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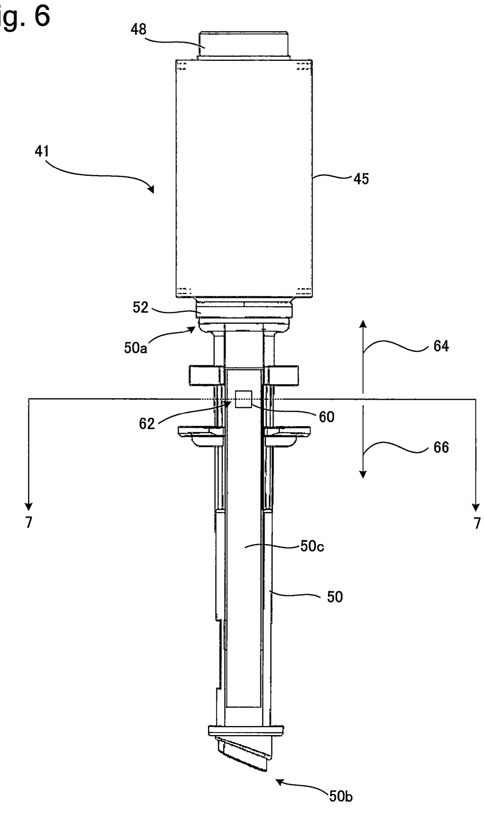
(54) SUCTION DEVICE

(57) Provided is a cartridge for an inhalation device and an inhalation device which have a new structure. The inhalation device comprises a cylindrical air channel forming element having a first end in communication with an air inlet and a second end in communication with an atomization chamber; a temperature sensor that is placed in a sensor placement portion provided to a wall surface of the air channel forming element; and a control portion configured to detect an air flow that enters from the air inlet into the air channel forming element and runs toward the atomization chamber according to a change of a value measured by the temperature sensor.

Fig. 6



EP 3 871 525 A1

Description

TECHNICAL FIELD

[0001] The invention relates to inhalation devices.

BACKGROUND ART

[0002] Inhalation devices for inhaling flavors or the like without burning material have conventionally been known. Known as such inhalation devices include, for example, a smoking material heating device that forms aerosol by heating smoking material consisting of tobacco that contains volatile components (see Patent Literature 1). The smoking material heating device described in the Patent Literature 1 includes a hollow cylinder-like heater.

CITATION LIST

PATENT LITERATURE

[0003] PTL 1: Japanese Unexamined Patent Application Publication (Kohyo) No. 2018-522551

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0004] An object of the invention is to provide an inhalation device having a new structure.

SOLUTION TO PROBLEM

[0005] One embodiment of the invention provides an inhalation device. The inhalation device includes a cylindrical air channel forming element having a first end in communication with an air inlet and a second end in communication with an atomization chamber; a temperature sensor that is placed in a sensor placement portion provided to a wall surface of the air channel forming element; and a control portion configured to detect an air flow that enters the air channel forming element from the air inlet and runs toward the atomization chamber according to a change of a value measured by the temperature sensor.

BRIEF DESCRIPTION OF DRAWINGS

[0006]

Fig. 1A is a perspective overall view of an inhalation device according to the present embodiment.
Fig. 1B is a perspective overall view of the inhalation device according to the present embodiment which holds a smoking article.
Fig. 2 is a cross-sectional view of a smoking article.
Fig. 3 is a cross-sectional view as viewed in a direction of an arrow 3—3 shown in Fig. 1A.
Fig. 4 is a side view as viewed in a direction of an arrow 4—4 shown in Fig. 1A.
Fig. 5 is a cross-sectional view of a heating assembly.
Fig. 6 is a side view of the heating assembly.
Fig. 7 is a cross-sectional view as viewed in a direction of an arrow 7—7 shown in Fig. 6.
Fig. 8 is a sectional side view of a bottom cap.

DESCRIPTION OF EMBODIMENTS

[0007] Embodiments of the invention will be discussed below with reference to the attached drawings. Regarding the drawings discussed below, the same or equivalent constituent elements will be provided with the same reference marks, and overlapping discussion will be omitted.

[0008] Fig. 1A is a perspective overall view of an inhalation device according to the embodiment. Fig. 1B is a perspective overall view of the inhalation device according to the embodiment which holds a smoking article. An inhalation device 10 according to the present embodiment is configured to generate aerosol containing a flavor, for example, by heating a smoking article 110 having a flavor source that includes an aerosol source.

[0009] As illustrated in Figs. 1A and 1B, the inhalation device 10 includes a top housing 11A, a bottom housing 11B, a cover 12, a switch 13, and a lid portion 14. The top housing 11A and the bottom housing 11B are connected together to form a housing 11 located on an outermost side of the inhalation device 10. The housing 11 is of such a size as to fit in a user's hand. When using the inhalation device 10, the user can hold the inhalation device 10 in his/her hand and inhale the flavor.

[0010] The top housing 11A has an opening, not shown. The cover 12 is coupled to the top housing 11A to close the opening. As illustrated in Fig. 1B, the cover 12 has an opening 12a into which the smoking article 110 can be inserted. The lid portion 14 is configured to open/close the opening 12a of the cover 12. To be specific, the lid portion 14 is attached to the cover 12 and configured to be movable between a first position for closing the opening 12a and a second position for opening the opening 12a along a surface of the cover 12. The lid portion 14 thus can allow or restrict access of the smoking article 110 to the inside of the inhalation device 10 (an opening of an outer fin 17 or an opening of a top cap 48 which will be discussed later).

[0011] The switch 13 is used to switch on and off the activation of the inhalation device 10. For example, if the user operates the switch 13 with the smoking article 110 inserted in the opening 12a as illustrated in Fig. 1B, electric power is supplied from a power source, not shown, to a heating member, not shown, which makes it possible to heat the smoking article 110 without burning the smoking article 110. The heating of the smoking article 110 causes aerosol to evaporate from the aerosol source included in the smoking article 110, and the flavor of the flavor source is taken into the aerosol. The user can inhale the aerosol containing the flavor by sucking a portion (which is illustrated in Fig. 1B) of the smoking article 110 which protrudes from the inhalation device 10. In the present specification, a longitudinal direction of the inhalation device 10 is a direction in which the smoking article 110 is inserted in the opening 12a.

[0012] The following discussion explains a configuration of the smoking article 110 used in the inhalation device 10 according to the present embodiment. Fig. 2 is a cross-sectional view of the smoking article 110. According to an embodiment shown in Fig. 2, the smoking article 110 includes a base material portion 110A including filling 111 and first wrapping paper 112 that wraps the filling 111, and a mouthpiece portion 110B that forms an opposite end portion from the base material portion 110A. The base material portion 110A and the mouthpiece portion 110B are joined together using second wrapping paper 113 that is separate from the first wrapping paper 112. It is possible, however, to use the first wrapping paper 112, instead of the second wrapping paper 113, to join the base material portion 110A and the mouthpiece portion 110B.

[0013] The mouthpiece portion 110B in Fig. 2 includes a paper tube portion 114, a filter portion 115, and a hollow segment portion 116 disposed between the paper tube portion 114 and the filter portion 115. The hollow segment portion 116 comprises, for example, a filling layer including one or more hollow channels, and a plug wrapper that covers the filling layer. The filling layer has a high fiber filling density. During inhalation, therefore, air and aerosol flow only through the hollow channel and hardly flow in the filling layer. If it is desired to repress a decrease in aerosol component which is caused by filtration of the filter portion 115 in the smoking article 110, the filter portion 115 is reduced in length, and the reduced amount is replaced with the hollow segment portion 116, which is effective to increase a delivery amount of the aerosol.

[0014] The mouthpiece portion 110B in Fig. 2 comprises three segments. According to the present embodiment, however, the mouthpiece portion 110B may comprise one or two segments or may comprise four or more segments. For example, it is possible to omit the hollow segment portion 116 and arrange the paper tube portion 114 and the filter portion 115 adjacently to each other to form the mouthpiece portion 110B.

[0015] According to the embodiment illustrated in Fig. 2, the smoking article 110 preferably has a longitudinal length ranging from 40 mm to 90 mm, more preferably from 50 mm to 75 mm, and still more preferably from 50 mm to 60 mm. The smoking article 110 preferably has a circumference ranging from 15 mm to 25 mm, more preferably from 17 mm to 24 mm, and still more preferably 20 mm to 23 mm. The smoking article 110 may include the base material portion 110A having a length of 20 mm, the first wrapping paper 112 having a length of 20 mm, the hollow segment portion 116 having a length of 8 mm, and the filter portion 115 having a length of 7 mm. However, the length of each of the aforementioned segments may be properly changed according to manufacturing suitability, quality requirement, and the like.

