



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
13.05.2020 Bulletin 2020/20

(51) Int Cl.:
F28F 3/02 (2006.01) **F28F 1/02** (2006.01)
F28F 1/04 (2006.01)

(21) Application number: **18382793.0**

(22) Date of filing: **07.11.2018**

(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
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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(54) **A FIN BODY FOR A HEAT EXCHANGE TUBE**

(57) The present invention relates to a fin body intended for being housed inside a heat exchange tube which is one from among heat exchange tubes showing a planar configuration. The fin body is configured in the form of a plate, this plate being the one inserted into the heat exchange tube. The plate is configured from a metal sheet bent into a plurality of consecutive bends. The in-

vention is characterized by a range of characteristic width to height ratio in the interval of 0.15-0.5, and according to more specific cases, in the lower subranges. As a result, the fin gives rise to a heat exchange tube with a higher efficiency than fins known in the state of the art without penalizing the pressure drop.

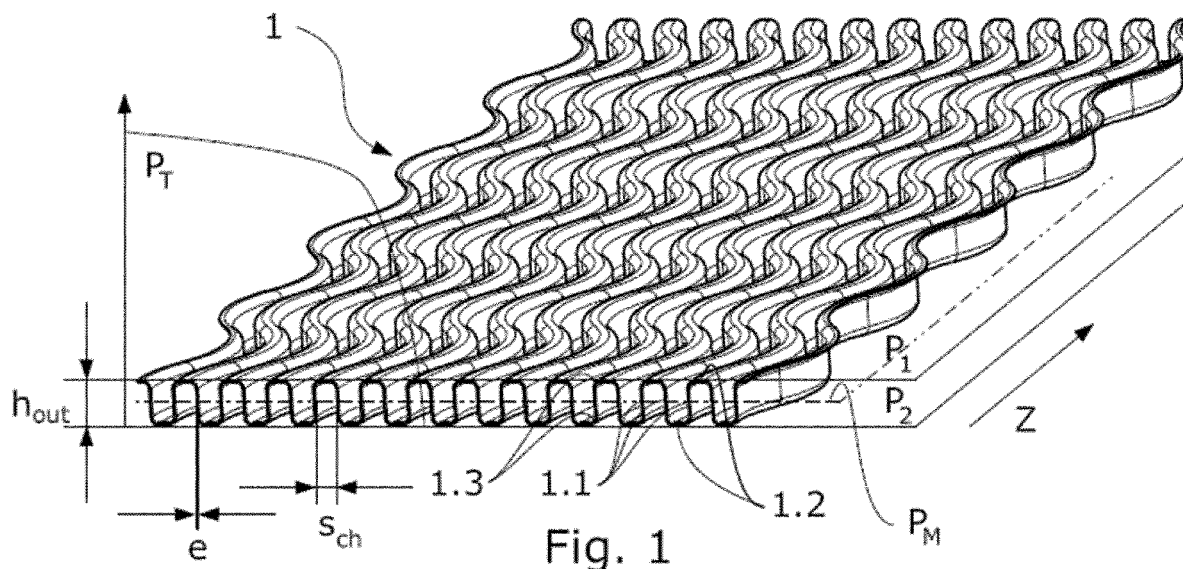


Fig. 1

Description

Object of the Invention

[0001] The present invention relates to a fin body intended for being housed inside a heat exchange tube which is one from among heat exchange tubes showing a planar configuration.

[0002] The fin body is configured in the form of a plate, this plate being the one inserted into the heat exchange tube. The plate is configured from a metal sheet bent into a plurality of consecutive bends. Each of the bends extends along a longitudinal direction which will be identified as Z and is oriented, in the operating position, in the longitudinal direction of the exchange tube.

[0003] The invention is characterized by the configuration of the plate of the fin body according to a transverse section with respect to direction Z. Throughout the text, the term transverse will be understood to be synonymous to perpendicular.

