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(54) A liquid-operated heat exchanger, particularly a heat recovery battery

(57) The present invention relates to a heat recovery battery (1) with a plurality of circuits (10), placed above each other, through which a heat transferring liquid circulates. The circuits comprise horizontal exchanger tubes (12), provided with ribs (15), which exchanger tubes within a circuit in the form of a vertical row or several adjacent vertical rows are connected to each other via row bends (13), located at the ends of the circuits, to row circuits (12), which in their turn in a horizontal direction are connected to an entire circuit via circuits bends (14) at the highest and the lowest points of the row circuits, the inlets and the outlets of the circuits respectively through connecting tubes (9 and 11 respectively) being connected to collecting tubes (3 and 5 respectively) on the inlet and the outlet side respectively, which connecting tubes are provided with discharge and aeration means respectively (18 and 19). According to the invention each formation of said circuit bends (14) to row circuits (12), located vertically above each other and consequently also the last-mentioned row circuits per se being connected to each other via a through connecting tube (16) with aeration and discharge means respectively (17).

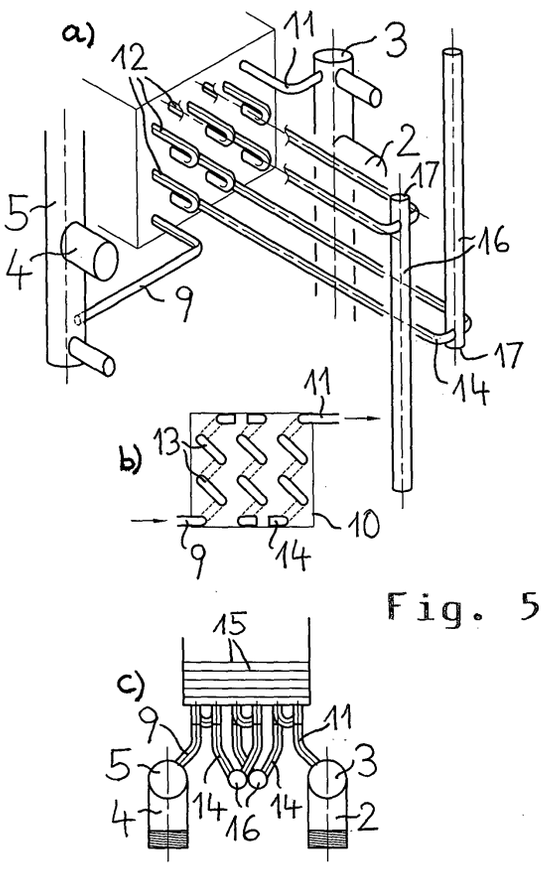

Fig. 5

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Description

[0001] The present invention relates to a liquid-operated heat exchanger, particularly a heat recovery battery, of the type set forth in detail in the preamble of claim 1.

[0002] Such heat exchangers typically are used for heating and cooling respectively air in ventilation plants and comprise a large number of ribs, which are fastened to a large number of tubes, through which warm or cold liquid is flowing, usually water with an anti-freezing solution. This type of heat exchanger is also used for heat recovery, i.e. to transfer, via a liquid , heat from one air stream to another.

[0003] Liquid-operated heat recovery batteries will, in order to attain the highest possible temperature efficiency, be counter flow-connected, i.e. the main direction of the liquid flow will be 180° in relation to the air stream. This is important, since the temperature differences typically are small. At the same time the liquid flow will have the same or a somewhat smaller temperature as and than respectively the average value of the temperature changes of the air flows for an optimal temperature efficiency.

[0004] The liquid speed in the tubes must be sufficiently high to attain a turbulent flow with the liquids, which contain an anti-freezing solution, e.g. glycol mixtures, which normally are used in this type of heat recovery systems. This means, that the batteries are to be connected in such a manner, that a large number of tubes will be parts of each circuit between inlet collecting tubes and outlet collecting tubes. If the number of tubes in one circuit is larger than the number of tube rows, often multiples, circuits with high and low points are obtained with simple counter current-connections, which points lead to problems with aeration and discharge of the battery. A discharge must be done after a hydrostatic test in order to avoid rupture freezing and when exchanging heat carrier liquids. It is also important to deair the systems carefully, i.a. in order to reduce the corrosion and in certain situations the breakdown of the heat carrier liquid . In order to discharge theses batteries out in the field, in the plants, it is necessary to use pressurized air in order to "blow" the liquid out of the batteries, often without successful results. An aeration is also a problem and must be repeated several times , using the pump in the system in order to drive out the air bubbles.

