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(54) **SUCTION NOZZLE AND ELECTRIC VACUUM CLEANER INCLUDING THE SAME**

(57) A suction nozzle of an electric vacuum cleaner including an electric blower, includes a suction inlet; an outlet; a suction passage extending along a center line joining a middle of the suction inlet in the longitudinal direction and a middle of the outlet in the longitudinal direction to connect the suction inlet and the outlet; and partition walls arranged in the suction passage to extend from the suction inlet side to the outlet side. The suction

passage includes a main passage and division passages arranged on both outer sides of the main passage. The main passage and the division passages are divided in the longitudinal direction of the suction inlet by the partition walls. A width of the main passage at the suction inlet measured in the longitudinal direction is arranged to be greater than a width of the main passage at the outlet measured in the longitudinal direction.

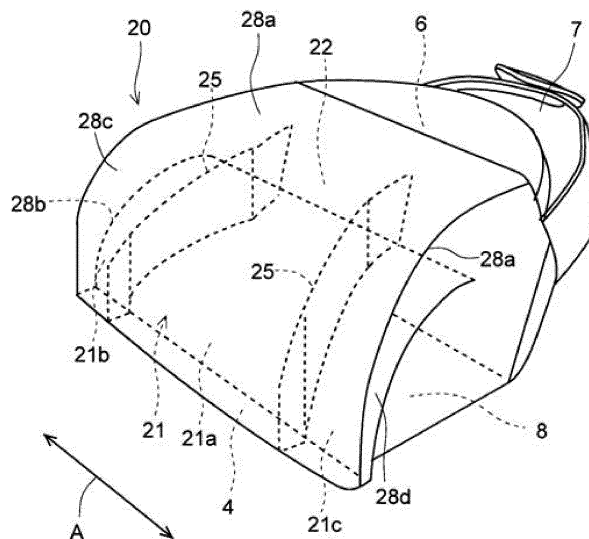


FIG. 4

Description

BACKGROUND OF THE DISCLOSURE

1. Field of the Disclosure

[0001] The disclosure relates to a suction nozzle for sucking air, and an electric vacuum cleaner including the same.

2. Description of the Related Art

[0002] A known electric vacuum cleaner is disclosed in JP-A 2015-70960. This electric vacuum cleaner includes a case including an air inlet and a discharge outlet for air, and an air passage that connects the air inlet and the discharge outlet is defined in the case. In the air passage, an electric blower that produces an air flow is arranged, and a dust collection portion that collects waste flowing in the air passage, such as, for example, dust, is arranged on the upstream side of the electric blower. Left and right wheels are attached to both side surfaces of the case. The case is thus able to travel on a floor in a room.

[0003] A hose is connected to the air inlet of the case, and a connection pipe is connected to an upstream end of the hose. A handle and an operation switch are arranged in the connection pipe. The operation switch is operated to, for example, turn on or off the electric vacuum cleaner, and change the rotation rate of the electric blower. An extension pipe is attached to an upstream end of the connection pipe. A suction head is attached to an upstream end of the extension pipe such that the suction head is detachable from the extension pipe. The suction head includes a housing extending in a direction substantially perpendicular to a direction in which the extension pipe extends.

[0004] In a bottom portion of the housing of the suction head, a suction opening portion extending in a longitudinal direction of the housing is open and is arranged opposite to the floor. A substantially circular outlet which is in communication with the extension pipe is open in an upper portion of a longitudinal middle portion of the housing of the suction head. The suction opening portion is arranged to extend between both longitudinal end portions of the housing, while a dimension of the outlet measured in the longitudinal direction of the housing is arranged to be smaller than that of the suction opening portion. A suction chamber that connects the suction opening portion and the outlet is defined in the housing.

[0005] If the operation switch of the electric vacuum cleaner having the above-described structure is operated to drive the electric blower, air including waste, such as, for example, dust, is sucked into the suction chamber through the suction opening portion of the suction head. After being sucked into the suction head, the air flows in the suction chamber, and flows into the extension pipe through the outlet. After flowing into the extension pipe,

the air flows into the case through the hose, and the waste in the air is collected in the dust collection portion in the case. The floor is thus cleaned.

[0006] However, in the suction head (i.e., a suction nozzle) of the above-described known electric vacuum cleaner, the outlet is open in the longitudinal middle portion of the housing. Therefore, portions of air flows sucked in through both end portions of the suction opening portion (i.e., a suction inlet) with respect to the longitudinal direction abruptly bend toward a longitudinal middle immediately after entering into the suction chamber (i.e., a suction passage), and join an air flow sucked in through a longitudinal middle portion of the suction opening portion. This may cause a turbulence in the suction chamber, resulting in reduced suction efficiency of the suction head.

SUMMARY OF THE DISCLOSURE

[0007] A suction nozzle according to a preferred embodiment of the disclosure is a suction nozzle to be provided in an electric vacuum cleaner including an electric blower, the suction nozzle including a suction inlet arranged to extend in a longitudinal direction that is predetermined, and arranged opposite to a surface to be cleaned; an outlet to be connected to the electric blower; a suction passage arranged to extend along a center line joining a middle of the suction inlet in the longitudinal direction and a middle of the outlet in the longitudinal direction to connect the suction inlet and the outlet; and a plurality of partition walls each of which is arranged in the suction passage to extend from a side on which the suction inlet is defined to a side on which the outlet is defined. The suction passage includes a main passage having the center line of the suction passage passing therethrough; and a plurality of division passages arranged on both outer sides of the main passage with respect to the longitudinal direction with one of the partition walls being arranged between the main passage and an adjacent one of the division passages on either side of the main passage. The main passage and the division passages are divided from one another in the longitudinal direction of the suction inlet by the partition walls. A width of the main passage at the suction inlet measured in the longitudinal direction is arranged to be greater than a width of the main passage at the outlet measured in the longitudinal direction.

[0008] An electric vacuum cleaner according to a preferred embodiment of the disclosure includes the above suction nozzle, a dust collection portion arranged downstream of the suction nozzle, and an electric blower arranged downstream of the dust collection portion.

[0009] The suction nozzle according to the above preferred embodiment of the disclosure is able to achieve improved suction efficiency. In addition, according to a preferred embodiment of the disclosure, an electric vacuum cleaner including the above suction nozzle is provided.

[0010] The above and other elements, features, steps, characteristics and advantages of the disclosure will become more apparent from the following detailed description of the preferred embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG. 1 is a perspective view of an electric vacuum cleaner according to a first preferred embodiment of the disclosure.

FIG. 2 is a bottom view of the electric vacuum cleaner according to the first preferred embodiment of the disclosure.

FIG. 3 is a side sectional view of the electric vacuum cleaner according to the first preferred embodiment of the disclosure.

FIG. 4 is a perspective view of a portion of an air passage on the suction side including a suction nozzle of the electric vacuum cleaner according to the first preferred embodiment of the disclosure.

FIG. 5 is a sectional front view of the suction nozzle of the electric vacuum cleaner according to the first preferred embodiment of the disclosure.

FIG. 6 is a perspective view illustrating a result of a simulation of flows of air in the portion of the air passage on the suction side of the electric vacuum cleaner according to the first preferred embodiment of the disclosure.

FIG. 7 is a side view illustrating the result of the simulation of the flows of air in the portion of the air passage on the suction side of the electric vacuum cleaner according to the first preferred embodiment of the disclosure.

FIG. 8 is a side view illustrating a result of a simulation of an air velocity distribution in the portion of the air passage on the suction side of the electric vacuum cleaner according to the first preferred embodiment of the disclosure.

FIG. 9 is a side view illustrating a result of a simulation of an air pressure distribution in the portion of the air passage on the suction side of the electric vacuum cleaner according to the first preferred embodiment of the disclosure.

FIG. 10 is a perspective view of a portion of an air passage on the suction side including a suction nozzle of an electric vacuum cleaner according to a second preferred embodiment of the disclosure.

FIG. 11 is a sectional front view of the suction nozzle of the electric vacuum cleaner according to the second preferred embodiment of the disclosure.

FIG. 12 is a perspective view of a portion of an air passage on the suction side including a suction nozzle of an electric vacuum cleaner according to a third preferred embodiment of the disclosure.

FIG. 13 is a sectional front view of the suction nozzle

of the electric vacuum cleaner according to the third preferred embodiment of the disclosure.

FIG. 14 is a perspective view of an electric vacuum cleaner according to a fourth preferred embodiment of the disclosure.

FIG. 15 is a sectional front view of a suction nozzle of the electric vacuum cleaner according to the fourth preferred embodiment of the disclosure.

FIG. 16 is a side sectional view of the suction nozzle of the electric vacuum cleaner according to the fourth preferred embodiment of the disclosure.

FIG. 17 is a perspective view of an electric vacuum cleaner according to a fifth preferred embodiment of the disclosure.

