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(71) Applicant: **Danfoss Micro Channel Heat Exchanger (Jiaxing) Co., Ltd.**
Haiyan County
Jiaxing
Zhejiang 314300 (CN)

(72) Inventor: **PERSSON, Lars**
Jiaxing
Zhejiang 314300 (CN)

(74) Representative: **Knoblauch, Andreas**
Patentanwälte Dr. Knoblauch PartGmbB
Reuterweg 51-53
60323 Frankfurt am Main (DE)

(54) HEAT EXCHANGE PLATE AND PLATE-TYPE HEAT EXCHANGER

(57) In the present invention a heat exchange plate is provided, at least one surface of each heat exchange plate comprising ridges and grooves which are arranged alternately. Multiple fluid distribution adjustment structures are disposed on crests of the ridges and/or trough bottoms of the grooves. In addition, the present invention also provides a plate heat exchanger using such a heat exchanger plate.

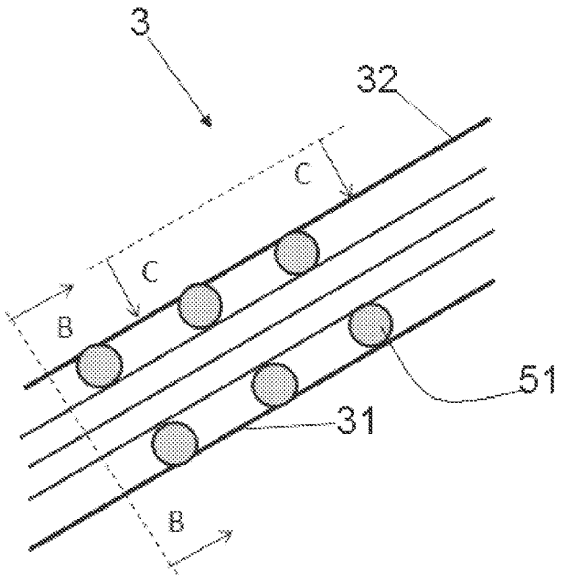


Fig. 3a

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Description

[0001] This application claims the priority of Chinese patent application no. 201410076347.4 with invention title "Heat exchange plate and plate-type heat exchanger", submitted on March 4, 2014, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present invention relates to the fields of heating, ventilation and air conditioning, motor vehicles, cooling and transportation, and in particular relates to a heat exchange plate and a plate-type heat exchanger using the heat exchange plate.

BACKGROUND ART

[0003] At present, plate-type heat exchangers are usually channel structures characterized by an inverted-V shape (fishbone form). Such a structure has good transverse flow priority, and can realize lateral flow distribution very well, and so has a good heat exchange effect. However, in the case of applications such as evaporators and condensers, the angular range of inverted-V-shaped structures is relatively inflexible, and offers little room for improvement in terms of significantly enhancing heat exchange and increasing strength (in order to reduce material thickness). The corrugation width and assembly result of an inverted-V-shaped structure determine the welding space per unit area, and therefore the strength is limited. The way in which channels between inverted-V-shaped plates intersect and the density of welding points thereof determine the intensity of turbulence arising when fluid passes these positions. Under restricted parameter variation conditions, the intensity of turbulence is limited, so there is no way of achieving a greater heat exchange enhancement effect.

[0004] In view of the above, there is definitely a need to provide a novel heat exchange plate and plate-type heat exchanger capable of at least partially solving the problem mentioned above.

SUMMARY OF THE INVENTION

[0005] The object of the present invention is to resolve at least one aspect of the abovementioned problems and shortcomings in the prior art.

[0006] In one aspect of the present invention, a heat exchange plate is provided, at least one surface of each heat exchange plate comprising ridges and grooves which are arranged alternately. Multiple fluid distribution adjustment structures are disposed on crests of the ridges and/or trough bottoms of the grooves. Specifically, each of the fluid distribution adjustment structures comprises protrusions on two edges respectively of the crest or trough bottom, and a center channel between the two edges.

[0007] Specifically, the protrusion comprises any one of a cylinder, a cuboid with rounded corners, a trapezoidal structural body and an arcuate protrusion, or any combination thereof; the center channel comprises a flat, straight channel and/or a channel formed by a multi-element curved-surfaced structural body. Specifically, a smooth connection structure is disposed between the protrusion and the heat exchange plate surface, and the multi-element curved-surfaced structural body comprises a combination of curved arc/multi-element curved line/multi-element arc and straight line/curved line/arc multi-element bodies. Specifically, the base of the center channel is substantially flush with or depressed relative to the crest or trough bottom.

[0008] Specifically, a part between the two protrusions on each edge forms an inlet or outlet of the center channel.

[0009] Specifically, the protrusions are disposed at intervals on the front edge and/or rear edge of the crest or trough bottom.

[0010] Specifically, the protrusions on the front edge are staggered with respect to the protrusions on the rear edge in a horizontal direction perpendicular to a direction of extension of the center channel. Specifically, the center channel is curved in the direction of extension of the crest or trough bottom. Specifically, at least a portion of the protrusions are set to at least partially cover the center channel so as to form an intermittent center channel. Specifically, a part or all of the surface is provided with a structural pattern with a single half-inverted-V-shape and/or inverted-V-shape, or a double half-inverted-V-shape and/or inverted-V-shape, or a greater number of repetitions of a half-inverted-V-shape and/or inverted-V-shape, and each heat exchange plate comprises a fluid inlet and a fluid outlet located at two opposite ends respectively in a direction of extension of the heat exchange plate.

[0011] In another aspect of the present invention, a plate-type heat exchanger is provided. The plate-type heat exchanger comprises the heat exchange plate described above.

