US 20090065186A1

(19) **United States**

(12) **Patent Application Publication**

Cheung

(10) **Pub. No.: US 2009/0065186 A1**

(43) **Pub. Date: Mar. 12, 2009**

(54) **CONDENSER ASSEMBLY**

(76) Inventor: **Wai Kwan Cheung**, Dongguan (CN)

Correspondence Address:
BYIP, LTD.
P.O. BOX 1484, GENERAL POST OFFICE
HONG KONG (CN)

(21) Appl. No.: **12/208,318**

(22) Filed: **Sep. 10, 2008**

(30) **Foreign Application Priority Data**

Sep. 11, 2007 (CN) 200710030182.7

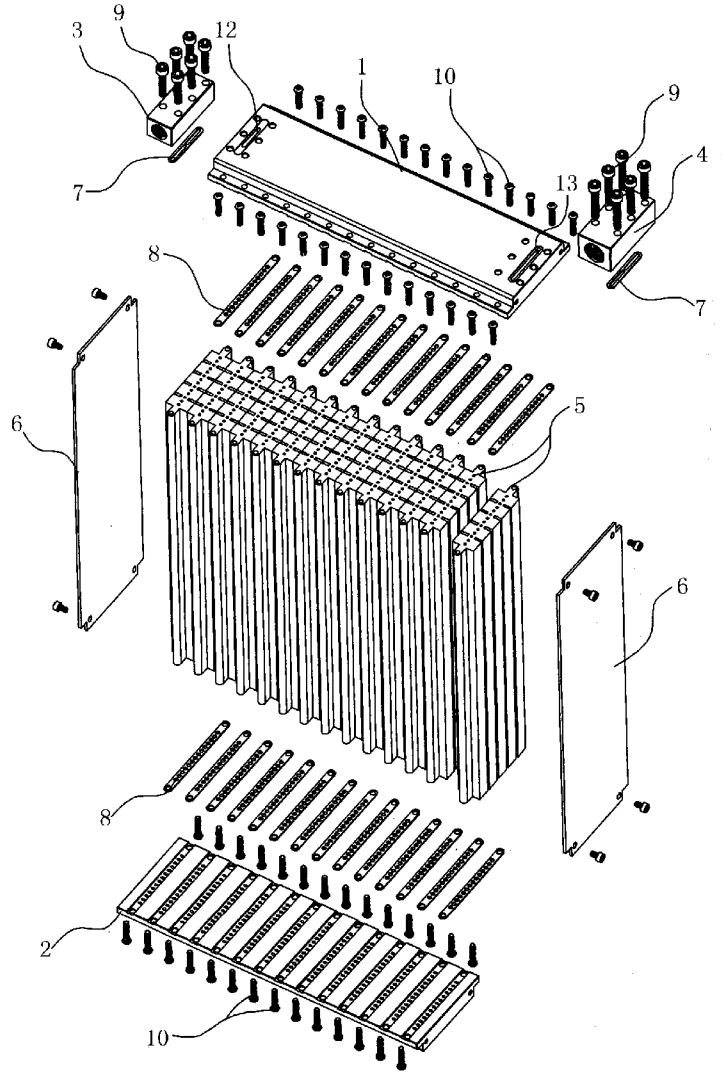
Publication Classification

(51) **Int. Cl.**
F28F 1/30 (2006.01)

(52) **U.S. Cl.** **165/182**

(57) **ABSTRACT**

A condenser assembly is provided. The condenser includes a first tube-and-fin module having a first flat tube with a first group of microchannels formed parallelly therethrough. The condenser also includes a second tube-and-fin module arranged next to the first tube-and-fin module. The second tube-and-fin module includes a second flat tube with a second group of microchannels formed parallelly therethrough. The condenser further includes a bottom panel having a bottom group of microchannels. The bottom panel is sealingly coupled to the first and second flat tubes at one common end thereof. The bottom group of microchannels extends between and communicates with the first and second groups of microchannels defining a plurality of continuous passages.



