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(54) Titre : POMPE SPIRALEE MULTICONDUITE POUR LE TRAITEMENT DE PRODUITS ALIMENTAIRES

(54) Title: MULTI-PIPING SPIRAL-PUMP FOR TREATING FOOD ITEMS

(57) Abrégé/Abstract:

The present invention relates to a method and a device for treating and/or transporting food items. The apparatus and method are designed to facilitate treating animals or food items in liquid. The device of the present invention is designed as a spiral pump with two or more channels wound around a horizontal axis. The apparatus of the present invention and the use thereof provides a method to treat live or slaughtered animals or food items in a spiral pump.



Abstract

The present invention relates to a method and a device for treating and/or transporting food items. The apparatus and method are designed to facilitate treating animals or food items in liquid. The device of the present invention is designed as a spiral pump with two or more channels wound around a horizontal axis. The apparatus of the present invention and the use thereof provides a method to treat live or slaughtered animals or food items in a spiral pump.

MULTI-PIPING SPIRAL-PUMP FOR TREATING FOOD ITEMS

Field of the invention

The invention relates to a method and apparatus for pumping and optionally treating food items and live or slaughtered animals.

5 Background

In the continuously developing field of food processing improved methods and devices are needed to increase speed of processing and reduce cost and environmental footprints. Processing steps such as cooling, rinsing, transferring, and bleeding of freshly slaughtered animals need to be able to facilitate fast, efficient but relatively gentle
10 handling and transportation of the animals and food products through these processes.

A part of food processing steps includes bleeding of slaughtered animals, cooling and treating slaughtered animals and food items for bacteria, but one of the problems in the food industry is getting rid of bacteria such as Listeria in Salmon and Salmonella in chicken. For Listeria, the solution has been to freeze the salmon to get rid of these
15 bacteria. This however poses a problem for delivery of fresh salmon for the market.

Spiral pumps have been used to transport and treat food items delicately through a closed environment in a low-pressure system. Such pumps are ideal for pumping water-mixed material such as raw and cooked shrimp, shellfish, and pelagic and other small fish according to the principle of Archimedes. By rotating slowly, the pump facilitates
20 transport and/or elevation of water and material through pipes, without using any propeller. The food items are gently conveyed in a closed environment. The system also prevents the items from being exposed to the outside environment.

WO 2018/185791 discloses a spiral pump with a tubing that is helically wound around a frame structure which rotates around a horizontal axis further having a second tubing, which is wound through the inlet of the first tubing and into the second winding. The
25 method is performed by introducing a calculated amount of liquid and food items into the first winding of the spiral pump and then rotating the tubing only one circle at the time to move the food items in the liquid into the second winding before introducing additives, such as ozone, into the second winding through a second tubing for killing bacteria and
30 for transporting items from one location to another at the same time.

WO 2020/012509 discloses an apparatus and a method to treat food items in a spiral pump, where the food items are treated cycle by cycle in the pump at various speed in each cycle and or with a rocking movement of the pump, where the tubing is wound

around the frame of the pump or with other shape to increase movement of the food items in the pump.

Summary of the Invention

One of the problems with prior art pumping devices for transferring and treating food items is providing continuous suction at the in-feeding end, when using pumps according to the principle of Archimedes. For such pumps, a pulsing motion of the pump and backflow of liquid and the material being pumped during the in-feed process reduces the capacity of the pump. Moreover, when suction pumps are being used for pumping animals, the stress on the animals is increased during the constant backflow at the in-feed end and the pulsing motion of the spiral pump itself. The present invention provides a method and a device for pumping, treating, processing and/or transporting living or slaughtered animals or food items in a pumping device using the principle of Archimedes, where the shortcomings of prior art methods are reduced or eliminated.

The apparatus and method are designed to facilitate pumping and/or treating living or slaughtered animals or food items in liquid, where two or more channels or tubes are wound or formed together in a spiral for sequential and repeated feeding at the infeed end through a plurality of in-feed openings. The new device uses a duct to re-direct the air phase from the out-feed end of the pumping device to the in-feed end in a closed system to reduce stimuli such as vacuum, ejector or any other forced introduction of an air phase into the loading structure of the pump. By monitoring and regulating the flow of the air phase from the out-feed end to the in-feed end, the water level and/or pressure level in an in-feed device can be set and/or regulated to provide an optimal speed of continuous and repeated loading of each first winding in the multi-piping pumping device. The apparatus comprises a loading structure and an out-feed structure which sequentially and repeatedly load and exit food items in liquid and air phase at a desired ratio in and out of the pumping device. The loading structure makes sure that the first winding of each tubing is fed with food items in liquid and air to provide a winding with a desired ratio of liquid containing food items and an air phase during a full 360° rotation of the spiral shaped windings. Unlike prior devices, wherein after filling the first winding of a first tubing, the loading structure feeds the next tubing in the same manner, the present device may be feeding two channels with food items in liquid and one winding with an air phase or vice versa. This provides a stable in-feed and out-feed of the pumping device.

The principle of Archimedes ensures that if the total amount of liquid, food items and additives does not exceed 50% of the volume of a winding the food items in the winding do not mix with the food items in the next winding and the air filling about 50% or more

of the volume of the winding pushes the content of a prior winding to the next one. It is possible to operate the pumping device of the present invention with a ratio of liquid containing food items and air, where the liquid containing food items exceeds 50% by 5-15%, but that reduces the pumping capacity of the device.

- 5 In some embodiments a loading structure is provided where feeding pipes deliver liquid containing food items and air phase from a collecting in-feed portion into each winding of the multi-winding pumping device, where the volume of each feeding pipe equals the volume of food items in liquid to be fed into each channel of the pump. The shape of the feeding pipes, the opening from the collecting in-feed portion into each feeding pipe and
10 the water level and/or pressure level in the collecting in-feed portion all contribute to a sequential and repeated loading of a desired ratio of food items in liquid and an air phase into each first winding of each channel in the multi-channel pump by means of monitoring and regulating the flow of liquid into the collecting in-feed portion. After having fed food items in liquid and air phase to all channels of the two or more channels
15 with food items in liquid and the channels have been rotated one full rotation, feeding of food items in liquid is continued into the two or more channels as long as there are food items in liquid to be fed into the apparatus. A mirror design of the out-feed structure provides out-feed pipes to provide the same stable and continuous out-feed from each channel in a sequential and repeated manner.
- 20 In some embodiments the diameter of the channels in the pumping device is much larger than the incoming feeding pipe. In such embodiments the pumping device may be used for treating animals during the transfer through the channels of the pumping device. Such pumping device may be provided with piping for redirecting a portion of the liquid from the out-feed structure back to the in-feed structure to provide sufficient liquid for a
25 pumping device with larger diameter channels. A heat exchange device may be arranged in the liquid piping for adjusting the temperature of the liquid for cooling or heating the content passing through the channels of the pumping device. For treatment such as for reducing or eliminating parasites such as sea lice off farmed salmon, a filter may be arranged in the piping. For treatment such as feeding fish to a slaughtering station the
30 pumping liquid may be infused with ozone or the oxygen content of the liquid reduced in some other manner for making the fish drowse or narcotise the fish. This provides animal welfare during processing reduces the stress level in the fish which reduces the quality of the meat after slaughtering. In some embodiments the pumping apparatus may be provided with means for generating electrical current for stunning fish as a way of
35 slaughtering. The means for generating electrical current may be arranged in a certain portion of each channel in the pumping device or after out-feed from the out-feed structure.

In some embodiments the speed of rotation is altered several time in each full rotation of the pumping device to maximise the capacity of the device. This may be done by rotating at a higher speed during a moment where an air-phase is filling one or two feeding pipes, whereas the speed may be reduced while a feeding pipe is properly filled with food items in liquid.

In some embodiments a continuous monitoring of the water level and/or pressure level in an in-feed structure and an out-feed structure is provided. An encoder may be provided for monitoring the rotation of the spiral shaped pump, where the water level and/or pressure level is regulated in a synchronized manner based on the position of the pump each moment.

In some embodiments before starting to pump food items in liquid through the pump an initiation phase is required, by rotating the channels backwards and feeding all the windings with liquid and an air phase at a desired ratio. During this phase the amount of air phase may need to be adjusted using one or more valves at the out-feed end of the device.

In some embodiments the channels of the new device can optionally be made from or formed in metal, such as steel in case the pump should be made with a larger diameter tubing. In such case, the tubing itself is the supporting structure of the tubing and is connected to a driving means to rotate the pump. The new device can further be designed to redirect the liquid from the out-feed end back to the in-feed end. For the purpose of treating food items, the re-directed liquid can be adjusted for temperature, filtered and supplemented with additives. The new device can also be rotated in a chamber with liquid for load bearing and heat exchange purposes.

In some embodiments the device and method of the invention is suitable for reducing or eliminating parasites such as sea lice off farmed salmon by pumping salmon from one pen to another or to separated space within a pen through at least one pumping device. By pumping salmon from a pen through the multi-spiral pump of the invention having a pumping liquid at different temperature than in the temperature of the pen, the salmon is subjected briefly to a temperature difference (ΔT), which results in detachment of the sea lice from the skin of the fish. As the pumping device is neither complicated nor space consuming the apparatus can be set up on a structure next to a pen or on the deck of a vessel and due to the suction properties of the first pumping device of the invention farmed fish can be effectively sucked out of the pen and into the first pump. The detachment of lice from salmon fish is obtained due to the size difference of the salmon fish and the sea lice, as well as the fat content of salmon fish, because the salmon fish

can tolerate the temperature difference for a short period of time, but the sea lice cannot.

