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(54) **MICROBUBBLE SPRAY HEAD, MICROBUBBLE TREATMENT AGENT BOX ASSEMBLY AND WASHING DEVICE**

(57) A microbubble spray head (52), a microbubble treatment agent box assembly (53) and a washing device. The washing device comprises the microbubble treatment agent box assembly (53), and the microbubble treatment agent box assembly (53) comprises the microbubble spray head (52). The microbubble spray head (52) comprises a spray pipe (521) and a microbubble bubbler (522) fixed to the outlet end of the spray pipe (521), a diameter-reducing conical channel part (216) and a mixing cavity (219) are provided in the spray pipe (521), at least one stage of diameter-reducing conical channel is provided in the diameter-reducing conical channel part (216) in the water flow direction, a throttling hole (218) is provided in the downstream end of the diameter-reducing conical channel part (216), and the diameter of the throttling hole (218) is smaller than that of the mixing cavity (219), such that water flow is sprayed into the mixing cavity (219) by means of the throttling hole (218), and negative pressure is generated in the mixing cavity (219); and the outlet end (214) of the spray pipe (521) and the microbubble bubbler (522) are respec-

tively provided with air suction ports (215, 222) that are in communication with each other, such that air can be sucked into the mixing cavity (219) by means of the air suction ports (215, 222) by means of negative pressure and is mixed with the water flow to form bubble water, and the bubble water is cut and mixed by means of the microbubble bubbler (522) to form microbubble water.

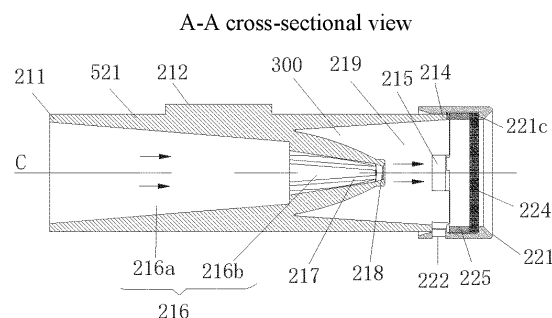


FIG. 4

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. "201911350677.7" filed on December 24, 2019;

Chinese patent application for invention with the application No. "201911348651.9" filed on December 24, 2019; and

Chinese patent application for invention with the application No. "201911228533.4" filed on December 4, 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 washing apparatus, and specifically to a micro-bubble spray head, a micro-bubble treatment agent box assembly and a washing apparatus having the micro-bubble treatment agent box assembly.

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 is usually 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 make the micro-bubbles have extremely strong cleaning and purifying abilities. At present, micro-bubbles have been widely used in washing apparatuses such as clothing washing machines.

[0004] For example, Chinese patent publication

CN108625120A discloses a washing machine. The washing machine has a water supply mechanism part (equivalent to a detergent box assembly), and the water supply mechanism part is provided therein with a detergent/treatment agent box (which is configured to accommodate powder, liquid detergent and softener) and a micro-bubble generator for providing micro-bubble water to the detergent/treatment agent box to dissolve the detergent/treatment agent. Specifically, CN108625120A discloses that the micro-bubble generator has a cylindrical spray pipe, and a one-stage diameter-decreased conical passage part, a protruding part (which forms a throttling hole) and a mixing cavity (having a diameter which is larger than that of the throttling hole and which keeps constant) are formed in the spray pipe in a water flow direction. After an electromagnetic water supply valve is opened, a water flow from a main water pipe is rapidly depressurized when it flows through this micro-bubble generator, so that air in the water flow is separated out to generate micro-bubbles in the water; then the micro-bubble water flows into the detergent/treatment agent box, mixes with the detergent or softener and the like in the detergent/treatment agent box, and then enters a washing cylinder for clothing washing. However, such a micro-bubble generator can only rely on the very limited air carried inside the liquid flowing therethrough to generate micro-bubbles; therefore, this micro-bubble generator cannot provide micro-bubble water containing enough micro-bubbles for the detergent/treatment agent box, thereby affecting the dissolution of detergent and/or softener and further resulting in poor cleaning effect. The residual detergent may cause hidden dangers to the health of user.

[0005] Accordingly, there is a need in the art for a new technical solution to solve the above problem.

SUMMARY OF THE INVENTION

[0006] In order to solve the above problem in the prior art, that is, to solve the technical problem that an efficiency of micro-bubble generation of existing micro-bubble spray heads is not high, the present disclosure provides a micro-bubble spray head. The micro-bubble spray head includes a spray pipe and a micro-bubble bubbler fixed at an outlet end of the spray pipe; a diameter-decreased conical passage part and a mixing cavity are provided in the spray pipe; there is an at-least-one-stage diameter-decreased conical passage part in a water flow direction; a throttling hole is arranged at a downstream end of the diameter-decreased conical passage part, and a diameter of the throttling hole is smaller than a diameter of the mixing cavity, so that a water flow is sprayed into the mixing cavity through the throttling hole and generates a negative pressure in the mixing cavity; the outlet end of the spray pipe and the micro-bubble bubbler are respectively provided with suction ports communicating with each other so that air can be sucked into the mixing cavity through

the suction ports by means of the negative pressure and mix with the water flow to form bubble water; and the bubble water is cut and mixed by the micro-bubble bubbler to form micro-bubble water.

[0007] In a preferred technical solution of the above micro-bubble spray head, the diameter of the mixing cavity keeps constant or is gradually increased in the water flow direction.

[0008] In a preferred technical solution of the above micro-bubble spray head, a flow disturbing part is arranged in the diameter-decreased conical passage part.

[0009] In a preferred technical solution of the above micro-bubble spray head, the suction ports are also overflow openings of the micro-bubble spray head.

[0010] In a preferred technical solution of the above micro-bubble spray head, the micro-bubble bubbler includes a multi-layer filter screen and a screen bracket for fixing the multi-layer filter screen.

[0011] In a preferred technical solution of the above micro-bubble spray head, a plurality of claws are arranged around an outer wall of the outlet end of the spray pipe, and a plurality of snap-fit openings are arranged around an axial end of the screen bracket that is close to the outlet end to accommodate one of the plurality of claws respectively.

[0012] In a preferred technical solution of the above micro-bubble spray head, the micro-bubble bubbler further includes a pressure ring, and the pressure ring is placed between an end face of the outlet end and the screen bracket so as to abut the multi-layer filter screen against the screen bracket.

[0013] In a preferred technical solution of the above micro-bubble spray head, a plurality of spaced apart bosses extending outward in an axial direction are respectively formed on two axial end faces of the pressure ring so that a groove is formed between the adjacent bosses.

[0014] 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 spray pipe and a micro-bubble bubbler fixed at the outlet end of the spray pipe. A diameter-decreased conical passage part and a mixing cavity are provided in the spray pipe. There is an at-least-one-stage diameter-decreased conical passage in the diameter-decreased conical passage part in the water flow direction, and a throttling hole is arranged at the downstream end of the diameter-decreased conical passage part. The at-least-one-stage diameter-decreased conical passage can pressurize the water flow flowing therethrough. The diameter of the throttling hole is much smaller than the diameter of the mixing cavity, so the pressurized water flow can be rapidly expanded and sprayed into the mixing cavity through the throttling hole and generate a negative pressure in the mixing cavity. The outlet end of the spray pipe and the micro-bubble bubbler are respectively provided with suction ports communicating with each other. These suction ports are configured such that the outside air can be sucked into the

mixing cavity in a large amount through these suction ports by means of the negative pressure and mix with the water flow in the mixing cavity to form bubble water. The generated bubble water is then cut and mixed by the micro-bubble bubbler to form micro-bubble water containing a large number of micro-bubbles. Therefore, the micro-bubble spray head of the present disclosure significantly improves the efficiency of micro-bubble generation.

[0015] Preferably, the diameter of the mixing cavity keeps constant after a sudden increase relative to the diameter of the throttling hole, or continues to increase gradually, thereby helping increase a mixing degree of the air and the water flow.

[0016] Preferably, the flow disturbing part provided on the inner wall of the diameter-decreased conical passage part can help the water flow mix with the sucked-in air more effectively at a downstream position by increasing the turbulence of water.

[0017] Preferably, the suction ports can also act as the overflow openings of the micro-bubble spray head when needed. When the water pressure in the spray pipe is insufficient and therefore the water flow cannot quickly penetrate the filter screen in the micro-bubble bubbler, the water flow can flow out from these overflow openings, avoiding the problem that the air cannot be sucked in due to blockage of the suction ports caused by the accumulation of water flow in the mixing cavity, and thus ensuring the high reliability of the micro-bubble spray head to continuously produce micro-bubble water.

[0018] Preferably, the multi-layer filter screen included in the micro-bubble bubbler can significantly reduce the diameter of the micro-bubbles and increase the mixing degree of the micro-bubbles with water. The multi-layer filter screen is fixed by the screen bracket, which can avoid the problem of the filter screen falling off the spray pipe under the impact of high water pressure.

[0019] Preferably, the mutual cooperation of the plurality of claws on the outlet end of the spray pipe and the plurality of snap-fit openings on the screen bracket enables the spray pipe and the micro-bubble bubbler to be fixed together by a snap-fit connection structure.

[0020] Preferably, the pressure ring located between the outlet end of the spray pipe and the screen bracket abuts the multi-layer filter screen against the screen bracket to further firmly fix the filter screen. Grooves are respectively formed between the plurality of bosses on the two axial end faces of the pressure ring, and these grooves can help suck in air from the outside, so as to further ensure the reliability of air suction.

[0021] In order to solve the technical problem that the efficiency of dissolving the detergent/treatment agent in existing micro-bubble treatment agent boxes is not high, the present disclosure further provides a micro-bubble treatment agent box assembly. In a first embodiment, the micro-bubble treatment agent box assembly includes a detergent/treatment agent box, and any one of the micro-bubble spray heads as described above, which is ar-

ranged on the detergent/treatment agent box; the micro-bubble spray head is configured to provide micro-bubble water to the detergent/treatment agent box to dissolve a detergent/treatment agent. By spraying the micro-bubble water generated by the micro-bubble spray head into the detergent/treatment agent box of the washing apparatus, the detergent/treatment agent contained in the detergent/treatment agent box can be quickly and efficiently dissolved.

[0022] In order to solve the above problem in the prior art, that is, to solve the technical problem that the efficiency of dissolving the detergent/treatment agent in existing micro-bubble treatment agent box assemblies is not high, the present disclosure provides a micro-bubble treatment agent box assembly. In a second embodiment, the micro-bubble treatment agent box assembly includes a detergent/treatment agent box and a micro-bubble spray head arranged on the detergent/treatment agent box; the micro-bubble spray head is formed as a water inlet of the detergent/treatment agent box and provides micro-bubble water for the detergent/treatment agent box; the micro-bubble spray head includes a spray pipe and a micro-bubble bubbler fixed at an outlet end of the spray pipe; a diameter-decreased conical passage part and a mixing cavity are provided in the spray pipe; there is an at-least-one-stage diameter-decreased conical passage in the diameter-decreased conical passage part in a water flow direction; a throttling hole is arranged at a downstream end of the diameter-decreased conical passage part, and a diameter of the throttling hole is smaller than a diameter of the mixing cavity, so that a water flow is sprayed into the mixing cavity through the throttling hole and generates a negative pressure in the mixing cavity; the outlet end of the spray pipe and the micro-bubble bubbler are respectively provided with suction ports that can communicate with each other so that air can be sucked into the mixing cavity through the suction ports by means of the negative pressure and mix with the water flow to form bubble water; and the bubble water is cut and mixed by the micro-bubble bubbler to form micro-bubble water.

[0023] In a preferred technical solution of the above micro-bubble treatment agent box assembly, the detergent/treatment agent box includes a water outlet, a detergent/treatment agent chamber communicating with the water outlet, and a siphon structure arranged in the detergent/treatment agent chamber to discharge liquid in the detergent/treatment agent chamber; the micro-bubble spray head protrudes into the detergent/treatment agent chamber to spray the micro-bubble water into the detergent/treatment agent chamber.

[0024] In a preferred technical solution of the above micro-bubble treatment agent box assembly, the diameter of the mixing cavity keeps constant or is gradually increased in the water flow direction.

[0025] In a preferred technical solution of the above micro-bubble treatment agent box assembly, a flow disturbing part is arranged in the diameter-decreased con-

ical passage part.

[0026] In a preferred technical solution of the above micro-bubble treatment agent box assembly, the suction ports are also overflow openings of the micro-bubble spray head.

[0027] In a preferred technical solution of the above micro-bubble treatment agent box assembly, the micro-bubble bubbler includes a multi-layer filter screen and a screen bracket for fixing the multi-layer filter screen.

[0028] In a preferred technical solution of the above micro-bubble treatment agent box assembly, a plurality of claws are arranged around an outer wall of the outlet end of the spray pipe, and a plurality of snap-fit openings are arranged around an axial end of the screen bracket that is close to the outlet end to accommodate one of the plurality of claws respectively.