[0016] According to the present embodiment, the filling 111 of the smoking article 110 may contain an aerosol source that is heated at predetermined temperature and generates aerosol. The aerosol source may be of any kind. Materials extracted from various natural products and/or constituents thereof may be selected depending on an intended use. Examples of the aerosol source include glycerin, propylene glycol, triacetin, 1,3-butanediol, and composites thereof. Contained amount of the aerosol source in the filling 111 is not particularly limited as long as the aerosol source sufficiently generates aerosol. From a perspective of provision of a good smoking flavor, the contained amount of the aerosol source is generally 5% by weight or more, preferably 10% by weight or more, and generally 50% by weight or less, preferably 20% by weight or less.

[0017] The filling 111 of the smoking article 110 according to the present embodiment may contain shred tobacco as a flavor source. The shred tobacco may be made of any material, and publicly-known materials including laminae and stems may be used. If the smoking article 110 is 22 mm in circumference and 20 mm in length, the contained amount of the filling 111 in the smoking article 110 ranges, for example, from 200 mg to 400 mg, preferably from 250 mg to 320 mg. The filling 111 has a moisture content, for example, ranging from 8% by weight to 18% by weight, preferably from 10% by weight to 16% by weight. The foregoing moisture content prevents a stain on wrapping paper and improves a winding suitability in manufacture of the base material portion 110A. There is no particular limitation in size and preparation method of the shred tobacco used as the filling 111. For example, dried tobacco leaves may be used, which are shredded into pieces each having a width ranging from 0.8 mm to 1.2 mm. It is also possible to use dried tobacco leaves that are pulverized to have an average particle diameter ranging from about 20 μm to about 200 μm to be uniformed, processed into a sheet, and shredded into pieces each having a width ranging from 0.8 mm to 1.2 mm. The leaves processed into a sheet may be gathered, instead of being shredded, to be used as the filling 111. The filling 111 may contain one or more aroma chemicals. The aroma chemicals may be of any kind. From a perspective of provision of a good smoking flavor, however, menthol is preferable.

[0018] According to the present embodiment, the first wrapping paper 112 and the second wrapping paper 113 of the smoking article 110 can be made of base paper having a basis weight ranging, for example, from 20 gsm to 65 gsm, preferably from 25 gsm to 45 gsm. The first wrapping paper 112 and the second wrapping paper 113 are not particularly limited in thickness. From a perspective of rigidity, air permeability, and ease of preparation in paper manufacturing, however, the first wrapping paper 112 and the second wrapping paper 113 have a thickness ranging from 10 μm to 100 μm, preferably from 20 μm to 75 μm, and more preferably from 30 μm to 50 μm.

[0019] According to the present embodiment, the first wrapping paper 112 and the second wrapping paper 113 of the smoking article 110 may contain loading material. Contained amount of the loading material may fall in a range from 10% by weight to 60% by weight relative to total weight of the first wrapping paper 112 and the second wrapping paper 113, and preferably from 15% by weight to 45% by weight. According to the present embodiment, the contained amount of the loading material preferably ranges from 15% by weight to 45% by weight relative to the preferable basis weight range (from 25 gsm to 45 gsm). As the loading material, for example, calcium carbonate, titanium dioxide, kaolin or the like may be used. Paper containing such loading materials provides white light color that is preferable from a perspective of external appearance of wrapping paper of the smoking article 110, and can maintain whiteness on a permanent basis. If the wrapping paper contains a large amount of such loading materials, for example, whiteness percentage of the wrapping paper in conformity with the ISO International Standards can be maintained at 83% or more. Considering a utilitarian purpose of the first wrapping paper 112 and the second wrapping paper 113 as wrapping paper for the smoking article 110, the first wrapping paper 112 and the second wrapping paper 113 preferably have a tensile strength of 8 N/15 mm or higher. The tensile strength can be increased by reducing the contained amount of the loading material. More specifically, the tensile strength can be increased by reducing the contained amount of the loading material less than the upper limit of the contained amount of the loading material with respect to each of the basis weight ranges mentioned above.

[0020] The following discussion explains an internal structure of the inhalation device 10 illustrated in Figs. 1A and 1B. Fig. 3 is a cross-sectional view as viewed in a direction of arrow 3—3 shown in Fig. 1A. Fig. 4 is a side view as viewed in a direction of an arrow 4—4 shown in Fig. 1A. As illustrated in Fig. 3, the inhalation device 10 includes a power source portion 20, a circuit portion 30 (which is an example of a control portion), and a heating portion 40 in an interior space of the housing 11. The circuit portion 30 includes a first circuit board 31 and a second circuit board 32 that is electrically connected to the first circuit board 31. The first circuit board 31 is disposed, for example, so as to extend in the longitudinal direction as illustrated in the figure. The power source portion 20 and the heating portion 40 are thus separated by the first circuit board 31. This represses transmission of the heat generated in the heating portion 40 to the power source portion 20.

[0021] The second circuit board 32 is disposed between the power source portion 20 and the switch 13 and extends in a direction orthogonal to the extending direction of the first circuit board 31. The switch 13 is disposed adjacently to the second circuit board 32. When the user presses down the switch 13, the switch 13 can partially contact the second circuit board 32.

[0022] The first circuit board 31 and the second circuit board 32 include, for example, a microprocessor or the like and are capable of controlling power supply from the power source portion 20 to the heating portion 40. This allows the first circuit board 31 and the second circuit board 32 to control the heating of the smoking article 110 which is carried out by the heating portion 40.

[0023] The power source portion 20 includes a power source 21 that is electrically connected to the first circuit board 31 and the second circuit board 32. The power source 21 may be, for example, a rechargeable or non-rechargeable battery. The power source 21 is electrically connected to the heating portion 40 through at least either one of the first circuit board 31 and the second circuit board 32. This allows the power source 21 to supply power to the heating portion 40 so as to properly heat the smoking article 110. As illustrated in the figure, the power source 21 is disposed adjacently to the heating assembly 41 in a direction orthogonal to the longitudinal direction of the heating portion 40. This makes it possible to repress an increase of the longitudinal length of the inhalation device 10 even if the power source 21 is increased in size.

[0024] As illustrated in Figs. 3 and 4, the inhalation device 10 further includes a terminal 22 that is connectable to an external power source. The terminal 22 may be connected, for example, to a cable of a micro USB or the like. If the power source 21 is a rechargeable battery, the power source 21 can be charged by connecting the external power source to the terminal 22 to apply current from the external power source to the power source 21. It is also possible to connect a data transmission cable of a micro USB or the like to the terminal 22 so that data associated to activation of the inhalation device 10 may be sent to an external device.

[0025] The heating portion 40 includes a heating assembly 41 extending in the longitudinal direction as illustrated in the figure. The heating assembly 41 comprises a plurality of cylindrical members and forms a cylindrical body as a whole. The heating assembly 41 is configured to be capable of accommodating part of the smoking article 110 inside. The heating assembly 41 has a function of defining a channel for air to be supplied to the smoking article 110 and a function of heating the smoking article 110 from an outer periphery thereof.

[0026] The bottom housing 11B is provided with a vent hole 15 (which is an example of an air inlet) that allows air to enter the heating assembly 41. More specifically, the vent hole 15 is in fluid communication with one end portion (end portion on the left side in Fig. 2) of the heating assembly 41. As illustrated in Figs. 3 and 4, the inhalation device 10 includes an attachable/detachable cap 16 at the vent hole 15. The cap 16 is disposed to face an upstream end 50b (see Fig. 5) of a bottom cap 50 discussed later which is a part of the heating assembly 41. The cap 16 includes a through hole 16a in communication with an inner channel of the heating assembly 41 to allow air to enter the heating assembly 41 though the vent hole 15 even in a position attached to the vent hole 15. The through hole 16a may be a notch formed in the cap 16. Since the cap 16 is attached to the vent hole 15, a substance produced from the smoking article 110 inserted in the heating assembly 41 is prevented from falling outside the housing 11 through the vent hole 15.

[0027] The other end portion (end portion on the right side in Fig. 3) of the heating assembly 41 is in fluid communication with the opening 12a (which is an example of an air outlet) illustrated in Fig. 1B. A substantially cylindrical outer fin 17 is provided between the cover 12 with the opening 12a and the other end portion of the heating assembly 41. The outer fin 17 is engaged with a downstream end of the top cap 48 discussed later. When the smoking article 110 is inserted from the opening 12a of the cover 12 into the inhalation device 10 as illustrated in Fig. 1B, at least the filling 111 (see Fig. 2) of the smoking article 110 passes through the outer fin 17 to be disposed inside the heating assembly 41. In short, the outer fin 17 forms a part of an opening portion for enabling the smoking article 110 to be accommodated. The outer fin 17 is preferably formed so that an opening on the cover 12 side (right side on Fig. 3) is larger than an opening on the heating assembly 41 side (left side on Fig. 3). This facilitates the insertion of the smoking article 110 from the opening 12a into the outer fin 17. When the smoking article 110 is not inserted in the heating assembly 41, the user can clean the inside of the heating assembly 41 by inserting a tool such as a brush from the opening 12a into the heating assembly 41. The cleaning tool also can be inserted from the one end portion (end portion on the left side on Fig. 3) of the heating assembly 41. In such a case, the cap is removed from the vent hole 15 of the inhalation device 10.

