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(54) A heat exchanger and a method of manufacturing thereof

(57) The invention relates to a heat exchanger (1) comprising a cooling core (2) consisting of plurality of parallel tubes and cooling fins, two manifolds (3) fluidly connected with opposite ends of each tube, and an inlet and outlet ports for a heat exchanging medium, and a method of manufacturing thereof.

To preliminary assemble the heat exchanger, which allows one-shot furnace brazing of all components thereof, with no need to use auxiliary supporting elements, said method comprises the steps of (i) preliminary assembling on the manifold (3) at least one bracket (4) having a mounting plate (5); (ii) making at least one

fitting block (7) having a slot (8) for the mounting plate (5) of the bracket (4) and a flow duct ended by an orifice (10) surrounded by annular groove (16) for a brazing agent (17), bordered at its outer side by securing ring (18); (iii) pushing the fitting block (7) in the mounting plate (5) of the bracket; (iv) placing at least one joint pipe (11) fluidly connected with the manifold (3), in the orifice (10) of the fitting block (7) to create an annular capillary gap; (v) placing the brazing agent (17) in the annular groove (16) and squeezing the securing ring (18) inwards, at least in few points; and (vi) one shot brazing of the heat exchanger components together.

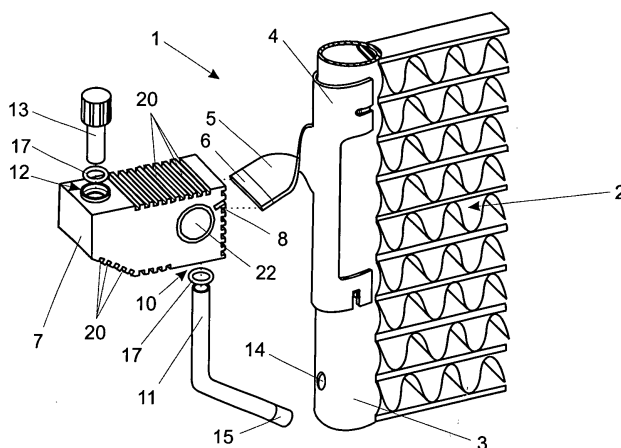


Fig. 1

Description

[0001] The present invention relates to a heat exchanger comprising a cooling core consisting of plurality of parallel tubes and cooling fins, two manifolds fluidly connected with opposite ends of each tube, and an inlet and outlet ports for a heat exchanging medium. The present invention also relates to the method of manufacturing of such a heat exchanger.

[0002] Known heat exchangers constructions comprise inlet and outlet ports for the heat exchanging medium made as jumper tubes brazed directly to manifolds. In case of automotive vehicle car radiators, such a connection often loses its leak proof features due to vibrations of the tubes caused by car engine run or automotive chassis movements. Therefore prior art solutions employ intermediate fitting blocks attached to a heat exchanger and fluidly connected with manifolds by means of joint pipes. The fitting blocks serve as attachment points for jumper tubes or can be employed as points of connection of the heat exchanger with the heat exchanging system.

[0003] The U.S. Pat. application 60/084,311 discloses a fitting block that can be attached to the manifold of a heat exchanger by means of brazing. The longitudinal axis of said block is parallel to the manifold axis and the block comprises a longitudinal surface substantially parallel to the manifold axis, a second surface having a port hole for a jumper tube to which the manifold block is configured for attachment. At least one of the surfaces comprises fins that facilitate heat transfer to the manifold so as to increase the overall heating rate of the manifold during brazing of the block to the jumper tube and the manifold. The port hole is surrounded by a counterbore being sized to serve as a reservoir for the molten braze metal and to prevent molten braze metal from flowing away from the jumper tube, toward the fins during brazing of the jumper tube to the port hole.

[0004] The object of the present invention is to provide a heat exchanger, which enables preliminary assembling, hence making possible to perform one-shot furnace brazing of all heat exchanger components with no need to use auxiliary supporting elements.

