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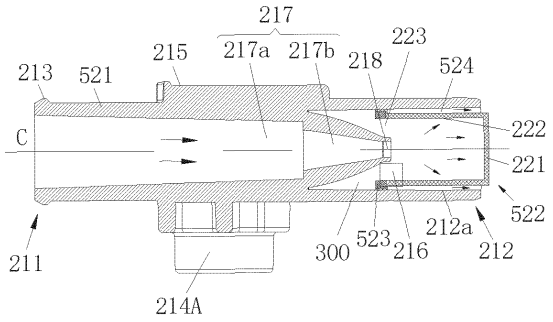
# (54) MICRO-BUBBLE SPRAY HEAD AND WASHING DEVICE WITH SAME

(57) A micro-bubble spray head and a washing device with the same. The microbubble spray head comprises an integrated nozzle (521) and a microbubble filter bag (522) fixed in the outlet end (212) of the integrated nozzle (521), and a Venturi tube structure is formed in the integrated nozzle (521), and a suction port (216) is provided with the integrated nozzle (521), so that the air is sucked into the integrated nozzle (521) through the suction port (216) by means of a negative pressure made by the Venturi tube structure, and mixed with the water flow in the integrated nozzle (521) to produce bubble water; the microbubble filter bag (522) comprises an opening (223), a bottom (221) and a side wall between the opening (223) and the bottom (221), the opening (223) faces the venturi tube structure, and a outlet space (524) is formed between the side wall (222) and the inner wall (212a) of the outlet end (212), so that the bubble water can pass through the side wall (222) and the bottom (221) to form microbubble water. Not only the bottom portion (221) of the microbubble filter bag (522) participates in mixing and cutting of the bubble water, but also the side walls (222) of the larger area of the micro-bubble filter bag (522) also participate in mixing and cutting of the bubble water, so that the yield of the microbubble water of the microbubble spray head can be significantly increased.




A-A cross-sectional view

**FIG. 5**

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## Description

### CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** The present application claims priority from the following Chinese patent applications for invention:

Chinese patent application for invention with the application No. "201911399452.0" filed on December 30, 2019;

Chinese patent application for invention with the application No. "201911229872.4" filed on December 4, 2019; and

Chinese patent application for invention with the application No. "201911348666.5" filed on December 24, 2019. The contents of these applications are incorporated herein by reference in their entirety.

### FIELD OF THE INVENTION

**[0002]** The present disclosure relates to a micro-bubble generation device, and specifically relate to a micro-bubble spray head and a washing apparatus having the micro-bubble spray head.

### BACKGROUND OF THE INVENTION

**[0003]** Micro-bubbles usually refer to tiny bubbles with a diameter below 50 micrometers (μm) during bubbles generation. Micro-bubbles may also be called micro-/nano-bubbles, micron-bubbles or nano-bubbles depending on their ranges of diameter. Due to their low buoyancy in a liquid, micro-bubbles stay for a longer time in the liquid. Furthermore, the micro-bubbles will shrink in the liquid until they finally break up, generating smaller nano-bubbles. In this process, a rising speed of the bubbles becomes slow since the bubbles become smaller, thus resulting in a high melting efficiency. When the micro-bubbles break up, high-pressure and high-temperature heat is locally generated, thereby destroying foreign objects such as organic matters floating in the liquid or adhering to objects. In addition, the shrinkage process of micro-bubbles is also accompanied by an increase in negative charges. A peak state of negative charges usually occurs when the diameter of the micro-bubbles is 1-30 microns, so it is easy for them to adsorb positively charged foreign matters floating in the liquid. The result is that the foreign matters are adsorbed by the micro-bubbles after they are destroyed due to the breaking up of the micro-bubbles, and then slowly float to a surface of the liquid. These properties enable the micro-bubbles to have extremely strong cleaning and purifying abilities. At present, micro-bubbles have been widely used in washing apparatuses such as clothing washing machines.

**[0004]** In order to produce micro-bubbles, micro-bubble generation devices of different structures have been developed. For example, Chinese patent application for invention (CN107321204A) discloses a micro-bubble generator. The micro-bubble generator includes a shell with two open ends; a water inflow pipe is connected to a first end of the shell, and a vortex column, a vortex column shell, a gas-liquid mixing pipe and a hole mesh positioned at a second end of the shell are arranged in sequence inside the shell in a water flow direction. The gas-liquid mixing pipe is sequentially formed with an accommodation cavity, an air flow part, an acceleration part and a circulation part that communicate with each other from head to tail. The vortex column shell and the vortex column located in the vortex column shell are positioned in the accommodation cavity; an air inlet is provided on a pipe wall of the air flow part; an inner wall of the air flow part protrudes toward the direction of the accommodation cavity, forming a funnel-shaped protruding part; a slit is formed between a large mouth end of the funnel-shaped protruding part and the conical vortex column shell so that the air entering from the air inlet can enter the air flow part; an inner diameter of the acceleration part gradually increases toward the direction of the tail. A water flow flows through the vortex column to form a high-speed rotating water flow inside the vortex column shell, and the high-speed rotating water flow flows out from an outlet of the vortex column shell and then enters a funnel-shaped space enclosed by the protruding part. Air is sucked in from the air inlet by a negative pressure formed around the water flow and mixed with the water flow before entering the acceleration part. Because of a conical surface of the vortex column shell and a pressure difference formed due to the inner diameter of the acceleration part gradually increasing toward the direction of the tail, the water flow mixed with a large amount of air (forming bubble water) flows in an accelerated state, and the bubble water flows to the hole mesh through the circulation part. The bubble water is cut and mixed by fine holes in the hole mesh to produce micro-bubble water containing a large number of micro-bubbles.

**[0005]** Chinese patent application for invention (CN107583480A) also discloses a micro-bubble generator. The micro-bubble generator includes a shell with two open ends; a water inflow pipe is connected to a first end of the shell, and a pressurizing pipe, a bubble generation pipe and a hole mesh positioned at a second end of the shell are arranged in sequence inside the shell in a water flow direction. From a first end to a second end, the bubble generation pipe is sequentially formed with an accommodation cavity, a gas-liquid mixing part, and an expansion and guide part. The pressurizing pipe is received in the accommodation cavity, and the pressurizing pipe has a conical end facing the accommodation cavity; in the gas-liquid mixing part, a conical gas-liquid mixing space whose size gradually decreases in a direction from the first end to the second end is formed; and an expansion and guide space whose size increases in the direction from the first end to the second end is formed

in the expansion and guide part. An air inflow passage is formed on a pipe wall of the bubble generation pipe, a gap is formed between an inner wall of the gas-liquid mixing part and an outer wall of the pressurizing pipe so as to communicate with the air inflow passage on the pipe wall of the bubble generation pipe, and a water outlet of the pressurizing pipe is arranged in a water inlet of the gas-liquid mixing part. The water flow flows through the pressurizing pipe and is pressurized to form a high-speed water flow. The high-speed water flow flows out from the water outlet of the pressurizing pipe and then enters the gas-liquid mixing cavity to form a negative pressure in the gas-liquid mixing cavity. The negative pressure sucks a large amount of air into the water flow through the air inflow passage and enables the air and water to mix with each other to form bubble water. The bubble water flows from the expansion and guide part to the hole mesh, and the bubble water is mixed and cut by the fine holes of the hole mesh to form micro-bubble water.

**[0006]** The above two kinds of micro-bubble generators each have at least five independent components: a shell, a water inflow pipe, a vortex column and a vortex column shell or a pressurizing pipe, a gas-liquid mixing pipe or a bubble generation pipe, and a hole mesh. These components all need to be designed with specific mating or connection structures so that all these components can be assembled together and the assembled micro-bubble generator can work reliably. Therefore, the components and structures of such micro-bubble generators are relatively complicated, and the manufacturing cost is also high.

**[0007]** Accordingly, there is a need in the art for a new technical solution to solve the above problem.

## SUMMARY OF THE INVENTION

**[0008]** In order to solve the above problem in the prior art, that is, to solve the technical problem that existing micro-bubble generators have a complicated structure and the manufacturing cost is high, the present disclosure provides a micro-bubble spray head. In a first embodiment, the micro-bubble spray head includes a one-piece spray pipe and a micro-bubble filter screen bag fixed inside an outlet end of the one-piece spray pipe; a Venturi tube structure is formed in the one-piece spray pipe, and a suction port is provided on the one-piece spray pipe, so that air is sucked into the one-piece spray pipe through the suction port by means of a negative pressure produced by the Venturi tube structure and mixes with a water flow in the one-piece spray pipe to produce bubble water; the micro-bubble filter screen bag includes an opening, a bottom and a side wall between the opening and the bottom; the opening faces the Venturi tube structure, and a water outflow space is formed between the side wall and an inner wall of the outlet end so that the bubble water can pass through the side wall and the bottom to form micro-bubble water.

**[0009]** In a preferred technical solution of the above micro-bubble spray head, the micro-bubble filter screen bag is formed by at least two layers of filter screens.

**[0010]** In a preferred technical solution of the above micro-bubble spray head, the micro-bubble filter screen bag is made of a metal filter screen or a macromolecular material mesh.

**[0011]** In a preferred technical solution of the above micro-bubble spray head, the micro-bubble filter screen bag is fixed on the inner wall of the outlet end by a circlip.

**[0012]** In a preferred technical solution of the above micro-bubble spray head, the Venturi tube structure is composed of a diameter-decreased conical passage part, an at-least-one-stage diameter-decreased conical passage is formed in the diameter-decreased conical passage part in a water flow direction, and a spray hole is arranged at a downstream end of the diameter-decreased conical passage part, so that the water flow pressurized by the at-least-one-stage diameter-decreased conical passage can be sprayed from the spray hole and generate a negative pressure in the one-piece spray pipe.

**[0013]** In a preferred technical solution of the above micro-bubble spray head, when the spray hole is positioned close to an inlet end of the one-piece spray pipe, the suction port is positioned close to the spray hole and/or positioned at the outlet end.

**[0014]** In a preferred technical solution of the above micro-bubble spray head, a first suction port and a second suction port are provided on the one-piece spray pipe; the first suction port is positioned close to the spray hole, and the second suction port is positioned at the outlet end to help suck in more outside air.

**[0015]** In a preferred technical solution of the above micro-bubble spray head, when the spray hole is positioned close to the outlet end, the suction port is positioned close to the spray hole.

**[0016]** In a preferred technical solution of the above micro-bubble spray head, the Venturi tube structure can be any one of the following structures: a structure having a plurality of diameter-decreased conical passages parallel to each other in a water flow direction; a structure having a single throttling hole in the water flow direction; a structure having a plurality of throttling holes parallel to each other in the water flow direction; a structure having a single passage whose diameter is first decreased and then increased in the water flow direction; or a structure having a plurality of passages parallel to each other in the water flow direction, whose diameter is first decreased and then increased.

**[0017]** It can be understood by those skilled in the art that in the technical solutions of the present disclosure, the micro-bubble spray head includes a one-piece spray pipe and a micro-bubble filter screen bag fixed inside an outlet end of the one-piece spray pipe. A Venturi tube structure is formed in the one-piece spray pipe, and a suction port is provided on the one-piece spray pipe, so that a large amount of outside air can be sucked into the one-piece spray pipe through the suction port by means

of a negative pressure produced by the Venturi tube structure and mixes with a water flow in the one-piece spray pipe to produce bubble water. The micro-bubble filter screen bag includes an opening, a bottom and a side wall between the opening and the bottom. The opening faces the Venturi tube structure, and a water outflow space is formed between the side wall and an inner wall of the outlet end so as to allow the bubble water in the one-piece spray pipe to pass through the side wall and bottom of the micro-bubble filter screen bag to form micro-bubble water. Not only the bottom of the micro-bubble filter screen bag participates in mixing and cutting the bubble water, but also the side wall with a larger area participates in mixing and cutting the bubble water, so the yield of the micro-bubble water will be significantly increased. In the technical solutions of the micro-bubble spray head of the present disclosure, the function of generating a large amount of micro-bubble water containing a large number of micro-bubbles is realized by the Venturi tube structure designed in the one-piece spray pipe and the micro-bubble filter screen bag fixed inside the outlet end of the one-piece spray pipe. Therefore, as compared with the micro-bubble generators having many components in the prior art, the micro-bubble spray head of the present disclosure not only has very good performance of micro-bubble water generation, but also has the number of components thereof greatly reduced, thus also eliminating the need for designing and manufacturing connection structures between the components and significantly reducing the manufacturing cost of the entire micro-bubble spray head.

**[0018]** Preferably, the micro-bubble filter screen bag is formed by at least two layers of filter screens to ensure the generation of micro-bubbles with a smaller diameter.

**[0019]** Preferably, the Venturi tube structure can take different forms; for example, it can either be a diameter-decreased conical passage part, or any one of the following structures: a structure having a plurality of diameter-decreased conical passages parallel to each other in the water flow direction; a structure having a single throttling hole in the water flow direction; a structure having a plurality of throttling holes parallel to each other in the water flow direction; a structure having a single passage whose diameter is first decreased and then increased in the water flow direction; or a structure having a plurality of passages parallel to each other in the water flow direction, whose diameter is first decreased and then increased.

**[0020]** In order to solve the above problem in the prior art, that is, to solve the technical problem that existing micro-bubble generators have a complicated structure and the manufacturing cost is high, the present disclosure provides a micro-bubble spray head. In a second embodiment, the micro-bubble spray head includes a one-piece spray pipe and a micro-bubble bubbler fixed at an outlet end of the one-piece spray pipe; a diameter-decreased conical passage part is arranged in the one-piece spray pipe, an at-least-one-stage diameter-decreased conical passage is formed in the diameter-decreased conical passage part in a water flow direction, and a spray hole is formed at a downstream end of the diameter-decreased conical passage part; the spray hole is configured such that after a water flow pressurized by the at-least-one-stage diameter-decreased conical passage is sprayed from the spray hole, a negative pressure is generated in the one-piece spray pipe; a suction port is provided on the one-piece spray pipe, and the suction port is positioned close to the spray hole so that air is sucked into the one-piece spray pipe through the suction port by means of the negative pressure and mixes with the water flow to generate bubble water; and the micro-bubble bubbler includes at least two stages of filter screens spaced apart from each other by a predetermined distance in the water flow direction to transform the bubble water into micro-bubble water.

**[0021]** In a preferred technical solution of the above micro-bubble spray head, the at-least-one-stage diameter-decreased conical passage includes a first-stage diameter-decreased conical passage and a second-stage diameter-decreased conical passage.

**[0022]** In a preferred technical solution of the above micro-bubble spray head, a flow disturbing part is formed on an inner wall of the diameter-decreased conical passage part.

**[0023]** In a preferred technical solution of the above micro-bubble spray head, a diameter of the spray hole is in a range of 0-6mm.

**[0024]** In a preferred technical solution of the above micro-bubble spray head, the at least two stages of filter screens include a first-stage filter screen and a second-stage filter screen, the first-stage filter screen includes at least one layer of filter screen, and the number of layers of the first-stage filter screen is smaller than the number of layers of the second-stage filter screen.

**[0025]** In a preferred technical solution of the above micro-bubble spray head, the micro-bubble bubbler includes a screen bracket to fix the at least two stages of filter screens together.

**[0026]** In a preferred technical solution of the above micro-bubble spray head, the screen bracket is directly fixed at the outlet end of the one-piece spray pipe.

**[0027]** In a preferred technical solution of the above micro-bubble spray head, the micro-bubble bubbler also includes a fixing member, and the screen bracket is fixed at the outlet end of the one-piece spray pipe through the fixing member.

**[0028]** In a preferred technical solution of the above micro-bubble spray head, at least one of the screen bracket and the fixing member is provided with an overflow opening.

