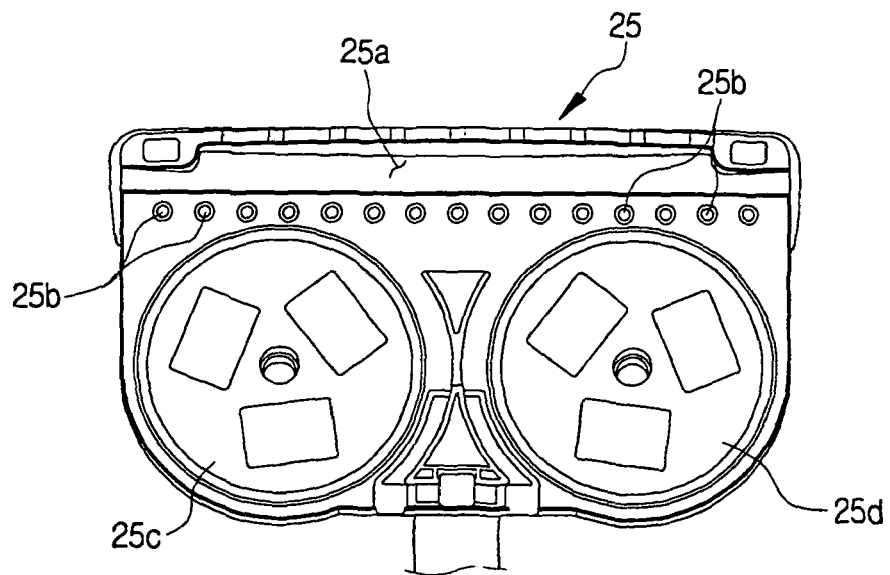
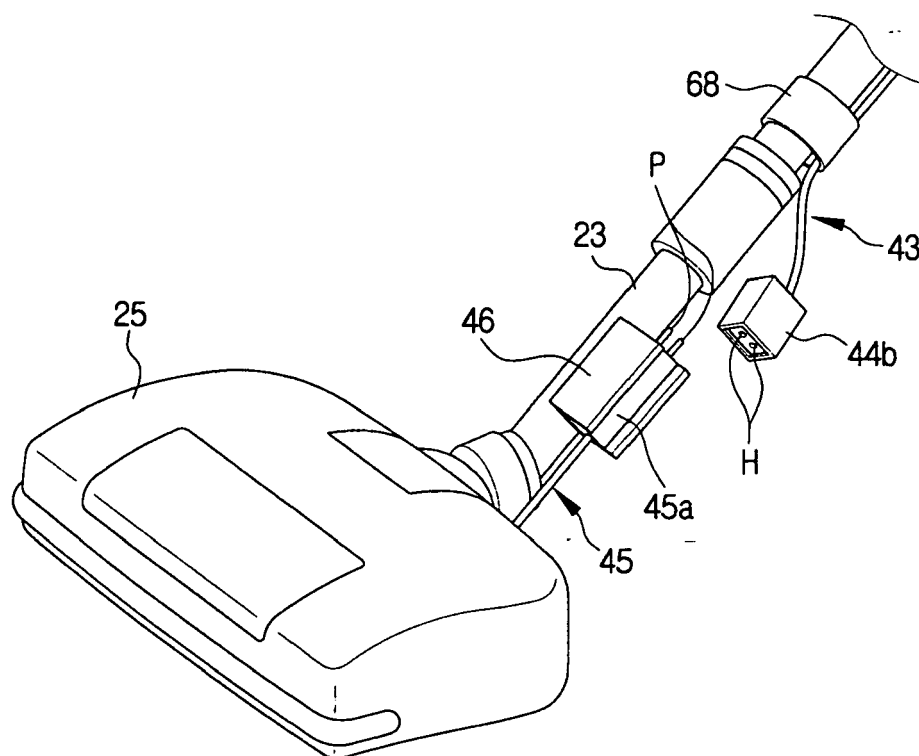


FIG. 8



**REFERENCES CITED IN THE DESCRIPTION**

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