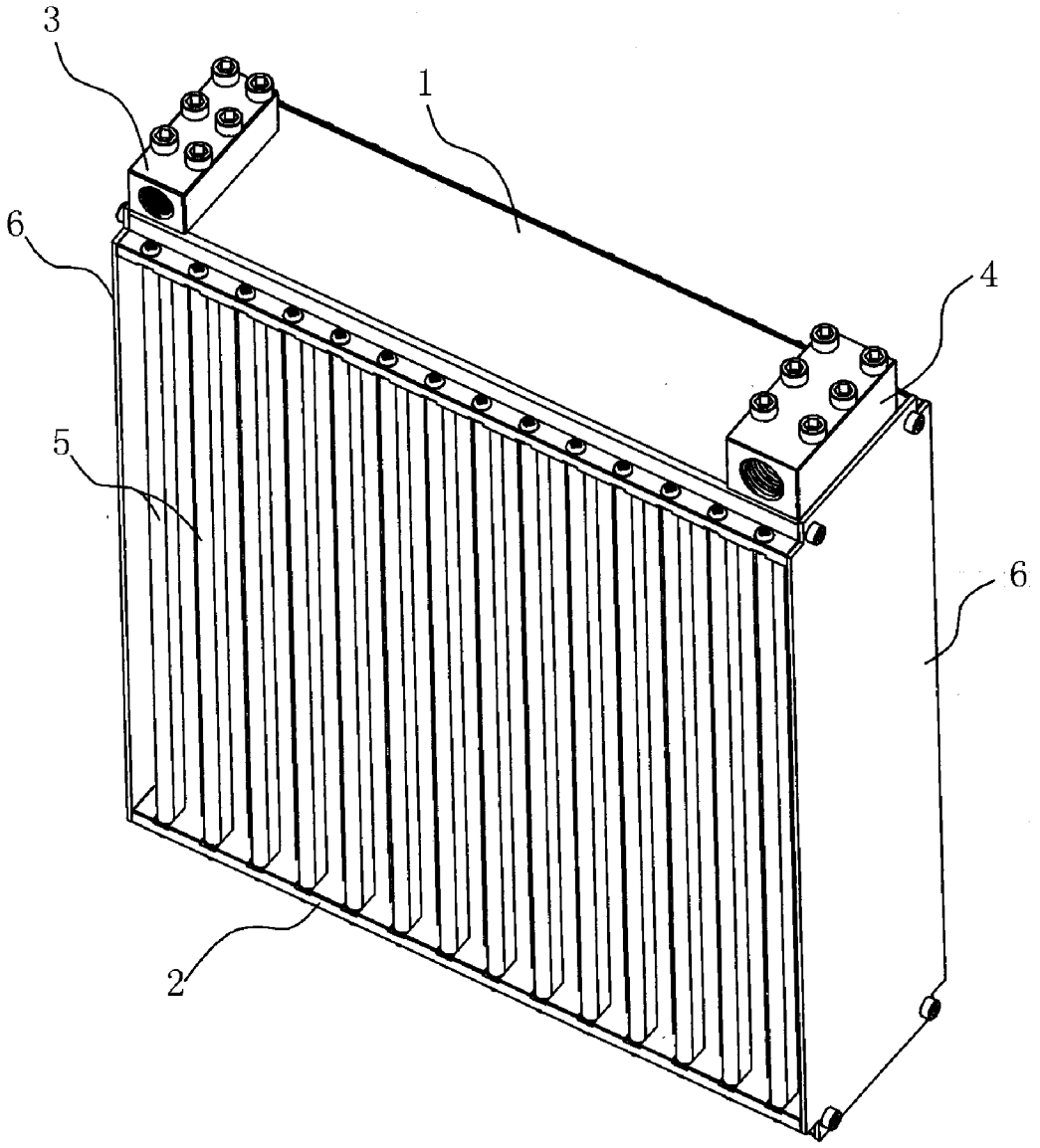


Figure 1

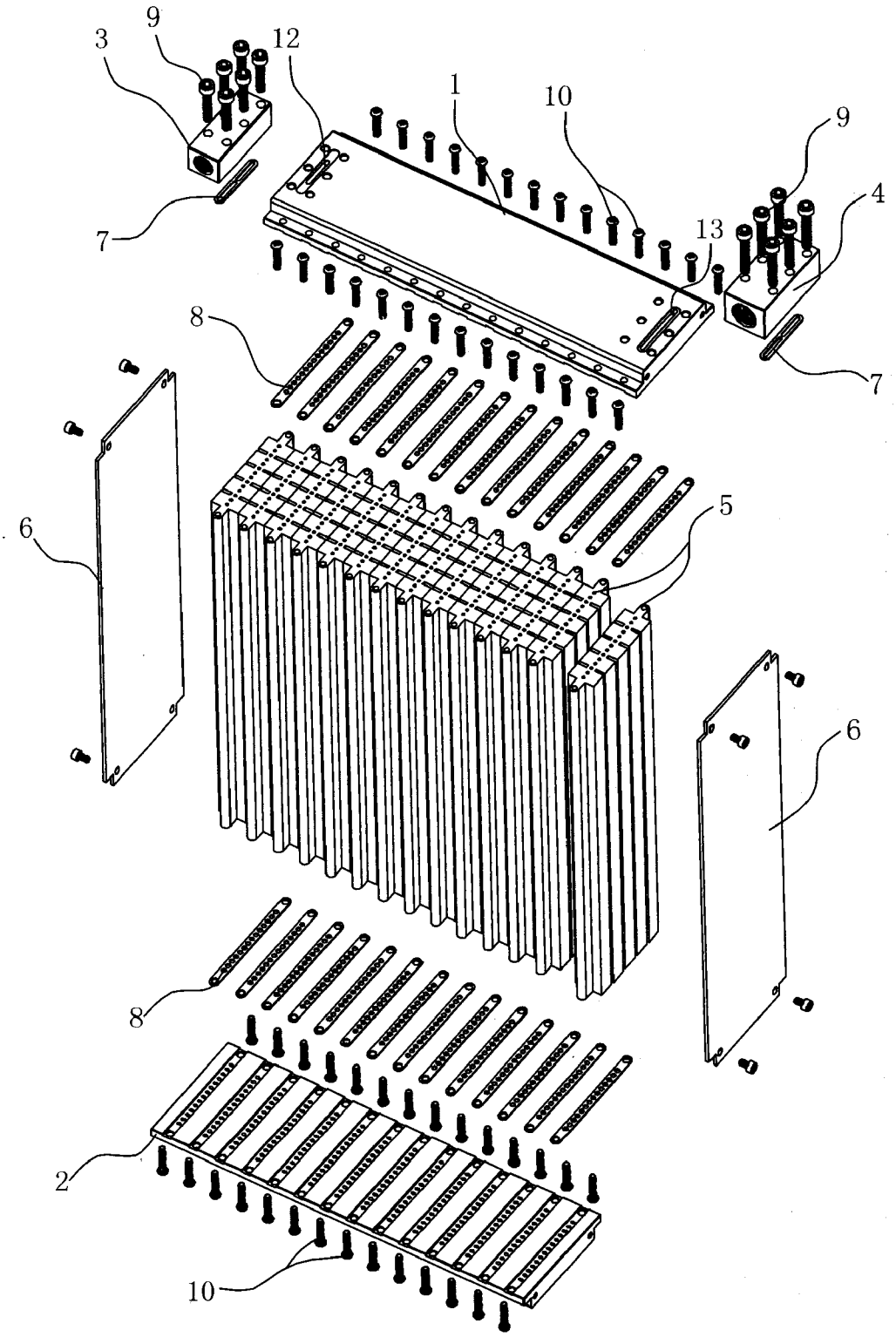


Figure 2

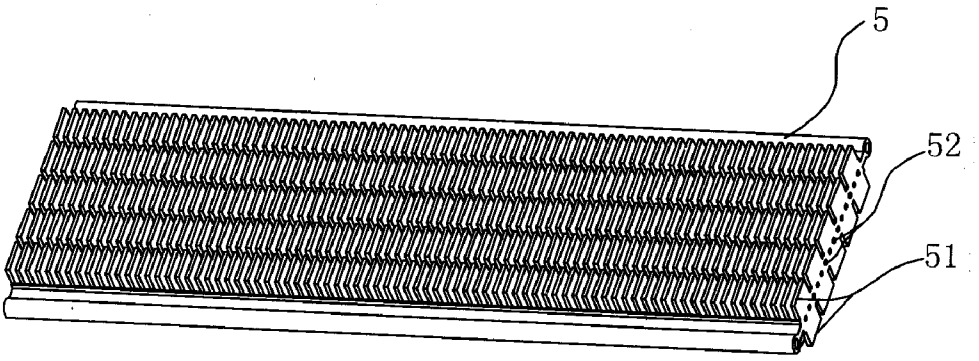


Figure 3

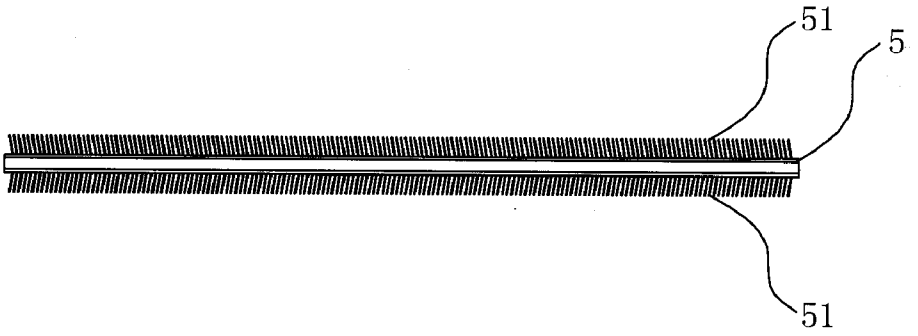


Figure 4

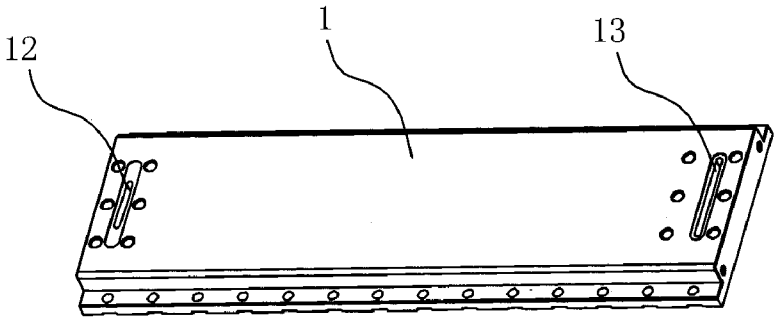


Figure 5

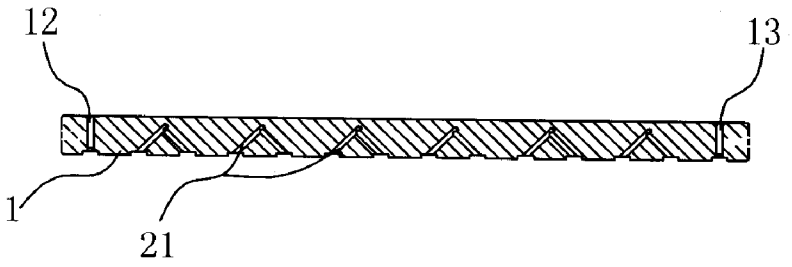


Figure 6

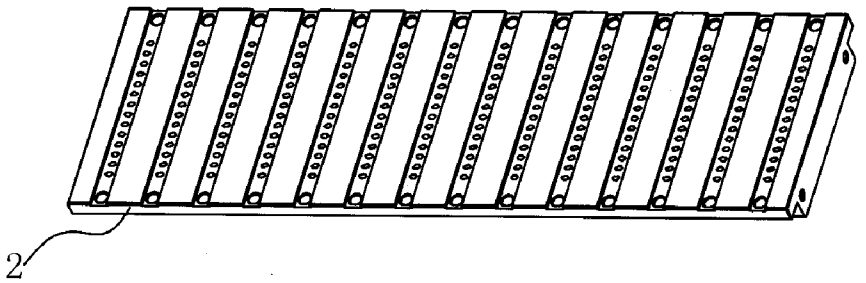


Figure 7

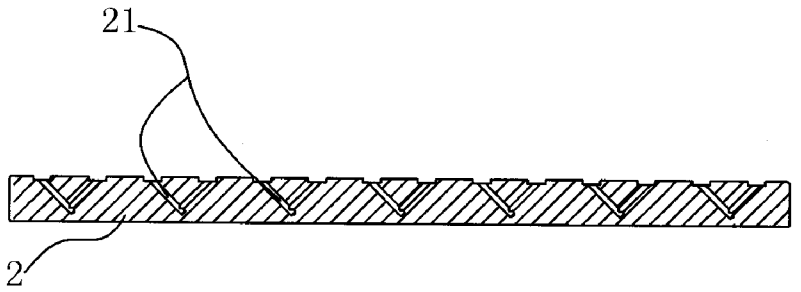


Figure 8

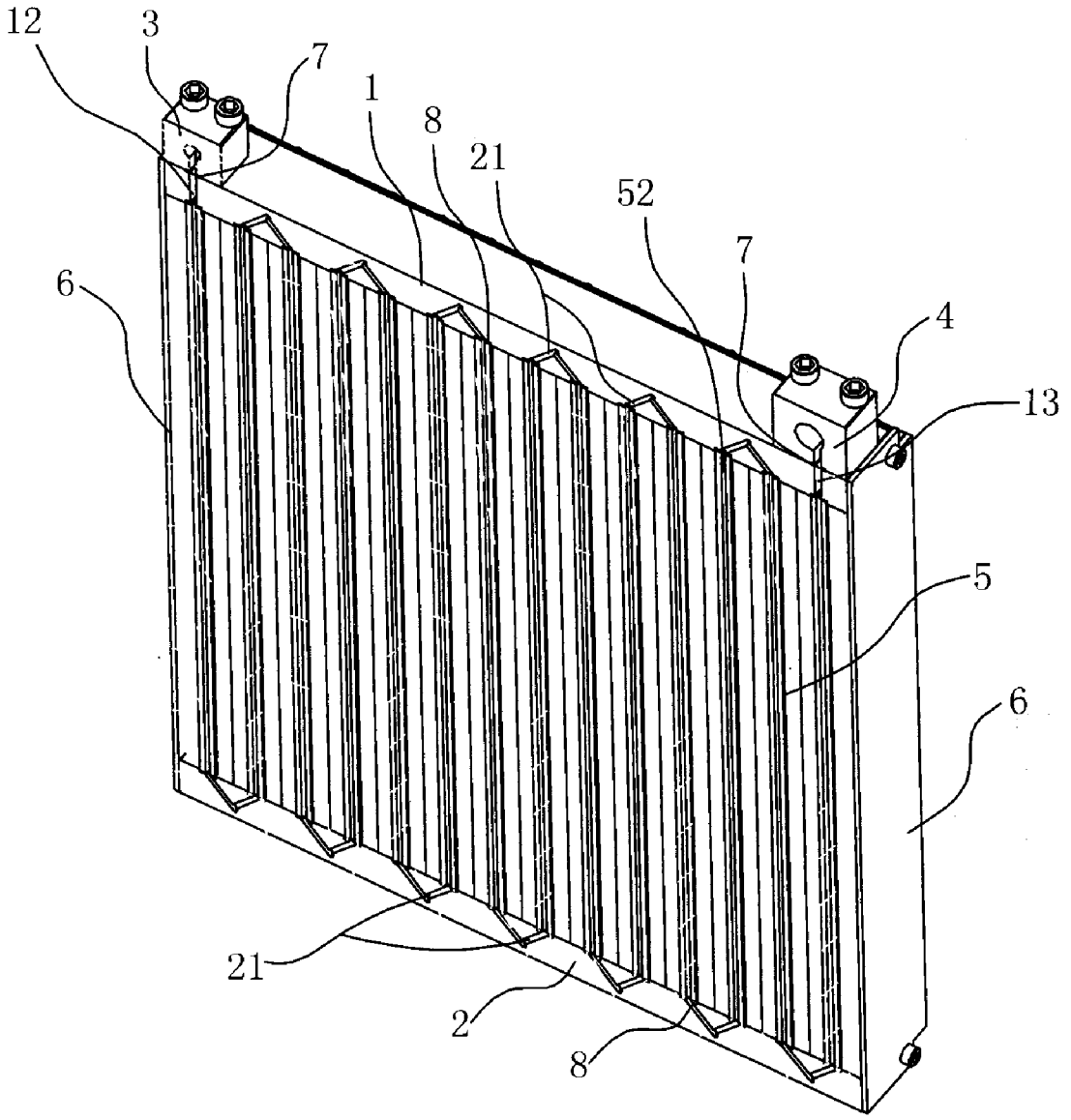


Figure 9

CONDENSER ASSEMBLY

CROSS-REFERENCE TO RELATED PATENT APPLICATION

[0001] This patent application claims priority of Chinese Patent Application No. 200710030182.7, filed on Sep. 11, 2007, which is hereby incorporated by reference.

FILED OF THE PATENT APPLICATION

[0002] The present patent application relates to a condenser assembly.

BACKGROUND

[0003] Conventional condenser assembly of an air conditioning system for automobiles or commercial/residential use contains tubes that are bent into U-shape or serpentine shape, and have parts that are connected together by welding. Due to long exposure to poor operating environment such as vibration, refrigerants inside these tubes may leak easily and are difficult to re-collect for reuse purposes. Refrigerant such as R134a is widely used. This kind of refrigerant has a global warming potential (GWP) of up to 3100 that can worsen global warming, and will release chemical substances that are hazardous to human health.