[0012] The inventive concept of the present invention lies in providing various protrusion structures, curved structures or depressed structures on flat edges of ridges and/or grooves in an inverted-V-shaped or fishbone heat exchange plate in the prior art. Such an arrangement enables the heat exchange plate to generate more turbulence, and increases heat transfer while maintaining consistent fluid distribution. Furthermore, the strength of fluid channels in the heat exchange plate is enhanced, and this is beneficial for reducing the thickness of the heat exchange plate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] These and/or other aspects and advantages of the present invention will become obvious and easy to understand through the following description of the pre-

ferred embodiments in conjunction with the accompanying drawings, wherein:

Fig. 1 is a partial view of a surface of the inverted-V-shaped heat exchange plate in the prior art;
Fig. 2 is a sectional view taken along line A-A in Figure 1;
Fig. 3a is a partial view of a ridge of a surface of the inverted-V-shaped heat exchange plate according to an embodiment of the present invention; Figs. 3b and 3c are sectional views taken along lines B-B and C-C in Fig. 3a, respectively;
Fig. 4 is a view of fluid flow for a surface of the heat exchange plate shown in Fig. 3a;
Fig. 5 is a view of another variation of a surface of the heat exchange plate shown in Fig. 3a;
Fig. 6 is a view of another variation of a surface of the heat exchange plate shown in Fig. 3a;
Fig. 7 is a view of another variation of a surface of the heat exchange plate shown in Fig. 3a;
Fig. 8a is a view of another variation of the heat exchange plate according to the present invention; and
Fig. 8b is a partial enlarged view of Fig 8a.

PARTICULAR EMBODIMENTS

[0014] The technical solution of the present invention is explained in further detail below by means of embodiments in conjunction with Figs. 1 - 8b. In this description, identical or similar drawing labels indicate identical or similar components. The following explanation of the embodiments of the present invention with reference to the accompanying drawings is intended to explain the overall inventive concept of the present invention, and should not be interpreted as a limitation of the present invention.

[0015] Reference is made to Figs. 1 and 2, which show a view of the overall structure of a heat exchange plate in the plate-type heat exchanger of the present invention and a corresponding sectional view. As is known by those skilled in the art, the plate-type heat exchanger comprises multiple A-shaped heat exchange plates and V-shaped heat exchange plates (referred to as a pair of heat exchange plates below for convenience of description), which are stacked together between an end plate and a base plate. Of course, the heat exchange plates may also be a combination of W-shaped and M-shaped heat exchange plates; this is common knowledge in the art, and is not described in detail again here. All that is required is for the multiple combined heat exchange plates to be capable of forming a manifold for the passage of fluid. In other words, a surface of the heat exchange plate may be provided with a pattern structure with a single inverted-V-shape (A/V shape), a pattern structure with a double inverted-V-shape (M/W shape) or a pattern structure with a greater number of repetitions of an inverted-V-shape. Of course, the pattern feature on the heat exchange plate may also be a single half-inverted-V-shape or a greater number of repetitions thereof.

[0016] It must be noted that only one heat exchange plate 10 in a pair of heat exchange plates fitted together in a plate-type heat exchanger is explained below as an example; in practice, the other heat exchange plate fitted thereto may be provided with a structural pattern cooperating therewith or symmetrical with respect thereto, by the same or a similar method.

[0017] Fig. 1 shows that the heat exchange plate 10 is a heat exchange plate having an inverted-V-shaped (or fishbone) pattern structure. That is, multiple ridges 1 and grooves 2 are arranged alternately in the longitudinal direction of the heat exchange plate 10. The trough bottoms of the grooves 2 are indicated by the dotted lines in Fig. 1. Those skilled in the art will appreciate that such a structural arrangement is a typical design for an existing inverted-V-shaped heat exchange plate pattern. Of course, parameters such as the widths of the ridges 1 and grooves 2, and the height of the ridges 1 and the depth of the grooves 2 may be designed as required. In Fig. 2, it can be seen that the ridges 1 and the grooves 2 have flat crests and trough bottoms, 3 and 4, respectively, with the widths thereof being indicated by the labels w1 and w2 respectively. The widths w1 and w2 may be set to be the same or different. As Fig. 2 shows, the width w1 of the flat crest 3 of the ridge 1 is greater than the width w2 of the flat trough bottom 4 of the groove 2. Furthermore, in this example, the widths of the flat crests 3 of the ridges 1 are all set to be the same, and correspondingly, the widths of the flat trough bottoms 4 of the grooves 2 are set to be the same as each other. However, those skilled in the art could set the abovementioned structural parameters as required. The scenario described above is merely an example, which must not be interpreted as a limitation of the present invention.

[0018] As Figs. 3a - 3c show, in order to generate greater turbulence and enhance the strength of fluid channels on the heat exchange plate 10, multiple fluid distribution adjustment structures are added to the flat crests 3 of the ridges 1 in the present invention. Furthermore, it is also possible to add multiple fluid distribution adjustment structures on the trough bottoms 4. The fluid distribution adjustment structure may comprise any one of a cylinder, a cuboid with rounded corners, a trapezoidal structural body and an arcuate protrusion, or any combination thereof. Here, for clarity of explanation and description, the fluid distribution adjustment structure is only provided on the crests 3 of the ridges 1 of the heat exchange plate 10, but those skilled in the art will understand, based on the disclosed content of the present invention, that the fluid distribution adjustment structure could likewise be provided on the trough bottoms 4 of the grooves 2 in a similar way. That is, those skilled in the art could choose to provide the fluid distribution adjustment structure on the crests 3 of the ridges 1 and/or on the trough bottoms 4 of the grooves 2 as required, with no need to be restricted to the case shown in the figures of the present invention.

[0019] As shown in Fig. 3a, for convenience of descrip-

tion, one ridge 1 and one groove 2 which are adjacent to each other are defined here as one flow unit. Of course, those skilled in the art could also regard two or more ridge/groove combinations as one flow unit. Two edges of the crest 3 of the ridge 1 are defined as or referred to as a front edge 31 and a rear edge 32. Multiple flow distribution adjustment structures 5 are disposed at intervals of a predetermined distance along the front edge 31 and/or the rear edge 32. It can be understood that the main function of the fluid distribution adjustment structure 5 is to further adjust and distribute fluid, and therefore any structural arrangement, such as a cylinder, a cuboid with rounded corners, a trapezoidal structural body or an arcuate protrusion, could be used as the fluid distribution adjustment structure referred to here, which is not restricted to any particular form. In this example, small cylinders and a middle gap therebetween are used as the fluid distribution adjustment structure 5. Clearly, the cylinders 51 may be disposed at equal intervals along the front edge 31 or rear edge 32, with the cylinders 51 on the front edge 31 and rear edge 32 being arranged in alignment or in one-to-one correspondence with one another in a direction perpendicular to the direction of extension of the front edge 31 or rear edge 32, but this is of course not necessary.