[0005] According to the present invention, a heat exchanger is provided, said heat exchanger comprising a cooling core consisting of plurality of parallel tubes and cooling fins, two manifolds fluidly connected with opposite ends of each tube, and an inlet and outlet ports for a heat exchanging medium, characterised in that it comprises at least one bracket having a mounting plate and fastened to the manifold; at least one fitting block with a slot for the mounting plate of the bracket and a flow duct ended with an orifice; at least one joint pipe, fluidly connected between the manifold and the orifice in the fitting block; wherein the orifice in the fitting block is surrounded by an annular groove for brazing agent, bordered at its outer side by securing ring, and between the joint pipe and the wall of the orifice an annular capillary

gap is provided for the brazing agent.

[0006] A fitting block allows preliminary assembling of heat exchanger components, which enables its further one-shot furnace brazing. The fitting block shall serve substantially for either inflow or outflow of the heat-exchanging medium, however it is obvious that application of only one fitting block, connected by means of appropriate piping both to inlet and outlet of the heat exchanger is also possible. It is also possible, depending on the selected design of the heat exchanger, to attach fitting blocks to the same manifold divided by a partitioning plate as well as to connect the fitting blocks to both manifolds. Thanks to the capillary gap, the connection of the joint pipe with the fitting block is extremely durable and relative vibrations of the fitting block and the heat exchanger are not transferred to the connection of the joint pipe with the manifold.

[0007] It is favourable if at least one surface of the fitting block is gaffered in order to equalize the thermal balance of the fitting block, the joint pipe and the bracket during the brazing process.

[0008] Goffering accelerates heating up of the fitting block, which has a bigger thermal capacity than the components it is attached to. Hence, the brazing time is shorter and technological conditions for brazing the individual components of the heat exchanger are improved.

[0009] It is also favourable if the flow duct in the fitting block is ended, at side opposite to the orifice for the joint pipe, with a second orifice for a jumper tube, wherein the shape of the second orifice is the same as the shape of the orifice for the joint pipe.

[0010] Moreover, it is favourable to provide the fitting block with additional assembling holes for attaching the heat exchanger to an appropriate holder structure, which in case of an automotive vehicle radiator, shall be the car chassis.

[0011] According to the present invention there is also provided a method of manufacturing the aforementioned heat exchanger comprising a cooling core consisting of plurality of parallel tubes and cooling fins, two manifolds fluidly connected with opposite ends of each tube and an inlet and outlet ports for a heat exchanging medium. Said method comprises the steps of

(i) preliminary assembling on the manifold at least one bracket having a mounting plate;

(ii) making at least one fitting block having a slot for the mounting plate of the bracket and a flow duct ended by an orifice surrounded by an annular groove for a brazing agent, bordered at its outer side by securing ring;

(iii) pushing the fitting block in the mounting plate of the bracket;

(iv) placing at least one joint pipe fluidly connected

with the manifold, in the orifice of the fitting block to create an annular capillary gap;

(v) placing the brazing agent in the annular groove and squeezing the securing ring inwards, at least in few points; and

(vi) one shot brazing of the heat exchanger components together.

[0012] Preassembling of the bracket and the manifold together is possible e.g. by using brackets having a clamping ring that tightly embraces the manifold or self-locking brackets, preferably in the form of single-unit shaped profiles. However it is essential that the applied bracket has a suitable mounting plate for a slot in the fitting block.

[0013] By squeezing the securing ring inwards the brazing agent is secured against slipping out from the annular groove.

[0014] With regard to the above, it is favourable if the brazing agent piece has a form of a ring.

[0015] Moreover, it is favourable if the flow duct of the fitting block is ended, at side opposite to the orifice for the joint pipe, by second orifice for a jumper tube, wherein the shape of the second orifice is the same as the shape of the orifice for the joint pipe and the jumper tube is placed in the orifice before one shot brazing of the heat exchanger components.

[0016] Using an additional jumper tube can be recommendable in certain constructions of heat exchangers.

[0017] Coating the mounting plate and/or the gap of the fitting block by brazing agent before one shot brazing process of the heat exchanger components is also favourable. Such a coating shall melt during brazing of the heat exchanger.