[0005] DE 19808753 relates to a heat exchanger, in which the connection is constantly rising and long transfer connection tubes from top to bottom are used in order to fill the circuits, which have reached the top. This connection manner is very circumstantial and limits the choice of connection alternatives. In this way the aeration points will obtain different static pressures , which means , that they cannot be connected to each other without paying attention to the pressure differences.

[0006] For a construction according to this document no standard batteries and standard methods respectively for their manufacture can be used, which makes such a product more complicated and expensive.

[0007] The object of the present invention is to counteract and as far as possible eliminate the above-mentioned drawbacks. Also, the state of the art in this field is to be developed through this invention in various respects.

[0008] These objects are attained according to the invention by designing a heat exchanger of the type described in the introduction substantially in such a way , which is set forth in the characterizing clause of claim 1. The high and the low points are obtained at the transfer bends between tube rows. By connecting those high points, which exist after a passage of the same number of rows from the inlet collecting tube , one tube being provided with de-airing means, a safe aeration result is obtained. For a discharge of those low points, which exist after a passage of the same number of tubes from the inlet collecting tube, the inlet collecting tube is provided in an analogous manner with a tube provided with a discharge valve. At several tube rows there are several such high points and low points respectively, which means, that several separate tubes for aeration and discharge respectively are required. Since the connected high and low points have the same number of tubes from the inlet collecting tube, they have the same static pressure, which means, that no flow arises in the aeration and the discharge tubes respectively. This results in its turn in, that the aeration and the discharge tubes respectively can have a smaller dimension. In order to reduce the number of aeration and discharge tubes, if a great number of tube rows are used, the circuits can be designed with an upwardly directed and a downwardly directed flow respectively in two tube rows, with only a marginal reduction of the efficiency.

[0009] A substantial advantage of such a solution is, that the standard connections, which are used today and cannot be completely discharged, can be retained with a minor modification. Those bends, which are high points and have the same static pressure, are replaced by an aeration tube with semi-bends, and in the same manner those bends, which are low points, are replaced by discharge tubes, with semi-bends. The aeration and the discharge tubes respectively can be placed on the same side as the inlet and outlet collecting tubes, which facilitates the accessibility.

[0010] Additional characterizing features and advantages of the invention are set forth in the following description, reference being made to the accompanying drawings, which depict a few preferred, but only exemplifying, embodiments of the invention. The drawings show in detail, partially schematically :

in Fig. 1 a lateral view of a typical connection of a portion of an already known heat recovery battery with a plurality of tube rows ;

in Fig. 2 a corresponding lateral view of the same

battery, prepared for a connection according to the invention ;
in Fig. 3 a planar view of a complete battery according to Fig. 2 ;
in Figs. 4a and 4b a lateral view of a battery according to view direction A-A in Fig. 3 before and after respectively the mounting of collecting tubes and connecting tubes ;
in Fig. 5a an exploded view of a portion of an embodiment according to Figs. 2-4 with a partial view 5b from one side and a partial planar view 5c ;
in Fig. 6 a lateral view of a typical connection of one portion of an already known heat recovery battery with a few tube rows ;
in Fig. 7 a corresponding lateral view of the same battery, prepared to be connected according to the invention ;
in Fig. 8 a planar view of a complete battery according to Fig. 7 ;
in Figs. 9a and 9b a lateral view of a battery according to view direction B-B in Fig. 8 before and after respectively the mounting of collecting tubes and connecting tubes; and
in Fig. 10a an exploded view of a portion of an embodiment according to Figs. 7-9 and a partial view 10b from one side and a partial planar view 10c.