[0028] If the user inhales from a portion of the smoking article 110 which protrudes from the inhalation device 10, that is, the filter portion 115 illustrated in Fig. 2, with the smoking article 110 inserted from the opening 12a in the inhalation device 10 as illustrated in Fig. 1B, air enters the heating assembly 41 through a through hole 16a of the cap 16 and the vent hole 15. After entering in the heating assembly 41, the air passes through the heating assembly 41 and reaches into the user's mouth together with the aerosol generated from the smoking article 110. Accordingly, an end of the heating assembly 41 which is close to the vent hole 15 is an upstream side, whereas an end of the heating assembly 41 which is close to the opening 12a (end close to the outer fin 17) is a downstream side.

[0029] A configuration of the heating assembly 41 illustrated in Fig. 3 will be now discussed. Fig. 5 is a cross-sectional view of the heating assembly 41. Fig. 6 is a side view of the heating assembly. Fig. 7 is a cross-sectional view as viewed in a direction of an arrow 7-7 shown in Fig. 6. For convenience in discussion, the vent hole 15 of the housing 11 is virtually illustrated in Fig. 5. As illustrated in Fig. 5, the heating assembly 41 includes an inner tube 42, a heating member 43, aerogel 44, and an outer tube 45. The inner tube 42 is provided in one end with a first opening 42a, in which the smoking article 110 can be inserted, and in the other end with a second opening 42b which forms an air inlet. According to the present embodiment, the inner tube 42 has a cylindrical shape and is configured to come into contact with at least part of the smoking article 110 inserted from the first opening 42a. The second opening 42b is located upstream of an air flow, and the first opening 42a is located downstream of the air flow.

[0030] The outer tube 45 is so disposed as to enclose the inner tube 42, which forms a predetermined space between the inner tube 42 and the outer tube 45. The heating member 43 may be a flexible film heater that is fabricated, for example, by sandwiching a heat-generating resistive element with two PI (polyimide) films or other like films. The heating member 43 is so disposed as to abut against the inner tube 42. To be more specific, in an example illustrated in the figure, the heating member 43 is disposed on an outer peripheral surface of the inner tube 42, and an inner surface of the heating member 43 contacts an outer surface of the inner tube 42. Since the heating member 43 is disposed along the outer peripheral surface of the inner tube 42, the heating member 43 is deformed into a substantially cylindrical shape as a whole.

[0031] The heating assembly 41 further includes a first ring-like member 46 extending in a circumferential direction.

The first ring-like member 46 is located between a downstream end portion (first opening 42a-side end portion) of the inner tube 42 and a downstream end portion (end portion close to the first opening 42a of the inner tube 42) of the outer tube 45. The heating assembly 41 includes a second ring-like member 47 extending in a circumferential direction. The second ring-like member 47 is located between an upstream end portion (second opening 42b-side end portion) of the inner tube 42 and an upstream end portion (end portion close to the second opening 42b of the inner tube 42) of the outer tube 45. The first ring-like member 46 is tightly connected to the downstream end portion of the inner tube 42 via the top cap 48 and a heat shrinkable tube 52 which will be discussed later. The second ring-like member 47 is tightly connected to the upstream end portion of the inner tube 42 via a bottom cap 50 and the heat shrinkable tube 52. The first ring-like member 46 and the second ring-like member are tightly connected to the outer tube 45. A sealed space 54 is thus provided between the inner tube 42 and the outer tube 45. The heating member 43 and the aerogel 44 are accommodated in the sealed space 54.

[0032] Disposed between the heating member 43 and the aerogel 44 is the heat shrinkable tube 52. The heat shrinkable tube 52 has a cylindrical shape and keeps the heating member 43 in contact with the inner tube 42. More specifically, the heat shrinkable tube 52 is thermally shrunk by being applied with heat while disposed on an outer peripheral side of the heating member 43. The heat shrinkable tube 52 thus applies stress to the heating member 43 so as to press the heating member 43 against the inner tube 42. The heat shrinkable tube 52 may be made, for example, of thermoplastic resin, such as perfluoroalkoxy fluoroplastics (PFA). According to the present embodiment, the heat shrinkable tube 52 is employed for the purpose of maintaining a state where the heating member 43 is in contact with the inner tube 42. Instead of the heat shrinkable tube 52, however, any member that achieves the same purpose may be employed. For example, an elastic tube or the like, instead of the heat shrinkable tube 52, may be employed.

[0033] The inner tube 42 is preferably made of metal material, such as SUS, which has a high heat conductivity. This facilitates transmission of heat of the heating member 43 to the entire inner tube 42, allowing the inner tube 42 to fulfill a function as heating means. If the heating member 43 generates heat with the smoking article 110 accommodated in the inner tube 42, the smoking article 110 is heated, and the aerosol is generated. The inner tube 42 is thus a part of the atomization chamber that is a space in which the aerosol source is atomized. The outer tube 45 may be made, for example, of the same metal material as the inner tube 42. Since the aerogel 44 is disposed between the heating member 43 and the outer tube 45, the heat generated from the heating member 43 is difficult to transmit to the outer tube 45. According to the present embodiment, the aerogel 44 is employed to insulate the heat generated from the heating member 43. The aerogel 44 may be made of aerogel materials of various kinds including silica aerogel, carbon aerogel, alumina aerogel, and the like. Instead of aerogel, other insulating materials are also usable, which include, for example, fiber-based heat insulating material, such as glass wool and rock wool, foam-based heat insulating material, such as urethane foam and phenol foam. It is also possible to vacuumize the sealed space 54 to form a vacuum insulating space. If silica aerogel 44 is used as heat insulating material, volume of the aerogel 44 preferably ranges from 85% to 100% of capacity of the sealed space 54. This represses air bubble incorporation in the sealed space 54 and thus prevents the transmission of heat of the heating member 43, the inner tube 42 and the like to the outer tube 45 through air bubbles. If incorporated in the sealed space 54, air bubbles freely move depending on a position of the heating assembly 41 and might transmit the heat.

[0034] The heating assembly 41 further includes the top cap 48 and the bottom cap 50 (which is an example of an air channel forming element). The top cap 48 and the bottom cap 50 may be made, for example, of resin material. The top cap 48 is a cylindrical member having an interior space in communication with the first opening 42a of the inner tube 42. The top cap 48 is so configured that the smoking article 110 can be inserted therein. As illustrated in Fig. 5, the top cap 48 is connected to the downstream end of the inner tube 42 (end portion on the first opening 42a side). The top cap 48 is provided with one or more convex portions 48a in an inner peripheral surface thereof. The convex portions 48a are circumferentially spaced at regular intervals. The present embodiment includes four convex portions 48a that are provided in the inner peripheral surface of the top cap 48. The convex portions 48a provide frictional resistance to the smoking article 110 inserted in the top cap 48 to engage the smoking article 110. The convex portions 48a thus repress an accidental slip of the smoking article 110 from the inhalation device 10.

[0035] The bottom cap 50 is an elongated cylindrical member that includes a downstream end 50a (which is an example of the second end) connected to an upstream end (second opening 42b-side end portion) of the inner tube 42 and an upstream end 50b (which is an example of the first end) located on an opposite side from the downstream end 50a. The upstream end 50b of the bottom cap 50 is in communication with the vent hole 15 illustrated in Fig. 3, and the downstream end 50a is in communication with an interior portion of the inner tube 42. The bottom cap 50 forms an inner channel that introduces air toward the second opening 42b of the inner tube 42. The inner channel of the bottom cap 50 has a diameter smaller than an outer diameter of the smoking article 110. A tip end portion of the smoking article 110 inserted in the inner tube 42 abuts against the bottom cap 50 to be positioned. The upstream end 50b (end portion on the lower side on the figure) of the bottom cap 50 is disposed closely or adjacently to the vent hole 15 illustrated in Fig. 3. Air from the vent hole 15 flows from the upstream end 50b to the downstream end 50a of the bottom cap 50, passes through the inner tube 42 and the top cap 48, and reaches into the user's mouth. In other words, the bottom cap 50, the inner tube

42, and the top cap 48 form an air channel that brings the vent hole 15 and the opening 12a of the cover 12 into airy communication with each other.

[0036] As illustrated in Figs. 5 and 6, the heating assembly 41 according to the present embodiment includes a temperature sensor 60. The temperature sensor 60 is placed in a sensor placement portion 62 that is provided to a wall surface of the bottom cap 50. When the activation of the inhalation device 10 is started by the switch 13 illustrated in Fig. 3, the temperature sensor 60 measures temperature once every predetermined time interval and sends measured temperature data to the circuit portion 30. The circuit portion 30 is capable of detecting an air flow that enters the bottom cap 50 from the vent hole 15 and runs toward the inner tube 42 according to a change of a value measured by the temperature sensor 60. In other words, the circuit portion 30 is capable of detecting the user's puffing action on the basis of the data received from the temperature sensor 60. The temperature sensor 60 is provided to the wall surface of the bottom cap 50 which is located between the vent hole 15 and the heating member 43, so that the circuit portion 30 is capable of detecting the user's puffing action in view of both the temperature of the heating member 43 and outside temperature, which improves an accuracy in puffing action detection .