[0020] As Fig. 3b shows, in a direction perpendicular to the direction of extension of the front edge 31 or rear edge 32, the cylinders 51 are located at the front edge 31 and rear edge 32 respectively. To further promote the generation of turbulence, a center channel 6 between the cylinders 51 is also provided on the crest 3. Generally, the fluid distribution adjustment structure 5 comprises protrusions (e.g. cylinders 51) at the front edge 31 and rear edge 32 of the crest 3 of each ridge 1, and the center channel 6 between two protrusions.

[0021] Clearly, the protrusions are not limited to structural bodies of regular shape such as cylinders, pits, cuboids with rounded corners and trapezoidal structural bodies, but may also be structural bodies of irregular shape such as ellipses and pointed tips. The center channel 6 comprises a flat, straight channel and/or a channel formed by a multi-element curved-surfaced structural body. In this example, for the purpose of explanation, the center channel is set to be substantially V-shaped.

[0022] As Fig. 3c shows, cylinders or small cylinders 51 are disposed at intervals along the front edge 31 or rear edge 32. In other words, a substantially light-impermeable cross section is obtained in the length direction of the heat exchange plate 10, as shown in Fig. 3c for example. Such a light-impermeable or quasi-light-impermeable cross section characteristic is very important for the evaporation process. Gaseous coolant in a two-phase coolant flowing in through a fluid inlet of the heat exchange plate 10 will flow away through the sides, to trigger the process of "boiling" of liquid coolant. Referring to Fig. 3b, the small center channel 6 is located between two cylinders 51, i.e. in the middle gap between two cylinders 51. The center channel 6 may be used to evaporate liquid coolant. The depth used for the center channel 6 is very small, and the boundary layer or liquid film thickness of liquid coolant is quite small; this is conducive to enhancement of the boiling process. Furthermore, when coolant passes through the above-mentioned region, there is significant turbulence. This is also conducive to enhancement of the boiling process.

[0023] Although protrusions and the center channel are shown specifically in Figs. 3a - 3c, it can be appreciated that in order to regulate fluid distribution more effectively, a smooth connection structure is provided between the protrusions and the surface of the heat exchange plate, i.e. there is a balanced transition between the protrusions and the surface of the heat exchange plate. Furthermore, the center channel 6 is generally formed of a multi-element curved-surfaced structural body which comprises a combination of curved arc/multi-element curved line/multi-element arc and straight line/curved line/arc multi-element bodies. In other words, the center channel 6 is generally set to have a curved surface structure which transitions smoothly.

[0024] Furthermore, it must be explained that the center channel 6 may be set to have a depressed V-shape relative to the crest 3 as shown in Fig. 3, but multiple protrusions are provided on the two opposite edges 31 and 32 of the crest 3, and therefore even if the center channel 6 were set to be substantially flush with the crest, the middle part or gap disposed between the opposite edges 31 and 32 would still be able to serve the function of a center channel.

[0025] It can be understood that the structural settings of the crest 3 described above are all suitable for the trough bottom 4, and since the crest 3 and the trough bottom 4 are symmetrical with respect to each other, corresponding settings can be performed in a similar way.

[0026] As Fig. 4 shows, an open space between two adjacent cylinders 51 on the front edge 31 or rear edge 32 is an inlet 71 and outlet 72 of the flow unit formed by one ridge 1 and one groove 2 which are adjacent to each other. The arrow shows the flow direction of fluid; the inlets 71 and outlets 72 on the front edge 31 and rear edge 32 are used to break up liquid coolant into small droplets. This is conducive to evaporation of coolant. Furthermore, the turbulence achieved here also enhances heat transfer. As stated above, the center channel 6 may be used to homogenize fluid distribution, and reduce the thickness of the coolant boundary layer and liquid film.

[0027] Fig. 5 shows another variation of the center channel according to the present invention. Clearly, in Fig. 3a the center channel 6 is set to extend in a flat and straight manner, substantially parallel to the front edge 31 and/or rear edge 32 of the ridge 1. The variation shown in Fig. 5 differs therefrom in that the center channel 6' is set to be curved along the front edge 31 and/or rear edge 32. In one embodiment, the center channel 6' is set to have a curved form along the front edge 31 and/or rear edge 32; of course, the center channel 6' could also be set to be curved in a direction different from the above-

mentioned direction, or to be curved in any form. Such an arrangement will make the process of coolant flow smoother. Thus, more active heat transfer regions (i.e. heat transfer areas) will be obtained. Furthermore, more turbulence is generated to enhance the boiling process.

[0028] Reference is made to Fig. 6, which shows the intermittent layout of inlets and outlets. As compared with Fig. 4, small cylinders 51 with the same structure are no longer disposed at intervals along the front edge 31 and/or rear edge 32; instead, small cylinders 51 and larger structural bodies (in this example, cuboids with chamfered or rounded corners) 81 are arranged alternately at predetermined intervals along the front edge 31 and/or rear edge 32. Thus, as compared with Fig. 4, the flow cross section of the basic flow unit is reduced, and the flow speed of fluid such as coolant will increase. Thus, more turbulence will be generated. This is conducive to enhancement of heat transfer. Furthermore, top regions on the two edges (front edge 31 and rear edge 32) are enlarged, such that greater strength will be achieved when two heat exchange plates are fitted together to form a flow path for fluid. The arrow shows the flow direction of fluid, such as coolant.