[0004] According to the transverse section, the bends show a profile defining a periodic zigzag wavy path with a characteristic width s and a characteristic height h , both measured on said path.

[0005] The wavy path follows the midplane of the metal sheet having a thickness e , so the plate height will be $h + e$ since on one of the faces of the plate the thickness contributes an amount of $e/2$ to the plate height with respect to the position of the path and another amount of $e/2$ on the opposite face of the plate. The total height of the plate will be identified as h_{out} and therefore verifies $h_{out} = h + e$. In practice, the measurement that can be most readily measured is h_{out} and the thickness e , and they both allow determining h .

[0006] Likewise, once the plate has been housed inside the heat exchange tube, the plate is supported on the inner faces thereof such that the bends form channels. The channel height will therefore be $h_{ch} = h$ given that it corresponds with the plate height h_{out} minus the thickness of the sheet reducing the amount e into the crest or trough, either when it is in the upper part or when it is in the lower part, respectively.

[0007] The same occurs with the characteristic width s . The channel width s_{ch} will be reduced by a value e because the channel becomes narrower by one amount $e/2$ on one side of the channel and by another amount $e/2$ on the other side of the channel. In other words, $s_{ch} = s - e$.

[0008] The characteristic width s used for determining s_{ch} is defined throughout this description as half the wavelength of the wavy path and the characteristic height h used for determining h_{ch} is defined as the distance between peaks of maximum amplitude of the wavy path.

[0009] Throughout the description, the properties of the plate expressed, for example, by means of correlations of efficiency or a pressure drop will be established from the channel width s_{ch} and plate height h_{out} unless it is explicitly specified that they are other variables.

[0010] The invention is characterized by a range of the channel width s_{ch} to plate height h_{out} ratio in the interval of 0.15-0.5, and according to more specific cases, in the lower subranges. As a result, the fin gives rise to a heat exchange tube with a higher efficiency than fins known in the state of the art without penalizing the pressure drop.

Background of the Invention

[0011] One of the fields of the art that has been subjected to the most intensive development is the field of heat exchangers, particularly those used in vehicles with internal combustion engines. There is very little space available in the engine compartment and the heat exchange requirements call for devices that are very compact and therefore offer an increasingly higher ratio between the heat that is exchanged and the volume taken up by the device.

[0012] One of the specific cases of interest are heat exchangers intended for reducing the temperature of hot exhaust gases by transferring heat to a liquid coolant. Heat exchangers of this type are found in exhaust gas recirculation (EGR) systems.

[0013] Another field of application of interest are heat recuperators where heat is transferred to a second fluid which allows making subsequent use of the heat extracted from the hot gas. Likewise, other applications are exchangers for acclimatizing or controlling the temperature of the vehicle.

[0014] To increase this ratio, heat exchange tube configurations which increase heat transfer between the hot gas circulating through the inside thereof and the liquid coolant circulating on the outside of the tube are being developed.

[0015] Various methods are known for generating turbulence inside the tube and at the same time increasing the area of contact with the gas, for example, by means of inwardly projecting fins or ribs on the surface of the tube.

[0016] Greater turbulence generates flow structures which increase convection between the tube surfaces and gas. The total heat flow will be greater if, in addition to higher heat convection, the available exchange area is increased.

[0017] Nevertheless, not just any configuration which increases turbulence and the exchange area will do because the inclusion of fins or elements projecting into the tube cause a pressure drop that may not be acceptable.

[0018] The technical problem to be solved is that of providing an exchange tube configuration and elements which increase heat exchange in the exchange tube without penalizing the pressure drop or with the pressure drop being minimal.

[0019] Another significant limitation in the configuration of a heat exchange tube is the manufacturability. The configuration of metal structures with multiple folds or deformations with very small characteristic dimensions may limit manufacturability. This is the case of the use

of sheets with folds which require a very large number of folds and also with very small radii of curvature. The result can be a configuration which breaks during manufacture.

