

(19)



(11)

EP 3 575 728 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
16.12.2020 Bulletin 2020/51

(51) Int Cl.:
F28F 1/12 ^(2006.01) **F28D 1/053** ^(2006.01)

(21) Application number: **18461562.3**

(22) Date of filing: **30.05.2018**

(54) A CORE OF A HEAT EXCHANGER COMPRISING CORRUGATED FINS

KERN EINES WÄRMETAUSCHERS MIT GEWELLTEN RIPPEN

NOYAU D'UN ÉCHANGEUR DE CHALEUR COMPRENANT DES AILETTES ONDULÉES

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

(43) Date of publication of application:
04.12.2019 Bulletin 2019/49

(73) Proprietor: **Valeo Autosystemy SP. Z.O.O.**
32-050 Skawina (PL)

(72) Inventors:
• **SONTAG, Adam**
PL 32050 Skawina (PL)
• **WIDZYK, Lukasz**
PL 32050 Skawina (PL)

• **STRUS, Tomasz**
PL 32050 Skawian (PL)

(74) Representative: **Bialkowski, Adam**
Valeo Systèmes Thermiques
Industrial Property Department
ZA L'Agiot
8 rue Louis Lormand
CS 80517 LA VERRIERE
78322 Le Mesnil Saint Denis Cedex (FR)

(56) References cited:
WO-A1-03/076860 DE-A1- 10 003 104
US-A1- 2009 173 477 US-B1- 6 213 196

EP 3 575 728 B1

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

THE FIELD OF THE INVENTION

5 **[0001]** The invention relates to a core of heat exchanger comprising corrugated fins, and in particular it relates to the shape of a corrugated fin.

THE STATE OF THE ART

10 **[0002]** Heat exchangers are well known in the state of the art, for example, in the automotive industry. Heat exchangers usually comprise a core consisting of a plurality of oblate pipes for leading a heating medium, i.e. flow of liquid or gas, and corrugated fins located between the oblate pipes along the whole length of the pipes. The ends of the pipes are connected with manifolds and tanks for, respectively, supplying to the pipes and leading away, the medium circulating in heat exchanger pipes. Each corrugated fin is usually shaped from sheet metal and has wavelike ridges disposed
15 transversely to the core length. In the spaces between individual ridges of a fin there are defined channels for leading the second medium, i.e. flow of another gas, for example air, participating in heat exchange. The fin ridges are heated as a result of their contact with pipes wherein a heating medium flows, i.e. hot liquid or gas, whereas the second medium flowing through the channels is heated by contact with the heated fin ridges.

[0003] In order to increase heat exchange between the heating medium and the heated medium attempts are being made to construct fins that have various shapes and are placed in various position relative to the pipes.

[0004] The publication of US 2005/0199378 A1 discloses a core of a heat exchanger which comprises corrugated fins as described above located in contact with and between each pair of neighbouring oblate pipes, and each fin consists of ridges having flanks forming channels for the flow of a heated medium between the inlet thereof on the front surface of the core and the outlet on the rear surface of the core. The ridges extend obliquely to the front and rear surface of
25 the core and consequently for a particular channel the inlet of the heated medium is displaced relative to the outlet of the heated medium relative to the line perpendicular to the front and rear surface of the core as a result of which the flow of the heated medium, being supplied in the direction perpendicular to the front surface of the core, hits the surfaces of the ridge flanks and intensifies the absorption of heat by the heated medium.

[0005] The publication of US2009/0173477 discloses a heat exchanger comprising a core consisting of flat pipes and corrugated fins located in contact with and between said pipes. The fins are formed of a corrugated metal strip and the crests of such formed ridges extend in a direction transverse to the flat pipes and thus form channels for the flow of a heated medium between the inlet thereof on the front surface of the core and the outlet on the rear surface of the core. Each ridge has slits formed on the flanks thereof which change the direction of the heated medium flow through said channels to improve efficiency of heat exchange. Fin ridges may be bent in V-shaped form along their width, which
35 additionally boosts heat exchange efficiency. US2009/0173477 discloses a core for a heat exchanger according to the preamble of claim 1.

