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(54) **DEVICE FOR DISTRIBUTING A FLUID FOR A HEAT EXCHANGER, PREFERABLY AN EVAPORATOR**

(57) Device (10) for distributing a fluid comprising an inlet zone (18) of the fluid and an outlet zone (19) of the fluid, wherein the outlet zone (19) of the fluid comprises a plurality of outlet channels (23). Between the inlet zone (18) and the outlet channels (23) there is a main channel (21) configured to create a swirling motion of the fluid before the latter enters the outlet channels (23), so that in each of them there is substantially the same vapor quality.

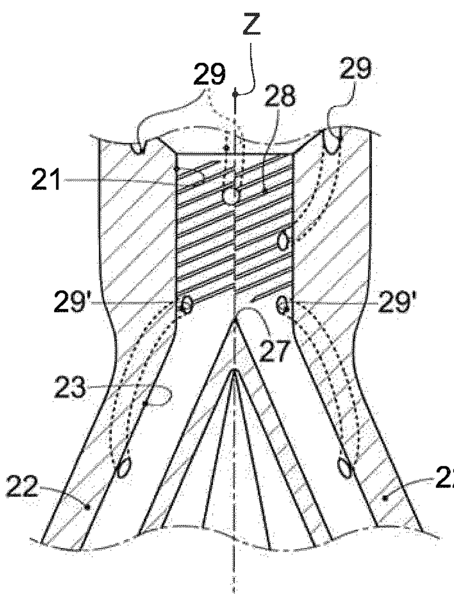

fig. 10

Description

FIELD OF THE INVENTION

[0001] The present invention concerns a device for distributing a fluid for a heat exchanger, preferably, but not exclusively, for an evaporator, even more preferably for an evaporator with a refrigeration cycle, in which the fluid comprises a liquid part and a gaseous part. The distribution device according to the present invention is configured to be disposed upstream of a heat exchange coil of the heat exchanger, and has the function of mixing the liquid part and the gaseous part present in the fluid at inlet, uniformly redistributing the fluid in a plurality of flows exiting from the distribution device in a homogeneous manner.

BACKGROUND OF THE INVENTION

[0002] Devices for distributing fluids are known, for use in heat exchangers, for example evaporators. Their function is to distribute the flow of a fluid at inlet, coming for example from a lamination valve, and to convey it in a plurality of capillary pipes exiting toward a heat exchange coil.

[0003] Among these known devices, the so-called "simple" distributors are included, that is, provided with an inlet channel, or zone, with a plurality of outlet channels and an intermediate accumulation zone between the inlet channel and the plurality of outlet channels. The accumulation zone allows the fluid to be distributed in the direction of the outlet channels.

[0004] Hereafter we shall refer to the term "vapor quality", by which we mean the ratio between the mass of the fluid in its vapor state (mv) and the sum of the mass of the fluid in its vapor state (mv) and the mass of the fluid in the liquid state (ml), that is, $x=mv/(mv+ml)$.

[0005] The fluid exiting from the lamination valve is both in the liquid state and also in the vapor state. Normally the vapor quality of the fluid is low (for example, 10-20% m/m), but according to the laws of state, the percentage in volume of the liquid in the vapor state is very high (for example, > 50% V/V).

[0006] The disadvantage of "simple" distributors as described above is that the force of gravity, in combination with the geometry of the simple distributor, make the distribution of the fluid uneven, so that, in particular, some outlet channels have a very low vapor quality compared to other outlet channels where the vapor quality is higher.

[0007] This lack of homogeneity, which is all the more accentuated the greater the number of capillary pipes present, negatively affects the general performance of the heat exchanger on which the fluid distributor is installed, in particular in the case of an evaporator, since the heat exchange coil operates with a different quantity of liquid mass and gaseous mass between the various inlet channels, so that, as a consequence, the thermodynamic changes of the fluid in the heat exchanger are not uniform.

[0008] To overcome this disadvantage it is known to use distributors having a neck in the intermediate accumulation zone, as described, for example in the Japanese document JP-S5435468. However, distributors with a neck only partly solve the problem of the lack of homogeneity of the vapor quality of the fluid in the outlet channels. In fact, the neck causes a pressure drop, accelerating the fluid and creating a turbulent motion that allows the mixing of the fluid in the liquid state and in the vapor state, homogenizing the vapor quality of the fluid entering the various capillary pipes, but not always optimally.

[0009] In addition or as an alternative to the neck, it is known to obtain said turbulent motion by making a plurality of grooves on the walls of the inlet channel. Examples of this type of distributors are described in the patent documents published with the publication number n. JP 2008-267689 and JP2000-320929.

[0010] Furthermore, such distributors with a neck and/or grooves on the inlet channel also have the disadvantage that they do not guarantee complete efficiency when the heat exchanger with which they are combined works in a partialized condition, that is, with a different flow rate, in particular lower than the nominal design one, so the problem of a distribution of the fluid with a non-uniform quality in the different outlet channels remains unsolved.

[0011] Another disadvantage of distributors with a neck and/or grooves on the inlet channel is that their operation is optimal only for a specific fluid chosen in the design step, while it is not optimal when the type of fluid used changes, due to the particular chemical and physical characteristics of each fluid.

[0012] One purpose of the present invention is to provide a device for distributing a fluid for a heat exchanger, preferably, but not exclusively, an evaporator, which can optimally homogenize the vapor quality at outlet, for example toward the capillary pipes of the heat exchanger, and such as not to lose the efficiency of the latter on which the device is installed, even when working in a partialized condition.

[0013] Another purpose of the present invention is to provide a device for distributing a fluid for a heat exchanger, preferably, but not exclusively, an evaporator, which can maintain a high efficiency as the fluid passing through it varies, without having to vary the sizes thereof, or of some of its components such as for example the distribution device, for each type of fluid.