[0029] In a preferred technical solution of the above micro-bubble treatment agent box assembly, the micro-bubble bubbler further includes a pressure ring, and the pressure ring is placed between an end face of the outlet end and the screen bracket so as to abut the multi-layer filter screen against the screen bracket.

[0030] In a preferred technical solution of the above micro-bubble treatment agent box assembly, a plurality of spaced apart bosses extending outward in an axial direction are respectively formed on two axial end faces of the pressure ring so that a groove is formed between the adjacent bosses.

[0031] It can be understood by those skilled in the art that in the technical solutions of the present disclosure, the micro-bubble treatment agent box assembly includes a detergent/treatment agent box and a micro-bubble spray head arranged on the detergent/treatment agent box. The micro-bubble spray head is not only formed as a water inlet of the detergent/treatment agent box, but also provides micro-bubble water for the detergent/treatment agent box. The micro-bubble spray head includes a spray pipe and a micro-bubble bubbler fixed at the outlet end of the spray pipe. A diameter-decreased conical passage part and a mixing cavity are provided in the spray pipe. There is an at-least-one-stage diameter-decreased conical passage in the diameter-decreased conical passage part in the water flow direction, and a throttling hole is arranged at the downstream end of the diameter-decreased conical passage part. The at-least-one-stage diameter-decreased conical passage can pressurize the water flow flowing therethrough. The diameter of the throttling hole is much smaller than the diameter of the mixing cavity, so the pressurized water flow can be rapidly expanded and sprayed into the mixing cavity through the throttling hole and generate a negative pressure in the mixing cavity. The outlet end of the spray pipe and the micro-bubble bubbler are respectively provided with suction ports communicating with each other. These suction ports are configured such that the outside air can be sucked into the mixing cavity in a large amount through these suction ports by means of the negative pressure and mix with the water flow in the mixing cavity to form

bubble water. The generated bubble water is then cut and mixed by the micro-bubble bubbler to form micro-bubble water containing a large number of micro-bubbles. Such micro-bubble water is then sprayed into the detergent/treatment agent box, so that the detergent/treatment agent contained in the detergent/treatment agent box can be dissolved quickly and efficiently.

[0032] Preferably, the siphon structure arranged in the detergent/treatment agent chamber can ensure that the water contained therein is completely discharged through a siphon effect.

[0033] Preferably, the diameter of the mixing cavity keeps constant after a sudden increase relative to the diameter of the throttling hole, or continues to increase gradually, thereby helping increase a mixing degree of the air and the water flow.

[0034] Preferably, the flow disturbing part provided on the inner wall of the diameter-decreased conical passage part can help the water flow mix with the sucked-in air more effectively at a downstream position by increasing the turbulence of water.

[0035] Preferably, the suction ports can also act as the overflow openings of the micro-bubble spray head when needed. When the water pressure in the spray pipe is insufficient and therefore the water flow cannot quickly penetrate the filter screen in the micro-bubble bubbler, the water flow can flow out from these overflow openings, avoiding the problem that the air cannot be sucked in due to blockage of the suction ports caused by the accumulation of water flow in the mixing cavity, and thus ensuring the high reliability of the micro-bubble spray head to continuously produce micro-bubble water.

[0036] Preferably, the multi-layer filter screen included in the micro-bubble bubbler can significantly reduce the diameter of the micro-bubbles and increase the mixing degree of the micro-bubbles with water. The multi-layer filter screen is fixed by the screen bracket, which can avoid the problem of the filter screen falling off the spray pipe under the impact of high water pressure.

[0037] Preferably, the mutual cooperation of the plurality of claws on the outlet end of the spray pipe and the plurality of snap-fit openings on the screen bracket enables the spray pipe and the micro-bubble bubbler to be fixed together by a snap-fit connection structure.

[0038] Preferably, the pressure ring located between the outlet end of the spray pipe and the screen bracket abuts the multi-layer filter screen against the screen bracket to further firmly fix the filter screen. Grooves are respectively formed between the plurality of bosses on the two axial end faces of the pressure ring, and these grooves can help suck in air from the outside, so as to further ensure the reliability of air suction.

[0039] In order to solve the above problem in the prior art, that is, to solve the technical problem that a micro-bubble production yield of existing water injection boxes is not high, the present disclosure provides a micro-bubble treatment agent box assembly. In a third embodiment, the micro-bubble treatment agent box assembly includes

a housing and a treatment agent box accommodated in the housing; the housing is provided with a micro-bubble water inflow pipe part, a diameter-decreased conical passage part, an air inflow passage and a micro-bubble bubbler; an at-least-one-stage diameter-decreased conical passage is arranged 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 diameter-decreased conical passage part is positioned such that a water flow entering the micro-bubble water inflow pipe part is pressurized inside the at-least-one-stage diameter-decreased conical passage and is sprayed from the spray hole in an expanded state to generate a negative pressure near the spray hole; the air inflow passage is positioned close to the spray hole, so that outside air is sucked in through the air inflow passage by means of the negative pressure and mixes with the sprayed water flow to form bubble water; and the bubble water flows through the micro-bubble bubbler to form micro-bubble water which is then sprayed into the treatment agent box.

[0040] In a preferred technical solution of the above micro-bubble treatment agent box assembly, the diameter-decreased conical passage part and the micro-bubble bubbler are arranged in the micro-bubble water inflow pipe part.

[0041] In a preferred technical solution of the above micro-bubble treatment agent box assembly, the diameter-decreased conical passage part and the micro-bubble bubbler are arranged between the micro-bubble water inflow pipe part and the treatment agent box.

[0042] In a preferred technical solution of the above micro-bubble treatment agent box assembly, a sprinkling chamber is further provided on the housing, and the sprinkling chamber is located above the treatment agent box to sprinkle the micro-bubble water into the treatment agent box.

[0043] In a preferred technical solution of the above micro-bubble treatment agent box assembly, the micro-bubble bubbler is arranged in the sprinkling chamber.

[0044] In a preferred technical solution of the above micro-bubble treatment agent box assembly, the housing is further provided with at least one non-micro-bubble water inflow pipe part for providing non-micro-bubble water for the treatment agent box.

[0045] In a preferred technical solution of the above micro-bubble treatment agent box assembly, a flow disturbing part is arranged on an inner wall of the diameter-decreased conical passage part.

[0046] In a preferred technical solution of the above micro-bubble treatment agent box assembly, 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.

[0047] In a preferred technical solution of the above micro-bubble treatment agent box assembly, the micro-

bubble bubbler is a hole mesh structure, and the hole mesh structure has at least one fine hole having a diameter reaching a micron scale.

[0048] It can be understood by those skilled in the art that in the technical solutions of the present disclosure, the micro-bubble treatment agent box assembly includes a housing and a treatment agent box accommodated in the housing. The housing is provided with a micro-bubble water inflow pipe part, a diameter-decreased conical passage part, an air inflow passage and a micro-bubble bubbler. An at-least-one-stage diameter-decreased conical passage is arranged 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 diameter-decreased conical passage part is positioned such that a water flow entering the micro-bubble water inflow pipe part will flow into the at-least-one-stage diameter-decreased conical passage and will be pressurized therein before being rapidly sprayed from the spray hole in an expanded state to generate a negative pressure near the spray hole. The air inflow passage is positioned close to the spray hole, so that outside air is sucked in through the air inflow passage under the action of the negative pressure and mixes with the water flow sprayed from the spray hole to form bubble water. The bubble water then flows through the micro-bubble bubbler to become micro-bubble water which is then sprayed into the treatment agent box, so that the micro-bubble water is used to dissolve one or more treatment agents in the treatment agent box and mix with them. Therefore, through a joint action of the diameter-decreased conical passage part, the air inflow passage and the micro-bubble bubbler, the micro-bubble treatment agent box assembly of the present disclosure significantly improves the efficiency of micro-bubble generation, thereby more effectively promoting the treatment agent to be quickly dissolved and mixed in the water, and making it possible to save the amount of treatment agent used, which is also advantageous for the health of the user.

[0049] Preferably, the flow disturbing part provided on the inner wall of the diameter-decreased conical passage part can help the water flow mix with the sucked-in air more effectively at a downstream position by increasing the turbulence of water. For example, the flow disturbing part can be 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.

[0050] In order to solve the above problem in the prior art, that is, to solve the technical problem that the cleaning effect of existing washing apparatuses is not good and the residual detergent may cause hidden dangers to the health of user, the present disclosure also provides a washing apparatus. The washing apparatus includes any one of the micro-bubble treatment agent box assemblies described above, and the micro-bubble treatment agent

box assembly is arranged inside the washing apparatus to provide the washing apparatus with a micro-bubble water mixture in which a detergent/treatment agent is dissolved. By spraying the micro-bubble water generated by the micro-bubble spray head into the detergent/treatment agent box of the washing apparatus, it is possible to help more effectively promote the detergent/treatment agent to be quickly dissolved and mixed in the water, thereby improving the cleaning ability of the washing apparatus, and meanwhile saving the amount of detergent/treatment agent used, which is also advantageous for the health of the user.

BRIEF DESCRIPTION OF THE DRAWINGS

[0051] Preferred embodiments of the present disclosure will be described below with reference to the accompanying drawings, in which:

FIG. 1 is a top view of an example of a micro-bubble spray head of the present disclosure;

FIG. 2 is a front view of the example of the micro-bubble spray head of the present disclosure shown in FIG. 1;

FIG. 3 is an exploded perspective view of the example of the micro-bubble spray head of the present disclosure shown in FIG. 1;

FIG. 4 is a cross-sectional view of the example of the micro-bubble spray head of the present disclosure taken along section line A-A in FIG. 1;

FIG. 5 is a top view of an example of a micro-bubble treatment agent box assembly of the present disclosure in a first embodiment;

FIG. 6 is a cross-sectional view of the example of the micro-bubble treatment agent box assembly of the present disclosure in the first embodiment, taken along section line B-B in FIG. 5;

FIG. 7 is a top view of an example of the micro-bubble treatment agent box assembly of the present disclosure in a second embodiment;

FIG. 8 is a cross-sectional view of the example of the micro-bubble treatment agent box assembly of the present disclosure in the second embodiment, taken along section line A-A in FIG. 7;

FIG. 9 is a schematic structural view of an example of the washing apparatus of the present disclosure in the first and second embodiments;

FIG. 10 is a schematic structural view of another example of the washing apparatus of the present dis-

closure in the first and second embodiments;

FIG. 11 is a schematic perspective view of an example of the micro-bubble treatment agent box assembly of the present disclosure in a third embodiment;

FIG. 12 is a front view of the example of the micro-bubble treatment agent box assembly of the present disclosure in the third embodiment shown in FIG. 11;

FIG. 13 is a top view of the example of the micro-bubble treatment agent box assembly of the present disclosure in the third embodiment shown in FIG. 11;

FIG. 14 is a cross-sectional view of a first example of the micro-bubble treatment agent box assembly of the present disclosure in the third embodiment, taken along section line A-A in FIG. 13;

FIG. 15 is a cross-sectional view of a second example of the micro-bubble treatment agent box assembly of the present disclosure in the third embodiment, taken along section line A-A in FIG. 13;

FIG. 16 is a schematic structural view of an example of the washing apparatus of the present disclosure in the third embodiment; and

FIG. 17 is a schematic structural view of another example of the washing apparatus of the present disclosure in the third embodiment.

List of reference signs:

[0052] 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; 52: micro-bubble spray head; 521: spray pipe; 211: inlet end; 212: positioning part; 213: claw; 214: outlet end; 214a: outlet end face; 215: suction port on spray pipe; 216: diameter-decreased conical passage part; 216a: first-stage diameter-decreased conical passage; 216b: second-stage diameter-decreased conical passage; 217: flow disturbing rib; 218: throttling hole; 219: mixing cavity; 300: annular cavity; 522: micro-bubble bubbler; 221: screen bracket; 221a: first axial end; 221b: second axial end; 221c: step; 222: suction port on micro-bubble bubbler; 223: snap-fit opening; 224: filter screen; 225: pressure ring; 225a: first axial end face; 225b: second axial end face; 251: boss; 252: groove; 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; 961: sealing window gasket; 97: door; 98: foot of drum

washing machine.

[0053] First embodiment: 53: micro-bubble treatment agent box assembly; 531: detergent/treatment agent box; 532: water outlet.

[0054] Second embodiment: 53: micro-bubble treatment agent box assembly; 531: detergent/treatment agent box; 531a: housing of detergent/treatment agent box; 531b: annular chamber; 531c: detergent/treatment agent chamber; 532: water outlet; 533: siphon pipe.

[0055] Third embodiment: 52: micro-bubble treatment agent box assembly; 521: housing; 522: treatment agent box; 523: first fixing part; 524: second fixing part; 525: main water inflow pipe part; 526: softener water inflow pipe part; 527: micro-bubble water inflow pipe part; 221: detergent chamber; 222: care agent chamber; 271: inlet end; 272: diameter-decreased conical passage part; 272a: one-stage diameter-decreased conical passage; 273: spray hole; 274: micro-bubble bubbler; 275: air inflow passage; 275': auxiliary air inflow passage; 276: sprinkling chamber.

