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(54) **COLLECTOR PIPE FOR A HEAT EXCHANGER DEVICE, A HEAT EXCHANGER DEVICE AND A METHOD FOR EMPTYING A HEAT EXCHANGER DEVICE**

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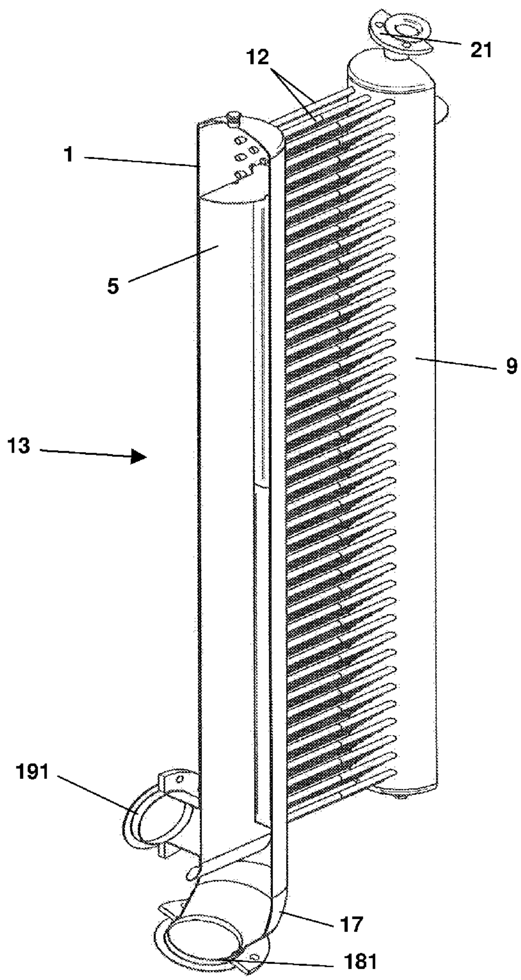
(57) **ABSTRACT**

A collection tube for a heat exchanger apparatus includes an outflow opening, an inflow opening, a plurality of deflection openings, and a separation element. The separation element is configured and arranged in the collection tube to divide the collection tube into an outflow region in which the outflow opening is arranged, an inflow region in which the inflow opening is arranged, and a first deflection region in which the deflection openings are arranged, the separation element being arranged with respect to a collection tube axis such that the separation element encloses an angle with the collection tube axis, the collection tube axis extending in an axial longitudinal direction of the collection tube.