[0029] Fig. 7 shows an example in which the crest of the ridge has an intermittent center channel. Although Fig. 4 shows that the center channel 6 is continuous, the center channel 6 may also be set to have an intermittently blocked form. As the figure shows, compared with the case of Fig. 4, the interval between small cylinders 51 disposed along the front edge 31 and rear edge 32 has been expanded, in order to accommodate, between two small cylinders 51 which are adjacent in the direction of extension of the front edge 31 and/or rear edge 32, a structural body 82 which is larger than the small cylinder. The structural body 82 is dimensioned so as to keep spaced apart the small cylinders 51 adjacent thereto on the front edge 31 and/or rear edge 32, and at the same time partially or completely block the center channel 6. Fig. 7 shows the case in which an ellipsoid, elongated rounded body or cuboid with rounded corners 82 completely blocks the center channel 6 in a direction perpendicular to the front edge 31 or rear edge 32, wherein the cuboid 82 is spaced apart from four adjacent small cylinders 51.

[0030] The arrangement described above is merely one example; however, any arrangement which enables the center channel 6 to be blocked intermittently is suitable for the present invention. Those skilled in the art will easily understand that such a pattern structure is conducive to enhancement of the strength of fluid channels in the heat exchange plate 10 and to an increase in pressure drop (i.e. the generation of more turbulence). Of course, the restriction of fluid distribution in the center channel 6 will be weakened; however, adjustment of fluid distribution can still be carried out in fluid channels of the heat exchange plate 10 with the inverted-V-shaped pattern (specifically in the grooves 2 shown in Fig. 1). The final result depends on the overall design of the heat exchange plate 10 (or other structural parameters).

[0031] Figs. 8a and 8b show, respectively, an overall view of the heat exchange plate 10 according to another embodiment of the present invention, and the main features in the optimized technical solution in Fig. 8a. In Fig. 8a, the heat exchange plate 10 comprises ports 11, 12, 13 and 14 for fluid. It can be understood that those skilled in the art could select suitable ports 11, 12, 13 and 14, as required, for fluid to flow in and flow out.

[0032] Fig. 8b shows an enlarged view of a middle part of the heat exchange plate 10 in Fig. 8a. It can be seen from the enlarged view that ridges 1 and grooves 2 are disposed alternately from left to right, with multiple fluid distribution adjustment structures 5 being disposed at intervals (in a direction from bottom to top) on the front edges 31 and rear edges 32 of the ridges 1. Since the fluid distribution adjustment structure 5 is set to be a curved or winding structure as shown in the figure (e.g. substantially in the shape of a double hook), a curved center channel 6' is formed in a part between the front edge 31 and rear edge 32.

[0033] Of course, the scenario shown here is merely one example, the objective thereof being to illustrate that different ways of arranging the fluid distribution adjustment structures as described above may be applied to the heat exchange plate 10.

[0034] Furthermore, the structures shown in Figs. 8a and 8b reflect a notable advantage of the present invention in terms of the design of the ratio of groove width to ridge width. That is, by adjusting the width ratio relationship between the ridges and grooves, and the dimensions of the corresponding fluid adjustment structures, it is very easy to obtain a heat exchange plate with a high degree of asymmetry. When applied to refrigerating machine evaporators with a large channel flow rate and heat pump evaporators in which an aqueous solution of ethylene glycol etc. is used as a secondary coolant, on the one hand, the present invention will provide a better evaporation result, and provide a user with a higher evaporation temperature under the same conditions; on the other hand, the present invention also effectively reduces the channel pressure drop on the water side (auxiliary side), thereby increasing the energy efficiency of the water pump in the user unit system.

[0035] Apart from the characteristics mentioned above, welding points of two adjacent heat exchange plates should match each other when fitted together. Furthermore, in the case of common inverted-V-shaped plate-type heat exchangers, a plate design pattern of a substantially W-shaped and M-shaped pattern may also be used for the present invention.

[0036] Two plates having the above-mentioned structural features can be fitted together to form a manifold. In the case of an inverted-V-shaped plate-type heat exchanger, one of the heat exchange plates is referred to as the A(M)-shaped heat exchange plate, while the other matching heat exchange plate is referred to as the V(W)-shaped heat exchange plate. These are universal

specialized terms in inverted-V-shaped or fishbone plate-type heat exchangers. Pairs of heat exchange plates are fitted together to form the plate-type heat exchanger.

[0037] It can be seen from the above that the concept of the present invention lies in combining the advantages of inverted-V-shaped heat exchange plates and dimpled heat exchangers. Details of the advantages are explained and illustrated by means of the manner of flow and the heat transfer process in the plate-type heat exchanger.

[0038] When the present invention is used in an evaporator of a plate-type heat exchanger, a two-phase coolant flows into fluid channels on the heat exchange plates. When the coolant encounters a net gap (such as the groove 2 shown in Fig. 1), the coolant will preferably flow away from the sides. The entire V/A(M/W)-shaped center channel will be filled. This is beneficial for fluid distribution. Coolant will then enter through the inlets 71 on the front edge 31 of the ridge 1. The small entry space will control the liquid coolant to uniformly distribute them. Furthermore, the semi-closed cross-sectional space will force vapor of gaseous coolant to flow in a curved, winding manner, for the purpose of preventing bypass flow. The use of a structure which generates turbulence and a small groove depth will ensure that an effective boiling process takes place in the center channel. The vapor of gaseous coolant will push liquid coolant to leave the center channel 6 through the outlets 72 on the rear edges 32 of the ridge 1. Furthermore, this will enhance boiling. This process is carried out alternately. Based on the assembly features of the A-V(M-W)-shaped plates, a reflux action will be achieved here. This is also beneficial for fluid distribution and enhancement of heat transfer.

[0039] The above are merely some embodiments of the present invention. Those skilled in the art will understand that changes may be made to these embodiments without departing from the principles and spirit of the overall concept of the present invention. The scope of the present invention is defined by the claims and their equivalents.

Claims

1. A heat exchange plate, at least one surface of each heat exchange plate comprising ridges and grooves which are arranged alternately,**characterized in that**:

   multiple fluid distribution adjustment structures are disposed on crests of the ridges and/or trough bottoms of the grooves.

2. The heat exchange plate as claimed in claim 1, **characterized in that**:

   each of the fluid distribution adjustment structures comprises protrusions on two edges of the crest or
   trough bottom respectively, and a center channel between the two edges.