[0014] Another purpose of the present invention is to provide a method to manufacture said distribution device which allows to manufacture the device in a versatile and flexible way according to the most suitable geometry based on the operating specifications of the heat exchanger, including the type of fluid that passes through it.

[0015] The Applicant has devised, tested and embodied the present invention to overcome the shortcomings of the state of the art and to obtain these and other purposes and advantages.

SUMMARY OF THE INVENTION

[0016] The present invention is set forth and characterized in the independent claims. The dependent claims describe other characteristics of the present invention or variants to the main inventive idea.

[0017] In accordance with the above purposes, a device for distributing a fluid having a liquid component and a gaseous component in a heat exchanger, according to the present invention, comprises an inlet zone of the fluid and an outlet zone of the fluid, wherein the outlet zone of the fluid comprises a plurality of outlet channels independent from each other.

[0018] In accordance with one aspect of the present invention, the device for distributing a fluid also comprises mixing means disposed between the inlet zone and the outlet zone of the fluid, the mixing means being configured to create a swirling motion of the fluid in order to homogenize the vapor quality of the fluid portions exiting from the plurality of outlet channels.

[0019] In accordance with another aspect of the present invention, the distribution device also comprises a hollow body in which there is a cylindrical conduit defining a main, or mixing, channel which extends from the inlet zone to a distribution zone disposed at the beginning of the plurality of outlet channels. Furthermore, the mixing means comprise at least one groove present on the internal surface of the cylindrical conduit, or both on the internal surface of the cylindrical conduit and also on the internal surface of at least one portion of one or more of the outlet channels.

[0020] In accordance with another aspect of the present invention, the at least one groove has a substantially helical shape, and it is disposed coaxial to a longitudinal axis of the cylindrical conduit.

[0021] In accordance with another aspect of the present invention, the mixing means comprise one or more secondary channels, each of which begins in the inlet zone, extends inside the cylindrical conduit and ends in the main channel, so that each of the secondary channels can allow at least a part of the fluid coming from the inlet zone to pass, in order to introduce it into the main channel.

[0022] In accordance with another aspect of the present invention, each of the one or more secondary channels has a curved trajectory, so as to terminate substantially tangent to the internal surface of the cylindrical conduit.

[0023] In accordance with another aspect of the present invention, the one or more secondary channels enter the main channel at different heights along the longitudinal axis.

[0024] In accordance with an example embodiment of the present invention, there are three secondary channels, disposed radially at an angle of approximately 120° from each other with respect to the longitudinal axis.

[0025] In accordance with another aspect of the present invention, in the inlet zone there is a reduction of the passage section of the fluid coming from a connection pipe and directed into the main channel, thus forming a neck.

[0026] In accordance with another aspect of the present invention, the plurality of outlet channels is defined by a corresponding plurality of outlet conduits independent from each other, which spread apart preferably in a substantially symmetrical manner with respect to the longitudinal axis.

[0027] In accordance with another aspect of the present invention, the mixing means can comprise a discoidal element provided with one or more through fissures configured so that the fluid passes through them in the path from the inlet zone to the outlet zone or, alternatively, a plurality of fins. Both the discoidal element and also the fins are preferably disposed according to a transversal orientation, more in particular orthogonal, with respect to the flow of the fluid between the inlet zone and the outlet zone.

[0028] According to another aspect of the present invention, a method is provided to manufacture a device for distributing a fluid having a liquid component and a gaseous component, obtained by working a hollow body.

[0029] The method comprises the steps of making:

- an inlet zone of the fluid, shaped in such a way as to create a neck, that is, a narrowing of the section for the fluid at inlet,
- an outlet zone of the fluid comprising a plurality of outlet conduits, independent from each other, which define a corresponding plurality of outlet channels, each of which ends in the outlet zone,
- in the hollow body, a cylindrical conduit having a main channel connecting the inlet zone with the outlet zone,
- mixing means, between the inlet zone and the outlet zone, configured to create a swirling motion of the fluid in order to homogenize the vapor quality of the fluid portions exiting from the plurality of outlet channels.

[0030] According to one aspect of the present invention, these manufacturing steps provide to perform additive manufacturing techniques, placing a succession of suitable printing materials on top of each other, by means of a three-dimensional printing device provided with at least one printing head.

[0031] In accordance with another aspect of the present invention, a heat exchanger, comprising at least one compressor, a condenser, a heat exchange coil, and possibly a lamination valve, which is interposed between the condenser and the heat exchange coil, also comprises at least one device for distributing a fluid as above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] These and other aspects, characteristics and advantages of the present invention will become apparent from the following description of some embodiments, given as a non-restrictive example with reference to the attached drawings wherein:

- fig. 1 is an example schematic representation of a heat exchanger on which a device for distributing a fluid according to the present invention is installed;
- fig. 2 is a perspective view of the distribution device of fig. 1;
- fig. 3 is a front view of the distribution device of fig. 1;
- fig. 4 is a section view along line IV-IV of fig. 3;
- fig. 5 is a perspective section view of the distribution device of fig. 1;
- fig. 6 is a cross-section view of a variant of the distribution device in accordance with the present invention;
- figs. from 7 to 10 are partial and schematic longitudinal section views of other variants of the distribution device in accordance with the present invention.

[0033] We must clarify that in the present description and in the claims the terms vertical, lower, upper, high and low, with their declinations, have the sole function of better illustrating the present invention with reference to the drawings and must not be in any way used to limit the scope of the invention itself, or the field of protection defined by the claims.

[0034] Furthermore, the person of skill in the art will recognize that certain sizes, or characteristics, may have been enlarged or deformed in the drawings, or shown in an unconventional or non-proportional way in order to provide a version of the present invention that is easier to understand. When sizes and/or values are specified in the following description, the sizes and/or values are provided for illustrative purposes only and must not in any way be construed as limiting the scope of protection of the present invention, unless such sizes and/or values are present in the attached claims.