[0004] For refrigerant such as carbon dioxide, its operating pressure is quite high. Therefore, for the sake of safety, tubes of a condenser using carbon dioxide as refrigerant usually have wall that is quite thick. However, tubes with thick wall can reduce the functionality of the condenser.

[0005] The inner diameter of the tubes also has great influence on the heat transfer capacity of a condenser. If the diameter of the tubes decreases, the flow rate of the refrigerant and the convective heat transfer increases. On the other hand, if the diameter of the tubes increases, the wall thickness needs to be increased in order to withstand the high pressure inside the tubes. This results in an increase in the weight of the condenser and an increase in the power of the compressor, and therefore is a waste of energy.

[0006] The above description of the background is provided to aid in understanding of a condenser, but is not admitted to describe or constitute pertinent prior art to the condenser assembly disclosed in the present patent application.

SUMMARY

[0007] A condenser assembly is provided. In one aspect, the condenser includes a first tube-and-fin module having a first flat tube with a first group of microchannels formed parallelly therethrough. The condenser also includes a second tube-and-fin module arranged next to the first tube-and-fin module. The second tube-and-fin module includes a second flat tube with a second group of microchannels formed parallelly therethrough. The condenser further includes a bottom panel having a bottom group of microchannels. The bottom panel is sealingly coupled to the first and second flat tubes at one common end thereof. The bottom group of microchannels extends between and communicates with the first and second groups of microchannels defining a plurality of continuous passages.

[0008] The condenser may also include a top panel sealingly coupled to the first and second flat tubes at the other common end thereof. The top panel includes an inlet through-hole which is in communication with inlets of the plurality of continuous passages. The top panel further includes an outlet through-hole which is in communication with outlets of the plurality of continuous passages.

[0009] The condenser may further include a third tube-and-fin module arranged next to the second tube-and-fin module. The third tube-and-fin module includes a third flat tube with a third group of microchannels formed parallelly therethrough. The top panel includes a top group of microchannels and is sealingly coupled to the third flat tube. The top group of microchannels extends between and communicates with the second and third groups of microchannels defining a plurality of extensions of the continuous passages.

[0010] The condenser may include a plurality of heat-dissipating fins thermally connected to each of the flat tubes.

[0011] The condenser may include an inlet nozzle sealingly coupled to the top panel at the inlet through-hole and an outlet nozzle sealingly coupled to the top panel at the outlet through-hole.

[0012] The condenser may include a plurality of tube-and-fin modules arranged side-by-side and next to the third tube-and-fin module forming a plurality of continuous serpentine passages.

[0013] The condenser may include two side panels covering two opposite sides of the assembly, respectively.

[0014] In one embodiment, the microchannels have a circular cross section and a diameter of about 0.9 mm to about 1.0 mm.

[0015] In one embodiment, the flat tubes are straight seamless tubes formed by extrusion.

[0016] In one embodiment, the flat tubes are made of aluminum.

[0017] In one embodiment, the bottom and top groups of microchannels are integrally formed in the bottom and top panels, respectively.

[0018] In one embodiment, the bottom and top panels are sealingly coupled to the flat tubes.

