



US 20140224455A1

(19) **United States**(12) **Patent Application Publication**
Kalbacher et al.(10) **Pub. No.: US 2014/0224455 A1**(43) **Pub. Date: Aug. 14, 2014**(54) **CONDENSER WITH A STACK OF HEAT EXCHANGER PLATES**(71) Applicant: **Modine Manufacturing Company,**
Racine, WI (US)(72) Inventors: **Klaus Kalbacher**, Rangendingen (DE);
Rebecca Frey, Esslingen (DE)(21) Appl. No.: **14/179,653**(22) Filed: **Feb. 13, 2014**(30) **Foreign Application Priority Data**

Feb. 14, 2013 (DE) 102013002545.1

Publication Classification(51) **Int. Cl.**
F28F 3/08 (2006.01)
F25B 39/04 (2006.01)(52) **U.S. Cl.**CPC **F28F 3/086** (2013.01); **F25B 39/04**
(2013.01)USPC **165/104.21**

(57)

ABSTRACT

A condenser has a stack of heat exchanger plates that includes at least a first section for condensation of a refrigerant and a second section for supercooling the refrigerant. A refrigerant flow channel and another flow channel for a liquid coolant stream are formed in each of the first and second sections between the heat exchanger plates that are in heat-exchanging relation. The stack of heat exchanger plates is perforated by inflow and outflow channels for the coolant stream and for the refrigerant, which are connected to the at least one flow channel or the other flow channel. The coolant stream can be divided into a coolant main stream and at least one coolant partial stream, and at least one coolant partial stream, a throttle-like device is arranged in the inflow channel to divert the at least one coolant partial stream, and the at least one coolant partial stream is positioned to super-cool the refrigerant.