[0035] To facilitate comprehension, the same reference numbers have been used, where possible, to identify identical common elements in the drawings. It is understood that elements and characteristics of one embodiment can be conveniently combined or incorporated into other embodiments without further clarifications.

DETAILED DESCRIPTION OF SOME EMBODIMENTS

[0036] With reference to fig. 1, a device 10 for distributing a fluid, according to the present invention, is configured to be installed in a heat exchanger 11, preferably an evaporator, even more preferably an evaporator with refrigeration cycle.

[0037] In order to better frame an application of the distribution device 10, fig. 1 shows an operating diagram of the heat exchanger 11, for example of the multi-circuit type.

[0038] In this schematic representation, the heat exchanger 11 comprises a compressor 12 configured to convey the fluid in the direction of a condenser 13, as indicated by the arrows, which releases at least part of the heat Q of the fluid to the outside of the circuit. The condenser 13 is connected to a lamination valve 14, the output of which is connected to a heat exchange coil 16 by means of the distribution device 10.

[0039] The distribution device 10 is configured to divide the fluid into a plurality of capillary pipes 15 which continue their path inside the heat exchange coil 16, in which the fluid acquires heat from the outside and subsequently restarts its path from the compressor 12. In the case of an evaporator, the fluid evaporates in the process of acquiring heat from the outside.

[0040] The fluid used in the event that the heat exchanger 11 is an evaporator with refrigeration cycle is a refrigerant fluid, for example R448A, which is formed by a mixture of different refrigerant fluids; however, other refrigerant fluids can also be used, such as for example R449A, R407H, R134A, or other suitable ones, depending on the application.

[0041] In particular, the distribution device 10 (figs. 2, 3 and 4) comprises a hollow body 17, having an inlet zone 18 (figs. 2 and 4), preferably flared toward the inside, and an outlet zone 19 of the fluid.

[0042] The hollow body 17 comprises a cylindrical conduit 20 having a main, or mixing, channel 21 coaxial to its own longitudinal axis Z (fig. 4) and a plurality of outlet conduits 22, independent from each other, which define a corresponding plurality of outlet channels 23, each of which ends in the outlet zone 19. For example, in the embodiment shown here, there are twelve outlet conduits and channels 22, 23; however, there could be more, but also fewer, as a function of the application requirements of the distribution device 10 in the heat exchanger 11.

[0043] For example, the number of outlet channels 23 can be comprised between 2 and 100, preferably between 2 and 63.

[0044] Indicatively, the diameter D 1 of the mixing channel 21 is comprised between 3 mm and 20 mm, preferably between 5 mm and 12 mm, while each of the outlet channels 23 can have a diameter D2 comprised between about 1 mm and about 10 mm, preferably between about 3 mm and about 6 mm.

[0045] The outlet conduits 22, and therefore the outlet channels 23, spread apart in a substantially symmetrical manner with respect to the longitudinal axis Z and are preferably distanced radially in a substantially uniform manner.

[0046] In alternative forms, the plurality of outlet conduits 22 could be replaced by a single cone containing the plurality of outlet channels 23, or have other shapes.

[0047] The cylindrical conduit 20 is configured to be connected to a connection pipe 24 which represents the output of the lamination valve 14 (fig. 1); their connection can be made with any suitable mean, such as for example threaded members, clamps, or by welding.

[0048] Each outlet conduit 22, in its outlet zone 19, comprises a connection seating 25 in which the end of a corresponding capillary pipe 15 can be inserted, for example by interlocking or by welding.

[0049] Between the mixing channel 21 and the plurality of outlet channels 23 there is a distribution zone 26, in the center of which there is a distribution cone 27, which is configured to equally divide the fluid into the plurality of outlet channels 23.

[0050] The inlet zone 18 is shaped in such a way as to create a neck, that is, a narrowing of the section for the fluid at inlet up to the diameter D1 of the mixing channel 21. This narrowing of the section causes an acceleration of the fluid in the mixing channel 21.

[0051] The distribution device 10 can be made of various suitable materials, for example aluminum or its alloys, stainless steel, metallic materials, such as brass, or plastic materials.

[0052] The distribution device 10 also comprises mixing elements, or means, configured to obtain a swirling motion of the fluid inside the mixing channel 21 and the distribution zone 26. In the embodiment described here, the mixing means (figs. 3, 4 and 5) comprise at least one groove 28 (fig. 4) present on the internal surface of the mixing channel 21 and one or more secondary, or bypass, channels 29, made in the cylindrical conduit 20, in an intermediate zone between its external cylindrical surface and the cylindrical conduit 20.

[0053] In particular, the groove 28 has a substantially helical shape, it is coaxial to the longitudinal axis Z, it resembles an internal thread, which can be single-start or double-start, with a screwing sense from the inlet zone 18 to the distribution zone 26, and it preferably extends over the entire axial extension of the mixing channel 21.

[0054] Each groove 28 could also have a shape other than a helical one; for example it could be cylindrical, with the center in the longitudinal axis Z.

[0055] The helical shaped grooves 28 allow to give the fluid a swirling motion with respect to the longitudinal axis Z, thus causing a mixing of the fluid in the liquid state and in the vapor state, in such a way as to uniform the vapor quality in the distribution zone 26. The fluid distributed by means of the distribution cone 27 into the plurality of outlet channels 23 will therefore have substantially the same vapor quality in each outlet channel 23 and therefore in each capillary pipe 15 of the heat exchange coil 16 (fig. 1).

[0056] The pitch, the height of the crest of each groove 28 (fig. 4), and the number of grooves 28 are calculated on the basis of the diameter D1 of the mixing channel 21 and on the basis of the chemical and physical properties of the fluid, as well as on the basis at least of speed, pressure, temperature, in order to achieve the desired swirling effect. By way of example, the height of the crest of the grooves 28 is comprised between about 0.5 mm and about 3 mm.