FIG. 18 is a perspective view of an electric vacuum cleaner according to a sixth preferred embodiment of the disclosure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] Hereinafter, preferred embodiments of the disclosure will be described in detail with reference to the accompanying drawings. It is assumed herein that a direction toward a floor F (i.e., a surface to be cleaned) illustrated in FIG. 3 is a downward direction, while a direction away from the floor F is an upward direction. It is also assumed herein that, with respect to a front-rear direction, a direction leading from an electric blower 7 to a suction inlet 4 is a forward direction, while a direction leading from the suction inlet 4 to the electric blower 7 is a rearward direction. It is also assumed herein that a direction perpendicular to the front-rear direction and parallel to the floor F is a right-left direction (i.e., a longitudinal direction). It is also assumed herein that a surface parallel to the front-rear direction and perpendicular to the right-left direction is referred to as a "side surface". It is also assumed herein that an upstream side and a downstream side are defined with respect to a direction in which air sucked in through the suction inlet 4 when the electric blower 7 is in operation flows. It is also assumed herein that the wording "the suction inlet 4 arranged opposite to the floor F (i.e., the surface to be cleaned)" and the like can refer to a situation in which the suction inlet 4 and the floor F face each other with another member (e.g., a rotary brush, etc.) arranged therebetween, in addition to a situation in which the suction inlet 4 and the floor F face each other directly with no other member arranged between the suction inlet 4 and the floor F.

[0013] An electric vacuum cleaner 1 according to a first preferred embodiment of the disclosure will be described below. FIGS. 1, 2, and 3 are a perspective view, a bottom view, and a side sectional view, respectively, of the electric vacuum cleaner 1 according to the first preferred embodiment. The electric vacuum cleaner 1 is a so-called robot-type electric vacuum cleaner, and includes a case 2 which is substantially circular in a horizontal section (i.e., a section parallel to the floor F).

[0014] A display portion 15 and an operation portion 16 are arranged in an upper surface of the case 2. The operation portion 16 includes a plurality of buttons (not shown). By operating the operation portion 16, a user can, for example, issue an instruction to turn on or off the electric vacuum cleaner 1, issue an instruction to change the rotation rate of the electric blower 7, which will be described below, or enter a condition, such as, for example, a time at which the electric vacuum cleaner 1 is to start cleaning. The display portion 15 includes, for example, a liquid crystal display panel or the like, and displays, for example, the condition entered with the operation portion 16.

[0015] In addition, a position sensor (not shown) is arranged in the upper surface of the case 2. The position sensor is used to detect the position of the electric vacuum cleaner 1 in a room, for example.

[0016] The suction inlet 4, which is arranged to extend in the right-left direction (i.e., a longitudinal direction A), is defined in a bottom surface (i.e., a lower surface) of the case 2, and a discharge outlet 5, which is arranged to extend in the right-left direction, is defined in a rear portion of the case 2. The suction inlet 4 is arranged opposite to the floor F (i.e., the surface to be cleaned) inside the room, and the discharge outlet 5 is arranged to face obliquely rearward and upward from the case 2. A rotary brush (not shown) is arranged in the vicinity of the suction inlet 4 in a bottom portion of the case 2. Note that the rotary brush may alternatively be arranged in the suction inlet 4.

[0017] An air passage 6, which connects the suction inlet 4 and the discharge outlet 5, is arranged inside of the case 2. The electric blower 7, which is arranged to produce an air flow, is arranged in the air passage 6. Once the electric blower 7 is driven, air in the room flows into the air passage 6 through the suction inlet 4 as indicated by arrows S, and is sent out into the room through the discharge outlet 5. A centrifugal fan is preferably used as the electric blower 7, but other types of electric blowers, such as, for example, an axial flow fan, may alternatively be used.

[0018] In the air passage 6, a dust collection portion 8 and a filter 9 are arranged in the order named from the upstream side to the downstream side with respect to the direction in which the air flows between the suction inlet 4 and the electric blower 7. Dust included in the air flowing in the air passage 6 is blocked by the filter 9, and is collected in the dust collection portion 8, which is defined in the shape of a container. Each of the dust collection portion 8 and the filter 9 is detachably fitted in the case 2. On the downstream side of the filter 9, the air passage 6 is arranged to decrease in a channel width (i.e., width in the longitudinal direction A) toward an air inlet (not shown) of the electric blower 7.

[0019] A suction nozzle 20 in the shape of a nozzle is detachably fitted in the case 2 on the upstream side of the dust collection portion 8 in the air passage 6. The suction nozzle 20 includes the suction inlet 4 and an outlet

22 at an upstream end and a downstream end, respectively, and a suction passage 21 which connects the suction inlet 4 and the outlet 22 is defined in the suction nozzle 20. The suction inlet 4 is arranged to extend in the predetermined longitudinal direction A, and is arranged opposite to the floor F (i.e., the surface to be cleaned). The outlet 22 is connected to the electric blower 7. The width of the outlet 22 measured in the longitudinal direction A is arranged to be substantially equal to the width of the suction inlet 4 measured in the longitudinal direction A.

[0020] The suction passage 21 is arranged to extend upward from the suction inlet 4 and curve rearward, and is connected to an upper portion of the dust collection portion 8 through the outlet 22. The upper side of a portion of the dust collection portion 8 is covered with the suction nozzle 20. That is, the suction passage 21 is arranged to extend upward from the suction inlet 4, and is connected to the upper portion of the dust collection portion 8, and the upper side of a portion of the dust collection portion 8 is covered with the suction nozzle 20. The details of the suction nozzle 20 will be described below.

[0021] Left and right drive wheels 19a are arranged at left and right end portions of the bottom surface of the case 2. A trailer wheel 19b, which is defined by a caster, is arranged at a front end portion of the bottom surface of the case 2. Each drive wheel 19a is connected to a drive motor (not shown). The case 2 is thus able to travel on the floor F.

[0022] In addition, the electric vacuum cleaner 1 includes a control portion (not shown) which controls various portions of the electric vacuum cleaner 1. The electric blower 7, the display portion 15, the operation portion 16, the drive motor, the position sensor, a storage portion, and so on are connected to the control portion. The storage portion is arranged to store a control program for the electric vacuum cleaner 1 and, in addition, the condition entered with the operation portion 16 and so on.

[0023] A power supply portion 11 including a secondary battery and so on is arranged in a front portion of the case 2. The power supply portion 11 is arranged to supply power to the electric blower 7, the control portion, the drive motor, and so on, and includes a case-side contact point (not shown) exposed in the bottom surface of the case 2. The case-side contact point is arranged to make contact with a charger stand-side contact point of a charger stand (not shown) connected to a commercial power supply (not shown). The secondary battery of the power supply portion 11 is thus charged through the charger stand. Before a cleaning operation is started, the electric vacuum cleaner 1 is placed on the charger stand.

[0024] FIG. 4 is a perspective view of a portion of the air passage 6 on the suction side including the suction nozzle 20, and FIG. 5 is a sectional front view of the suction nozzle 20. The suction nozzle 20 includes the suction inlet 4, the outlet 22, the suction passage 21, and a plurality of partition walls 25. The suction passage 21 is arranged to extend along a center line CT, which joins

a middle of the suction inlet 4 in the longitudinal direction A and a middle of the outlet 22 in the longitudinal direction A, to connect the suction inlet 4 and the outlet 22. Upper and lower surfaces of the suction passage 21 are defined by an upper wall 28a and a lower wall 28b, respectively, and left and right surfaces of the suction passage 21 are defined by a side wall 28c and a side wall 28d, respectively. Each of the upper wall 28a and the lower wall 28b is arranged to slant in such a manner as to increase in height as the upper wall 28a or the lower wall 28b extends rearward, and the suction passage 21 is arranged to slant and guide an air flow to the outlet 22.

[0025] In the suction passage 21, the plurality of (two in the present preferred embodiment) partition walls 25 are arranged side by side in the longitudinal direction A. Each of the partition walls 25 is arranged in the suction passage 21, and is arranged to extend from a side on which the suction inlet 4 is defined to a side on which the outlet 22 is defined. The partition walls 25 are arranged to extend from the suction inlet 4 to the outlet 22 to divide the suction passage 21 into a main passage 21a and a plurality of (two in the present preferred embodiment) division passages 21b and 21c, which are divided from one another in the longitudinal direction A. The main passage 21a has the center line CT of the suction passage 21 passing therethrough. The division passages 21b and 21c are arranged on both outer sides of the main passage 21a with respect to the longitudinal direction A with one of the partition walls 25 being arranged between the main passage 21a and an adjacent one of the division passages 21b and 21c on either side of the main passage 21a. The main passage 21a and the division passages 21b and 21c are divided from one another in the longitudinal direction A of the suction inlet 4 by the partition walls 25. That is, the main passage 21a is arranged on the center line CT, and the division passages 21b and 21c are arranged on both outer sides of the main passage 21a with respect to the longitudinal direction A.

[0026] In addition, the suction inlet 4 is divided by the partition walls 25 into suction inlets 4a, 4b, and 4c. The suction inlets 4a, 4b, and 4c are arranged at upstream ends of the main passage 21a, the division passage 21b, and the division passage 21c, respectively. Each of the suction inlets 4b and 4c is arranged adjacent to the suction inlet 4a.

[0027] Each partition wall 25 includes an upstream vertical portion 25a, a first curved portion 25b, a second curved portion 25c, and a downstream vertical portion 25d arranged in the order named from the upstream side to the downstream side with respect to the direction in which the air flows. The upstream vertical portion 25a is arranged at an upstream end of the partition wall 25, and is arranged to be substantially perpendicular to the longitudinal direction A. That is, each partition wall 25 includes the upstream vertical portion 25a, which is substantially perpendicular to the longitudinal direction A, at the upstream end thereof. The first curved portion 25b is defined continuously with a downstream side of the up-

stream vertical portion 25a, and is arranged to curve so as to be convex away from the center line CT (i.e., outward in the longitudinal direction A). That is, each partition wall 25 includes the first curved portion 25b, which is defined continuously with the downstream side of the upstream vertical portion 25a and is arranged to curve so as to be convex away from the center line CT. The second curved portion 25c is defined continuously with a downstream side of the first curved portion 25b, and is arranged to curve so as to be convex toward the center line CT (i.e., inward in the longitudinal direction A). That is, each partition wall 25 includes the second curved portion 25c, which is defined continuously with the downstream side of the first curved portion 25b and is arranged to curve so as to be convex toward the center line CT. The downstream vertical portion 25d is defined continuously with the second curved portion 25c at a downstream end, and is arranged to be substantially perpendicular to the longitudinal direction A. That is, each partition wall 25 includes, at the downstream end thereof, the downstream vertical portion 25d, which is defined continuously with the second curved portion 25c and is arranged to be substantially perpendicular to the longitudinal direction A.