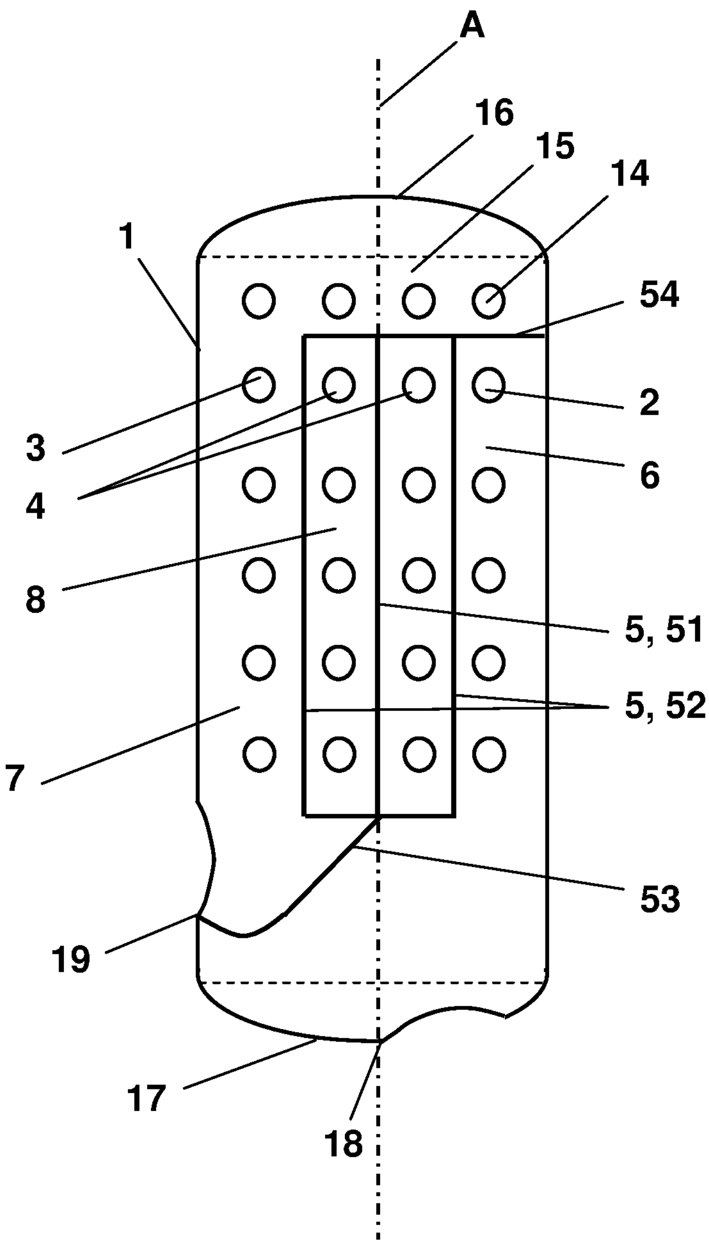


Fig. 1

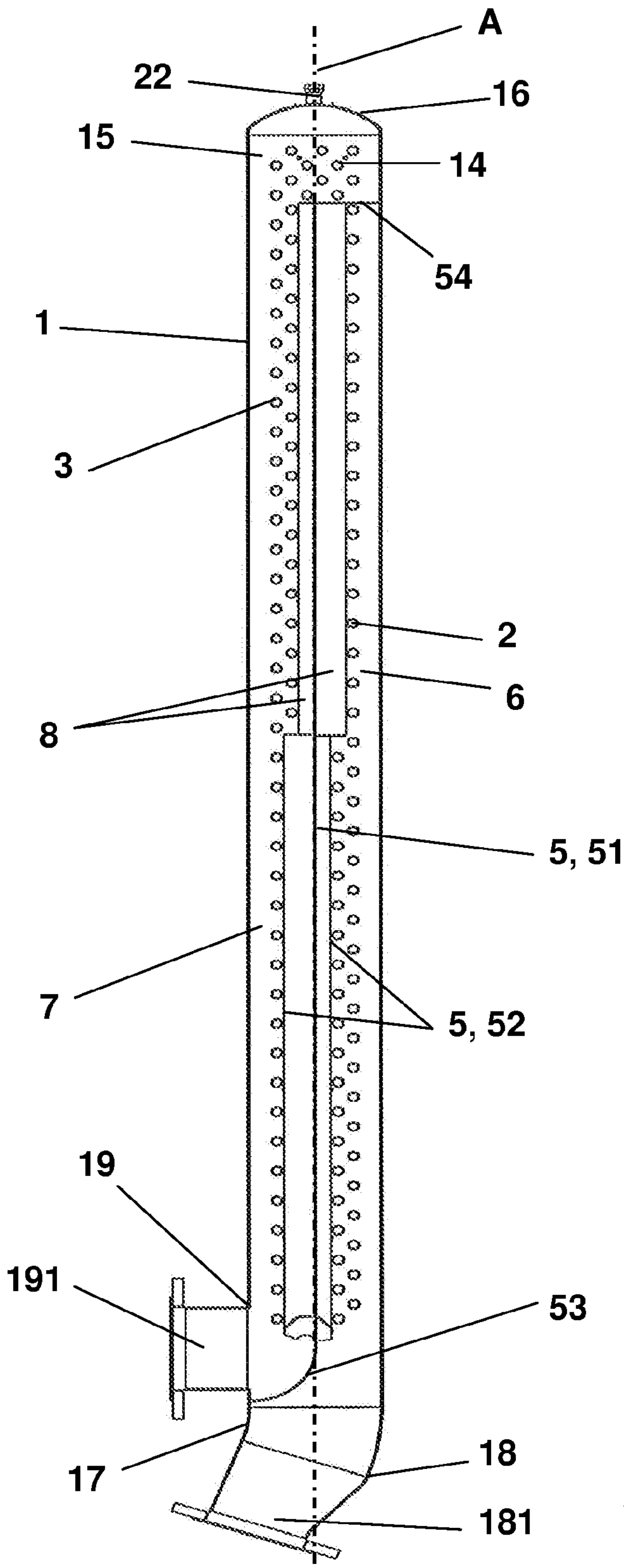


Fig. 2

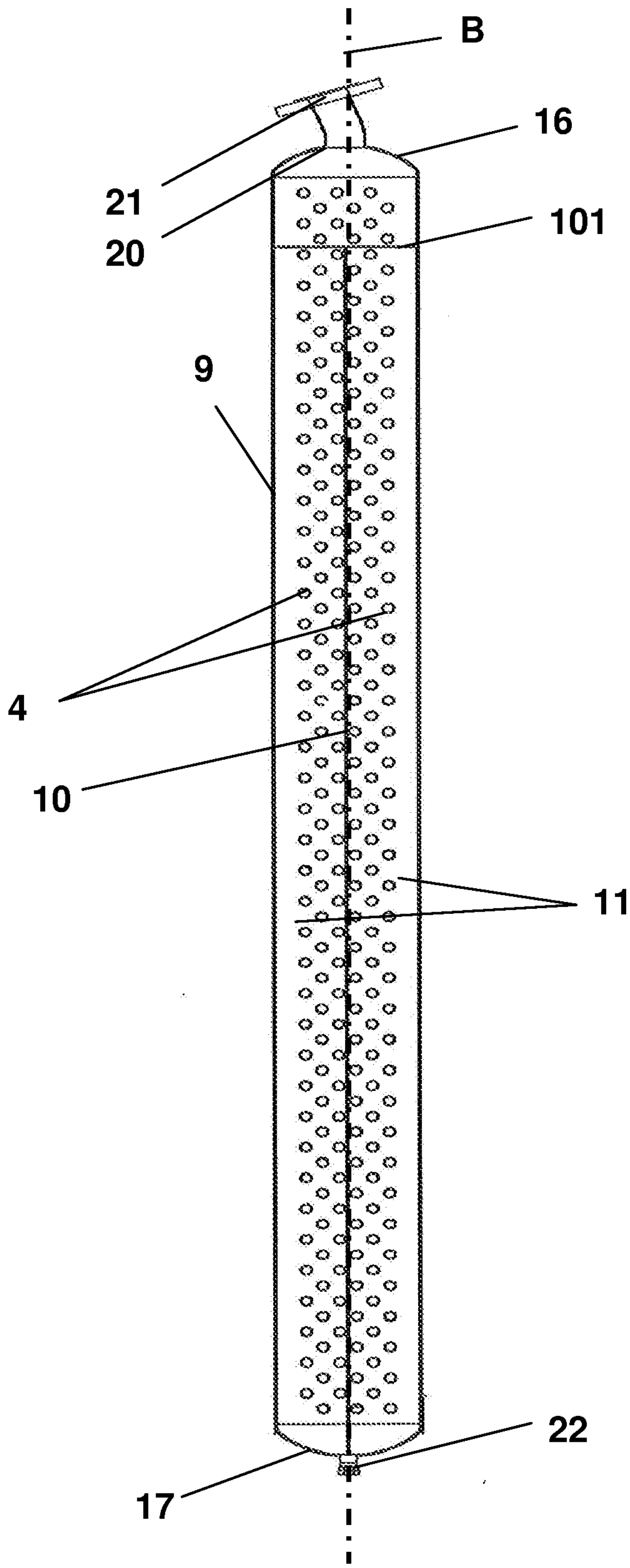


Fig. 3

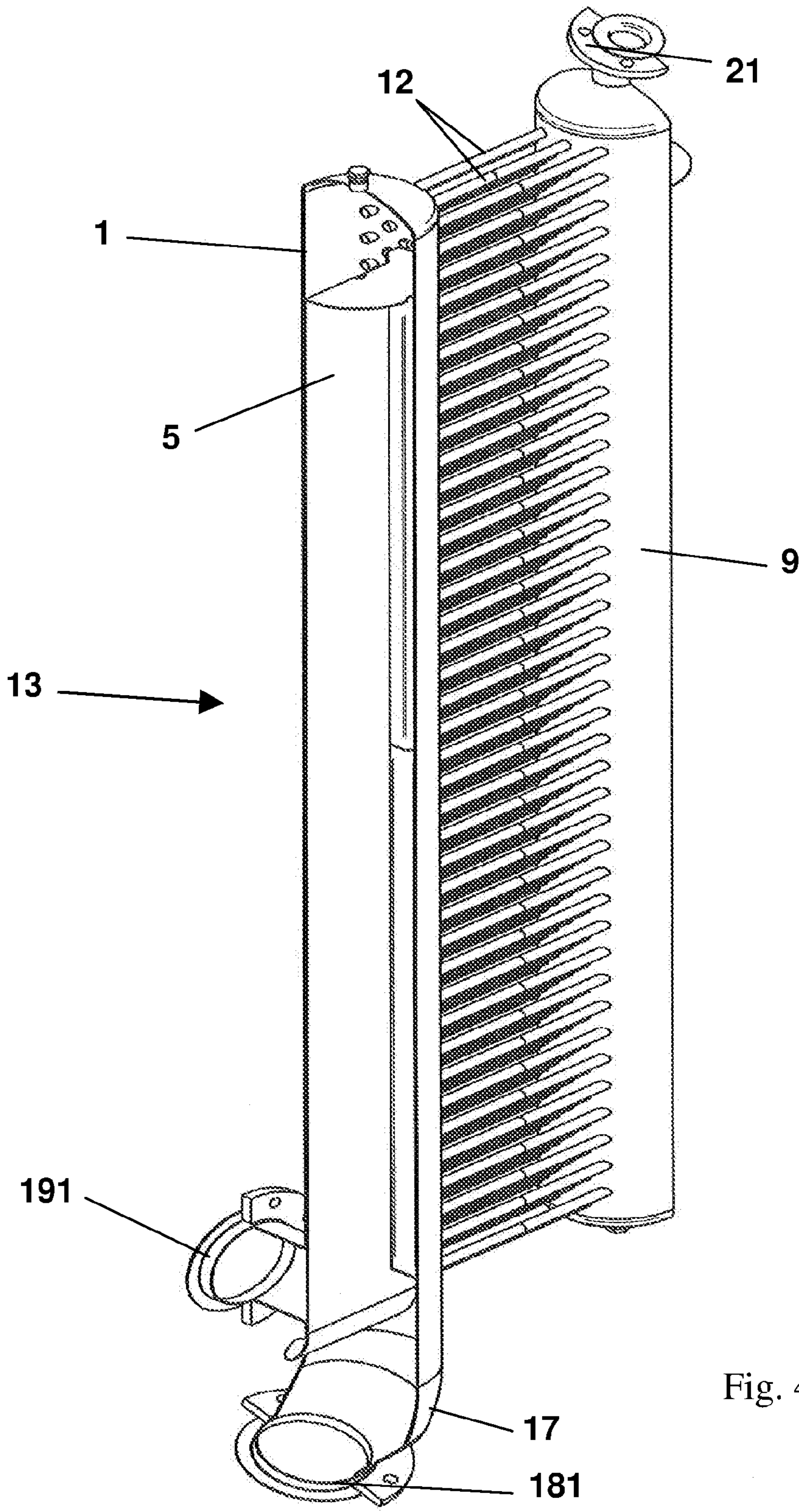


Fig. 4

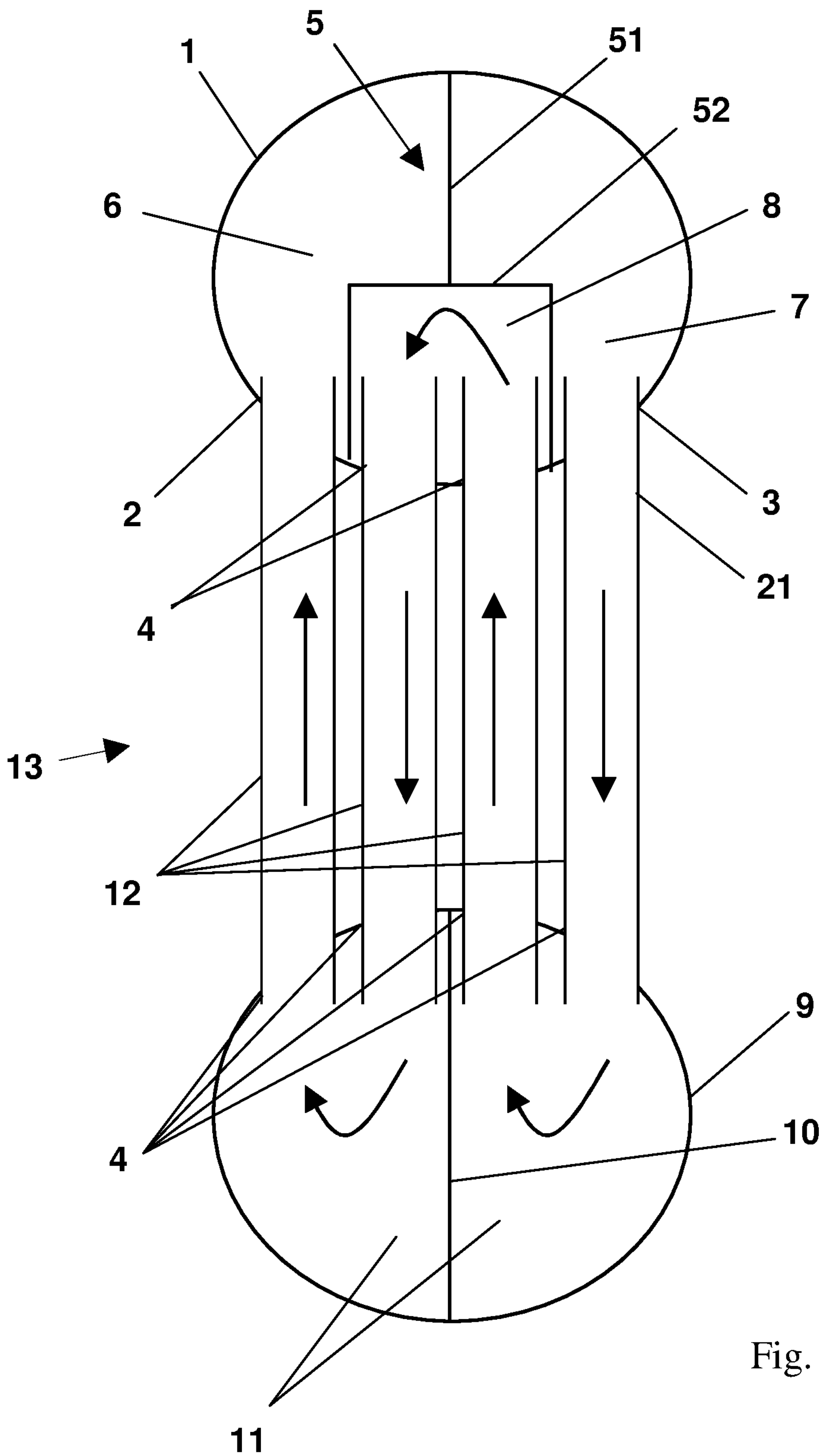


Fig. 5

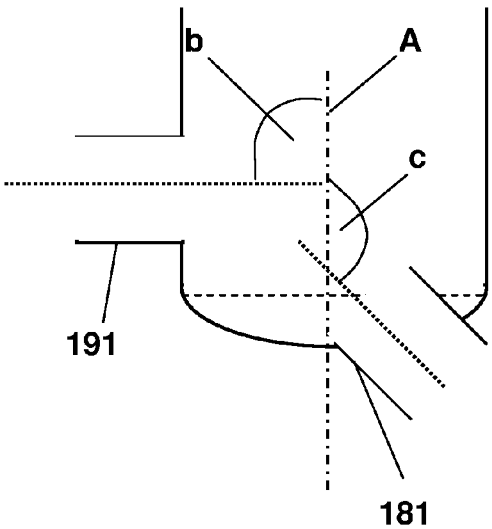


Fig. 6A

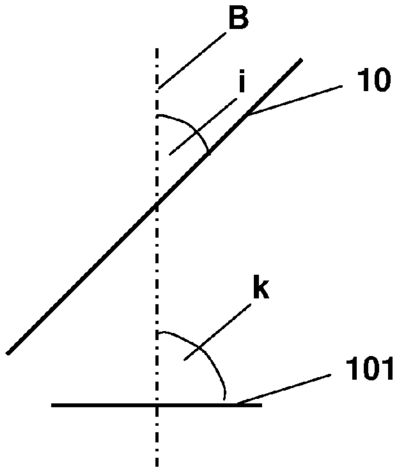


Fig. 6B

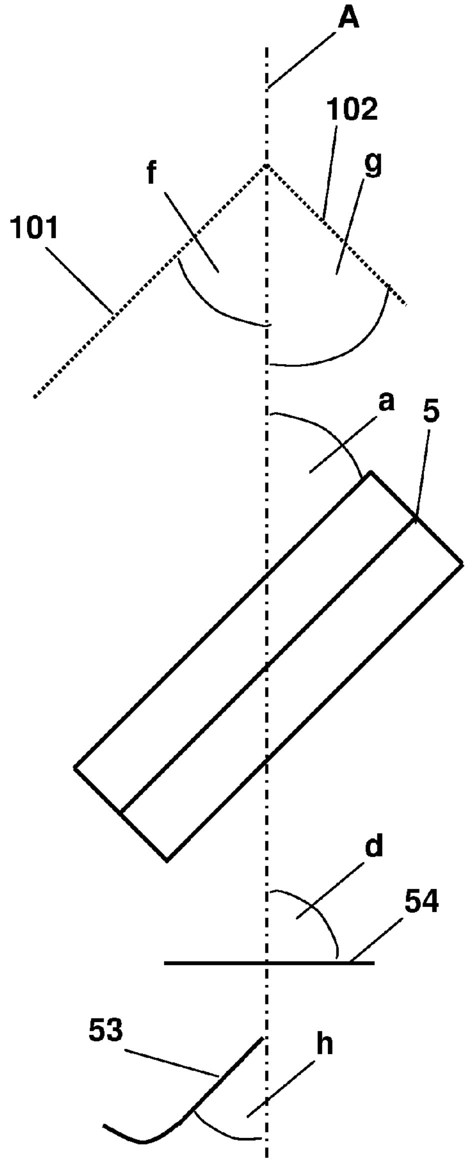


Fig. 6C

COLLECTOR PIPE FOR A HEAT EXCHANGER DEVICE, A HEAT EXCHANGER DEVICE AND A METHOD FOR EMPTYING A HEAT EXCHANGER DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a U.S. National Stage Application of International Application No. PCT/EP2014/063703, filed Jun. 27, 2014, which claims priority to European Application No. 13177985.2, filed Jul. 25, 2013, the contents of each of which is hereby incorporation herein by reference.

BACKGROUND

[0002] 1. Field of Invention

[0003] The invention relates to a collection tube for a heat exchanger apparatus, to a heat exchanger apparatus and to a method of emptying a heat exchanger apparatus.

[0004] 2. Background Information

[0005] Heat exchanger apparatuses are found in a plurality of technical applications, for example, in cooling systems and cooling apparatuses for cooling rooms or for household fridges, in heating and air conditioning systems for houses, or for means of transport, such as, for example, cars, busses, ships and airplanes, or as coolers in power plants, combustion motors, computers or other installations producing heat. When used in practice, the heat exchanger apparatuses are frequently connected to a circuit which includes a fluid, such as a heat transfer medium, for example a coolant, wherein the heat exchanger apparatuses can directly absorb heat from the fluid or gas-like fluid or output this to the same. In other words, the heat transfer medium can absorb heat from the fluid or gas-like fluid or output this to the same without a phase transition or can also be effective as a condenser or as an evaporator for the fluid.

[0006] A commonly used design is the finned heat exchanger apparatus. In the most simple case, a finned heat exchanger apparatus is composed of a tube for conducting through a fluid and of a plurality of fins which are connected to the tube and which are in contact with a second medium during operation. This manner of construction is particularly useful when the second medium is gaseous and is, for example composed of environmental air, since this has a comparatively low heat transfer coefficient which can be compensated by a correspondingly large surface of the fins. Naturally, the finned heat exchanger apparatus can also include a plurality of tubes for more than one fluid or the tubes can be connected in parallel to one another and/or in series to one another in dependence on the requirement.