[0057] The secondary channels 29 (figs. 3, 4 and 5) can be of a variable number, preferably from one to ten, as a function of the sizes of the hollow body 17. In the embodiment described here, there are three secondary channels 29 disposed angularly at 120°, with the center on the longitudinal axis Z (fig. 3).

[0058] The secondary channels 29, by way of example, have a diameter comprised between about 0.5 mm and about 4 mm, preferably between about 0.5 mm and about 2 mm.

[0059] Each secondary channel 29 has a shape such that it is as if it were partly screwed into the hollow body 17, starting from the inlet zone 18 and then continuing with a curved path until it flows into the distribution channel 21, tangent to the internal surface of the cylindrical conduit 20. Furthermore, when there are at least two secondary channels 29, they preferably flow out at different heights of the mixing channel 21, in the direction of the longitudinal axis Z, in order to allow a better mixing of the fluid in the liquid state and in the vapor state. These heights can correspond, for example, to approximately 30%, 60% and 90% of the length of the mixing channel 21.

[0060] In particular, each secondary channel 29, in a first initial part thereof, is substantially parallel to the longitudinal axis Z, while after this, in a second part thereof, it is inclined toward the mixing channel 21 in order to introduce the fluid inside it. In this second part, each secondary channel 29 follows a curved trajectory, with a sense preferably concordant with the direction of rotation of each groove 28 of the grooves 29.

[0061] In the embodiment shown here, the radial coordinate with respect to the longitudinal axis Z in which a single secondary channel 29 flows into the mixing channel 21 is different from its starting radial coordinate, in the inlet zone 18.

[0062] The part in which each secondary channel 29 flows into the mixing channel 21 is flared, so as to facilitate the exit of the fluid in the latter and increase the swirl of the flow inside the mixing channel 21.

[0063] The secondary channels 29 have been described with an approximate and schematized development in order to emphasize their effect; however, they could also have different shapes. For example, each of them could have a first part parallel to the longitudinal axis Z and a second part that flows tangent in a straight line onto the mixing channel 21, or a first part parallel to the longitudinal axis Z and a second part coplanar with respect to the longitudinal axis Z, or flow directly into the distribution zone 26.

[0064] According to the embodiment described here, a first part of the flow present in the inlet zone 18 passes through the mixing channel 21, while a second part enters the one or more secondary channels 29 and is introduced into the mixing channel 21 in order to create turbulence and/or swirling in the flow.

[0065] According to simplified variants of the distribution device 10, not shown in the drawings, but easy to understand for a person of skill in the art, the mixing means can comprise only one or more grooves 28, or only one or more secondary channels 29.

[0066] Therefore, the distribution device 10 described heretofore advantageously provides to mix and distribute the fluid in the liquid state and in the vapor state with a homogeneous quality in the different capillary pipes downstream of the device. This characteristic is also maintained in a partialized condition and is a very important aspect, since heat exchangers, in particular evaporators, are subject to variations of the flow rate both during the day and also over the course of a year.

[0067] The uniformity of the vapor quality of the fluid contributes to the increase in the efficiency of the heat exchange in the heat exchanger, in particular if it is a multi-circuit evaporator. The uniformity of the vapor quality of the fluid in the outlet channels 23 and the efficiency of the operation in the partialized condition allow a net increase in the efficiency of the entire heat exchange apparatus.

[0068] The distribution device 10, designed in a manner coherent with the embodiment described above, including its variants, also performs well when the characteristics of the fluid flowing through it vary, keeping the efficiency of each individual embodiment stable for a plurality of fluids that can flow through it.

[0069] With reference to figs. from 6 to 10, some variants of the distribution device 10 are described below, all of which come within the scope of protection of the present invention. These variants show other possible embodiments, provided here by way of a non-limiting example, of the mixing means as above configured to create the swirling motion of the fluid.

[0070] In the embodiment shown in fig. 6, the mixing means comprise a discoidal element 30, preferably disposed inside the main channel 21, in particular disposed orthogonal with respect to the longitudinal axis Z. The discoidal element 30 is provided with one or more through fissures 31, configured so that the fluid passes through them in the path from the inlet zone 18 to the outlet zone 19. According to one possible example, there are four fissures 31 and they can have a radial disposition, in such a way as to intersect the longitudinal axis Z, which in this variant constitutes an axis of symmetry for the plurality of fissures 31. It is quite clear that the fissures 31 can be in a number other than four and/or have a different geometric configuration, in terms of sizes and orientation, based on the fluid dynamic effect to be imparted to the fluid by means of the discoidal element 30. In the version shown, the main channel 21 is without the grooves 28, but in other embodiments, not shown, the discoidal element 30 can be provided in combination with the grooves 28.

[0071] In the embodiment shown in fig. 7, the mixing means comprise a plurality of fins 32, protruding from the internal surface of the main channel 21 toward the center of the channel itself, that is, toward the longitudinal axis Z. In the example shown, there are six fins 32, with a shape tapered from the base, which is attached to the internal surface of the main channel 21, to their tip, and projecting from such surface in a manner orthogonal to the surface itself. It is quite clear that the fins 32 can be in a number other than six and/or assume a different geometric configuration, in terms of sizes, shapes and orientation, based on the fluid dynamic effect to be imparted to the fluid by means of the fins 32. For example, the fins can be arched or straight, configured as seams or ribs, or according to yet other shapes, and even be disposed parallel to the longitudinal axis Z, or with a certain inclination with respect to the latter. In the version shown, the main channel 21 is without the grooves 28; however, in other embodiments, not shown, the fins 32 can be provided in combination with the grooves 28.