**[0029]** It can be understood by those skilled in the art that in the technical solutions of the present disclosure, the micro-bubble spray head includes a one-piece spray pipe and a micro-bubble bubbler fixed at an outlet end of the one-piece spray pipe. A diameter-decreased conical passage part is arranged in the one-piece spray pipe,

and an at-least-one-stage diameter-decreased conical passage is formed in the diameter-decreased conical passage part in a water flow direction. When the water flow flows through the at-least-one-stage diameter-decreased conical passage, the water flow is pressurized and also accelerated. A spray hole is formed at a downstream end of the diameter-decreased conical passage part. The pressurized water flow will be rapidly sprayed from the spray hole in an expanded state, thereby generating a negative pressure in a downstream passage of the one-piece spray pipe. A suction port is provided on the one-piece spray pipe, and the suction port is positioned close to the spray hole; as a result, a large amount of air is sucked into the one-piece spray pipe from the outside through the suction port under the action of the negative pressure and mixes with the water flow to produce bubble water containing a large number of bubbles. The micro-bubble bubbler includes at least two stages of filter screens spaced apart from each other by a predetermined distance in the water flow direction, so that the bubble water can be cut and mixed by each stage of the filter screen in turn, thus generating micro-bubble water containing a large number of micro-bubbles more effectively. In the technical solutions of the micro-bubble spray head of the present disclosure, the function of generating micro-bubbles is realized by the diameter-decreased conical passage part designed in the one-piece spray pipe and the micro-bubble bubbler fixed at the outlet end of the one-piece spray pipe. Therefore, as compared with the micro-bubble generators having many components in the prior art, although the micro-bubble spray head of the present disclosure has a simple structure and the manufacturing cost is therefore also significantly reduced, it has very good performance of micro-bubble generation.

**[0030]** Preferably, more than one stage of diameter-decreased conical passage can provide a higher degree of pressurization and acceleration of the water flow.

**[0031]** Preferably, the flow disturbing part can help the water flow mix with the sucked-in air more effectively at a downstream position by increasing the turbulence of the water.

**[0032]** Preferably, the design of the overflow opening can prevent excess water from flooding the suction port, thereby preventing a situation in which the micro-bubble water cannot be produced since the air cannot be sucked into the one-piece spray pipe due to blockage of the suction port.

**[0033]** In order to solve the above problem in the prior art, that is, to solve the technical problem that existing micro-bubble generators have a complicated structure and the manufacturing cost is high, the present disclosure provides a micro-bubble spray head. In a third embodiment, the micro-bubble spray head includes a one-piece spray pipe and a micro-bubble mesh fixed at an outlet end of the one-piece spray pipe; a diameter-decreased conical passage part is arranged in the one-piece spray pipe, an at-least-one-stage diameter-decreased conical passage is formed in the diameter-decreased conical passage part in a water flow direction, and a spray hole is formed at a downstream end of the diameter-decreased conical passage part; the spray hole is configured such that a water flow flowing through the at-least-one-stage diameter-decreased conical passage is sprayed from the spray hole and generates a negative pressure in the one-piece spray pipe; a suction port is provided on the one-piece spray pipe, and the suction port is positioned such that air can be sucked into the one-piece spray pipe through the suction port by means of the negative pressure and mix with the water flow to generate bubble water; and the bubble water becomes micro-bubble water when it passes through the micro-bubble mesh.

**[0034]** In a preferred technical solution of the above micro-bubble spray head, the micro-bubble mesh is sleeved over the outlet end of the one-piece spray pipe and is fixed on an outer wall of the one-piece spray pipe through a fixing device.

**[0035]** In a preferred technical solution of the above micro-bubble spray head, the micro-bubble mesh includes at least two layers of meshes.

**[0036]** In a preferred technical solution of the above micro-bubble spray head, the micro-bubble mesh includes a metal mesh or a macromolecular material mesh.

**[0037]** In a preferred technical solution of the above micro-bubble spray head, the diameter-decreased conical passage part is positioned close to an inlet end of the one-piece spray pipe, and the suction port is positioned close to the spray hole.

**[0038]** In a preferred technical solution of the above micro-bubble spray head, the diameter-decreased conical passage part is positioned close to an inlet end of the one-piece spray pipe, and the suction port is positioned close to the outlet end of the one-piece spray pipe.

**[0039]** In a preferred technical solution of the above micro-bubble spray head, the diameter-decreased conical passage part is positioned close to the outlet end of the one-piece spray pipe, and the suction port is positioned close to the spray hole.

**[0040]** In a preferred technical solution of the above micro-bubble spray head, a flow disturbing part is arranged on an inner wall of the diameter-decreased conical passage part.

**[0041]** In a preferred technical solution of the above micro-bubble spray head, the flow disturbing part is at least one radial protrusion arranged on the inner wall of the diameter-decreased conical passage part or at least one flow disturbing rib extending longitudinally along the inner wall of the diameter-decreased conical passage part.

**[0042]** It can be understood by those skilled in the art that in the technical solutions of the present disclosure, the micro-bubble spray head includes a one-piece spray pipe and a micro-bubble mesh fixed at an outlet end of the one-piece spray pipe. A diameter-decreased conical passage part is arranged in the one-piece spray pipe, an

at-least-one-stage diameter-decreased conical passage is formed in the diameter-decreased conical passage part in a water flow direction, and a spray hole is arranged at a downstream end of the diameter-decreased conical passage part. The water flow is pressurized (accelerated) in the at-least-one-stage diameter-decreased conical passage, and the pressurized water flow is rapidly sprayed into a downstream passage of the one-piece spray pipe from the spray hole in an expanded state and generates a negative pressure in the downstream passage. A suction port is provided on the one-piece spray pipe, and the suction port is within an action range of the negative pressure. Therefore, under the action of the negative pressure, a large amount of air is sucked into the one-piece spray pipe from the outside through the suction port and mixes with the water to produce bubble water containing a large number of bubbles. The bubble water is then cut and mixed by the micro-bubble mesh located at the outlet end of the one-piece spray pipe when it flows through the micro-bubble mesh, thus producing micro-bubble water containing a large number of micro-bubbles. In the technical solutions of the micro-bubble spray head of the present disclosure, the function of generating micro-bubbles is realized by the diameter-decreased conical passage part designed in the one-piece spray pipe and the micro-bubble mesh fixed at the outlet end of the one-piece spray pipe. Therefore, as compared with the micro-bubble generators having many components in the prior art, the micro-bubble spray head of the present disclosure not only has good performance of micro-bubble generation, but also has the number of components thereof greatly reduced, thus also eliminating the need for designing and manufacturing connection structures between the components and significantly reducing the manufacturing cost of the entire micro-bubble spray head.

**[0043]** Preferably, a flow disturbing part is provided on the inner wall of the diameter-decreased conical passage part. The flow disturbing part can help the water flow mix with the sucked-in air more effectively at a downstream position by increasing the turbulence of the water.

**[0044]** The present disclosure also provides a washing apparatus, which includes any of the micro-bubble spray heads as described above, and the micro-bubble spray head is configured to generate micro-bubble water in the washing apparatus. The micro-bubble spray head generates micro-bubble water containing a large number of micro-bubbles in the washing apparatus, so it can not only improve the cleaning ability of the washing apparatus, but also can reduce the amount of detergent used and a residual amount of detergent such as in the clothing.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0045]** Preferred embodiments of the present disclosure will be described below with reference to the accompanying drawings, in which:

FIG. 1 is a schematic structural view of an example of a washing apparatus including a micro-bubble spray head according to the present disclosure;

FIG. 2 is a schematic structural view of another example of the washing apparatus including the micro-bubble spray head according to the present disclosure;

FIG. 3 is a top view of the example of the micro-bubble spray head of the present disclosure in a first embodiment;

FIG. 4 is a front view of the example of the micro-bubble spray head of the present disclosure in the first embodiment;

FIG. 5 is a cross-sectional view of a first example of the micro-bubble spray head of the present disclosure in the first embodiment, taken along section line A-A in FIG. 4;

FIG. 6 is a cross-sectional view of a second example of the micro-bubble spray head of the present disclosure in the first embodiment, taken along section line A-A in FIG. 4;

FIG. 7 is a cross-sectional view of a third example of the micro-bubble spray head of the present disclosure in the first embodiment, taken along section line A-A in FIG. 4;

FIG. 8 is a cross-sectional view of a fourth example of the micro-bubble spray head of the present disclosure in the first embodiment, taken along section line A-A in FIG. 4;

FIG. 9 is a schematic perspective view of an example of the micro-bubble spray head of the present disclosure in a second embodiment;

FIG. 10 is a top view of the example of the micro-bubble spray head of the present disclosure shown in FIG. 9 in the second embodiment;

FIG. 11 is a left view of the example of the micro-bubble spray head of the present disclosure shown in FIG. 9 in the second embodiment;

FIG. 12 is a front view of the example of the micro-bubble spray head of the present disclosure shown in FIG. 9 in the second embodiment;

FIG. 13 is a cross-sectional view of the example of the micro-bubble spray head of the present disclosure in the second embodiment, taken along section line A-A in FIG. 12;

FIG. 14 is a cross-sectional view of the example of the micro-bubble spray head of the present disclosure in the second embodiment, taken along section line B-B in FIG. 12;

FIG. 15 is an exploded perspective view of a first example of the micro-bubble spray head of the present disclosure in the second embodiment;

FIG. 16 is an exploded perspective view of a second example of the micro-bubble spray head of the present disclosure in the second embodiment;

FIG. 17 is a top view of an example of the micro-bubble spray head of the present disclosure in a third embodiment;

FIG. 18 is a left view of the example of the micro-bubble spray head of the present disclosure in the third embodiment;

FIG. 19 is a front view of the example of the micro-bubble spray head of the present disclosure in the third embodiment;

FIG. 20 is a cross-sectional view of a first example of the micro-bubble spray head of the present disclosure in the third embodiment, taken along section line A-A in FIG. 19;

FIG. 21 is a cross-sectional view of a second example of the micro-bubble spray head of the present disclosure in the third embodiment, taken along section line A-A in FIG. 19;

FIG. 22 is a cross-sectional view of a third example of the micro-bubble spray head of the present disclosure in the third embodiment, taken along section line A-A in FIG. 19; and

FIG. 23 is a cross-sectional view of a fourth example of the micro-bubble spray head of the present disclosure in the third embodiment, taken along section line A-A in FIG. 19;

List of reference signs:

**[0046]** 1: pulsator washing machine; 11: cabinet; 12: tray; 13: upper cover; 14: foot of pulsator washing machine; 21: outer tub; 31: inner tub; 311: spin-drying hole; 32: pulsator; 33: transmission shaft of pulsator washing machine; 34: motor of pulsator washing machine; 35: balance ring; 41: drain valve; 42: drain pipe; 51: water inflow valve; 9: drum washing machine; 91: shell; 92: outer cylinder; 93: inner cylinder; 931: motor of drum washing machine; 932: transmission shaft of drum washing machine; 933: bearing; 94: top panel; 95: control panel; 96: observation window; 97: door; 98: foot of drum washing machine.

**[0047]** First embodiment: 52: micro-bubble spray head; 521: one-piece spray pipe; 522: micro-bubble filter screen bag; 523: circlip; 524: water outflow space; 211: inlet end; 212: outlet end; 212a: inner wall of outlet end; 213: anti-disengagement part; 214A: first fixed installation part; 214B: second fixed installation part; 215: positioning part; 216: suction port; 216a: first suction port; 216b: second suction port; 217: diameter-decreased conical passage part; 217a: first-stage diameter-decreased conical passage; 217b: second-stage diameter-decreased conical passage; 218: spray hole; 219: flow disturbing part; 221: bottom of micro-bubble filter screen bag; 222: side wall of micro-bubble filter screen bag; 223: opening of micro-bubble filter screen bag; 300: annular gap.

**[0048]** Second embodiment: 52: micro-bubble spray head; 521: one-piece spray pipe; 522: micro-bubble bubbler; 211: inlet end; 212: outlet end; 212a: external thread; 212b: snap-fit groove; 213: anti-disengagement part; 214A: first fixed installation part; 214B: second fixed installation part; 215: positioning part; 216: suction port; 217: spray hole; 218: flow disturbing part; 219: diameter-decreased conical passage part; 219a: first-stage diameter-decreased conical passage; 219b: second-stage diameter-decreased conical passage; 221: filter screen; 221a: first-stage filter screen; 221b: second-stage filter screen; 222: fixing member; 223: overflow opening of fixing member; 224: connection part of second-stage filter screen; 225: screen bracket; 226: overflow opening of screen bracket; 300: annular gap.

**[0049]** Third embodiment: 52: micro-bubble spray head; 521: one-piece spray pipe; 522: micro-bubble mesh; 523: pressure ring; 211: inlet end; 212: outlet end; 213: anti-disengagement part; 214A: first fixed installation part; 214B: second fixed installation part; 215: positioning part; 216: suction port; 217: diameter-decreased conical passage part; 217a: flow disturbing part; 217b: first-stage diameter-decreased conical passage; 217c: second-stage diameter-decreased conical passage; 218: spray hole; 300: annular gap.

## DETAILED DESCRIPTION OF THE EMBODIMENT(S) OF THE INVENTION

**[0050]** Preferred embodiments of the present disclosure will be described below with reference to the accompanying drawings. It should be understood by those skilled in the art that these embodiments are only used to explain the technical principle of the present disclosure, and are not intended to limit the scope of protection of the present disclosure.

**[0051]** It should be noted that in the description of the present disclosure, terms indicating directional or positional relationships, such as "upper", "lower", "left", "right", "inner", "outer" and the like, are based on the directional or positional relationships shown in the accompanying drawings. They are only used for ease of de-

scription, and do not indicate or imply that the device or element must have a specific orientation, or be constructed or operated in a specific orientation, and therefore they should not be considered as limitations to the present disclosure. In addition, terms "first" and "second" are only used for descriptive purposes, and should not be interpreted as indicating or implying relative importance.

**[0052]** In addition, it should also be noted that in the description of the present disclosure, unless otherwise clearly specified and defined, terms "install", "arrange" and "connect" should be understood in a broad sense; for example, the connection may be a fixed connection, or may also be a detachable connection, or an integral connection; it may be a direct connection, or an indirect connection implemented through an intermediate medium, or it may be internal communication between two elements. For those skilled in the art, the specific meaning of the above terms in the present disclosure can be interpreted according to specific situations.

First embodiment

**[0053]** In order to solve the problem that existing micro-bubble generators have a complicated structure and the manufacturing cost is high, the present disclosure provides a micro-bubble spray head. In the first embodiment, the micro-bubble spray head includes a one-piece spray pipe 521 and a micro-bubble filter screen bag 522 fixed inside an outlet end 212 of the one-piece spray pipe 521 (see FIGS. 3 to 8). A Venturi tube structure is provided in the one-piece spray pipe 521, and a suction port 216 is provided on the one-piece spray pipe, so that air can be sucked into the one-piece spray pipe 521 through the suction port 216 by means of a negative pressure produced by the Venturi tube structure and mixes with a water flow in the one-piece spray pipe 521 to produce bubble water. The micro-bubble filter screen bag 522 includes an opening 223, a bottom 221 and a side wall 222 located between the opening 223 and the bottom 221. The opening 223 faces the Venturi tube structure, and a water outflow space 524 is formed between the side wall 222 and an inner wall 212a of the outlet end 212 so that the bubble water can pass through the side wall 222 and the bottom 221 to form micro-bubble water. Therefore, as compared with the micro-bubble generators in the prior art, both the number of components and the structure of the micro-bubble spray head of the present disclosure are greatly simplified, and the manufacturing cost of the micro-bubble spray head is also greatly reduced. At the same time, the micro-bubble spray head has very good performance of micro-bubble water generation.

**[0054]** In one or more examples, the Venturi tube structure can take many different forms, such as a diameter-decreased conical passage part 217 (shown in FIGS. 5-8). Alternatively, the Venturi tube structure includes, but is not limited to: a structure having a plurality of diameter-decreased conical passages parallel to each other in a water flow direction C; a structure having a single throttling hole in the water flow direction C; a structure having a plurality of throttling holes parallel to each other in the water flow direction C; a structure having a single passage whose diameter is first decreased and then increased in the water flow direction C; or a structure having a plurality of passages parallel to each other in the water flow direction C, whose diameter is first decreased and then increased (not shown in the figure).