[0037] According to the present embodiment, the sensor placement portion 62 is located on an outer wall of the bottom cap 50. The temperature sensor 60 is thus disposed outside the air channel and therefore prevented from being physically affected by air passing through the air channel, aerosol that might flow backward into the air channel or the like.

[0038] If distance from the upstream end of the heating member 43 to an axially central portion of the temperature sensor 60 in an axial direction of the bottom cap 50 is d1, the distance d1 ranges, for example, from 5 mm to 9 mm, preferably from 6 mm to 8 mm, and is typically 7 mm. If distance from the vent hole 15 to the axially central portion of the temperature sensor 60 in the axial direction of the bottom cap 50 is d2, the distance d2 ranges, from 38 mm to 42 mm, preferably from 39 mm to 41 mm, and is typically 40 mm. A ratio of the distance d2 to the distance d1 (d2/d1) ranges, for example, from 4.22 to 8.40, preferably from 4.88 to 6.83, and is typically 5.71. When the ratio falls in the aforementioned range, the temperature sensor 60 is affected by both the air entering from the vent hole 15 and the heating member 43 in a balanced way. In other words, in the foregoing case, the temperature sensor 60 is prevented from being overly affected by either the air entering from the vent hole 15 or the heating member. This improves a detection accuracy of the temperature sensor 60 and thus improves the accuracy of puffing action detection of the circuit portion 30.

[0039] When the heating member 43 disposed along the inner tube 42 generates heat, the sensor placement portion 62 is increased in temperature due to heat transmission through the inner tube 42 and the bottom cap 50. If this temperature increase is $\Delta T1$, the temperature increase $\Delta T1$ ranges, for example, from 45°C to 55°C, preferably from 47.5°C to 52.5°C, and is typically 50°C. The temperature increase $\Delta T1$ can be adjusted by changing a heat generation amount of the heating member 43, the distances d1 and d2 and the like. According to the present embodiment, the temperature increase $\Delta T1$ is an increased temperature when temperature at the start of a time period in which smoking can be performed after the heating of the smoking article 110 or more specifically temperature at the issuance of a signal (for example, lighting of LED, not shown) indicating that preheating by the heating member 43 is ended, and therefore that smoking can be performed, is increased from atmospheric temperature (25°C, for example) outside of the inhalation device 10. The temperature of the heating member43 can be basically maintained within a predetermined range in most of a time period including the start point of the time period in which smoking can be performed. The temperature range is, for example, a range, an upper limit of which is 240°C, and a lower limit of which is 185°C. The temperature increase $\Delta T1$ can basically be fixed through the time period in which smoking can be performed.

[0040] When air enters from the vent hole 15 and passes through the inner channel of the bottom cap 50 while the heating member 43 is generating heat, the air receives the heat from the bottom cap 50 and the like to be increased in temperature. If temperature increase of the air that enters from the vent hole 15 into the bottom cap 50 to reach the sensor placement portion 62 is $\Delta T2$, the temperature increase $\Delta T2$ ranges, for example, from 10°C to 20°C, preferably from 12.5°C to 17.5°C, and is typically 15°C. The temperature increase $\Delta T2$ can be adjusted by changing the heat generation amount of the heating member 43, the distances d1 and d2 and the like. According to the present embodiment, the temperature increase $\Delta T2$ can be obtained, for example, from temperature detected by the temperature sensor 60 when the mouthpiece portion of the smoking article 110 inserted in the atomization chamber is sucked for 2 seconds by an inhalation amount of 27.5 ml/second. To be more specific, the temperature increase $\Delta T2$ may correspond to difference between the atmospheric temperature (25°C, for example) outside of the inhalation device 10 and the temperature detected by the temperature sensor 60 on the above-mentioned inhalation conditions. A ratio of the temperature increase $\Delta T1$ to the temperature increase $\Delta T2$ ($\Delta T1/\Delta T2$) ranges, for example, from 2.25 to 5.50, preferably from 2.71 to 4.20, and is typically 3.33. The temperature of the sensor placement portion 62 is thus prevented from being dominantly affected by either the heating member 43 or outside atmosphere. This enables the temperature sensor 60 to accurately measure a temperature change caused by the user's puffing action.

[0041] As illustrated in Fig. 6, the bottom cap 50 includes a downstream portion 64 located on the inner tube 42 side as viewed from the sensor placement portion 62, and an upstream portion 66 located on the vent hole 15 side as viewed from the sensor placement portion 62. The bottom cap 50 preferably has a smaller thickness at the sensor placement portion 62 than at the upstream portion 66. Furthermore, the bottom cap 50 preferably has a smaller thickness at the sensor placement portion 62 than at the downstream portion 64. In other words, the sensor placement portion 62 is preferably located at a thinnest region in the wall surface of the bottom cap 50 in the axial direction. As illustrated in Figs. 6 and 7, an outer surface of the bottom cap 50 which includes the sensor placement portion 62 is formed approximately flat. As illustrated in Fig. 7, the sensor placement portion 62 is preferably located at a thinnest region in the wall surface of the bottom cap 50 in a circumferential direction. If the wall surface on which the sensor placement portion 62 is located is small in thickness, a heat capacity of the sensor placement portion 62 is relatively small. Therefore, when air passes through the inner channel of the bottom cap 50, the sensor placement portion 62 is easy to decrease in temperature. This enables the temperature sensor 60 to accurately detect a temperature change caused by the air passing through the inner channel of the bottom cap 50.

[0042] A specific structure of the bottom cap 50 will be now discussed. Fig. 8 is a sectional side view of the bottom cap 50. For convenience in discussion, Fig. 8 shows the inner tube 42 as well. The bottom cap 50 includes an inner channel 72 through which air that enters from the vent hole 15 passes. The inner channel 72 is a channel extending from the upstream end 50b of the bottom cap 50 to the upstream end of the inner tube 42. As illustrated, the inner channel 72 of the present embodiment has a tapered shape spreading out from the upstream end 50b toward the downstream end 50a. The inner channel 72 has a smaller sectional area at the upstream end 50b than at the downstream end 50a. If the air entering from the vent hole 15 has a fixed flow volume, therefore, flow velocity is relatively large at the upstream end 50b of the bottom cap 50 and relatively small at the downstream end 50a. Consequently, the flow velocity of the air between the upstream end 50b of the bottom cap 50 and the sensor placement portion 62 is relatively large, which reduces a response time before puffing action is detected. Furthermore, the flow velocity of the air that enters the inner tube 42 is relatively small, so that the heat in the inner tube 42 is prevented from being excessively lost due to the entry of the air.

[0043] As illustrated in Fig. 8, if a largest diameter of the inner channel 72 of the bottom cap 50 is Dmax, and a diameter of the inner tube 42 is Dc, a ratio of the diameter Dc to the largest diameter Dmax (Dc/Dmax) ranges, for example, from 1.40 to 2.34, preferably from 1.56 to 2.01, and is typically 1.75. When the diameter Dc of the inner tube 42 is 7.00 mm, therefore, the largest diameter Dmax of the inner channel 72 of the bottom cap 50 ranges, for example, from 2.99 mm to 4.99 mm, preferably from 3.49 mm to 4.49 mm, and is typically 3.99 mm. If the ratio of the diameter Dc to the largest diameter Dmax is large, airflow resistance (namely pressure loss) increases, which is not preferable. At the same time, if the ratio is too small, a step between the inner channel 72 and the inner tube 42 is reduced, which disables the smoking article to be securely held.

[0044] If inclination angle, that is, taper angle of an inner wall surface of the bottom cap 50 which forms the inner channel 72, relative to a central axis of the inner channel 72 of the bottom cap 50, is θ, the taper angle θ ranges, for example, from 0.25 degree to 1.0 degree, and is typically 0.5 degree. Table 1 shows results of measurement of airflow resistance in the inner channel 72 (Rt) which are obtained when the taper angle θ is changed while largest sectional area Smax of the inner channel 72 of the bottom cap 50 is fixed. Table 1 further shows a ratio (Rt/Rd) of the air resistance (Rt) in the inner channel 72 having the taper angle θ, relative to airflow resistance (Rd) in a straight tube-like channel that has sectional area equal to the largest sectional area Smax of the inner channel 72 and is not provided with taper angle. The airflow resistance (Rt) and the airflow resistance ratio (Rt/Rd) in Table 1 are measurement results obtained when the bottom cap 50 provided with the inner channel 72 having an entire length of 40 mm is employed, and the inhalation amount through the mouthpiece of the smoking article inserted in the atomization chamber is 25.0 ml/second.