[0006] One problem connected with the use of corrugated fins known from the state of the art is that the pressure of a heated medium, usually air, drops as the medium flows between the front and the rear surface of a heat exchanger. The greater the drop in the heated medium pressure, the worse the efficiency of heat exchange in a heat exchanger.

40 **[0007]** The purpose of the present invention is to provide a heat exchanger core that would exhibit enhanced heat exchange efficiency and a smaller drop in the pressure of a heated medium led through the channels of a corrugated rib, and which would also be easy to manufacture and use.

SUMMARY OF THE INVENTION

45 **[0008]** The purpose of the invention is fulfilled by a heat exchanger core whose features are defined in the independent claim 1.

[0009] The remaining preferable features of the invention are presented in the dependent claims 2-7.

[0010] The use of the heat exchanger core according to the invention makes it possible to reduce pressure drop of the heated medium during its flow between the inlet thereof on the front surface of the heat exchanger and the outlet on the rear surface of the heat exchanger, which in consequence increases mass flow of a cooling medium. This fact may be used to boost efficiency of heat exchangers and makes it possible to reduce the power of fan system that generates a cooling medium stream.

BRIEF DESCRIPTION OF THE FIGURES

55 **[0011]** The invention is presented in the figures which are used for illustrative purposes only and are not intended to limit the scope of the invention.

Fig. 1 shows a front view of a heat exchanger comprising a core according to the present invention;

Fig. 2 shows an enlarged perspective view of a fragment of a corrugated fin of the core according to the invention;

Fig. 3 shows schematically the shape of one ridge of the corrugated fin in a cross-section A-A of Fig. 2;

Fig. 4 shows schematically the shape of one ridge of a fin in a view from direction B in Fig. 2.

DESCRIPTION OF AN EMBODIMENT OF THE INVENTION

[0012] The following description is only exemplary and it is not intended to limit the present invention or its application and use.

[0013] Fig. 1 presents a heat exchanger 1 comprising a core 2 according to the invention and a pair of manifolds 3 disposed on both flanks of the core 2. The core 2 comprises oblate pipes 4 disposed in the length direction L of the core 2. The pipes 4 are connected at their ends with manifolds 3 of the heat exchanger 1 for supplying and leading away a heating medium flowing through the pipes 4 and heating them. Between each pair of neighbouring pipes 4 there is disposed a corrugated fin 5 being in contact therewith. The corrugated fin 5 extends along the whole length L of the core 2 and of the pipes 4, and comprises a plurality of ridges 6 which have crests 7 and troughs 8. The ridges 6 extend in the transverse direction relative to the length L of the core 2, i.e. between the front surface 2a and the rear surface 2b of the core 2. Between individual ridges 6 of a rib 5 and external surfaces of the pipes 4 there are formed channels for the flow of a heated medium which is directed transversely to the length L of the core 2 between the front surface 2a of the core 2 defining the inlet of the heated medium and the rear surface 2b of the core 2 defining the outlet of the heated medium. The ridges 6 have a width W corresponding to the width of the core 2 (which can be more clearly seen in Fig. 2).

[0014] The ridges 6 of a fin 5 may be disposed perpendicularly to the front surface 2a and the rear surface 2b of the core 2, as shown in Fig. 1, or they can be disposed obliquely to said surfaces 2a, 2b to which intensify the heat exchange.