**[0055]** The micro-bubble spray head of the present disclosure can be applied in the field of washing, the field of sterilization, or other fields that require micro-bubbles. For example, the micro-bubble spray head of the present disclosure can be applied not only to a washing apparatus, but also to devices such as bathroom faucets or showers.

**[0056]** Therefore, the present disclosure also provides a washing apparatus, which includes the micro-bubble spray head 52 of the present disclosure. The micro-bubble spray head 52 is configured to generate micro-bubble water in the washing apparatus. The micro-bubble water containing a large number of micro-bubbles is generated in the washing apparatus by the micro-bubble spray head 52. The micro-bubble water can not only improve the washing ability of the washing apparatus, but also can reduce the amount of detergent used and a residual amount of detergent such as in the clothing, which is not only advantageous for the user's health, but also can improve the user experience.

**[0057]** Reference is made to FIG. 1, which is a schematic structural view of an example of a washing apparatus including a micro-bubble spray head according to the present disclosure. In this example, the washing apparatus is a pulsator washing machine 1. Alternatively, in other examples, the washing apparatus may be a drum washing machine or a washing-drying integrated machine, etc.

**[0058]** As shown in FIG. 1, the pulsator washing machine 1 (hereinafter referred to as the washing machine) includes a cabinet 11. Feet 14 are provided at a bottom of the cabinet 11. An upper part of the cabinet 11 is provided with a tray 12, and the tray 12 is pivotally connected with an upper cover 13. An outer tub 21 serving as a water containing tub is provided inside the cabinet 11. An inner tub 31 is arranged in the outer tub 21, a pulsator 32 is arranged at a bottom of the inner tub 31, and a motor 34 is fixed at a lower part of the outer tub 21. The motor 34 is drivingly connected with the pulsator 32 through a transmission shaft 33. A spin-drying hole 311 is provided on a side wall of the inner tub 31. A drain valve 41 is provided on a drain pipe 42, and an upstream end of the drain pipe 42 communicates with a bottom of the outer tub 21. The washing machine further includes a water inflow valve 51 and a micro-bubble spray head 52 communicating with the water inflow valve 51, and the micro-bubble spray head 52 is installed at a top of the outer tub 21. Water enters the micro-bubble spray head 52 through the water inflow valve 51 to generate

micro-bubble water containing a large number of micro-bubbles. The micro-bubble spray head 52 first sprays the micro-bubble water into a detergent box to mix with a detergent, and then the micro-bubble water enters the inner tub 31 through the detergent box for clothing washing. The micro-bubbles in the water impact the detergent during the breaking up process, and negative charges carried by the micro-bubbles can also adsorb the detergent, so the micro-bubbles can increase a mixing degree of the detergent and the water, thereby reducing the amount of detergent used and a residual amount of detergent in the clothing. In addition, the micro-bubbles in the inner tub 31 will also impact stains on the clothing, and will adsorb foreign matters that generate the stains. Therefore, the micro-bubbles also enhance a stain removal performance of the washing machine. Optionally, the micro-bubble spray head can also directly spray the micro-bubble water carrying a large number of micro-bubbles into the outer tub 21 or the inner tub 31 of the washing machine to further reduce the amount of detergent used and enhance the cleaning ability of the washing machine.

**[0059]** Reference is made to FIG. 2, which is a schematic structural view of another example of the washing apparatus including the micro-bubble spray head according to the present disclosure. In this example, the washing apparatus is a drum washing machine 9.

**[0060]** As shown in FIG. 2, the drum washing machine 9 includes a shell 91 and feet 98 located at a bottom of the shell. A top panel 94 is provided at a top of the shell 91. A front side of the shell 91 (an operation side facing the user) is provided with a door 97 that allows the user to put clothing and the like into the drum washing machine, and the door 97 is also provided with an observation window 96 for viewing an interior of the washing machine. A sealing window gasket 961 is also provided between the observation window 96 and the shell 91, and the sealing window gasket 961 is fixed on the shell 91. A control panel 95 of the drum washing machine 9 is arranged on an upper part of the front side of the shell 91 to facilitate the user's operation. An outer cylinder 92 and an inner cylinder 93 are arranged inside the shell 91. The inner cylinder 93 is positioned inside the outer cylinder 92. The inner cylinder 93 is connected to a motor 931 (e.g., a direct drive motor) through a transmission shaft 932 and a bearing 933. A water inflow valve 51 is provided on an upper part of a rear side of the shell 91, and the water inflow valve 51 is connected to a micro-bubble spray head 52 through a water pipe. As shown in FIG. 2, the micro-bubble spray head 52 is positioned close to the upper part of the front side of the shell 91 and located below the control panel 95. Similar to the above example, water enters the micro-bubble spray head 52 through the water pipe from the water inflow valve 51 to generate micro-bubble water containing a large number of micro-bubbles. The micro-bubble spray head 52 first sprays the micro-bubble water into a detergent box to mix with a detergent, and then the micro-bubble water enters the inner cylinder 93 through the detergent box for clothing washing. Optionally, the micro-bubble spray head 52 can also directly spray the micro-bubble water carrying a large number of micro-bubbles into the outer cylinder 92 or the inner cylinder 93 of the washing machine to further reduce the amount of detergent used and enhance the cleaning ability of the washing machine.

**[0061]** Reference is made to FIGS. 3 and 4, which are schematic views of an example of the micro-bubble spray head according to the present disclosure, in which FIG. 3 is a top view of the example of the micro-bubble spray head of the present disclosure, and FIG. 4 is a front view of the example of the micro-bubble spray head of the present disclosure. As shown in FIGS. 3 and 4, in one or more examples, the micro-bubble spray head 52 of the present disclosure includes a one-piece spray pipe 521. A micro-bubble filter screen bag 522 is installed inside an outlet end 212 of the one-piece spray pipe 521, and the micro-bubble filter screen bag 522 is configured to be capable of cutting and mixing the bubble water when the bubble water flows through the micro-bubble filter screen bag 522 to produce a large amount of micro-bubble water containing a large number of micro-bubbles.

**[0062]** Referring to FIGS. 3 and 4, in one or more examples, the one-piece spray pipe 521 has an inlet end 211 and the outlet end 212. The micro-bubble filter screen bag 522 is fixed inside the outlet end 212, and the inlet end 211 is configured to be connected to an external water source. Optionally, an anti-disengagement part 213 may be provided on the inlet end 211, such as an anti-disengagement rib protruding radially outward around an outer wall of the inlet end 211 or an annular groove structure recessed inward from the outer wall of the inlet end 211. The anti-disengagement part can prevent the one-piece spray pipe 521 from falling off a connected pipeline which provides water supply.

**[0063]** With continued reference to FIGS. 3 and 4, in one or more examples, the outer wall of the one-piece spray pipe 521 is provided with a first fixed installation part 214A, a second fixed installation part 214B, and a positioning part 215, which are used to position and fix the micro-bubble spray head 52 to a predetermined position.

**[0064]** With continued reference to FIGS. 3 and 4, the first fixed installation part 214A and the second fixed installation part 214B are symmetrically positioned on the outer wall of the one-piece spray pipe 521, and are located in the middle of the one-piece spray pipe 521. The positioning part 215 is a long-strip-shaped rib, which protrudes radially outward from the outer wall of the one-piece spray pipe 521 and extends in a longitudinal direction of the one-piece spray pipe 521. The first fixed installation part 214A and the second fixed installation part 214B are distributed on both sides of the positioning part 215. Optionally, only one fixed installation part is provided on the one-piece spray pipe 521, and the positioning part 215 may also be in other suitable forms.

**[0065]** In one or more examples, the first and second fixed installation parts 214A, 214B are screw hole structures so that the spray head 52 can be fixed to a target position by screws. However, the fixed installation parts may be any suitable connection structure, such as a snap-fit connection structure, a welded connection structure, and the like.

**[0066]** FIG. 5 is a cross-sectional view of a first example of the micro-bubble spray head of the present disclosure, taken along section line A-A in FIG. 4. In one or more examples, a diameter-decreased conical passage part 217 is provided inside the one-piece spray pipe 521. A first-stage diameter-decreased conical passage 217a and a second-stage diameter-decreased conical passage 217b are formed in the diameter-decreased conical passage part 217 in a water flow direction C, and a spray hole 218 is arranged at a downstream end of the diameter-decreased conical passage part 217. The spray hole 218 is positioned close to the outlet end 212 of the one-piece spray pipe 521. The spray hole 218 is in direct communication with the upstream second-stage diameter-decreased conical passage 217b and a downstream passage inside the one-piece spray pipe 521. The first-stage diameter-decreased conical passage 217a extends downstream from the inlet end 211 of the one-piece spray pipe 521 to the second-stage diameter-decreased conical passage 217b, and a smallest diameter of the first-stage diameter-decreased conical passage 217a at its downstream end is larger than a largest diameter of the second-stage diameter-decreased conical passage 217b. In one or more alternative examples, in the diameter-decreased conical passage part 217, either one stage of diameter-decreased conical passage may be formed in the water flow direction C, or more than two stages of diameter-decreased conical passages may be formed, such as three or more stages of diameter-decreased conical passages.

**[0067]** The "diameter-decreased conical passage part" mentioned herein refers to a structure in which a diameter or cross-section of the passage formed inside this part is gradually decreased in the water flow direction so that the passage has a substantially conical shape.

**[0068]** As shown in FIG. 5, in one or more examples, an outer wall of the part of the diameter-decreased conical passage part 217 that corresponds to the second-stage diameter-decreased conical passage 217b is separate from the inner wall of the one-piece spray pipe 521, so that an annular gap 300 is formed between the outer wall of this part and the inner wall of the one-piece spray pipe 521. The annular gap 300 facilitates the mixing of air and the water flow, thereby generating more micro-bubbles.

**[0069]** As shown in FIG. 5, a suction port 216 is also formed on the one-piece spray pipe 521. In one or more examples, the suction port 216 is formed on a pipe wall of the one-piece spray pipe 521 and is positioned close to the spray hole 218; therefore, the suction port 216 is also located close to the outlet end 212. The water flow enters from the inlet end 211 of the one-piece spray pipe 521, first flows through the first-stage diameter-decreased conical passage 217a, and then flows into the second-stage diameter-decreased conical passage 217b, thereby being pressurized. The pressurized water flow is sprayed from the spray hole 218 into the downstream passage of the one-piece spray pipe 521 and is rapidly expanded, thereby generating a negative pressure in the downstream passage of the one-piece spray pipe 521. Under the action of the negative pressure, a large amount of outside air is sucked into the one-piece spray pipe 521 from the suction port 216 and mixes with the water flow therein to generate bubble water. The bubble water is then cut and mixed by the micro-bubble filter screen bag 522 as it flows through the micro-bubble filter screen bag 522, thereby producing micro-bubble water.

**[0070]** As shown in FIG. 5, in one or more examples, the micro-bubble filter screen bag 522 includes a bottom 221, an opening 223, and an annular side wall 222 extending between the opening 223 and the bottom 221. The opening 223 is oriented toward an interior of the one-piece spray pipe 521, faces the spray hole 218 and surrounds the spray hole 218. Optionally, the bottom 221 is exposed outside the one-piece spray pipe 521. In other words, the side wall 222 may extend outward beyond an end face of the outlet end 212. A predetermined annular gap is left between the side wall 222 and the inner wall 212a of the outlet end 212, and the annular gap forms the water outflow space 524. The water flow sprayed from the spray hole 218 can thus be rapidly expanded in the micro-bubble filter screen bag 218 and mix with a large amount of air sucked in through the suction port 216 to form bubble water. Due to the existence of the water outflow space 524, the bubble water can not only pass through the bottom 221 of the micro-bubble filter screen bag 522, but also can pass through the side wall 222 of the micro-bubble filter screen bag 55, so the bubble water is mixed and cut by mesh holes of both the bottom 221 and the side wall 222 to produce a large amount of micro-bubble water.

**[0071]** In one or more examples, the micro-bubble filter screen bag 522 is fixed on the inner wall 212a of the outlet end 212 through a circlip 523, such as a metal circlip. Alternatively. The micro-bubble filter screen bag 522 can also be fixed on the inner wall of the one-piece spray pipe 521 through other means, such as bonding or welding.

**[0072]** In one or more examples, the micro-bubble filter screen bag 522 is formed from at least two layers of filter screens. The more layers of the filter screen, the better the effect of micro-bubble generation, but the resistance to the water flow also increases. Preferably, the number of layers of the filter screen of the micro-bubble filter screen bag 522 is larger than or equal to 3 and smaller than or equal to 12. Alternatively, the number of layers of the filter screens of the micro-bubble filter screen bag 522 is preferably larger than or equal to 3 and smaller than or equal to 5. The multiple layers of filter screens

can ensure that the bubble water is cut more finely and mixed to a greater extent, thus enabling the generation of smaller-diameter micro-bubbles.

**[0073]** In one or more examples, the filter screens of the micro-bubble filter screen bag 522 has at least one fine hole having a diameter reaching a micron scale. Preferably, the diameter of the fine hole is between 0 and 1000 microns; more preferably, the diameter of the fine hole is between 5 and 500 microns. In one or more examples, the micro-bubble filter screen bag 522 may be made of a metal mesh or a macromolecular material mesh, or made of other suitable hole mesh structures. The metal mesh includes but is not limited to stainless steel wire, nickel wire, brass wire and other materials. The macromolecular material mesh usually refers to a mesh with a microporous structure made by first making a macromolecular material into a wire and then weaving this wire. In a woven Dutch wire mesh, wefts are densely arranged, which can be woven by the following weaving methods: plain weave, twill weave, plain Dutch weave, twill Dutch weave, or reverse Dutch weave. The macromolecular material mesh includes but is not limited to nylon (polyester) mesh, cotton mesh, polypropylene mesh, etc. For example, the filter screen may be formed of a cotton mesh.

**[0074]** FIG. 6 is a cross-sectional view of a second example of the micro-bubble spray head of the present disclosure taken along section line A-A in FIG. 4. As shown in FIG. 6, a diameter-decreased conical passage part 217 is also formed in the one-piece spray pipe 521. A first-stage diameter-decreased conical passage 217a and a second-stage diameter-decreased conical passage 217b are formed inside the diameter-decreased conical passage part 217 in the water flow direction C, and a spray hole 218 is arranged at a downstream end of the diameter-decreased conical passage part 217. The spray hole 218 is positioned close to the outlet end 212 of the one-piece spray pipe 521, and the suction port 216 is positioned close to the spray hole 218. In this example, a flow disturbing part 219 is formed on the inner wall of the diameter-decreased conical passage part 217 that corresponds to the second-stage diameter-decreased conical passage 217b to increase the turbulence of the water flow, thereby improving a mixing degree of water and air. In one or more examples, the flow disturbing part 219 is at least one flow disturbing rib extending longitudinally along the inner wall of this stage of diameter-decreased conical passage, such as a plurality of flow disturbing ribs. In an alternative example, the flow disturbing part 219 may be at least one radial protrusion on the inner wall of this stage of diameter-decreased conical passage, such as one or more cylindrical protrusions. Optionally, the flow disturbing part 219 may be formed only on the inner wall corresponding to the first-stage diameter-decreased conical passage, or formed on the inner wall corresponding to each stage of diameter-decreased conical passage, or formed on the inner wall corresponding to more than one stage of diameter-decreased conical passage. The other parts of this example that are not mentioned are the same as those of the above example.