DETAILED DESCRIPTION OF THE EMBODIMENT(S) OF THE INVENTION

[0056] 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.

[0057] 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 description, 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.

[0058] 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

[0059] In order to solve the technical problem that a micro-bubble production yield of existing micro-bubble generators is not high, the present disclosure provides a micro-bubble spray head 52. The micro-bubble spray head 52 includes a spray pipe 521 and a micro-bubble bubbler 522 fixed at an outlet end 214 of the spray pipe 521. A diameter-decreased conical passage part 216 and a mixing cavity 219 are provided in the spray pipe 521. There is an at-least-one-stage diameter-decreased conical passage in the diameter-decreased conical passage part 216 in a water flow direction C. A throttling hole 218 is arranged at a downstream end of the diameter-decreased conical passage part 216, and a diameter of the throttling hole 218 is smaller than that of the mixing cavity 219, so that a water flow is sprayed into the mixing cavity 219 through the throttling hole 218 and generates a negative pressure in the mixing cavity 219. The outlet end 214 of the spray pipe 521 and the micro-bubble bubbler 522 are respectively provided with suction ports 215, 222 communicating with each other so that air can be sucked into the mixing cavity 219 through the suction ports 215, 222 by means of the negative pressure and mix with the water flow to form bubble water. The bubble water is cut and mixed by the micro-bubble bubbler 522 to form micro-bubble water.

[0060] 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 cross section of the passage that is perpendicular to the water flow direction is gradually decreased so that the passage has a substantially conical shape.

[0061] FIG. 1 is a top view of an example of the micro-bubble spray head of the present disclosure, FIG. 2 is a front view of the example of the micro-bubble spray head of the present disclosure shown in FIG. 1, and FIG. 3 is an exploded perspective view of the example of the micro-bubble spray head of the present disclosure shown in FIG. 1. As shown in FIGS. 1 to 3, in one or more examples, the spray pipe 521 is a one-piece spray pipe and is substantially cylindrical. The spray pipe 521 has an inlet end 211 and an outlet end 214. The inlet end 211 is configured to connect to an external water source, such as tap water, and the micro-bubble bubbler 522 is fixed at the outlet end 214. Therefore, the water flow can flow into the spray pipe 521 from the inlet end 211, and then flow out of the spray pipe 521 from the outlet end 214 through the micro-bubble bubbler 522.

[0062] A positioning part 212 may be provided on an outer wall of the spray pipe 521 for positioning the micro-bubble spray head 52 at a suitable position. Referring to FIGS. 1 and 3, in one or more examples, the positioning part 212 may be a longitudinal rib extending or partially extending between the inlet end 211 and the outlet end 214 in an axial direction of the spray pipe 521. Alternatively, the positioning part 212 may also take other suitable forms, such as a cylindrical protrusion or groove.

[0063] Referring to FIGS. 1 and 3, in one or more examples, a plurality of claws 213, such as two, three or more claws 213, are provided on the outer wall of the outlet end 214 of the spray pipe 521, which are configured to fix the micro-bubble bubbler 522 and the spray pipe 521 together. Optionally, the claws 213 are distributed circumferentially along the outer wall of the outlet end 214 and extend radially outwardly, being spaced apart from each other by the same distance or different distances. With continued reference to FIG. 3, the outlet end 214 of the spray pipe 521 is further provided with a plurality of suction ports 215, such as two, three or more suction ports 215. These suction ports 215 are distributed along the circumferential direction of the outlet end 214 and are spaced apart from each other by the same distance or different distances. As shown in FIG. 3, in one or more examples, each suction port 215 is a substantially rectangular notch recessed from an outlet end face 214a of the outlet end 214 toward the inlet end 211 in an axial direction of the spray pipe 521. Alternatively, the suction ports 215 may also be through holes, such as circular holes, provided on the pipe wall of the outlet end 214.

[0064] As shown in FIGS. 2 and 3, in one or more examples, the micro-bubble bubbler 522 includes a filter screen 224 and a screen bracket 221 that fixes the filter screen 224 at the outlet end 214 of the spray pipe 521. As shown in FIG. 3, in one or more examples, the screen bracket 221 is open at both ends and is substantially cylindrical. The screen bracket 221 has a first axial end 221a and a second axial end 221b. The first axial end 221a is configured to be capable of abutting against the filter screen 224, and the second axial end 221b is configured to be capable of being sleeved over the outer wall of the outlet end 214 of the spray pipe 521, so that in a state where the micro-bubble bubbler 522 and the spray pipe 521 are assembled, the filter screen 224 is firmly sandwiched between the first axial end 221a of the screen bracket 221 and the outlet end face 214a of the spray pipe 521.

[0065] Referring to FIG. 3, in one or more examples, a plurality of suction ports 222 and a plurality of snap-fit openings 223 are provided on the second axial end 221b of the screen bracket 221. Both the suction ports 222 and the snap-fit openings 223 are arranged along the circumferential direction of the second axial end 221b. The distances between the suction ports 222 are the same or different, the distances between the snap-fit openings 223 are the same or different, and the distances between the suction ports 222 and the snap-fit openings 223 are the same or different. After the micro-bubble bubbler 522 and the spray pipe 521 are assembled, each suction port 222 on the screen bracket 221 corresponds to one suction port 215 at the outlet end 214 of the spray pipe 521 respectively, so that the corresponding suction ports 222 and 215 not only communicate with each other, but also communicate with the mixing cavity 219, thereby allowing the outside air to be sucked into the mixing cavity 219 of

the spray pipe 521 through these suction ports 222, 215. It should also be pointed out that these suction ports 222, 215 can also act as overflow openings at the same time. If the water pressure in the spray pipe 521 is insufficient, the water flow may not be able to quickly penetrate the filter screen in the micro-bubble bubbler 522, and thus will accumulate in the mixing cavity 219 of the spray pipe 521. These overflow openings allow the water flow to flow out therethrough, thereby avoiding a situation in which the air cannot be sucked in due to blockage of the suction ports caused by the accumulation of water flow in the mixing cavity, and thus ensuring the high reliability of the micro-bubble spray head to continuously produce micro-bubble water. Further, after the micro-bubble bubbler 522 and the spray pipe 521 are assembled, each snap-fit opening 223 on the screen bracket 221 receives a corresponding one of the claws 213 at the outlet end 214 of the spray pipe 521, so that the micro-bubble bubbler 522 and the spray pipe 521 are fixed together. Alternatively, the micro-bubble bubbler 522 and the spray pipe 521 can also be fixed together by using other connection methods, such as welding, screwing and the like.

[0066] As shown in FIG. 3, in one or more examples, the filter screen 224 includes a multi-layer filter screen, e.g., two, three or more layers. The filter screen is a hole mesh structure, and the hole mesh structure has at least one mesh hole having a diameter reaching a micron scale. Preferably, the diameter of the mesh hole is between 0 and 1000 microns; more preferably, the diameter of the mesh hole is between 5 microns and 500 microns. The filter screen 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 filter screen 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. When the bubble water flows through the hole mesh structure, the hole mesh structure mixes and cuts the bubble water, thereby generating a large amount of micro-bubble water.

[0067] With continued reference to FIG. 3, in one or more examples, the micro-bubble bubbler 522 further includes a pressure ring 225. The pressure ring 225 has a substantially circular ring shape. The pressure ring 225 has a first axial end face 225a and a second axial end face 225b. Optionally, in one or more examples, a plurality of bosses 251 are provided on each of the first axial end face 225a and the second axial end face 225b in the

circumferential direction. These bosses 251 are spaced apart from each other by a predetermined distance and extend axially outwardly from their respective corresponding end faces, so that a groove 252 is formed between every two bosses 251 on each of the axial end faces 225a, 225b. In the assembled state, the first axial end face 225a faces the filter screen 224 and the screen bracket 221, and the bosses 251 on the first axial end face 225a firmly abut the filter screen 224 against a step 221c extending radially inwardly and located inside the first axial end 221a of the screen bracket 221 (see FIG. 4); the second axial end face 225b faces the outlet end face 214a of the spray pipe 521, and the bosses 251 on the second axial end face 225b abut against the outlet end face 214a of the spray pipe 521. The grooves 252 located between the bosses 251 communicate with the mixing cavity 219, and thus can also act as suction ports. By allowing the outside air to be sucked in from these grooves 252, the reliability of the air introduction into the spray pipe is further improved.

[0068] FIG. 4 is a cross-sectional view of an example of the micro-bubble spray head of the present disclosure taken along section line A-A in FIG. 1. As shown in FIG. 4, in one or more examples, a first-stage diameter-decreased conical passage 216a and a second-stage diameter-decreased conical passage 216b are formed inside the diameter-decreased conical passage part 216 of the spray pipe 521 in the water flow direction C. Alternatively, one or more than two stages of diameter-decreased conical passages may be formed inside the diameter-decreased conical passage part 216 in the water flow direction. The first-stage diameter-decreased conical passage 216a extends from the inlet end 211 of the spray pipe 521 to the second-stage diameter-decreased conical passage 216b. A smallest diameter of the first-stage diameter-decreased conical passage 216a may be larger than a largest diameter of the second-stage diameter-decreased conical passage 216b. The second-stage diameter-decreased conical passage 216b continues to extend downstream in the water flow direction C to a throttling hole 218 located at a downstream end of the diameter-decreased conical passage part 216. A diameter of the throttling hole 218 is smaller than or equal to a smallest diameter of the second-stage diameter-decreased conical passage 216b. A diameter of the mixing cavity 219 located downstream of the throttling hole 218 is much larger than the diameter of the throttling hole 218. Optionally, the diameter of the mixing cavity 219 may keep constant in the water flow direction C, or the diameter of the mixing cavity 219 may gradually increase in the water flow direction C to increase a mixing degree of air and water.

[0069] The water flow flows into the spray pipe 521 from the inlet end 211, and then first flows through the first-stage diameter-decreased conical passage 216a and the second-stage diameter-decreased conical passage 216b to be pressurized therein. The pressurized water flow is rapidly expanded and sprayed into the

downstream mixing cavity 219 through the throttling hole 218 and generates a negative pressure in the mixing cavity 219. Therefore, under the action of the negative pressure, the outside air is sucked into the mixing cavity 219 through the suction ports 215, 222 and/or 252 and mixes with the water flow in the mixing cavity 219 to generate bubble water. The bubble water then flows through the filter screen 224 of the micro-bubble bubbler 522 to be cut and mixed, thereby generating micro-bubble water containing a large number of micro-bubbles.

[0070] As shown in FIG. 4, in one or more examples, a plurality of flow disturbing ribs 217 extending in the longitudinal direction are provided on the inner wall of the second-stage diameter-decreased conical passage 216b. These ribs 217 are spaced apart from each other to increase the turbulence of the water flow, which can help the water flow mix with the sucked-in air more effectively at a downstream position. Alternatively, the flow disturbing ribs may be replaced by at least one radial protrusion provided on the inner wall of this stage of diameter-decreased conical passage, such as one or more cylindrical protrusions. Alternatively, the flow disturbing ribs or other forms of flow disturbing parts may be formed on the inner wall of each stage of diameter-decreased conical passage.

[0071] With continued reference to FIG. 4, in one or more examples, the part of the diameter-decreased conical passage part 216 that corresponds to the second-stage diameter-decreased conical passage 216b is separate from the inner wall of the spray pipe 521, so that an annular cavity 300 is formed between this part and the corresponding inner wall of the spray pipe 521. The annular cavity 300 communicates with the mixing cavity 219 to form an entirety, thereby helping further enhance the mixing of air and water.

[0072] FIG. 5 is a top view of an example of the micro-bubble treatment agent box assembly of the present disclosure, and FIG. 6 is a cross-sectional view of the example of the micro-bubble treatment agent box assembly of the present disclosure, taken along section line B-B in FIG. 5. As shown in FIGS. 5 and 6, the present disclosure also provides a micro-bubble treatment agent box assembly 53. The micro-bubble treatment agent assembly 53 includes a detergent/treatment agent box 531 and a micro-bubble spray head 52 arranged on the detergent/treatment agent box 531. In one or more examples, the detergent/treatment agents that can be accommodated by the detergent/treatment agent box 531 include, but are not limited to, powder detergents, solid detergents, or liquid detergents. The detergent/treatment agent box 531 is provided with a water inlet and a water outlet 532, and the water inlet is provided by the micro-bubble spray head 52.

[0073] As shown in FIG. 6, in one or more examples, the micro-bubble spray head 52 is positioned on an upper part of one side wall of the detergent/treatment agent box 531, and the water outlet 532 is positioned at the bottom of another side wall of the detergent/treatment agent box

531. As shown in FIG. 5, the side wall where the micro-bubble spray head 52 is located and the side wall where the water outlet 532 is located are opposite to each other. Water from an external water source can be sprayed into the detergent/treatment agent box 531 through the micro-bubble spray head 52 from the inlet end 211 of the micro-bubble spray head 52 so that the micro-bubble water can be used to dissolve the detergent/treatment agent accommodated in the detergent/treatment agent box 531. The micro-bubble spray head 52 may be any one of the micro-bubble spray heads described above. A micro-bubble water mixture in which the detergent/treatment agent is dissolved is discharged from the water outlet 532; for example, it is supplied to a washing apparatus. As compared with the micro-bubble treatment agent box assembly with a micro-bubble generator in the prior art, the ability of the micro-bubble treatment agent box assembly of the present disclosure to generate micro-bubbles is greatly improved, thereby increasing a dissolving speed, a dissolution rate and a mixing degree of the detergent/treatment agent in the water, which can further save the amount of detergent/treatment agent used.