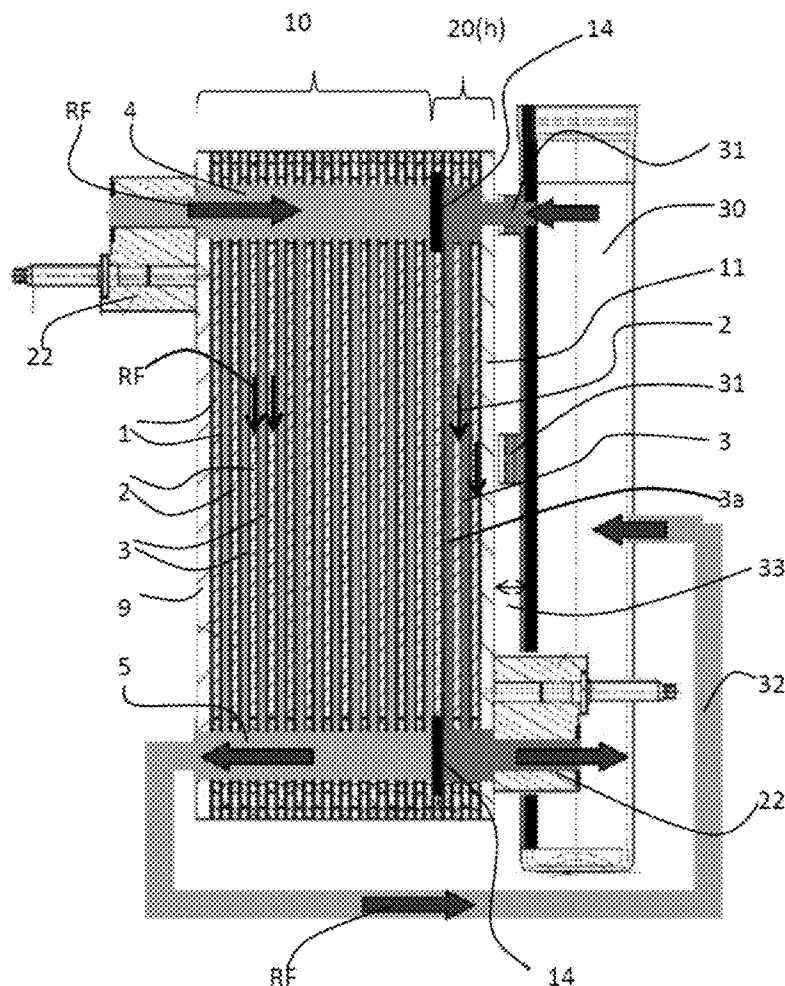


FIG. 1

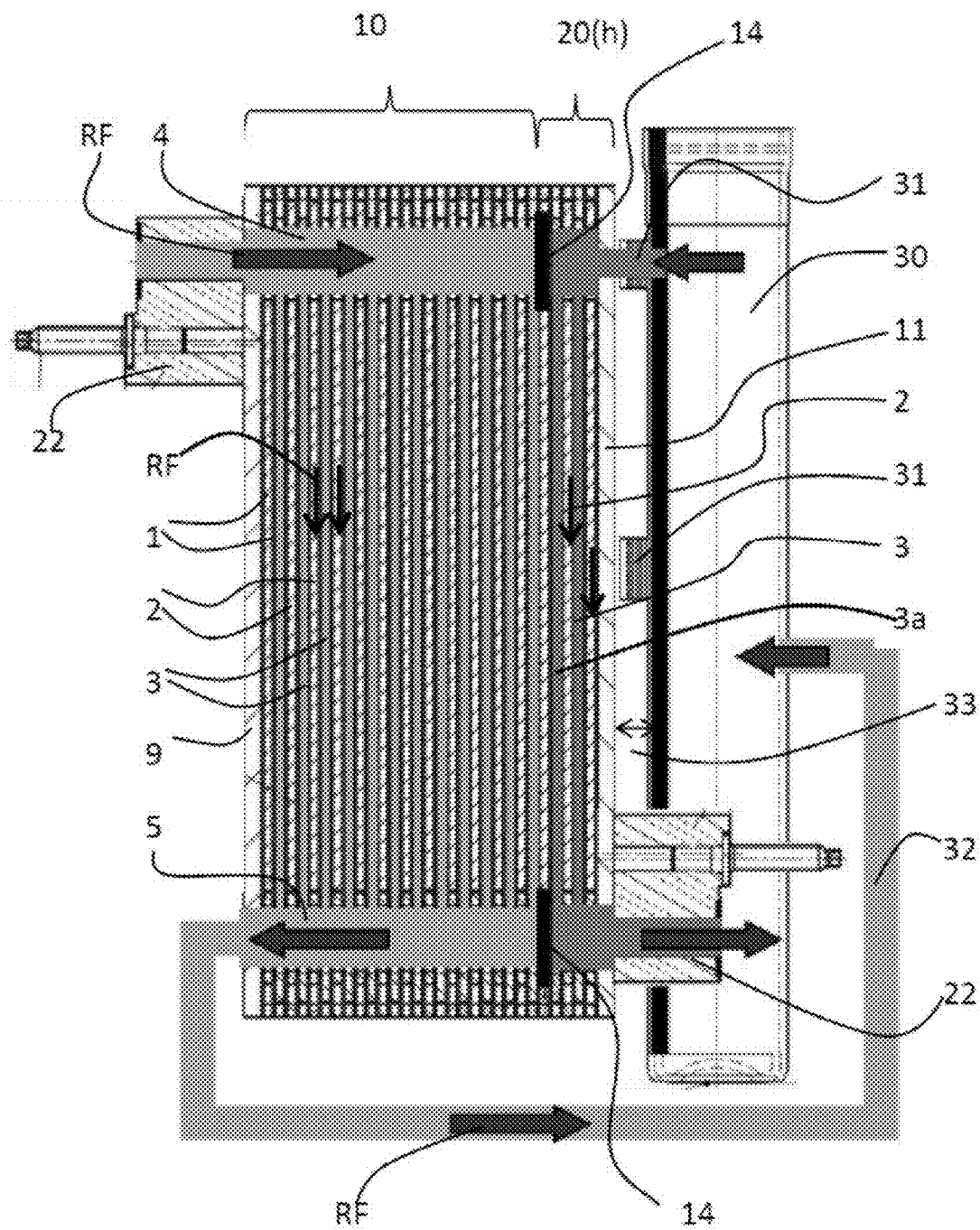


FIG. 2

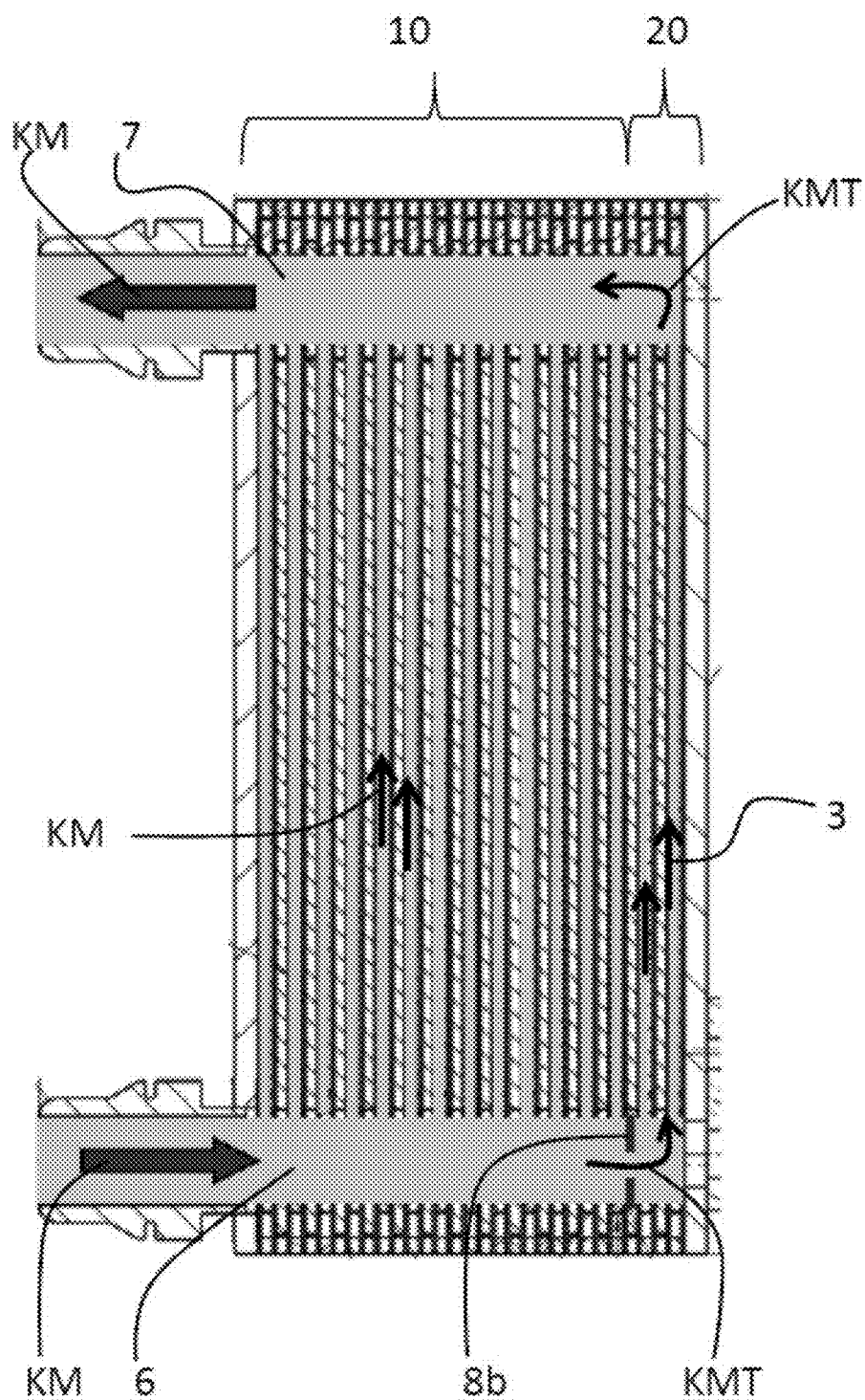


FIG. 3

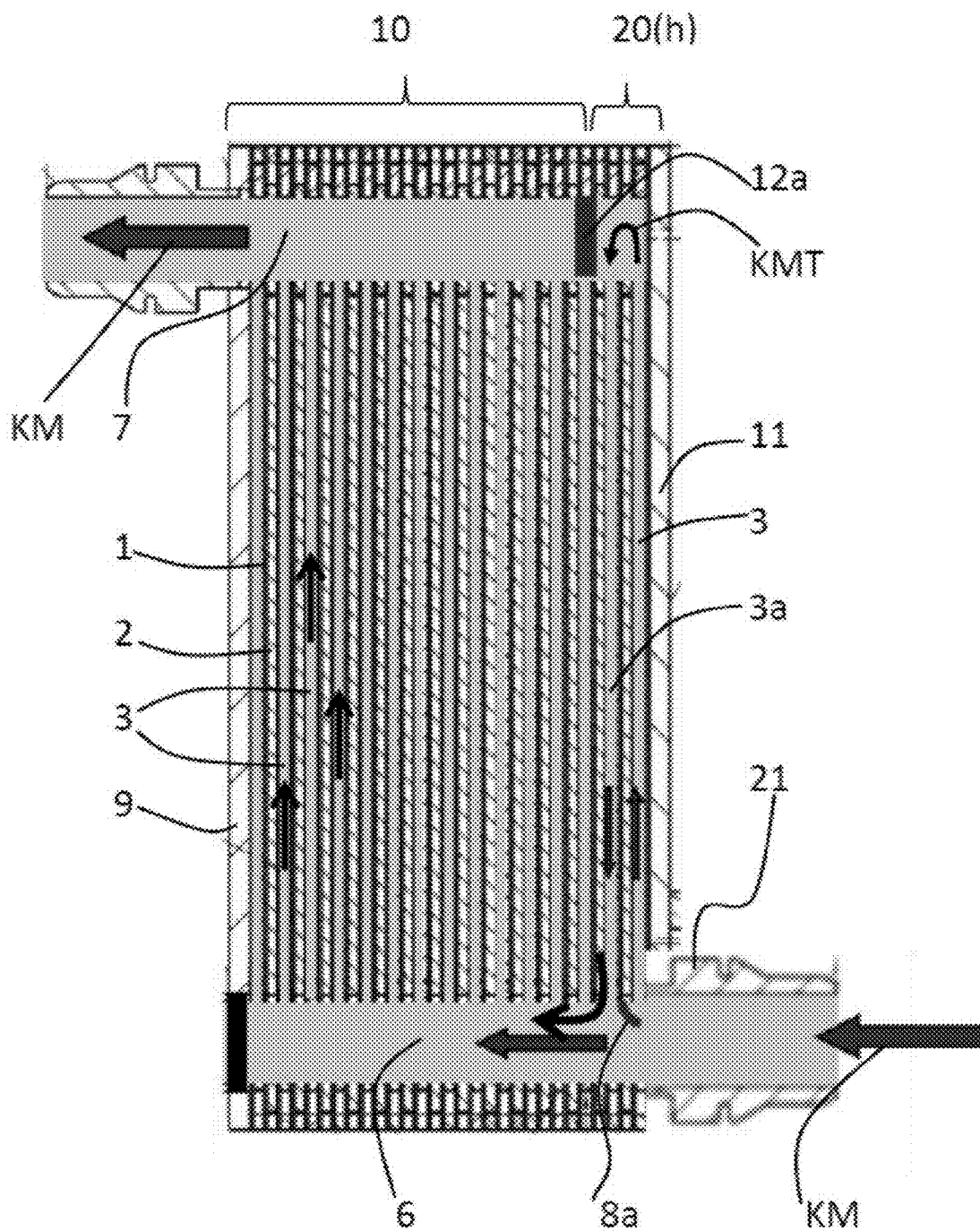


FIG. 4

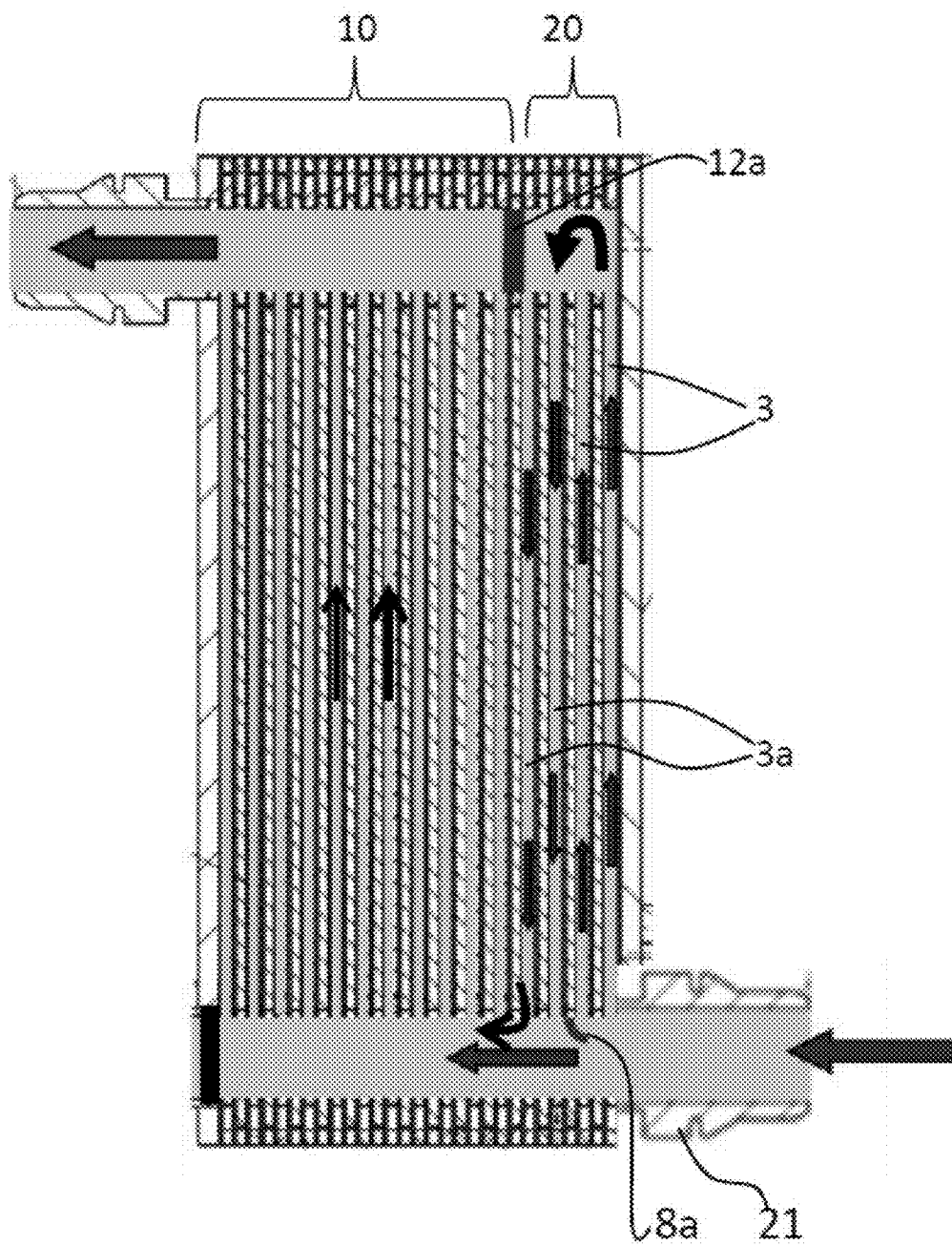
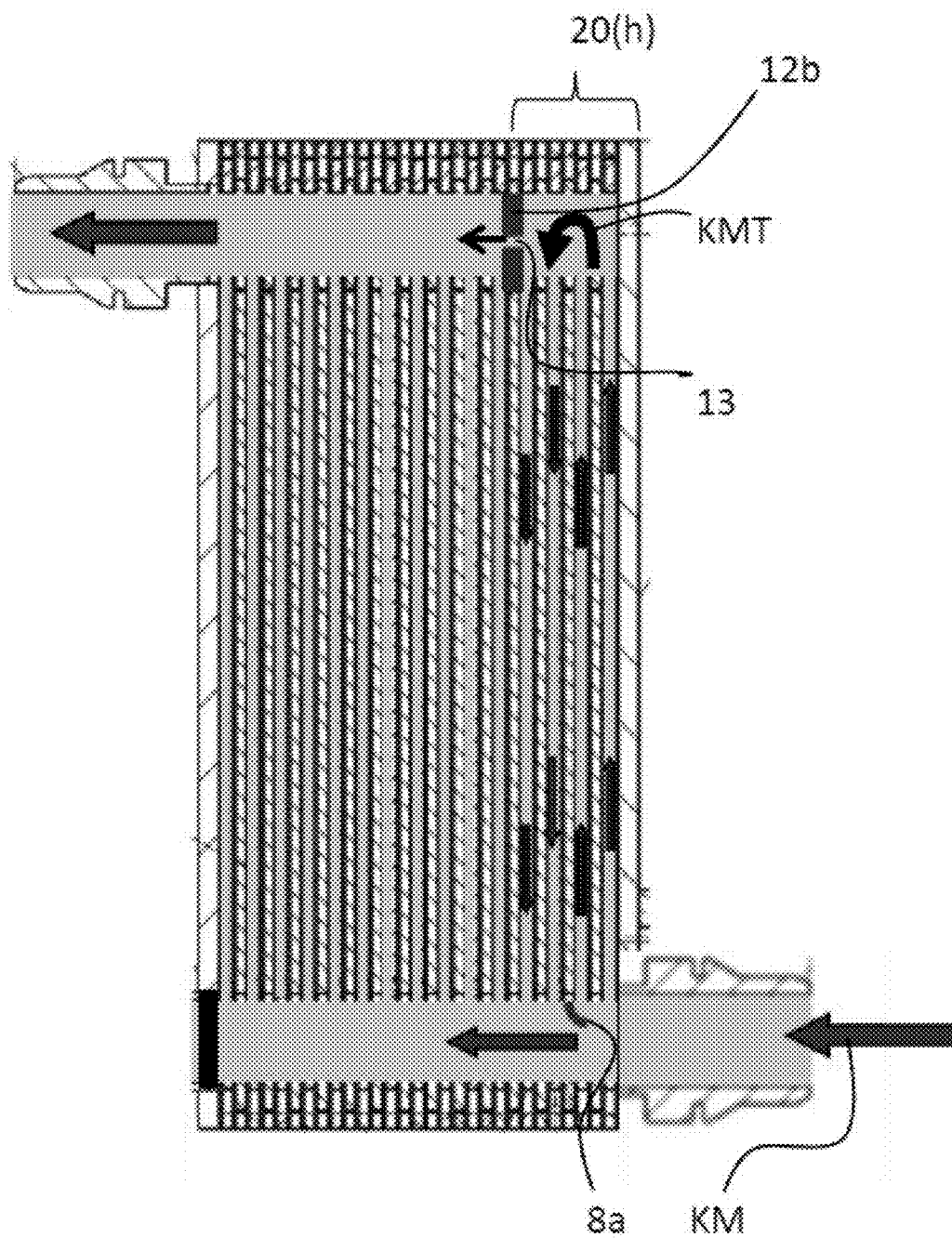


FIG. 5



CONDENSER WITH A STACK OF HEAT EXCHANGER PLATES

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to German Patent Application No. DE 10 2013 002 545.1, filed Feb. 14, 2013, the entire contents of which are hereby incorporated by reference herein.

BACKGROUND

[0002] The invention relates to a condenser with at least one stack of heat exchanger plates, which has a first section for condensation of a refrigerant and a second section for supercooling of the refrigerant, in which case at least one flow channel for the refrigerant and at least one other flow channel for a liquid coolant stream are formed between the heat exchanger plates in each section, which are in a heat-exchanging relation, the stack being perforated by inflow and outflow channels for the coolant stream and for the refrigerant, which are hydraulically connected to at least one or the other flow channel.