**[0075]** FIG. 7 is a cross-sectional view of a third example of the micro-bubble spray head of the present disclosure taken along section line A-A in FIG. 4. As shown in FIG. 7, in this example, a diameter-decreased conical passage part 217 is also formed in the one-piece spray pipe 521. A first-stage diameter-decreased conical passage 217a and a second-stage diameter-decreased conical passage 217b are formed inside the diameter-decreased conical passage part 217 in the water flow direction C, and a spray hole 218 is arranged at a downstream end of the diameter-decreased conical passage part 217. The spray hole 218 is positioned close to the inlet end 211 of the one-piece spray pipe 521, but the suction port 216 is positioned close to the outlet end 212 of the one-piece spray pipe 521, and thus also close to the micro-bubble filter screen bag 522. In this example, the suction port 216 is still within an action range of the negative pressure generated by the spray hole 218, so when the water flow is sprayed from the spray hole 218 into the downstream passage of the one-piece spray pipe 521 in an expanded state, the outside air is sucked into the one-piece spray pipe 521 from the suction port 216 under the action of the negative pressure and mixes with the water flow. In this example, a flow disturbing part 219 is also formed on the inner wall of the diameter-decreased conical passage part 217 that corresponds to the second-stage diameter-decreased conical passage 217b, such as a plurality of flow disturbing ribs extending longitudinally along this inner wall. The other parts of this example that are not mentioned are the same as those of the above examples.

**[0076]** FIG. 8 is a cross-sectional view of a fourth example of the micro-bubble spray head of the present disclosure taken along section line A-A in FIG. 4. As shown in FIG. 8, in this example, a diameter-decreased conical passage part 217 is also formed in the one-piece spray pipe 521. A first-stage diameter-decreased conical passage 217a and a second-stage diameter-decreased conical passage 217b are formed inside the diameter-decreased conical passage part 217 in the water flow direction C, and a spray hole 218 is arranged at a downstream end of the diameter-decreased conical passage part 217. The spray hole 218 is positioned close to the inlet end 211 of the one-piece spray pipe 521. In this example, the one-piece spray pipe 521 is provided with a first suction port 216a and a second suction port 216b. The first suction port 216a is positioned close to the spray hole 218 and thus close to the inlet end 211. The second suction port 216b is positioned close to the outlet end 212 of the one-piece spray pipe 521 and thus also close to the micro-bubble filter screen bag 522. Providing the first suction port and the second suction port at the same time helps suck in more outside air, thereby generating more micro-bubbles. In this example, a flow disturbing part 219 is also formed on the inner wall of the diameter-decreased conical passage part 217 that corresponds to

the second-stage diameter-decreased conical passage 217b, such as a plurality of flow disturbing ribs extending longitudinally along this inner wall. The other parts of this example that are not mentioned are the same as those of the above examples.

Second embodiment

**[0077]** In order to solve the problem that existing micro-bubble generators have a complicated structure and the manufacturing cost is high, the present disclosure provides a micro-bubble spray head. In the second embodiment, the micro-bubble spray head includes a one-piece spray pipe 521 and a micro-bubble bubbler 522 fixed at an outlet end 212 of the one-piece spray pipe 521 (see FIGS. 9 to 16). A diameter-decreased conical passage part 219 is arranged in the one-piece spray pipe 521. An at-least-one-stage diameter-decreased conical passage is formed in the diameter-decreased conical passage part 219 in a water flow direction C. A spray hole 217 is formed at a downstream end of the diameter-decreased conical passage part 219, and the spray hole 217 is configured such that after a water flow pressurized by the at-least-one-stage diameter-decreased conical passage is sprayed from the spray hole 217, a negative pressure is generated in the one-piece spray pipe 521. A suction port 216 is provided on the one-piece spray pipe 521, and the suction port 216 is positioned close to the spray hole 217 so that air is sucked into the one-piece spray pipe 521 through the suction port 216 by means of the negative pressure and mixes with the water flow to produce bubble water. The micro-bubble bubbler 522 includes at least two stages of filter screens 221 spaced apart from each other by a predetermined distance in the water flow direction C to transform the bubble water into micro-bubble water. Therefore, as compared with the micro-bubble generators in the prior art, both the number of components and the structure of the micro-bubble spray head of the present disclosure are greatly simplified, and the manufacturing cost of the micro-bubble spray head is also greatly reduced, but the micro-bubble spray head has very good performance of micro-bubble generation.

**[0078]** The "diameter-decreased conical passage part" mentioned herein refers to a structure in which a diameter of the passage formed inside this part or a section of the passage transverse to the water flow direction is gradually decreased so that the passage has a substantially conical shape.

**[0079]** The micro-bubble spray head of the present disclosure can be applied in the field of washing, the field of sterilization, or other fields that require micro-bubbles. For example, the micro-bubble spray head of the present disclosure can be applied not only to a washing apparatus, but also to devices such as bathroom faucets or showers.

**[0080]** Therefore, the present disclosure also provides a washing apparatus, which includes the micro-bubble spray head 52 of the present disclosure. The micro-bubble spray head 52 is configured to generate micro-bubble water in the washing apparatus. The micro-bubble water containing a large number of micro-bubbles is generated in the washing apparatus by the micro-bubble spray head. The micro-bubble water can not only improve the washing ability of the washing apparatus, but also can reduce the amount of detergent used and a residual amount of detergent such as in the clothing, which is not only advantageous for the user's health, but also can improve the user experience.

**[0081]** Reference is made to FIG. 1, which is a schematic structural view of an example of a washing apparatus including a micro-bubble spray head according to the present disclosure. In this example, the washing apparatus is a pulsator washing machine 1. Alternatively, in other examples, the washing apparatus may be a drum washing machine or a washing-drying integrated machine, etc.

**[0082]** As shown in FIG. 1, the pulsator washing machine 1 (hereinafter referred to as the washing machine) includes a cabinet 11. Feet 14 are provided at a bottom of the cabinet 11. An upper part of the cabinet 11 is provided with a tray 12, and the tray 12 is pivotally connected with an upper cover 13. An outer tub 21 serving as a water containing tub is provided inside the cabinet 11. An inner tub 31 is arranged in the outer tub 21, a pulsator 32 is arranged at a bottom of the inner tub 31, and a motor 34 is fixed at a lower part of the outer tub 21. The motor 34 is drivingly connected with the pulsator 32 through a transmission shaft 33. A spin-drying hole 311 is provided on a side wall of the inner tub 31 near a top end. A drain valve 41 is provided on a drain pipe 42, and an upstream end of the drain pipe 42 communicates with a bottom of the outer tub 21. The washing machine further includes a water inflow valve 51 and a micro-bubble spray head 52 communicating with the water inflow valve 51, and the micro-bubble spray head 52 is installed at a top of the outer tub 21. Water enters the micro-bubble spray head 52 through the water inflow valve 51 to generate micro-bubble water containing a large number of micro-bubbles. The micro-bubble spray head 52 first sprays the micro-bubble water into a detergent box to mix with a detergent, and then the micro-bubble water enters the inner tub 31 through the detergent box for clothing washing. The micro-bubbles in the water impact the detergent during the breaking up process, and negative charges carried by the micro-bubbles can also adsorb the detergent, so the micro-bubbles can increase a mixing degree of the detergent and the water, thereby reducing the amount of detergent used and a residual amount of detergent in the clothing. In addition, the micro-bubbles in the inner tub 31 will also impact stains on the clothing, and will adsorb foreign matters that generate the stains. Therefore, the micro-bubbles also enhance a stain removal performance of the washing machine. Optionally, the micro-bubble spray head can also directly spray the micro-bubble water carrying a large number of micro-

bubbles into the outer tub 21 or the inner tub 31 of the washing machine to further reduce the amount of detergent used and enhance the cleaning ability of the washing machine.

**[0083]** Reference is made to FIG. 2, which is a schematic structural view of another example of the washing apparatus including the micro-bubble spray head according to the present disclosure. In this example, the washing apparatus is a drum washing machine 9.

**[0084]** As shown in FIG. 2, the drum washing machine 9 includes a shell 91 and feet 98 located at a bottom of the shell. A top panel 94 is provided at a top of the shell 91. A front side of the shell 91 (an operation side facing the user) is provided with a door 97 that allows the user to put clothing and the like into the drum washing machine, and the door 97 is also provided with an observation window 96 for viewing an interior of the washing machine. A sealing window gasket 961 is also provided between the observation window 96 and the shell 91, and the sealing window gasket 961 is fixed on the shell 91. A control panel 95 of the drum washing machine 9 is arranged on an upper part of the front side of the shell 91 to facilitate the user's operation. An outer cylinder 92 and an inner cylinder 93 are arranged inside the shell 91. The inner cylinder 93 is positioned inside the outer cylinder 92. The inner cylinder 93 is connected to a motor 931 (e.g., a direct drive motor) through a transmission shaft 932 and a bearing 933. A water inflow valve 51 is provided on an upper part of a rear side of the shell 91, and the water inflow valve 51 is connected to a micro-bubble spray head 52 through a water pipe. As shown in FIG. 2, the micro-bubble spray head 52 is positioned close to the upper part of the front side of the shell 91 and located below the control panel 95. Similar to the above example, water enters the micro-bubble spray head 52 through the water pipe from the water inflow valve 51 to generate micro-bubble water containing a large number of micro-bubbles. The micro-bubble spray head 52 first sprays the micro-bubble water into a detergent box to mix with a detergent, and then the micro-bubble water enters the inner cylinder 93 through the detergent box for clothing washing. Optionally, the micro-bubble spray head 52 can also directly spray the micro-bubble water carrying a large number of micro-bubbles into the outer cylinder 92 or the inner cylinder 93 of the washing machine to further reduce the amount of detergent used and enhance the cleaning ability of the washing machine.

**[0085]** Reference is made to FIGS. 9 to 14, which are schematic views of an example of the micro-bubble spray head according to the present disclosure in the second embodiment, in which FIG. 9 is a schematic perspective view of the example of the micro-bubble spray head of the present disclosure in the second embodiment, FIG. 10 is a top view of the example of the micro-bubble spray head of the present disclosure shown in FIG. 9 in the second embodiment, FIG. 11 is a left view of the example of the micro-bubble spray head of the present disclosure shown in FIG. 9 in the second embodiment, FIG. 12 is a front view of the example of the micro-bubble spray head of the present disclosure shown in FIG. 9 in the second embodiment, and FIGS. 13 and 14 are cross-sectional views of the example of the micro-bubble spray head of the present disclosure in the second embodiment, taken along section lines A-A and B-B in FIG. 12 respectively. As shown in FIGS. 9 to 14, in one or more examples, the micro-bubble spray head 52 of the present disclosure includes a one-piece spray pipe 521. A micro-bubble bubbler 522 is installed at an outlet end 212 of the one-piece spray pipe 521, and the bubbler 522 is configured to be capable of cutting and mixing the bubble water when the bubble water flows through the bubbler 522 to produce micro-bubble water containing a large number of micro-bubbles.

**[0086]** Referring to FIG. 9, in one or more examples, the one-piece spray pipe 521 has an inlet end 211 and the outlet end 212. The micro-bubble bubbler 522 is fixed at the outlet end 212, and the inlet end 211 is configured to be connected to an external water source. Optionally, an anti-disengagement part 213 may be provided at the inlet end 211, such as an anti-disengagement rib protruding radially outward around an outer wall of the inlet end 211 or an annular groove structure recessed inward from the outer wall of the inlet end 211. The anti-disengagement part can prevent the one-piece spray pipe from falling off a connected pipeline which provides water supply.

**[0087]** With continued reference to FIG. 9, in one or more examples, the outer wall of the one-piece spray pipe 521 is provided with a first fixed installation part 214A, a second fixed installation part 214B, and a positioning part 215, which are used to position and fix the micro-bubble spray head 52 to a predetermined position.

**[0088]** With reference to FIGS. 10 to 12, the first fixed installation part 214A and the second fixed installation part 214B are symmetrically positioned on the outer wall of the one-piece spray pipe 521, and are located in the middle of the one-piece spray pipe 521. The positioning part 215 is a long-strip-shaped rib, which protrudes radially outward from the outer wall of the one-piece spray pipe 521 and extends in a longitudinal direction of the one-piece spray pipe 521. The first fixed installation part 214A and the second fixed installation part 214B are distributed on both sides of the positioning part 215. Optionally, only one fixed installation part is provided on the one-piece spray pipe 521, and the positioning part 215 may also be in other suitable forms.

**[0089]** In one or more examples, the first and second fixed installation parts 214A, 214B are screw hole structures so that the spray head 52 can be fixed to a target position such as on a washing apparatus by screws. However, the fixed installation parts may be any suitable connection structure, such as a snap-fit connection structure, a welded connection structure, and the like.

**[0090]** With reference to FIGS. 13 and 14, a diameter-decreased passage part 219 is provided inside the one-

piece spray pipe 521. A first-stage diameter-decreased conical passage 219a and a second-stage diameter-decreased conical passage 219b are formed in the diameter-decreased conical passage part 219 in a water flow direction C. The first-stage diameter-decreased conical passage 219a extends from the inlet end 211 of the one-piece spray pipe 521 to the second-stage diameter-decreased conical passage 219b. A spray hole 217 is formed at a downstream end of the diameter-decreased passage part 219. The spray hole 217 directly communicates with the second-stage diameter-decreased conical passage 219b located upstream thereof and a downstream passage in the one-piece spray pipe 521 located downstream thereof, so that the first-stage diameter-decreased conical passage 219a and the second-stage diameter-decreased conical passage 219b are communicated with the downstream passage of the one-piece spray pipe 521. Preferably, a diameter of the spray hole 217 is in a range of 0 to 6mm; more preferably, the diameter of the spray hole 217 is in a range of 1.2mm to 3.5mm. In one or more alternative examples, it is possible to form only one stage of diameter-decreased conical passage in the diameter-decreased conical passage part 219, or more than two stages of diameter-decreased conical passages may also be formed.

**[0091]** With continued reference to FIGS. 13 and 14, a flow disturbing part 218 is formed on the inner wall that surroundingly forms the second-stage diameter-decreased conical passage 219b. In one or more examples, the flow disturbing part 218 is at least one flow disturbing rib extending longitudinally along the inner wall of this stage of diameter-decreased conical passage, such as a plurality of flow disturbing ribs. In an alternative example, the flow disturbing part 218 may be at least one radial protrusion on the inner wall of this stage of diameter-decreased conical passage, such as one or more cylindrical protrusions. In an alternative example, the flow disturbing part 218 may also be formed on the inner wall that surroundingly forms the first-stage diameter-decreased conical passage 219a, or the inner wall of each stage of diameter-decreased conical passage is formed with the flow disturbing part.

**[0092]** As shown in FIGS. 13 and 14, an outer wall of the part of the diameter-decreased conical passage part 219 that corresponds to the second-stage diameter-decreased conical passage 219b is separate from the inner wall of the one-piece spray pipe 521, so that an annular gap 300 is formed between the outer wall and the inner wall of the one-piece spray pipe 521. The annular gap 300 facilitates the mixing of air and the water flow, thereby generating more micro-bubbles.

**[0093]** As shown in FIGS. 13 and 14, the outer wall of the one-piece spray pipe 521 is formed with two rows of a plurality of suction ports 216 arranged in a ring shape. These suction ports 216 are all positioned close to the spray hole 217. The water flow enters from the inlet end 211 and first flows through the first-stage diameter-decreased conical passage 219a and the second-stage diameter-decreased conical passage 219b to be pressurized stage by stage, and the flow disturbing part 218 further increases the vortex of the water flow. The accelerated water flow is rapidly sprayed into the downstream passage of the one-piece spray pipe 521 from the spray hole 217 in an expanded state, and generates a negative pressure therein. Under the action of the negative pressure, a large amount of outside air is sucked into the one-piece spray pipe 521 in the direction E from the suction ports 216 and mixes with the water flow therein to generate bubble water. In an alternative example, more or fewer suction ports may be provided as required, and they may be arranged in other forms, such as in a staggered arrangement. The bubble water then flows toward the micro-bubble bubbler 522.

**[0094]** As shown in FIGS. 13 and 14, the micro-bubble bubbler 522 includes a first-stage filter screen 221a and a second-stage filter screen 221b in the water flow direction C. The first-stage filter screen 221a and the second-stage filter screen 221b are arranged parallel to each other and spaced apart by a predetermined distance. The number of filter screen layers of the first-stage filter screen 221a is smaller than that of the second-stage filter screen 221b. In one or more examples, the first-stage filter screen 221a has one layer of filter screen, and the second-stage filter screen 221b has two or three layers of filter screens. Alternatively, the first-stage filter screen 221a also has more than one layer of filter screen. After the bubble water is cut and mixed by the first-stage filter screen 221a, it is then cut and mixed more finely by the second-stage filter screen 221b, thereby generating more micro-bubbles with a smaller diameter. In an alternative example, the micro-bubble bubbler may include more than two stages of filter screens to produce smaller-diameter micro-bubbles.