Second embodiment

[0074] In order to solve the technical problem that the efficiency of dissolving the detergent/treatment agent in existing micro-bubble treatment agent box assemblies is not high, the present disclosure provides a micro-bubble treatment agent box assembly 53. In the second embodiment, the micro-bubble treatment agent box assembly 53 includes a detergent/treatment agent box 531 and a micro-bubble spray head 52 arranged on the detergent/treatment agent box 531. The micro-bubble spray head 52 is formed as a water inlet of the detergent/treatment agent box 531 and provides micro-bubble water for the detergent/treatment agent box 531. The micro-bubble spray head 52 includes a spray pipe 521 and a micro-bubble bubbler 522 fixed at an outlet end 214 of the spray pipe 521. A diameter-decreased conical passage part 216 and a mixing cavity 219 are provided in the spray pipe 521. There is an at-least-one-stage diameter-decreased conical passage in the diameter-decreased conical passage part 216 in a water flow direction C. A throttling hole 218 is arranged at a downstream end of the diameter-decreased conical passage part 216, and a diameter of the throttling hole 218 is smaller than that of the mixing cavity 219, so that a water flow is sprayed into the mixing cavity 219 through the throttling hole 218 and generates a negative pressure in the mixing cavity 219. The outlet end 214 of the spray pipe 521 and the micro-bubble bubbler 522 are respectively provided with suction ports 215, 222 that can communicate with each other so that air can be sucked into the mixing cavity 219 through the suction ports 215, 222 by means of the negative pressure and mix with the water flow to form bubble water. The bubble water is cut and mixed by the micro-bubble bubbler 522 to form micro-bubble water.

[0075] 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 cross section of the passage that is perpendicular to the water flow direction is gradually decreased so that the passage has a substantially conical shape.

[0076] FIG. 7 is a top view of an example of the micro-bubble treatment agent box assembly of the present disclosure in the second embodiment, and FIG. 8 is a cross-sectional view of the example of the micro-bubble treatment agent box assembly of the present disclosure in the second embodiment, taken along section line A-A in FIG. 7. As shown in FIGS. 7 and 8, in one or more examples, the detergent/treatment agent box 531 includes a housing 531a, a detergent/treatment agent chamber 531c formed in the housing 531a, and an annular chamber 531b surrounding the detergent/treatment agent chamber 531c. The detergent/treatment agent chamber 531c is in fluid communication with the annular chamber 531b. The micro-bubble spray head 52 is arranged on an upper part of one side wall of the housing 531a and extends into the detergent/treatment agent chamber 531c to spray the micro-bubble water into the detergent/treatment agent chamber 531c. A water outlet 532 is also provided on the housing 531a, and the water outlet 532 is in fluid communication with the annular chamber 531b. The water outlet 532 is arranged on the other side wall of the housing 531a and near the bottom of this side wall. As shown in FIG. 7, the side wall where the water outlet 532 is located and the side wall where the micro-bubble spray head 52 is located are opposite to each other. Alternatively, the positions of the micro-bubble spray head 52 and the water outlet 532 can be adjusted according to actual needs.

[0077] The detergent/treatment agent chamber 531c can be used to accommodate different detergent/treatment agents, including but not limited to powder detergents, solid detergents, liquid detergents, or softeners. As shown in FIGS. 7 and 8, in one or more examples, a siphon structure is provided in the detergent/treatment agent chamber 531c. Optionally, the siphon structure includes a siphon pipe 533 and a siphon cap (not shown in the figure). As shown in FIG. 8, in one or more examples, the siphon pipe 533 extends vertically upward from the bottom of the detergent/treatment agent chamber 531c, and a height of the siphon pipe 533 is lower than a height of the lowest horizontal position of the micro-bubble spray head 52. Therefore, when a liquid level in the detergent/treatment agent chamber 531c is high, the siphon pipe 533 and the siphon cap cooperate with each other to produce a siphon effect to discharge a mixed liquid of, for example, the detergent/treatment agent and water in the detergent/treatment agent chamber 531c.

[0078] When in an operating state, water from the external water source first enters the micro-bubble spray head 52 through the inlet end 211 of the micro-bubble spray head 52, and generates micro-bubble water through the micro-bubble bubbler 522 of the micro-bub-

ble spray head 52. The micro-bubble water is then sprayed into the detergent/treatment agent chamber 531c so that the detergent/treatment agent accommodated in the detergent/treatment agent chamber 531c is dissolved by the micro-bubble water. The water flow in which the detergent/treatment agent is dissolved and mixed is discharged into the annular chamber 531b through the siphon structure and/or enters the annular chamber 531b by overflow, then flows out of the detergent/treatment agent box 531 through the water outlet 532 and enters the outer cylinder or outer tub of the washing apparatus. The micro-bubble treatment agent box assembly of the present disclosure increases a dissolving speed, a dissolution rate and a mixing degree of the detergent/treatment agent in the water by enhancing the ability of generating micro-bubbles of the micro-bubble spray head 52, which can further save the amount of detergent/treatment agent used.

[0079] FIG. 1 is a top view of an example of the micro-bubble spray head of the micro-bubble treatment agent box assembly of the present disclosure in the second embodiment, FIG. 2 is a front view of the example of the micro-bubble spray head of the micro-bubble treatment agent box assembly of the present disclosure shown in FIG. 1 in the second embodiment, and FIG. 3 is an exploded perspective view of the example of the micro-bubble spray head of the micro-bubble treatment agent box assembly of the present disclosure shown in FIG. 1 in the second embodiment. The micro-bubble spray head used by the micro-bubble treatment agent box assembly of the present disclosure in the second embodiment is the same as the micro-bubble spray head in the above first embodiment. As shown in FIGS. 1 to 3, in one or more examples, the spray pipe 521 is a one-piece spray pipe and is substantially cylindrical. The spray pipe 521 has an inlet end 211 and an outlet end 214. The inlet end 211 is configured to connect to an external water source, such as tap water, and the micro-bubble bubbler 522 is fixed at the outlet end 214. Therefore, the water flow can flow into the spray pipe 521 from the inlet end 211, and then flow out of the spray pipe 521 from the outlet end 214 through the micro-bubble bubbler 522.

[0080] A positioning part 212 may be provided on an outer wall of the spray pipe 521 for positioning the micro-bubble spray head 52 at a suitable position. Referring to FIGS. 1 and 3, in one or more examples, the positioning part 212 may be a longitudinal rib extending or partially extending between the inlet end 211 and the outlet end 214 in an axial direction of the spray pipe 521. Alternatively, the positioning part 212 may also take other suitable forms, such as a cylindrical protrusion or groove.

[0081] Referring to FIGS. 1 and 3, in one or more examples, a plurality of claws 213, such as two, three or more claws 213, are provided on the outer wall of the outlet end 214 of the spray pipe 521, which are configured to fix the micro-bubble bubbler 522 and the spray pipe 521 together. Optionally, the claws 213 are distributed circumferentially along the outer wall of the outlet end

214 and extend radially outwardly, being spaced apart from each other by the same distance or different distances. With continued reference to FIG. 3, the outlet end 214 of the spray pipe 521 is further provided with a plurality of suction ports 215, such as two, three or more suction ports 215. These suction ports 215 are distributed along the circumferential direction of the outlet end 214 and are spaced apart from each other by the same distance or different distances. As shown in FIG. 3, in one or more examples, each suction port 215 is a substantially rectangular notch recessed from an outlet end face 214a of the outlet end 214 toward the inlet end 211 in an axial direction of the spray pipe 521. Alternatively, the suction ports 215 may also be through holes, such as circular holes, provided on the pipe wall of the outlet end 214.

[0082] As shown in FIGS. 2 and 3, in one or more examples, the micro-bubble bubbler 522 includes a filter screen 224 and a screen bracket 221 that fixes the filter screen 224 at the outlet end 214 of the spray pipe 521. As shown in FIG. 3, in one or more examples, the screen bracket 221 is open at both ends and is substantially cylindrical. The screen bracket 221 has a first axial end 221a and a second axial end 221b. The first axial end 221a is configured to be capable of abutting against the filter screen 224, and the second axial end 221b is configured to be capable of being sleeved over the outer wall of the outlet end 214 of the spray pipe 521, so that in a state where the micro-bubble bubbler 522 and the spray pipe 521 are assembled, the filter screen 224 is firmly sandwiched between the first axial end 221a of the screen bracket 221 and the outlet end face 214a of the spray pipe 521.

[0083] Referring to FIG. 3, in one or more examples, a plurality of suction ports 222 and a plurality of snap-fit openings 223 are provided on the second axial end 221b of the screen bracket 221. Both the suction ports 222 and the snap-fit openings 223 are arranged along the circumferential direction of the second axial end 221b. The distances between the suction ports 222 are the same or different, the distances between the snap-fit openings 223 are the same or different, and the distances between the suction ports 222 and the snap-fit openings 223 are the same or different. After the micro-bubble bubbler 522 and the spray pipe 521 are assembled, each suction port 222 on the screen bracket 221 corresponds to one suction port 215 at the outlet end 214 of the spray pipe 521 respectively, so that the corresponding suction ports 222 and 215 not only communicate with each other, but also communicate with the mixing cavity 219, thereby allowing the outside air to be sucked into the mixing cavity 219 of the spray pipe 521 through these suction ports 222, 215. It should also be pointed out that these suction ports 222, 215 can also act as overflow openings at the same time. If the water pressure in the spray pipe 521 is insufficient, the water flow may not be able to quickly penetrate the filter screen in the micro-bubble bubbler 522, and thus will accumulate in the mixing cavity 219 of the spray pipe

521. These overflow openings allow the water flow to flow out therethrough, thereby avoiding a situation in which the air cannot be sucked in due to blockage of the suction ports caused by the accumulation of water flow in the mixing cavity, and thus ensuring the high reliability of the micro-bubble spray head to continuously produce micro-bubble water. Further, after the micro-bubble bubbler 522 and the spray pipe 521 are assembled, each snap-fit opening 223 on the screen bracket 221 receives a corresponding one of the claws 213 at the outlet end 214 of the spray pipe 521, so that the micro-bubble bubbler 522 and the spray pipe 521 are fixed together. Alternatively, the micro-bubble bubbler 522 and the spray pipe 521 can also be fixed together by using other connection methods, such as welding, screwing and the like.

[0084] As shown in FIG. 3, in one or more examples, the filter screen 224 includes a multi-layer filter screen, e.g., two, three or more layers. The filter screen is a hole mesh structure, and the hole mesh structure has at least one mesh hole having a diameter reaching a micron scale. Preferably, the diameter of the mesh hole is between 0 and 1000 microns; more preferably, the diameter of the mesh hole is between 5 microns and 500 microns. The filter screen 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 filter screen 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. When the bubble water flows through the hole mesh structure, the hole mesh structure mixes and cuts the bubble water, thereby generating a large amount of micro-bubble water.

[0085] With continued reference to FIG. 3, in one or more examples, the micro-bubble bubbler 522 further includes a pressure ring 225. The pressure ring 225 has a substantially circular ring shape. The pressure ring 225 has a first axial end face 225a and a second axial end face 225b. Optionally, in one or more examples, a plurality of bosses 251 are provided on each of the first axial end face 225a and the second axial end face 225b in the circumferential direction. These bosses 251 are spaced apart from each other by a predetermined distance and extend axially outwardly from their respective corresponding end faces, so that a groove 252 is formed between every two bosses 251 on each of the axial end faces 225a, 225b. In the assembled state, the first axial end face 225a faces the filter screen 224 and the screen

bracket 221, and the bosses 251 on the first axial end face 225a firmly abut the filter screen 224 against a step 221c extending radially inwardly and located inside the first axial end 221a of the screen bracket 221 (see FIG. 4); the second axial end face 225b faces the outlet end face 214a of the spray pipe 521, and the bosses 251 on the second axial end face 225b abut against the outlet end face 214a of the spray pipe 521. The grooves 252 located between the bosses 251 communicate with the mixing cavity 219, and thus can also act as suction ports. By allowing the outside air to be sucked in from these grooves 252, the reliability of the air introduction into the spray pipe is further improved.