In some embodiments the tubing of the pumping device is arranged to thread the in-feed end through the centre space of the windings to exit by the last winding of the pumping device and the out-feed end is threaded through the centre space of the windings to exit by the first winding of the pumping device.

It is an object of the present invention to overcome and/or ameliorate the aforementioned drawbacks of the prior art and to provide an improved and/or alternative and/or additional method or device for facilitating processing or treatment of living or slaughtered animals or food items using spiral pump(s).

It is one preferred object of the present invention to provide a method and device to facilitate transfer(pumping) and/or treatment of food items. Moreover, it is a preferred object of the present invention to provide a method and device, preferably designed as a multi-channel spiral pump having two or more channels or tubing formed or wound in a spiral to increase efficiency, providing continuous and stable suction and reducing backflow during in-feed and pulsing movement of the pump during pumping. Another preferred object of the present invention is to provide a pumping device where the air phase in the pumping device is re-directed from an out-feed structure back to the in-feed structure in a closed system and where the flow of re-directed air back to the in-feed structure is monitored and regulated. One preferred embodiment of the present invention is to provide an in-feed and out-feed structure having a design where the in-feeding ends of the plurality of the channels of the apparatus are serially and continuously feed with food items in liquid and air-phase and the out-feed structure serially and continuously feeds food items in liquid and air-phase out of the pumping device.

The object(s) underlying the present invention is (are) particularly solved by the features defined in the independent claims. The dependent claims relate to preferred embodiments of the present invention. Further additional and/or alternative aspects are discussed below.

Thus, at least one of the preferred objects of the present invention is solved by an apparatus for transferring and/or treating food items in liquid media, the apparatus comprises: i) two or more channels each comprising an in-feed end and an out-feed end, wherein of the two or more channels are wound in parallel into a spiral shaped channel having three or more windings to be rotated around a central axis, ii) a loading device for sequentially and repeatedly loading each first winding of the two or more spiral shaped channels with food items in liquid media and air phase, iii) an out-feed device for

sequentially and repeatedly collecting the food items in liquid media and the air phase from each of the two or more spiral shaped channels, iv) an air/gas-duct for re-directing the air/gas phase from the out-feed device back to the loading device, v) means for rotating the two or more spiral shaped channels. The apparatus further comprises means for means for detecting the water level in the loading device and in the out-feed device.. This allows continuous adjustment of the water level in the in-feed and the out-feed structure so that each first winding of the plurality of channels in the apparatus are feed with a desired ratio of food items in liquid media and air phase.

Another preferred object of the present invention is solved by a method for transferring and/or treating food items in liquid media, the method comprising:

- a) providing a pumping device, said spiral pump further comprising: i) two or more channels each comprising an in-feed end and an out-feed end, wherein of the two or more channels are wound in parallel into a spiral shaped channel having three or more windings to be rotated around a central axis, ii) a loading device for sequentially and repeatedly loading each first winding of the two or more spiral shaped channels with food items in liquid media and air phase, iii) an out-feed device for sequentially and repeatedly collecting the food items in liquid media and the air phase from each of the two or more spiral shaped channels, iv) an air/gas-duct for re-directing the air/gas phase from the out-feed device back to the loading device, v) means for rotating the two or more spiral shaped channels.
- b) rotating the two or more spiral shaped channels 360° such that each first winding of the two or more spiral shaped channels is fed with food items in liquid media,
- c) at the same time re-directing the air/gas phase from the out-feed device back to the loading device such that each first winding of the two or more spiral shaped channels is fed with an air phase during the same 360° rotation as in step b),
- d) sequentially performing step b) and c) for the number of spiral shaped channels of the apparatus,
- e) repeating step b) to d) while there are food items to be feed into the apparatus.

The method further comprises the step of continuously monitoring and regulating the water level in the loading device and in the out-feed device by a means for detecting the water level in the loading device and in the out-feed device. to ensure that each first winding of the plurality of channels in the apparatus are feed with a desired ratio of food items in liquid media and air phase.

Another preferred object of the present invention is solved by an apparatus for transferring and/or treating food items in liquid media, the apparatus comprises: i) two or more channels each comprising an in-feed end and an out-feed end, wherein of the

two or more channels are wound in parallel into a spiral shaped channel having three or more windings to be rotated around a central axis, ii) a loading device for sequentially and repeatedly loading each first winding of the two or more spiral shaped channels with food items in liquid media and air phase, iii) an out-feed device for sequentially and repeatedly collecting the food items in liquid media and the air phase from each of the two or more spiral shaped channels, iv) an air/gas-duct for re-directing the air/gas phase from the out-feed device back to the loading device, v) means for rotating the two or more spiral shaped channels. The loading device further comprises a separate opening and in-feed pipes for connection to the in-feed end of each of the two or more spiral shaped channels at the outer periphery of the two or more spiral shaped channels 1, and the out-feed device further comprises a separate opening and out-feed pipes for connection to the out-feed end of each of the two or more spiral shaped channels. The in-feed pipes are curved and rotate eccentrically to the central axis of the two or more spiral shaped channels such that the shape of an in-feed pipe and the water level in the in-feed structure generates i) an air-lock when the feeding pipe is no longer able to deliver liquid into the first winding at the end of loading a winding, and ii) a water-lock when the feeding pipe no longer able to provide a free flow of air into the first winding during loading the upper portion of a winding with air phase.

In the present context the terms "channels", "piping" and "tubing" " are used equally for referring to piping or channel structures forming the channels in a spiral shaped pump according the principle of Archimedes, where the pump has a plurality (two or more) channels, each having an in-feed and an out-feed end, where the plurality of channels are wound/formed in a spiral and where the plurality of piping is feed sequentially with items in liquid to be pumped through the spiral pump and out of the out-feed end of each channel. The piping/channels can be wound in parallel as is shown in Fig. 1C.

In the present context the terms "treating food items", "treating food items in liquid media" and "processing or treating food items in liquid" relate to rinsing, washing, bleeding, cooling, heating or adding substances to food items such as, but not limited to, salts, phosphates or anti-bacterial agents etc.

In the present context the terms "food items" and "live or slaughtered animals or food items" are used equally for live animals, such as salmon, and food items such as slaughtered fish or chicken, as well as for parts or animals such as aquatic animals, birds or other smaller slaughtered animals, fruit, vegetables, berries, plants, algae and any other food items for human or animal consumption being treated in pumping devices in liquid.

In the present context the terms "loading structure" and "loading device" refer to an in-feeding mechanism which loads each of the channels in the apparatus with food items in liquid and air or gas.

5 In the present context the terms "outfeed (collecting) structure" and "outfeed device" refer to an out-feeding mechanism which receives items in liquid from each of the channels in the apparatus.

10 In the present context the term "means for rotating the spiral shaped channels" refers to any drive means for rotating the channels in the apparatus to perform the pumping activity of the apparatus. Such drive means are selected from, but not limited to, a motor or a gear device.

15 In the present context the term "sequentially and repeatedly" in reference to feeding the apparatus of the present invention refers to feeding each channel of the apparatus with food items in liquid and an air phase during rotation of the channels. After having fed food items in liquid and air phase to all channels of the two or more channels with food items in liquid and the channels have been rotated one full rotation, feeding of food items in liquid is continued into the two or more channels as long as there are food items in liquid to be fed into the apparatus.

20 In the present context the terms "pumping device", "spiral pump", and "apparatus for transferring and/or treating food items in liquid media" are used equally for the apparatus of the present invention having two or more channels for pumping, transferring and/or treating food items in liquid.

25 In an embodiment of the present invention the means for detecting the water level in the loading device and in the out-feed device comprises a pipe or hose and a sensor between the upper and lower part of the loading device and the out-feed device. Preferably in the outer collecting portion of the loading device and the out-feed device.

In an embodiment of the present invention the apparatus further comprises means for detecting the air pressure in the loading device and in the out-feed device. The means for detecting the air pressure in the loading device and in the out-feed device is used to determine the water level in the loading device and in the out-feed device.

30 In an embodiment of the present invention the means for detecting the water level in the loading device and in the out-feed device the comprises a pipe or hose, a sensor for determining the water level and a sensor to determine the air pressure in the loading device and the out-feed device.

In an embodiment of the present invention the sensor for determining the water level comprises a pipe or hose and a sensor between lower part of the loading device and the out-feed device, preferably in the outer collecting portion of the loading device and the out-feed device.

- 5 In an embodiment of the present invention the means for detecting the water level and/or the air pressure in the loading device and in the out-feed device is used to estimate the water level and control opening and closing of pressure valves in the the means for regulating the flow of air redirected from the out-feed device back to the loading device.
- 10 In an embodiment of the present invention the means for detecting the water level and/or the air pressure in the loading device and in the out-feed device is used to determine the water level in the loading device to further determine the working volume of food items and liquid to be fed into each spiral shaped channel of the pumping device of the present invention.
- 15 In an embodiment of the present invention the means for detecting the water level in the loading device and in the out-feed device comprises a water level sensor associated with the outer collecting portion of the loading device and the out-feed device.