[0011] In the drawings parts, which correspond to each other, have the same reference numbers.

[0012] Thus, heat exchanger 1, particularly a heat recovery battery, comprises a vertical outlet collecting tube 3, provided with a main outlet joint 2, and a vertical inlet collecting tube 5, provided with a main inlet joint 4. The inlet collecting tube may project downwards somewhat below the other parts of the heat exchanger in order to be provided there with a valve 18 for discharge , whereas the outlet collecting tube suitably projects upwards somewhat above the other parts of the heat exchanger in order to be provided there with a valve 19 for aeration. A duct 6 extends between the two joints and is provided with a circulation pump 7 and e.g. consumption means 8 for heat and cold respectively.

[0013] Connecting tubes 9 extend between the inlet collecting tube and circuits 10 in the heat exchanger, i. e. a lowermost to each circuit, whereas at the top a connecting tube 11 extends from each circuit to the outlet collecting tube in the embodiment shown in Fig. 1. In the embodiment shown in Fig. 7 the corresponding connecting levels for tubes 9 and 11 are both located in the lower part. Each circuit typically extends along the entire width and depth of the heat exchanger and along a portion of the height. In Figs. 1 and 2 as well as 6 and 7 respectively five and four such circuits respectively are shown for instance. Between the two connecting tubes 9 and 11, which belong to each circuit, a large amount of mutually parallel exchanger tubes 12 extend, which extend along the entire width of the heat exchanger and the ends of which are connected to each other via bends, a pattern of reciprocating rising and falling flows being obtained. The exchanger tubes can be arranged in groups at the same level, but suitably with a vertical displacement between the groups, which follow each other in a vertical direction, oblique bends connecting exchanger tubes, located above each other and only the bends between adjacent vertical groups being horizontal (Fig. 1 and 2), but exchanger tubes, which follow each other in a vertical direction may also be located within vertical planes with oblique bends in a horizontal direction adjacent vertical rows (Figs. 6 and 7), the rows possibly being mutually displaced in a vertical direction. Bends 13 within a row are called row bends , whereas bends 14, which connect the adjacent rows with each other, are called circuit bends. The embodiment shown in Fig. 1 and 2 has a plurality of tube rows, i.e. six in the horizontal direction and six in the vertical direction, whereas the embodiment in Figs. 6 and 7 has a few, i.e. four, tube rows in the horizontal direction and twelve in the vertical direction . Of course, in this context several variations are possible, but at least two circuits must be used.

[0014] Mutually parallel ribs 15 are fastened to the exchanger tubes in a known fashion and are, in the two shown embodiments, vertical and extend downwards along the heat exchanger.

[0015] So far the heat exchanger constructions are already known and are impaired by the drawbacks mentioned in the introduction. It is evident from the conventional embodiments according to Figs. 1 and 6, how difficult it is to aerate and discharge the circuits respectively.

[0016] According to the present invention and as shown in Figs. 2 and 8 respectively the circuit bends 14 are to be divided or opened up or completely or partially removed and the opened up circuit bend ends, which then may be semi-bends or the ends of the respective exchanger tubes, e.g. via suitable special bends, are to be connected to at least mainly vertical through connecting tubes 16, the one end of which at least suitably projects a short distance beyond the upper and the lower exchanger tubes respectively, where it will be provided with a valve 17 for aeration and discharge respectively. In this way one or several connecting tubes are provided, which can be used for aeration or discharge depending on the position of the heat exchanger. If the heat exchanger is turned around 180° according to Figs. 4 or 9, the function of the connecting tubes will be exchanged, i.e. the tubes, which first were used for aeration, will now be used for discharge and vice versa. The corresponding functional exchange may, but it does not have to, take place also for the collecting tubes and their valves.

[0017] It is evident from the description above, that it is also possible to utilize the invention in already existing heat exchangers without having to make any substantial changes. Of course, as regards new constructions, there is more freedom, when a suitable design is to be selected.