**[0095]** In one or more examples, both the first-stage filter screen 221a and the second-stage filter screen 221b have at least one fine hole having a diameter reaching a micron scale. Preferably, the diameter of the fine hole is between 0 and 1000 microns; more preferably, the diameter of the fine hole is between 5 microns and 500 microns. The first-stage filter screen 221a and the second-stage filter screen 221b can be a plastic fence, a metal mesh, a macromolecular material mesh, or other suitable hole mesh structures. The plastic fence usually refers to a macromolecular fence, which is integrally injection-molded by using a macromolecular material; or a macromolecular material is first made into a plate, and then a microporous structure is formed on the plate by machining to form the plastic fence. The macromolecular material mesh usually refers to a mesh with a microporous structure made by first making a macromolecular material into wires, and then weaving the wires. The macromolecular material mesh may include nylon mesh, cotton mesh, polyester mesh, polypropylene mesh, and the like. Alternatively, the first-stage filter screen 221a and the second-stage filter screen 221b may be other hole mesh structures capable of generating micro-bubbles,

such as a hole mesh structure composed of two non-micron-scale honeycomb structures.

**[0096]** FIG. 15 is an exploded perspective view of a first example of the micro-bubble spray head of the present disclosure in the second embodiment. As shown in FIG. 15, in this example, the micro-bubble bubbler 522 includes a screen bracket 225 for fixing the first-stage filter screen 221a and the second-stage filter screen 221b together, and a fixing member 222 for fixing the screen bracket 225 onto the outlet end 212 of the one-piece spray pipe 521.

**[0097]** In one or more examples, the screen bracket 225 is of a circular ring shape. As shown in FIGS. 13 to 14, the first-stage filter screen 221a and the second-stage filter screen 221b are respectively attached to two axial ends of the screen bracket 225, and the specific attachment methods include but are not limited to over-molding, bonding or cladding. In one or more examples, a plurality of overflow openings (or overflow holes) 226 are formed on a circumferential surface of the screen bracket 225. When a flow rate of the jet water flow is relatively large, part of the water is allowed to overflow from these overflow openings 226, which can not only help clean the filter screens, but also can prevent excess water from flowing back through the suction ports to make it impossible to suck in the air through the suction ports. When the flow rate of the jet water flow is relatively small, these overflow openings 226 can also act as auxiliary suction ports for sucking in more air.

**[0098]** In one or more examples, the fixing member 222 is substantially cylindrical, having a first end with an inner diameter larger than the outer diameter of the outlet end 212 of the one-piece spray pipe 521, and a second end with an opening inner diameter smaller than the inner diameter of the outlet end 212 of the one-piece spray pipe 521. Internal threads (not shown in the figure) are formed on the inner wall of the first end, and the inner threads can mesh with external threads 212a formed on the outlet end 212 of the one-piece spray pipe 521. When the fixing member 222 is fastened on the outlet end 212 of the one-piece spray pipe 521, the screen bracket 225 together with the first-stage filter screen 221a and the second-stage filter screen 221b are pressed between an end face of the outlet end 212 of the one-piece spray pipe 521 and an inner end face of the second end of the fixing member 222.

**[0099]** Optionally, the fixing member 222 is provided with a plurality of overflow openings (or overflow holes) 223 on its periphery, and these overflow openings are positioned close to the second end of the fixing member 222. When the bubble water cannot pass through the first-stage filter screen 221a and/or the second-stage filter screen 221b in time, the excess bubble water can flow out from the overflow openings 223, thereby preventing the excess water from flowing back and flooding the suction ports 216. Therefore, the overflow openings 223 can prevent a situation in which the air cannot be sucked into the one-piece spray pipe due to the blockage of the suction ports so that the micro-bubble water cannot be generated. In an alternative example, more or fewer overflow openings 223 may be provided as needed.

**[0100]** Optionally, a set gap can be reserved between the meshed external threads 212a and internal threads of the fixing member 222 to allow the air to be sucked into the one-piece spray pipe 521 through the gap. In an alternative example, the fixing member 222 may be connected to the outlet end 212 of the one-piece spray pipe 521 through other connection means, such as snap-fit, screw connection, or welding.

**[0101]** Optionally, a connection part 224 is provided on the periphery of the second-stage filter screen 221b. The screen bracket 225 presses the connection part 224 on the inner end surface of the second end of the fixing member 222, so that the second-stage filter screen 221b can be firmly fixed, and that the second-stage filter screen 221b will not fall off the outlet end 212 of the one-piece spray pipe 521 when subjected to the impact of high-pressure water flow. The other parts of this example that are not mentioned are the same as those of the above examples.

**[0102]** FIG. 16 is an exploded perspective view of a second example of the micro-bubble spray head of the present disclosure in the second embodiment. As shown in FIG. 16, in this example, the screen bracket 225 incorporating the first-stage filter screen 221a and the second-stage filter screen 221b is directly fixed at the outlet end 212 of the one-piece spray pipe 521. In one or more examples, a snap-fit arm 227 is provided on an axial end of the screen bracket 225 that faces the outlet end 212 of the one-piece spray pipe 521. Correspondingly, the outlet end 212 of the one-piece spray pipe 521 is provided with a snap-fit groove 212b. By clamping the snap-fit arm 227 in the snap-fit groove 212b, the screen bracket 225 is directly fixed at the outlet end 212, and no additionally fabricated fixing member is required. Alternatively, the screen bracket 225 can also be fixed to the outlet end 212 of the one-piece spray pipe 521 by screwing or welding, etc. Optionally, in this example, a plurality of overflow openings (or overflow holes) 226 are formed on a circumferential surface of the screen bracket 225. These overflow openings 226 can prevent a situation in which the air cannot be sucked into the one-piece spray pipe due to the blockage of the suction ports so that the micro-bubble water cannot be generated. The other parts of this example that are not mentioned are the same as those of the above examples.

Third embodiment

**[0103]** In order to solve the problem that existing micro-bubble generators have a complicated structure and the manufacturing cost is high, the present disclosure provides a micro-bubble spray head. The micro-bubble spray head includes a one-piece spray pipe 521 and a micro-bubble mesh 522 (see FIGS. 3 to 9). A diameter-decreased conical passage part 217 is arranged in the

one-piece spray pipe 521. An at-least-one-stage diameter-decreased conical passage is formed in the diameter-decreased conical passage part 217 in a water flow direction C, and a spray hole 218 is formed at a downstream end of the diameter-decreased conical passage part 217. The spray hole 218 is configured such that a water flow flowing through the at-least-one-stage diameter-decreased conical passage is sprayed from the spray hole and generates a negative pressure in the one-piece spray pipe 521. A suction port 216 is provided on a pipe wall of the one-piece spray pipe 521, and the suction port 216 is positioned such that air can be sucked into the one-piece spray pipe 521 through the suction port 216 by means of the negative pressure and mix with the water flow to produce bubble water. The bubble water becomes micro-bubble water when it passes through the micro-bubble mesh 522. Therefore, as compared with the micro-bubble generators in the prior art, both the number of components and the structure of the micro-bubble spray head of the present disclosure are greatly simplified, and the manufacturing cost of the micro-bubble spray head is also greatly reduced. At the same time, the micro-bubble spray head has good performance of micro-bubble generation.

**[0104]** The "diameter-decreased conical passage part" mentioned herein refers to a structure in which a diameter of the passage formed inside this part is gradually decreased in the water flow direction so that the passage has a conical shape.

**[0105]** The micro-bubble spray head of the present disclosure can be applied in the field of washing, the field of sterilization, or other fields that require micro-bubbles. For example, the micro-bubble spray head of the present disclosure can be applied not only to a washing apparatus, but also to devices such as bathroom faucets or showers.

**[0106]** Therefore, the present disclosure also provides a washing apparatus, which includes the micro-bubble spray head 52 of the present disclosure. The micro-bubble spray head 52 is configured to generate micro-bubble water in the washing apparatus. The micro-bubble water containing a large number of micro-bubbles is generated in the washing apparatus by the micro-bubble spray head 52. The micro-bubble water can not only improve the washing ability of the washing apparatus, but also can reduce the amount of detergent used and a residual amount of detergent such as in the clothing, which is not only advantageous for the user's health, but also can improve the user experience.

**[0107]** Reference is made to FIG. 1, which is a schematic structural view of an example of a washing apparatus including a micro-bubble spray head according to the present disclosure. In this example, the washing apparatus is a pulsator washing machine 1. Alternatively, in other examples, the washing apparatus may be a drum washing machine or a washing-drying integrated machine, etc.

**[0108]** As shown in FIG. 1, the pulsator washing machine 1 (hereinafter referred to as the washing machine) includes a cabinet 11. Feet 14 are provided at a bottom of the cabinet 11. An upper part of the cabinet 11 is provided with a tray 12, and the tray 12 is pivotally connected with an upper cover 13. An outer tub 21 serving as a water containing tub is provided inside the cabinet 11. An inner tub 31 is arranged in the outer tub 21, a pulsator 32 is arranged at a bottom of the inner tub 31, and a motor 34 is fixed at a lower part of the outer tub 21. The motor 34 is drivingly connected with the pulsator 32 through a transmission shaft 33. A spin-drying hole 311 is provided on a side wall of the inner tub 31. A drain valve 41 is provided on a drain pipe 42, and an upstream end of the drain pipe 42 communicates with a bottom of the outer tub 21. The washing machine further includes a water inflow valve 51 and a micro-bubble spray head 52 communicating with the water inflow valve 51, and the micro-bubble spray head 52 is installed at a top of the outer tub 21. Water enters the micro-bubble spray head 52 through the water inflow valve 51 to generate micro-bubble water containing a large number of micro-bubbles. The micro-bubble spray head 52 first sprays the micro-bubble water into a detergent box to mix with a detergent, and then the micro-bubble water enters the inner tub 31 through the detergent box for clothing washing. The micro-bubbles in the water impact the detergent during the breaking up process, and negative charges carried by the micro-bubbles can also adsorb the detergent, so the micro-bubbles can increase a mixing degree of the detergent and the water, thereby reducing the amount of detergent used and a residual amount of detergent in the clothing. In addition, the micro-bubbles in the inner tub 31 will also impact stains on the clothing, and will adsorb foreign matters that generate the stains. Therefore, the micro-bubbles also enhance a stain removal performance of the washing machine. Optionally, the micro-bubble spray head can also directly spray the micro-bubble water carrying a large number of micro-bubbles into the outer tub 21 or the inner tub 31 of the washing machine to further reduce the amount of detergent used and enhance the cleaning ability of the washing machine.

**[0109]** Reference is made to FIG. 2, which is a schematic structural view of another example of the washing apparatus including the micro-bubble spray head according to the present disclosure. In this example, the washing apparatus is a drum washing machine 9.

**[0110]** As shown in FIG. 2, the drum washing machine 9 includes a shell 91 and feet 98 located at a bottom of the shell. A top panel 94 is provided at a top of the shell 91. A front side of the shell 91 (an operation side facing the user) is provided with a door 97 that allows the user to put clothing and the like into the drum washing machine, and the door 97 is also provided with an observation window 96 for viewing an interior of the washing machine. A sealing window gasket 961 is also provided between the observation window 96 and the shell 91, and the sealing window gasket 961 is fixed on the shell 91.

A control panel 95 of the drum washing machine 9 is arranged on an upper part of the front side of the shell 91 to facilitate the user's operation. An outer cylinder 92 and an inner cylinder 93 are arranged inside the shell 91. The inner cylinder 93 is positioned inside the outer cylinder 92. The inner cylinder 93 is connected to a motor 931 (e.g., a direct drive motor) through a transmission shaft 932 and a bearing 933. A water inflow valve 51 is provided on an upper part of a rear side of the shell 91, and the water inflow valve 51 is connected to a micro-bubble spray head 52 through a water pipe. As shown in FIG. 2, the micro-bubble spray head 52 is positioned close to the upper part of the front side of the shell 91 and located below the control panel 95. Similar to the above example, water enters the micro-bubble spray head 52 through the water pipe from the water inflow valve 51 to generate micro-bubble water containing a large number of micro-bubbles. The micro-bubble spray head 52 first sprays the micro-bubble water into a detergent box to mix with a detergent, and then the micro-bubble water enters the inner cylinder 93 through the detergent box for clothing washing. Optionally, the micro-bubble spray head 52 can also directly spray the micro-bubble water carrying a large number of micro-bubbles into the outer cylinder 92 or the inner cylinder 93 of the washing machine to further reduce the amount of detergent used and enhance the cleaning ability of the washing machine.

**[0111]** Reference is made to FIGS. 17 to 19, which are schematic views of an example of the micro-bubble spray head according to the present disclosure in the third embodiment, in which FIG. 17 is a top view of the example of the micro-bubble spray head of the present disclosure in the third embodiment, FIG. 18 is a left view of the example of the micro-bubble spray head of the present disclosure in the third embodiment, and FIG. 19 is a front view of the example of the micro-bubble spray head of the present disclosure in the third embodiment. As shown in FIGS. 17 to 19, in one or more examples, the micro-bubble spray head 52 of the present disclosure includes a one-piece spray pipe 521. A micro-bubble mesh 522 is installed at an outlet end 212 of the one-piece spray pipe 521, and the micro-bubble mesh 522 is configured to be capable of cutting and mixing the bubble water when the bubble water flows through the micro-bubble mesh 522 to produce micro-bubble water containing a large number of micro-bubbles.

**[0112]** Referring to FIGS. 17 to 19, in one or more examples, the one-piece spray pipe 521 has an inlet end 211 and the outlet end 212. The micro-bubble mesh 522 is fixed at the outlet end 212, and the inlet end 211 is configured to be connected to an external water source. Optionally, an anti-disengagement part 213 may be provided at the inlet end 211, such as an anti-disengagement rib protruding radially outward around an outer wall of the inlet end 211 or an annular groove structure recessed inward from the outer wall of the inlet end 211. The anti-disengagement part can prevent the one-piece spray pipe from falling off a connected pipeline which provides water supply.

**[0113]** With continued reference to FIGS. 17 to 19, in one or more examples, the outer wall of the one-piece spray pipe 521 is provided with a first fixed installation part 214A, a second fixed installation part 214B, and a positioning part 215, which are used to position and fix the micro-bubble spray head 52 to a predetermined position.

**[0114]** With reference to FIGS. 17 and 19, the first fixed installation part 214A and the second fixed installation part 214B are symmetrically positioned on the outer wall of the one-piece spray pipe 521, and are located in the middle of the one-piece spray pipe 521. The positioning part 215 is a long-strip-shaped rib, which protrudes radially outward from the outer wall of the one-piece spray pipe 521 and extends in a longitudinal direction of the one-piece spray pipe 521. The first fixed installation part 214A and the second fixed installation part 214B are distributed on both sides of the positioning part 215. Optionally, only one fixed installation part is provided on the one-piece spray pipe 521, and the positioning part 215 may also be in other suitable forms.

**[0115]** In one or more examples, the first and second fixed installation parts 214A, 214B are screw hole structures so that the spray head 52 can be fixed to a target position by screws. However, the fixed installation parts may be any suitable connection structure, such as a snap-fit connection structure, a welded connection structure, and the like.

**[0116]** With reference to FIGS. 17 to 19, in one or more examples, the micro-bubble mesh 522 is sleeved over the outlet end 212 of the one-piece spray pipe 521, and is fixed on the outer wall of the one-piece spray pipe 521 through a fixing device, such as a pressure ring 523. Optionally, the pressure ring 523 may be a metal circlip. Alternatively, a suitable material, such as an elastic ring of elastic material (e.g., a rubber band) or a plastic tie, may also be used to fix the micro-bubble mesh 522.