[0019] In one embodiment, the bottom and top groups of microchannels are V-shaped.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Specific embodiments of the condenser assembly disclosed in the present patent application will now be described by way of example with reference to the accompanying drawings wherein:

[0021] FIG. **1** is a perspective view of a condenser assembly according to an embodiment disclosed in the present patent application;

[0022] FIG. **2** is an exploded view of the condenser assembly of FIG. **1**;

[0023] FIG. **3** is a perspective view of a tube-and-fin module of the condenser assembly;

[0024] FIG. **4** is a side view of the tube-and-fin module of FIG. **3**;

[0025] FIG. **5** is a perspective of a top panel of the condenser assembly;

[0026] FIG. **6** is a cross sectional view of the top panel of FIG. **5**;

[0027] FIG. **7** is a perspective of a bottom panel of the condenser assembly;

[0028] FIG. **8** is a cross sectional view of the bottom panel of FIG. **7**; and

[0029] FIG. **9** is a cross sectional view of the condenser assembly.

DETAILED DESCRIPTION

[0030] It should be understood that the condenser assembly disclosed in the present patent application is not limited to the precise embodiments described below and that various changes and modifications thereof may be effected by one skilled in the art without departing from the spirit or scope of the appended claims. For example, elements and/or features of different illustrative embodiments may be combined with each other and/or substituted for each other within the scope of this disclosure and appended claims.

[0031] For illustration purposes, the terms "upper", "lower", "left", "right", "vertical", "horizontal", "top", or "bottom" appeared hereinafter relate to the embodiment as it is oriented in the drawings. It is understood that the condenser assembly may assume various positions, except where expressly specified to the contrary. Furthermore, it is understood that the specific devices shown in the drawings, and described in the following description, are simply exemplary embodiments of the invention. Hence, specific dimensions and other physical characteristics related to the embodiments disclosed hereinafter are not to be considered as limiting.

[0032] It should be noted that throughout the specification and claims herein, when one element is said to be "coupled" to another, this does not necessarily mean that one element is fastened, secured, or otherwise attached to another element. Instead, the term "coupled" means that one element is either connected directly or indirectly to another element or is in mechanical or electrical communication with another element.

[0033] FIG. **1** is a perspective view of the condenser assembly according to an embodiment disclosed in the present patent application. The condenser assembly includes a plurality of tube-and-fin modules **5**, a top panel **1**, a bottom panel **2**, and two side panels **6**.

[0034] The plurality of tube-and-fin modules **5** may be disposed vertically and arranged side-by-side to form a condensation core with a plurality of serpentine condensation passages. The condensation core may be covered by the top panel **1**, the bottom panel **2**, and the two side panels **6**.

[0035] The condenser assembly may be provided with an inlet nozzle **3** and an outlet nozzle **4**. Evaporated refrigerant can enter the condenser assembly through the inlet nozzle **3**, passes through the tube-and-fin modules **5** where it condenses, and then the condensate can exit through the outlet nozzle **4**.

[0036] FIG. **2** is an exploded view of the condenser assembly of FIG. **1**. It is appreciated that the number and length of the tube-and-fin modules can be altered to satisfy different requirements on heat exchange capacity. There should be at least two tube-and-fin modules **5** in a condenser assembly. According to the illustrated embodiment, there are fourteen tube-and-fin modules **5**, and each tube-and-fin module **5** has fourteen microchannels **52**.

[0037] The inlet and outlet nozzles **3**, **4** can be sealingly coupled to the top panel **1** by means of two sealing gaskets **7** respectively. The two sealing gaskets **7** may be made of rubber or any other suitable material.

[0038] Similarly, the top and bottom panels **1**, **2** can be sealingly coupled to the tube-and-fin modules **5** by means of a set of sealing gaskets **8**. The set of sealing gaskets **8** may be made of silicone or any other suitable material.

[0039] Screws **9** or any suitable fasteners of different sizes may be employed to fasten the inlet and outlet nozzles **3**, **4** to the top panel **1**, and to fasten the top, bottom and side panels **1**, **2**, **6** to the tube-and-fin modules **5**. It can be seen that the assembling of the condenser assembly disclosed in the present patent application does not require any welding process.

[0040] FIG. **3** is a perspective view of the tube-and-fin module **5** of the condenser assembly. Each tube-and-fin module **5** may include a plurality of heat-dissipating fins **51** and a flat tube having a plurality of microchannels **52** extending parallelly therethrough.

[0041] The flat tubes may be straight seamless flat tubes formed by extrusion. The flat tubes may be made of aluminum, or aluminum alloy, or any other suitable material. Each microchannel **52** may have a circular cross section and a diameter of about 0.9 mm to 1.0 mm. It is understood that the microchannels **52** may have other cross sections.

[0042] The heat-dissipating fins **51** may be disposed one on top of the other to form a stack of heat-dissipating fins **51**. Each heat-dissipating fin **51** can be provided with an opening through which the flat tube can pass. The plurality of straight microchannels **52** may run parallel to one another on a common plane.

[0043] FIG. **4** is a side view of the tube-and-fin module **5** of FIG. **3**. It can be seen that the heat-dissipating fins **51** may be symmetrically and evenly distributed about the common plane on which the plurality of straight microchannels **52** runs.

[0044] FIG. **5** is a perspective of the top panel **1** of the condenser assembly. FIG. **6** is a cross sectional view of the top panel **1** of FIG. **5**.