[0072] In the embodiment shown in fig. 8, the mixing means are configured as the grooves 28 described above. However, in this variant, the grooves 28, in addition to being present on the internal surface of the main channel 21, are also present on the internal surface of one or more outlet conduits 22, for at least a portion of the respective outlet channels 23. In the example shown, the grooves 28 are also made on the mouth portion of the outlet channel 23 shown on the left, and for the entire length of the outlet channel 23 shown on the right. This advantageously allows to impart different pressure drops to the fluid flowing through different outlet conduits 22. In the example provided, the fluid flowing through the outlet conduit 22 shown on the right will undergo a greater distributed pressure drop than the fluid flowing through the other outlet conduit 22 shown on the left, due to the presence of the grooves 28 along the entire respective outlet conduit 23.

[0073] In the embodiment shown in fig. 9, the mixing means are configured as the grooves 28 described above. However, in this variant, at least some of the outlet channels 23 can have a diameter D2 different from that of the other outlet channels 23. The difference between the diameters is shown in fig. 9, in which, by way of example, a first outlet channel 23 (on the left) is shown having a diameter, indicated with the reference D2', which is smaller than the diameter of a second outlet channel 23 (on the right), in turn indicated with the reference D2". It is evident that the other outlet channels 23 not shown in the section of fig. 9 can have diameters equal to the diameters D2', D2" mentioned above, or diameters that further differ from them. This embodiment also advantageously allows to impart different pressure drops to the fluid that flows through different outlet conduits 22.

[0074] The fact that the outlet conduits 22 have different structures from each other is particularly useful in the case of heat exchangers 11, configured for example as evaporators, comprising a large number of capillary pipes 15, and consequently a heat exchange coil 16 of a significant size. In these cases, in fact, the problem of the homogeneous distribution of the fluid having the same vapor quality in the parallel circuits is more pronounced. Thanks to the different structures of the outlet conduits

22, the mixing means impart differentiated pressure drops to the fluid that passes through them, this facilitates achieving the desired homogenization, preventing technicians from having to intervene directly at the time of installation, adopting improvised and empirical solutions on the basis of the evidence of the different frosting that characterizes the different circuits at the start of the exchanger. For example, it is possible to provide a different configuration of the mixing means in the outlet conduits 22 which lead to the ranks disposed at a higher vertical height of the heat exchange coil 16, compared to the outlet conduits 22 that lead to the ranks disposed at a lower vertical height of the coil, the former being able to have the grooves 28 for their entire length or a smaller diameter D2', while the latter, for example, being able to have the grooves 28 only in the mouth zone, or a larger diameter D2".

[0075] In the embodiment shown in fig. 10, the mixing means are configured as the grooves 28 and the secondary channels 29 described above. However, in this variant, a second group of secondary channels is provided, indicated by the numerical reference 29', disposed downstream with respect to the secondary channels 29 with reference to the flow of the fluid between the inlet zone 18 and the outlet zone 19. Each secondary channel 29' of this second group departs from the distribution channel 21 and flows into one of the outlet channels 23, preferably in an initial segment thereof. The secondary channels 29' of this second group can be substantially similar in shape and size to the secondary channels 29 described above. In particular, also in this case each secondary channel 29' can open onto the walls of the distribution channel 21 and of the outlet channel 23 in a direction tangent thereto, screwing into the cylindrical conduit in the manner described above. The number of secondary channels 29' of this second group is equal to or lower than the number of outlet conduits 22, that is, equal to or lower than twelve in the example provided here.

[0076] It is understood that, in other variants, not shown, the mixing means can only comprise the secondary channels 29' of the second group, in a distribution device 10 without both the grooves 28 as well as the secondary channels 29.

[0077] It is understood that the variants described above with reference to figs. from 6 to 10 can all be combined with the embodiments described previously, in which the mixing means can comprise, in addition or as an alternative to the groove 28, the one or more secondary channels 29, as can be seen, for example, in figs. 7 and 8.

[0078] According to other variants, not shown, which can be combined with all the embodiments previously described, the position of the distribution cone 27 can be at a higher vertical height than that shown in the drawings, penetrating further into the main channel 21.

[0079] The distribution device 10 can be made by means of known additive manufacturing techniques. This allows to make the different embodiments of the device previously described, as well as their variants, with great versatility. Thanks to additive manufacturing techniques, it is possible to make distribution devices 10 with customized geometries based on the fluid dynamic needs of the plant in which the device is integrated. It should also be noted that additive manufacturing techniques allow to obtain complex shapes, such as for example those of the secondary channels 29, 29', or of the fins 32, or of the outlet channels 23 having differentiated diameters D2', D2" or grooved segments with different lengths, which would be difficult to obtain with other traditional manufacturing techniques, such as for example molding, die casting or mechanical machining by chip removal.

[0080] The method can provide to deposit a succession of layers of suitable printing materials of a known type on top of each other, such as for example metal powders or resins or polymer materials, or a mixture thereof. The three-dimensional printing device, of the type known in the state of the art, can be easily selected by the person of skill in the art from among known apparatuses suitable to print three-dimensional objects with such materials.

[0081] It is clear that modifications and/or additions of parts or steps may be made to the distribution device 10 and to the method to manufacture it as described heretofore, without departing from the field and scope of the present invention as defined by the claims.

[0082] It is also clear that, although the present invention has been described with reference to some specific examples, a person of skill in the art shall certainly be able to make many other equivalent forms of a device for distributing a fluid or of a method to manufacture it, all coming within the field and scope of the present invention.

[0083] In the following claims, the sole purpose of the references in brackets is to facilitate reading: they must not be considered as restrictive factors with regard to the field of protection defined by the same claims.

Claims

1. Device (10) for distributing a fluid having a liquid component and a gaseous component in a heat exchanger, comprising an inlet zone (18) of said fluid and an outlet zone (19) of said fluid, wherein said outlet zone (19) comprises a plurality of outlet channels (23) independent from each other, **characterized in that** between said inlet zone (18) and said outlet zone (19) there are mixing means (28, 29, 29', 30, 31, 32) configured to create a swirling motion of said fluid in order to homogenize the vapor quality of the fluid portions exiting from said plurality of outlet channels (23).