[0018] The subject of the present invention is presented below in exemplary embodiments, with reference to the figures of the drawing, of which:

Fig. 1 shows an axonometric view of a fragment of a heat exchanger after preassembling of most of its components, but before attaching the joint pipe, the fitting block and the connecting jumper tube,

Fig. 2 shows the heat exchanger after preassembling of all its components together, just before the one-shot brazing procedure.

Fig. 3 shows a cross-section of the joint between the fitting block and the joint pipe after the one-shot brazing procedure, along with enlarged fragment of said joint.

Fig. 4 shows axonometric view of another embodiment of the heat exchanger fitting block, and

Fig. 5 shows a heat exchanger that employs fitting

blocks of different types, as they are shown in Fig. 2 and Fig. 4.

[0019] The heat exchanger 1, of the type of an automotive vehicle radiator, as shown in the drawing Fig. 5, has a cooling core 2 comprising plurality of parallel tubes and cooling fins disposed between the tubes, fluidly connected with two manifolds 3 capable to be connected to the overall cooling system.

[0020] During the manufacturing process of the heat exchanger, individual components of the device are preliminarily assembled, next the whole heat exchanger undergoes the furnace brazing process. Obviously, the number of assembling operations should be minimized, first and foremost permanent consolidation of the whole heat exchanger should be preferably carried out by means of one-shot brazing.

[0021] The drawings Fig. 1 and Fig. 2 show a fragment of the heat exchanger 1 before brazing. The manifold 3, fluidly connected with the cooling core 2, has a bracket 4 attached. In this case the bracket is a self-locking unit made as a shaped aluminium profile. The bracket 4 comprises a mounting plate 5 coated by a brazing agent 6.

[0022] The fitting block 7 made of aluminium is a separate component of the heat exchanger 1. The fitting block 7 has a slot 8, which enables to slide the block onto the mounting plate 5 of the bracket 4.

[0023] Inside the fitting block 7 there is a flow duct 9 (cf. drawing Fig. 3), which ends at its one side with an orifice 10 for a joint pipe 11 and at the other side with an orifice 12 for a jumper tube 13 serving as either inlet or outlet channel for cooling liquid.

[0024] Attaching the joint pipe 11 and the jumper tube 13 to the fitting block 7 with further brazing the components together are characteristic and unique for the present invention.

[0025] As shown in the drawing Fig. 3, the orifice 10 for the joint pipe 11 is surrounded by an annular groove 16 for the brazing agent 17 and bordered from its outer side by the securing ring 18. The orifice 10 has such dimensions that between the joint pipe 11 and the wall of the orifice 10 there is the capillary gap 19 for the brazing agent 17 that shall be inducted into the gap during brazing of the heat exchanger 1. Shaping the brazing agent 17 in the form of a ring is favourable.

[0026] The joint pipe 11 is inserted, from its one side, into the orifice 14 of the manifold 3 and from its other side into the orifice 10 of the fitting block. Around its outlet 14, the joint pipe 11 is covered by a layer of brazing agent 15. Obviously, instead of a layer of brazing agent a ring of the same can be applied, similarly as in the case of the orifice 10.

[0027] The shape and the construction of the second orifice 12 for the jumper tube 13 is substantially identical as the shape and construction of the orifice 10 for the joint pipe 11.

[0028] During assembling, the joint pipe 11 is slipped

into the orifice 10. The brazing agent 17 is placed inside the annular groove 16 and edges of the securing ring 18 are bent and squeezed inwards either along the whole circle or at several points to preserve the brazing agent 17 from slipping out. The drawing Fig. 2 shows the assembled heat exchanger before brazing operation.

[0029] To equalize the heat balance of the fitting block 7, the joint pipe 11, the jumper tube 13 and the bracket 4 during the brazing process, both the top and bottom surfaces of the fitting block 7 are goffered. As a result a grid of parallel recess hollows and fins 20 is formed, which accelerate the heating up the fitting block 7.