[0003] Such a condenser can be used in air conditioning systems of vehicles.

[0004] The liquid coolant in U.S. Pat. No. 7,469,554 B2 enters the second section, flows through it and in so doing supercools the already condensed refrigerant. The coolant then flows with an already somewhat increased temperature through the first section in order to condense the refrigerant.

[0005] It is proposed in DE 10 2011 008 429 A1 to traverse the first and/or second section with a coolant having a lower temperature. This permits a performance improvement of the condenser. However, the system costs are quite high, since a cooling loop must be equipped accordingly in order to furnish coolant at a lower temperature.

SUMMARY

[0006] The task of the invention includes a performance improvement of such condensers without having to equip the coolant loop and without having to make corresponding investments.

[0007] It is important according to some aspects of the invention that the coolant stream within the condenser is divisible into a coolant main stream and at least one coolant partial stream. To implement this aspect it is further proposed that a throttle-like device be arranged in the inlet channel for the coolant stream to divert the partial stream from the coolant entering the condenser. The partial stream serves for supercooling of the refrigerant in the second section, i.e., it traverses the at least one other flow channel of the second section, namely the supercooling section of the condenser.

[0008] The coolant main stream can enter the at least one other flow channel of the first section and effectively perform condensation of the refrigerant without already being significantly heated beforehand.

[0009] In a variant according to the invention it is proposed that the partial stream can be fed back to the inlet channel by at least a second other flow channel in the second section. The partial stream therefore covers at least a U-shaped path within the second section or the supercooling section.

[0010] In terms of design it can be advantageous in this context that a cutoff be arranged in the outflow channel for the coolant stream, which forces the coolant stream to traverse at

least a second other flow channel in the second section. Instead of cutoff, another connection could also be provided between the first other flow channel and the second other flow channel at their ends, which, however, may be somewhat more cumbersome, since the other flow channels in this case must not discharge into the outflow channel.

[0011] Some advantages are expected from this embodiment because the still relatively cool coolant has a fairly high temperature difference relative to the refrigerant. Because the partial stream is fed back to the inlet channel the entire coolant stream can then flow through the first section and be used for condensation of the refrigerant.

[0012] According to some embodiments according to the invention, the partial stream, after traversing the supercooling section and the at least one other flow channel, discharges directly into the outflow channel for the coolant stream and leaves the condenser through it, together with the main stream of the coolant coming from the first section. Here again there is a higher temperature difference that can lead to performance improvements.

[0013] The performance improvement of the condenser is expected without having to provide a low temperature cooling loop. The system costs will be comparatively low.

[0014] Naturally the condenser according to the invention can also be installed in cooling systems, for example, in or of vehicles which are equipped anyway with a low temperature cooling loop for other reasons. In these cases, at least the direct connection costs of the condenser can be reduced, since lines from this loop to the condenser and back again are not required.

[0015] The invention is described with reference to the appended drawings in three practical examples. This description contains additional features that might turn out later to be beneficial to the invention.

[0016] Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

[0017] The appended figures can be understood as sections through a condenser.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. 1 shows a condenser according to the invention with flow on the refrigerant side.

[0019] FIG. 2 shows the condenser according to FIG. 1 with flow on the coolant side in a practical example.

[0020] FIG. 3 shows another practical example with flow on the coolant side.

[0021] FIGS. 4 and 5 show modifications of the practical example according to FIGS. 1 and 3.

DETAILED DESCRIPTION

[0022] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways.

[0023] The condenser according to FIGS. 1-5 has a stack of preferably rectangular heat exchanger plates 1. First and second cover plates 9, 11 are situated on the stack, which can be seen in the figures on the left and right side of the stack. The heat exchanger plates 1 have a peripheral bent edge, which is

not shown in the drawings, and a generally flat bottom, which, however, can also have local structures to generate turbulence. The individual plates **1** lie against each other on this edge so that flow channels **2** for a refrigerant RF and flow channels **3** for a liquid coolant stream KM remain between their bottoms, in which heat exchange mostly occurs. In the practical examples another flow channel **3** for coolant therefore follows the flow channel **2** for refrigerant, i.e., the channels **2, 3** alternate, as can be seen from the figures. The flow channels **2** for refrigerant RF are shown with dashed lines. Inserted turbulizers (fins or the like) can also be arranged in the flow channels **2, 3** (not shown).

[0024] An inflow channel **4** for refrigerant RF, which is formed by means of openings in plates **1** and extends through the plate stack, is connected via the flow channels **2** to an outflow channel **5** for refrigerant also extending through the plate stack (FIG. 1). Likewise, another inflow channel **6** for the coolant stream is connected via flow channels **3** to the outflow channel **7** for the coolant (FIGS. 2-5). The openings that form the inflow and outflow flow channels **4-7** are arranged in the corner areas of the plates **1**.