[0018] Figs. 3 and 8 show, that all the collecting tubes, connecting tubes and circuit bends are located on one and the same side of the heat exchanger, which should be an advantage regarding the manufacture and the handling of the heat exchanger. However, these parts may be partially located on the other side of the heat exchanger.

[0019] The present invention is not to be limited to the description above and the embodiments shown in the accompanying drawings , but it can be modified and supplemented in an arbitrary way within the scope of the inventive idea and the following claims.

Claims

1. A liquid-operated heat exchanger (1) , particularly a heat recovery battery, with a plurality of circuits (10), mounted above each other, through which a heat transferring liquid is to be circulated, each of said circuits comprising horizontal exchanger tubes (12), provided with ribs (15), which tubes within one circuit in the form of a vertical row or several lateral rows are connected to each other via end-located row bends (13) to obtain row circuits (12), which in their turn in a horizontal direction are connected to an entire circuit via circuit bends (14) at the highest and the lowest points of the row circuits , the inlets and the outlets of the circuits through connecting tubes (9 and 11 respectively) being connected to collecting tubes (3 and 5 respectively) on the inlet and the outlet side, which collecting tubes are provided with discharge and aeration means (18 and 19 respectively), **characterized in that** each formation of said circuit bends (14) to row circuits (12), placed vertically above each other, and consequently also the last-mentioned row circuits per se are connected to each other via a through , at least mainly vertical connecting tube (16) with aeration and discharge means (17).

2. A heat exchanger (1) according to claim 1, **characterized in that** existing conventional circuit bends (14) are divided or opened up , and **in that** the open circuit bend ends, which may be semi-bends, are connected to said connecting tube (16)

3. A heat exchanger (1) according to claim 1, **characterized in that** existing conventional circuit bends (14) completely or partially are removed and/or replaced by special bends, which are connected to the respective exchanger tubes (12) and to which in their turn said connecting tubes (16) are connected.

4. A heat exchanger (1) according to any of claims 1-3, **characterized in that** at least one end of the connecting tubes (16) projects above the uppermost exchanger tubes (12) and below the lowermost tubes (12) respectively and is there provided with said aeration and discharge means respectively (17) for aeration and discharge.

5. A heat exchanger (1) according to any of claims 1-4, **characterized in that** the heat exchanger can be turned around 180°, the function of the connecting tubes (16) and possibly also the collecting tubes (3,5) being changed, i.e. those tubes and means respectively , which earlier were used for aeration , now being used for discharge and vice versa, and as regards the collecting tubes, the inlet function of the connecting tubes being changed to the outlet function and vice versa respectively.

6. A heat exchanger (1) according to any of claims 1-5, **characterized in that** all the collecting tubes (3,5) , the connecting tubes (16) and the circuit bends (14) are located on one and the same side of the heat exchanger.