[0086] FIG. 4 is a cross-sectional view of an example of the micro-bubble spray head of the micro-bubble treatment agent box assembly of the present disclosure taken along section line B-B in FIG. 3. As shown in FIG. 4, in one or more examples, a first-stage diameter-decreased conical passage 216a and a second-stage diameter-decreased conical passage 216b are formed inside the diameter-decreased conical passage part 216 of the spray pipe 521 in the water flow direction C. Alternatively, one or more than two stages of diameter-decreased conical passages may be formed inside the diameter-decreased conical passage part 216 in the water flow direction. The first-stage diameter-decreased conical passage 216a extends from the inlet end 211 of the spray pipe 521 to the second-stage diameter-decreased conical passage 216b. A smallest diameter of the first-stage diameter-decreased conical passage 216a may be larger than a largest diameter of the second-stage diameter-decreased conical passage 216b. The second-stage diameter-decreased conical passage 216b continues to extend downstream in the water flow direction C to a throttling hole 218 located at a downstream end of the diameter-decreased conical passage part 216. A diameter of the throttling hole 218 is smaller than or equal to a smallest diameter of the second-stage diameter-decreased conical passage 216b. A diameter of the mixing cavity 219 located downstream of the throttling hole 218 is much larger than the diameter of the throttling hole 218. Optionally, the diameter of the mixing cavity 219 may keep constant in the water flow direction C, or the diameter of the mixing cavity 219 may gradually increase in the water flow direction C to increase a mixing degree of air and water.

[0087] The water flow flows into the spray pipe 521 from the inlet end 211, and then first flows through the first-stage diameter-decreased conical passage 216a and the second-stage diameter-decreased conical passage 216b to be pressurized therein. The pressurized water flow is rapidly expanded and sprayed into the downstream mixing cavity 219 through the throttling hole 218 and generates a negative pressure in the mixing cavity 219. Therefore, under the action of the negative pressure, the outside air is sucked into the mixing cavity 219 through the suction ports 215, 222 and/or 252 and mixes with the water flow in the mixing cavity 219 to generate

bubble water. The bubble water then flows through the filter screen 224 of the micro-bubble bubbler 522 to be cut and mixed, thereby generating micro-bubble water containing a large number of micro-bubbles.

[0088] As shown in FIG. 4, in one or more examples, a plurality of flow disturbing ribs 217 extending in the longitudinal direction are provided on the inner wall of the second-stage diameter-decreased conical passage 216b. These ribs 217 are spaced apart from each other to increase the turbulence of the water flow, which can help the water flow mix with the sucked-in air more effectively at a downstream position. Alternatively, the flow disturbing ribs may be replaced by at least one radial protrusion provided on the inner wall of this stage of diameter-decreased conical passage, such as one or more cylindrical protrusions. Alternatively, the flow disturbing ribs or other forms of flow disturbing parts may be formed on the inner wall of each stage of diameter-decreased conical passage.

[0089] With continued reference to FIG. 4, in one or more examples, the part of the diameter-decreased conical passage part 216 that corresponds to the second-stage diameter-decreased conical passage 216b is separate from the inner wall of the spray pipe 521, so that an annular cavity 300 is formed between this part and the corresponding inner wall of the spray pipe 521. The annular cavity 300 communicates with the mixing cavity 219 to form an entirety, thereby helping further enhance the mixing of air and water.

[0090] The present disclosure also provides a washing apparatus, which includes any one of the micro-bubble treatment agent box assemblies 53 in the first and second embodiments of the present disclosure. The micro-bubble treatment agent box assembly 53 is arranged to provide a mixture of the detergent/treatment agent and the micro-bubble water in the washing apparatus. The micro-bubble treatment agent box assembly can not only improve the cleaning ability of the washing apparatus, but also can reduce the amount of the detergent/treatment agent used and the residual amount of the detergent/treatment agent such as in the clothing, which is not only advantageous for the health of users, but also can improve the user experience.

[0091] Reference is made to FIG. 9, which is a schematic structural view of an example of the washing apparatus of 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.

[0092] As shown in FIG. 9, 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 close to 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, a micro-bubble spray head 52 communicating with the water inflow valve 51, and a micro-bubble treatment agent box assembly 53 incorporating the micro-bubble spray head 52. The micro-bubble treatment agent box assembly 53 is installed above a top of the outer tub 21. The micro-bubble spray head 52 may be any one of the micro-bubble spray heads described above. The water first enters the micro-bubble spray head 52 through the water inflow valve 51 to generate micro-bubble water, and the micro-bubble water then enters the micro-bubble treatment agent box assembly 53 so that the detergent/treatment agent in the detergent/treatment agent box, such as powder detergent, solid detergent or liquid detergent, is quickly dissolved by the micro-bubble water. The micro-bubble treatment agent box assembly 53 then provides a mixture of the detergent/treatment agent and the micro-bubble water to the outer tub 21 for clothing washing. The micro-bubbles in the water impact the detergent/treatment agent during the breaking up process, and negative charges carried by the micro-bubbles can also adsorb the detergent/treatment agent, so the micro-bubbles can increase a mixing degree of the detergent/treatment agent and the water, thereby reducing the amount of detergent/treatment agent used and a residual amount of detergent/treatment agent 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.

[0093] Reference is made to FIG. 10, which is a schematic structural view of another example of the washing apparatus of the present disclosure. In this example, the washing apparatus is a drum washing machine 9.

[0094] As shown in FIG. 10, 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 communicates with a micro-bubble spray head 52 through a water pipe. The micro-bubble spray head 52 is incorporated in the micro-bubble treatment agent box assembly 53 to provide the detergent/treatment agent box with micro-bubble water. The micro-bubble spray head 52 can be any one of the micro-bubble spray heads described above. As shown in FIG. 10, the micro-bubble treatment agent box assembly 53 is positioned below the top panel 94 and above the outer cylinder 92. Similar to the above example, water enters the micro-bubble spray head 52 from the water inflow valve 51 through the water pipe and becomes micro-bubble water through the micro-bubble spray head 52. The micro-bubble water is then sprayed into the micro-bubble treatment agent box assembly 53 so that the detergent/treatment agent in the detergent/treatment agent box, such as powder detergent, solid detergent or liquid detergent, is rapidly dissolved by the micro-bubble water. The micro-bubble treatment agent box assembly 53 then provides a mixture of the detergent/treatment agent and the micro-bubble water to the outer cylinder 92 for clothing washing.

Third embodiment

[0095] In order to solve the technical problem that a micro-bubble production yield of existing water injection boxes is not high, the present disclosure provides a micro-bubble treatment agent box assembly 52. In the third embodiment, the micro-bubble treatment agent box assembly includes a housing 521 and a treatment agent box 522 accommodated in the housing 521. The housing 521 is provided with a micro-bubble water inflow pipe part 527, a diameter-decreased conical passage part 272, an air inflow passage 275 and a micro-bubble bubbler 274. An at-least-one-stage diameter-decreased conical passage is arranged in the diameter-decreased conical passage part 272 in a water flow direction C, and a spray hole 273 is arranged at a downstream end of the diameter-decreased conical passage part 272. The diameter-decreased conical passage part 272 is positioned such that a water flow entering the micro-bubble water inflow pipe part 527 is pressurized inside the at-least-one-stage diameter-decreased conical passage and is sprayed from the spray hole 273 in an expanded state to generate a negative pressure near the spray hole 273. The air inflow passage 275 is positioned close to the spray hole 273, so that outside air is sucked in through the air inflow passage 275 by means of the negative pressure and mixes with the sprayed water flow to form bubble water. The bubble water flows through the micro-bubble bubbler 274 to form micro-bubble water which is then sprayed into the treatment agent box 522. Therefore, as

compared with the water injection boxes with a micro-bubble generator in the prior art, the ability of the micro-bubble treatment agent box assembly of the present disclosure to generate micro-bubbles is greatly improved, thereby increasing a dissolving speed, a dissolution rate and a mixing degree of the treatment agent in the water, which can further save the amount of treatment agent used.

[0096] 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 cross section of the passage that is perpendicular to the water flow direction is gradually decreased so that the passage has a substantially conical shape.

[0097] FIG. 11 is a schematic perspective view of an example of the micro-bubble treatment agent box assembly of the present disclosure, FIG. 12 is a front view of the example of the micro-bubble treatment agent box assembly of the present disclosure shown in FIG. 11, and FIG. 13 is a top view of the example of the micro-bubble treatment agent box assembly of the present disclosure shown in FIG. 11.

[0098] With reference to FIGS. 11 to 13, in one or more examples, the micro-bubble treatment agent box assembly 52 includes a housing 521 and a treatment agent box 522. The treatment agent box 522 can be accommodated inside the housing 521 and is movable inside the housing 521 so as to be pushed into or pulled out of the housing 521. Herein, the treatment agent includes detergent, one or more clothing care agents and the like, and the clothing care agent may be, for example, a softener, a sterilizing liquid and the like.

[0099] As shown in FIGS. 11 to 13, in one or more examples, the housing 521 is provided with a main water inflow pipe part 525, a softener water inflow pipe part 526, and a micro-bubble water inflow pipe part 527. The main water inflow pipe part 525, the softener water inflow pipe part 526 and the micro-bubble water inflow pipe part 527 are all arranged at a top of the housing 521 and are distributed on both sides of the top. The micro-bubble water inflow pipe part 527 and the softener water inflow pipe part 526 are located on the same side of the housing 521. Both the main water inflow pipe part 525 and the softener water inflow pipe part 526 can be connected to an external water source, and they respectively provide non-micro-bubble water for a detergent chamber 221 and a care agent chamber 222 in the treatment agent box 522, such as tap water or well water or other water sources. Therefore, the main water inflow pipe part 525 and the softener water inflow pipe part 526 both belong to a non-micro-bubble water inflow pipe part. The micro-bubble water inflow pipe part 527 is configured to provide micro-bubble water for the treatment agent box 522. With respect to a push/pull direction of the treatment agent box 522, two symmetrical first fixing parts 523 and two symmetrical second fixing parts 524 are provided on left and right sides of the housing 521 respectively. The first fixing parts 523 and the second fixing parts 524 are used

to fix the micro-bubble treatment agent box assembly 52 to, for example, a washing apparatus, such as by screwing or welding. In an alternative example, in addition to the micro-bubble water inflow pipe part 527, only one non-micro-bubble water inflow pipe part, such as the main water inflow pipe part 525, can be provided on the housing 521, or more than two non-micro-bubble water inflow pipe parts can also be provided as required.

[0100] FIG. 14 is a cross-sectional view of a first example of the micro-bubble treatment agent box assembly 52 of the present disclosure in the third embodiment, taken along section line A-A in FIG. 13. As shown in FIG. 14, in one or more examples, the treatment agent box 522 has a detergent chamber 221 and a care agent chamber 222 arranged side by side. The detergent chamber 221 is configured to accommodate a detergent, and the care agent chamber 222 is configured to accommodate a softener. In an alternative example, only one chamber for example for accommodating the detergent can be provided in the treatment agent box 522. In an alternative example, multiple chambers can be provided in the treatment agent box 522, which for example includes two or more care agent chambers, each for accommodating a different care agent. In one or more examples, the main water inflow pipe part 525 is configured to provide tap water for the detergent chamber 221, and the softener water inflow pipe part 526 is configured to provide tap water for the care agent chamber 222.

[0101] With reference to FIG. 14, the micro-bubble water inflow pipe part 527 has an inlet end 271 for connecting to an external water source, so as to allow water to flow into the micro-bubble water inflow pipe part 527 in the flow direction C when needed. A diameter-decreased conical passage part 272 is formed in a horizontal portion of the micro-bubble water inflow pipe part 527. A one-stage diameter-decreased conical passage 272a is formed inside the diameter-decreased conical passage part 272 in the water flow direction C. Alternatively, two or more stages of diameter-decreased conical passages may be formed in the diameter-decreased conical passage part 272 in the water flow direction. A spray hole 273 is formed at a downstream end of the diameter-decreased conical passage part 272. The spray hole 273 communicates the one-stage diameter-decreased conical passage 272a with a flow passage located downstream of the spray hole 273. After entering the micro-bubble water inflow pipe part 527, the water flow must flow through the one-stage diameter-decreased conical passage 272a to be pressurized therein. The pressurized water flow is rapidly expanded and sprayed into a downstream flow passage through the spray hole 273 and generates a negative pressure near the spray hole 273. The air inflow passage 275 is formed on a lower pipe wall of the horizontal portion of the micro-bubble water inflow pipe part 527, and is positioned close to the spray hole 273. Therefore, under the action of the negative pressure, the outside air is sucked into the micro-bubble water inflow pipe part 527 through the air inflow passage 275

and mixes with the water flow sprayed from the spray hole 273 to generate bubble water. The micro-bubble bubbler 274 is also arranged in the horizontal portion of the micro-bubble water inflow pipe part 527, and is located downstream of the diameter-decreased conical passage part 272. The micro-bubble bubbler 274 is arranged transverse to the micro-bubble water inflow pipe part 527. Therefore, the bubble water needs to first flow through the micro-bubble bubbler 274 before it leaves the micro-bubble water inflow pipe part 527, and the bubble water is cut and mixed by the micro-bubble bubbler 274 to generate micro-bubble water. The micro-bubble water is then sprayed into the detergent chamber 221 and/or the care agent chamber 222 of the treatment agent box 522, thereby helping quickly dissolve the detergent in the detergent chamber 221 and/or the care agent in the care agent chamber 222, such as softener.