[0025] Corresponding connectors **21** are soldered to the cover plates **9, 11** on the inflow channel **6** for coolant KM and on the outflow channel **7**. Other connections **22** are provided for refrigerant RF on the inflow and outflow channels **4, 5**.

[0026] As is also apparent from FIG. 1, a collecting tank **30** is fastened on the stack, more precisely stated, on its second cover plate **11**, which takes up the condensed refrigerant coming from the first section **10** through a refrigerant line **32** and which flows from the collecting tank **30** into the second section **20** for supercooling. The collecting tank **30** causes any gas bubbles still present in refrigerant RF to be separated and only liquid refrigerant can reach the second section **20**. It can also contain a dryer (not shown). The collecting tank **30** is equipped with a connector **31** having at least one passage opening, through which the liquid refrigerant RF can flow into the second section **20**. The connector **31** is situated on the opposite end of the mentioned inlet channel **4** on the second cover plate **11**. The refrigerant encounters a partition **14** or section separation in the inlet channel **4** mentioned further below and then flows into the second section **20**. It leaves the second section **20** via the outflow channel **5**, in which a partition **14** is also situated, and flows through another connection **22** back into circulation (not shown). The connector **31** is simultaneously formed as a solder connector **31** in order to permit the mentioned fastening. The solder connector **31** ensures a slight spacing **33** between the other wall of the collecting tank **30** and cover plate **11**, which has manufacturing advantages.

[0027] With the practical example according to FIG. 2, a situation is achieved in which a partial stream KMT of liquid coolant also arrives in the second section **20**, or in the supercooling section with a fairly low temperature, although the beginning of the inflow channel **6** is situated on the first section **10** which is the condensation section. This is made possible by the fact that a throttle-like device in the form of a perforated disk **8b** is arranged within the condenser close to the end of the inlet channel **6**, namely at the transition from the first **10** to the second section **20**. The position of the perforated disk **8b** hydraulically separates two flow channels **3** for coolant from the stack in this practical example, which together with two other flow channels **2** for refrigerant RF form the second section **20**. The coolant stream KMT flows through the two flow channels **3** and discharges directly into outflow

channel **7**. A coolant main stream can enter the flow channels **3** of the first section **10** in front of the perforated disk **8b** with low temperature -viewed in its direction of flow.

[0028] The two flow channels **2** for refrigerant RF are then separated by means of the mentioned partitions **14**, viewed hydraulically, from the stack, which are situated in corresponding positions in the inflow and outflow channels **4, 5** for refrigerant, as is readily apparent from FIG. 1.

[0029] The practical examples according to FIGS. 3-5 can result in larger thermodynamic advantages. In these practical examples, the beginning of the inflow channel **6** (in contrast to FIG. 2) is situated on the second section **20** or on the supercooling section. Relatively close to the mentioned beginning, namely in the area of the second section **20**, another throttle-like device is arranged in the inflow channel **6**, i.e., within the condenser in the form of a vane **8a** or the like, extending into the inflow channel **6**. The vane **8a** is designed somewhat curved in the direction of the arriving coolant in order to equip it with guiding properties to divert the coolant partial stream KMT from the coolant. The partial stream KMT can be adjusted by the size of vane **8a**, which extends into the inflow channel **6**, starting at the mentioned flow channel **3**. In FIG. 3 the vane **8a** is situated in the position in which it provides a single flow channel **3**, in which the coolant stream KMT flows to the outflow channel **7**, and an additional flow channel **3a**, in which the partial stream KMT flows back to the inflow channel **6** in the second section **20**. For this purpose a full cutoff **12a** is arranged in the outflow channel **7**, which causes a reversal of the direction of flow.

[0030] FIGS. 4 and 5 differ from FIG. 3 by an altered position of the vane **8a** and cutoff **12a**. In these figures the positions were chosen so that two flow channels **3** are present for inflow of the partial stream KMT and two additional flow channels **3a** for its backflow.

[0031] Generally speaking, the vane **8a** is always situated roughly at half-height h of the second section **20**. Cutoff **12a** is situated, on the other hand, in a position that corresponds to roughly height h of the second section **20**. Height h in the drawings corresponds roughly to the plate area shown by the braces and the reference number **20** (see FIGS. 3 and 5).

[0032] In contrast to FIGS. 3 and 4, the cutoff **12b** in FIG. 5 is designed as a partial cutoff **12b**. In the illustrated case, the partial cutoff **12b** is provided by the fact that cutoff **12a** is provided with a central hole **13**. Through corresponding hole sizes the flow through the second section **20** can be optimized by means of partial stream KMT, which also applies to the perforated disk **8b**, which was discussed in conjunction with FIG. 2 above.

[0033] The coolant main stream in the practical examples (viewed in its flow direction) enters the flow channels **3** of the first section **10** with even lower temperature beyond the throttle-like device **8a**.