In an embodiment of the present invention the means for regulating the flow of air redirected from the out-feed device back to the loading device comprises one or more of:

- 20 i) a low air compensation device/additional air input valve, ii) an control valve for air circulation, iii) a high air compensation device/release valve for excess air, iv) an air release valve/water stop, v) an air damper/buffer device, and vi) a shut-off valve.

In an embodiment of the present invention the means for regulating the flow of air redirected from the out-feed device back to the loading device comprises a low air compensation device in the (connected to the) air/gas-duct or in the out-feed device.

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In an embodiment of the present invention the means for regulating the flow of air redirected from the out-feed device back to the loading device comprises a high air compensation device in the (connected to the) air/gas-duct or in the out-feed device.

In an embodiment of the present invention the means for regulating the flow of air redirected from the out-feed device back to the loading device comprises an air release valve in the (connected to the) air/gas-duct.

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In an embodiment of the present invention the means for regulating the flow of air redirected from the out-feed device back to the loading device comprises a control valve for air phase circulation in the (connected to the) air/gas-duct.

In an embodiment of the present invention the means for regulating the flow of air redirected from the out-feed device back to the loading device comprises a shut-off valve in the (connected to the) air/gas-duct.

5 In an embodiment of the present invention the means for regulating the flow of air redirected from the out-feed device back to the loading device comprises an air damper/buffer device in the (connected to the) air/gas-duct.

In an embodiment of the present invention the means for regulating the flow of air redirected from the out-feed device back to the loading device comprises an air inlet in the out-feed device.

10 In an embodiment of the present invention the means for regulating the flow of air redirected from the out-feed device back to the loading device comprises an air outlet in the (connected to the) air/gas-duct or in the out-feed device.

15 In an embodiment of the present invention the in-feed end of each of the two or more spiral shaped channels connects to the loading structure in different locations on the loading structure and wherein the loading structure is at least partially rotatable with the two or more spiral shaped channels.

In an embodiment of the present invention the loading structure further comprises guiding means for guiding the food items in liquid media into in-feeding pipes which connect to the in-feed end of each of the two or more spiral shaped channels.

20 In an embodiment of the present invention the loading structure is rotatable with the two or more spiral shaped channels and wherein in-feeding occurs sequentially and repeatedly into all channels of the pump through a 360° rotation of the spiral shaped channels.

25 In an embodiment of the present invention the guiding means of the loading structure comprises channels, blades or bars for guiding food items in liquid to an in-feed opening of a channel.

30 In an embodiment of the present invention the loading device further comprises a separate opening and in-feed pipes for connection to the in-feed end of each of the two or more spiral shaped channels (at the outer periphery of the two or more spiral shaped channels).

In an embodiment of the present invention the out-feed device further comprises a separate opening and out-feed pipes for connection to the out-feed end of each of the two or more spiral shaped channels.

In an embodiment of the present invention the volume capacity for each in-feed pipe for food items and liquid media in a 360° rotation of the two or more spiral shaped channels equals the about 50% of the volume of a one winding, but can also be slightly more or slightly less (e.g. $\pm 10\%$), such as in the range from about 40%, or about 45% or about 48% or about 49%, to about 51%, or to about 52%, or to about 45% or to about 60%.

In an embodiment of the present invention in-feed pipes form a curved and or eccentric connection to in-feed end (at the outer periphery) of each of the two or more spiral shaped channels.

In an embodiment of the present invention in-feed pipes comprise a curved form such as an elbow shaped form where, when the separate opening for a specific in-feed pipe is in a 90° position or 3 o'clock position in a circle, the elbow is formed first inwardly into the spiral, then it is curved back outwardly out of the spiral and then upwardly to join the in-feed end of it's connecting spiral shaped channel.

In an embodiment of the present invention the volume of each in-feed pipe equals the volume of food items in liquid to be fed into each winding of the two or more channels.

In an embodiment of the present invention the in-feed pipes are curved and rotate eccentrically to the central axis of the two or more spiral shaped channels.

In an embodiment of the present invention the loading structure is at least partially rotatable with the two or more spiral shaped channels.

In an embodiment of the present invention the loading structure comprises i) an inlet portion, ii) an outer (out of frame) collecting portion and iii) an inner feeding portion.

In an embodiment of the present invention the inner feeding portion of the loading structure rotates with the two or more spiral shaped channels.

In an embodiment of the present invention the inner feeding portion of the loading structure is rotatable around the same central axis as the the two or more spiral shaped channels.

In an embodiment of the present invention the separate openings of the loading device are formed in the inner feeding portion.

In an embodiment of the present invention the inner feeding portion is at least partially circular and wherein the separate openings of the loading device are evenly distributed around a 360° circular portion of the inner feeding portion.

In an embodiment of the present invention the inlet portion of the loading structure connects to an incoming feeding pipe for liquid and food items and has an increasing diameter to connect to the outer collecting portion.

5 In an embodiment of the present invention the outer collecting portion has an inlet for the air phase.

In an embodiment of the present invention the apparatus further comprises an out-feed device for collecting the food items in liquid media and the air phase from each of the two or more spiral shaped channels.

10 In an embodiment of the present invention the out-feed device comprises i) an inner out-feed portion, ii) an outer (out of frame) collecting portion and iii) an outlet portion.

15 In an embodiment of the present invention the out-feed device is adapted for sequentially and repeatedly offloading (exiting) food items in liquid media and air phase from each last winding of the two or more spiral shaped channels, said out-feed device comprising a separate opening and out-feed pipes for connection to the out-feed end of each of the two or more spiral shaped channels.

In an embodiment of the present invention out-feed pipes form a curved connection to out-feed end (at the outer periphery) of each of the two or more spiral shaped channels, and wherein the volume of each out-feed pipe equals the volume of food items in liquid to be fed out of each winding of the two or more channels.

20 In an embodiment of the present invention out-feed pipes comprise a curved form such as an elbow shaped form where, when the separate opening for a specific out-feed pipe is in a 90° position or 3 o'clock position in a circle (seen from the in-feed end), the elbow is formed first inwardly from the out-feed device into the spiral, then it is curved back outwardly out of the spiral and then downwards to join the out-feed end of it's
25 connecting spiral shaped channel.

In an embodiment of the present invention the inner out-feed portion of the outfeed collecting structure is rotatable around the same central axis as the the two or more spiral shaped channels.

30 In an embodiment of the present invention the separate openings of the outfeed collecting structure are formed in the inner out-feed portion.

In an embodiment of the present invention the inner out-feed portion is at least partially circular and wherein the separate openings of the outfeed collecting structure are evenly distributed around a 360° circular portion of the inner out-feed portion.

5 In an embodiment of the present invention the outlet portion of the outfeed collecting structure connects to an outlet pipe for liquid and food items and has an decreasing diameter from the outer collecting portion towards the outlet pipe.

In an embodiment of the present invention the outer collecting portion has an outlet for the air phase.

10 In an embodiment of the present invention the out-feed pipes are curved to rotate eccentrically to the central axis of the two or more spiral shaped channels.

In an embodiment of the present invention the loading device further comprises a separate opening and in-feed pipes for connection to the in-feed end of each of the two or more spiral shaped channels (at the outer periphery of the two or more spiral shaped channels).

15 In an embodiment of the present invention the out-feed device further comprises a separate opening and out-feed pipes for connection to the out-feed end of each of the two or more spiral shaped channels.

20 In an embodiment of the present invention one or more of the pumping devices is arranged to thread the in-feed end through the centre space of the windings to enter by the last winding of the pumping device and wherein the out-feed end is threaded through the centre space of the windings to enter by the first winding of the pumping device.

In an embodiment of the present invention the means for rotating the two or more spiral shaped channels is a motor.

25 In an embodiment of the present invention the apparatus further comprises control means for controlling rotation of the two or more spiral shaped channels.

In an embodiment of the present invention the control means alters the speed of the rotation at least once during every full cycle rotation.

In an embodiment of the present invention the speed of rotation is altered at least once for the number of spiral shaped channels.

30 In an embodiment of the present invention the speed of rotation is altered two times or more for each spiral shaped channel in the apparatus.

In an embodiment of the present invention the apparatus comprises a computing means for controlling the rotation of the pumping device and optionally the interval (time) between and/or in each rotation of the spiral shaped channels. The computing means also calculates the amount of liquid and food items, and optionally additives, fed into the first winding of each spiral shaped channel to maintain a desired volume and ratio of food items vs. liquid.

In an embodiment of the present invention the apparatus further comprises a sensor for determining the position of the windings of the pump in each cycle of rotation.

In an embodiment of the present invention the number of the two or more spiral shaped channels is two, three or four spiral shaped channels.

In an embodiment of the present invention the apparatus further comprises means for generating electrical current in each of the two or more spiral shaped channels.

In an embodiment of the present invention the loading structure further comprises guiding means for guiding the food items in liquid media into infeed end of each of the two or more spiral shaped channels.

In an embodiment of the present invention the two or more spiral shaped channels are made from hose or pipe like flexible material.

In an embodiment of the present invention the three or more windings of the two or more spiral shaped channels are wound around or in a horizontally rotating frame/support structure, wherein the tubing is formed in a spiral in connection with rotating frame/support structure.

In an embodiment of the present invention the three or more windings of the two or more spiral shaped channels are made from metal, such as steel.

In an embodiment of the present invention the metal spiral shaped channels are the load bearing structure being rotated for transferring and/or treating food items in liquid media.