SUMMARY

[0007] The degree of efficiency is decisively determined by the temperature difference between the fins, on the one hand, and the tube or the tubes, on the other hand. The temperature difference is all the more smaller the larger the conductivity and the thickness of the fins is and the smaller the mutual spacing of the tubes is, this means the heat transfer is all the more effective the smaller the temperature difference is. With respect to the degree of efficiency it is thus advantageous when many tubes are used. However, many tubes also means higher costs of material and processing so that a higher degree of efficiency is normally associated with higher costs.

[0008] The well-known finned heat exchanger apparatus, like all types of heat exchanger apparatus, serves for the transfer of heat between two media, e.g. for the transfer from a fluid to air or vice versa, such as it is, for example, known for a classical household fridge in which heat is output to the environmental air for the generation of a cooling performance in the interior of the fridge via the heat exchanger apparatus. The second medium outside of the heat exchanger apparatus, this means e.g. water, oil or frequently simply the environmental air which, for example, takes up the heat or from which the heat is transferred to the heat exchanger apparatus is in this connection either correspondingly cooled or heated. In each case the second medium, this means e.g. the air, has a significantly lower heat transfer coefficient than the fluid, this means the heat transfer medium, e.g. the coolant, which circulates in the heat exchanger apparatus. This is compensated by severely different heat transfer surfaces for the two media: The medium having the high heat transfer coefficient flows in the tube which has a strongly increased surface at the outer side by means of thin sheet metal parts (ribs, fins) at which the heat transfer e.g. with the air takes place.

[0009] The manufacture of these so-called finned heat exchanger apparatuses takes place in accordance with a standardized process known for a long time: The fins are stamped by means of a press and a special tool and are placed in packages with respect to one another. Subsequently, the tubes are inserted and are either mechanically or hydraulically widened such that good contact and thus good heat transfer arises between the tube and the fins. The individual tubes are then connected to one another by arcs and collector tubes as well as distributor tubes, frequently by welding.

[0010] The degree of efficiency is in this connection essentially determined by the fact that the heat which is transferred between the surface of the fins and the air must be transferred via heat conduction through the fins to the tube. For an as high as possible degree of efficiency the tube spacing should be as small as possible which, however, leads to the problem that many tubes are required. However, many tubes also means higher costs, since the tubes (generally made of copper) are considerably more expensive than the thin fins.

[0011] Moreover, a plurality of tubes, in particular having many windings and many arcs in many applications, for example as coolers in power plants, can have the effect that the heat exchanger apparatus cannot be completely emptied during the idle time which is, however, an essential requirement for an application in these fields.

[0012] For this reason it is an object of the present invention to suggest a collection tube, in particular for a heat exchanger apparatus which has a functional division and/or can be manufactured in a more simple manner and/or a more cost-effective manner and is optimized for the respective application.

[0013] This object is satisfied by a collection tube for a heat exchanger apparatus described herein, by a heat exchanger apparatus described herein and by a method of emptying a heat exchanger apparatus described herein.

[0014] In accordance with the invention, a collection tube for a heat exchanger apparatus is suggested, wherein the collection tube comprises an outflow opening, an inflow opening and a plurality of deflection openings and wherein a collection tube axis is configured in an axial longitudinal direction of the collection tube. The collection tube comprises a separation element, wherein the separation element is configured and arranged in the collection tube in such a way that the separation element divides the collection tube into an outflow region in which the outflow opening is arranged, into an inflow region in which the inflow opening is arranged and into a first deflection region in which the deflection openings are arranged. In this connection, the separation element is arranged with respect to the collection tube axis such that the separation element encloses an angle a with respect to the collection tube axis.

[0015] The collection tube can, for example be a tubular hollow body, preferably, but not necessarily having a circular, elliptical or polygonal base surface. Also the collection tube can be configured as a substantially hollow cylindrical tube which is open at a first and at a second axial end. The collection tube axis can be configured in an axial longitudinal direction of the collection tube, preferably by the geometric center of the two base surfaces of the collection tube.

[0016] The collection tube comprises the outflow opening, the inflow opening and a plurality of deflection openings. The outflow opening or the inflow opening or the deflection opening can, for example, be a bore or an aperture in a jacket surface of the collection tube which can be uniform, this means cylindrical, elliptical or polygonal. An inner cross-section of the inner bounding surface of the outflow opening or of the inflow opening or of the deflection opening can be uniform, for example rectangular or non-uniform, this means it can, for example, be of convex or of concave design. A plurality of tubes which can be arranged at the outflow opening or at the inflow opening or at the deflection opening can, for example, be radially centrally arranged with respect to the collection tube axis, but preferably precisely do not stand perpendicular to the outer jacket surface, i.e., are not radially, centrally arranged with respect to the collection tube axis. Different outflow openings, or inflow openings or deflection openings can have a like inlet cross-section and/or diameter or a like outlet cross-section and/or diameter; however, preferably these have a different like inlet cross-section and/or diameter or outlet cross-section and/or diameter. Advantageously, a fluid can thus flow out of the tubes in a better manner in this way.

[0017] The outflow opening or the inflow opening or the deflection opening can be arranged such that openings of the same category are arranged in a first plane, for example having the same spacing between the openings. The first plane can in this connection include an angle f of 0 to 50 degrees with respect to the collection tube axis, preferably an angle f of 0 to 30 degrees, particularly preferably of 0 degrees, this means it can be arranged in parallel to the collection tube axis. Openings of different categories can be arranged next to one another, preferably having the same spacing between the openings, at a second plane. The second plane can include an angle g of 40 to 90 degrees with respect to the collection tube axis, preferably an angle of 70 to 90 degrees, particularly an angle of 90 degrees, this means it can be arranged perpendicular to the collection tube axis. A plurality of first planes can, for example, be arranged in parallel to one another and from a first stack of planes and/or a plurality of second planes can, for example, be arranged in parallel to one another and form a second stack of planes. The outflow opening or the inflow opening or the deflection opening can, however, also be arranged arbitrarily displaced with respect to one another.

[0018] The separation element can be a film-like material, for example, a sheet metal part, wherein the material can, for example, be a metal or a metal alloy, a stainless steel or a plastic. The film-like material is advantageously composed of a pressure stable material, for example a metal alloy. The thickness of the film-like material can, for example, lie in a range of between 2 and 10 mm.

[0019] The separation element can comprise a separation section and a deflection section. The separation section can, for example, have a rectangular shape and can be formed as a planar sheet metal part. The deflection section can have an open polygonal, this means, for example, a triangular or square or a semi-circular internal cross-section and, for example, be configured as a U-shaped sheet metal part or as a groove. The separation element, this means the deflection section and the separation section can have a Y-shaped inner cross-section, wherein the deflection section can be symmetrically or asymmetrically arranged with respect to the separation section. Likewise the separation section and the deflection section can be of one-part design or of multi-part design. The separation element can also be of one-part design or of multi-part design. The complete separation element can, however, also be configured as a rectangular, singularly or multiply folded sheet metal part arranged in parallel to the collection tube axis. The separation element can have a leakage opening, in particular at the boundaries of the separation element, for example, round or polygonal gaps, grooves or tubular connection elements, through which, for example, a pressure compensation can take place, this means through which a fluid can flow.

[0020] The separation element can be arranged in the collection tube and can, for example, be displaced in an axial direction and can be rotationally symmetric with respect to the collection tube axis. The separation element can, however, also be arranged arbitrarily displaced with respect to the collection tube axis so that an arbitrary arrangement is possible within the collection tube. The separation element can be arranged with respect to the collection tube axis in such a way that the separation element encloses an angle a with regard to these collection tube axis. The separation element can include an angle a of 0 to 40 degrees, preferably of 0 to 30 degrees with respect to the collection tube axis. In particular, the separation element having the separation section can be aligned along the collection tube axis, for example, it can be aligned in parallel so that the angle a is 0 degrees. The separation section of the separation element can be aligned precisely at the collection tube axis, this means that the collection tube axis can lie in the separation element over a complete collection tube length. The separation element can be fastened at the collection tube, for example the separation element can be welded to the collection tube or it can be adhesively bonded to the collection tube. The separation element can, however, also be connected to the collection tube by means of a fastening element, for example, the separation element can be arranged in a guiderail in the collection tube or it can be clamped, stapled or screwed in the collection tube. The separation element can, however, also be arranged without fastening elements in the collection tube.