2. Device (10) for distributing a fluid as in claim 1, **characterized in that** it also comprises a hollow body (17) in which there is a cylindrical conduit (20) defin-

ing a main channel (21) which extends from said inlet zone (18) to a distribution zone (26) disposed at the beginning of said plurality of outlet channels (23), **and in that** said mixing means comprise at least one groove (28) present on the internal surface of said cylindrical conduit (20), or both on the internal surface of said cylindrical conduit (20) and also on the internal surface of at least one portion of one or more of said outlet channels (23).

3. Device (10) for distributing a fluid as in claim 2, **characterized in that** said at least one groove (28) has a substantially helical shape and is disposed coaxial to a longitudinal axis (Z) of said cylindrical conduit (20).

4. Device (10) for distributing a fluid as in claim 2 or 3, **characterized in that** said mixing means comprise one or more secondary channels (29), each of which begins in said inlet zone (18), extends inside said cylindrical conduit (20) and ends in said main channel (21), so that each of said secondary channels (29) can allow at least a part of said fluid coming from said inlet zone (18) to pass, in order to introduce it into said main channel (21).

5. Device (10) for distributing a fluid as in claim 4, **characterized in that** each of said one or more secondary channels (29) has a curved development, so as to terminate substantially tangent to the internal surface of said cylindrical conduit (20).

6. Device (10) for distributing a fluid as in claims 3 and 4, or 3 and 5, **characterized in that** said one or more secondary channels (29) enter said main channel (21) at different heights along said longitudinal axis (Z).

7. Device (10) for distributing a fluid as in any claim from 4 to 6, **characterized in that** there are three of said secondary channels (29), disposed radially at an angle of approximately 120° from each other, with respect to said longitudinal axis (Z).

8. Device (10) for distributing a fluid as in any claim hereinbefore, **characterized in that** said mixing means comprise a second group of secondary channels (29’), each of which begins in said main channel (21), extends inside said cylindrical conduit (20) and ends in a respective one of said outlet channels (23), so that each of said secondary channels (29’) of said second group can allow at least a part of said fluid coming from said inlet zone (18) to pass, in order to introduce it into said respective outlet channel (23).

9. Device (10) for distributing a fluid as in any claim hereinbefore, **characterized in that** in said inlet zone (18) there is a reduction of the passage section of said fluid coming from a connection pipe (24) and directed into said main channel (21), thus forming a neck.

10. Device (10) for distributing a fluid as in any claim hereinbefore, **characterized in that** said plurality of outlet channels (23) is defined by a corresponding plurality of outlet conduits (22) independent from each other, which spread apart preferably in a substantially symmetrical manner with respect to said longitudinal axis (Z).

11. Device (10) for distributing a fluid as in claim 10, **characterized in that** one or more of said outlet channels (23) has a diameter (D2) different from the diameter of the remaining outlet channels (23).

12. Device (10) for distributing a fluid as in any claim hereinbefore, **characterized in that** said mixing means comprise a discoidal element (30) provided with one or more through fissures (31) configured so that the fluid passes through them between said inlet zone (18) and said outlet zone (19), wherein said discoidal element (30) is disposed preferably along a transversal orientation, more in particular orthogonal, with respect to the flow of the fluid between said inlet zone (18) and said outlet zone (19).

13. Device (10) for distributing a fluid as in any claim hereinbefore, **characterized in that** said mixing means comprise a plurality of fins (32), wherein said fins (32) are disposed preferably along a transversal orientation, more in particular orthogonal, with respect to the flow of the fluid between said inlet zone (18) and said outlet zone (19).

14. Method to manufacture a device (10) for distributing a fluid having a liquid component and a gaseous component, obtained by working a hollow body (17), wherein the method comprises the steps of making:

- an inlet zone (18) of said fluid, shaped so as to create a neck, that is, a narrowing of the section for the fluid at inlet,
- an outlet zone (19) of said fluid comprising a plurality of outlet conduits (22), independent from each other, which define a corresponding plurality of outlet channels (23), each of which ends in said outlet zone (19),
- in said hollow body (17), a cylindrical conduit (20) having a main channel (21) which connects said inlet zone (18) with said outlet zone (19),
- mixing means (28, 29, 29’, 30, 31, 32) between said inlet zone (18) and said outlet zone (19), configured to create a swirling motion of said fluid in order to homogenize the vapor quality of the fluid portions exiting from said plurality of outlet channels (23),

wherein said method is **characterized in that** said manufacturing steps provide to perform additive manufacturing techniques, placing a succession of suitable printing materials on top of each other, by means of a three-dimensional printing device equipped with at least one printing head.

15. Heat exchanger, comprising at least a compressor (12), a condenser (13), a heat exchange coil (16), and possibly a lamination valve (14), which is interposed between said condenser (13) and said heat exchange coil (16), **characterized in that** it also comprises at least one device (10) for distributing a fluid as in any claim from 1 to 13.