**[0117]** In one or more examples, the micro-bubble mesh 522 has at least one fine hole having a diameter reaching a micron scale. Preferably, the diameter of the fine hole is between 0 and 1000 microns; more preferably, the diameter of the fine hole is between 5 and 500 microns. In one or more examples, the micro-bubble mesh 522 may be a metal mesh or a macromolecular material mesh, or other suitable hole mesh structures. The metal mesh includes but is not limited to stainless steel wire, nickel wire, brass wire and other materials. The macromolecular material mesh usually refers to a mesh with a microporous structure made by first making a macromolecular material into a wire and then weaving this wire. In a woven Dutch wire mesh, wefts are densely arranged, which can be woven by the following weaving methods: plain weave, twill weave, plain Dutch weave, twill Dutch weave, reverse Dutch weave. The macromolecular material mesh includes but is not limited to nylon (polyester) mesh, cotton mesh, polypropylene mesh, etc.

For example, the micro-bubble mesh may be formed of a cotton mesh. When the bubble water flows through the micro-bubble mesh 522, the bubble water is mixed and cut by the micro-bubble mesh 522, thereby generating micro-bubble water.

**[0118]** In one or more examples, the micro-bubble mesh 522 has a structure of at least two layers. The more layers of the micro-bubble mesh 522, the better the effect of micro-bubble generation, but the resistance to the water flow also increases. Optionally, the number of layers of the micro-bubble mesh 522 is not smaller than 3 and not larger than 12. In an alternative example, the number of layers of the micro-bubble mesh 522 is not smaller than 3 and not larger than 5.

**[0119]** FIG. 20 is a cross-sectional view of a first example of the micro-bubble spray head of the present disclosure in the third embodiment, taken along section line A-A in FIG. 19. With reference to FIG. 20, in one or more examples, a diameter-decreased conical passage part 217 is provided inside the one-piece spray pipe 521. The diameter-decreased conical passage part 217 is positioned close to the inlet end 211 of the one-piece spray pipe 521. A first-stage diameter-decreased conical passage 217b is formed inside the diameter-decreased conical passage part 217 in the water flow direction C, and a spray hole 218 is arranged at a downstream end of the diameter-decreased conical passage part 217. The spray hole 218 communicates with the upstream first-stage diameter-decreased conical passage 217b and a downstream passage inside the one-piece spray pipe 521 respectively. A short second-stage diameter-decreased conical passage 217c is also formed inside the inlet end 211 of the one-piece spray pipe 521 in the water flow direction C. The second-stage diameter-decreased conical passage 217c extends directly downstream to the first-stage diameter-decreased conical passage 217b, and a smallest diameter of the second-stage diameter-decreased conical passage 217c at its downstream end is larger than a largest diameter of the first-stage diameter-decreased conical passage 217b. In one or more alternative examples, more than one stage of diameter-decreased conical passage may be formed in the diameter-decreased conical passage part 217 in the water flow direction C, such as two stages, three stages or more stages of diameter-decreased conical passages.

**[0120]** With continued reference to FIG. 20, a flow disturbing part 217a is formed on the inner wall of the diameter-decreased conical passage part 217. In one or more examples, the flow disturbing part 217a is at least one flow disturbing rib extending longitudinally along the inner wall of the diameter-decreased conical passage part, such as a plurality of flow disturbing ribs. In an alternative example, the flow disturbing part 217a may be at least one radial protrusion on the inner wall of the diameter-decreased conical passage part, such as one or more cylindrical protrusions. Optionally, the flow disturbing part 217a may be formed only on the inner wall corresponding to the first-stage diameter-decreased conical passage, or formed on the inner wall corresponding to each stage of diameter-decreased conical passage, or formed on the inner wall corresponding to more than one stage of diameter-decreased conical passage.

**[0121]** As shown in FIG. 20, in one or more examples, an outer wall of the diameter-decreased conical passage part 217 is separate from the inner wall of the one-piece spray pipe 521, so that an annular gap 300 is formed between the outer wall of the diameter-decreased conical passage part 217 and the inner wall of the one-piece spray pipe 521. The annular gap 300 facilitates the mixing of air and the water flow, thereby generating more micro-bubbles.

**[0122]** As shown in FIG. 20, a suction port 216 is also formed on the one-piece spray pipe 521. The suction port 216 is formed on a pipe wall of the one-piece spray pipe 521 and is positioned close to the spray hole 218. The water flow enters from the inlet end 211 of the one-piece spray pipe 521, first flows through the first-stage diameter-decreased conical passage 217c, and then flows into the second-stage diameter-decreased conical passage 217b, thereby being pressurized, whereas the flow disturbing part 217a can increase the vortex of the water flow. The pressurized water flow is sprayed into the downstream passage of the one-piece spray pipe 521 from the spray hole 218 and is rapidly expanded, thereby generating a negative pressure in the downstream passage of the one-piece spray pipe 521. Under the action of the negative pressure, a large amount of outside air is sucked into the one-piece spray pipe 521 from the suction port 216 and mixes with the water flow therein to generate bubble water. The bubble water is cut and mixed by the micro-bubble mesh 522 when it flows through the micro-bubble mesh 522, thereby producing micro-bubble water.

**[0123]** FIG. 21 is a cross-sectional view of a second example of the micro-bubble spray head of the present disclosure in the third embodiment, taken along section line A-A in FIG. 19. As shown in FIG. 21, in this example, the diameter-decreased conical passage part 217 is positioned close to the inlet end of the one-piece spray pipe 521, but the suction port 216 is positioned close to the outlet end of the one-piece spray pipe 521, and thus close to the micro-bubble mesh 522. In this example, the suction port 216 is still within an action range of the negative pressure generated by the spray hole 218, so when the water flow is sprayed from the spray hole 218 into the downstream passage of the one-piece spray pipe 521 in an expanded state, the outside air is sucked into the one-piece spray pipe from the suction port 216 under the action of the negative pressure and mixes with the water flow. The other parts of this example that are not mentioned are the same as those of the above examples.

**[0124]** FIG. 22 is a cross-sectional view of a third example of the micro-bubble spray head of the present disclosure in the third embodiment, taken along section line A-A in FIG. 19. As shown in FIG. 22, in this example, the diameter-decreased conical passage part 217 is posi-

tioned close to the outlet end 212 of the one-piece spray pipe 521, and the suction port 216 is positioned close to the spray hole 218 at the downstream end of the diameter-decreased conical passage part 217. A second-stage diameter-decreased conical passage 217c extends by a longer distance from the inlet end 211 of the one-piece spray pipe 521 to a first-stage diameter-decreased conical passage 217b inside the diameter-decreased conical passage part 217. In this example, no flow disturbing part is provided in the diameter-decreased conical passage part 217. The other parts of this example that are not mentioned are the same as those of the above examples.

**[0125]** FIG. 23 is a cross-sectional view of a fourth example of the micro-bubble spray head of the present disclosure in the third embodiment, taken along section line A-A in FIG. 19. As shown in FIG. 23, in this example, the diameter-decreased conical passage part 217 is also positioned close to the outlet end 212 of the one-piece spray pipe 521, and the suction port 216 is positioned close to the spray hole 218 at the downstream end of the diameter-decreased conical passage part 217. A second-stage diameter-decreased conical passage 217c extends by a longer distance from the inlet end 211 of the one-piece spray pipe 521 to a first-stage diameter-decreased conical passage 217b inside the diameter-decreased conical passage part 217. In this example, the diameter-decreased conical passage part 217 is provided therein with a flow disturbing part 217a, specifically a plurality of longitudinal flow disturbing ribs extending along the inner wall of the diameter-decreased conical passage part 217. The other parts of this example that are not mentioned are the same as those of the above examples.

**[0126]** Hitherto, the technical solutions of the present disclosure have been described in connection with the preferred embodiments shown in the accompanying drawings, but it is easily understood by those skilled in the art that the scope of protection of the present disclosure is obviously not limited to these specific embodiments. Without departing from the principles of the present disclosure, those skilled in the art can combine technical features from different embodiments, and can also make equivalent changes or replacements to relevant technical features. All these technical solutions after such changes or replacements will fall within the scope of protection of the present disclosure.

## Claims

1. A micro-bubble spray head, wherein the micro-bubble spray head comprises a one-piece spray pipe and a micro-bubble filter screen bag fixed inside an outlet end of the one-piece spray pipe;

   a Venturi tube structure is formed in the one-piece spray pipe, and a suction port is provided on the one-piece spray pipe, so that air is sucked into the one-piece spray pipe through the suction port by means of a negative pressure produced by the Venturi tube structure and mixes with a water flow in the one-piece spray pipe to produce bubble water; and

   the micro-bubble filter screen bag comprises an opening, a bottom and a side wall between the opening and the bottom; the opening faces the Venturi tube structure, and a water outflow space is formed between the side wall and an inner wall of the outlet end so that the bubble water can pass through the side wall and the bottom to form micro-bubble water.

2. The micro-bubble spray head according to claim 1, wherein the micro-bubble filter screen bag is formed by at least two layers of filter screens.

3. The micro-bubble spray head according to claim 1 or 2, wherein the micro-bubble filter screen bag is made of a metal filter screen or a macromolecular material mesh.

4. The micro-bubble spray head according to claim 1 or 2, wherein the micro-bubble filter screen bag is fixed on the inner wall of the outlet end by a circlip.

5. The micro-bubble spray head according to claim 1 or 2, wherein the Venturi tube structure is composed of a diameter-decreased conical passage part, an at-least-one-stage diameter-decreased conical passage is formed in the diameter-decreased conical passage part in a water flow direction, and a spray hole is arranged at a downstream end of the diameter-decreased conical passage part, so that the water flow pressurized by the at-least-one-stage diameter-decreased conical passage can be sprayed from the spray hole and generate a negative pressure in the one-piece spray pipe.

6. The micro-bubble spray head according to claim 5, wherein when the spray hole is positioned close to an inlet end of the one-piece spray pipe, the suction port is positioned close to the spray hole and/or positioned at the outlet end.

7. The micro-bubble spray head according to claim 6, wherein a first suction port and a second suction port are provided on the one-piece spray pipe, the first suction port is positioned close to the spray hole, and the second suction port is positioned at the outlet end.

8. The micro-bubble spray head according to claim 5, wherein when the spray hole is positioned close to the outlet end, the suction port is positioned close to the spray hole.

9. The micro-bubble spray head according to claim 1 or 2, wherein the Venturi tube structure can be any one of the following structures: a structure having a plurality of diameter-decreased conical passages parallel to each other in a water flow direction; a structure having a single throttling hole in the water flow direction; a structure having a plurality of throttling holes parallel to each other in the water flow direction; a structure having a single passage whose diameter is first decreased and then increased in the water flow direction; or a structure having a plurality of passages parallel to each other in the water flow direction, whose diameter is first decreased and then increased.

10. A washing apparatus, wherein the washing apparatus comprises the micro-bubble spray head according to any one of claims 1 to 9, and the micro-bubble spray head is arranged to generate micro-bubble water in the washing apparatus.

11. A micro-bubble spray head, wherein the micro-bubble spray head comprises a one-piece spray pipe and a micro-bubble bubbler fixed at an outlet end of the one-piece spray pipe;

a diameter-decreased conical passage part is arranged in the one-piece spray pipe, an at-least-one-stage diameter-decreased conical passage is formed in the diameter-decreased conical passage part in a water flow direction, and a spray hole is formed at a downstream end of the diameter-decreased conical passage part; the spray hole is configured such that after a water flow pressurized by the at-least-one-stage diameter-decreased conical passage is sprayed from the spray hole, a negative pressure is generated in the one-piece spray pipe;
a suction port is provided on the one-piece spray pipe, and the suction port is positioned close to the spray hole so that air is sucked into the one-piece spray pipe through the suction port by means of the negative pressure and mixes with the water flow to generate bubble water; and
the micro-bubble bubbler comprises at least two stages of filter screens spaced apart from each other by a predetermined distance in the water flow direction to transform the bubble water into micro-bubble water.

12. The micro-bubble spray head according to claim 11, wherein the at-least-one-stage diameter-decreased conical passage comprises a first-stage diameter-decreased conical passage and a second-stage diameter-decreased conical passage.

13. The micro-bubble spray head according to claim 11 or 12, wherein a flow disturbing part is formed on an inner wall of the diameter-decreased conical passage part.

14. The micro-bubble spray head according to claim 11 or 12, wherein a diameter of the spray hole is in a range of 0-6mm.

15. The micro-bubble spray head according to claim 11 or 12, wherein the at least two stages of filter screens comprise a first-stage filter screen and a second-stage filter screen, the first-stage filter screen comprises at least one layer of filter screen, and the number of layers of the first-stage filter screen is smaller than the number of layers of the second-stage filter screen.

16. The micro-bubble spray head according to claim 11 or 12, wherein the micro-bubble bubbler comprises a screen bracket to fix the at least two stages of filter screens together.

17. The micro-bubble spray head according to claim 16, wherein the screen bracket is directly fixed at the outlet end of the one-piece spray pipe.

18. The micro-bubble spray head according to claim 16, wherein the micro-bubble bubbler also comprises a fixing member, and the screen bracket is fixed at the outlet end of the one-piece spray pipe through the fixing member.

19. The micro-bubble spray head according to claim 18, wherein at least one of the screen bracket and the fixing member is provided with an overflow opening.

20. A washing apparatus, wherein the washing apparatus comprises the micro-bubble spray head according to any one of claims 11 to 19, and the micro-bubble spray head is arranged to generate micro-bubble water in the washing apparatus.

21. A micro-bubble spray head, wherein the micro-bubble spray head comprises a one-piece spray pipe and a micro-bubble mesh fixed at an outlet end of the one-piece spray pipe;

a diameter-decreased conical passage part is arranged in the one-piece spray pipe, an at-least-one-stage diameter-decreased conical passage is formed in the diameter-decreased conical passage part in a water flow direction, and a spray hole is formed at a downstream end of the diameter-decreased conical passage part; the spray hole is configured such that a water flow flowing through the at-least-one-stage diameter-decreased conical passage is sprayed from the spray hole and generates a negative pressure in the one-piece spray pipe;

and
a suction port is provided on the one-piece spray pipe, and the suction port is positioned such that air can be sucked into the one-piece spray pipe through the suction port by means of the negative pressure and mix with the water flow to generate bubble water; and the bubble water becomes micro-bubble water when it passes through the micro-bubble mesh.

**22.** The micro-bubble spray head according to claim 21, wherein the micro-bubble mesh is sleeved over the outlet end of the one-piece spray pipe and is fixed on an outer wall of the one-piece spray pipe through a fixing device.

**23.** The micro-bubble spray head according to claim 21 or 22, wherein the micro-bubble mesh comprises at least two layers of meshes.

**24.** The micro-bubble spray head according to claim 21 or 22, wherein the micro-bubble mesh comprises a metal mesh or a macromolecular material mesh.

**25.** The micro-bubble spray head according to claim 21 or 22, wherein the diameter-decreased conical passage part is positioned close to an inlet end of the one-piece spray pipe, and the suction port is positioned close to the spray hole.

**26.** The micro-bubble spray head according to claim 21 or 22, wherein the diameter-decreased conical passage part is positioned close to an inlet end of the one-piece spray pipe, and the suction port is positioned close to the outlet end of the one-piece spray pipe.

**27.** The micro-bubble spray head according to claim 21 or 22, wherein the diameter-decreased conical passage part is positioned close to the outlet end of the one-piece spray pipe, and the suction port is positioned close to the spray hole.

**28.** The micro-bubble spray head according to claim 21 or 22, wherein a flow disturbing part is arranged on an inner wall of the diameter-decreased conical passage part.

**29.** The micro-bubble spray head according to claim 28, wherein the flow disturbing part is at least one radial protrusion arranged on the inner wall of the diameter-decreased conical passage part or at least one flow disturbing rib extending longitudinally along the inner wall of the diameter-decreased conical passage part.

**30.** A washing apparatus, wherein the washing apparatus comprises the micro-bubble spray head according to any one of claims 21 to 29, and the micro-bubble spray head is arranged to generate micro-bubble water in the washing apparatus.