[0021] The separation element is configured and arranged in the collection tube in such a way that the separation element divides the collection tube into an outflow region in which the outflow opening is arranged, into an inflow region in which the inflow opening is arranged and into a first deflection region in which the deflection openings are arranged. The separation elements can divide the first stack of planes in the collection tube into a plurality of spatially separate first planes having outflow openings, having inflow openings and having deflection openings. The separation element can thus advantageously divide the collection tube into a plurality of functional regions so that a plurality of functions, for example, a deflection of the fluid, as well as an inflow and an outflow of the fluid can be realized in a collection tube.

[0022] A fluid, this means a heat transfer medium, for example a coolant, can flow in the collection tube. Due to the collection tube in accordance with the invention the fluid can, for example, only flow in a certain region in a preferably constrained direction. In the outflow region the fluid can, for example, flow in the direction of an outflow opening or of the first or of the second axial ends of the collection tube. In the inflow region the fluid can, for example, flow from the direction of an inflow opening or from the first or from second axial ends of the collection tube into the collection tube. In the deflection region the fluid can flow into the collection tube at a deflection opening can then be deflected by means of the deflection section and flow out of the collection tube at a different deflection opening. The outflow region and/or the inflow region and/or the first deflection region can be connected to one another in a flow conducting manner by leakage openings.

[0023] It is of advantage that, due to the separation element, a functional division of the collection tube can be created in a simple kind and manner, so that discrete inflow regions, outflow regions and deflection regions are realized in the collection tube. The collection tube in accordance with the invention having a functional division is thus simple to manufacture. Moreover, no additional components, for example, arcs or distribution tubes are required and/or components, such as mountings or further installations for deflecting the fluid can be saved, so that the collection tube can be produced in a cost-effective manner. Likewise the collection tube can be of different design and in this way, for example, the wall thicknesses of the collection tube or the size of the collection tube can be reduced with respect to known sizes and designs and/or can be advantageously matched to certain requirements.

[0024] In an embodiment of the invention a first termination element is arranged at a first axial end and/or a second termination element is arranged at a second axial end, wherein the first and the second termination elements close off the collection tube in a sealing manner. The collection tube comprises an inflow opening and/or an outflow opening. A fluid flows into the collection tube through the inflow opening and/or the fluid flows out of the collection tube through the outflow opening. An inflow is arranged at the inflow opening and the inflow is arranged at an angle b with respect to the collection tube axis and/or an outflow is arranged at the outflow opening and the outflow is arranged at an angle c with respect to the collection tube axis.

[0025] The collection tube can, for example, be closed off at the first and at the second axial ends by means of the first and the second termination elements. The first and the second termination elements can, for example, be configured as a semi-spherical terminal. A cylindrical section can additionally be configured at the semi-spherical terminal. An outer diameter of the cylindrical section can, for example, correspond to an inner diameter of the collection tube or vice versa. The first and/or the second termination elements can be arranged at the collection tube. The first and/or second termination elements can be fastened to the collection tube, for example by being welded, screwed or adhesively bonded thereto. The first and/or the second termination elements can, however, also be connected to the connection tube by a fastening element, for example, the first and/or the second termination elements can be arranged at the collection tube and can be clamped, stapled or riveted thereto. The first and/or the second termination element can, however, also be arranged at the collection tube without fastening elements. For example, a respective sealing element can be arranged between the first and the second termination elements and the collection tube so that the axial ends of the collection tube can be closed off in a sealing manner. Likewise an air opening can be provided in the first or the second termination element, for example a bore. The air opening can be closed and opened so that, for example air can flow into the collection tube.

[0026] The inflow opening and the outflow opening can both be arranged at the first or the second axial end at the first or the second termination element of the collection tube. Likewise only the outflow opening can be arranged at the first or the second axial end at the first or the second termination element and the inflow opening can be arranged at the jacket surface of the collection tube or vice versa. However, also the inflow opening and the outflow opening can be arranged at the jacket surface of the collection tube. The inflow opening and the outflow opening can be configured as a bore or as a stamped aperture. The shape of the inflow opening and of the outflow opening can, for example be circular, oval or also polygonal.

[0027] A fluid, in particular a liquid fluid or a gaseous fluid, for example a heat transfer medium, can flow into the collection tube through the inflow opening. The fluid can flow out of the collection tube through the outflow opening. An inflow can be arranged at the inflow opening. Likewise an outflow can be arranged at the outflow opening through which the fluid flows out of the collection tube. The inflow and the outflow can be connections, for examples to lines. A supply line can be connected at the inflow through which the fluid is guided into the collection tube. A drainage line can be connected at the outflow through which the fluid can be guided away from the collection tube. The inflow can be arranged at an angle b, wherein the angle b can be included between the collection tube axis and a straight line going through an opening in the inflow. The angle b can lie between 0 to 90 degrees, preferably lies between 20 to 90 degrees and particularly preferably corresponds to 50 to 90 degrees. The outflow can be arranged at an angle c, wherein the angle c can be included between the collection tube axis and a straight line going through an opening in the outflow. The angle c can lie between 0 to 90 degrees, preferably lies between 0 to 50 degrees and particularly preferably corresponds to 0 to 30 degrees.

[0028] The advantage of this design is that the collection tube can be of modular design. Thus, the configuration of the collection tube, this means the arrangement of the first or the second termination element, as well as of the inflow opening and of the outflow opening and of the inflow and of the outflow can be varied and can be adapted to different applications. Moreover, the collection tube can be produced in a cost-effective manner due to this modular mode of construction.

[0029] In an embodiment of the invention, a deflection plate is arranged at the separation element. In this connection, the deflection plate is configured and arranged in such a way that the inflow opening is arranged in the inflow region and the outflow opening is arranged in the outflow region.

[0030] The deflection plate can be configured as a part of the separation element, so that the deflection plate can, for example, be configured as a folded end piece of the separation element. The deflection plate can, however, also be configured as a separate component and can be fastened to the separation element, for example, the deflection plate can be welded, adhesively bonded, stapled or screwed to the separation element. The deflection plate can be arranged in a direction of the first or of the second axial ends. The deflection plate can be circular, rectangular or polygonal, in particular the deflection plate can be composed of a rectangular and of a semi-circular section. The deflection plate can be arranged in the direction of the first or the second axial ends of the collection tube at the separation element, preferably the semi-circular section can be aligned in the direction of the first or of the second axial end. Moreover, the deflection plate can be arranged such that the inflow opening is arranged in the inflow region and the outflow opening is arranged in the outflow region. However, also a plurality of deflection plates, can be arranged at the separation element, for example, a first deflection plate can be arranged at an end of the separation element and a second deflection plate can be arranged at the other end of the separation element. The deflection plate can be arranged at an angle h, wherein the angle h can be formed between the collection tube axis and the deflection plate. The angle h can lie between 0 and 140 degrees, preferably lies between 20 to 70 degrees. Advantageously, the deflection plate enables a variable arrangement of the inflow region and of the outflow region, so that the degree of efficiency of a heat exchanger is higher.

[0031] In an embodiment of the invention, a first termination plate is arranged at the separation element and the first termination plate is arranged at an angle d with respect to the collection tube axis. The first termination plate is configured and arranged in such a way that the first or the second termination element and the first termination plate form an overflow region. Moreover, the first termination plate separates the deflection region and the outflow region from the overflow region.

[0032] The first termination plate can be configured as a part of the separation element, so that the first termination plate is, for example, configured as a folded end piece of the separation element. The first termination element can, however, also be configured as a separate component and can be fastened to the separation element, for example, the first termination plate can be welded, adhesively bonded, stapled or screwed to the separation element. The first termination plate can be arranged in the direction of the first or the second axial end. The first termination plate can be rectangular or polygonal, however, in particular circular. Preferably, the first termination plate can have a semi-circular shape, wherein a diameter of the first termination plate can correspond to the inner radius of the collection tube. The first termination plate can be arranged in the direction of the first or the second axial ends of the collection tube at the separation element, preferably the semi-circular first termination plate can be aligned in the direction of the first axial end at the separation element. The first termination plate can be arranged at an angle b with respect to the collection tube axis, wherein the angle d can be configured between the collection tube axis and the first termination plate. The angle d can lie between 0 to 140 degrees, preferably lies between 50 to 100 degrees and particularly lies between 80 to 100 degrees.