In an embodiment of the present invention the treatment of food items comprises cooling food items in liquid media.

In an embodiment of the present invention the apparatus further comprises piping for re-directing the liquid from the out-feed device back to the loading device.

In an embodiment of the present invention the piping further comprises a heat exchange device to regulate the temperature of the liquid being re-directed to the loading device.

In an embodiment of the present invention the piping further comprises a filter device to filter the liquid being re-directed to the loading device.

In an embodiment of the present invention the piping further comprises a circulation pump for re-directing the liquid from the out-feed device back to the loading device.

- 5 In an embodiment of the present invention the piping connects to the outer collecting portion of the out-feed device and to the outer collecting portion of the loading device.

In an embodiment of the present invention the outer collecting portion of the loading device further comprises a liquid inlet for feeding additional liquid into the loading device.

- 10 The apparatus according to claim, wherein the two or more spiral shaped channels are at least partially arranged in a liquid container containing heat exchange medium.

In an embodiment of the present invention the treatment of food items comprises treating the food items in liquid media with anti-bacterial agents.

In an embodiment of the present invention the apparatus is set up on a vessel or on a structure adjacent to a pen structure for farming fish.

- 15 In an embodiment of the present invention the apparatus further comprises an item counter, such as a fish counter.

- 20 In an embodiment of the present invention the apparatus further comprises a cooling system or a heat exchange device bringing the liquid for treating the food items to a predetermined temperature and for making the liquid a salt-controlled and temperature-controlled solution.

In an embodiment of the present invention the liquid separated in the liquid outlet of the pumping device is filtered before it is re-circulated the liquid through a heat exchange element and back to the in-feed end of the pumping device.

- 25 In an embodiment of the present invention, each helical wound channel has three to fifty windings, such as three to twenty-five windings or three to ten windings. The thickness of the tubing is determined by the amount of food items to be treated and the speed of treatment in each winding of the pump.

In an embodiment of the present invention ozone is fed into the mixture of liquid and food items.

- 30 In an embodiment of the present invention the loading device and the out-feed device of the pumping device further comprise a separate opening and in-feed pipes for connection

to the in-feed end and out-feed end respectively of each of the two or more spiral shaped channels, wherein the volume capacity for in-feeding of each in-feed pipe and for discharging of each out-feed pipe the food items and liquid media during a 360° rotation of the two or more spiral shaped channels equals about 50% of the volume of a single winding or the desired ratio of food items in liquid and air phase, and wherein the water level in the loading device and in the out-feed device is monitored and regulated continuously to ensure correct feeding of both food items in liquid and air phase into each channel.

In an embodiment of the present invention the loading device further comprises a separate opening and in-feed pipes for connection to the in-feed end of spiral shaped channel, and wherein the volume capacity for in-feeding of the food items and liquid media through each in-feed pipe during a 360° rotation of the two or more spiral shaped channels equals the desired ratio of food items in liquid and air phase.

In an embodiment of the present invention the water level in the loading device and in the out-feed device is monitored and adjusted continuously to maintain feeding of both food items in liquid and air phase into each of the two or more spiral shaped channels at the desired ratio.

In an embodiment of the present invention further pumping device further comprises means for regulating the flow of air redirected from the out-feed device back to the loading device, and wherein the method comprises using means for regulating the flow of air redirected from the out-feed device back to the loading device to adjust the water level such that each first winding is fed with a desired ratio of food items in liquid vs air phase.

In an embodiment of the present invention the adjustment of the water level is determined such that the position and shape of an in-feed pipe and the water level in the in-feed structure generates an air-lock when the feeding pipe is no longer able to deliver liquid into the first winding at the end of loading a winding.

In an embodiment of the present invention the adjustment of the water level is determined such that the position and shape of an in-feed pipe and the water level in the in-feed structure generates a water-lock when the feeding pipe no longer able to provide a free flow of air into the first winding during loading the upper portion of a winding with air phase.

In an embodiment of the present invention the working volume of each in-feed pipe for food items and liquid in relation to the "working" volume of food items and liquid in a

single winding of the spiral shaped channel is regulated by the water level in the in-feed structure.

In an embodiment of the present invention the ratio of liquid and food items vs air phase is about 50/50, the volume capacity of an in-feeding pipe may be about 50% of the
 5 volume of a single winding of the spiral shaped channel, such as in the range 40-60%, e.g. in the range from about 40% or from about 45% or from about 48% or from about 49%, to about 51% or to about 52%, or to about 45% or to about 60%.

In an embodiment of the present invention a free flow of air/gas into any feeding pipe after it has completed loading a winding of the spiral shaped channel with food items and
 10 liquid, the feeding pipe will continue and complete filling the upper portion of said winding with an air phase before a water lock forms in the in-feed pipe as liquid starts to flow into the in-feed pipe.

Description of various embodiments

15 The present invention will become more fully understood from the detailed description given hereinafter and the accompanying drawings which are given by way of illustration only, and thus, are not limitative of the present invention, and wherein:

FIG. 1 is a side view of spiral shaped multi-pumping device with an air duct for re-direction of air-flow.

20 FIG. 2 is a transparent side view of a spiral shaped three winding pumping device outlining the in-feed and outfeed structure.

FIG. 3 is a transparent perspective view of the pumping device in Fig. 2.

FIG. 4 is a sectional front (A) and top (B) view of the loading capacity of the in-feed pipes.

25 FIG. 5 is a rotation sequence of a spiral pump outlining the loading function of the feeding pipes.

FIG. 6 shows two embodiments of a treatment function of the device of the present invention.

FIG. 7 shows two embodiments for monitoring and regulating the re-directed air-flow in
 30 the device of the present invention.

FIG. 8 shows the position of a water level monitoring device in the in-feed structure.

FIG. 9 shows an embodiment of crossing the in-feeding structure and the outfeed structure through the windings of a multi-winding pump.

Figure 1 shows outlines the main components of a multi-winding pumping device having a helical tubing/channels 1 wound around a horizontal central axis. Each channel has an in-feed end 2 and an out-feed end 3, where the in-feed end for each of the parallel wound channels 1 is connected to a loading structure 4 for loading each first winding of the parallel wound tubing 1 with food items in liquid media and an air phase. In the same manner the out-feed end of each of the three parallel wound tubing 1 is connected to an out-feed collecting structure 5 the air phase and food items in liquid media from each of the three parallel wound tubing 1. In the embodiment shown in Fig. 1 the windings 8 of the helical wound tubing are wound around and into a cylindrical frame structure 7, which rotates around the horizontal central axis of the frame structure 7. The outfeed collecting structure has an outlet for the air phase, which is being re-directed back to the loading structure 4 via an air-duct 6.

Figure 2 shows an embodiment of the present invention wherein a pumping apparatus comprises 3 helical wound channels. The figure shows a loading structure 4 and an out-feed structure 5 for sequentially and repeatedly loading each first winding of three spiral shaped channels with food items in liquid media and air phase and for sequentially and repeatedly collecting the food items in liquid media and the air phase from each of the three spiral shaped channels 1. The loading structure 4 comprises an inlet portion 9, an outer collecting portion 10, positioned outside the rotating frame structure, and an inner feeding portion 11 which is at least partially rotating with the frame structure. In this embodiment the outer collecting portion 10 is a static component connected to the partially rotating inner feeding portion 11 which rotates with the helical wound tubing. The loading structure 4 has a separate opening 12 and in-feed pipes 13 for connection to the in-feed end 2 of each of the spiral shaped channels 1. This connection is at the outer periphery of the three spiral shaped channels 1 in the embodiment shown in Fig. 1. The in-feed pipes 13 connect to the openings 12 and form a curved connection to the in-feed end 2 at the outer periphery of each of the three spiral shaped channels. The inlet portion 9 of the loading structure 4 connects to an incoming feeding pipe 14 for pumping up and/or feeding liquid and food items to the pumping device. The inlet portion 9 shown herein has an increasing diameter to connect to the broader diameter outer collecting portion 10. The outer collecting portion 10 has an inlet for the air phase being re-directed from the out-feed structure through the air-duct 6.

The out-feed structure 5 for collecting the food items in liquid media and the air phase from each of the three spiral shaped channels 1 has a mirror design from the in-feed structure comprising an inner out-feed portion 15, an outer (out of frame) collecting

portion 16 and an outlet portion 17. The out-feed device 5 is designed in the same way, but opposite direction, as the in-feed structure, to sequentially and repeatedly exit food items in liquid media and air phase from each last winding 8 of the three spiral shaped channels 1. The out-feed device 5 has a separate opening 18 and out-feed pipes 19 for connection to the out-feed end 3 of each of the three spiral shaped channels 1, where the separate openings 18 of the outfeed collecting structure 5 are formed in the inner out-feed portion 15. The out-feed pipes 19 form a curved connection from the openings 18 to the out-feed end 3 of each of the three spiral shaped channels 1. The inner out-feed portion 15 of the outfeed collecting structure 5 is rotatable around the same central axis as the three spiral shaped channels 1, whereas the outer collecting portion 16 is static and has an outlet for the air phase to the air-duct 6. The outer collecting portion 16 connects to the outlet portion 17 of the outfeed collecting structure 5, which connects to an outlet pipe 20 for liquid and food items and has a decreasing diameter from the outer collecting portion towards the outlet pipe 20.