[0030] The drawing Fig. 4 presents another embodiment of the fitting block 7'. Although the shape of the block as well as layout of the slots differ from the previous solution, basic features, including the method of attaching the joint pipe 11' as well as the gap 8', which enables to slide the fitting block onto the mounting plate 5' of the bracket 4' attached to the manifold 3 are still the same.

[0031] The drawing Fig. 5 shows the heat exchanger with the brackets 4 and 4' as well the fitting blocks 7 and 7' as they are shown in the drawings Fig. 1, Fig. 2 and Fig. 4. In that embodiment the fitting blocks are attached to the same manifold, which is divided by the partitioning plate 21. It is obvious that connecting the heat exchanger to both manifolds is possible with no need to use the partitioning plate 21. Fitting blocks and brackets of the same type, e.g. 4 and 7 can also be applied.

[0032] The fitting blocks 7 and 7' make possible to attach the heat exchanger 1 to other components of the cooling system, for which suitable orifices 22 and 22' are provided.

[0033] In an alternative construction of the heat exchanger the jumper tubes 13 and 13' can be eliminated. Instead, the fitting blocks 7 and 7' can be provided with appropriate connecting means, e.g. threaded orifices.

Claims

1. A heat exchanger comprising a cooling core consisting of a plurality of parallel tubes and cooling fins, two manifolds fluidly connected with opposite ends of each tube, and an inlet and outlet ports for a heat exchanging medium, **characterised in that** it comprises at least one bracket (4, 4') having a mounting plate (5, 5') and fastened to the manifold (3); at least one fitting block (7, 7') with a slot (8, 8') for the mounting plate (5, 5') of the bracket (4, 4') and a flow duct (9) ended with an orifice (10); at least one joint pipe (11), fluidly connected between the manifold (3) and the orifice (10) in the fitting block (7, 7'); wherein the orifice (10) in the fitting block (7, 7') is surrounded by an annular groove (16) for brazing agent (17), bordered at its outer side by securing ring (18), and between the joint pipe (11,

11') and the wall of the orifice (10) an annular capillary gap (19) is provided for the brazing agent (17).

2. A heat exchanger according to claim 1, **characterised in that** at least one surface of the fitting block (7, 7') is goffered in order to equalize the thermal balance of the fitting block (7, 7'), the joint pipe (11, 11') and the bracket (4, 4') during the brazing process.
3. A heat exchanger according to claim 1, **characterised in that** the flow duct in the fitting block (7, 7') is ended, at side opposite to the orifice (10) for the joint pipe (11, 11'), with a second orifice (12) for a jumper tube (13), wherein the shape of the second orifice (12) is the same as the shape of the orifice (10) for the joint pipe (11, 11').
4. A heat exchanger according to claim 1, **characterised in that** the fitting block (7, 7') comprises additional assembling holes (22, 22').
5. A method of assembling a heat exchanger comprising a cooling core consisting of a plurality of parallel tubes and cooling fins, two manifolds fluidly connected with opposite ends of each tube and an inlet and outlet ports for a heat exchanging medium, **characterised in that** it comprises the steps of
 - (i) preliminary assembling on the manifold (3) at least one bracket (4, 4') having a mounting plate (5, 5');
 - (ii) making at least one fitting block (7, 7') having a slot (8, 8') for the mounting plate (5, 5') of the bracket (4, 4') and a flow duct (9) ended by an orifice (10) surrounded by an annular groove (16) for a brazing agent (17), bordered at its outer side by securing ring (18);
 - (iii) pushing the fitting block (7, 7') in the mounting plate (5, 5') of the bracket;
 - (iv) placing at least one joint pipe (11, 11') fluidly connected with the manifold (3), in the orifice (10) of the fitting block (7, 7') to create an annular capillary gap;
 - (v) placing the brazing agent (17) in the annular groove (16) and squeezing the securing ring (18) inwards, at least in few points; and
 - (vi) one shot brazing of the heat exchanger components together.
6. A method according to claim 5, **characterised in that** the brazing agent (17) has a form of a ring.