Fig. 1

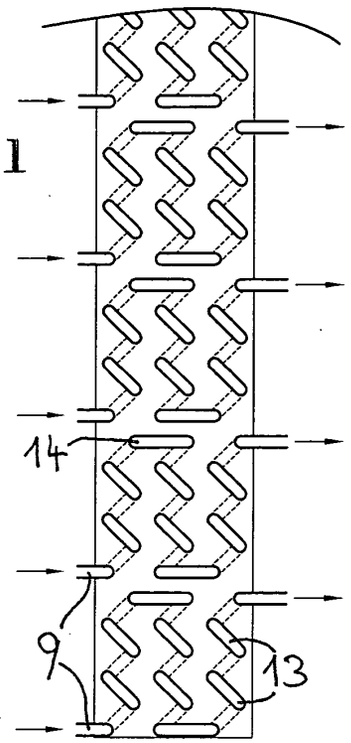


Fig. 2

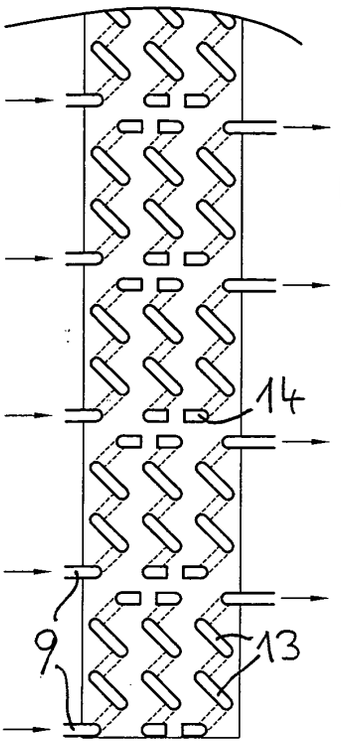


Fig. 6

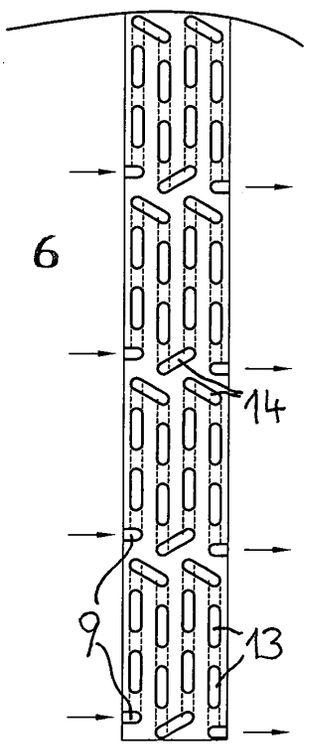


Fig. 7

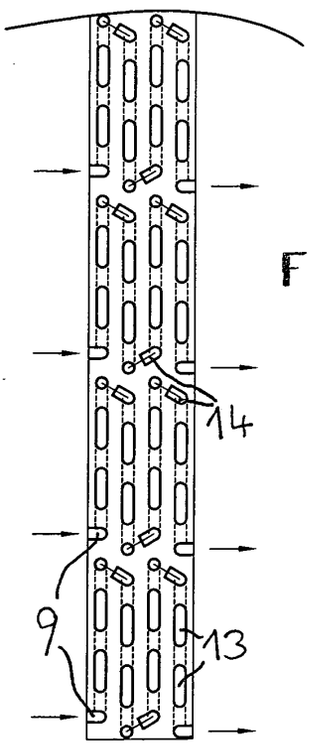