Figure 3 shows the shape and the connection of the in-feed pipes and the out-feed pipes to each winding of three channels (a, b, c) in a multi-winding pump in the same embodiment as is shown in Fig. 2. The inner feeding portion 11 is partially circular and then starts to form separate openings 12a, 12b, and 12c of the loading device, which are evenly distributed around a 360° circular portion of the inner feeding portion 11. The figure shows the connection of the feeding pipes 12a, 12b and 12c to the in-feed end 2a, 2b and 2c of all three windings. At the out-feed end only connections of one winding (a) is shown to the inner out-feed portion 15. The food items in liquid and the air phase exit the out-feed end 3a into the out-feed pipes 19a and through the opening 18a for feeding into the outer collecting portion 16.

Figure 4 shows the volume capacity of the in-feed or out-feed pipes of the embodiment in Figs 2 and 3. The figure is a transparent and sectional view from the front (A) and from the top (B) and demonstrates the volume capacity (I) of each in-feed pipe 13 for food items and liquid (shaded) in relation to the "working" volume (II) of food items and liquid in a single winding 8 of the pumping device. This drawing indicates that the volume capacity (i) for each in-feed pipe 13 for food items and liquid media, as the channels 1 of the pumping device are rotated a full circle (360°) equals the about 50% of the volume (II) of a winding 8 food items and liquid in a single winding of the pumping device during optimal operation of the pumping device. Figure 4B further demonstrates how the curved in-feed pipes 13 rotate eccentrically around the central axis of the spiral shaped channels 1 of the pumping device. The dotted line indicates the water level in the in-feed structure.

Figure 5 outlines the function of the feeding pipes. In Fig. 5A in-feed pipes 13a and 13b are loading their first windings 8a, 8b with food items in liquid whereas in-feed pipe 13c is filling its first winding 8c with air. In Fig 5B an airlock has formed in winding 8b by the position of in-feed pipe and the water level in the in-feed structure. In Fig. 5C the airlock in winding 8b remains, liquid and food items are flowing into winding 1a and there is a free flow of air into winding 8c. In Fig. 5D there is a free flow of air into winding 8b and winding 8a is being loaded, whereas a water-lock has formed in the in-feed pipe 13 by the position of in-feed pipe 13 and the water level in the in-feed structure. The air in the in-feed pipe 13c is still sufficient to fill the remaining upper portion of winding 8c with air. The air lock and the water-lock are indicated with an elliptical circle in a dotted line in the drawing.

This drawing further outlines how the volume capacity of each in-feed pipe 13 for food items and liquid in relation to the "working" volume of food items and liquid in a single winding of the pumping device is regulated by the water level in the in-feed structure. In a pumping device with a ratio of liquid and food items vs air phase about 50/50, the volume capacity of an in-feeding pipe may be around 50% of the volume of a single winding. As there is a free flow of air/gas into any feeding pipe after it has completed loading a winding with food items and liquid, the feeding pipe will continue and complete filling the upper portion of winding with an air phase before a water lock forms in the in-feed pipe as liquid starts to flow into the in-feed pipe.

Figures 6A and 6B show embodiments for treating food items as they are pumped through a multi-winding spiral pump of the present invention. Figure 6A shows an embodiment where a portion of the liquid used for pumping and treating the food items is redirected to be re-used in the pumping and treatment process. The liquid is re-directed through piping 21 using a heat exchange device 22 to set the temperature of the liquid re-directed to the outer collecting portion 11 of the in-feed structure. A filter device 23 is arranged in the piping to filter the liquid before it enters the heat exchange device 22. A circulation pump 24 is shown to facilitate the circulation of liquid back to the outer collecting portion 11 of the in-feed structure. The figure also shows an item counter 42, such as a fish counter, arranged near the in-feed structure for counting items being fed into the pump.

In Fig. 6B the pumping device is shown in a chamber 26 which is partially filled with liquid 27, such as heating or cooling liquid. The benefits of operating the pumping device in such a chamber are several such as forming a load bearing part of the device. For example, a multi-winding pumping device with high number of windings will be quite heavy and so will pumping devices where the windings are formed from metal.

Figure 7 outlines two embodiments for monitoring and regulating or controlling the re-directed flow or the air phase from the out-feed device 5 back to the loading device 4 in a pumping device. In Fig 7A, the air/gas-duct 6 for re-directing the air/gas phase from the out-feed device 5 back to the loading device 4 is connected to an opening 38 in the outer collecting portion 10 of the loading device 4 and an opening 39 in outer collecting portion 16 of the out-feed device 5. A water level detection device 28 is arranged with the outer collecting portion 10/16 of the loading device 4 and in the out-feed device 5, where a pipe or hose and a sensor are arranged between the upper and lower part of the outer collecting portion 10/16 of the loading device 4 and the out-feed device 5 for detecting or continuously monitoring the water level in the outer collecting portion 10/16. By monitoring the water/liquid level in the outer collecting portion 10 at the in-feed end, the flow of air can be adjusted such that each first winding is fed with about 50% of the volume of food items in liquid based on the interior and openings onto the windings of the pumping device in the rotating inner feeding portion of the in-feed device. The means for regulating the flow or the air phase from the out-feed device 5 back to the loading device 4 further comprises: i) an air release valve 32 ii) a high air compensation device 33 iii) a control valve 34 for air phase circulation, and iv) a low air compensation device 35 arranged in the air/gas-duct 6.

In Fig. 7B another embodiment is shown for monitoring and regulating or controlling the re-directed flow or the air phase from the out-feed device 5 back to the loading device 4 in a pumping device. The air/gas-duct 6 is connected to an opening 38 in the outer collecting portion 10 of the loading device 4 and an opening 39 in outer collecting portion 16 of the out-feed device 5 in the same manner as in the embodiment shown in Fig. 7A. A water level sensing device 29 is associated with the outer collecting portion 10/16 of the loading device 4 and the out-feed device 5. The means for regulating the flow or the air phase from the out-feed device 5 back to the loading device 4 further comprises a low air compensation device (valve) 35 in the out-feed device 5 for additional air input, but this may be useful if air/gas is lost from the system with the out-feed of food items. A high air compensation device (valve) 33 or release valve for excess air is also shown in the out-feed device 5 for exiting excess air which may find its way into the pump in the mass of food items. An air release valve 32 having a water stop function for release of the air phase from the out-feed device without admitting water into the air/gas-duct 6 is arranged at the beginning of air/gas-duct 6. The air phase from the release valve 32 is collected into an air damper or buffer device 36 for managing extra air/gas content and assisting with the regulation of the flow of air phase over to the in-feed device. The means for regulating the flow or the air phase from the out-feed device 5 back to the loading device 4 further comprise a control valve for air circulation and a shut-off valve (not shown) in the air/gas-duct 6.

Figure 8 shows an embodiment of water level sensing device 29 is associated with the outer collecting portion of the loading device and the out-feed device. The figure shows the water level sensing device 29 at the in-feed end where it is connected to the chamber of the outer collecting portion 10 through connections 40, 41. The water level sensing device 29 may also comprise a sensor for detecting the air pressure in the loading device and in the out-feed device to determine the water level in the loading device and in the out-feed device. When the speed of flow is high through the loading device and the out-feed device it may affect the water level measurement. Therefore, a complementary measurement of the water level in the loading device and in the out-feed device may be provided by a measurement of the the air pressure in the loading device and in the out-feed device.

Figure 9 shows an embodiment of crossing the inlet and outlet through the windings of a pumping device's rotating structure. Fig. 9A is a front view and Fig. 9B is a section view of Fig. 9A outlining the connection of the windings to the in-feed and the out-feed devices. The figures shown how the inlet 2 and the outlet 3 ends of a pumping device are threaded through the spiral of the pump such that the in-feed pipes 13 connect to the inner collecting structure 12 of the of the in-feed device though openings 12 in the middle of the pumping device and where the inner collecting structure 12 extends through the last winding 8b of the pumping device. In the same manner the out-feed pipes 19 connect to the inner collecting structure 17 of the of the out-feed device though openings 18 in the middle of the pumping device and where the inner collecting structure 18 extends through the first winding 8a of the pumping device. In Figs. 9C and 9D this embodiment is outlined in a back view of the pumping device showing the in-feed structure and the threading of the out-feed pipes 19 in between the windings of the pump.

As used herein, including in the claims, singular forms of terms are to be construed as also including the plural form and vice versa, unless the context indicates otherwise.

Thus, it should be noted that as used herein, the singular forms "a," "an," and "the" include plural references unless the context clearly dictates otherwise.

Throughout the description and claims, the terms "comprise", "including", "having", and "contain" and their variations should be understood as meaning "including but not limited to", and are not intended to exclude other components.

The present invention also covers the exact terms, features, values and ranges etc. in case these terms, features, values and ranges etc. are used in conjunction with terms

such as about, around, generally, substantially, essentially, at least etc. (i.e., "about 3" shall also cover exactly 3 or "substantially constant" shall also cover exactly constant).

The term "at least one" should be understood as meaning "one or more", and therefore includes both embodiments that include one or multiple components. Furthermore,
5 dependent claims that refer to independent claims that describe features with "at least one" have the same meaning, both when the feature is referred to as "the" and "the at least one".