[0028] Thus, the upstream end of each partition wall 25 is arranged outward of the downstream end thereof with respect to the longitudinal direction A, so that a width W1 of the main passage 21a at the suction inlet 4a measured in the longitudinal direction A is greater than a width W2 of the main passage 21a at the outlet 22 measured in the longitudinal direction A. A width W3 of the suction inlet 4b measured in the longitudinal direction A is smaller than a width W4 of the division passage 21b at the outlet 22 measured in the longitudinal direction A. A width W5 of the suction inlet 4c measured in the longitudinal direction A is smaller than a width W6 of the division passage 21c at the outlet 22 measured in the longitudinal direction A.

[0029] The width W3 of the suction inlet 4b and the width W5 of the suction inlet 4c are arranged to be substantially equal to each other, and the width W1 of the suction inlet 4a is arranged to be greater than the width W3 of the suction inlet 4b and the width W5 of the suction inlet 4c. The width W4 of the division passage 21b at the outlet 22 and the width W6 of the division passage 21c at the outlet 22 are arranged to be substantially equal to each other. In addition, since each of the division passages 21b and 21c becomes wider on the downstream side, each of the width W4 of the division passage 21b at the outlet 22 and the width W6 of the division passage 21c at the outlet 22 approaches the width W2 of the main passage 21a at the outlet 22. In the present preferred embodiment, the width W2 of the main passage 21a at the outlet 22, the width W4 of the division passage 21b at the outlet 22, and the width W6 of the division passage 21c at the outlet 22 are arranged to be substantially equal to one another. Note that the width W3 of the suction inlet 4b and the width W5 of the suction inlet 4c may be dif-

ferent from each other.

[0030] Note that the number of partition walls 25 is not limited to two, but may alternatively be an even number equal to or greater than four. In this case, the suction passage 21 is divided into one main passage and an even number of division passages, the even number being equal to or greater than four.

[0031] If a cleaning start time previously stored in the storage portion of the electric vacuum cleaner 1 having the above-described structure comes, the case 2 leaves the charger stand and automatically travels on the floor F. At this time, the electric blower 7 is driven, and the rotary brush is caused to rotate. The cleaning operation of the electric vacuum cleaner 1 is thus started. Air flows including dust on the floor F enter into the main passage 21a and the division passages 21b and 21c through the suction inlets 4a, 4b, and 4c, respectively, as indicated by arrows S (see FIG. 5).

[0032] At this time, the upstream vertical portion 25a of each partition wall 25 contributes to reducing turbulence in the vicinity of the upstream end of the partition wall 25. Thus, the air flow smoothly enters into each of the main passage 21a and the division passages 21b and 21c. After entering into each of the main passage 21a and the division passages 21b and 21c, the air flows along the first curved portion 25b and then the second curved portion 25c. Thus, the air which has flowed into each of the division passages 21b and 21c is smoothly guided toward the center line CT. This contributes to reducing turbulence of the air in each of the division passages 21b and 21c, and causing the air to flow more smoothly therein.

[0033] In addition, because the widths W4 and W6 of the division passages 21b and 21c, respectively, at the outlet 22 approach the width W2 of the main passage 21a at the outlet 22, suction forces of equivalent magnitude act in the main passage 21a and the division passages 21b and 21c. Thus, suction forces are substantially evenly distributed in the longitudinal direction A of the suction inlet 4.

[0034] In addition, the width W1 of the suction inlet 4a of the main passage 21a, where turbulence does not easily occur, is arranged to be greater than the widths W3 and W5 of the suction inlets 4b and 4c, respectively, and this leads to improved suction efficiency of the suction nozzle 20.

[0035] In addition, the downstream vertical portion 25d of each partition wall 25 contributes to causing air which has reached a downstream portion of each of the main passage 21a and the division passages 21b and 21c to be smoothly guided downstream of the outlet 22.

[0036] After passing in the main passage 21a and the division passages 21b and 21c, the air flows enter into the dust collection portion 8 through the outlet 22. At this time, dust D in the air is blocked by the filter 9, and is collected in the dust collection portion 8. After passing through the filter 9, the air flows in a portion of the air passage 6 on the downstream side of the filter 9, and is

then sent out of the case 2 through the discharge outlet 5. The floor F is cleaned in the above-described manner.

[0037] After traveling over the entire floor F while keeping the electric blower 7 in operation, the electric vacuum cleaner 1 returns to the charger stand, and the electric blower 7 is stopped. The cleaning operation of the electric vacuum cleaner 1 is thus completed.

[0038] FIGS. 6 and 7 are a perspective view and a side view, respectively, illustrating a result of a simulation of flows of air in the portion of the air passage 6 on the suction side. In these figures, almost no turbulence can be observed in any of the main passage 21a and the division passages 21b and 21c, and air flows in a laminar state in each of the main passage 21a and the division passages 21b and 21c. In addition, a turbulent flow that is so large as to rescatter the accumulated dust cannot be observed in the dust collection portion 8.

[0039] For a comparative example, a similar simulation was performed with the partition walls 25 being omitted, and the result was that large turbulent flows were observed in the dust collection portion 8 and both end portions of the suction passage 21 with respect to the longitudinal direction A.

[0040] FIG. 8 is a side view illustrating a result of a simulation of an air velocity distribution in the portion of the air passage 6 on the suction side. The result shows that, in the suction passage 21, air flows at a substantially uniform velocity at about 25 m/s, and in the dust collection portion 8, air flows at a substantially uniform velocity at about 0.041 m/s. In contrast, in the aforementioned comparative example, the air velocity varied widely in both the suction nozzle 20 and the dust collection portion 8.

[0041] FIG. 9 is a side view illustrating a result of a simulation of an air pressure distribution in the portion of the air passage 6 on the suction side. This figure shows that air pressure is substantially uniform in the suction nozzle 20 and the dust collection portion 8 at about -230 Pa. In contrast, in the aforementioned comparative example, the air pressure varied widely in the suction nozzle 20 and the dust collection portion 8.

[0042] The above results show that the suction nozzle 20 according to the present preferred embodiment is able to reduce turbulence in both the suction passage 21 and the dust collection portion 8.

[0043] In the present preferred embodiment, the plurality of partition walls 25, which are arranged to divide the suction passage 21 into the main passage 21a and the division passages 21b and 21c which are divided from one another in the longitudinal direction A of the suction inlet 4, are provided in the suction nozzle 20. This prevents a narrowing of a channel on a side closer to an air inlet of the electric blower 7 from causing flows of air sucked in through both end portions of the suction inlet 4 with respect to the longitudinal direction A to abruptly bend toward the center line CT immediately after entering into the suction passage 21, and thus contributes to reducing turbulence of the air.

[0044] In addition, the width W1 of the main passage

21a at the suction inlet 4 measured in the longitudinal direction A is greater than the width W2 of the main passage 21a at the outlet 22 measured in the longitudinal direction A. This causes each of the widths W4 and W6 of the division passages 21b and 21c, respectively, at the outlet 22 to approach the width W2 of the main passage 21a at the outlet 22, resulting in an increase in the suction force that acts in each of the division passages 21b and 21c. Thus, the suction forces are substantially evenly distributed over the suction inlet 4 in the longitudinal direction A. This leads to improved suction efficiency of the suction nozzle 20.

[0045] In addition, each partition wall 25 includes the upstream vertical portion 25a, which is substantially perpendicular to the longitudinal direction A, at an upstream end of the suction passage 21. This contributes to further reducing turbulence in the vicinity of the upstream end of the partition wall 25.

[0046] In addition, each partition wall 25 includes the first curved portion 25b, which is defined continuously with the downstream side of the upstream vertical portion 25a and is arranged to curve so as to be convex away from the center line CT. This contributes to causing air sucked in through the suction inlets 4b and 4c at both end portions with respect to the longitudinal direction A to smoothly flow in the division passages 21b and 21c.

[0047] In addition, each partition wall 25 includes the second curved portion 25c, which is defined continuously with the downstream side of the first curved portion 25b and is arranged to curve so as to be convex toward the center line CT. This contributes to causing the air sucked in through the suction inlets 4b and 4c at both end portions with respect to the longitudinal direction A to be smoothly guided to a downstream portion of the suction passage 21.

[0048] In addition, each partition wall 25 includes, at the downstream end thereof, the downstream vertical portion 25d, which is defined continuously with the second curved portion 25c and is arranged to be substantially perpendicular to the longitudinal direction A. This contributes to causing the air flowing in each of the main passage 21a and the division passages 21b and 21c to be smoothly guided to the outlet 22.