[0034] It is also possible to split off the coolant partial stream KMT outside the condenser but preferably in its immediate vicinity from the coolant stream KM and to feed it separately into the second section **20**, which was not shown. Flow through the condenser by means of the main stream and partial stream KMT then remains unchanged.

[0035] Finally, it should be mentioned that the condenser can be also traversed meander-like by arranging additional cutoffs **12** and partitions **14** in the inflow and outflow channels **4-7** in the first and second sections **10, 20**, so that it has corresponding subsections. The arrows in the figures of the

practical examples, on the other hand, show that only simple flow and in the second section 20, preferably also, U-shaped flow are provided.

[0036] In condensers that use air as coolant and which ordinarily have plate stacks that do not form flow channels, but a tube-rib stack, a meander-like flow can also occur on the refrigerant side in one or both sections 10, 20. The ribs represent flow channels for the cooling air and the tubes are flow channels for the refrigerant RF. The partitions 14 forming the mentioned subsections for deflection of the refrigerant are situated in collecting tubes arranged on the tube ends.

[0037] Various features and advantages of the invention are set forth in the following claims.

What is claimed is:

1. A condenser comprising:
 - at least one stack of heat exchanger plates;
 - at least a first section for condensation of a refrigerant; and
 - at least a second section for supercooling of the refrigerant, wherein at least one flow channel for the refrigerant and at least one flow channel for a liquid coolant stream are formed in each of the first and second sections between the heat exchanger plates,
 - wherein the at least one flow channel for the refrigerant and the least one flow channel for the liquid coolant are in heat-exchanging relation,
 - wherein the stack of heat exchanger plates are perforated by inflow and outflow channels for the liquid coolant stream and for the refrigerant, the inflow and the outflow channels are connected to the at least one flow channel for the refrigerant and the at least one flow channel for a liquid coolant stream,
 - wherein the liquid coolant stream is divided into a coolant main stream and at least one coolant partial stream, and wherein a throttle-like device is arranged in the inflow channel to divert the at least one coolant partial stream, the at least one coolant partial stream positioned to supercool the refrigerant.
2. The condenser according to claim 1, wherein the at least one coolant partial stream is fed back to the inflow channel at least mostly through at least one second flow channel for the liquid coolant stream arranged in the second section.
3. The condenser according to claim 1, wherein the at least one flow channel for the liquid coolant stream arranged in the second section discharges directly in the outflow channel for the coolant.
4. The condenser according to claim 1, wherein the at least one coolant partial stream discharges directly in the outflow channel for the coolant.
5. The condenser according to claim 1, further comprising a cutoff arranged in the outflow channel for the coolant stream, the cutoff essentially separates an area from this outflow channel in which all or at least most of the partial stream is forced to flow through the at least one second other flow channel in the second section and to flow back to the inflow channel.
6. The condenser according to claim 1, wherein the inflow channel, as viewed in the direction of the inflowing coolant,

begins on the second section, the throttle-like device being arranged relatively close to the beginning of the inflow channel, the throttle-like device including at least one vane extending into the inflow channel, the at least one vane deflects the partial stream into the at least one other flow channel of the second section.

7. The condenser according to claim 6, wherein the throttle-like device is arranged roughly at half-height of the second section in the inflow channel.

8. The condenser according to claim 6, wherein the partial stream enters the inflow channel again behind the throttle-like device, as viewed in the direction of the inflowing coolant.

9. The condenser according to claim 1, wherein the inflow channel, as viewed in the direction of the inflowing coolant, begins on the first section and the throttle-like device is arranged relatively close to the end of the inflow channel.

10. The condenser according to claim 5, wherein the throttle-like device includes a perforated disk.

11. The condenser according to claim 10, further comprising a first partition arranged in the inflow channel and a second partition arranged in the outflow channel for the refrigerant.

12. The condenser according to claim 11, wherein the first and second partitions, the cutoff and the perforated disk lie at roughly one level and define the barrier between the first and second sections.

13. The condenser according to claim 1, wherein the throttle-like device is a cross-sectional narrowing of the inflow channel.

14. The condenser according to claim 11, further comprising a collecting tank fastened on the stack, the collecting tank takes up condensed refrigerant coming from the first section, and dispenses condensed refrigerant into the second section for supercooling.

15. The condenser according to claim 14, wherein one wall of the collecting tank is formed with a connector having a passage opening.

16. The condenser according to claim 15, wherein the stack further includes a first and second cover plate and the connector for fastening of the collecting tank to the second cover plate, wherein a spacing is defined between the wall and the second cover plate.

17. The condenser according to claim 16, wherein the connector provides a flow connection from the collecting tank through the second cover plate into the part of the inflow channel separated by the first partition and into the second section.

18. The condenser according to claim 1, wherein the coolant main stream, as viewed in the flow direction of the main stream, enters at least another flow channel of the first section behind the throttle-like device and flows through it.

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