[0015] As shown in Fig. 2 and 3, according to the invention each ridge 6 of a fin 5 is bent along its width W in the direction perpendicular to its width W and forms an offset 9 dividing the ridge 6 into two sections 20, 30 which are disposed one after the other in the width direction W of the ridge 6 and are translated relative to each other in the length direction L of the core 2 at a distance ΔL (as shown in FIG. 3 and 4). The measure of the distance ΔL of the parallel translation of neighbouring sections 20, 30 of a ridge 6 is defined as the distance between central planes "a" and "b" of the neighbouring sections 20, 30 of a ridge 6 (as shown in FIG. 4). According to the invention the neighbouring sections 20, 30 are translated parallelly to each other at a distance ΔL which fulfils the following condition:

$$0 < \Delta L \leq fp/4, \quad (1)$$

where fp is the pitch of a corrugated fin 5 defined as the distance between the troughs 8 of one ridge 6, and the central planes "a", "b" are defined as planes passing through the centre of a crest 7 and at even distances from the centres of troughs 8 of one given ridge 6.

[0016] The use of a corrugated fin 5 shaped according to the invention in a heat exchanger 1 makes it possible to reduce pressure drop in a heated medium as it flows between the inlet thereof on the front surface 2a of the core 2 and the outlet on the rear surface 2b of the core 2. It has been found that in the case of the heated medium flow rate of 2 m/s and the shape of ridges 6 with translation ΔL fulfilling the condition (1) the flow pressure drop may be reduced by 6% and the heat exchanger efficiency may be enhanced by 0.12% compared to the pressure drop and heat exchanger efficiency for the same flow rate of the heated medium in a conventional core. It has also been found that in the case of the heated medium flow rate of 5 m/s and the shape of ridges 6 with translation ΔL fulfilling the condition (1) the flow pressure drop may be reduced by 6% and the heat exchanger efficiency may be enhanced by 0.4% compared to the pressure drop and heat exchanger efficiency for the same flow rate of the heated medium in a conventional core.

[0017] Sections 20, 30 of a ridge 6 may have widths W1 and W2, respectively, which widths may be the same or different.

[0018] It should be noted that, although the drawing presents an embodiment wherein there is one bend and one offset 9 along the width W of a ridge 6, it has been envisaged that in the case of wider cores 2 of a heat exchanger 1 there may be more than one bend and more than one offset 9 along the width W, and more than two sections translated to each other in the length direction L of the core 2 may be formed. In such case the translation distance ΔL at the offset 9 between each pair of neighbouring sections fulfils the condition (1). In this case also the widths of the sections may be the same or may differ.

[0019] Each ridge 6 of a fin 5 has two flanks 10 which may be provided with slits 11 having deflected edges and forming louvers 12 for leading and directing a heated medium passing through the flanks 10 between the neighbouring channels

formed on both sides of a ridge 6. Preferably, the louvers 12 are arranged in the same direction in individual sections 20, 30 on both sides of the central planes "a", "b" thereof, and in the opposite directions in the neighbouring sections 20, 30, as it makes it possible to lead a heated medium through the heat exchanger core in both directions transverse to the core length while ensuring the same effects of heat exchange.

[0020] The core of a heat exchanger according to the invention may be used in heat exchangers of any type, such as an engine cooler, a condenser, an intercooler, and the like.

Claims

1. A core (2) for a heat exchanger (1), having a front surface (2a) defining an inlet of a heated medium and an opposite rear surface (2b) defining an outlet of the heated medium and comprising:

oblate pipes (4) for the flow of a heating medium disposed in the length direction (L) of the core (2);
corrugated fins (5) located in contact with and between each pair of neighbouring pipes (4) and comprising ridges (6); the ridges (6) having a width (W) and forming channels for the flow of the heated medium and extending transversely to the length (L) of the core (2) between the front surface (2a) and rear surface (2b) of the core (2),

characterized in that

each ridge (6) of a fin (5) is bent at least in one place along its width (W) in the direction transverse to its width (W) thus forming an offset (9) dividing the ridge (6) into two sections (20, 30);

the sections (20,30) are disposed one after the other in the width direction (W) of the ridge (6) and are translated in parallel to each other in the length direction (L) of the core (2) at a distance ΔL ;

the distance ΔL is defined as a distance between central planes (a, b) of the neighbouring sections (20, 30) of that ridge (6), wherein the central planes (a, b) are defined as planes passing through the centre of a crest (7) and at equal distances from the centres of troughs (8) of individual sections (20,30) of the ridge (6); and

the distance ΔL of the parallel translation of the neighbouring sections (20, 30) relative to each other fulfils the following condition:

$0 < \Delta L \leq fp/4$ where fp is the pitch of a corrugated fin (5) defined as a distance between troughs (8) of one ridge (6).