[0049] In addition, the width W1 of the main passage 21a at the suction inlet 4 measured in the longitudinal direction A is arranged to be greater than each of the widths W3 and W5 of the division passages 21b and 21c, respectively, at the suction inlet 4 measured in the longitudinal direction A. Arranging air to be sucked in through three separate suction inlets as described above contributes to reducing the likelihood of an occurrence of turbulence in the suction nozzle 20, and increasing the amount of air sucked in by the suction nozzle 20. Further, arranging each of the division passages 21b and 21c, which are relatively narrow, on the outer side with respect to the longitudinal direction A of the suction inlet 4 contributes to further improving suction efficiency at end portions of the suction nozzle 20 with respect to the longitu-

dinal direction A, at which weak suction forces tend to be observed most often in related art.

[0050] In addition, the electric vacuum cleaner 1 includes the suction nozzle 20, the dust collection portion 8 arranged downstream of the suction nozzle 20, and the electric blower 7 arranged downstream of the dust collection portion 8. The electric vacuum cleaner 1 is thus able to easily achieve improved suction efficiency and cleaning efficiency. In addition, because air flows in the laminar state in each of the main passage 21a and the division passages 21b and 21c, the dust D can be smoothly sucked in through even the suction inlets 4b and 4c at both end portions with respect to the longitudinal direction A without an increase in the rotation rate of the electric blower 7. This contributes to reducing the turbulence in the dust collection portion 8, and preventing the dust D accumulated in the dust collection portion 8 from being rescattered.

[0051] In addition, the suction passage 21 is arranged to extend upward from the suction inlet 4, and is connected to the upper portion of the dust collection portion 8, and the upper side of a portion of the dust collection portion 8 is covered with the suction nozzle 20. This contributes to reducing the size of the electric vacuum cleaner 1.

[0052] Note that, in the present preferred embodiment, the first curved portion 25b may alternatively be arranged to extend from a downstream end of the upstream vertical portion 25a to the outlet 22 with the second curved portion 25c and the downstream vertical portion 25d being omitted.

[0053] Next, a second preferred embodiment of the disclosure will now be described below. FIG. 10 is a perspective view of a portion of an air passage on the suction side including a suction nozzle of an electric vacuum cleaner according to the second preferred embodiment. FIG. 11 is a sectional front view of the suction nozzle of the electric vacuum cleaner according to the second preferred embodiment. For the sake of convenience in description, members or portions that have their equivalents in the above-described first preferred embodiment illustrated in FIGS. 1 to 9 are denoted by the same reference numerals as those of their equivalents in the first preferred embodiment. The second preferred embodiment is different from the first preferred embodiment in the shape of partition walls 25. The second preferred embodiment is otherwise similar to the first preferred embodiment.

[0054] In a suction passage 21, a plurality of plate-shaped partition walls 25 are arranged side by side in the longitudinal direction A. Each partition wall 25 is defined by a plate perpendicular to a lower wall 28b, and is arranged to extend in a straight line from a side on which a suction inlet 4 is defined to a side on which an outlet 22 is defined. That is, the partition wall 25 is in the shape of a plate, and is arranged to extend in a straight line from the side on which the suction inlet 4 is defined to the side on which the outlet 22 is defined. In a front view, two of the partition walls 25 are arranged to incline toward each

other as they extend from the suction inlet 4 toward the outlet 22.

[0055] The present preferred embodiment is able to achieve beneficial effects similar to those of the first preferred embodiment. In addition, each partition wall 25 is in the shape of a plate, and is arranged to extend in a straight line from the side on which the suction inlet 4 is defined to the side on which the outlet 22 is defined. This contributes to easily preventing a separation of an air flow passing in each of a main passage 21a and division passages 21b and 21c from any partition wall 25, and further reducing the likelihood of an occurrence of turbulence.

[0056] Next, a third preferred embodiment of the disclosure will now be described below. FIG. 12 is a perspective view of a portion of an air passage on the suction side including a suction nozzle of an electric vacuum cleaner according to the third preferred embodiment. FIG. 13 is a sectional front view of the suction nozzle of the electric vacuum cleaner according to the third preferred embodiment. For the sake of convenience in description, members or portions that have their equivalents in the above-described first preferred embodiment illustrated in FIGS. 1 to 9 are denoted by the same reference numerals as those of their equivalents in the first preferred embodiment. The third preferred embodiment is different from the first preferred embodiment in the shape of partition walls 25. The third preferred embodiment is otherwise similar to the first preferred embodiment.

[0057] Each partition wall 25 includes an upstream vertical portion 25a, a straight portion 25e, and a downstream vertical portion 25d arranged in the order named from the upstream side to the downstream side with respect to the direction in which air flows. The third preferred embodiment is different from the second preferred embodiment in that each partition wall 25 includes the downstream vertical portion 25d, which is arranged to be substantially perpendicular to the longitudinal direction A, at a downstream end thereof. This causes air which has reached a downstream portion of each of a main passage 21a and division passages 21b and 21c to be smoothly guided downstream of an outlet 22. The straight portion 25e is defined continuously with each of a downstream end of the upstream vertical portion 25a and an upstream end of the downstream vertical portion 25d, and is arranged to extend in a straight line.

[0058] The present preferred embodiment is also able to achieve beneficial effects similar to those of the first preferred embodiment. Note that the upstream vertical portion 25a or the downstream vertical portion 25d may alternatively be omitted in the present preferred embodiment.

[0059] Next, a fourth preferred embodiment of the disclosure will now be described below. FIG. 14 is a perspective view of an electric vacuum cleaner according to the fourth preferred embodiment. FIGS. 15 and 16 are a sectional front view and a side sectional view, respectively, of a suction nozzle of the electric vacuum cleaner

according to the fourth preferred embodiment. For the sake of convenience in description, members or portions that have their equivalents in the above-described first preferred embodiment illustrated in FIGS. 1 to 9 are denoted by the same reference numerals as those of their equivalents in the first preferred embodiment. The fourth preferred embodiment is different from the first preferred embodiment in that a so-called canister-type electric vacuum cleaner 30 is used instead of the robot-type electric vacuum cleaner 1. The fourth preferred embodiment is otherwise similar to the first preferred embodiment.

[0060] The electric vacuum cleaner 30 includes an air inlet 31 and a discharge outlet 5 in a front surface and a rear surface, respectively, of a case 2 thereof. An air passage 6, which is arranged to connect the air inlet 31 and the discharge outlet 5, is defined in the case 2. In the air passage 6, a dust collection portion 8, a filter 9, and an electric blower 7 are arranged in the order named from the upstream side to the downstream side. Left and right wheels 39 are attached to side surfaces of the case 2. In addition, the electric vacuum cleaner 30 is provided with a power supply cord (not shown) which is capable of being connected to a commercial power supply (not shown).

[0061] A hose 32 is connected to the air inlet 31 of the case 2, and a connection pipe 34 is connected to an upstream end of the hose 32. A handle portion 35 and an operation portion 16 are arranged in the connection pipe 34. The operation portion 16 is operated to issue an instruction to turn on or off the electric vacuum cleaner 30, an instruction to change the rotation rate of the electric blower 7, or the like. An extension pipe 33 is attached to an upstream end of the connection pipe 34. A suction nozzle 20 is attached to an upstream end of the extension pipe 33 such that the suction nozzle 20 is detachable from the extension pipe 33.

[0062] The suction nozzle 20 includes a joint pipe 27 connected to the extension pipe 33 at the rear of a housing 26 thereof, and an outlet 22 is open at a downstream end of the joint pipe 27. A width W7 of the outlet 22 measured in the longitudinal direction A is arranged to be smaller than a width W8 of a suction inlet 4 measured in the longitudinal direction A. A width of an opening portion 29 at an upstream end of the joint pipe 27 measured in the longitudinal direction A is arranged to be substantially equal to the width W7 of the outlet 22. In addition, downstream ends of partition walls 25 are arranged within the range of the width W7 of the outlet 22 measured in the longitudinal direction A.

[0063] If a user of the electric vacuum cleaner 30 having the above-described structure inserts a plug of the power supply cord into a socket (not shown), and operates the operation portion 16, the electric blower 7 is driven. As a result, air including dust D flows into each of a main passage 21a and division passages 21b and 21c through the suction inlet 4 of the suction nozzle 20. At this time, because the downstream ends of the partition walls 25 are arranged within the range of the width W7

of the outlet 22 measured in the longitudinal direction A, air flowing in each of the main passage 21a and the division passages 21b and 21c is smoothly guided to the outlet 22.

[0064] After flowing through each of the main passage 21a and the division passages 21b and 21c, the air flows through the extension pipe 33, the connection pipe 34, and the hose 32 in the order named, and then flows into the case 2 through the air inlet 31. The dust D in the air which has flowed into the case 2 is collected in the dust collection portion 8. A floor F is thus cleaned.

[0065] The present preferred embodiment is also able to achieve beneficial effects similar to those of the first preferred embodiment. In addition, the canister-type electric vacuum cleaner 30 is also able to achieve improved suction efficiency and cleaning efficiency.

[0066] Next, a fifth preferred embodiment of the disclosure will now be described below. FIG. 17 is a perspective view of an electric vacuum cleaner according to the fifth preferred embodiment. For the sake of convenience in description, members or portions that have their equivalents in the above-described first preferred embodiment illustrated in FIGS. 1 to 9 are denoted by the same reference numerals as those of their equivalents in the first preferred embodiment. The fifth preferred embodiment is different from the first preferred embodiment in that a so-called stick-type electric vacuum cleaner 40 is used instead of the robot-type electric vacuum cleaner 1. The fifth preferred embodiment is otherwise similar to the first preferred embodiment.