Fig. 9

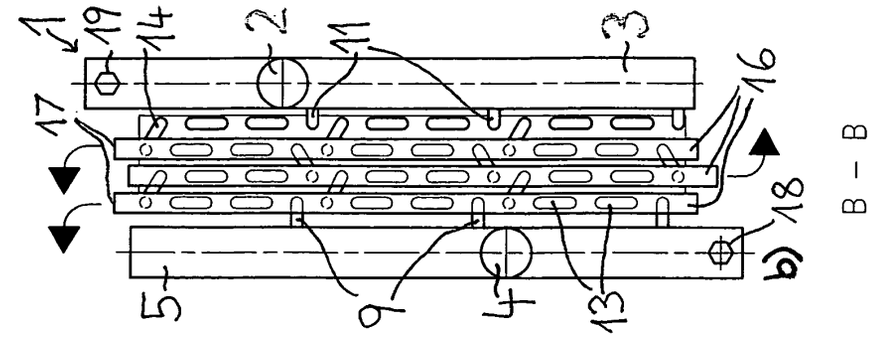


Fig. 8

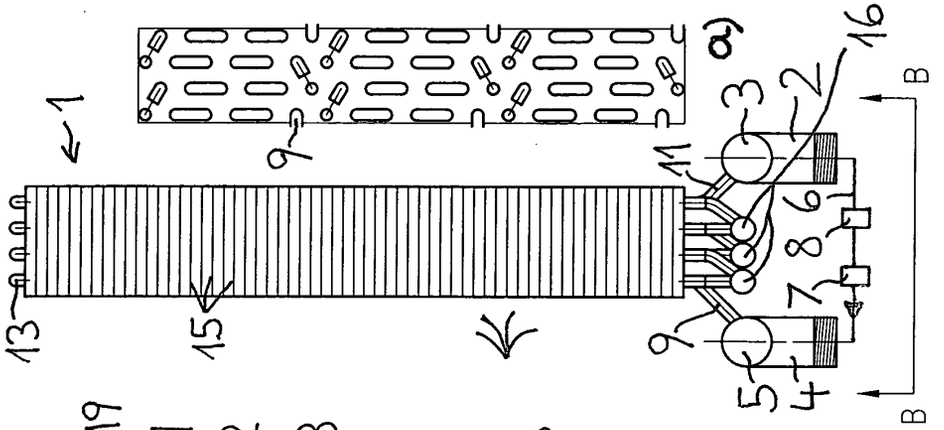


Fig. 4

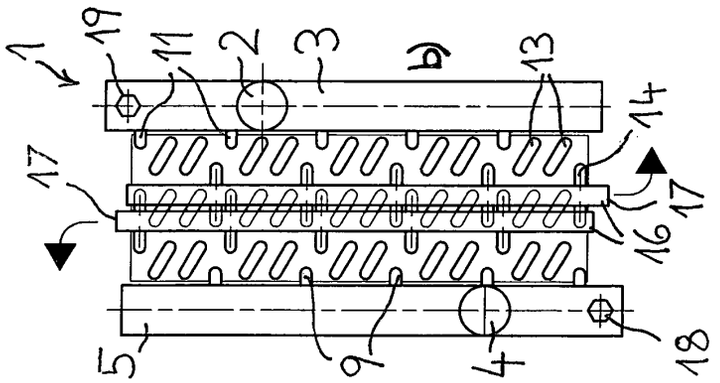
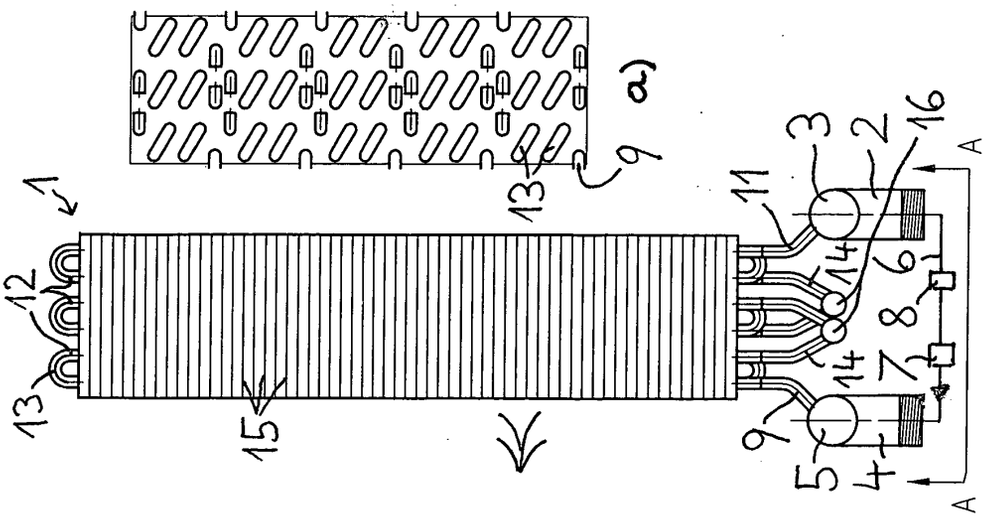