2. The core for a heat exchanger according to claim 1, wherein sections (20, 30) of a ridge (6) have widths W1, W2, respectively, which are equal.

3. The core for a heat exchanger according to claim 1, wherein sections (20,30) of a ridge (6) have widths W1, W2, respectively, which are different.

4. The core for a heat exchanger according to claim 1, wherein each ridge (6) has two flanks (10) which are provided with slits (11) having deflected edges forming louvers (12) for leading and directing a heated medium through the flanks (10) between neighbouring channels formed by the ridges (6).

5. The core for a heat exchanger according to claim 4, wherein the louvers (12) are disposed in the same direction in individual sections (20, 30) on both sides of their central planes (a, b) and in opposite directions in the neighbouring sections (20, 30).

6. The core for a heat exchanger according to claims 1-5, wherein the ridges (6) of the fins (5) are disposed transversely to the front surface (2a) and the rear surface (2b) of the core (2).

7. The core for a heat exchanger according to claims 1-5, wherein the ridges (6) of the fins (5) are disposed perpendicularly to the front surface (2a) and the rear surface (2b) of the core (2).

Patentansprüche

1. Kern (2) für einen Wärmetauscher (1), der eine vordere Oberfläche (2a), die einen Einlass für ein erwärmtes Medium definiert, und eine gegenüberliegende hintere Oberfläche (2b), die einen Auslass für das erwärmte Medium definiert, aufweist und Folgendes umfasst:

abgeflachte Rohre (4) für die Strömung eines Wärmemediums, die in der Längsrichtung (L) des Kerns (2) angeordnet sind;

gewellte Rippen (5), die sich in Kontakt mit und zwischen jedem Paar von benachbarten Rohren (4) befinden und Furchen (6) umfassen; wobei die Furchen (6) eine Breite (W) aufweisen und Kanäle für die Strömung des erwärmten Mediums bilden und sich quer zur Länge (L) des Kerns (2) zwischen der vorderen Oberfläche (2a) und der hinteren Oberfläche (2b) des Kerns (2) erstrecken,

dadurch gekennzeichnet, dass

jede Furche (6) einer Rippe (5) mindestens an einem Ort entlang ihrer Breite (W) in die Richtung quer zu ihrer Breite (W) gebogen ist, wodurch sie einen Versatz (9) bildet, der die Furche (6) in zwei Abschnitte (20, 30) teilt; die Abschnitte (20, 30) in der Breitenrichtung (W) der Furche (6) nacheinander vorgesehen sind und parallel zueinander in der Längsrichtung (L) des Kerns (2) mit einem Abstand ΔL verschoben sind;

der Abstand ΔL als ein Abstand zwischen Zentralebenen (a, b) der benachbarten Abschnitte (20, 30) dieser Furche (6) definiert ist, wobei die Zentralebenen (a, b) als Ebenen definiert sind, die durch die Mitte eines Wellenkamms (7) und in gleichen Abständen von den Mitten der Wellentäler (8) der einzelnen Abschnitte (20, 30) der Furche (6) gehen, und

der Abstand ΔL der parallelen Verschiebung der benachbarten Abschnitte (20, 30) relativ zueinander die folgende Bedingung erfüllt:

$$0 < \Delta L \leq f_p/4$$

wobei f_p die Teilung einer gewellten Rippe (5) ist, die als ein Abstand zwischen Wellentälern (8) einer Furche (6) definiert ist.