It will be appreciated that variations to the foregoing embodiments of the invention can be made while still falling within the scope of the invention. Features disclosed in the
10 specification, unless stated otherwise, can be replaced by alternative features serving the same, equivalent or similar purpose. Thus, unless stated otherwise, each feature disclosed represents one example of a generic series of equivalent or similar features.

Use of exemplary language, such as "for instance", "such as", "for example" and the like, is merely intended to better illustrate the invention and does not indicate a limitation on
15 the scope of the invention unless so claimed. Any steps described in the specification may be performed in any order or simultaneously, unless the context clearly indicates otherwise.

All of the features and/or steps disclosed in the specification can be combined in any combination, except for combinations where at least some of the features and/or steps
20 are mutually exclusive. In particular, preferred features of the invention are applicable to all aspects of the invention and may be used in any combination.

Claims

1. An apparatus for transferring and/or treating food items in liquid media, the apparatus comprising:
 - two or more channels 1 each comprising an in-feed end 2 and an out-feed end 3, wherein of the two or more channels are wound in parallel into a spiral shaped channel having three or more windings 8 to be rotated around a central axis,
 - a loading device 4 for sequentially and repeatedly loading each first winding 8 of the two or more spiral shaped channels 1 with food items in liquid media and air phase,
 - an out-feed device 5 for sequentially and repeatedly collecting the food items in liquid media and the air phase from each of the two or more spiral shaped channels 1,
 - an air/gas-duct 6 for re-directing the air/gas phase from the out-feed device 5 back to the loading device 4,
 - means for rotating the two or more spiral shaped channels 1,

characterised in that the apparatus further comprises means for detecting the water level 28/29 in the loading device 4 and in the out-feed device 5.
2. The apparatus according to claim 1, wherein the means for detecting the water level 28/29 in the loading device 4 and in the out-feed device 5 comprises a pipe or hose and a sensor between the upper and lower part of the loading device 4 and the out-feed device 5.
3. The apparatus according to claim 1, wherein the means for detecting the water level 28/29 in the loading device 4 and in the out-feed device 5 further comprises means to determine the air pressure in the loading device 4 and in the out-feed device 5.
4. The apparatus according to claim 1, wherein the means for detecting the water level 28/29 in the loading device 4 and in the out-feed device 5 is positioned in the outer collecting portion 10/16 of the loading device 4 and the out-feed device 5.
5. The apparatus according to claim 1, wherein the apparatus further comprises means for monitoring and regulating the re-directed flow or the air phase from the out-feed device 5 back to the loading device 4.

6. The apparatus according to claim 5, wherein the means for regulating the flow of air redirected from the out-feed device 5 back to the loading device 4 comprises one or more of:
- low air compensation device/additional air input valve 35,
 - control valve for air circulation 34,
 - high air compensation device/release valve for excess air 33,
 - air release valve/water stop 32
 - air damper/buffer device 36, and
 - shut-off valve 37.
7. The apparatus according to claim 1, wherein the loading device 4 further comprises a separate opening 12 and in-feed pipes 13 for connection to the in-feed end 2 of each of the two or more spiral shaped channels 1.
8. The apparatus according to claim 7, wherein the volume capacity for each in-feed pipe 13 for food items and liquid media in a 360° rotation of the two or more spiral shaped channels 1 equals about 50% of the volume of a one winding 8.
9. The apparatus according to claim 7, wherein the volume of each in-feed pipe 13 equals the volume of food items in liquid to be fed into each winding of the two or more channels.
10. The apparatus according to claim 7, wherein the in-feed pipes 13 are curved and rotate eccentrically to the central axis of the two or more spiral shaped channels 1.
11. The apparatus according to claim 7, wherein the loading structure 4 further comprises guiding means for guiding the food items in liquid media into infeed end of each of the two or more spiral shaped channels 1.
12. The apparatus according to claim 1, wherein the loading structure 4 comprises i) an inlet portion 9, ii) an outer (out of frame) collecting portion 10 and iii) an inner feeding portion 11.
13. The apparatus according to claim 1, wherein the apparatus further comprises an out-feed device 5 for collecting the food items in liquid media and the air phase from each of the two or more spiral shaped channels 1, wherein the out-feed device 5 is a mirror design of the in-feed structure.
14. The apparatus according to claim 1, wherein the apparatus further comprises piping 21 for re-directing the liquid from the out-feed device 5 back to the loading device 4.

15. The apparatus according to claim 1, wherein one or more of the pumping devices is arranged to thread the in-feed end through the centre space of the windings to enter by the last winding of the pumping device and wherein the out-feed end is threaded through the centre space of the windings to enter by the first winding of the pumping device.

16. A method for transferring and/or treating food items in liquid media, the method comprising:

a) providing a pumping device, said spiral pump comprising:

- two or more channels 1 each comprising an in-feed end 2 and an out-feed end 3, wherein of the two or more channels are wound in parallel into a spiral shaped channel having three or more windings 8 to be rotated around a central axis,
- a loading device 4 for sequentially and repeatedly loading each first winding 8 of the two or more spiral shaped channels 1 with food items in liquid media and air phase,
- an out-feed device 5 for sequentially and repeatedly collecting the food items in liquid media and the air phase from each of the two or more spiral shaped channels 1,
- an air/gas-duct 6 between the out-feed device 5 and the loading device 4,
- means for rotating the two or more spiral shaped channels 1,

b) rotating the two or more spiral shaped channels 1 360° such that each first winding 8 of the two or more spiral shaped channels 1 is fed with food items in liquid media,

c) at the same time re-directing the air/gas phase from the out-feed device 5 back to the loading device 4 such that each first winding 8 of the two or more spiral shaped channels 1 is fed with an air phase during the same 360° rotation as in step b),

d) sequentially performing step b) and c) for the number of spiral shaped channels 1 of the apparatus,

e) repeating step b to d) while there are food items to be feed into the apparatus,

characterised in that the method further comprises the step of monitoring and regulating the water level in the loading device and in the out-feed device by a means for detecting the water level 28/29 in the loading device 4 and in the out-feed device 5.

17. The method according to claim 16, wherein the loading device 4 further comprises a separate opening and in-feed pipes for connection to the in-feed end 2 of spiral shaped channel, and wherein the volume capacity for in-feeding of the food items and liquid media in each in-feed pipe during a 360° rotation of the two or more spiral shaped channels 1 equals the desired ratio of food items in liquid and air phase.
18. The method according to claim 16, wherein the water level in the loading device and in the out-feed device is monitored and adjusted continuously to maintain feeding of both food items in liquid and air phase into each of the two or more spiral shaped channels at the desired ratio.
19. The method according to claim 16, wherein further pumping device further comprises means for regulating the flow of air redirected from the out-feed device 5 back to the loading device 4, and wherein the method comprises using means for monitoring and regulating the flow of air redirected from the out-feed device 5 back to the loading device 4 to adjust the water level such that each first winding is fed with a desired ratio of food items in liquid vs air phase.
20. The method according to claims 17-19, wherein the adjustment of the water level is determined such that the position and shape of an in-feed pipe and the water level in the in-feed structure generates an air-lock when the feeding pipe is no longer able to deliver liquid into the first winding at the end of loading a winding.
21. The method according to claims 17-19, wherein the adjustment of the water level is determined such that the position and shape of an in-feed pipe and the water level in the in-feed structure generates a water-lock when the feeding pipe is no longer able to provide a free flow of air into the first winding during loading the upper portion of a winding with air phase.
22. The method according to the claim 16, wherein the speed of rotation is altered at least once for the number of spiral shaped channels 1.
23. The method according to claim 16, wherein the speed of rotation is altered two times or more for each spiral shaped channel 1 in the apparatus.