[0067] The electric vacuum cleaner 40 includes a case 2 including an air inlet 41 and a discharge outlet 5 in a lower surface and an upper surface, respectively, thereof. An air passage 6, which is arranged to connect the air inlet 41 and the discharge outlet 5, is defined in the case 2. In the air passage 6, a dust collection portion 8, a filter 9, and an electric blower 7 are arranged in the order named from the upstream side to the downstream side. In addition, the electric vacuum cleaner 40 is provided with a power supply cord (not shown) similar to that of the fourth preferred embodiment.

[0068] A handle portion 35 and an operation portion 16 are arranged at an upper portion of the case 2. A suction pipe 47 in the shape of a stick is connected to the air inlet 41 of the case 2. A suction nozzle 20 is attached to an upstream end of the suction pipe 47 such that the suction nozzle 20 is detachable from the suction pipe 47. The suction nozzle 20 according to the present preferred embodiment is similar in structure to the suction nozzle 20 according to the fourth preferred embodiment.

[0069] The present preferred embodiment is also able to achieve beneficial effects similar to those of the first preferred embodiment. In addition, the stick-type electric vacuum cleaner 40 is also able to achieve improved suction efficiency and cleaning efficiency.

[0070] Next, a sixth preferred embodiment of the disclosure will now be described below. FIG. 18 is a perspective view of an electric vacuum cleaner according to

the sixth preferred embodiment. For the sake of convenience in description, members or portions that have their equivalents in the above-described first preferred embodiment illustrated in FIGS. 1 to 9 are denoted by the same reference numerals as those of their equivalents in the first preferred embodiment. The sixth preferred embodiment is different from the first preferred embodiment in that a so-called handy-type electric vacuum cleaner 50 is used instead of the robot-type electric vacuum cleaner 1. The sixth preferred embodiment is otherwise similar to the first preferred embodiment.

[0071] The electric vacuum cleaner 50 is similar in structure to the electric vacuum cleaner 40 according to the fifth preferred embodiment with the suction pipe 47 being omitted. A user can clean a floor F, a desktop (i.e., a surface to be cleaned), or the like with the electric vacuum cleaner 50 while holding a handle portion 35.

[0072] The present preferred embodiment is also able to achieve beneficial effects similar to those of the first preferred embodiment. In addition, the handy-type electric vacuum cleaner 50 is also able to achieve improved suction efficiency and cleaning efficiency.

[0073] Note that, instead of the partition walls 25 according to the first preferred embodiment, partition walls similar to the partition walls 25 according to one of the second and third preferred embodiments may alternatively be arranged in the suction nozzle 20 according to each of the fourth to sixth preferred embodiments.

[0074] Also note that a rotary brush may be arranged in the suction inlet 4 of the suction nozzle 20 according to each of the fourth to sixth preferred embodiments.

[0075] Preferred embodiments of the disclosure are applicable to suction nozzles and electric vacuum cleaners including suction nozzles.

[0076] Features of the above-described preferred embodiments and the modifications thereof may be combined appropriately as long as no conflict arises.

[0077] While preferred embodiments of the disclosure have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing from the scope and spirit of the disclosure. The scope of the disclosure, therefore, is to be determined solely by the following claims.

Claims

1. A suction nozzle (20) to be provided in an electric vacuum cleaner (1, 30, 40, 50) including an electric blower (7), the suction nozzle (20) comprising:

a suction inlet (4) arranged to extend in a longitudinal direction (4) that is predetermined, and arranged opposite to a surface to be cleaned (F);
an outlet (22) to be connected to the electric blower (7);

a suction passage (21) arranged to extend along a center line (CT) joining a middle of the suction

- inlet (4) in the longitudinal direction (A) and a middle of the outlet (22) in the longitudinal direction (A) to connect the suction inlet (4) and the outlet (22); and
 a plurality of partition walls (25) each of which is arranged in the suction passage (21) to extend from a side on which the suction inlet (4) is defined to a side on which the outlet (22) is defined; wherein
 the suction passage (21) includes:
- a main passage (21a) having the center line (CT) of the suction passage (21) passing therethrough; and
 - a plurality of division passages (21b, 21c) arranged on both outer sides of the main passage (21a) with respect to the longitudinal direction (A) with one of the plurality of partition walls (25) being arranged between the main passage (21a) and an adjacent one of the plurality of division passages (21b, 21c) on either side of the main passage (21a), the main passage (21a) and the plurality of division passages (21b, 21c) being divided from one another in the longitudinal direction (A) of the suction inlet (4) by the plurality of partition walls (25); and
 - a width (W1) of the main passage (21a) at the suction inlet (4) measured in the longitudinal direction (A) is arranged to be greater than a width (W2) of the main passage (21a) at the outlet (22) measured in the longitudinal direction (A).
2. The suction nozzle according to claim 1, wherein each partition wall (25) includes, at an upstream end thereof, an upstream vertical portion (25a) arranged to be substantially perpendicular to the longitudinal direction (A).
 3. The suction nozzle according to claim 2, wherein each partition wall (25) further includes a first curved portion (25b) defined continuously with a downstream side of the upstream vertical portion (25a), and arranged to curve so as to be convex away from the center line (CT).
 4. The suction nozzle according to claim 3, wherein each partition wall (25) further includes a second curved portion (25c) defined continuously with a downstream side of the first curved portion (25b), and arranged to curve so as to be convex toward the center line (CT).
 5. The suction nozzle according to claim 4, wherein each partition wall (25) further includes, at a downstream end thereof, a downstream vertical portion (25d) defined continuously with the second curved
- portion (25c), and arranged to be substantially perpendicular to the longitudinal direction (A).
6. The suction nozzle according to claim 1 or 2, wherein each partition wall (25) includes, at a downstream end thereof, a downstream vertical portion (25d) arranged to be substantially perpendicular to the longitudinal direction (A).
 7. The suction nozzle according to claim 1, wherein each partition wall (25) is in a shape of a plate, and is arranged to extend in a straight line from the side on which the suction inlet (4) is defined to the side on which the outlet (22) is defined.
 8. The suction nozzle according to any one of claims 1 to 7, wherein
 a width (W7) of the outlet (22) measured in the longitudinal direction (A) is arranged to be smaller than a width (W8) of the suction inlet (4) measured in the longitudinal direction; and
 downstream ends of the plurality of partition walls (25) are arranged within a range of the width (W7) of the outlet (22) measured in the longitudinal direction (A).
 9. The suction nozzle according to any one of claims 1 to 8, wherein the width (W1) of the main passage (21a) at the suction inlet (4) measured in the longitudinal direction (A) is arranged to be greater than a width (W3, W5) of each division passage (21b, 21c) at the suction inlet (4) measured in the longitudinal direction (A).
 10. An electric vacuum cleaner comprising the suction nozzle of any one of claims 1 to 9, a dust collection portion (8) arranged downstream of the suction nozzle (20), and the electric blower (7) arranged downstream of the dust collection portion (8).
 11. The electric vacuum cleaner according to claim 10, wherein the suction passage (21) is arranged to extend upward from the suction inlet (4), and is connected to an upper portion of the dust collection portion (8), and an upper side of a portion of the dust collection portion (8) is covered with the suction nozzle (20).