3. The heat exchange plate as claimed in claim 2, **characterized in that**:

   the protrusion comprises any one of a cylinder, a cuboid with rounded corners, a trapezoidal structural body and an arcuate protrusion, or any combination thereof; the center channel comprises a flat, straight channel and/or a channel formed by a multi-element curved-surfaced structural body.

4. The heat exchange plate as claimed in claim 2 or 3, **characterized in that**:

   a smooth connection structure is disposed between the protrusion and the heat exchange plate surface, and the multi-element curved-surfaced structural body comprises a combination of curved arc/multi-element curved line/multi-element arc and straight line/curved line/arc multi-element bodies.

5. The heat exchange plate as claimed in claim 2 or 3, **characterized in that**:

   the base of the center channel is substantially flush with or depressed relative to the crest or trough bottom.

6. The heat exchange plate as claimed in any one of claims 2 - 5, **characterized in that**:

   a part between the two protrusions on each edge forms an inlet or outlet of the center channel.

7. The heat exchange plate as claimed in any one of claims 2 - 6, **characterized in that**:

   the protrusions are disposed at intervals on the front edge and/or rear edge of the crest or trough bottom.

8. The heat exchange plate as claimed in claim 7, **characterized in that**:

   the protrusions on the front edge are staggered with respect to the protrusions on the rear edge in a horizontal direction perpendicular to a direction of extension of the center channel.

9. The heat exchange plate as claimed in any one of claims 1 - 8, **characterized in that**:

   the center channel is curved in the direction of

extension of the crest or trough bottom.

10. The heat exchange plate as claimed in any one of claims 2 - 9, **characterized in that**:

at least a portion of the protrusions are set to at least partially cover the center channel so as to form an intermittent center channel.

11. The heat exchange plate as claimed in any one of claims 1 - 10, **characterized in that**:

a part or all of the surface is provided with a structural pattern with a single half-inverted-V-shape and/or inverted-V-shape, or a double half-inverted-V-shape and/or inverted-V-shape, or a greater number of repetitions of a half-inverted-V-shape and/or inverted-V-shape, and each heat exchange plate comprises a fluid inlet and a fluid outlet located at two opposite ends respectively in a direction of extension of the heat exchange plate.

12. A plate-type heat exchanger, **characterized in that** the plate-type heat exchanger comprises the heat exchange plate as claimed in any one of claims 1 - 11.