[Table 1]

Smax, mm^2	Smin, mm^2	θ	Airflow Resistance (Rt), mmH_2O	Airflow Resistance Ratio (Rt/Rd)
11.9	11.9	0.00 (straight tube)	8	1
11.9	9.84	0.25	8	1
11.9	7.94	0.5	9	1.125
11.9	6.25	0.75	15	1.875
11.9	4.75	1	24	3
11.9	0.79	2	150	18.75

[0045] As is apparent from Table 1, when the taper angle θ is 0.25 degree or larger, the airflow resistance begins to substantially increase. Therefore, the taper angle θ of 0.25 degree or larger enhances an effect of increasing the air flow velocity at the upstream end 50b of the bottom cap 50. When the taper angle θ is 1.0 degree or smaller, the airflow resistance can be reduced by about three times as much as the airflow resistance in a case where the bottom cap 50 has a straight tube-like shape. If an increase rate is about triple, it is possible to reduce influence on the user's inhalation feeling by adjusting the airflow resistance of the smoking article 110. Accordingly, if the airflow resistance ratio (Rt/Rd) is set within the aforementioned range, it is possible to improve responsiveness of puffing action detection by the temperature sensor 60 and the circuit portion 30 and also reduce the influence on the inhalation feeling which is caused by the airflow resistance increase in the inner channel 72.

[0046] If sectional area of the through hole 16a of the cap 16 illustrated in Fig. 4 is So, the sectional area So may have predetermined upper and lower limits. The upper limit of the sectional area So may be set, for example, so that a liquid residual product generated from the smoking article 110 is prevented from flowing outside the inhalation device 10 through the through hole 16a. The lower limit of the sectional area So of the through hole 16a may be set, for example, so as to prevent an excessive increase of the airflow resistance of the entire air channel comprising the through hole 16a and the inner channel 72.

[0047] As illustrated in Fig. 8, the bottom cap 50 according to the present embodiment is designed longer in axial length than the inner tube 42. Since the bottom cap 50 is therefore long in axial length, the aerosol generated inside the inner tube 42 is prevented from flowing out from the upstream end 50b of the bottom cap 50.

[0048] The embodiments according to the invention have been discussed. The invention, however, does not necessarily have to be made according to the above-described embodiments. The invention may be modified in various ways in a scope of the claims and the technical ideas discussed in the specification and drawings. Any shape and material that provide the operation and advantageous effects of the invention are in the scope of technical ideas of the invention even if there is no direct reference to such a shape and material in the specification and drawings.

[0049] Several embodiments disclosed in the present specification are described below.

[0050] According to a first embodiment, an inhalation device is provided. The inhalation device comprises a cylindrical air channel forming element having a first end in communication with an air inlet and a second end in communication with an atomization chamber; a temperature sensor placed in a sensor placement portion provided to a wall surface of the air channel forming element; and a control portion configured to detect an air flow that enters the air channel forming element from the air inlet and runs toward the atomization chamber according to a change of a value measured by the temperature sensor.

[0051] According to a second embodiment, in the inhalation device of the first embodiment, the air channel forming element forms a tapered inner channel that spreads from the first end toward the second end.

[0052] According to a third embodiment, in the inhalation device of the first or second embodiment, the inhalation device includes a heating member disposed along the atomization chamber; and d2/d1 ranges from 4.22 to 8.40, where d1 is distance from an upstream end of the heating member to the temperature sensor in an axial direction of the air channel forming element, and d2 is distance from the air inlet to the temperature sensor in the axial direction of the air channel forming element.

[0053] According to a fourth embodiment, in the inhalation device of the third embodiment, d2/d1 ranges from 4.88 to 6.83.

[0054] According to a fifth embodiment, in the inhalation device of any one of the first to fourth embodiments, the inhalation device includes a heating member; and $\Delta T1$ ranges from 45°C to 55°C, where $\Delta T1$ is temperature increase in the sensor placement portion which is caused by heat transmission from the heating member.

[0055] According to a sixth embodiment, in the inhalation device of the fifth embodiment, $\Delta T1$ ranges from 47.5°C to 52.5°C.

[0056] According to a seventh embodiment, in the inhalation device of the first to sixth embodiments, $\Delta T2$ ranges from 10°C to 20°C, where $\Delta T2$ is temperature increase of air that enters from the air inlet into the air channel forming element to reach the sensor placement portion.

[0057] According to an eighth embodiment, in the inhalation device of the seventh embodiment, $\Delta T2$ ranges from 12.5°C to 17.5°C.

[0058] According to a ninth embodiment, in the inhalation device of any one of the first to eighth embodiments, the inhalation device includes a heating member; and $\Delta T1/\Delta T2$ ranges from 2.25 to 5.50, where $\Delta T1$ is temperature increase of the sensor placement portion which is caused by heat transmission from the heating member, and $\Delta T2$ is temperature increase of air that enters from the air inlet into the air channel forming element to reach the sensor placement portion.

[0059] According to a 10th embodiment, in the inhalation device of the ninth embodiment, $\Delta T1/\Delta T2$ ranges from 2.71 to 4.20.

[0060] According to an 11th embodiment, in the inhalation device of any one of the first to 10th embodiments, the sensor placement portion is located on an outer wall of the air channel forming element.

[0061] According to a 12th embodiment, in the inhalation device of any one of the first to 11th embodiments, the air channel forming element includes an upstream portion located on the air inlet side as viewed from the sensor placement portion; and the air channel forming element is smaller in thickness at the sensor placement portion than at the upstream portion.

[0062] According to a 13th embodiment, in the inhalation device of any one of the first to 12th embodiments, the air channel forming element includes a downstream portion located on the atomization chamber side as viewed from the sensor placement portion; and the air channel forming element is smaller in thickness at the sensor placement portion than at the downstream portion.

[0063] According to a 14th embodiment, in the inhalation device of any one of the first to 13th embodiments, the sensor placement portion is located at a thinnest region in the air channel forming element in a circumferential direction.

[0064] According to a 15th embodiment, in the inhalation device of any one of the first to 14th embodiments, θ ranges from 0.25 degree to 1.0 degree, where θ is an inclination angle of an inner wall surface that forms the inner channel relative to a central axis of the inner channel.

[0065] According to a 16th embodiment, in the inhalation device of any one of the first to 15th embodiments, Dc/Dmax ranges from 1.40 to 2.34, where Dmax is a largest diameter of the inner channel, and Dc is a diameter of the atomization chamber having a cylindrical shape.

[0066] According to a 17th embodiment, in the inhalation device of the 16th embodiment, Dc/Dmax ranges from 1.56 to 2.01.

[0067] According to an 18th embodiment, in the inhalation device of any one of the first to 17th embodiments, the inhalation device includes a cap disposed on an opposite side from the first end of the air channel forming element; and the cap includes a through hole in communication with an inner channel of the air channel forming element.

[0068] According to a 19th embodiment, in the inhalation device of any one of the first to 18th embodiments, the air channel forming element is longer in axial length than the atomization chamber.

REFERENCE SIGN LIST

[0069]

0	Inhalation device
15	Vent hole
16	Cap
16a	Through hole
30	Circuit portion
42	Inner tube
43	Heating member
50	Bottom cap
50a	Downstream end
50b	Upstream end
60	Temperature sensor
62	Sensor placement portion
64	Downstream portion
66	Upstream portion
72	Inner channel
110	Smoking article

Claims

1. An inhalation device comprising a cylindrical air channel forming element having a first end in communication with an air inlet and a second end in communication with an atomization chamber;
a temperature sensor placed in a sensor placement portion provided to a wall surface of the air channel forming element; and
a control portion configured to detect an air flow that enters the air channel forming element from the air inlet and runs toward the atomization chamber according to a change of a value measured by the temperature sensor.

2. The inhalation device according to Claim 1,
wherein the air channel forming element forms a tapered inner channel that spreads from the first end toward the second end.

3. The inhalation device according to Claim 1 or 2,
wherein the inhalation device includes a heating member disposed along the atomization chamber; and
wherein d2/d1 ranges from 4.22 to 8.40, where d1 is distance from an upstream end of the heating member to the

temperature sensor in an axial direction of the air channel forming element, and d2 is distance from the air inlet to the temperature sensor in the axial direction of the air channel forming element.

4. The inhalation device according to Claim 3, wherein d2/d1 ranges from 4.88 to 6.83.

5. The inhalation device according to any one of Claims 1 to 4, wherein the inhalation device includes a heating member; and wherein $\Delta T1$ ranges from 45°C to 55°C, where $\Delta T1$ is temperature increase in the sensor placement portion which is caused by heat transmission from the heating member.

6. The inhalation device according to Claim 5, wherein $\Delta T1$ ranges from 47.5°C to 52.5°C.

7. The inhalation device according to any one of Claims 1 to 6, wherein $\Delta T2$ ranges from 10°C to 20°C, where $\Delta T2$ is temperature increase of air that enters from the air inlet into the air channel forming element to reach the sensor placement portion.