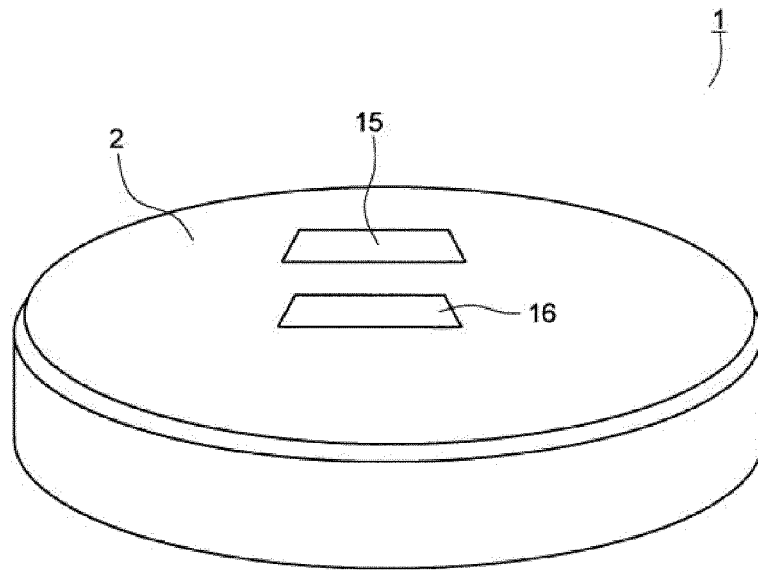


FIG. 1

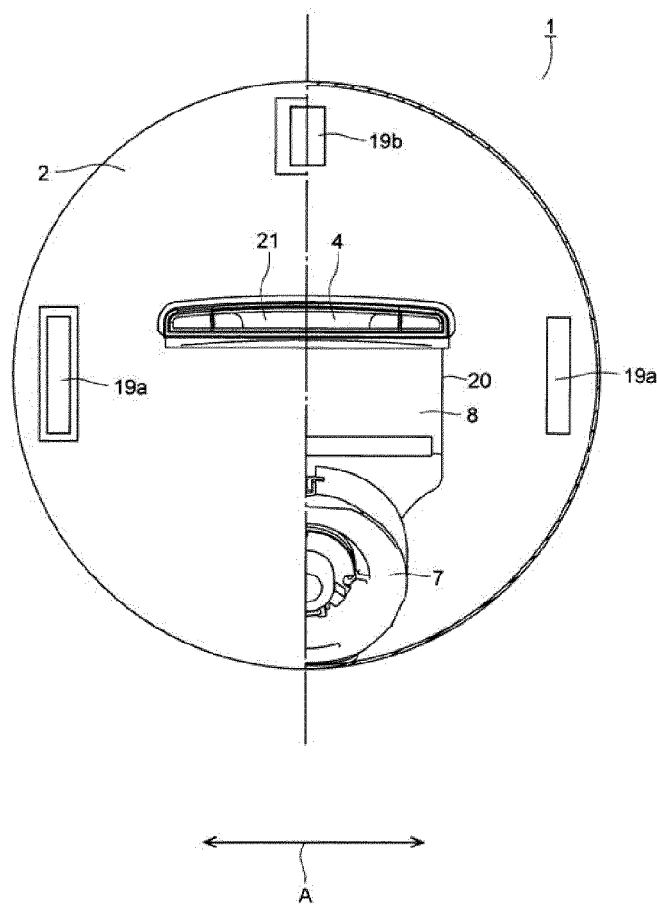


FIG. 2

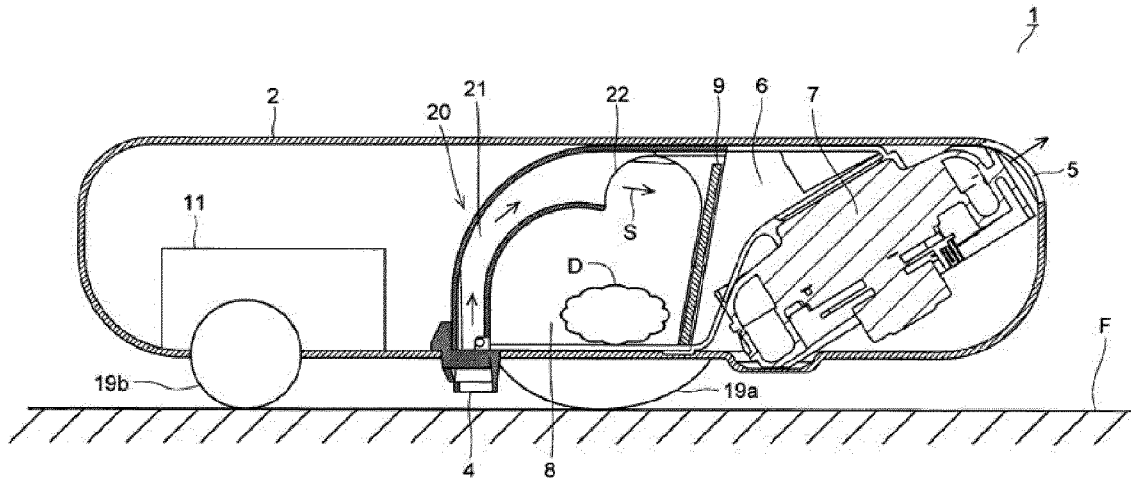


FIG. 3

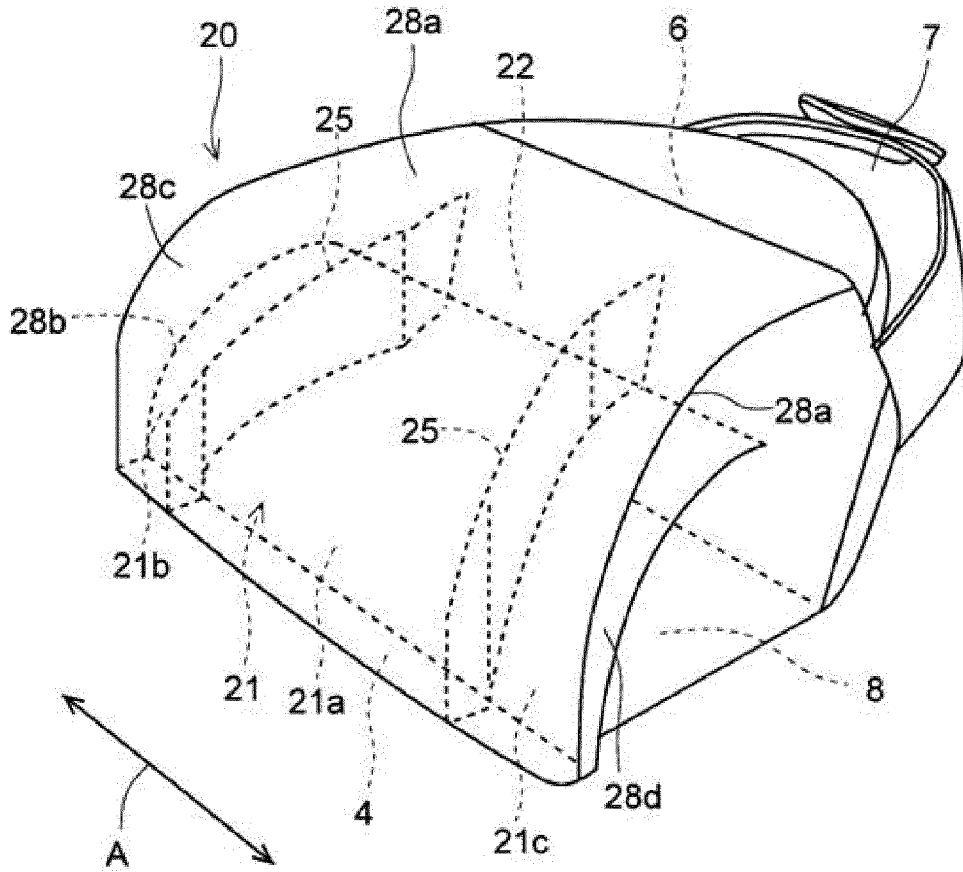


FIG. 4

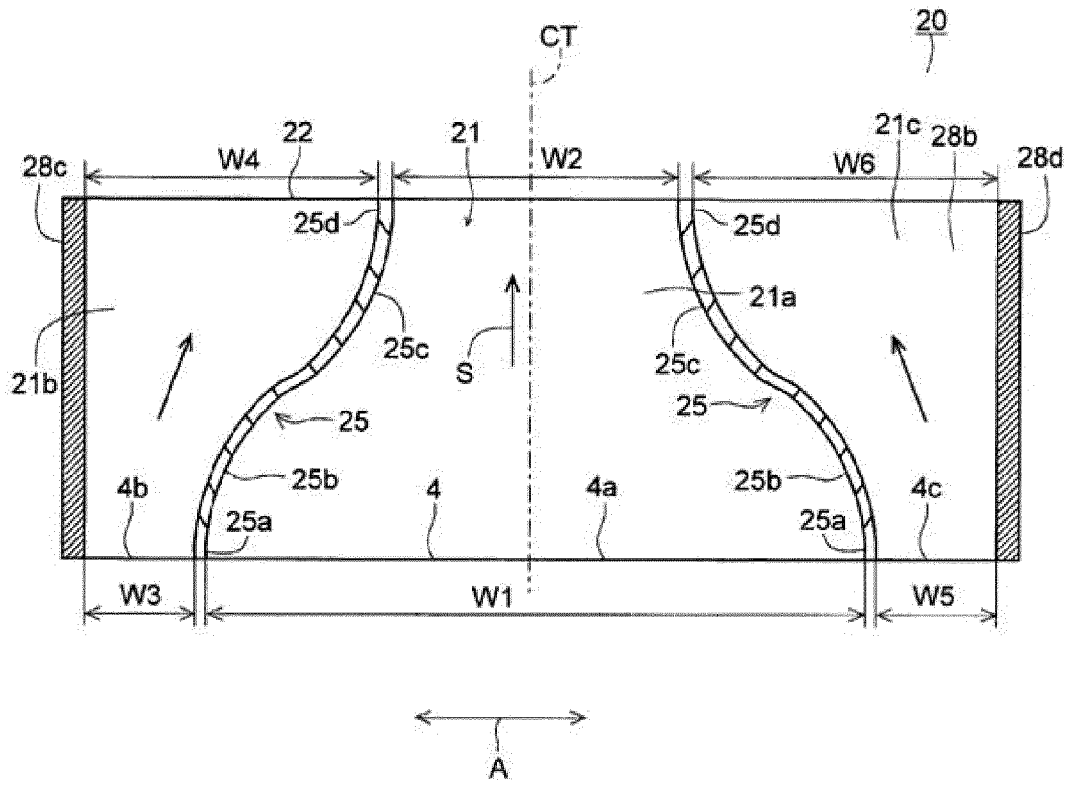


FIG. 5

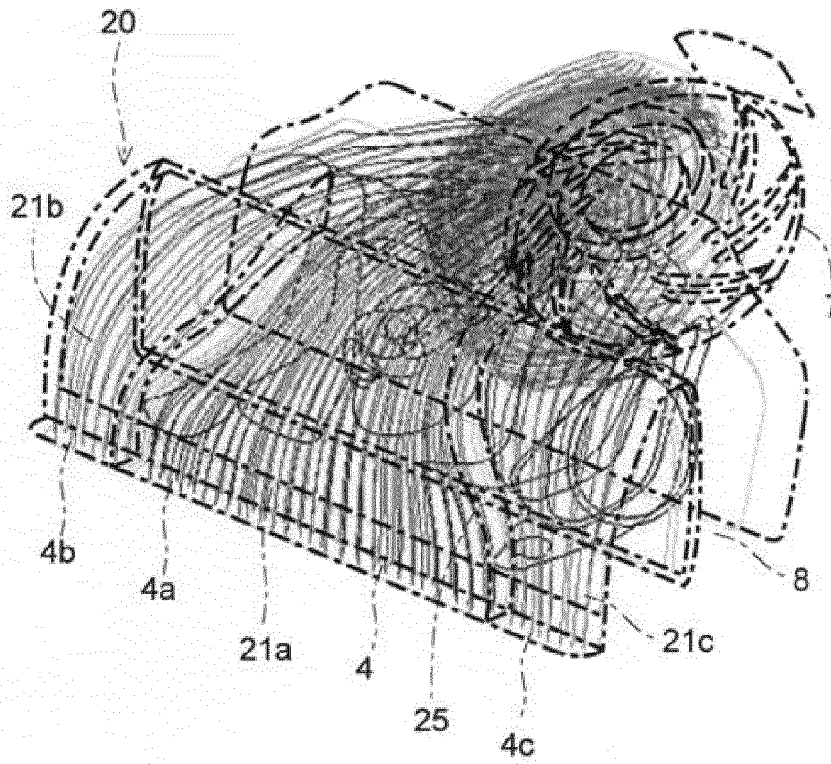


FIG. 6

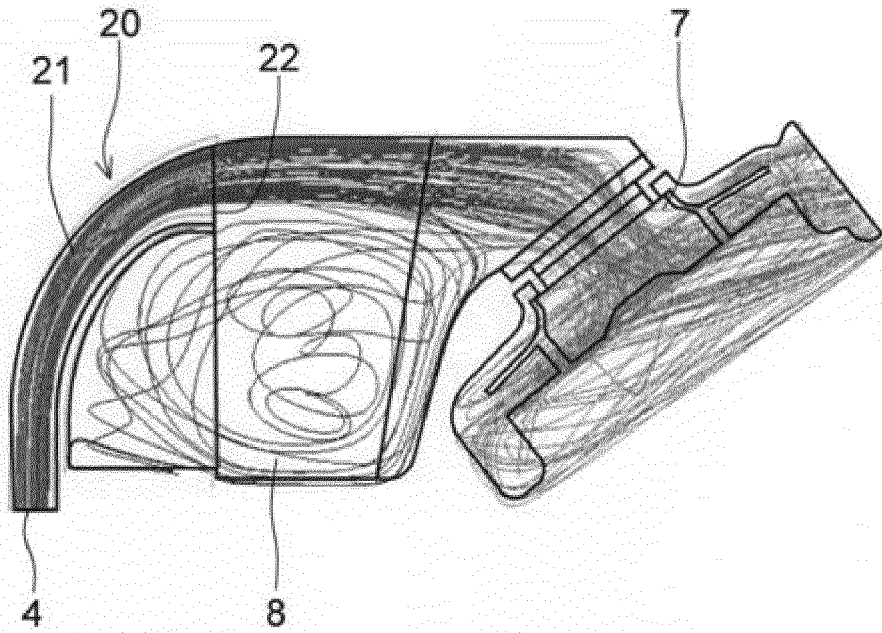