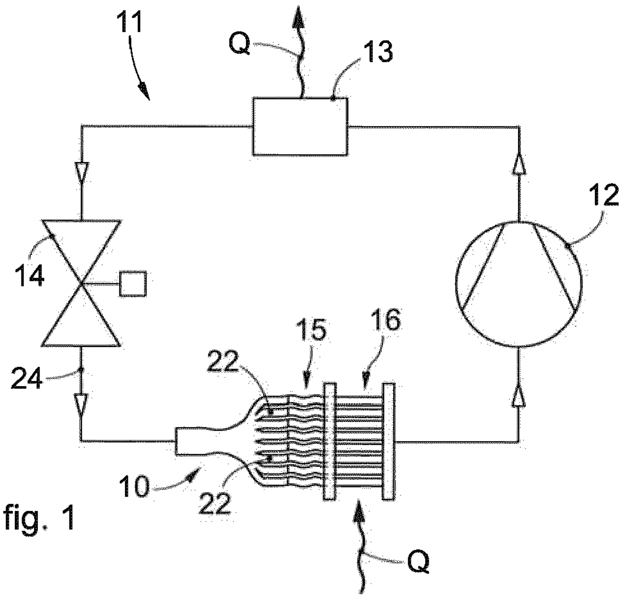

fig. 1

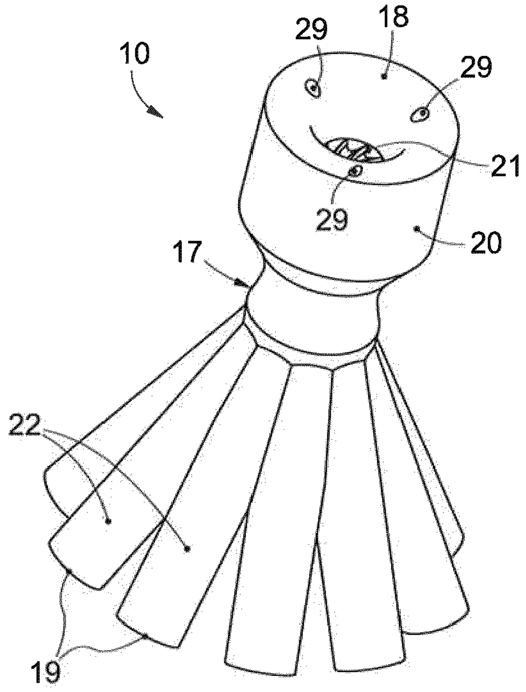

fig. 2

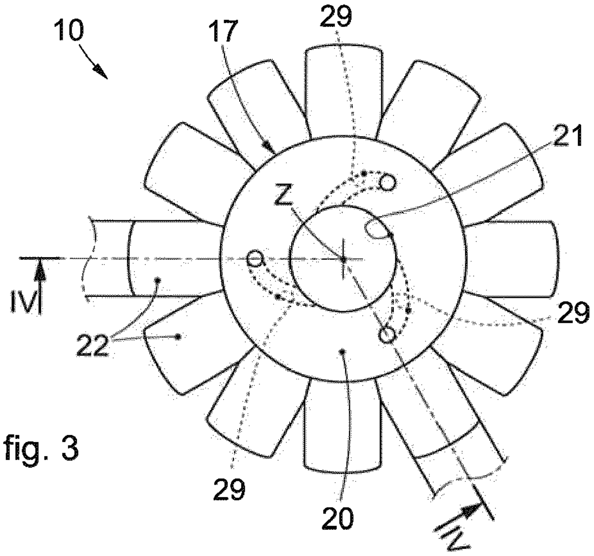

fig. 3

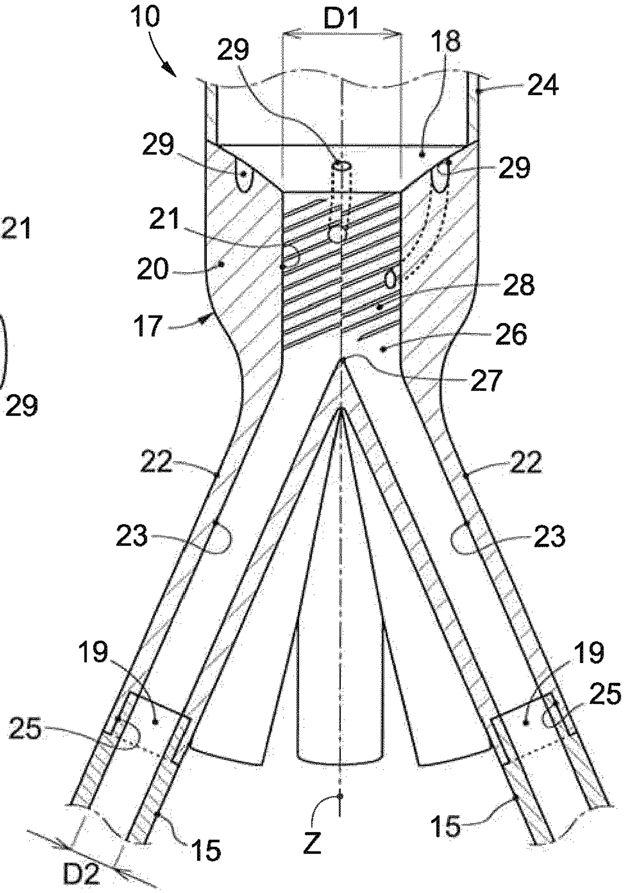

fig. 4

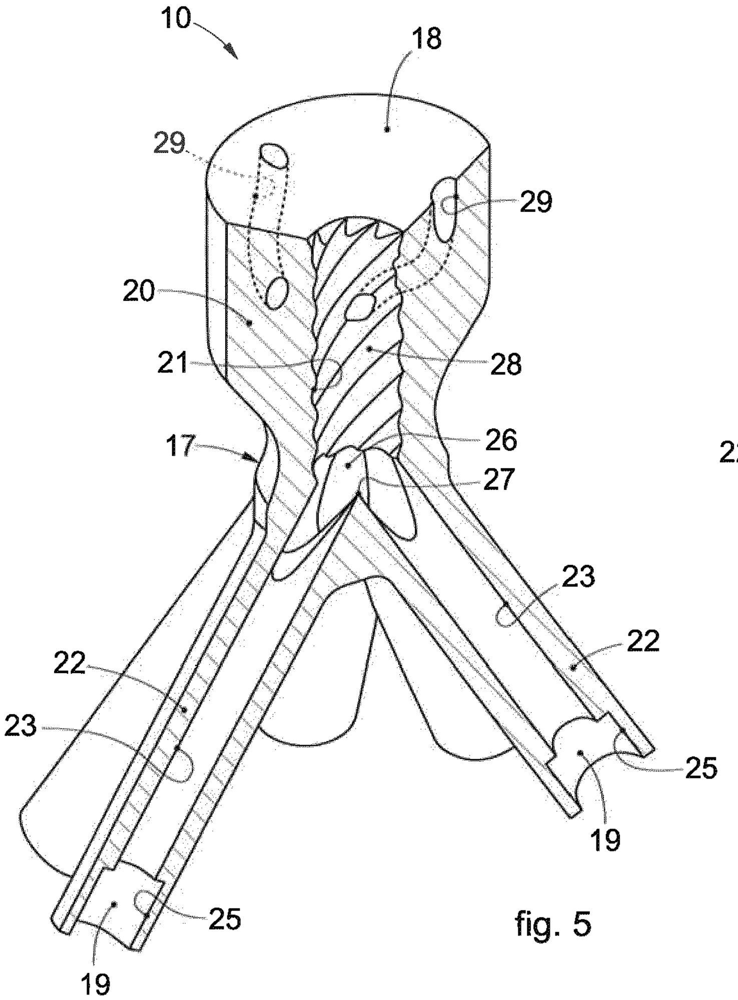

fig. 5

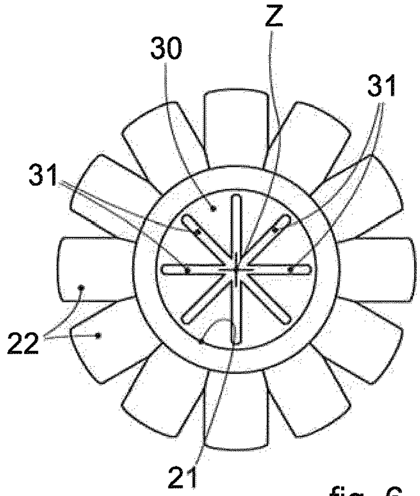

fig. 6

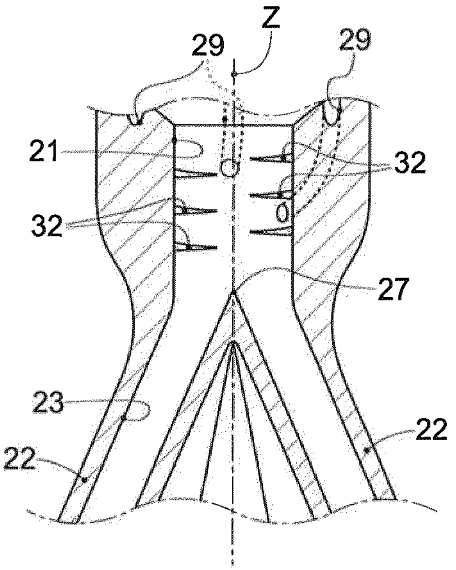

fig. 7

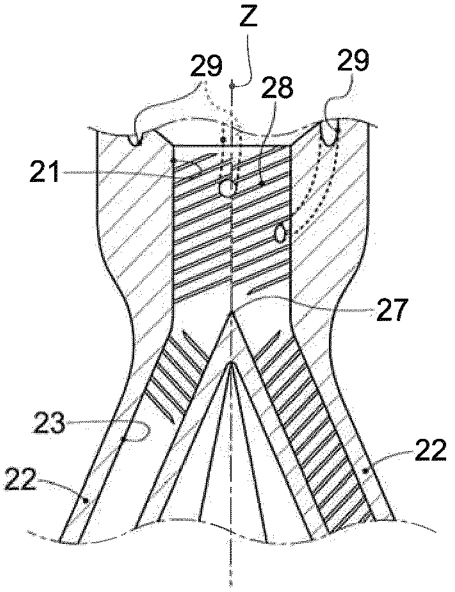