7. A method according to claim 5 or 6, **characterised in that** the flow duct of the fitting block (7, 7') is ended, at side opposite to the orifice (10) for the joint pipe (11, 11'), by second orifice (12) for a jumper tube (13), wherein the shape of the second orifice (12) is the same as the shape of the orifice (10) for the joint pipe (11, 11') and the jumper tube (13) is placed in the orifice (12) before one shot brazing of the heat exchanger components.
8. A method according to claim 5, **characterised in that** the mounting plate (5, 5') and/or the gap (8, 8') of the fitting block (7, 7') is coated by brazing agent (6) before one shot brazing process of the heat exchanger components.

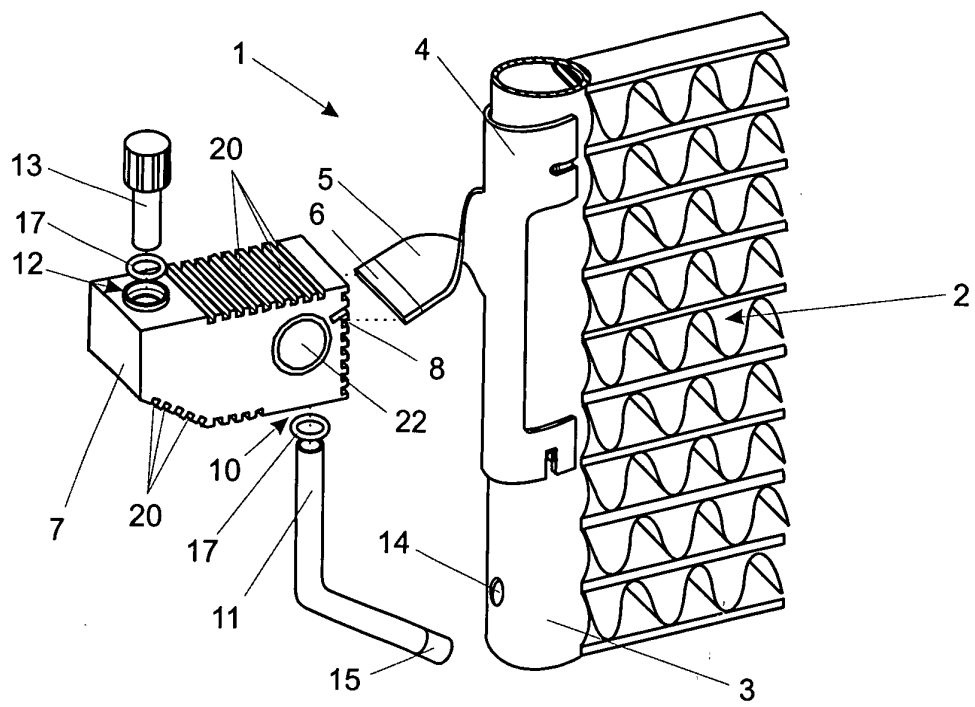


Fig. 1

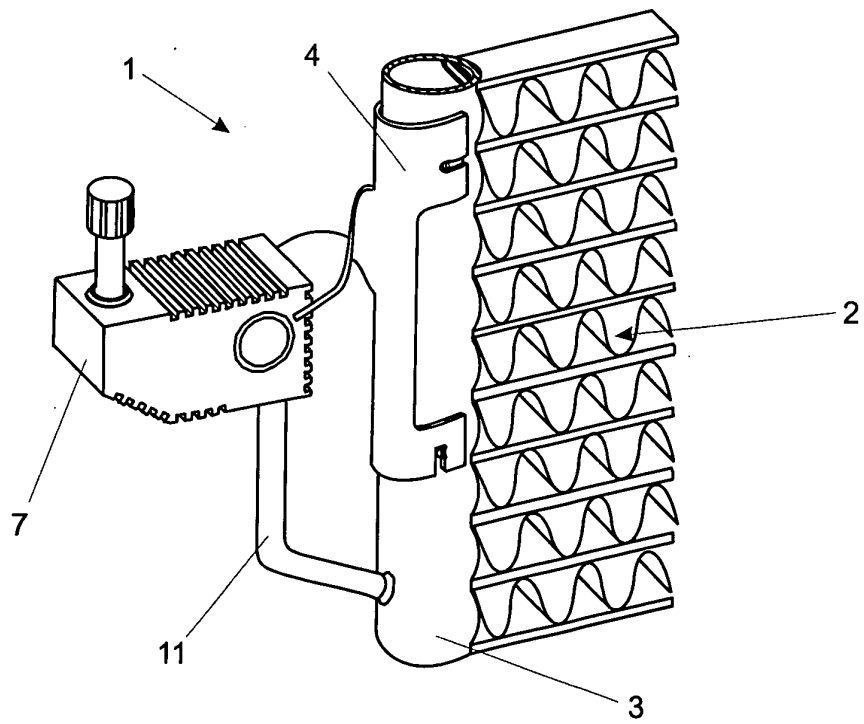


Fig. 2

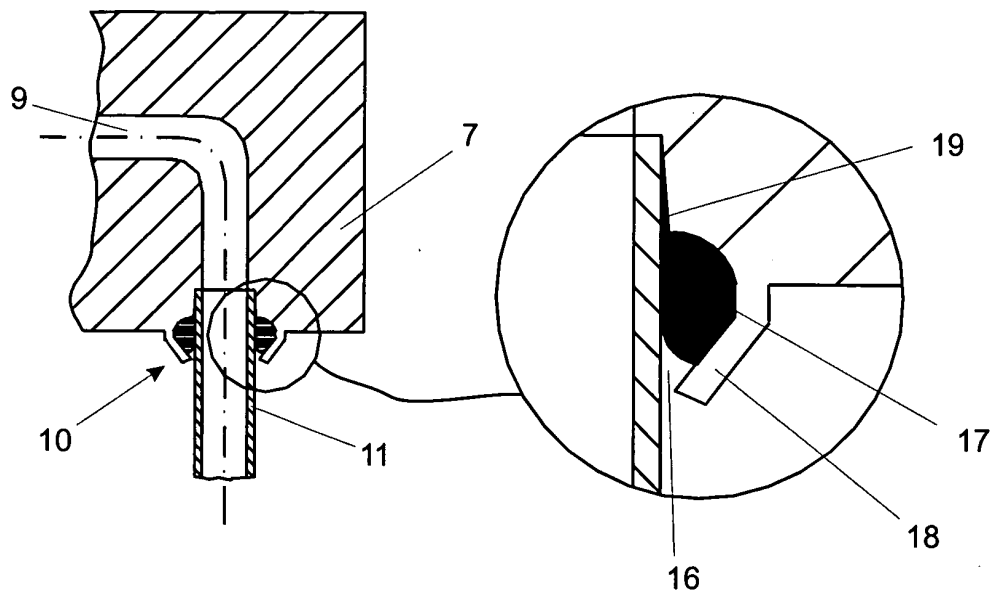


Fig. 3

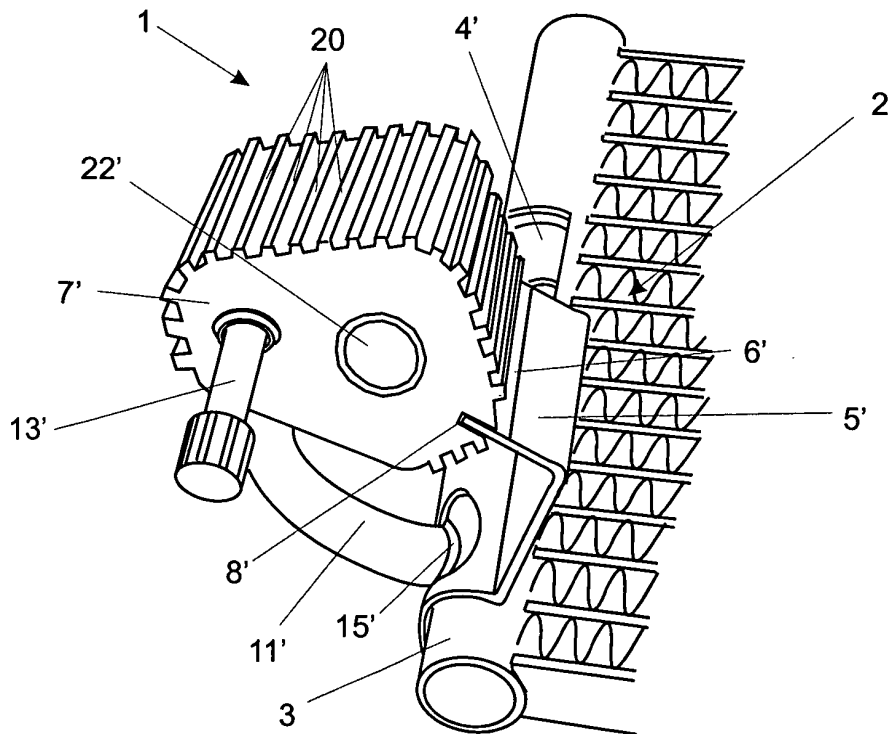


Fig. 4

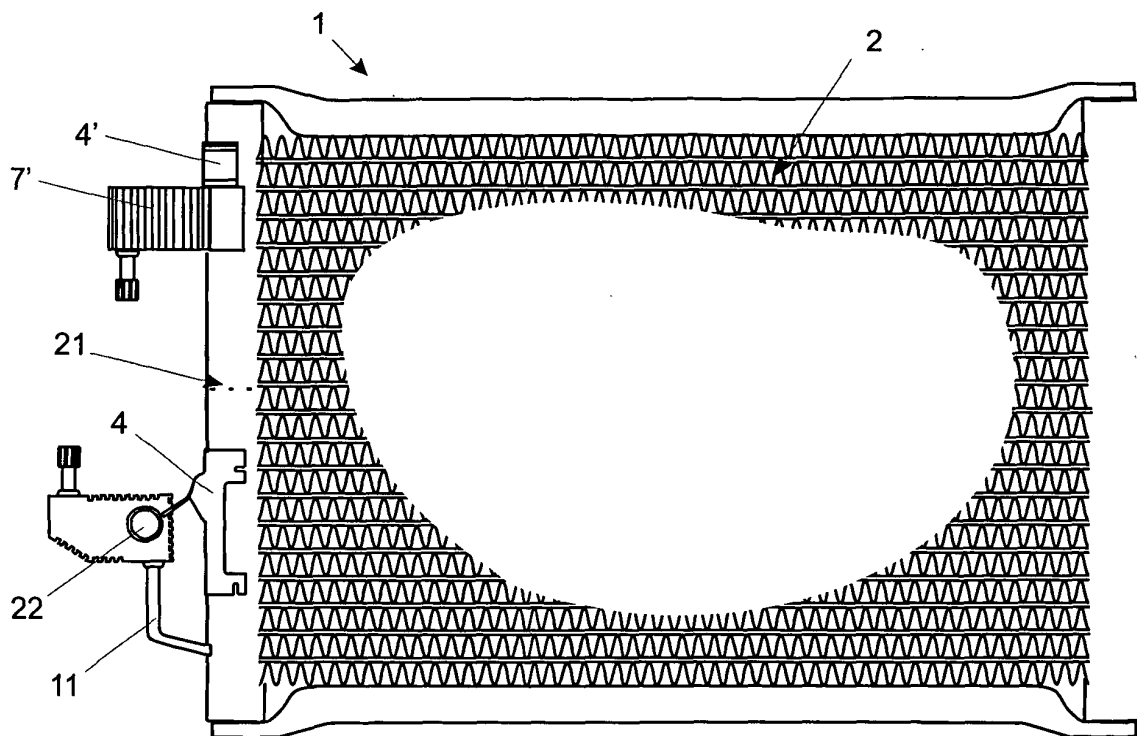


Fig. 5