[0045] The top panel **1** is provided with a plurality of integrally formed microchannels **21**. The microchannels **21** can be of any appropriate shape. According to the illustrated embodiment, each microchannel **21** is V-shaped and has two straight microchannel sections. Each V-shaped microchannel **21** has an inlet and an outlet.

[0046] The top panel **1** may be sealingly coupled to an upper common end of the tubes of the tube-and-fin modules **5** such that each V-shaped microchannel **21** extends between and communicates with two adjacent straight microchannels **52**. It is contemplated that the inlet of each V-shaped microchannel **21** is in communication with an outlet of a straight microchannel **52**, and the outlet of each V-shaped microchannel **21** is in communication with an inlet of an adjacent straight microchannel **52** to define a continuous passage.

[0047] The far left side of the top panel **1** may be provided with an inlet through-hole **12**, and the far right side of the top panel **1** may be provided with an outlet through-hole **13**. The inlet through-hole **12** is in communication with the inlets of the continuous passages of the condenser assembly, and outlet through-hole **13** is in communication with the outlets of the continuous passages of the condenser assembly.

[0048] The inlet nozzle **3** may be mounted over the inlet through-hole **12** of the top panel **1**, and the outlet nozzle **4** may be mounted over the outlet through-hole **13** of the top panel **1**.

[0049] FIG. **7** is a perspective of the bottom panel **2** of the condenser assembly. FIG. **8** is a cross sectional view of the bottom panel **2** of FIG. **7**.

[0050] Similar to the top panel **1**, the bottom panel **2** is provided with a plurality of integrally formed microchannels

21. According to the illustrated embodiment, each microchannel **21** is also V-shaped. Each V-shaped microchannel **21** has an inlet and an outlet.

[0051] The bottom panel **2** may be sealingly coupled to a lower common end of the tubes of the tube-and-fin modules **5** such that each V-shaped microchannel **21** extends between and communicates with two adjacent straight microchannels **52**. It is contemplated that the inlet of each V-shaped microchannel **21** is in communication with an outlet of a straight microchannel **52**, and the outlet of each V-shaped microchannel **21** is in communication with an inlet of an adjacent straight microchannel **52**.

[0052] The V-shaped microchannels **21** are integrally formed on the top and bottom panels **1**, **2** and may have a circular cross section and a diameter of about 0.9 mm to 1.0 mm. It is understood that the V-shaped microchannels **21** may have other cross sections.

[0053] FIG. **9** is a cross sectional view of the condenser assembly of FIG. **1**.

[0054] Evaporated refrigerant enters the continuous passages of the condenser assembly through the inlet nozzle **3**, passes through the inlet through-hole **12**, down the straight microchannels **52** at the far left, through the V-shaped microchannels **21** at the bottom panel **2**, up the adjacent straight microchannels **52**, through the V-shaped microchannels **21** at the top panel **1**, and down again until it finally condenses as a condensate, and passes up the straight microchannels **52** at the far right, through the outlet through-hole **13**, and exits from the outlet nozzle **4**. It is appreciated that the flow along the continuous passages is uni-directional.

[0055] The condenser disclosed in the present patent application utilizes seamless microchannel technology that combines the advantages of seamless tube, thin wall and small microchannel tube diameter. Also, in view of the fact that the hydraulic radius of a seamless microchannel is very small, its fluid flow condition is quite different from that of a conventional flow channel. The fluid inside a seamless microchannel can enter a flowing condition at a low Reynolds number. This can substantially increase the heat exchange efficiency. Also, seamless microchannels provide a greater contact area, improve the heat transfer capacity, and reduce the size and weight of a condenser assembly.

[0056] The condenser assembly disclosed in the present patent application is configured to be simply assembled by screws without the necessity of welding. Furthermore, bending of tubes is not required. These can minimize the possibility of refrigerant leakage.

[0057] Also, the use of aluminum and aluminum alloy can lower the manufacturing cost as aluminum is ⅓ cheaper than copper.

[0058] The above characteristics result in a condenser assembly that is small in size, light in weight, low in manufacturing cost, high in heat transfer coefficient, high pressure endurable, and environmental-friendly.

[0059] While the condenser assembly disclosed in the present patent application has been shown and described with particular references to a number of embodiments thereof, it should be noted that various other changes or modifications may be made without departing from the scope of the appended claims.

What is claimed is:

1. A condenser assembly comprising:

a first tube-and-fin module comprising a first flat tube with a first group of microchannels formed parallelly therethrough;

a second tube-and-fin module arranged next to the first tube-and-fin module, the second tube-and-fin module comprising a second flat tube with a second group of microchannels formed parallelly therethrough;

a bottom panel comprising a bottom group of microchannels, the bottom panel being sealingly coupled to the first and second flat tubes at one common end thereof, the bottom group of microchannels extending between and communicating with the first and second groups of microchannels defining a plurality of continuous passages;

a top panel sealingly coupled to the first and second flat tubes at the other common end thereof, the top panel comprising an inlet through-hole which is in communication with inlets of the plurality of continuous passages, the top panel further comprising an outlet through-hole which is in communication with outlets of the plurality of continuous passages; and

a third tube-and-fin module arranged next to the second tube-and-fin module, the third tube-and-fin module comprising a third flat tube with a third group of microchannels formed parallelly therethrough, wherein the top panel comprises a top group of microchannels and is sealingly coupled to the third flat tube, the top group of microchannels extends between and communicates with the second and third groups of microchannels defining a plurality of extensions of the continuous passages, the top and bottom groups of microchannels are integrally formed in the top and bottom panels respectively, and the top and bottom groups of microchannels are V-shaped.