Fig. 3



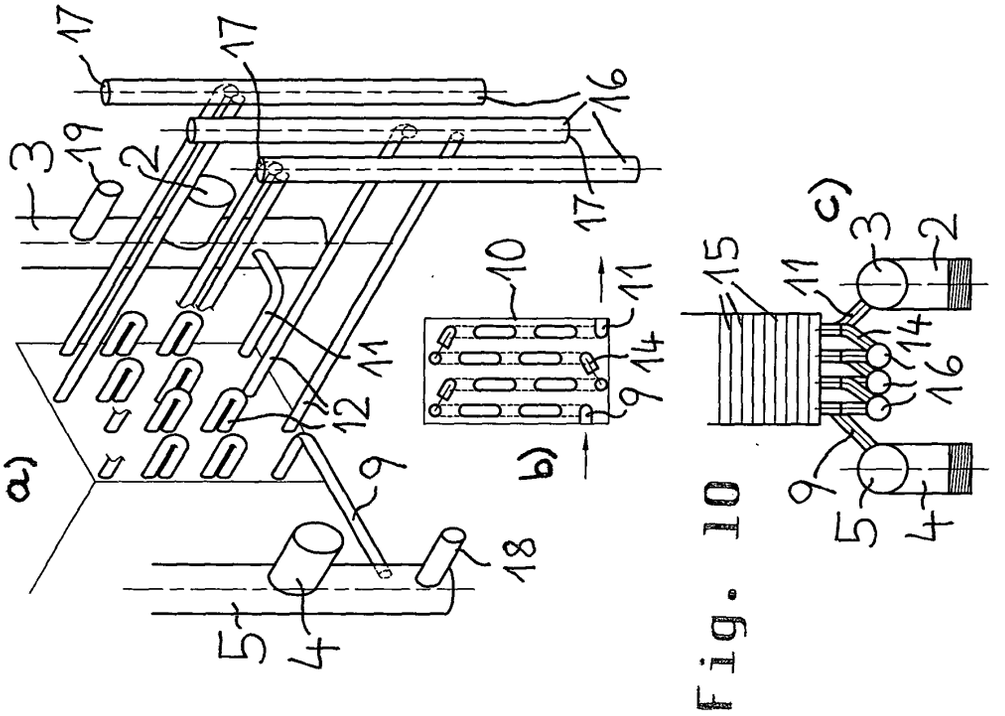

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Fig. 10

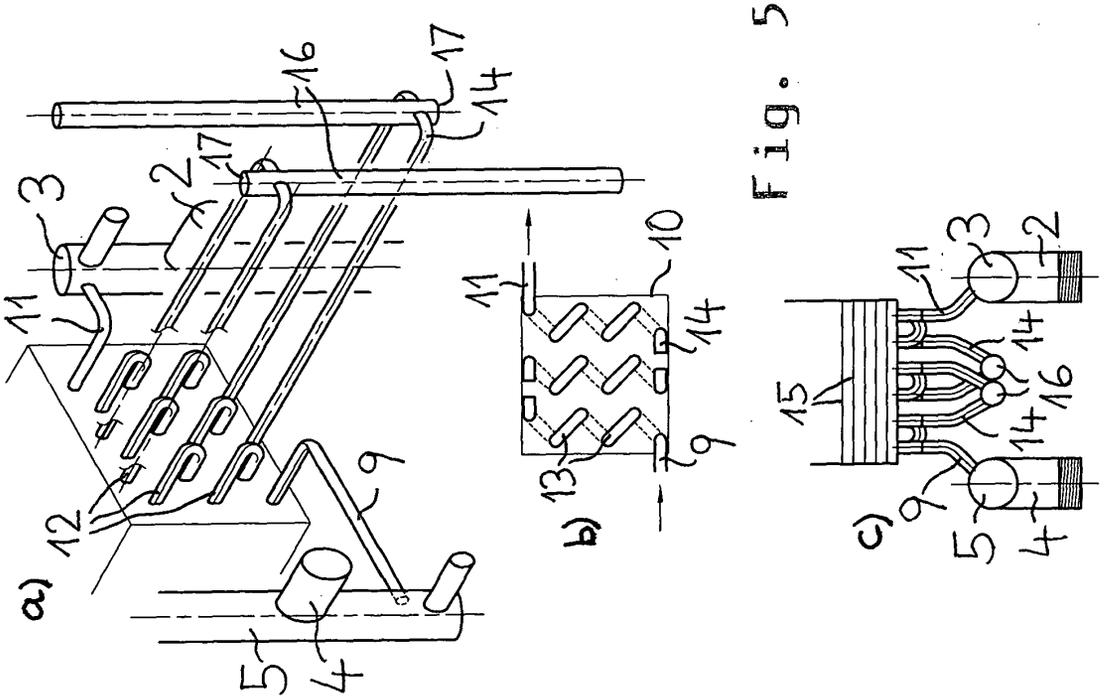
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Fig. 5