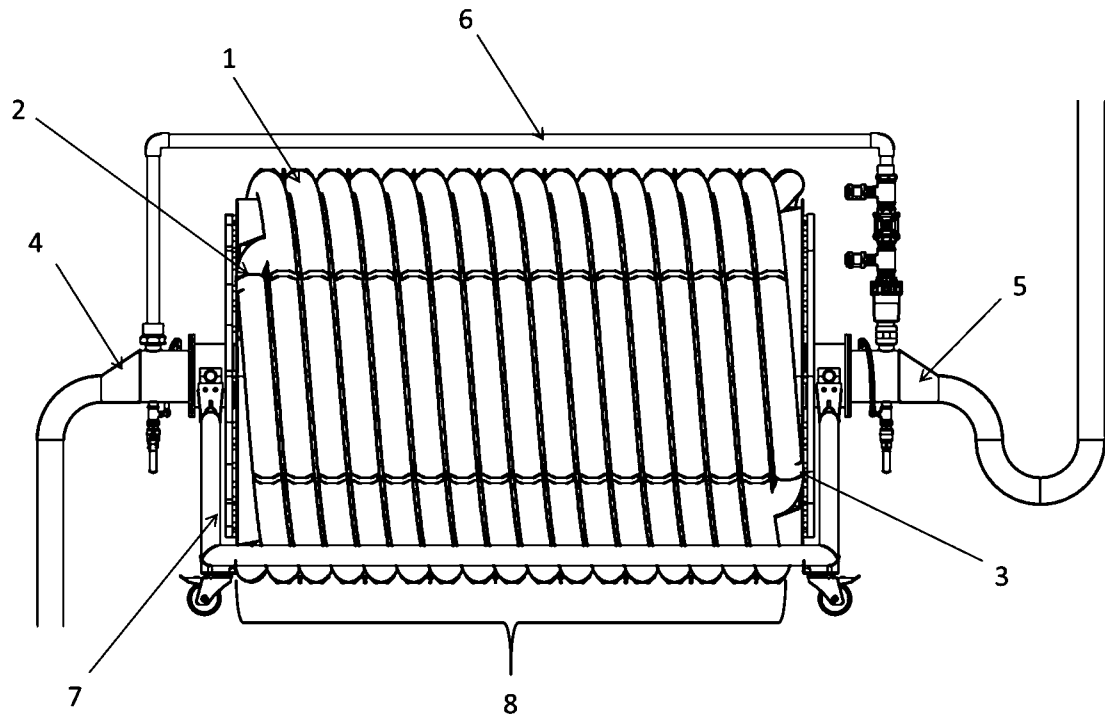


Fig. 1

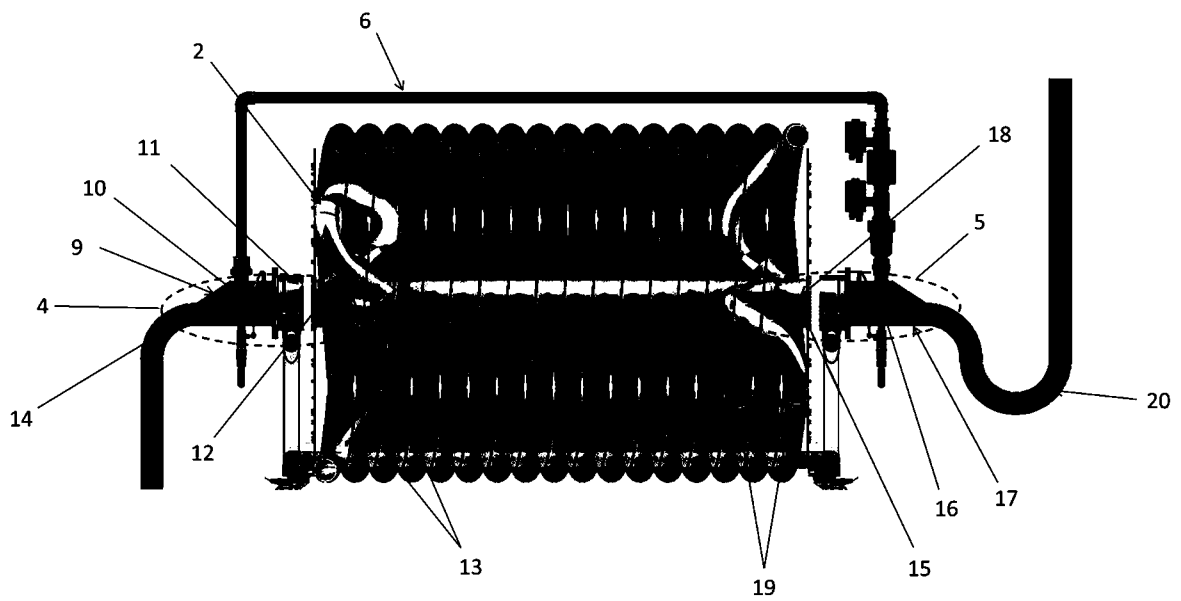


Fig. 2

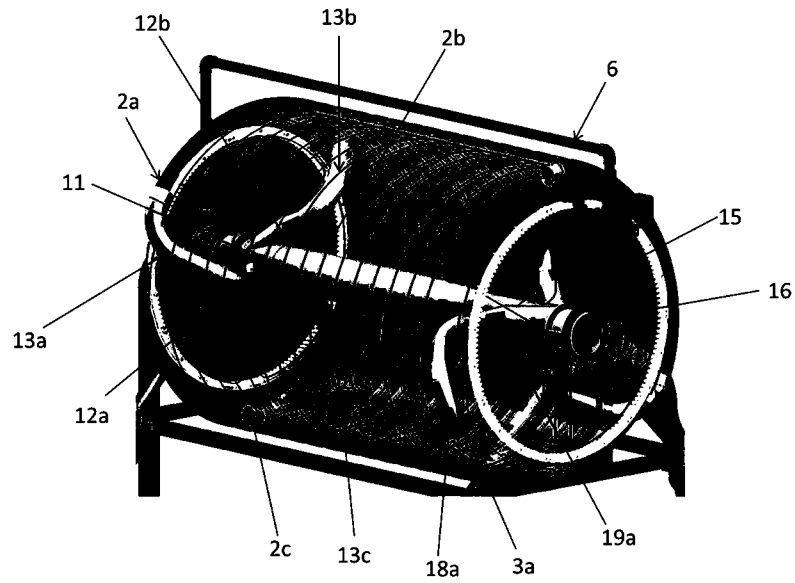


Fig. 3

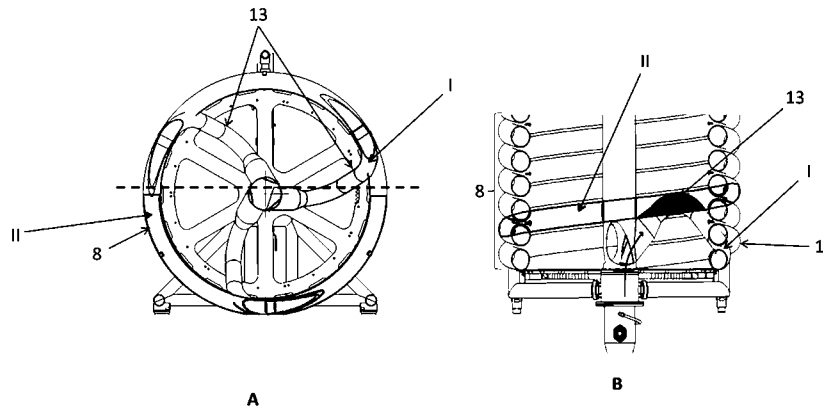


Fig. 4

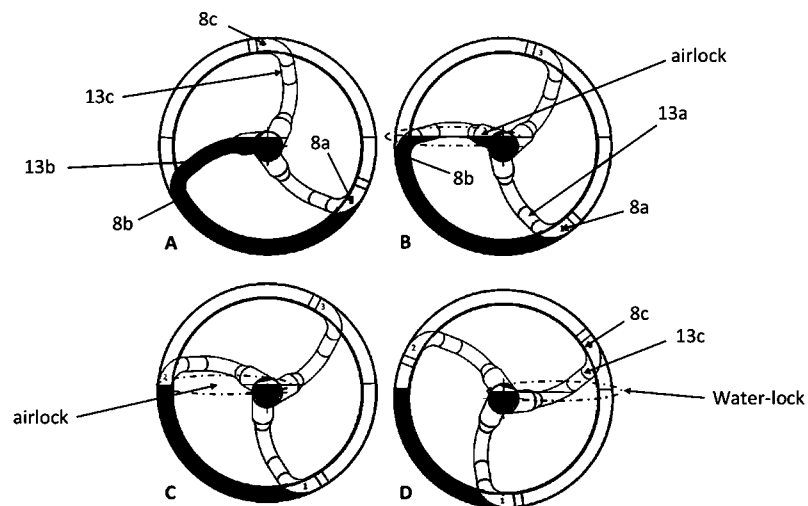