2. The assembly as claimed in claim **5**, further comprising two side panels covering two opposite sides of the assembly, respectively.

3. The assembly as claimed in claim **5**, further comprising a plurality of tube-and-fin modules arranged side-by-side and next to the third tube-and-fin module forming a plurality of continuous serpentine passages.

4. A condenser assembly comprising:

a first tube-and-fin module comprising a first flat tube with a first group of microchannels formed parallelly therethrough;

a second tube-and-fin module arranged next to the first tube-and-fin module, the second tube-and-fin module comprising a second flat tube with a second group of microchannels formed parallelly therethrough;

a bottom panel comprising a bottom group of microchannels, the bottom panel being sealingly coupled to the first and second flat tubes at one common end thereof, the bottom group of microchannels extending between and communicating with the first and second groups of microchannels defining a plurality of continuous passages;

a top panel sealingly coupled to the first and second flat tubes at the other common end thereof, the top panel comprising an inlet through-hole which is in communication with inlets of the plurality of continuous passages, the top panel further comprising an outlet through-hole which is in communication with outlets of the plurality of continuous passages;

a third tube-and-fin module arranged next to the second tube-and-fin module, the third tube-and-fin module

comprising a third flat tube with a third group of microchannels formed parallelly therethrough, wherein the top panel comprises a top group of microchannels and is sealingly coupled to the third flat tube, the top group of microchannels extends between and communicates with the second and third groups of microchannels defining a plurality of extensions of the continuous passages, and the bottom and top groups of microchannels are integrally formed in the bottom and top panels respectively; and

a plurality of heat-dissipating fins thermally connected to each of the first, second and third flat tubes.

5. The assembly as claimed in claim **4**, wherein the bottom and top groups of microchannels are V-shaped.

6. The assembly as claimed in claim **4**, further comprising a plurality of tube-and-fin modules arranged side-by-side and next to the third tube-and-fin module forming a plurality of continuous serpentine passages.

7. The assembly as claimed in claim **4**, further comprising two side panels covering two opposite sides of the assembly, respectively.

8. A condenser assembly comprising:

a first tube-and-fin module comprising a first flat tube with a first group of microchannels formed parallelly therethrough;

a second tube-and-fin module arranged next to the first tube-and-fin module, the second tube-and-fin module comprising a second flat tube with a second group of microchannels formed parallelly therethrough; and

a bottom panel comprising a bottom group of microchannels, the bottom panel being sealingly coupled to the first and second flat tubes at one common end thereof, and the bottom group of microchannels extending between and communicating with the first and second groups of microchannels defining a plurality of continuous passages.

9. The assembly as claimed in claim **8**, further comprising a top panel sealingly coupled to the first and second flat tubes at the other common end thereof, the top panel comprising an inlet through-hole which is in communication with inlets of the plurality of continuous passages, the top panel further comprising an outlet through-hole which is in communication with outlets of the plurality of continuous passages.

10. The assembly as claimed in claim **9**, further comprising a third tube-and-fin module arranged next to the second tube-and-fin module, the third tube-and-fin module comprising a third flat tube with a third group of microchannels formed parallelly therethrough, wherein the top panel comprises a top group of microchannels and is sealingly coupled to the third flat tube, the top group of microchannels extends between and communicates with the second and third groups of microchannels defining a plurality of extensions of the continuous passages.

11. The assembly as claimed in claim **10**, further comprising a plurality of tube-and-fin modules arranged side-by-side and next to the third tube-and-fin module forming a plurality of continuous serpentine passages.

12. The assembly as claimed in claim **10**, wherein the first, second, third, bottom and top groups of microchannels comprise a circular cross section and a diameter of about 0.9 mm to about 1.0 mm.

13. The assembly as claimed in claim **10**, wherein the first, second and third flat tubes comprise straight seamless tubes formed by extrusion.

14. The assembly as claimed in claim **10**, wherein the first, second and third flat tubes comprise aluminum.

15. The assembly as claimed in claim **10**, further comprising a plurality of heat-dissipating fins thermally connected to each of the first, second and third flat tubes.

16. The assembly as claimed in claim **10**, wherein the bottom and top groups of microchannels are integrally formed in the bottom and top panels, respectively.

17. The assembly as claimed in claim **10**, further comprising:

an inlet nozzle sealingly coupled to the top panel at the inlet through-hole; and

an outlet nozzle sealingly coupled to the top panel at the outlet through-hole.

18. The assembly as claimed in claim **10**, wherein the bottom and top panels are sealingly coupled to the first, second and third flat tubes.

19. The assembly as claimed in claim **10**, wherein the bottom and top groups of microchannels are V-shaped.

20. The assembly as claimed in claim **9**, further comprising two side panels covering two opposite sides of the assembly, respectively.

* * * * *