[0033] The first termination plate can be configured and arranged in such a way that the first or the second termination element and the first termination plate form an overflow region. An overflow opening can be arranged in the overflow region, so that the fluid which is, for example excessively present, can advantageously flow out of the collection tube, in particular out of the heat exchanger apparatus. Moreover, the first termination plate can separate the deflection region and the outflow region from the overflow region. Also the inflow region and the overflow region can be connected in a flow conducting manner. The advantage of the design of the overflow region and of its functional separation from the outflow region and the deflection region is a more effective use of the collection tube and in turn thus an increase of the degree of efficiency of the heat exchanger.

[0034] In an embodiment of the invention a separation element comprises a deflection section, wherein the deflection section is configured such that a flow direction of the fluid can be deflected in the first deflection region.

[0035] The deflection section can have an open polygonal, this means, for example, a triangular or a quadratic or a semi-circular inner cross-section and can preferably be configured as a U-shaped sheet metal part or as a groove. The deflection section can be symmetrically or asymmetrically arranged with respect to the separation section and/or the separation element. The deflection section can be configured as a section of the separation element or as a separate component. Thus, the processing of additional deflection tubes can advantageously be saved in a cost-effective manner.

[0036] In an embodiment of the invention the separation element is of multi-part design, so that the separation element can advantageously be matched to different applications of the collection tube. In an embodiment of the invention the separation element comprises the deflection section and/or a separation section and/or the first termination plate and/or the deflection plate. The separation element can be of one-part design or of multi-part design in the direction of the collection tube axis, this means it can comprise two or more individual parts. The individual parts can have like or different lengths, preferably like lengths and can be displaced relative to one another with respect to the collection tube axis. Preferably, the separation element comprises the deflection section and the separation section. Furthermore, the separation section and the deflection section can be of one-part design or of multi-part design.

[0037] In accordance with the invention a heat exchanger apparatus comprising a collection tube is further provided. The collection tube in accordance with the invention can thus be a part of a heat exchanger apparatus. Thus, the heat exchanger apparatus can be advantageously produced in a more cost-effective manner and can be emptied in a simpler manner.

[0038] In an embodiment of the invention the heat exchanger apparatus comprises a deflection tube, wherein the deflection tube comprises a plurality of deflection openings and wherein a deflection tube axis can be configured in an axial longitudinal direction. Or the heat exchanger apparatus comprises a plurality of tubes which are arranged in a plane, wherein a first end of the tubes is arranged at an inflow opening or at an outflow opening or at a deflection opening of the collection tube and/or a second end of the tubes is arranged at the deflection openings of the deflection tube and/or the deflection tube comprises a deflection plate. The deflection plate is configured and arranged at the deflection tube in such a way that the deflection plate divides the deflection openings into a second deflection region and a second termination plate is arranged at the deflection plate.

[0039] The heat exchanger apparatus can be a finned heat exchanger which can, for example, comprise a collection tube, a plurality of tubes for guiding through a heat transfer medium and a plurality of fins. In this connection the fins can be connected to the tubes and are in connection with a second medium during operation. The fins or the tubes can be made from a good heat-conductible material, for example, aluminum or copper and are preferably made from stainless steel. Naturally the finned heat exchanger can also include a plurality of tubes for more than one heat transfer medium or the tubes can be connected to one another in parallel or in series in dependence on the requirement. The heat exchanger apparatus can, however, also be a plate heat exchanger or a micro-channel heat exchanger. A heat transfer element of the micro-channel heat exchanger can, for example, be configured as an extruded section which can be produced from a material having a good heat conductivity, such as, for example aluminum. The heat transfer elements can include a plurality of channels having a diameter of, for example, 0.5 to 3 mm for the heat transfer medium. Rather than smaller tubes preferably aluminum-extruded sections are used for a micro-channel heat transfer element. Moreover, a wetting apparatus for the heat exchanger apparatus can be provided.

[0040] The deflection tube can, for example, be a tube-like hollow body having a circular, elliptical or polygonal base surface. Preferably, the deflection tube can be configured as a generally hollow cylindrical tube which is open at a first and at a second axial end. The deflection tube axis can be configured in an axial longitudinal direction of the deflection tube, preferably by the geometric center of the two base surfaces of the deflection tube. The deflection tube comprises a plurality of deflection openings, wherein the design and arrangement of the deflection openings at the deflection tube can correspond to the design and arrangement of the deflection openings at the collection tube.

[0041] The deflection plate can be a film-like material, for example a sheet metal part, and the material can, for example, be composed of a metal or of a metal alloy, of a stainless steel or of a plastic. The film-like material is advantageously composed of a pressure stable material, for example a metal alloy. The thickness of the film-like material can, for example, lie in a range of between 2 to 10 mm.

[0042] The deflection plate can, for example, be configured as a rectangular sheet metal part. Likewise the deflection plate can have a polygonal, this means, for example, a triangular or a square or a semi-circular inner cross-section having an open side and can, for example, be configured as a U-shaped sheet metal part or as a groove. The deflection plate can include a leakage opening, for example, round or polygonal gaps, indentations or tubular connection elements, through which, for example, a pressure compensation can take place, this means through which the fluid can flow.

[0043] The deflection plate can be arranged in the deflection tube, can be displaced along the deflection tube axis, for example, in an axial direction and can be rotationally symmetrically arranged about the deflection tube axis so that an arbitrary arrangement within the deflection tube is possible. In this connection the deflection plate can be arranged with respect to the deflection tube axis in such a way that the deflection plate encloses an angle i with respect to the deflection tube axis. The deflection plate can include an angle i of 0 to 40 degrees, preferably of 0 to 30 degrees, with respect to the deflection tube axis. In particular, the deflection plate can be aligned along the deflection tube axis, for example, it can be configured in parallel, so that the angle i is 0 degrees. The deflection plate can thus be aligned precisely at the deflection tube axis, this means that the deflection tube axis can lie in the deflection plate over a complete deflection tube length. The deflection plate can be fastened to the deflection tube, for example, the deflection plate can be welded or adhesively bonded to the deflection tube. The deflection plate can, however, also be connected to the deflection tube by a fastening element, this means it can, for example, be clamped, stapled or screwed thereto. Likewise the deflection plate can be arranged in the deflection tube by means of a guiderail. The deflection plate can, however, also be arranged without fastening means in the deflection tube.

[0044] A first end of the tube is arranged at an inflow opening and/or at an outflow opening and/or at a deflection opening of the collection tube and/or a second end of the tube can be arranged at the deflection openings of the deflection tube. The deflection plate is configured and arranged at the deflection tube in such a way that the deflection plate divides the deflection openings into a second deflection region. Due to the deflection tube having the deflection plate the fluid can only flow into a certain region in a preferably constrained direction. The fluid can, for example, be deflected from a deflection opening into a different deflection opening in the second deflection region. Thus, no additional components, for example arcs or distribution tubes are advantageously required, so that the deflection tube can be manufactured in a cost-effective manner and can be matched to the most diverse applications in a more simple manner.

[0045] In an embodiment of the invention a first termination element is arranged at a first axial end and/or a second termination element is arranged at a second axial end, wherein the first and the second termination elements close off the deflection tube in a sealing manner and an overflow opening is arranged at the deflection tube and/or an overflow is arranged at the overflow opening. The design and the arrangement of the first and the second termination elements corresponds to the design and the arrangement of the first and the second termination elements at the collection tube.

[0046] The overflow opening can be arranged at the first or the second axial ends or at the first or the second termination elements of the collection tube. Likewise only the overflow opening can be arranged at the jacket surface of the deflection tube. The overflow opening can be configured as a bore or as a stamped aperture. The shape of the overflow opening can, for example, be circular, oval or also polygonal.

[0047] A fluid, in particular a liquid fluid or a gaseous fluid, for example, a heat transfer medium can flow out of the deflection tube through the overflow opening. An overflow can be arranged at the overflow opening. An overflow line can be connected to the overflow. The overflow can be arranged in the same kind and manner like the inflow or the outflow at an angle alpha, wherein the angle alpha can be included between the deflection tube axis and a straight line going through the geometric center of the overflow opening. The angle alpha can lie between 0 to 90 degrees, preferably lies between 20 to 90 degrees and particularly preferably corresponds to 90 degrees.