FIG. 7

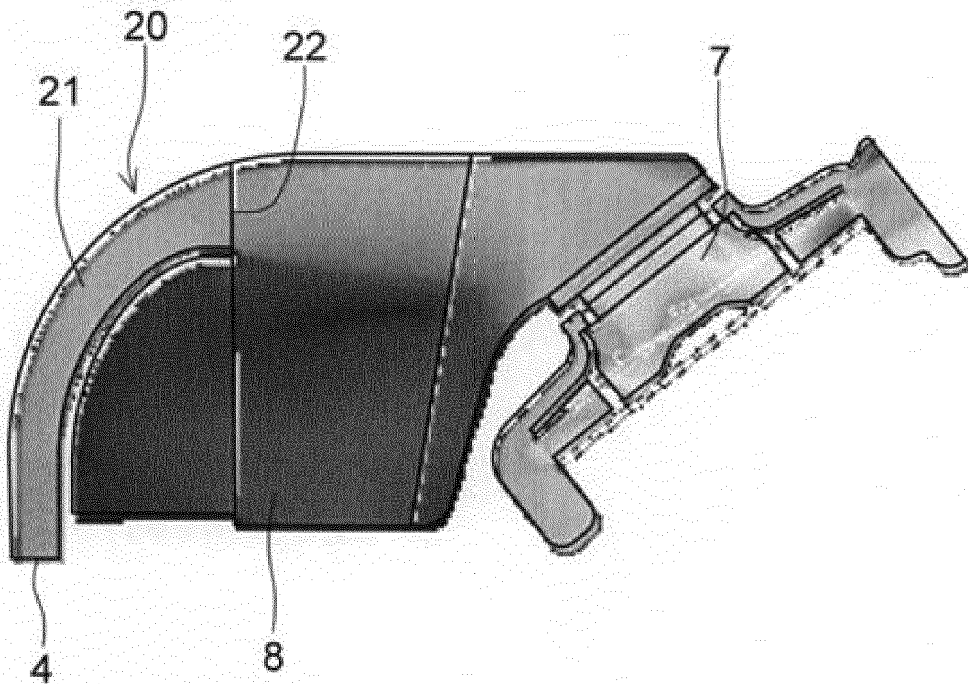


FIG. 8

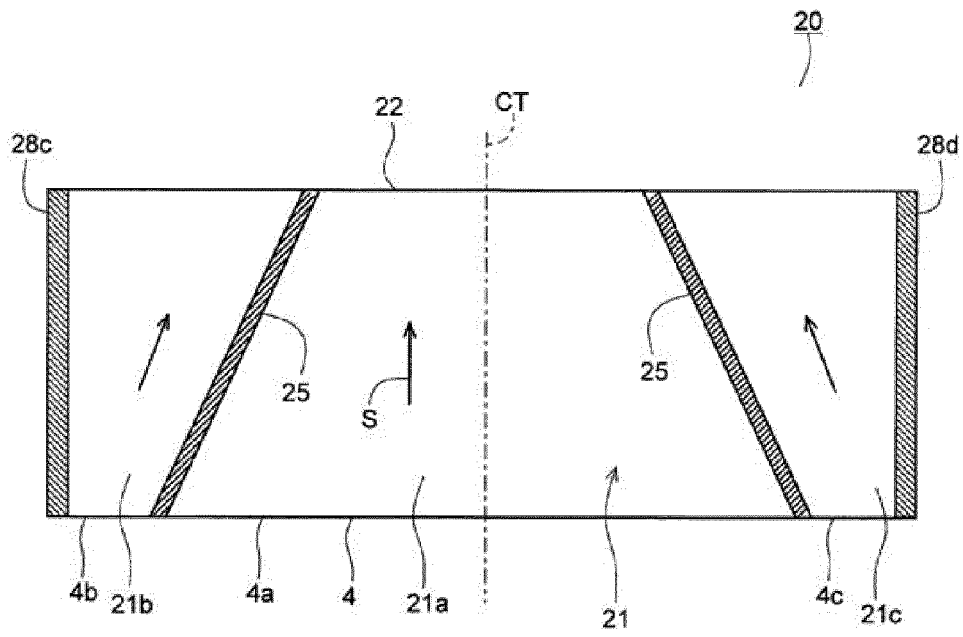


FIG. 11

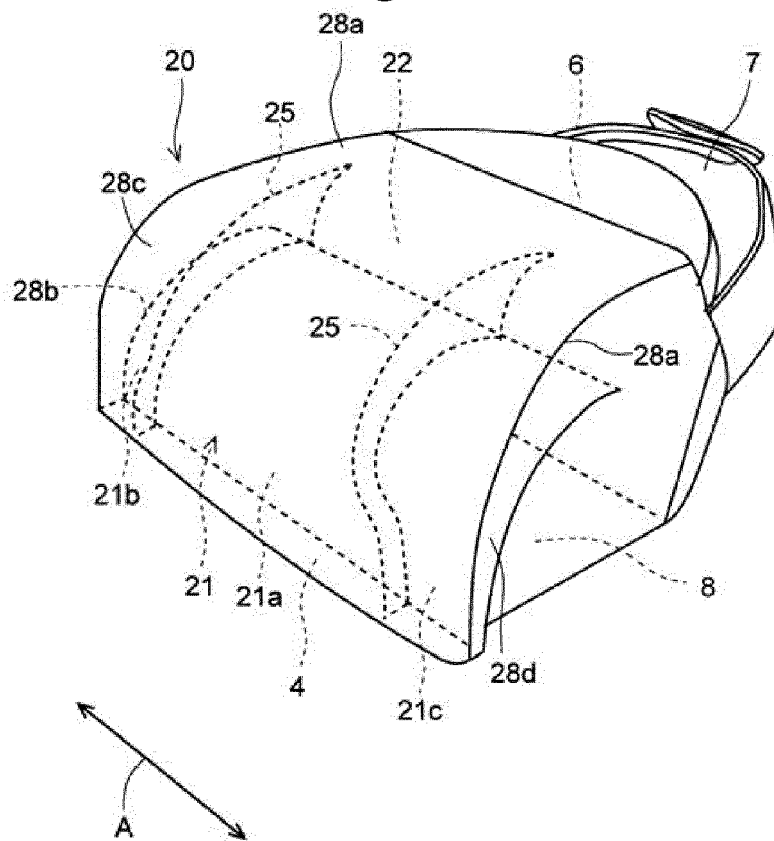


FIG. 12

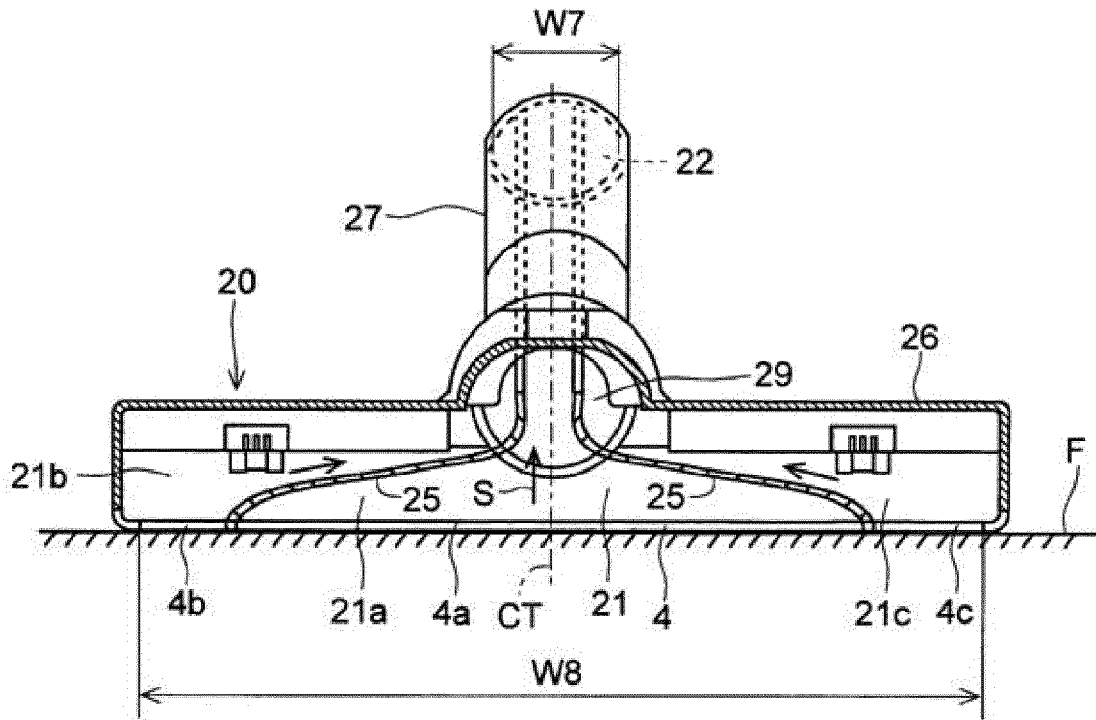


FIG. 15

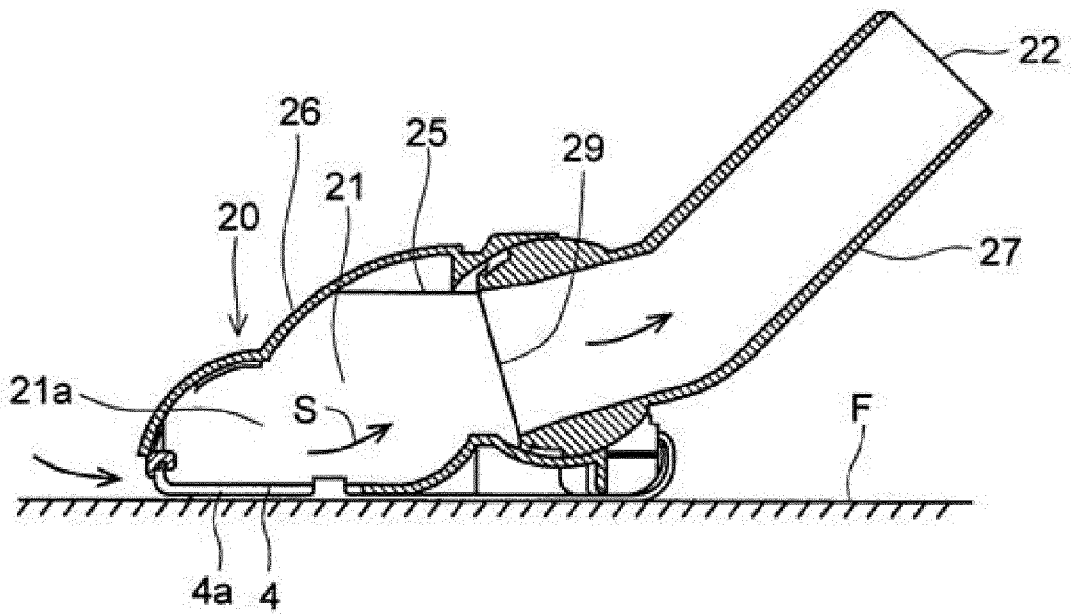


FIG. 16

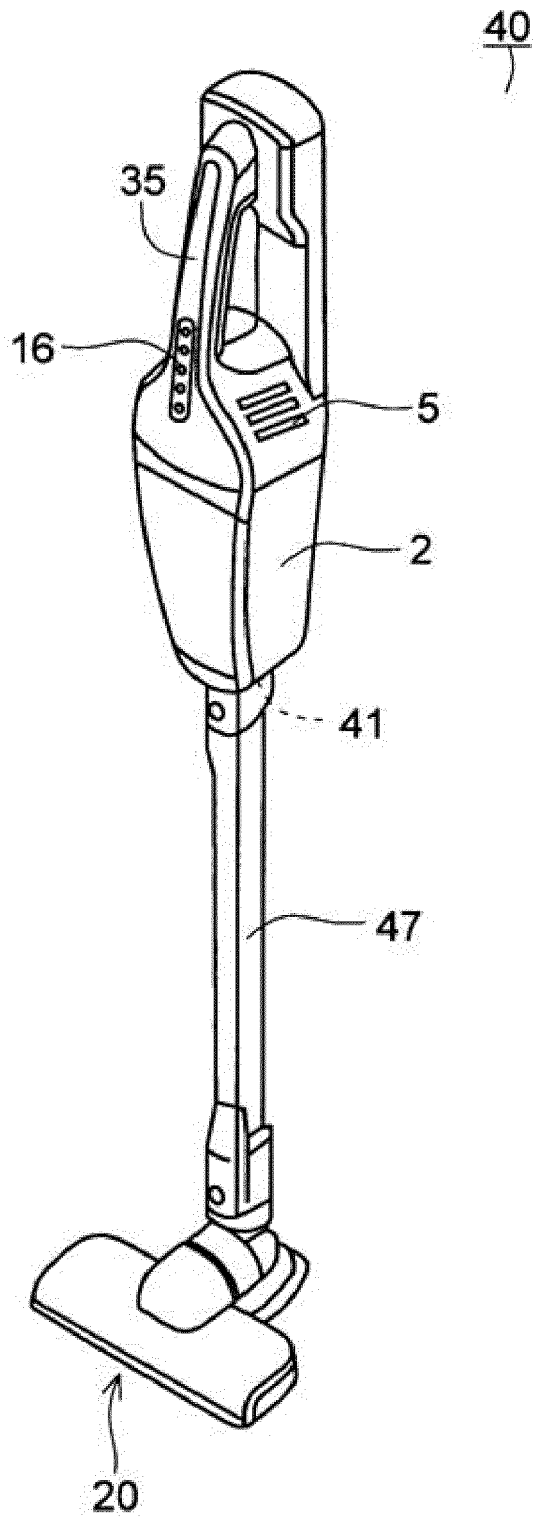


FIG. 17