2. Kern für einen Wärmetauscher nach Anspruch 1, wobei die Abschnitte (20, 30) einer Furche (6) jeweils Breiten W1, W2 aufweisen, die gleich sind.

3. Kern für einen Wärmetauscher nach Anspruch 1, wobei die Abschnitte (20, 30) einer Furche (6) jeweils Breiten W1, W2 aufweisen, die unterschiedlich sind.

4. Kern für einen Wärmetauscher nach Anspruch 1, wobei jede Furche (6) zwei Flanken (10) aufweist, die mit Schlitzten (11) versehen sind, die ausgelenkte Kanten aufweisen, die Lamellen (12) zum Leiten und Richten eines erwärmten Mediums durch die Flanken (10) zwischen benachbarten Kanälen, die durch die Furchen (6) gebildet sind, bilden.

5. Kern für einen Wärmetauscher nach Anspruch 4, wobei die Lamellen (12) in den einzelnen Abschnitten (20, 30) auf beiden Seiten ihrer Zentralebenen (a, b) in derselben Richtung und in den benachbarten Abschnitten (20, 30) in entgegengesetzten Richtungen angeordnet sind.

6. Kern für einen Wärmetauscher nach Anspruch 1-5, wobei die Furchen (6) der Rippen (5) quer zu der vorderen Oberfläche (2a) und der hinteren Oberfläche (2b) des Kerns (2) angeordnet sind.

7. Kern für einen Wärmetauscher nach Anspruch 1-5, wobei die Furchen (6) der Rippen (5) senkrecht zu der vorderen Oberfläche (2a) und der hinteren Oberfläche (2b) des Kerns (2) angeordnet sind.

Revendications

1. Noyau (2) d'un échangeur de chaleur (1), ayant une surface avant (2a) définissant une entrée d'un milieu chauffé et une surface arrière opposée (2b) définissant une sortie du milieu chauffé et comprenant :

des tuyaux aplatis (4) pour l'écoulement d'un milieu de chauffage, disposés dans la direction longitudinale (L) du noyau (2) ;

des ailettes ondulées (5) situées en contact avec, et entre, chaque paire de tuyaux adjacents (4) et comprenant des arêtes (6) ; les arêtes (6) ayant une largeur (W) et formant des canaux pour l'écoulement du milieu chauffé et s'étendant transversalement à la longueur (L) du noyau (2) entre la surface avant (2a) et la surface arrière (2b) du noyau (2),

caractérisé en ce que

chaque arête (6) d'une ailette (5) est courbée au moins en un emplacement le long de sa largeur (W) dans la direction transversale à sa largeur (W) pour ainsi former un décalage (9) divisant l'arête (6) en deux sections (20, 30) ;

les sections (20, 30) sont disposées l'une derrière l'autre dans la direction de la largeur (W) de l'arête (6) et

EP 3 575 728 B1

sont déplacées en translation parallèlement l'une à l'autre dans la direction de la longueur (L) du noyau (2) à une distance ΔL ;

la distance ΔL est définie comme une distance entre des plans centraux (a, b) des sections adjacentes (20, 30) de cette arête (6), les plans centraux (a, b) étant définis comme étant des plans passant à travers le centre d'une crête (7) et équidistants des centres de creux (8) de sections individuelles (20, 30) de l'arête (6) ;

et

la distance ΔL de la translation parallèle des sections adjacentes (20, 30) l'une par rapport à l'autre satisfaisant à la condition suivante :

$$0 < \Delta L \leq fp/4,$$

où fp est le pas d'une ailette ondulée (5) défini comme la distance entre des creux (8) d'une arête (6) .

2. Noyau d'un échangeur de chaleur selon la revendication 1, dans lequel des sections (20, 30) d'une arête (6) présentent des largeurs respectives W1, W2 qui sont identiques.

3. Noyau d'un échangeur de chaleur selon la revendication 1, dans lequel des sections (20, 30) d'une arête (6) présentent des largeurs respectives W1, W2 qui sont différentes.