[0048] A second termination plate can be arranged at the deflection plate and the second termination plate can be arranged at an angle k with respect to the deflection tube axis. The second termination plate can be configured and arranged in such a way that the first or the second termination element and the second termination plate form an overflow region.

Moreover, the second termination plate separates the deflection region from the overflow region.

[0049] The second termination plate can be configured as a part of the deflection plate so that the second termination plate is, for example, configured as a folded end piece of the deflection plate. The second termination plate can, however, also be configured as a separate component and can be fastened to the deflection plate, for example, the second termination plate can be welded, adhesively bonded, stapled or screwed to the deflection plate. The second termination plate can be arranged in the direction of the first or the second axial end. The second termination plate can be rectangular or polygonal, in particular, however, circular.

[0050] Preferably, the second termination plate can have a circular shape, wherein a diameter of the second termination plate approximately corresponds to the inner radius of the collection tube. The second termination plate can be arranged in the direction of the first or of the second axial end of the deflection tube at the deflection plate, preferably the circular second termination plate can be aligned in the direction of the first axial end at the deflection plate. The second termination plate can be arranged at an angle k with respect to the deflection tube axis, wherein the angle k can be configured between the deflection tube axis and the second termination plate. The angle k can lie between 0 to 140 degrees, preferably lies between 50 to 90 degrees and particularly preferably lies between 80 to 90 degrees.

[0051] The second termination plate can be configured and arranged in such a way that the first or the second termination element and the second termination plate form an overflow region. An overflow opening can be arranged in the overflow region so that the fluid which is, for example excessively present, can advantageously flow out through the overflow opening. Moreover, the second termination element can separate the deflection region from the overflow region. Also the deflection region and the overflow region can be connected in a flow conducting manner. The advantage of this design of the overflow region and of its functional separation from the deflection region is a more effective use of the collection tube and thus in turn an increase of the degree of efficiency of the heat exchanger apparatus.

[0052] However, it can also be possible that the functions of the collection tube and/or of the deflection tube can be distributed to a plurality of tubes. The collection tube then merely comprises a simple deflection plate which divides the outflow opening having the outflow region and/or the inflow opening having the inflow region. The deflection then takes place by means of one or more deflection tubes which are arranged, for example, at both sides of the heat exchanger apparatus and at the collection tube.

[0053] The invention further relates to a method of emptying a heat exchanger apparatus, wherein air flows in via an overflow and a fluid flows out via the overflow, via an inflow and via an outflow. In the operating state the heat exchanger apparatus is flowed through by a fluid. If the operation is interrupted, this means if a compulsory through-flow of the heat exchanger apparatus is broken down, the heat exchanger fills with air, the fluid flows out and the heat exchanger apparatus empties itself.

[0054] In an embodiment of the invention the heat exchanger apparatus is installed at a tilt. For this purpose the heat exchanger apparatus can be assembled such that the overflow can be the highest point.

BRIEF DESCRIPTION OF THE DRAWINGS

[0055] The invention will be explained in more detail hereinafter with reference to the drawings.

[0056] FIG. **1** is a schematic illustration of a first embodiment of a collection tube;

[0057] FIG. **2** is a schematic illustration of a second embodiment of a collection tube;

[0058] FIG. **3** is a schematic illustration of a first embodiment of a deflection tube;

[0059] FIG. **4** is a schematic illustration of a first embodiment of a heat exchanger apparatus having a collection tube and a deflection tube;

[0060] FIG. **5** is a schematic cross-section through a second embodiment of a heat exchanger apparatus having a collection tube and a deflection tube; and

[0061] FIGS. **6A-6C** are schematic illustrations of the angles a, b, c, d, f, g, h, i and k.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0062] FIG. **1** shows a schematic illustration of a first embodiment of the collection tube **1** in accordance with the invention. The collection tube **1** is configured as a generally hollow cylindrical tube, in particular as a hollow circular cylinder, which is open at a first and at a second axial end. The collection tube **1** comprises an outflow opening **2**, an inflow opening **3** and a plurality of deflection openings **4**. The outflow opening or the inflow opening or the deflection openings **2**, **3**, **4** are configured as an opening in a jacket surface of the collection tube **1**. A plurality of outflow openings **2** are arranged vertically above one another, preferably having the same spacing at a first plane. Likewise a plurality of inflow openings or deflection openings **3**, **4** are arranged vertically above one another, preferably having the same spacing, at a parallel first plane. The outflow opening or the inflow opening or the deflection openings **2**, **3**, **4** are horizontally arranged next to one another, preferably having the same spacing at a second plane.

[0063] A separation element **5** is configured as a sheet metal part, wherein the separation element **5** comprises a separation section **51** and a deflection section **52**. The separation section **51** has a rectangular shape. The deflection section **51** is configured as a groove which is open to one side and which has a square inner cross-section. The separation element **5**, this means the separation section **51** and the deflection section **52** as a whole have a substantially Y-shaped internal cross-section, wherein the separation element **5** is of one-part design.

[0064] Moreover, one or more leakage opening(s) (not illustrated) are configured at the boundaries of the separation element **5**, through which, for example, a pressure compensation can take place, this means through which a fluid can flow.

[0065] In this connection, the separation element **5** is arranged in the collection tube **1** with respect to the collection tube axis A in such a way that the separation element **5** encloses an angle a (not illustrated) with respect to the collection tube axis A and the angle a amounts to 0 degrees. The separation element **5** is aligned in parallel to the collection tube axis A with the separation section **51**. The separation element **5** is configured and arranged with the collection tube **1** in such a way that the separation element **5** divides the collection tube **1** into an outflow region **6** in which the outflow opening **2** is arranged, into an inflow region **7** in which the inflow opening **3** is arranged and into a first deflection region **8** in which the deflection openings **4** are arranged. The fluid flows through a tube (not illustrated) in the direction of the outflow opening **2** of the collection tube **1** in the outflow region **6**. The fluid flows from the direction of an inflow opening **19** into the collection tube **1** in the inflow region **7** and through the inflow opening **3** into the tube (not illustrated). In the operating state the fluid flows out of the tube out of a deflection opening **4** in a first deflection region **8** (not illustrated) and is deflected into a different deflection opening **4** into the tube (not illustrated) by means of the separation element **5**.

[0066] A first termination element **16** is arranged at the first axial end and a second termination element **17** is arranged at the second axial end. The first and the second termination elements **16**, **17** close off the collection tube **1** in a sealing manner. Moreover, the collection tube comprises an inflow opening **19** and an outflow opening **18**, wherein a fluid flows into the collection tube **1** through the inflow opening **19** and/or the fluid flows out of the collection tube **1** through the outflow opening **18**. The inflow opening **19** is arranged at a jacket surface of the collection tube **1** above the second axial end and the outflow opening **18** is arranged at the second axial termination element **17**. A deflection plate **53** is arranged at the separation element **5**, wherein the deflection plate **53** is configured and arranged in such a way that the inflow opening **19** is arranged in the inflow region and the outflow opening **18** is arranged in the outflow region. A termination plate **54** is arranged in the direction of the first axial end. The first termination plate **54** is configured and arranged in such a way that the first termination element **16** and the first termination plate **54** form an overflow region **15** and the first termination plate **54** separates the deflection region **8** and the outflow region **6** from the overflow region **15**.

[0067] A schematic illustration of a second embodiment of the collection tube **1** is illustrated in FIG. **2**. The assembly of the collection tube **1** in this connection has many similarities to the collection tube **1** of FIG. **1**, for which reason reference is only made to the differences. The first termination element **16** further comprises a compensation opening **22**, wherein air flows into the collection tube for an open compensation opening **22**. The separation element **5** is of two-part design, wherein the two parts of the separation element **5** are horizontally displaced with respect to one another so that the separation element **5** divides a like number of outflow openings, inflow openings and deflection openings **2**, **3**, **4** in a radial direction of the collection tube axis A. An inflow **191** is further arranged at the inflow opening **19** and an outflow **181** is further arranged at the outflow opening **18**.