Fig. 5

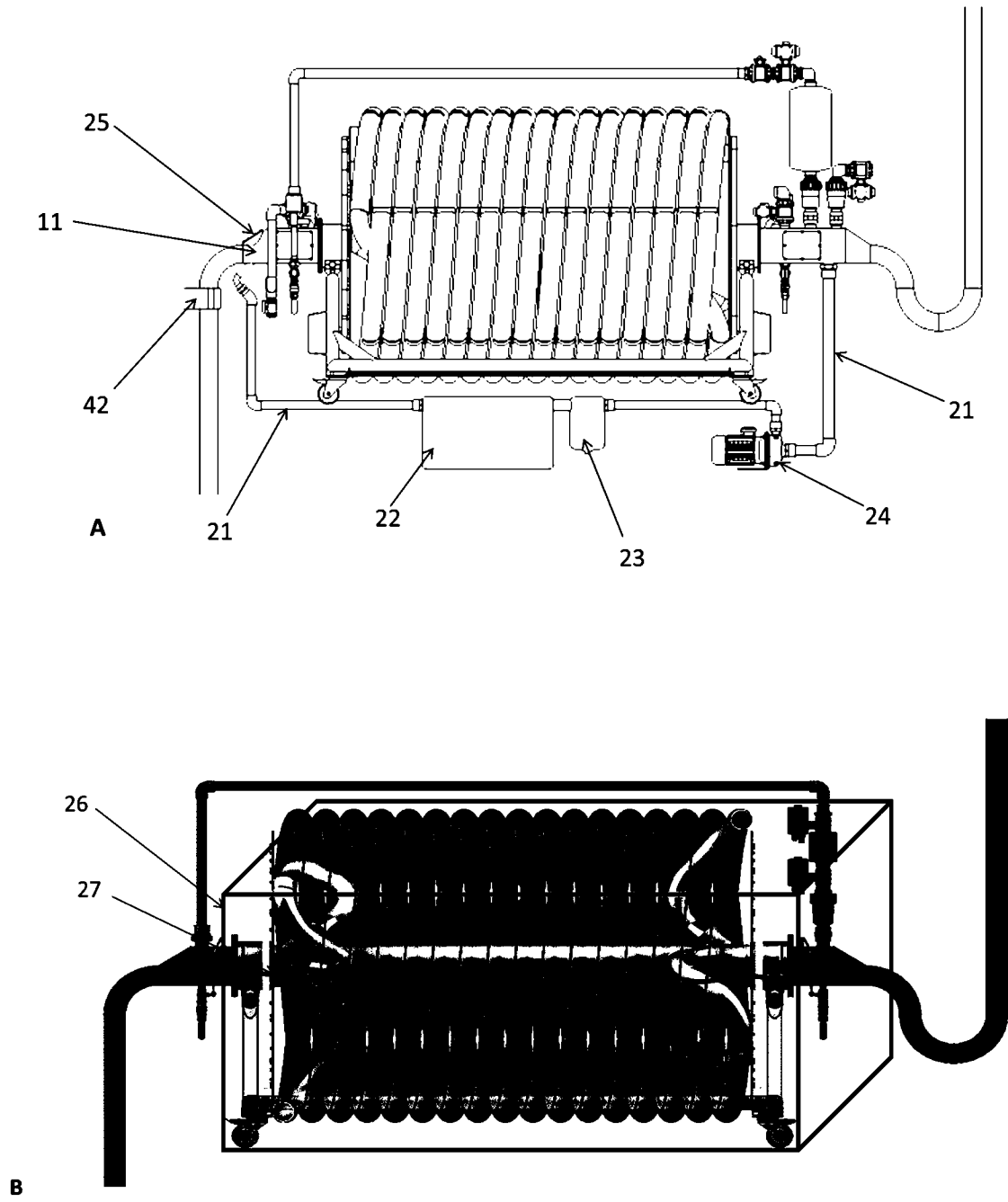


Fig. 6

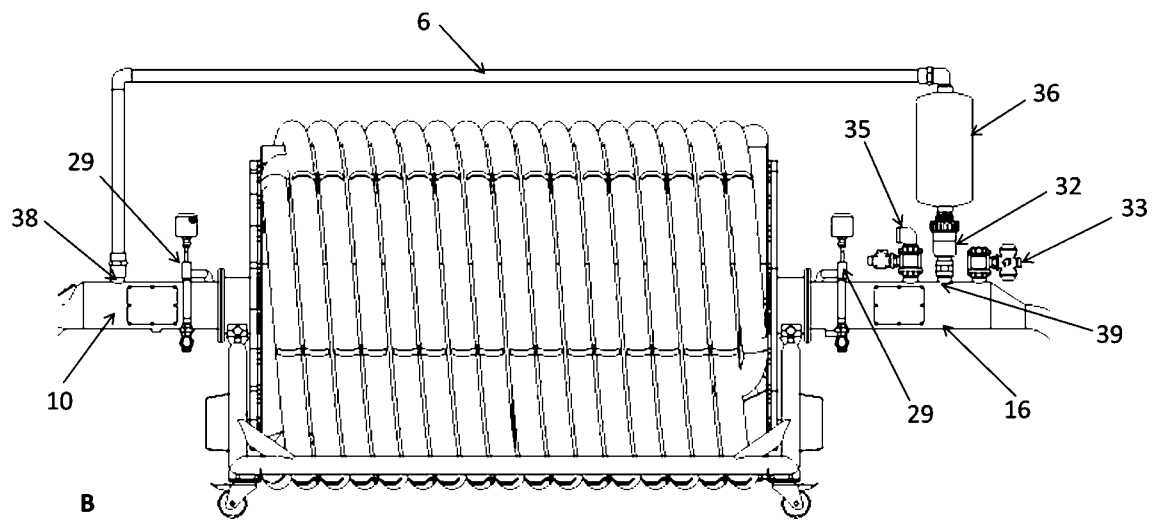
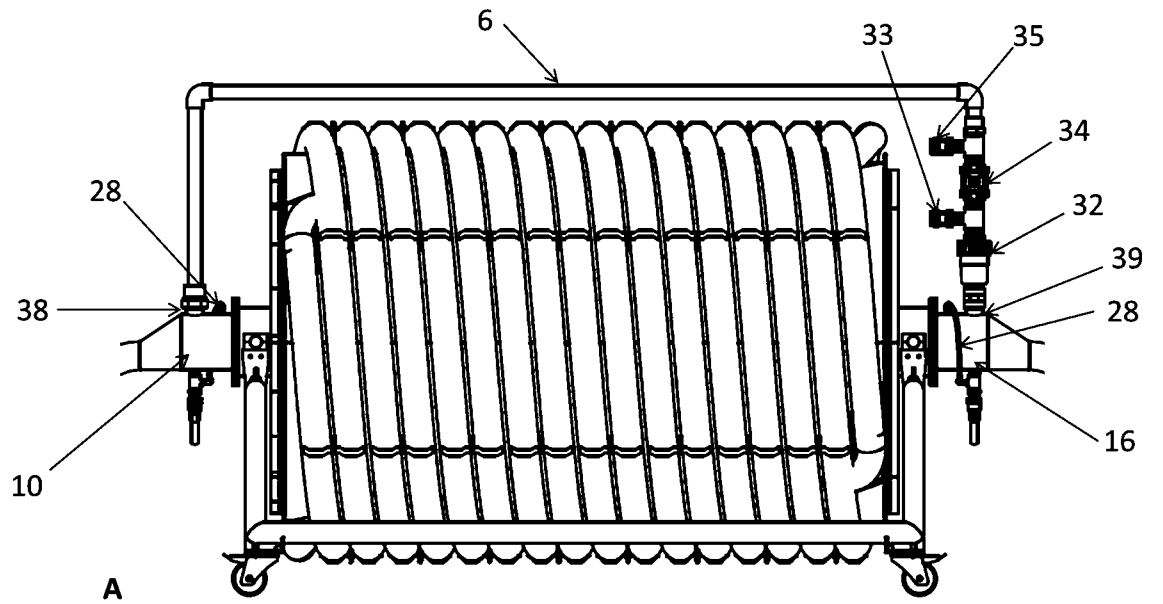


Fig. 7

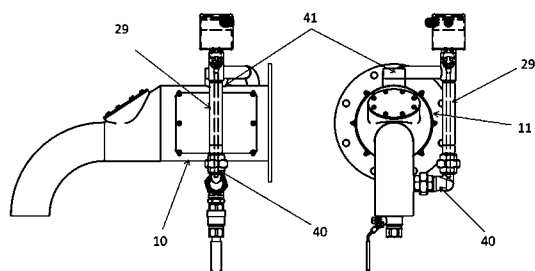


Fig. 8

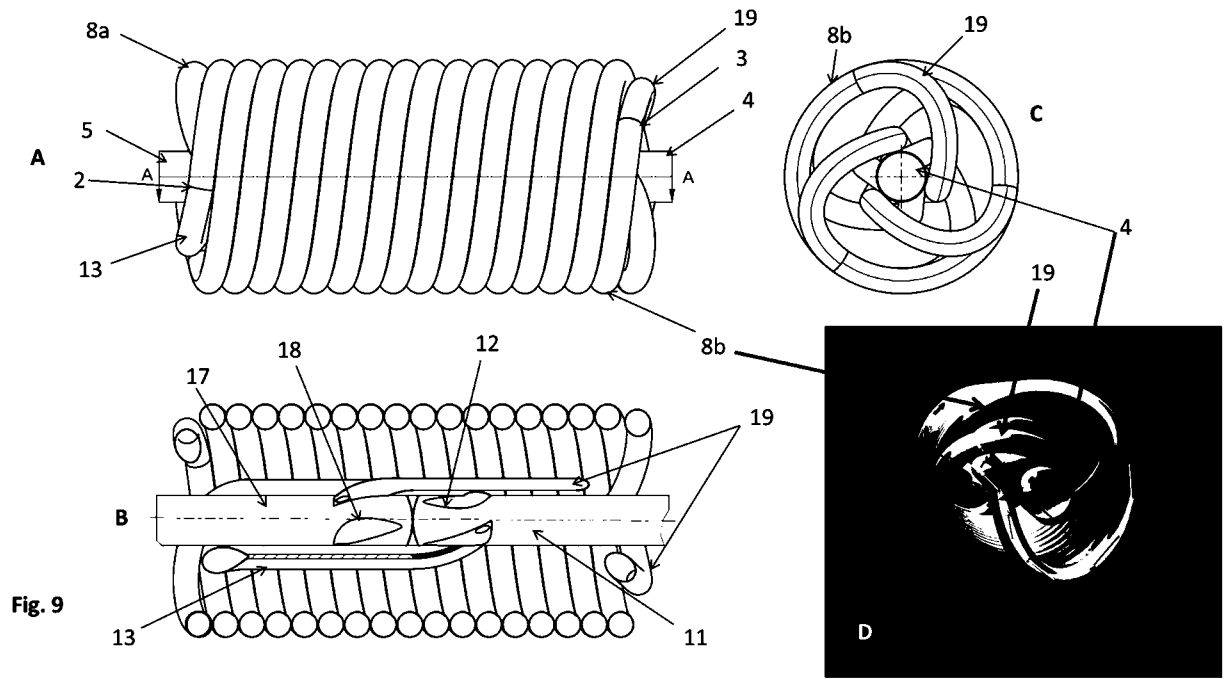


Fig. 9