8. The inhalation device according to Claim 7, wherein $\Delta T2$ ranges from 12.5°C to 17.5°C.

9. The inhalation device according to any one of Claims 1 to 8, wherein the inhalation device includes a heating member; and wherein $\Delta T1/\Delta T2$ ranges from 2.25 to 5.50, where $\Delta T1$ is temperature increase of the sensor placement portion which is caused by heat transmission from the heating member, and $\Delta T2$ is temperature increase of air that enters from the air inlet into the air channel forming element to reach the sensor placement portion.

10. The inhalation device according to Claim 9, wherein $\Delta T1/\Delta T2$ ranges from 2.71 to 4.20.

11. The inhalation device according to any one of Claims 1 to 10, wherein the sensor placement portion is located on an outer wall of the air channel forming element.

12. The inhalation device according to any one of Claims 1 to 11, wherein the air channel forming element includes an upstream portion located on the air inlet side as viewed from the sensor placement portion; and wherein the air channel forming element is smaller in thickness at the sensor placement portion than at the upstream portion.

13. The inhalation device according to any one of Claims 1 to 12, wherein the air channel forming element includes a downstream portion located on the atomization chamber side as viewed from the sensor placement portion; and wherein the air channel forming element is smaller in thickness at the sensor placement portion than at the downstream portion.

14. The inhalation device according to any one of Claims 1 to 13, wherein the sensor placement portion is located at a thinnest region in the air channel forming element in a circumferential direction.

15. The inhalation device according to any one of Claims 1 to 14, wherein θ ranges from 0.25 degree to 1.0 degree, where θ is an inclination angle of an inner wall surface that forms the inner channel relative to a central axis of the inner channel.

16. The inhalation device according to any one of Claims 1 to 15, wherein Dc/Dmax ranges from 1.40 to 2.34, where Dmax is a largest diameter of the inner channel, and Dc is a diameter of the atomization chamber having a cylindrical shape.

17. The inhalation device according to Claim 16, wherein Dc/Dmax ranges from 1.56 to 2.01.

18. The inhalation device according to any one of Claims 1 to 17,
wherein the inhalation device includes a cap disposed on an opposite side from the first end of the air channel forming element; and
wherein the cap includes a through hole in communication with an inner channel of the air channel forming element.

19. The inhalation device according to any one of Claims 1 to 18,
wherein the air channel forming element is longer in axial length than the atomization chamber.

Fig. 1A

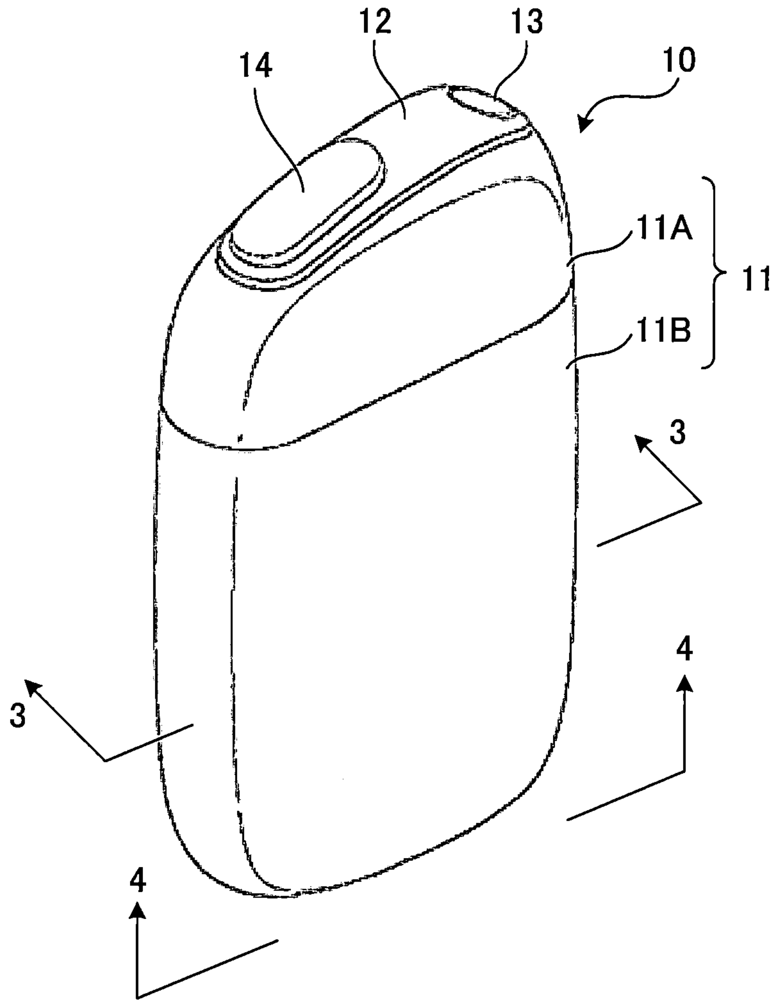
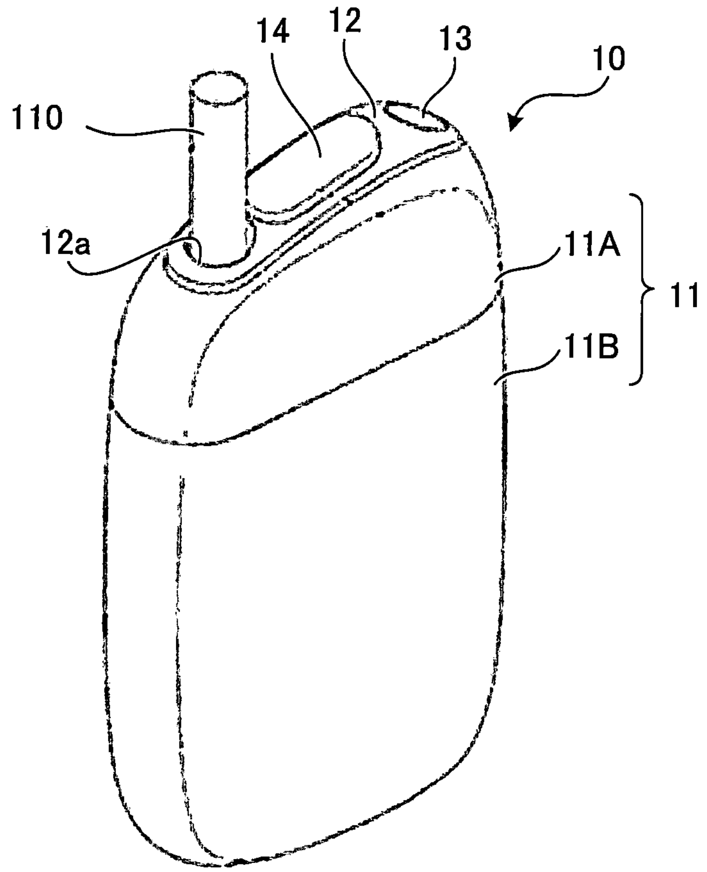


Fig. 1B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11A
11
11B

Fig. 2

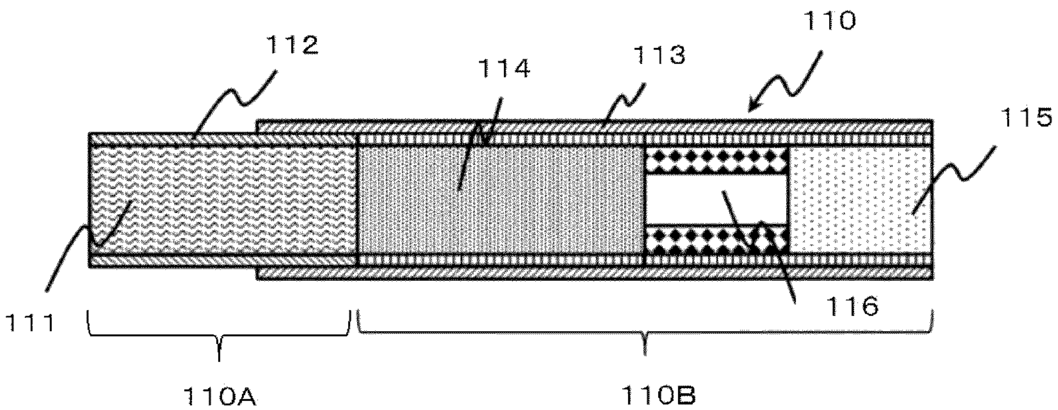
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Fig. 3