[0102] In one or more examples, a flow disturbing part (not shown in the figure) can be formed on an inner wall of the one-stage diameter-decreased conical passage 272a. In one or more examples, the flow disturbing part may be 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 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 may be formed on the inner wall of a most downstream stage of diameter-decreased conical passage, or on the inner wall of each stage of diameter-decreased conical passage.

[0103] In one or more examples, the micro-bubble bubbler 274 is a hole mesh structure. The hole mesh structure 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 microns and 500 microns. The hole mesh structure 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 hole mesh structure 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. When the bubble water flows through the hole mesh structure, the hole mesh structure mixes and cuts the bubble water, thereby generating micro-bubble water.

[0104] In one or more examples, the housing 521 is further provided with a sprinkling chamber 276. The sprinkling chamber 276 is located above the treatment agent box 522. A bottom of the sprinkling chamber 276 is provided with a plurality of sprinkling holes (not shown in the figure), and these sprinkling holes are configured to communicate with the detergent chamber 221 and/or the care agent chamber 222 of the treatment agent box 522, so as to sprinkle the micro-bubble water from the micro-bubble bubbler 274 into the detergent chamber 221 and/or the care agent chamber 222.

[0105] FIG. 15 is a cross-sectional view of a second example of the micro-bubble treatment agent box assembly 52 of the present disclosure in the third embodiment, taken along section line A-A in FIG. 13. As shown in FIG. 15, in this example, the treatment agent box 522 also has a detergent chamber 221 and a care agent chamber 222 arranged side by side. The detergent chamber 221 is configured to accommodate a detergent, and the care agent chamber 222 is configured to accommodate a softener. The main water inflow pipe part 525 is configured to provide tap water for the detergent chamber 221, and the softener water inflow pipe part 526 is configured to provide tap water for the care agent chamber 222.

[0106] With reference to FIG. 15, in this example, the micro-bubble water inflow pipe part 527 has an inlet end 271 for connecting to an external water source, so as to allow water to flow into the micro-bubble water inflow pipe part 527 in the flow direction C when needed. A diameter-decreased conical passage part 272 is formed at an outlet of the micro-bubble water inflow pipe part 527. A one-stage diameter-decreased conical passage 272a extending downward is formed inside the diameter-decreased conical passage part 272 in the water flow direction C. Alternatively, two or more stages of diameter-decreased conical passages may be formed in the diameter-decreased conical passage part 272 in the water flow direction. A spray hole 273 is formed at a downstream end of the diameter-decreased conical passage part 272. The spray hole 273 communicates the one-stage diameter-decreased conical passage 272a with a flow passage located downstream of the spray hole 273. After entering the micro-bubble water inflow pipe part 527, the water flow must flow through the one-stage diameter-decreased conical passage 272a to be pressurized therein. The pressurized water flow is rapidly expanded and sprayed into a downstream flow passage through the spray hole 273 and generates a negative pressure near the spray hole 273. As shown in FIG. 15, in this example, the housing 521 is further provided with a sprinkling chamber 276, and the sprinkling chamber 276 is located above the treatment agent box 522. An air inflow passage 275 is formed on a connection part (not shown) between the micro-bubble water inflow pipe part 527 and the sprinkling chamber 276, and is also positioned close to the spray hole 273. Optionally, an auxiliary air inflow passage 275' may be formed at a junction between the sprinkling chamber 276 and the connection

part, and the auxiliary air inflow passage 275' is also positioned close to the spray hole 273. Alternatively, only the auxiliary air inflow passage 275' may be provided in the housing 521 to act as the air inflow passage. Therefore, under the action of the negative pressure, the outside air is sucked into a space enclosed by the connection part through the air inflow passage 275 and/or the auxiliary air inflow passage 275' and mixes with the water flow sprayed from the spray hole 273 to generate bubble water. The micro-bubble bubbler 274 is arranged at a bottom of the sprinkling chamber 276 and covers sprinkling holes located at the bottom of the sprinkling chamber 276. Therefore, the bubble water needs to first flow through the micro-bubble bubbler 274 to form micro-bubble water before being sprinkled into the detergent chamber 221 and/or the care agent chamber 222 from the sprinkling holes, thereby helping quickly dissolve the detergent in the detergent chamber 221 and/or the care agent in the care agent chamber 222, such as softener. The parts not mentioned in this example are the same as those in the above examples.

[0107] The present disclosure also provides a washing apparatus, which includes the micro-bubble treatment agent box assembly 52 of the present disclosure. The micro-bubble treatment agent box assembly 52 is arranged to provide a mixture of the treatment agent and the micro-bubble water in the washing apparatus. The micro-bubble treatment agent box assembly can not only improve the cleaning ability of the washing apparatus, but also can reduce the amount of detergent used and the residual amount of the detergent such as in the clothing, which is not only advantageous for the health of users, but also can improve the user experience.

[0108] Reference is made to FIG. 16, which is a schematic structural view of an example of the washing apparatus of the present disclosure having the micro-bubble treatment agent box assembly. 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.

[0109] As shown in FIG. 16, 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 close to 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-bub-

ble treatment agent box assembly 52 communicating with the water inflow valve 51. The micro-bubble treatment agent box assembly 52 is installed above a top of the outer tub 21. The water enters the micro-bubble treatment agent box assembly 52 through the water inflow valve 51 so that one or more treatment agents in the treatment agent box, such as the detergent and/or one or more clothing care agents, are quickly dissolved by the micro-bubble water. The micro-bubble treatment agent box assembly 52 then provides a mixture of the treatment agent and the micro-bubble water to the outer tub 21 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.

[0110] Reference is made to FIG. 17, which is a schematic structural view of another example of the washing apparatus of the present disclosure having the micro-bubble treatment agent box assembly. In this example, the washing apparatus is a drum washing machine 9.

[0111] As shown in FIG. 17, 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 treatment agent box assembly 52 through a water pipe. As shown in FIG. 17, the micro-bubble treatment agent box assembly 52 is positioned below the top panel 94 and above the outer cylinder 92. Similar to the above example, water enters the micro-bubble treatment agent box assembly 52 from the water inflow valve 51 through the water pipe so that one or more treatment agents in the treatment agent box, such as the detergent and/or one or more clothing care agents, are quickly dissolved

by the micro-bubble water. The micro-bubble treatment agent box assembly 52 then provides a mixture of the treatment agent and the micro-bubble water to the outer cylinder 92 for clothing washing.

[0112] 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, comprising a spray pipe and a micro-bubble bubbler fixed at an outlet end of the spray pipe;

wherein a diameter-decreased conical passage part and a mixing cavity are provided in the spray pipe; there is an at-least-one-stage diameter-decreased conical passage in the diameter-decreased conical passage part in a water flow direction; a throttling hole is arranged at a downstream end of the diameter-decreased conical passage part, and a diameter of the throttling hole is smaller than a diameter of the mixing cavity, so that a water flow is sprayed into the mixing cavity through the throttling hole and generates a negative pressure in the mixing cavity; and

the outlet end of the spray pipe and the micro-bubble bubbler are respectively provided with suction ports that can communicate with each other so that air can be sucked into the mixing cavity through the suction ports by means of the negative pressure and mix with the water flow to form bubble water; and the bubble water is cut and mixed by the micro-bubble bubbler to form micro-bubble water.

2. The micro-bubble spray head according to claim 1, wherein the diameter of the mixing cavity keeps constant or is gradually increased in the water flow direction.
3. The micro-bubble spray head according to claim 1 or 2, wherein a flow disturbing part is arranged in the diameter-decreased conical passage part.
4. The micro-bubble spray head according to claim 1

or 2, wherein the suction ports are also overflow openings of the micro-bubble spray head.

5. The micro-bubble spray head according to claim 1 or 2, wherein the micro-bubble bubbler comprises a multi-layer filter screen and a screen bracket for fixing the multi-layer filter screen.
6. The micro-bubble spray head according to claim 5, wherein a plurality of claws are arranged around an outer wall of the outlet end of the spray pipe, and a plurality of snap-fit openings are arranged around an axial end of the screen bracket that is close to the outlet end to accommodate one of the plurality of claws respectively.
7. The micro-bubble spray head according to claim 5, wherein the micro-bubble bubbler further comprises a pressure ring, and the pressure ring is placed between an end face of the outlet end and the screen bracket so as to abut the multi-layer filter screen against the screen bracket.
8. The micro-bubble spray head according to claim 7, wherein a plurality of spaced apart bosses extending outward in an axial direction are respectively formed on two axial end faces of the pressure ring so that a groove is formed between the adjacent bosses.
9. A micro-bubble treatment agent box assembly, comprising a detergent/treatment agent box, and the micro-bubble spray head according to any one of claims 1 to 8, which is arranged on the detergent/treatment agent box, wherein the micro-bubble spray head is configured to provide micro-bubble water to the detergent/treatment agent box to dissolve a detergent/treatment agent.
10. A washing apparatus, comprising the micro-bubble treatment agent box assembly according to claim 9, wherein the micro-bubble treatment agent box assembly is arranged inside the washing apparatus to provide the washing apparatus with a micro-bubble water mixture in which a detergent/treatment agent is dissolved.
11. A micro-bubble treatment agent box assembly, comprising a detergent/treatment agent box and a micro-bubble spray head arranged on the detergent/treatment agent box; wherein the micro-bubble spray head is formed as a water inlet of the detergent/treatment agent box and provides micro-bubble water for the detergent/treatment agent box, and the micro-bubble spray head comprises a spray pipe and a micro-bubble bubbler fixed at an outlet end of the spray pipe;

a diameter-decreased conical passage part and

- a mixing cavity are provided in the spray pipe; there is an at-least-one-stage diameter-decreased conical passage in the diameter-decreased conical passage part in a water flow direction; a throttling hole is arranged at a downstream end of the diameter-decreased conical passage part, and a diameter of the throttling hole is smaller than a diameter of the mixing cavity, so that a water flow is sprayed into the mixing cavity through the throttling hole and generates a negative pressure in the mixing cavity; and the outlet end of the spray pipe and the micro-bubble bubbler are respectively provided with suction ports that can communicate with each other so that air can be sucked into the mixing cavity through the suction ports by means of the negative pressure and mix with the water flow to form bubble water; and the bubble water is cut and mixed by the micro-bubble bubbler to form micro-bubble water.
12. The micro-bubble treatment agent box assembly according to claim 11, wherein the detergent/treatment agent box comprises a water outlet, a detergent/treatment agent chamber communicating with the water outlet, and a siphon structure arranged in the detergent/treatment agent chamber to discharge liquid in the detergent/treatment agent chamber; and wherein the micro-bubble spray head protrudes into the detergent/treatment agent chamber to spray the micro-bubble water into the detergent/treatment agent chamber.
 13. The micro-bubble treatment agent box assembly according to claim 11 or 12, wherein the diameter of the mixing cavity keeps constant or is gradually increased in the water flow direction.
 14. The micro-bubble treatment agent box assembly according to claim 11 or 12, wherein a flow disturbing part is arranged in the diameter-decreased conical passage part.
 15. The micro-bubble treatment agent box assembly according to claim 11 or 12, wherein the suction ports are also overflow openings of the micro-bubble spray head.
 16. The micro-bubble treatment agent box assembly according to claim 11 or 12, wherein the micro-bubble bubbler comprises a multi-layer filter screen and a screen bracket for fixing the multi-layer filter screen.
 17. The micro-bubble treatment agent box assembly according to claim 16, wherein a plurality of claws are arranged around an outer wall of the outlet end of the spray pipe, and a plurality of snap-fit openings are arranged around an axial end of the screen bracket that is close to the outlet end to accommodate one of the plurality of claws respectively.
 18. The micro-bubble treatment agent box assembly according to claim 16, wherein the micro-bubble bubbler further comprises a pressure ring, and the pressure ring is placed between an end face of the outlet end and the screen bracket so as to abut the multi-layer filter screen against the screen bracket.
 19. The micro-bubble treatment agent box assembly according to claim 18, wherein a plurality of spaced apart bosses extending outward in an axial direction are respectively formed on two axial end faces of the pressure ring so that a groove is formed between the adjacent bosses.
 20. A washing apparatus, comprising the micro-bubble treatment agent box assembly according to any one of claims 11 to 19, wherein the micro-bubble treatment agent box assembly is arranged inside the washing apparatus to provide the washing apparatus with a micro-bubble water mixture in which a detergent/treatment agent is dissolved.
 21. A micro-bubble treatment agent box assembly, comprising a housing and a treatment agent box accommodated in the housing; wherein the housing is provided with a micro-bubble water inflow pipe part, a diameter-decreased conical passage part, an air inflow passage and a micro-bubble bubbler;

an at-least-one-stage diameter-decreased conical passage is arranged 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 diameter-decreased conical passage part is positioned such that a water flow entering the micro-bubble water inflow pipe part is pressurized inside the at-least-one-stage diameter-decreased conical passage and is sprayed from the spray hole in an expanded state to generate a negative pressure near the spray hole; and

the air inflow passage is positioned close to the spray hole, so that outside air is sucked in through the air inflow passage by means of the negative pressure and mixes with the sprayed water flow to form bubble water; and the bubble water flows through the micro-bubble bubbler to form micro-bubble water which is then sprayed into the treatment agent box.
 22. The micro-bubble treatment agent box assembly according to claim 21, wherein the diameter-decreased conical passage part and the micro-bubble bubbler

are arranged in the micro-bubble water inflow pipe part.