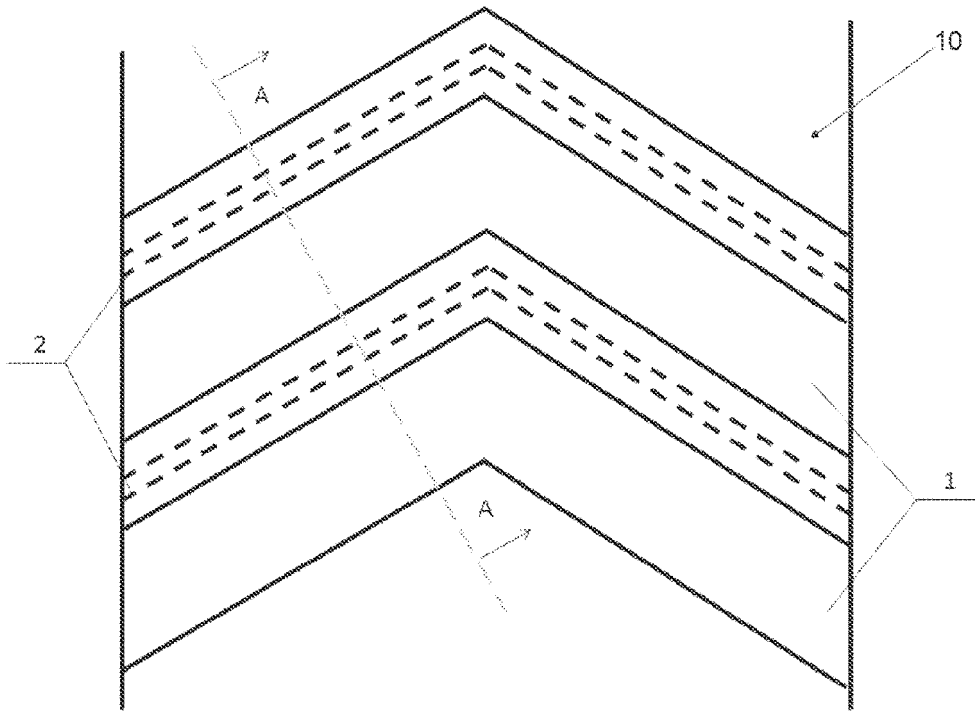


Fig. 1

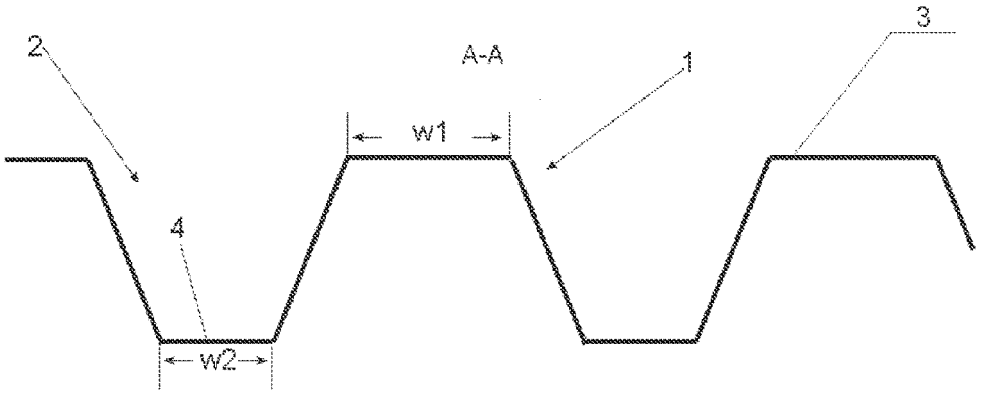


Fig. 2

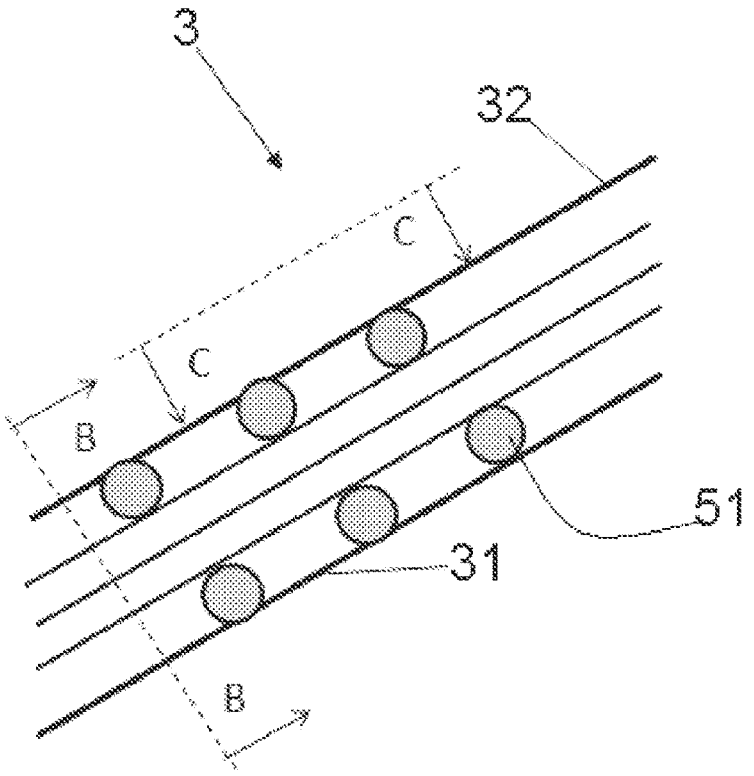


Fig. 3a

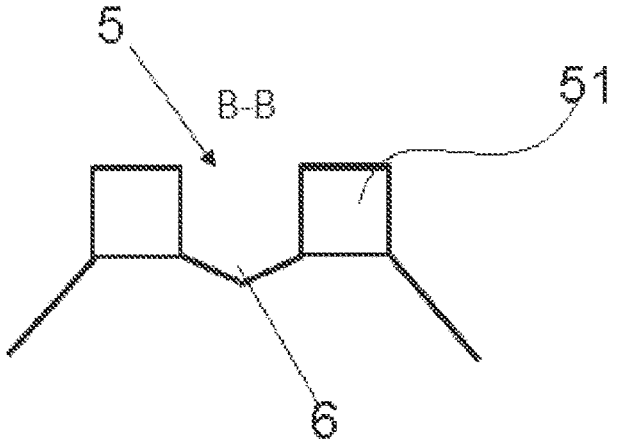


Fig. 3b

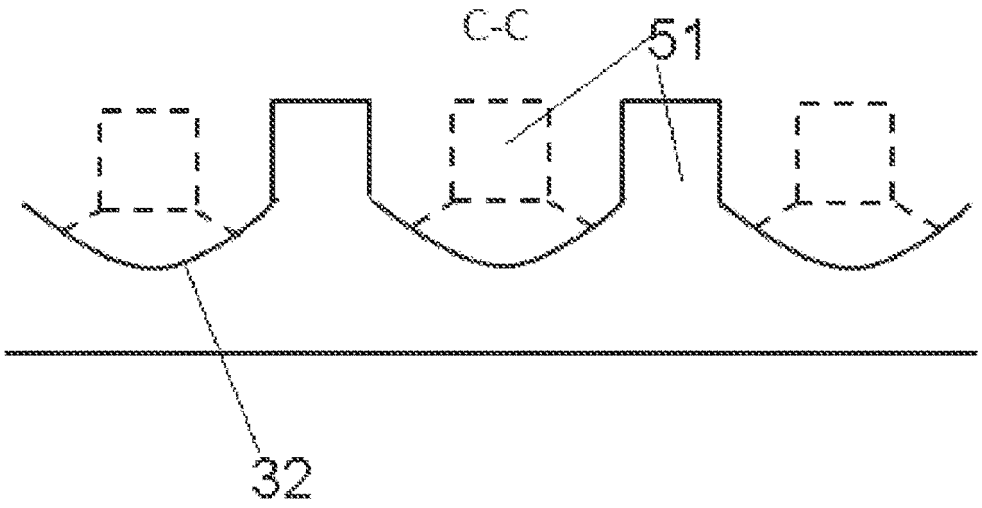


Fig. 3c

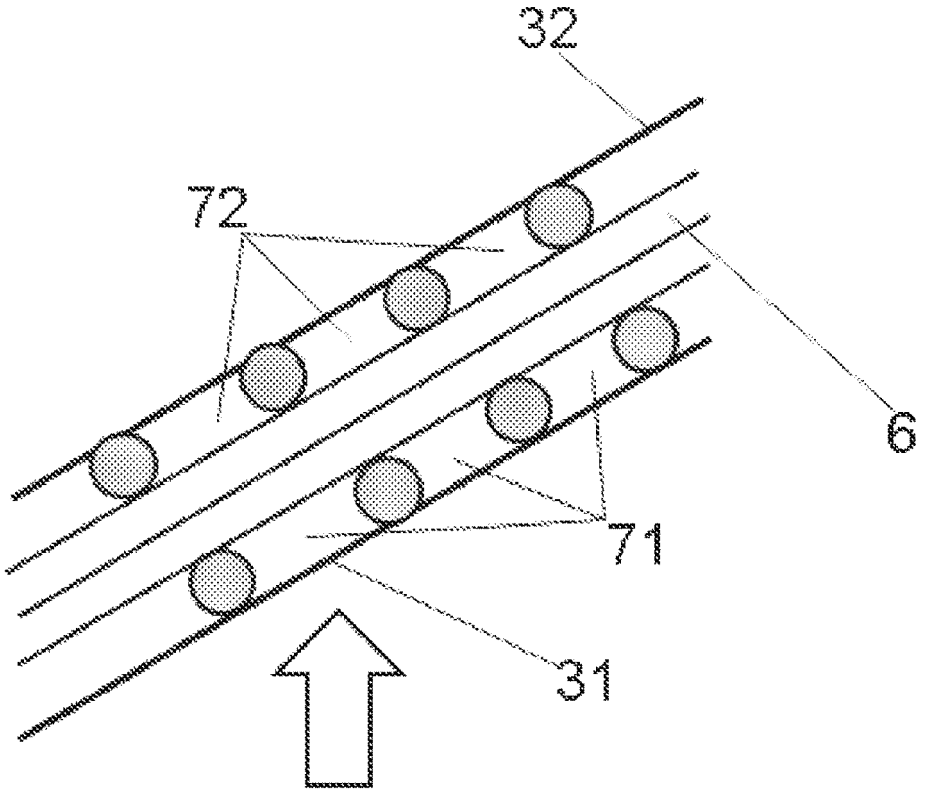


Fig. 4

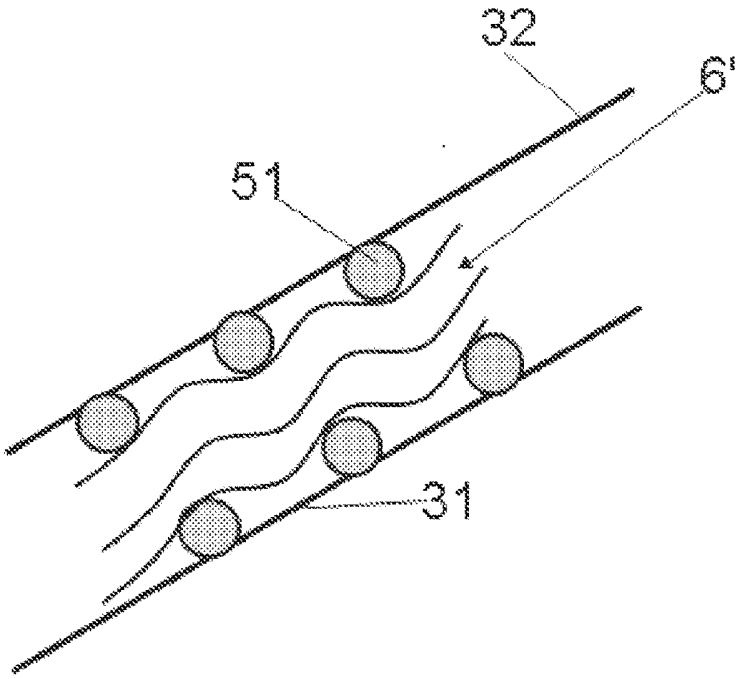


Fig. 5

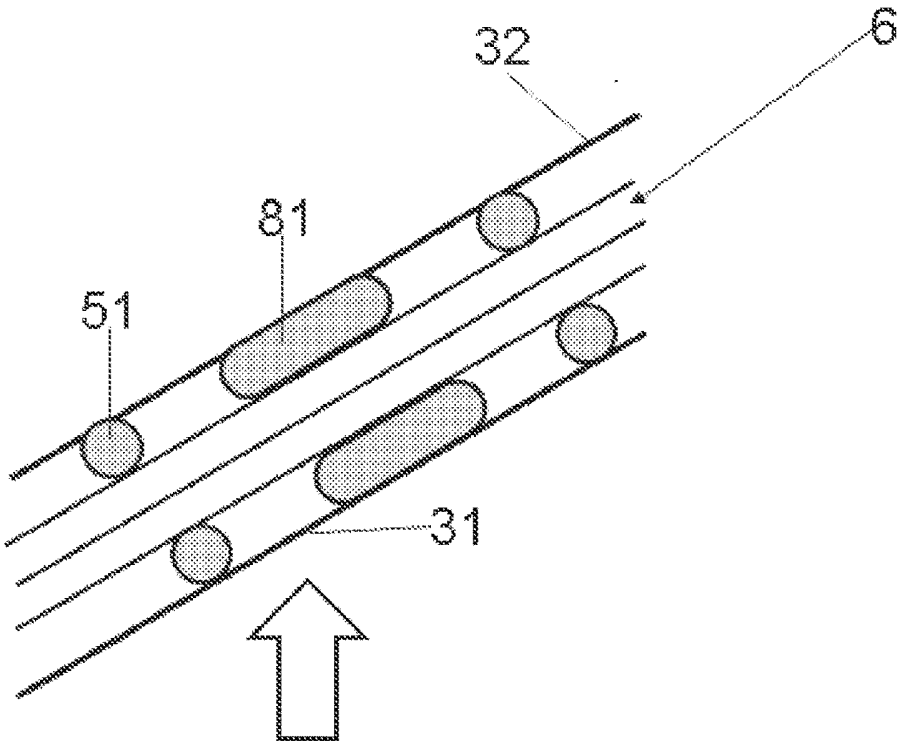


Fig. 6

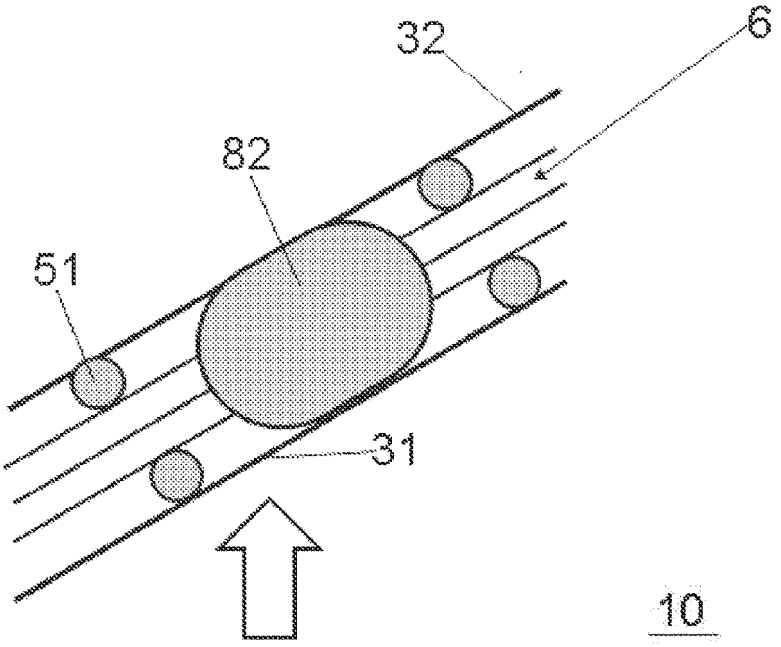


Fig. 7

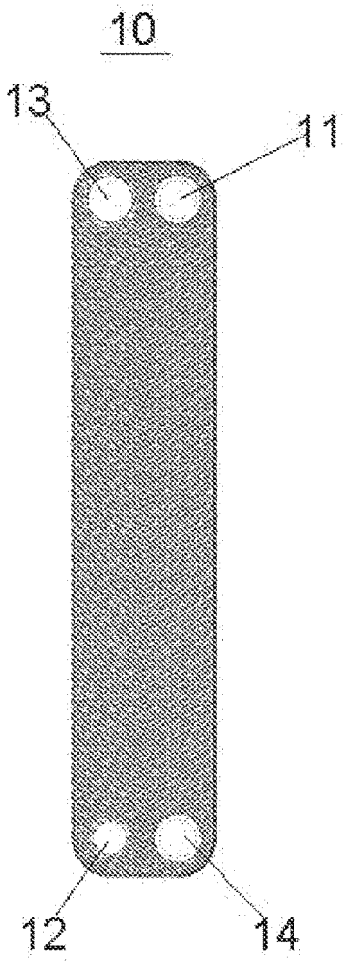


Fig. 8a

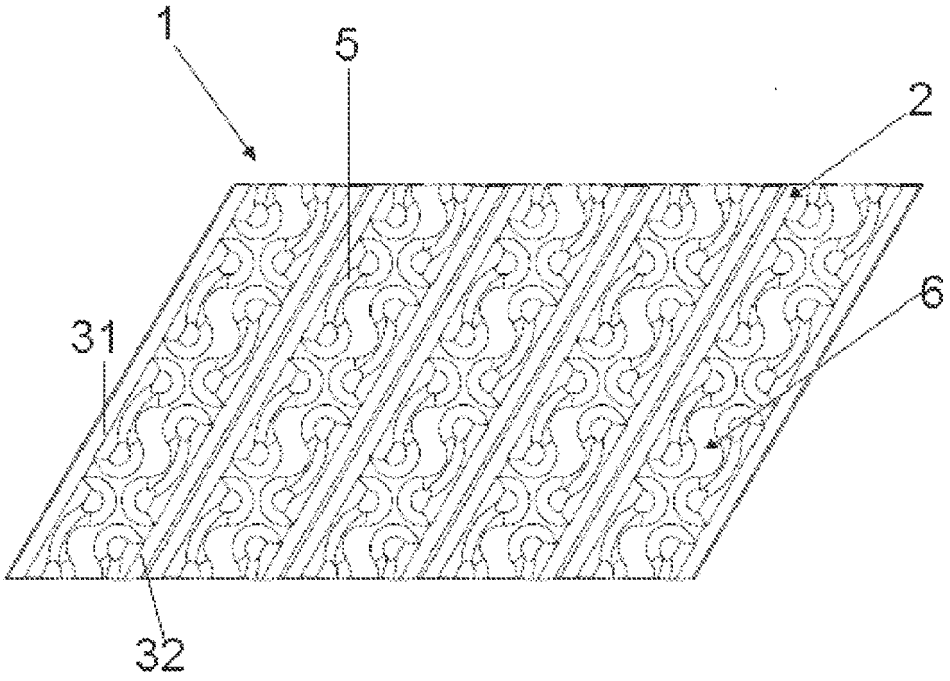


Fig. 8b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2015/073025

A. CLASSIFICATION OF SUBJECT MATTER

F28F 3/04 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F28F 3; F28D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, CNKI, VEN: heat, exchange, plate, panel, extrude, protrude, project, convex, heave, groove, slot