4. Noyau d'un échangeur de chaleur selon la revendication 1, dans lequel chaque arête (6) présente deux flancs (10) qui sont pourvus de fentes (11) ayant des bords décalés formant des lames (12) pour conduire et diriger un milieu chauffé à travers les flancs (10) entre des canaux adjacents formés par les arêtes (6).

5. Noyau d'un échangeur de chaleur selon la revendication 4, dans lequel les lames (12) sont disposées dans la même direction dans des sections individuelles (20, 30) des deux côtés de leurs plans centraux (a, b) et dans des directions opposées dans les sections adjacentes (20, 30).

6. Noyau d'un échangeur de chaleur selon les revendications 1 à 5, dans lequel les arêtes (6) des ailettes (5) sont disposées transversalement à la surface avant (2a) et à la surface arrière (2b) du noyau (2).

7. Noyau d'un échangeur de chaleur selon les revendications 1 à 5, dans lequel les arêtes (6) des ailettes (5) sont disposées perpendiculairement à la surface avant (2a) et à la surface arrière (2b) du noyau (2).

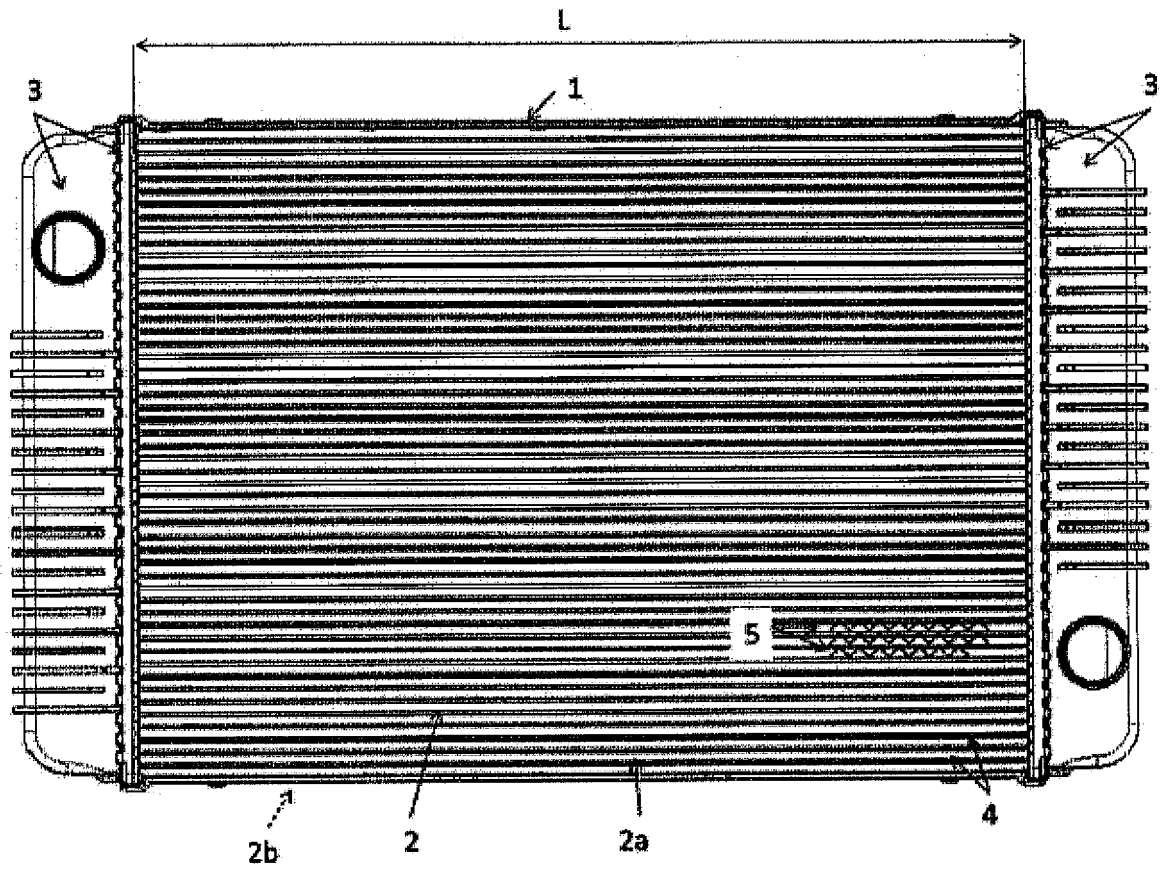


FIG. 1

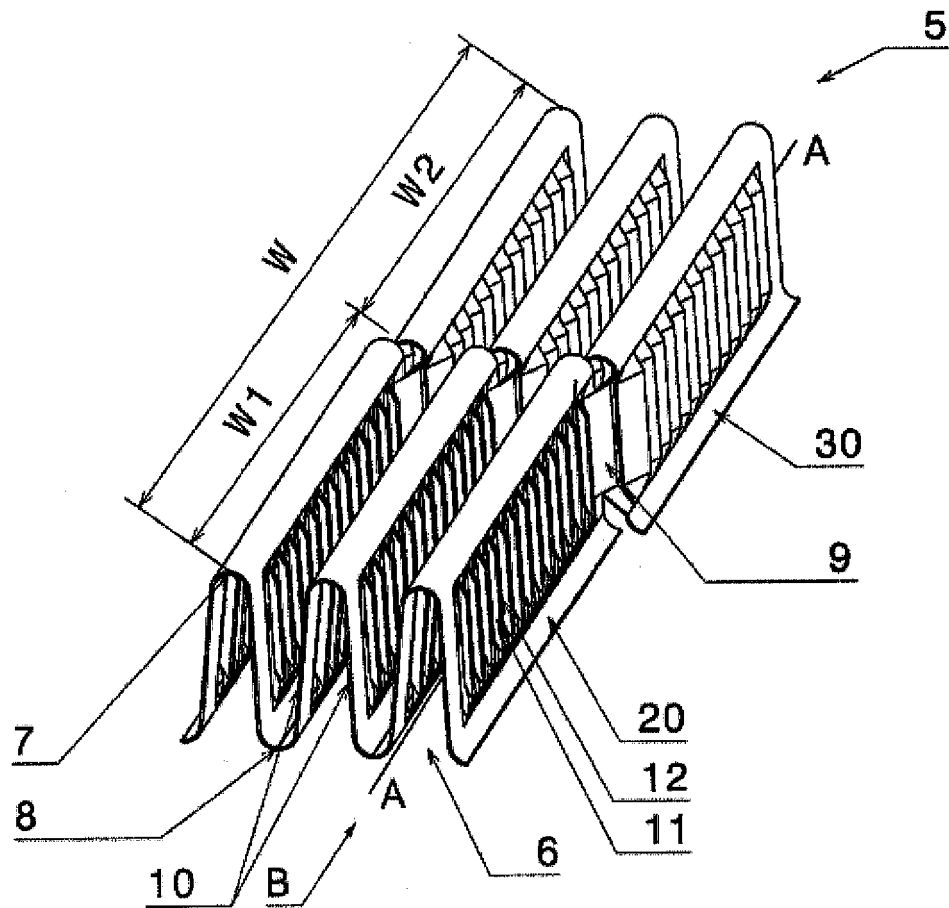


FIG. 2

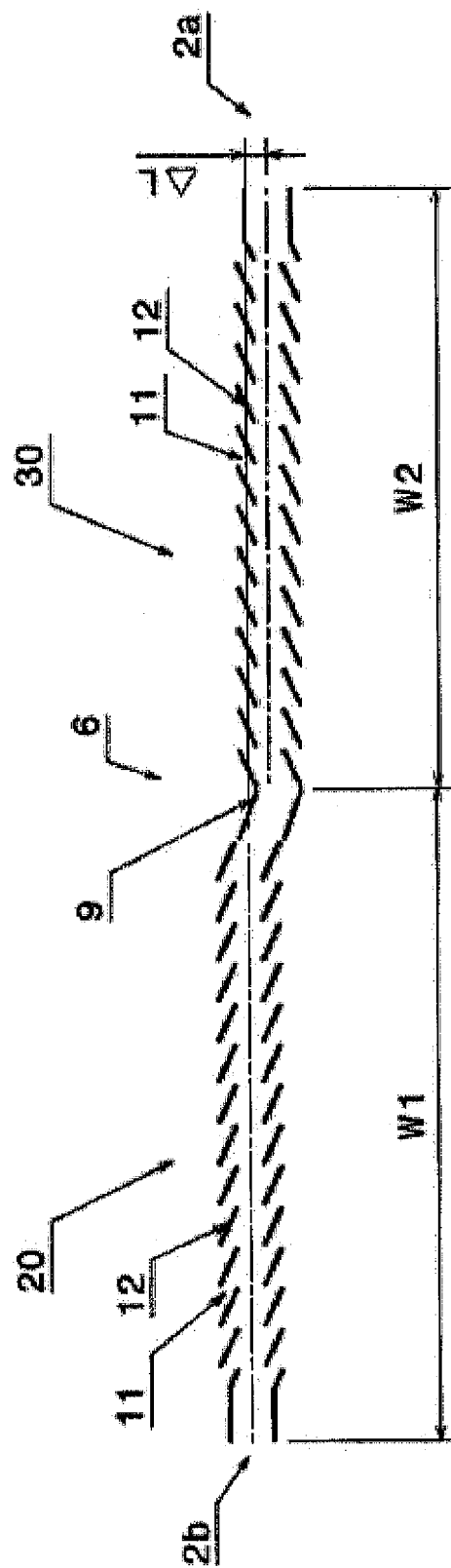


FIG. 3

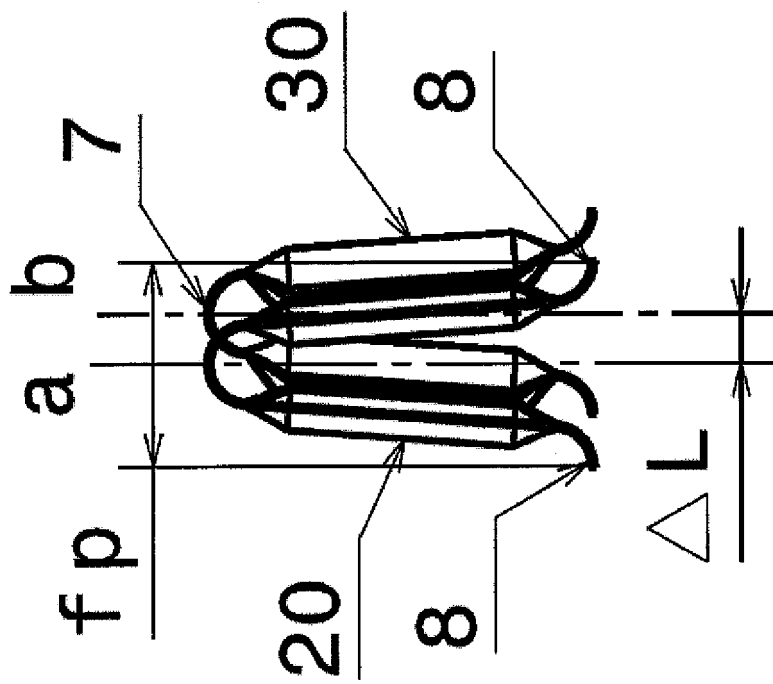


FIG. 4

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 20050199378 A1 [0004]
- US 20090173477 A [0005]