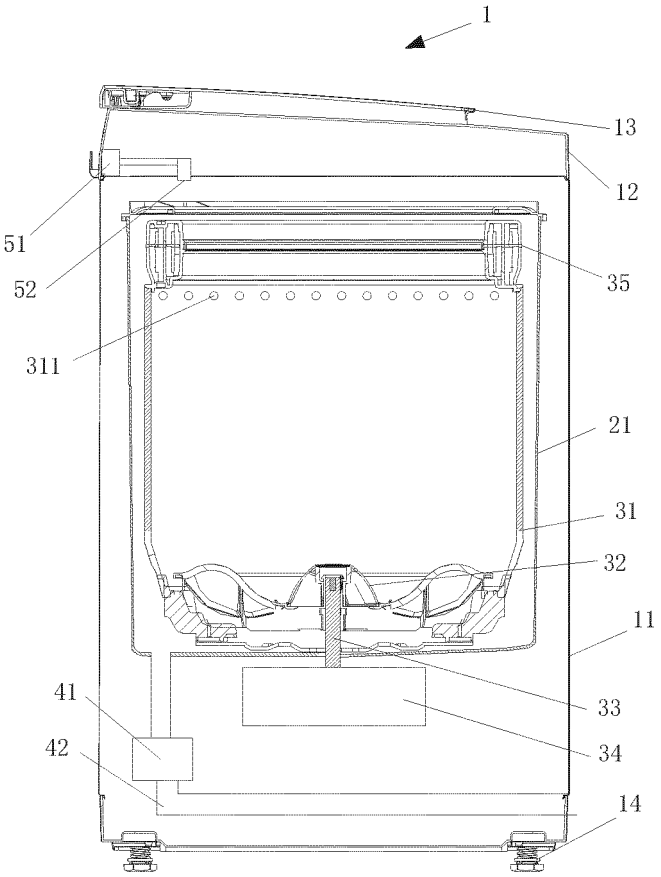



FIG. 1

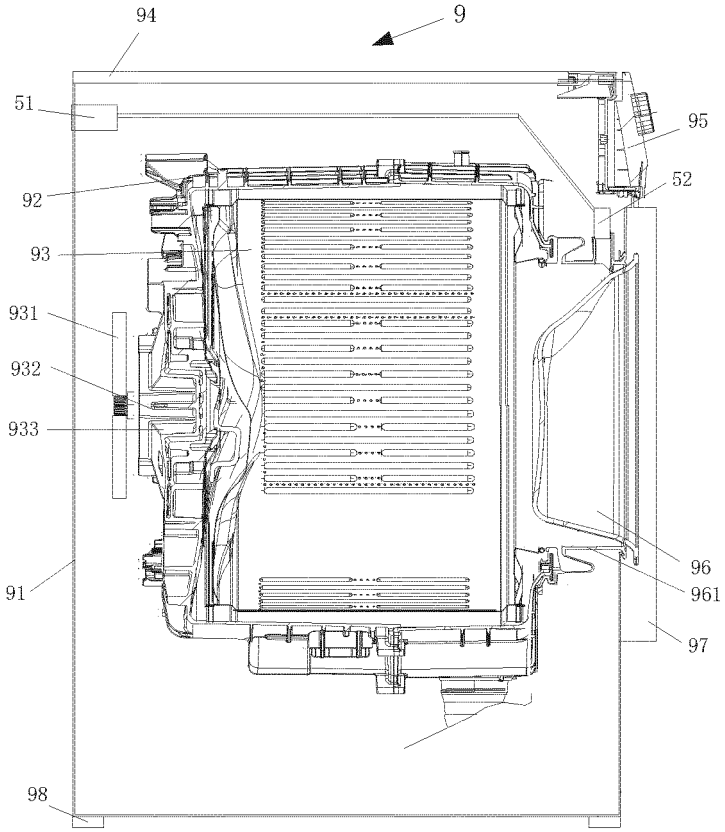



FIG. 2

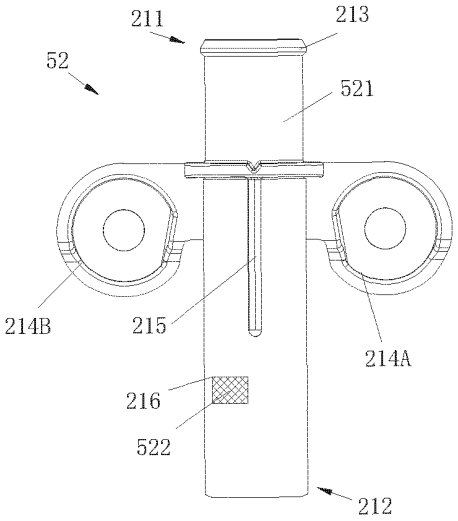



FIG. 3

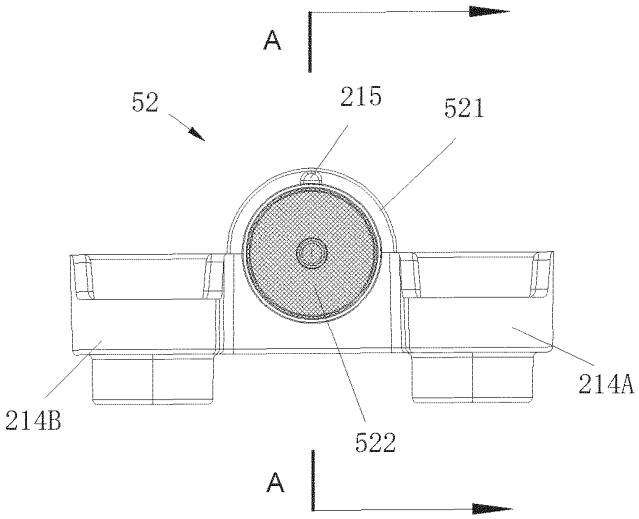
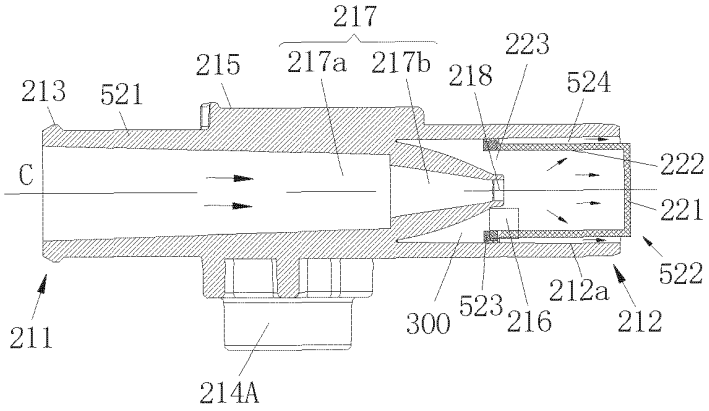
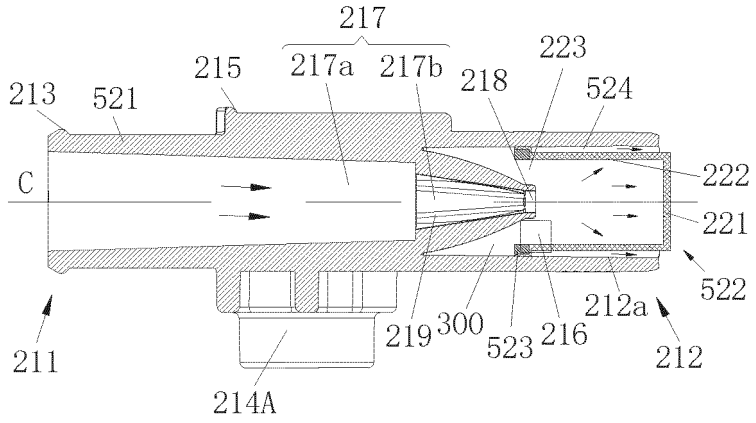



FIG. 4



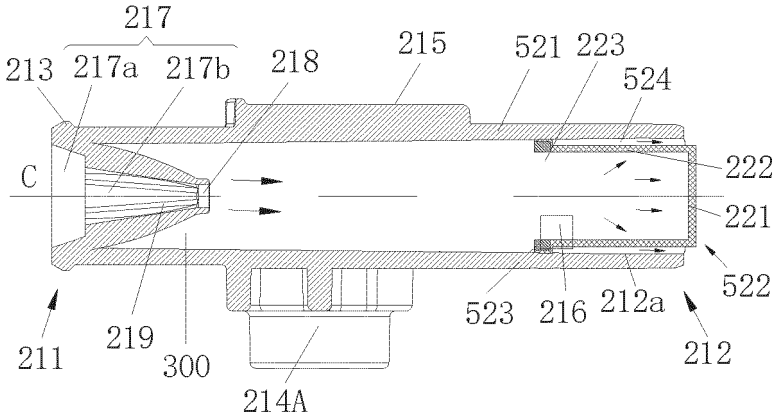

A-A cross-sectional view

FIG. 5



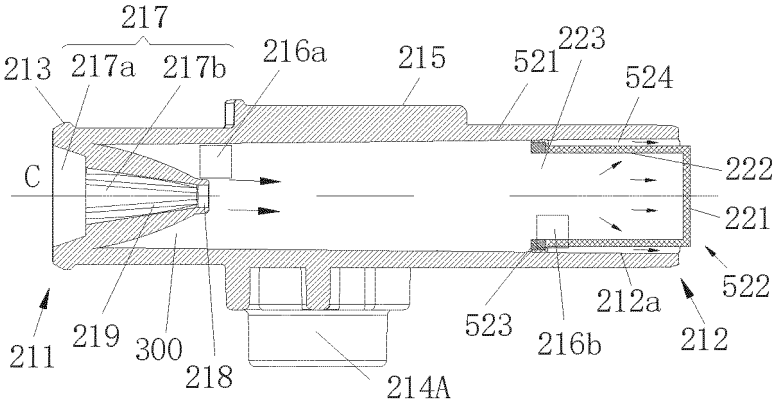

A-A cross-sectional view

**FIG. 6**



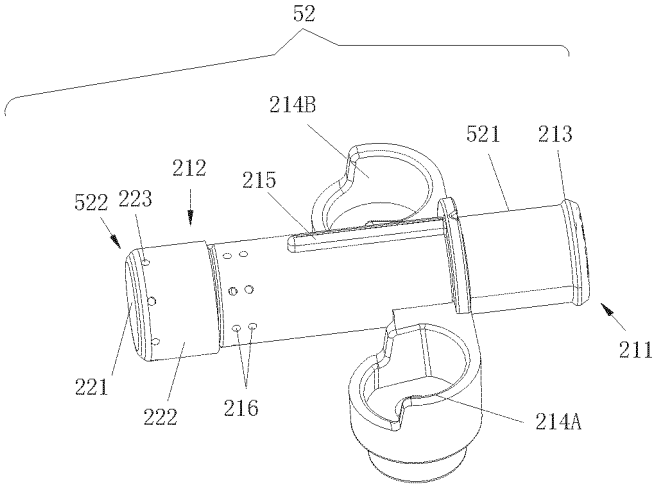

A-A cross-sectional view

**FIG. 7**




A-A cross-sectional view

**FIG. 8**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214B
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FIG. 9

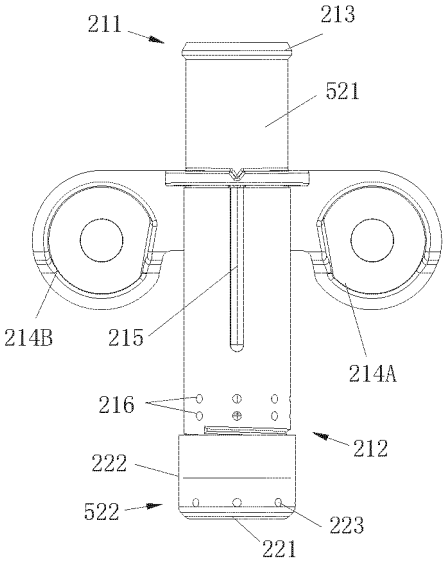
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FIG. 10

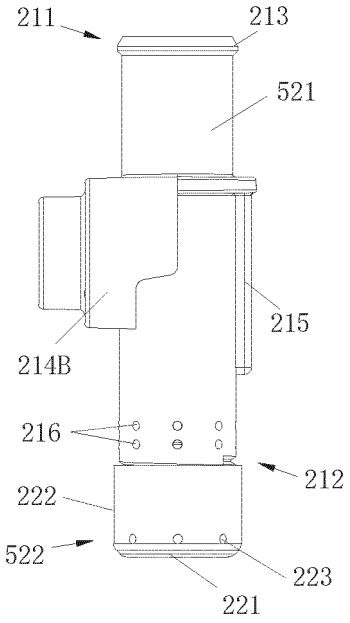
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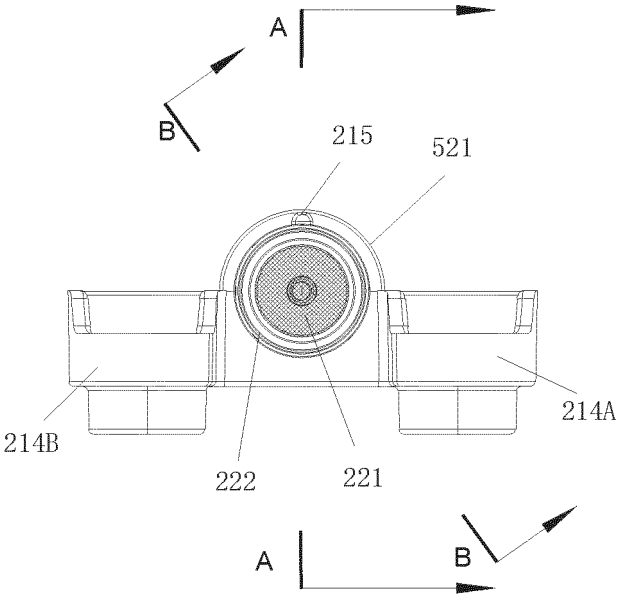
FIG. 11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214A
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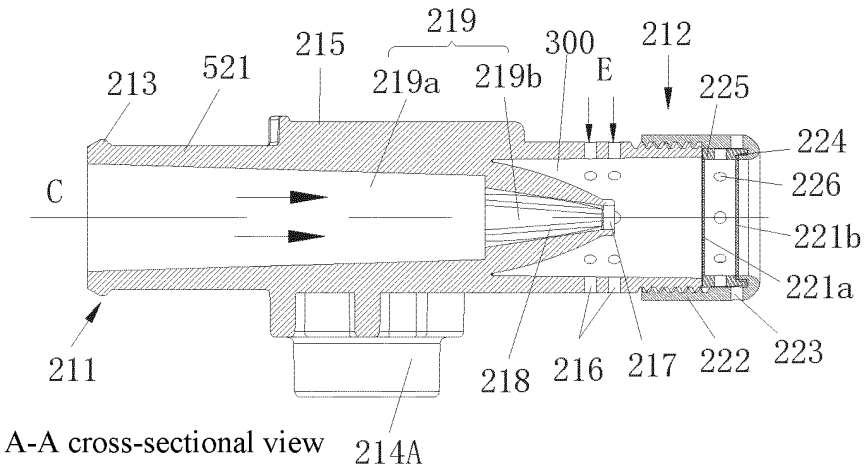
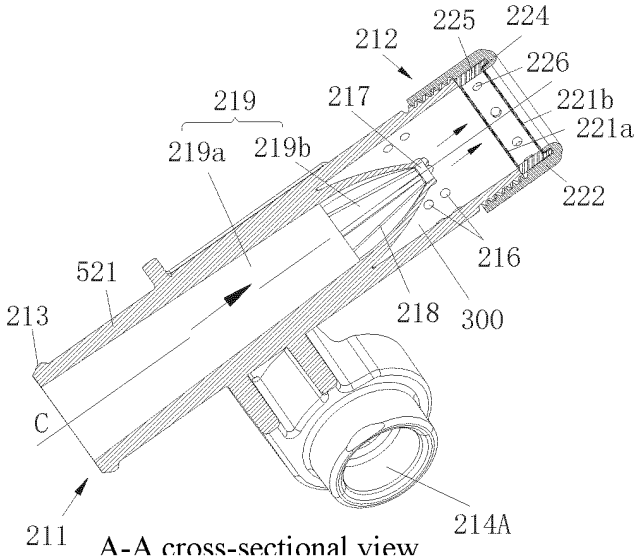
B