[0068] A schematic illustration of a first embodiment of a deflection tube is illustrated in FIG. **3**. The deflection tube **9** is configured as a hollow cylindrical tube that is open at a first and at a second axial end. The deflection tube **9** comprises a plurality of deflection openings **4**. The deflection openings **4** and/or the center point of the deflection openings (not illustrated) are arranged in a second plane having approximately the same spacing, wherein the second plane encloses an angle f (not illustrated) of 90 degrees with respect to the deflection tube axis B. The deflection plate **10** has a rectangular shape and is arranged in parallel to the deflection tube axis B in the deflection tube **9**, wherein the deflection tube axis B lies in the deflection plate **10** over a complete deflection tube length.

[0069] The deflection plate **10** is configured and arranged at the deflection tube **9** in such a way that the deflection plate **10** divides the deflection openings **4** into a second deflection region **11**, wherein two second deflection regions **11** are illustrated. Due to the deflection tube **9** having the deflection plate **10** the fluid flows into the second deflection region **11** in a preferably constrained direction. The fluid is thus deflected from one deflection opening **4** out of the tube (not illustrated) into a different deflection opening **4** into a different tube (not illustrated) in the second deflection region **11**.

[0070] An overflow opening **20** is arranged at a first axial end at the deflection tube **9** and an overflow **21** is arranged at the overflow opening **20**. A second termination element **17** is arranged at a second axial end which closes off the deflection tube **9** at the second axial end in a sealing manner. The second termination element **17** further comprises a compensation opening **22**, wherein air flows into the deflection tube **9** for an open compensation opening **22**.

[0071] A first embodiment of a heat exchanger apparatus **13** having a collection tube **1** and a deflection tube **9** is illustrated in FIG. **4**. The assembly of the collection tube **1** in this connection has many similarities to the collection tube **1** of FIG. **2** and the deflection tube **9** has many similarities to the deflection tube **9** of FIG. **3**, for which reason reference is only made to the differences. The collection tube **1** and the deflection tube **9** are connected by means of a plurality of tubes **12**. A first end of the tubes **12** is arranged at an inflow opening **3** or at an outflow opening **2** or at a deflection opening **4** of the collection tube **1** and a second end of the tubes **12** is arranged at the deflection openings **4** of the deflection tube **9**.

[0072] A schematic cross-section through a second embodiment of a heat exchanger apparatus **13** having a collection tube and a deflection tube is illustrated in FIG. **5**. The principle assembly of the heat exchanger apparatus **13** can be compared to that of FIG. **4**. The flow direction of the fluid is schematically illustrated by means of the arrows.

[0073] The heat exchanger apparatus **13** comprises a collection tube **1**, a deflection tube **9** and a plurality of tubes **12**. The collection tube **1** comprises an outflow opening **2**, an inflow opening **3** and a plurality of deflection openings **4**. The outflow opening or the inflow opening or the deflection openings **2**, **3**, **4** are configured as an opening in the jacket surface of the collection tube **1**. The separation element **5** is configured and arranged in the collection tube **1** in such a way that the separation element **5** divides a collection tube **1** into an outflow region **6** in which the outflow opening **2** is arranged, into an inflow region **7** in which the inflow opening **3** is arranged and into a first deflection region **8** in which the deflection opening **4** is arranged. The fluid flows into a specific region in a preferably constrained direction in the collection tube **1** in accordance with the invention. The fluid flows through the tube **12** in a direction of the outflow opening **2** in the outflow region **6** or through the first or through the second axial end (not illustrated) of the collection tube **1**. The fluid flows from the direction of an inflow opening (not illustrated) or from the first or from the second axial end (not illustrated) of the collection tube **1** into the collection tube **1** in the inflow region **7** and into the tube **12** through the inflow opening **3**. The fluid flows out of the tube **12** out of a deflection opening **4** in the first deflection region **8** and is deflected via a different deflection opening **4** into the tube **12** in the operating state. The deflection tube **9** is divided into a second deflection region **11** by means of the deflection plate **10**. The fluid flows in a preferably constrained direction in the second deflection region **11** due to the deflection plate **10**. The fluid is thus deflected out of the tube **12** from a deflection opening **4** into a different deflection opening **4** into a different tube **12** in the second deflection region **11**.

[0074] The principle assembly of FIG. **6**A is comparable to that of FIG. **1**, wherein only the lower part of the FIG. **1** is shown. A design of the inflow **191** at an angle b and a design of the outflow **181** at an angle c are schematically illustrated in FIG. **6**A.

[0075] The principle assembly of FIG. **6**B is comparable to that of FIG. **3**, wherein the deflection tube axis B having the deflection plate **10** arranged at an angle i and the second termination element **101** arranged at an angle k are schematically illustrated.

[0076] The principle assembly of FIG. **6**C is comparable to that of FIG. **1**, wherein the collection tube axis A having a first plane arranged at an angle f and having a second plane arranged at an angle g are schematically illustrated. Likewise, the separation element **5** arranged at an angle a, the first termination plate **54** arranged at an angle d, as well as the deflection plate **53** arranged at an angle h are schematically illustrated.

1. A collection tube for a heat exchanger apparatus, the collection tube comprising:

a first outflow opening;

a first inflow opening;

a plurality of deflection openings; and

a separation element configured and arranged in the collection tube to divide the collection tube into an outflow region in which the first outflow opening is arranged, an inflow region in which the first inflow opening is arranged, and a first deflection region in which the deflection openings are arranged, the separation element being arranged with respect to a collection tube axis such that the separation element encloses an angle with the collection tube axis, the collection tube axis extending in an axial longitudinal direction of the collection tube.

2. A collection tube in accordance with claim **1**, wherein a first termination element is arranged at a first axial end or a second termination element is arranged at a second axial end, the first and the second termination elements close off the collection tube in a sealing manner.

3. A collection tube in accordance with claim **1**, further comprising an second inflow opening or an second outflow opening, and a fluid flows into the collection tube through the second inflow opening or out of the collection tube through the second outflow opening.

4. A collection tube in accordance with claim **3**, wherein an inflow is arranged at the second inflow opening and the inflow is arranged at an angle with respect to the collection tube axis or an outflow is arranged at the second outflow opening and the outflow is arranged at an angle with respect to the collection tube axis.

5. A collection tube in accordance with claim **3**, further comprising a deflection plate arranged at the separation element and the deflection plate being configured and arranged such that the second inflow opening is arranged in the inflow region and that the second outflow opening is arranged in the outflow region.

6. A collection tube in accordance with claim **2**, further comprising a first termination plate arranged at the separation element and the first termination plate being arranged at an angle with respect to the collection tube axis.

7. A collection tube in accordance with claim **6**, wherein the first termination plate is configured and arranged such that the first or the second termination element and the first termination plate form an overflow region and the first termination plate separates the first deflection region and the outflow region from the overflow region.

8. A collection tube in accordance with claim **1**, wherein the separation element comprises a deflection section, the deflection section being configured such that a flow direction of the fluid can be deflected in the first deflection region.

9. A collection tube in accordance with claim **1**, wherein the separation element is of multi-part design.

10. A collection tube in accordance with claim **1**, wherein the separation element comprises a deflection section or a separation section or a first termination plate or a deflection plate.

11. A heat exchanger apparatus comprising a collection tube in accordance with claim **1**.

12. A heat exchanger apparatus in accordance with claim **11**, further comprising a deflection tube, the deflection tube including the plurality of deflection openings, and a deflection tube axis configured in an axial longitudinal direction of the deflection tube or including a plurality of tubes arranged in a plane, a first end of the plurality of tubes being arranged at the first inflow opening or at the first outflow opening and/or at the deflection openings of the deflection tube of the collection tube or a second end of the plurality of tubes is arranged at the deflection openings of the deflection tube, or the deflection tube includes a deflection plate, the deflection plate being configured and arranged at the deflection tube such that the deflection plate divides the deflection openings into a second deflection region and a termination plate is arranged at the deflection plate.

13. A heat exchanger apparatus in accordance claim **12**, wherein a first termination element is arranged at the deflection tube at a first axial end or a second termination element is arranged at a second axial end, the first and the second termination elements closing off the deflection tube in a sealing manner or an overflow opening is arranged at the deflection tube or an overflow is arranged at the overflow opening.

14. A method of emptying a heat exchanger apparatus in accordance with claim **11**, comprising flowing air in via an overflow and flowing a fluid out via the overflow or via an inflow or via an outflow.

15. A method in accordance with claim **14**, wherein the heat exchanger apparatus is disposed so as to tilt.

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