23. The micro-bubble treatment agent box assembly according to claim 21, wherein the diameter-decreased conical passage part and the micro-bubble bubbler are arranged between the micro-bubble water inflow pipe part and the treatment agent box. 5
24. The micro-bubble treatment agent box assembly according to any one of claims 21 to 23, wherein a sprinkling chamber is further provided on the housing, and the sprinkling chamber is located above the treatment agent box to sprinkle the micro-bubble water into the treatment agent box. 10
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25. The micro-bubble treatment agent box assembly according to claim 24, wherein the micro-bubble bubbler is arranged in the sprinkling chamber. 20
26. The micro-bubble treatment agent box assembly according to any one of claims 21 to 23, wherein the housing is further provided with at least one non-micro-bubble water inflow pipe part for providing non-micro-bubble water for the treatment agent box. 25
27. The micro-bubble treatment agent box assembly according to any one of claims 21 to 23, wherein a flow disturbing part is arranged on an inner wall of the diameter-decreased conical passage part. 30
28. The micro-bubble treatment agent box assembly according to claim 27, 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. 35
29. The micro-bubble treatment agent box assembly according to any one of claims 21 to 23, wherein the micro-bubble bubbler is a hole mesh structure, and the hole mesh structure has at least one fine hole having a diameter reaching a micron scale. 40
45
30. A washing apparatus, comprising the micro-bubble treatment agent box assembly according to any one of claims 21 to 29, wherein the micro-bubble treatment agent box assembly is arranged inside the washing apparatus to provide the washing apparatus with a micro-bubble water mixture in which a treatment agent is dissolved. 50

55

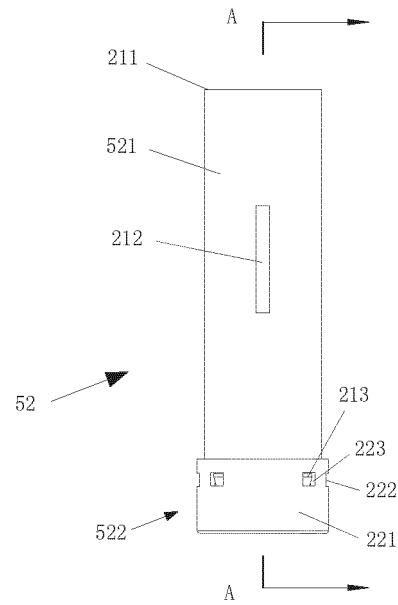


FIG. 1

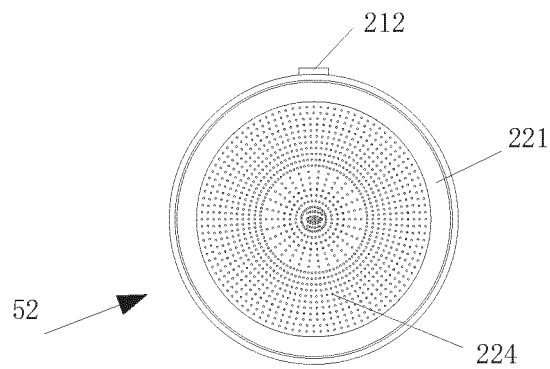


FIG. 2

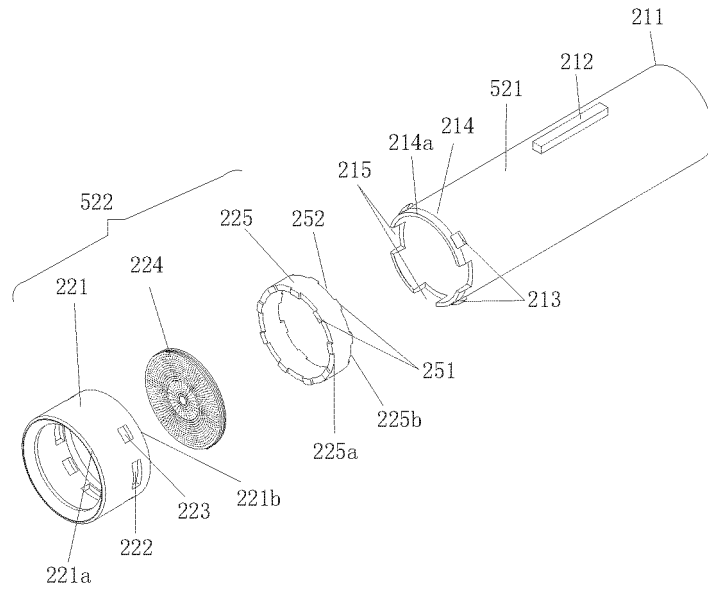


FIG. 3

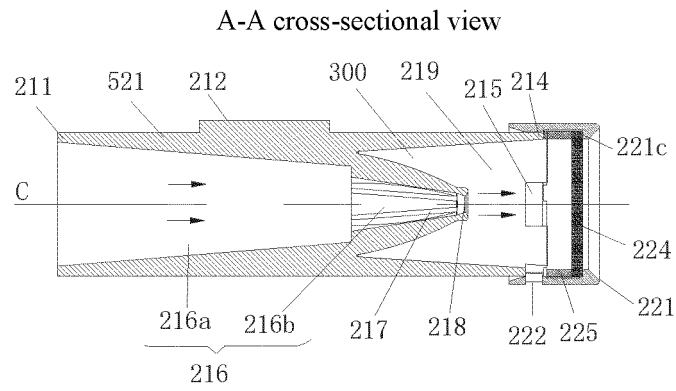


FIG. 4

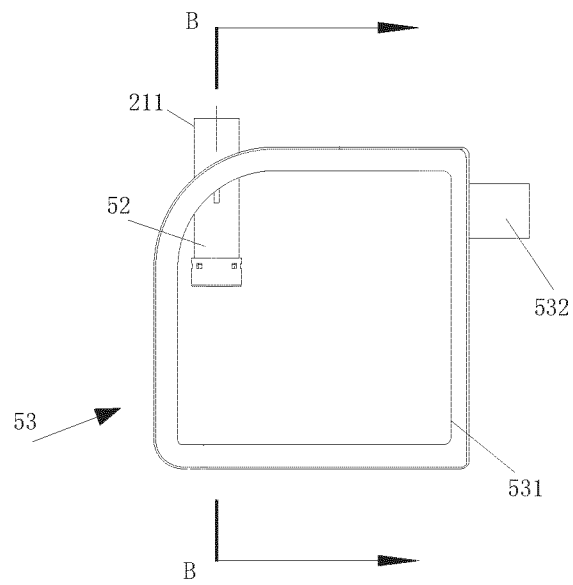


FIG. 5

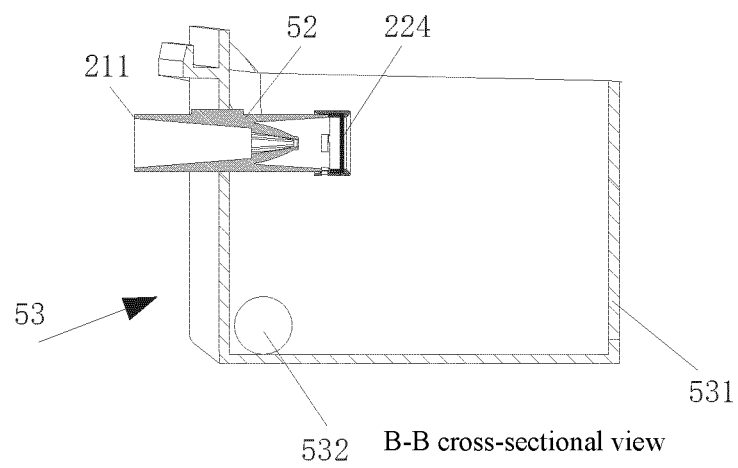


FIG. 6

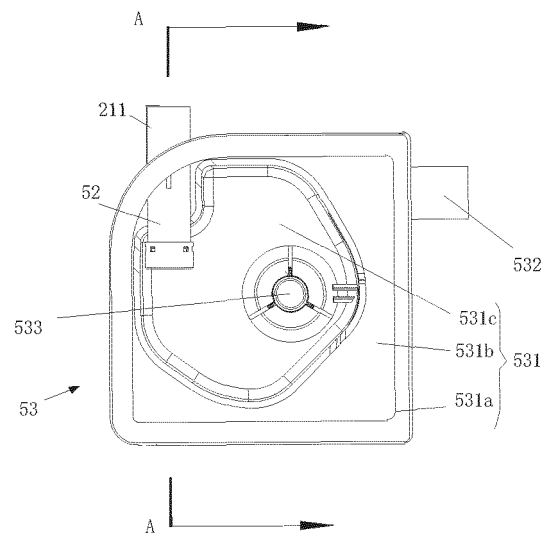
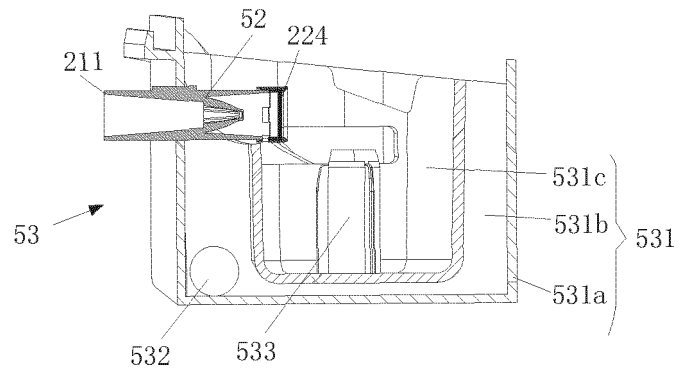