FIG. 12




A-A cross-sectional view

FIG. 13




A-A cross-sectional view

FIG. 14

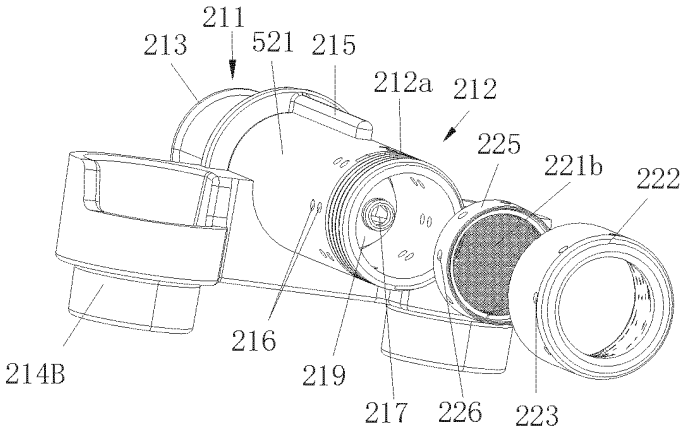
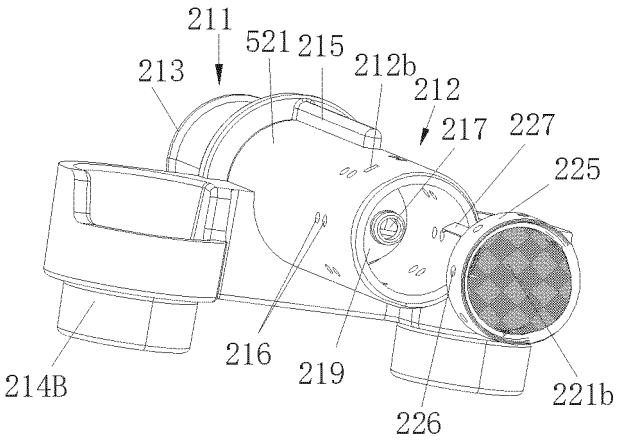



FIG. 15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214B
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FIG. 16

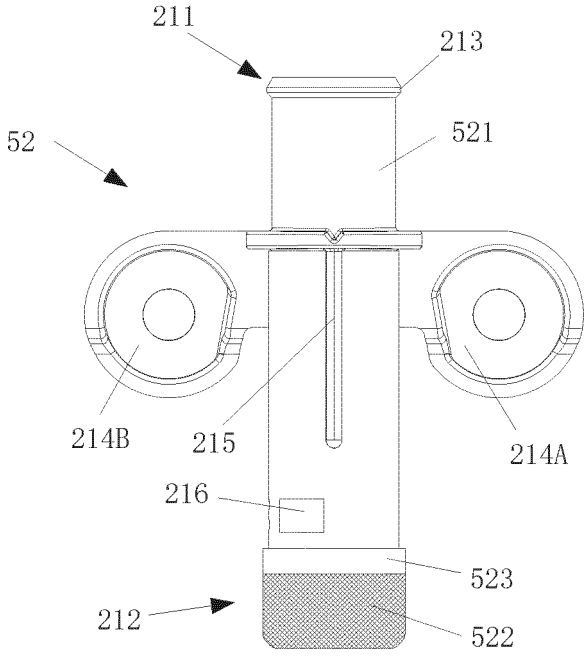
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FIG. 17

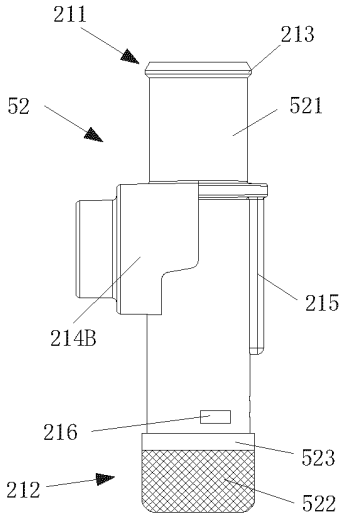



FIG. 18

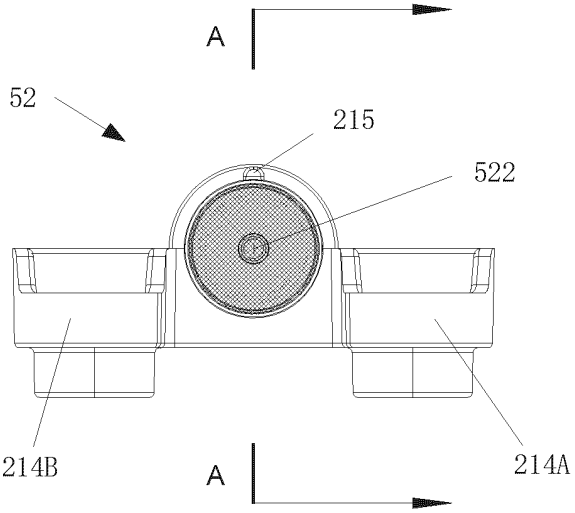
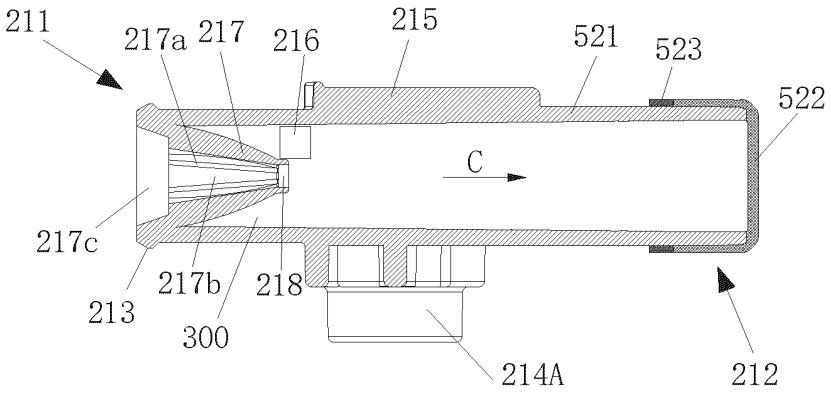



FIG. 19




A-A cross-sectional view

FIG. 20

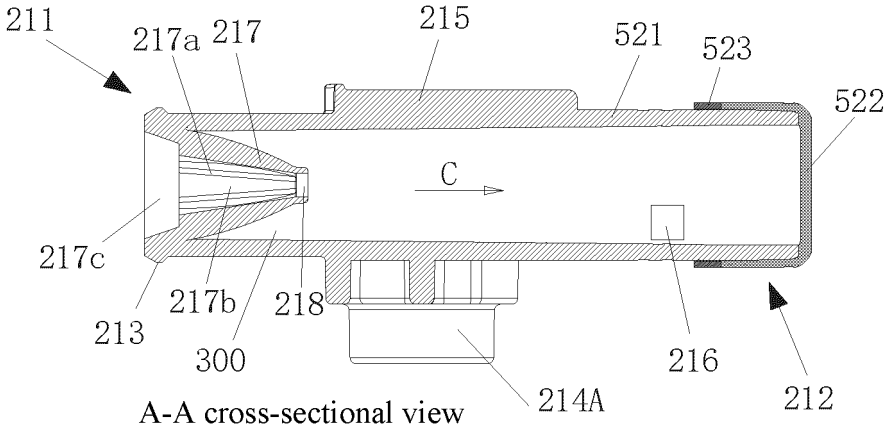



FIG. 21

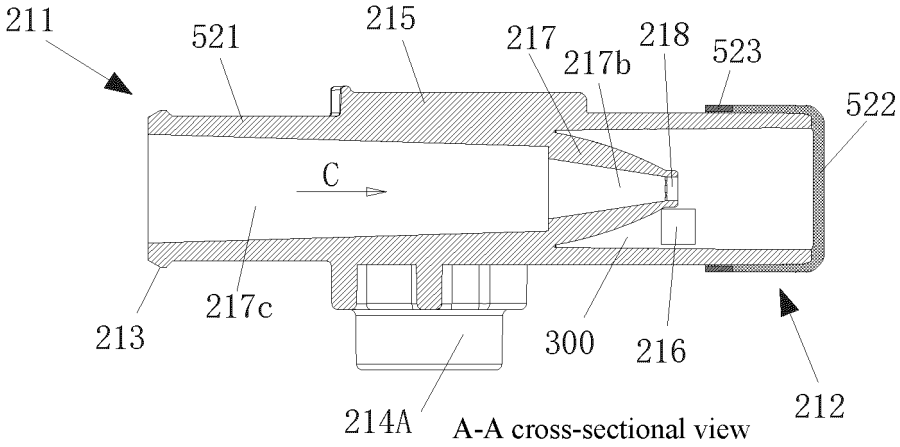



FIG. 22

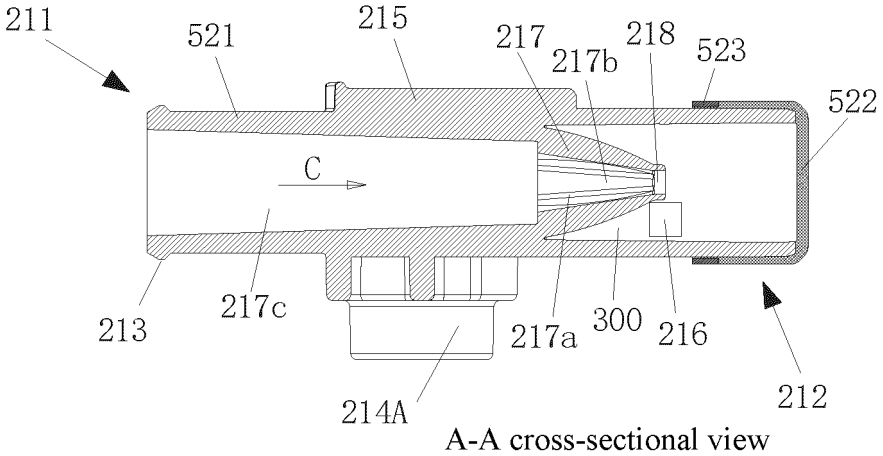



FIG. 23

**INTERNATIONAL SEARCH REPORT**

International application No.
**PCT/CN2020/132826**

**A. CLASSIFICATION OF SUBJECT MATTER**

D06F 35/00(2006.01)i; B05B 7/00(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)

D06F35/-; B05B7/-; B01F3/-; B01F5/-

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

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

CNPAT, CNKI, WPI, EPODOC: 喷头, 洗涤, 洗衣, 微气泡, 气泡, 文丘里, 负压, 孔, 滤网, 过滤 SPRAY+, NOZZLE?, WASH +, BUBBLE?, MICRO, WENTURI, NEGATIVE, PRESSURE, HOLE, APERTURE, FILT+, SCREEN

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| PX | CN 211772131 U (QINGDAO HAIER DRUM WASHING MACHINE CO., LTD. et al.) 27 October 2020 (2020-10-27)<br>description, specific embodiment, and figures 1-8 | 1-30 |
| PX | CN 211368092 U (QINGDAO HAIER DRUM WASHING MACHINE CO., LTD. et al.) 28 August 2020 (2020-08-28)<br>description, specific embodiment, and figures 1-6 | 1-30 |
| PX | CN 211772133 U (QINGDAO HAIER WASHING MACHINE CO., LTD. et al.) 27 October 2020 (2020-10-27)<br>description, specific embodiment, and figures 1-8 | 1-30 |
| PX | CN 211772134 U (QINGDAO HAIER WASHING MACHINE CO., LTD. et al.) 27 October 2020 (2020-10-27)<br>description, specific embodiment, and figures 1-8 | 1-30 |
| PX | CN 211368090 U (QINGDAO HAIER WASHING MACHINE CO., LTD. et al.) 28 August 2020 (2020-08-28)<br>description, specific embodiment, and figures 1-9 | 1-30 |

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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 |
|---|---|
| **10 February 2021** | **04 March 2021** |
| Name and mailing address of the ISA/CN<br>**China National Intellectual Property Administration (ISA/CN)**<br>**No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088**<br>**China**<br>Facsimile No. **(86-10)62019451** | Authorized officer<br><br>Telephone No. |

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2020/132826

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| PX | CN 211395013 U (QINGDAO HAIER WASHING MACHINE CO., LTD. et al.) 01 September 2020 (2020-09-01)<br>description, specific embodiment, and figures 1-9 | 1-30 |
| PX | CN 211395014 U (QINGDAO HAIER WASHING MACHINE CO., LTD. et al.) 01 September 2020 (2020-09-01)<br>description, specific embodiment, and figures 1-10 | 1-30 |
| X | CN 107583479 A (JODEN SANITARY WARE (JIANGMEN) CO., LTD.) 16 January 2018 (2018-01-16)<br>description, paragraphs [0024]-[0045], and figures 1-4 | 1-30 |
| X | CN 207591642 U (JODEN INDUSTRIES (JIANGMEN) INC.) 10 July 2018 (2018-07-10)<br>description, paragraphs [0023]-[0045], and figures 1-4 | 1-30 |
| A | CN 108380067 A (JODEN SANITARY WARE (JIANGMEN) CO., LTD.) 10 August 2018 (2018-08-10)<br>entire document | 1-30 |
| A | CN 107321204 A (SHANGHAI JIUTIAN AUTO PARTS MANUFACTURING CO., LTD.) 07 November 2017 (2017-11-07)<br>entire document | 1-30 |
| A | JP 2008142688 A (OKUMURA KATSUYUKI) 26 June 2008 (2008-06-26)<br>entire document | 1-30 |
| A | US 2018274152 A1 (DONGBU DAEWOO ELECTRONICS CORP.) 27 September 2018 (2018-09-27)<br>entire document | 1-30 |

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

**INTERNATIONAL SEARCH REPORT**
**Information on patent family members**

International application No.
**PCT/CN2020/132826**

| Patent document cited in search report | | | Publication date (day/month/year) | Patent family member(s) | | | Publication date (day/month/year) |
|---|---|---|---|---|---|---|---|
| CN | 211772131 | U | 27 October 2020 | None | | | |
| CN | 211368092 | U | 28 August 2020 | None | | | |
| CN | 211772133 | U | 27 October 2020 | None | | | |
| CN | 211772134 | U | 27 October 2020 | None | | | |
| CN | 211368090 | U | 28 August 2020 | None | | | |
| CN | 211395013 | U | 01 September 2020 | None | | | |
| CN | 211395014 | U | 01 September 2020 | None | | | |
| CN | 107583479 | A | 16 January 2018 | None | | | |
| CN | 207591642 | U | 10 July 2018 | WO | 2019056868 | A1 | 28 March 2019 |
| | | | | TW | 201914685 | A | 16 April 2019 |
| CN | 108380067 | A | 10 August 2018 | WO | 2019214342 | A1 | 14 November 2019 |
| | | | | CN | 208563472 | U | 01 March 2019 |
| CN | 107321204 | A | 07 November 2017 | WO | 2019037470 | A1 | 28 February 2019 |
| | | | | CN | 207137714 | U | 27 March 2018 |
| JP | 2008142688 | A | 26 June 2008 | None | | | |
| US | 2018274152 | A1 | 27 September 2018 | KR | 20180108031 | A | 04 October 2018 |
| | | | | CN | 108625105 | A | 09 October 2018 |

Form PCT/ISA/210 (patent family annex) (January 2015)

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


- CN 201911399452 **[0001]**
- CN 201911229872 **[0001]**
- CN 201911348666 **[0001]**
- CN 107321204 A **[0004]**
- CN 107583480 A **[0005]**