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 103822521 A (DANFOSS MICROCHANNEL HEAT EXCHANGER JIAX) 28 May 2014 (28.05.2014) claims 1-12	1-12
X	CN 2415336 Y (LIU, Chengqing) 17 January 2001 (17.01.2001) description, page 2, line 22 to page 4, line 12, and figures 1 to 4	1-12
A	CN 101970907 A (KOREA DELPHI AUTOMOTIVE SYSTEM) 09 February 2011 (09.02.2011) the whole document	1-12

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 April 2015	13 May 2015

Name and mailing address of the ISA	Authorized officer
State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No. (86-10) 62019451	YANG, Yi Telephone No. (86-10) 62084859

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2015/073025

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 102395853 A (KOREA DELPHI AUTOMOTIVE SYSTEM) 28 March 2012 (28.03.2012) the whole document	1-12
A	JP 2000283682 A (HISAKA WORKS LTD) 13 October 2000 (13.10.2000) the whole document	1-12

Form PCT/ISA /210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2015/073025

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 103822521 A	28 May 2014	None	
CN 2415336 Y	17 January 2001	None	
CN 101970907 A	09 February 2011	JP 5191066 B2	24 April 2013
		EP 2295834 A4	06 July 2011
		EP 2295834A2	16 March 2011
		JP 2011517757 A	16 June 2011
		WO 2010005179 A2	14 January 2010
		WO 2010005179 A3	11 March 2010
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		EP 2295834 B1	09 January 2013
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		WO 2010120125 A3	10 March 2011
		WO 2010120125 A2	21 October 2010
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		CN 102395853 B	02 April 2014
		EP 2420791 A2	22 February 2012
		EP 2420791 A4	05 March 2014
JP 2000283682 A	13 October 2000	None	

Form PCT/ISA /210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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- CN 201410076347 **[0001]**