FIG. 7



A-A cross-sectional view

FIG. 8

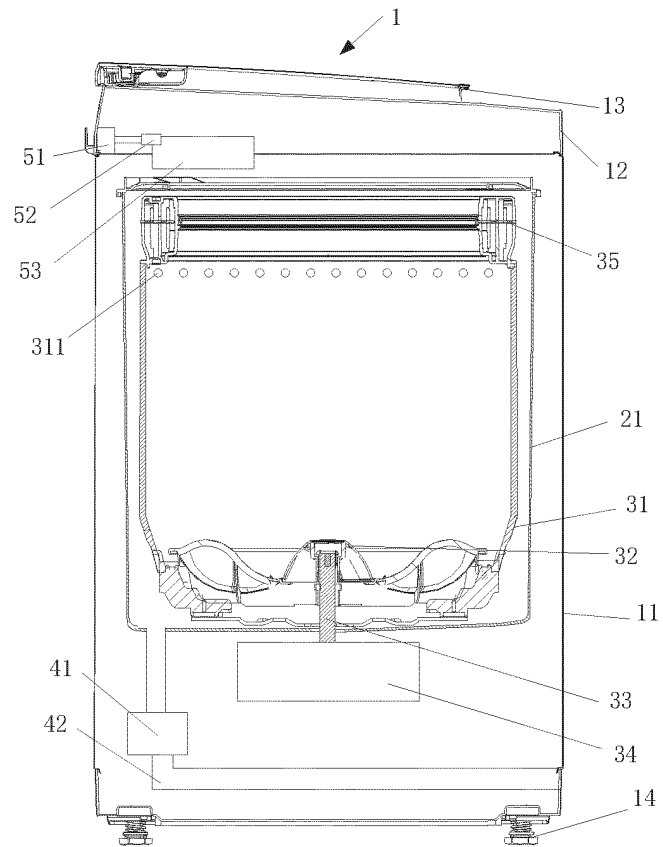


FIG. 9

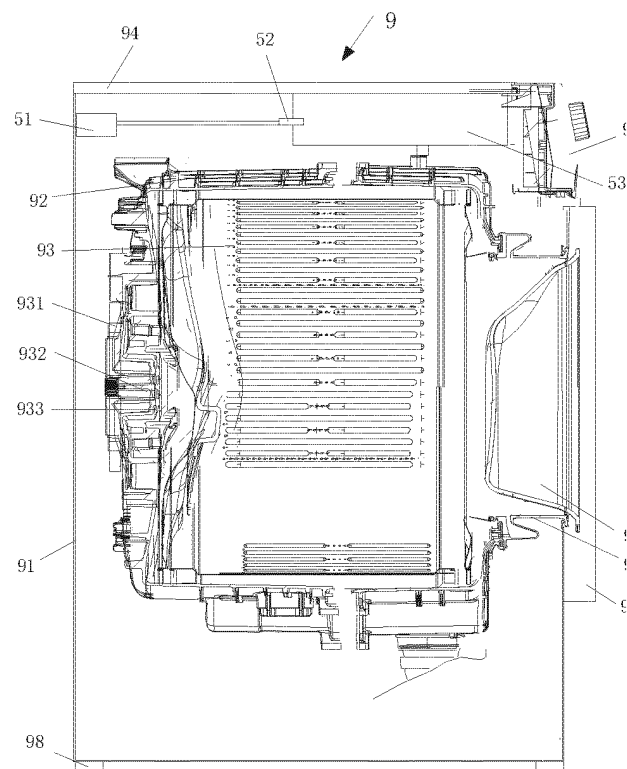


FIG. 10

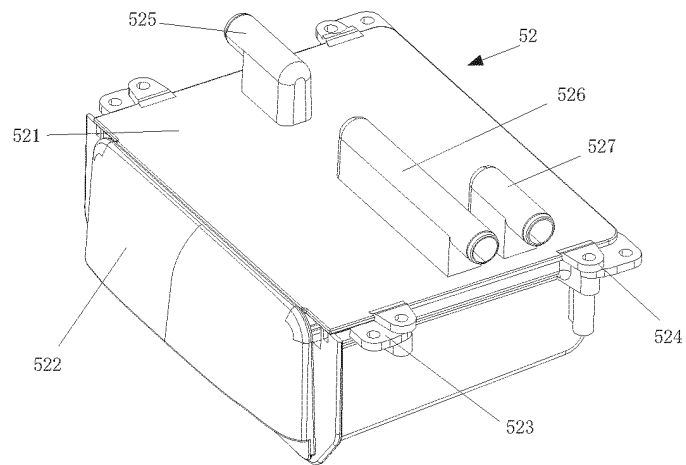


FIG. 11

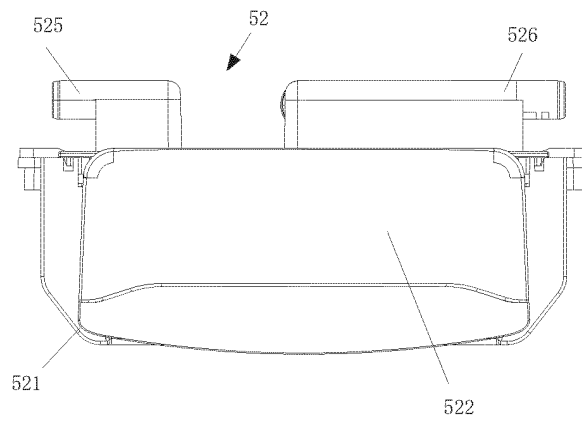


FIG. 12

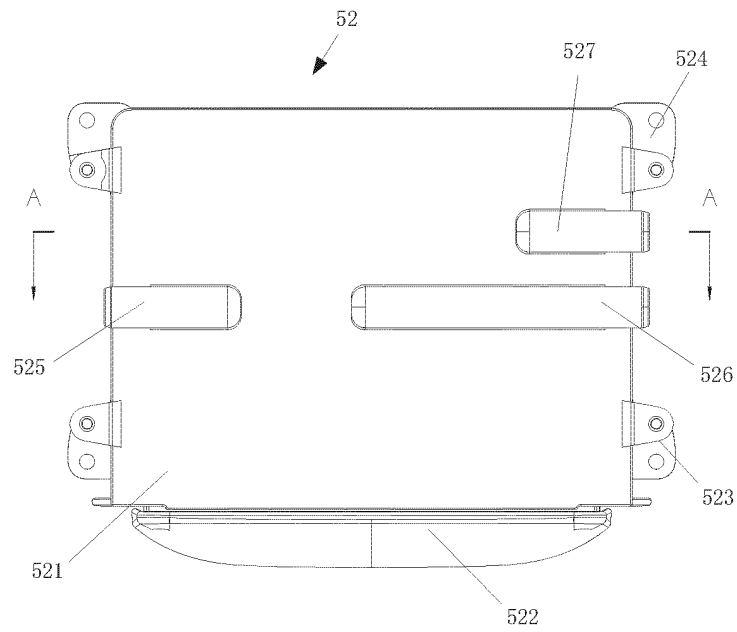


FIG. 13

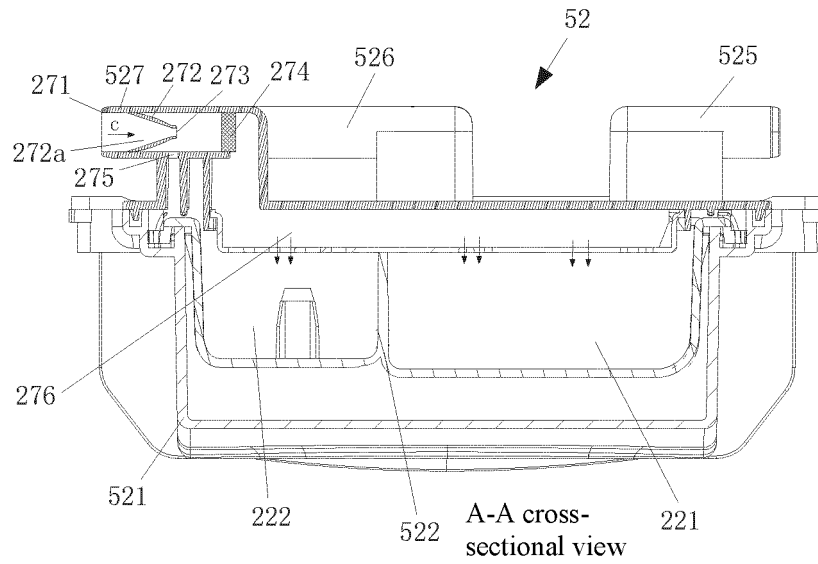


FIG. 14

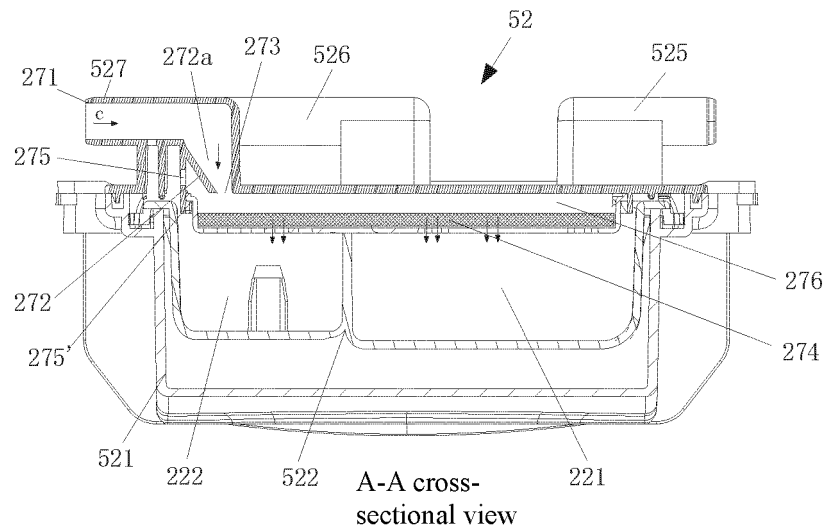


FIG. 15

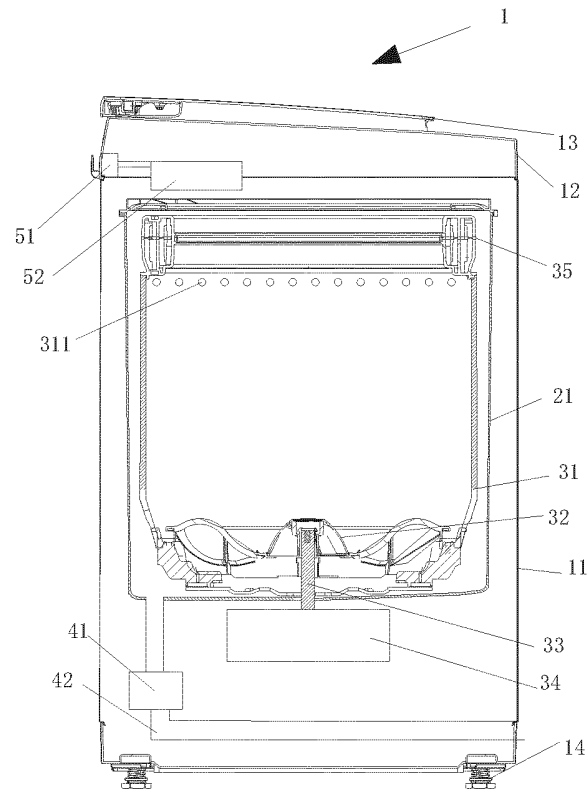


FIG. 16

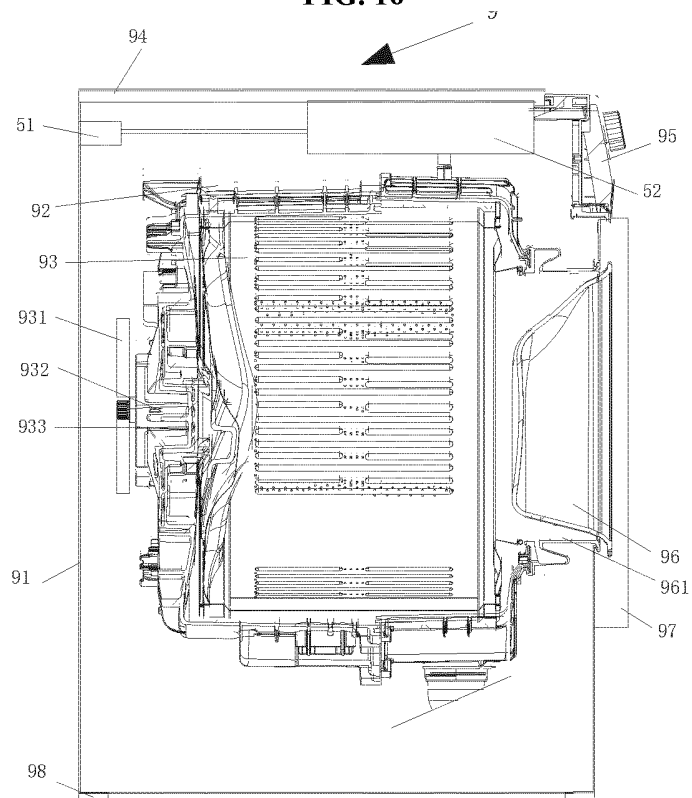


FIG. 17

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/132281

A. CLASSIFICATION OF SUBJECT MATTER

D06F 35/00(2006.01)i; D06F 39/00(2020.01)i; B01F 3/04(2006.01)i; B01F 5/06(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)

D06F,B01F

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, EPODOC, WPI, CNKI: 海尔洗衣机有限公司, 洗衣机, 洗涤剂, 洗衣液, 洗衣粉, 混合, 溶解, 泡沫, 气泡, 微气泡, 气泡产生器, 起泡器, 喷管, 喷头, 喷嘴, 吸气, 进气, 负压, 口, 孔, washer, washing, scour, bubble, mix, blend, dissolve, melt, muzzle, nozzle, aperture, hole, bore.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 211368092 U (QINGDAO HAIER DRUM WASHING MACHINE CO., LTD. et al.) 28 August 2020 (2020-08-28) description, paragraphs 29-52, and figures 1-6	1-30
PX	CN 211772131 U (QINGDAO HAIER DRUM WASHING MACHINE CO., LTD. et al.) 27 October 2020 (2020-10-27) description, paragraphs 36-59, and figures 1-8	1-30
PX	CN 211772134 U (QINGDAO HAIER WASHING MACHINE CO., LTD. et al.) 27 October 2020 (2020-10-27) description, paragraphs 35-58, and figures 1-8	1-30
Y	CN 102383292 A (SUZHOU SAMSUNG ELECTRONICS CO., LTD.) 21 March 2012 (2012-03-21) description, paragraphs 9-22, and figures 1-2	1-30
Y	CN 104278490 A (LIN, Weiming et al.) 14 January 2015 (2015-01-14) description, paragraphs 22-32, and figures 1-11	1-30
A	JP 2007160080 A (SHARP K.K.) 28 June 2007 (2007-06-28) entire document	1-30

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

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

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“&” document member of the same patent family

Date of the actual completion of the international search

16 February 2021

Date of mailing of the international search report

08 March 2021

Name and mailing address of the ISA/CN

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Facsimile No. (86-10)62019451

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Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/132281

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 109420436 A (RUAN, Qingyuan et al.) 05 March 2019 (2019-03-05) entire document	1-30

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2020/132281

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 211368092 U	28 August 2020	None	
CN 211772131 U	27 October 2020	None	
CN 211772134 U	27 October 2020	None	
CN 102383292 A	21 March 2012	None	
CN 104278490 A	14 January 2015	None	
JP 2007160080 A	28 June 2007	JP 4895768 B2	14 March 2012
CN 109420436 A	05 March 2019	None	

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

REFERENCES CITED IN THE DESCRIPTION

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- CN 201911348651 [0001]
- CN 201911228533 [0001]
- CN 108625120 A [0004]