fig. 8

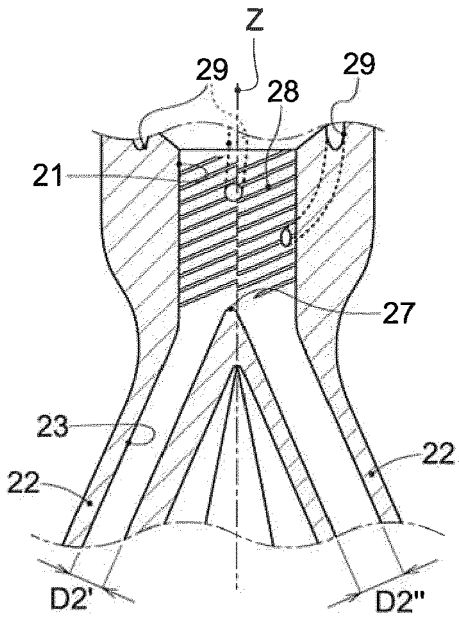

fig. 9

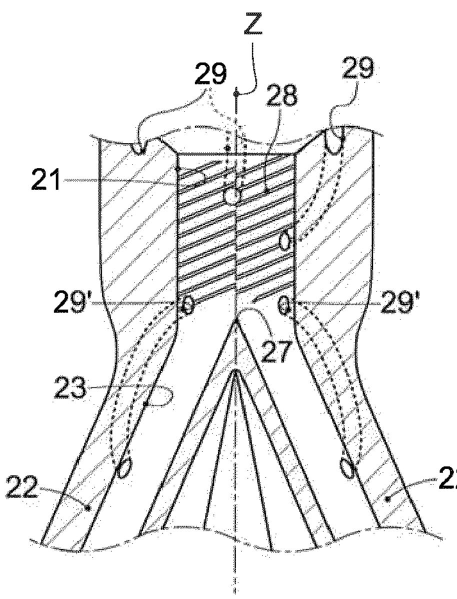

fig. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 21 20 9132

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Place of search	Date of completion of the search	Examiner
Munich	15 February 2022	Martínez Rico, Celia

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