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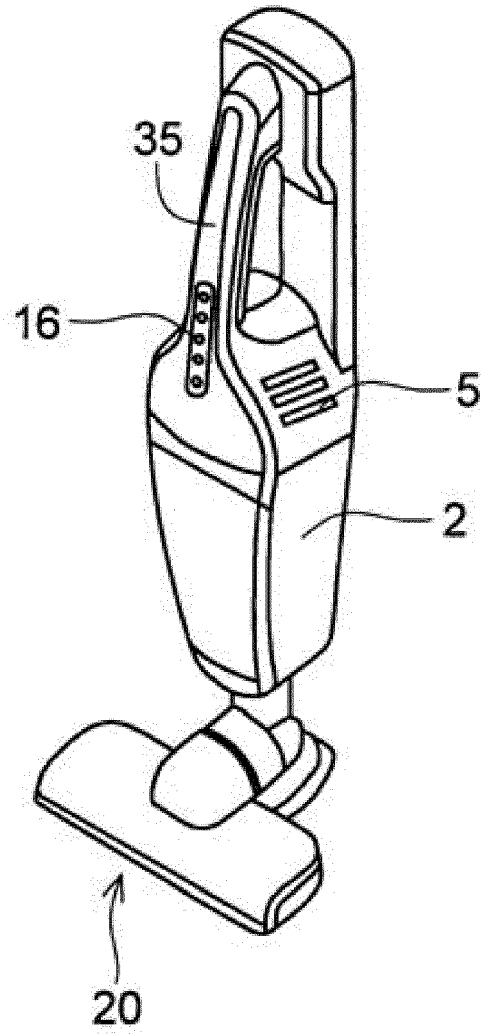


FIG. 18



EUROPEAN SEARCH REPORT

Application Number
EP 17 16 9854

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			A47L
Place of search		Date of completion of the search	Examiner
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