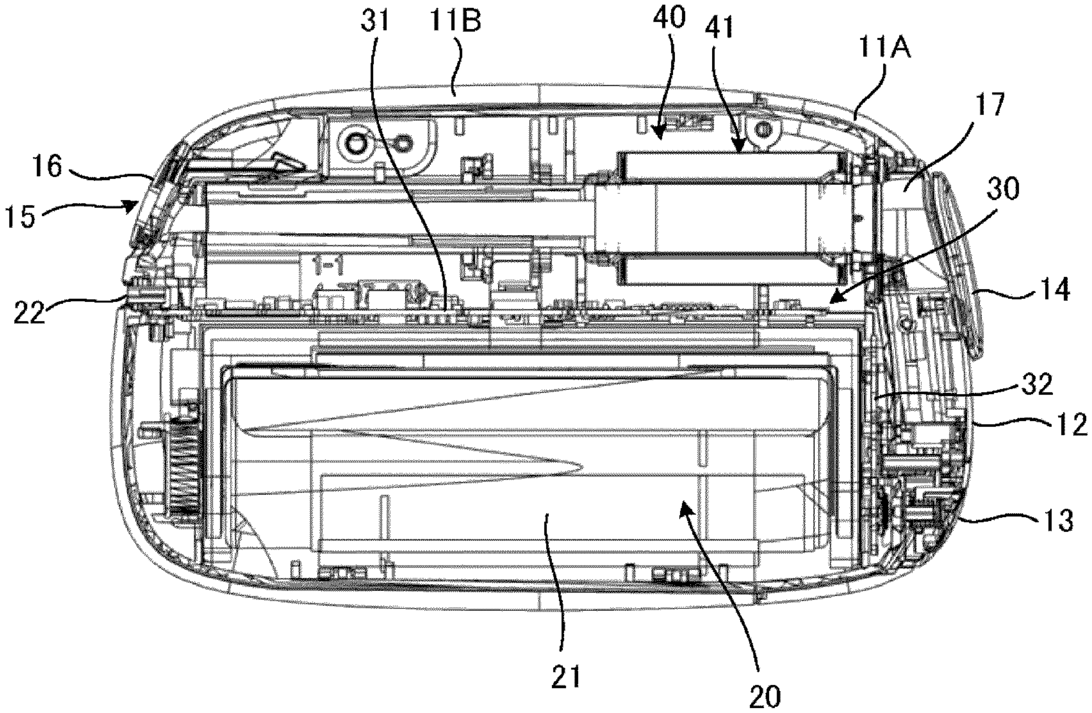


Fig. 4

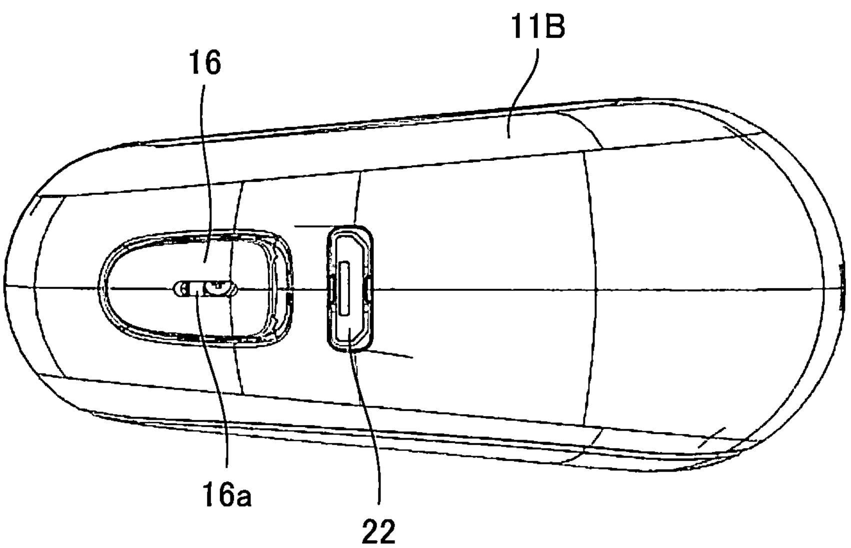


Fig. 5

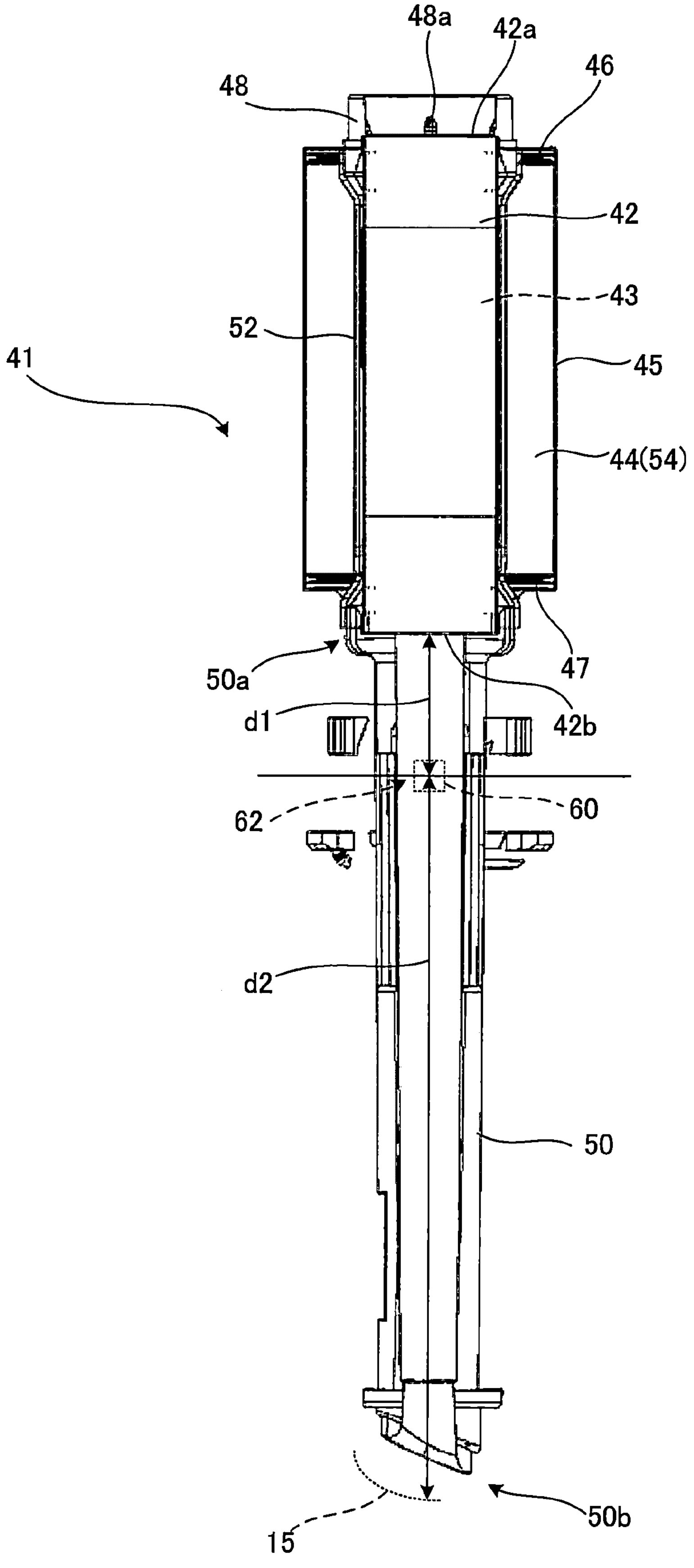


Fig. 6

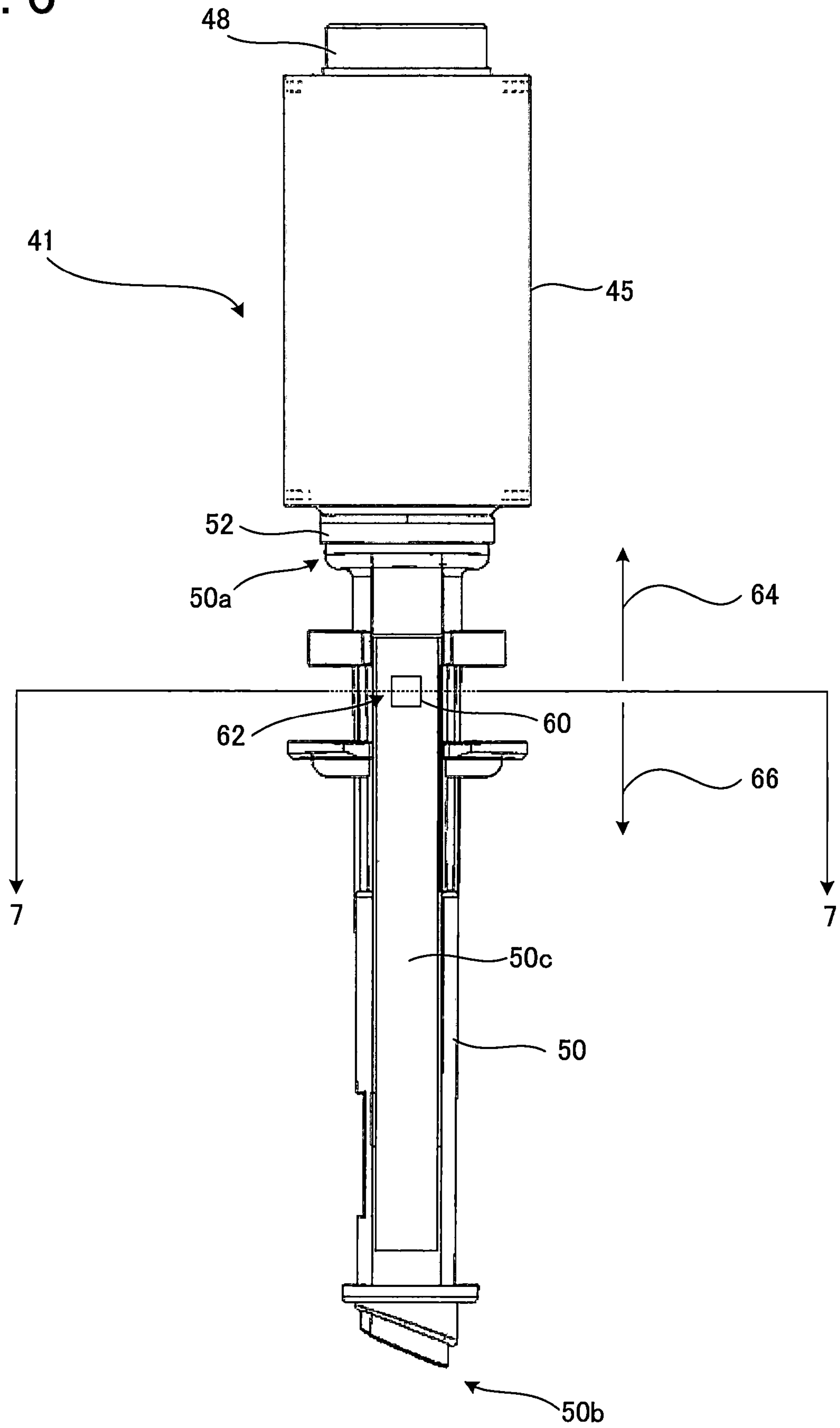


Fig. 7

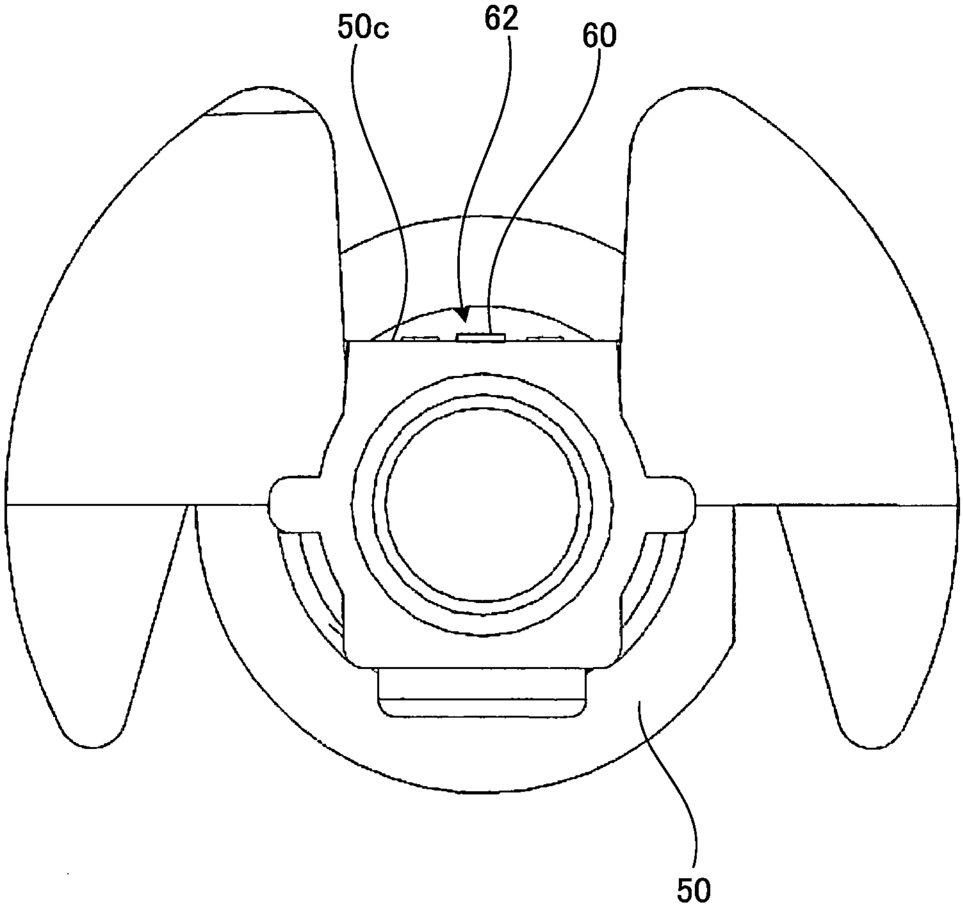
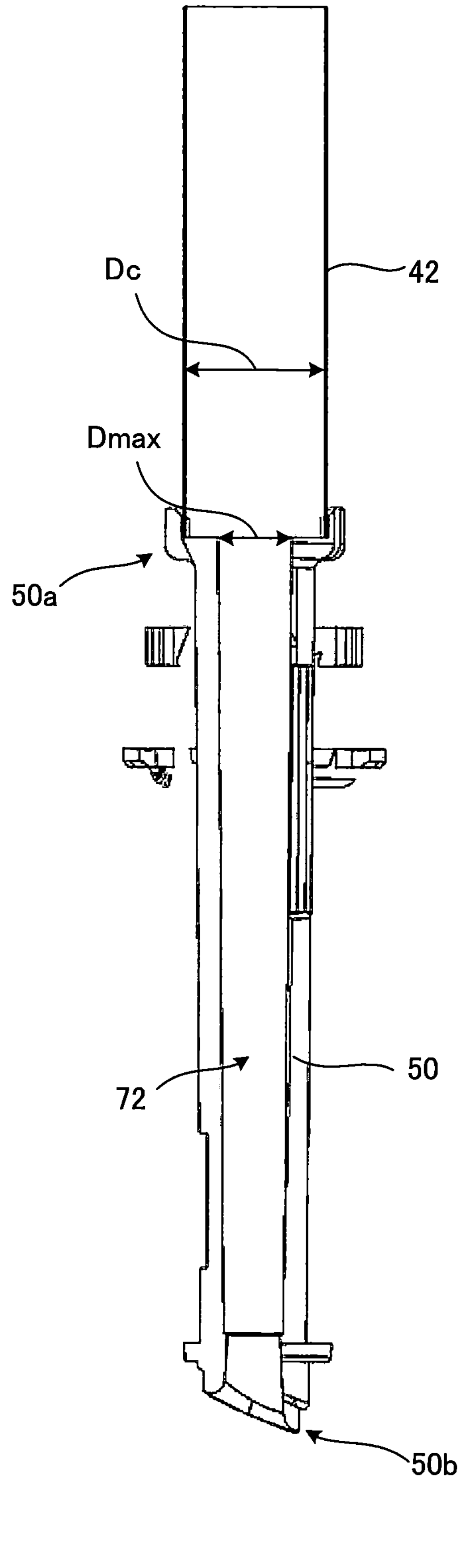


Fig. 8



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/039862

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. A24F47/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. A24F47/00, A61M15/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 2015-507477 A (PHILIP MORRIS PRODUCTS S.A.) 12 March 2015, paragraphs [0029], [0030], fig. 1-3 & US 2014/0345633 A1, paragraphs [0043]-[0045], fig. 1-3 & WO 2013/098398 A2 & EP 2609820 A1 & CN 103997921 A & KR 10-2014-0118985 A	1, 3-14, 19 16-18 2, 15
X Y A	US 2018/0020725 A1 (ALARCON, Ramon) 25 January 2018, paragraph [0038], fig. 2 & WO 2018/020421 A2	1, 3-14, 19 16-18 2, 15
X Y A	JP 2016-525345 A (FONTEM HOLDINGS 4 B.V.) 25 August 2016, paragraphs [0031]-[0045], fig. 3-5 & US 2016/0366939 A1, paragraphs [0031]-[0045], fig. 3-5 & WO 2014/205263 A1 & EP 3011405 A1 & CN 105452977 A & KR 10-2016-0033112 A	1, 3-14, 19 16-18 2, 15

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20.12.2018	08.01.2019

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2018/039862

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	JP 2017-225357 A (STEP K 3 KK) 28 December 2017, paragraphs [0025], [0026], fig. 2 (Family: none)	18
A	JP 2004-184177 A (NIKKISO CO., LTD.) 02 July 2004, entire text, all drawings (Family: none)	1-19

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

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