[0020] The present invention solves the technical problem being considered by proposing designs that are close to the limits of manufacturability which, although possible, are hard to achieve, and which a designer tends to not use. These designs are characterized by a wavy aspect ratio in a very narrow range of values where it has been experimentally proven that, far from what was expected, efficiency values that are surprisingly higher than those obtained in the state of the art and with low pressure drops have been obtained.

Description of the Invention

[0021] The invention relates to a fin body intended to be housed inside a heat exchange tube having a planar configuration. Once the fin body has been housed therein, the heat exchange tube is provided with fins considerably increasing the heat exchange area when hot gas flows through the inside thereof in the operating mode.

[0022] The configuration of the heat exchange tube is a constraint because by housing the fin body therein, the tube has walls closing the space where said fin body is housed and the attachment between both elements is established in these inner walls. Specifically, the attachment is established on the faces of the exchange tube which are shown as planar inner faces, parallel to and facing one another.

[0023] The heat exchange tube extends along a longitudinal direction which will be identified throughout the text as X-X'. As indicated, the exchange tubes have a planar configuration comprising two planar inner faces, parallel to and facing one another. In the preferred embodiment, the planar faces will have a pre-established constant width and are connected on the sides through a straight or curved wall.

[0024] *The fin body is configured in the form of a plate and formed from a metal sheet having a thickness e, bent into a plurality of consecutive bends extending according to a direction Z, where the direction Z is intended for being parallel to the longitudinal direction X-X' of the heat exchange tube housing it.*

[0025] The fin body is a planar plate configured from a metal sheet with a specific width configured for enabling the housing thereof in the heat exchange tube and also a length suited to the length of the heat exchange tube. The plate height is achieved by means of folds of the metal sheet. By way of example, a method for manufacturing this sheet is by stamping between two molds, or according to a second example, the method is a continuous method, by rolling the metal sheet between two rollers with opposite or complementary configurations.

[0026] The bends of the sheet give rise to the fin plate height. The height is identified as defined in the description above as " h_{out} " and is different from and strictly greater

than the value of the thickness of the metal sheet which will be identified with the letter "e".

[0027] The bends of the plurality of bends are parallel to one another, both when they are straight bends and when they are curved wavy shapes, and extend along a direction which has been identified as direction Z. This direction is the longitudinal direction of the tube when the fin body is operatively housed inside the tube. If the plurality of bends has a wavy generatrix, the direction Z is the direction in which said generatrix extends. A specific case of a wavy generatrix is a sine wave. The direction Z will be the axis around which the sine wave oscillates.

[0028] *Additionally, the bends are configured by alternating between a first plane P_1 and a second plane P_2 parallel to the first plane P_1 , and with both planes being spaced from one another, wherein the first plane P_1 and the second plane P_2 are intended to coincide with the planar inner faces of the heat exchange tube, parallel to and facing one another;*

[0029] The bends give rise to a constant height h_{out} in the entire plate and are limited between two parallel planes identified as P_1 and P_2 . This condition allows the plate to be housed inside the heat exchange tube having a planar configuration, such that the plate is in contact with its parallel inner faces. Once the fin body has been housed inside the tube, both components can be attached by means of welding, for example.

[0030] With respect to the configuration of the bends, according to a transverse section P_T with respect to direction z, said bends show a periodic zigzag wavy path, wherein

- said wavy path T comprises segments, the segments being connected by vertices located in the peaks of maximum amplitude;
- the characteristic width s is half the wavelength of the wavy path T and the characteristic height h is the distance between peaks of maximum amplitude of the wavy path.

[0031] Once the direction Z along which the bends extend has been established, this condition is applied to the configuration of the fin body considering the transverse section P_T with respect to said direction Z. Transverse section P_T is understood to be the section according to a plane perpendicular to direction Z.

[0032] The transverse section P_T of the fin body formed by bends results in a wavy path. The two different wavy shapes that appear throughout the description must be differentiated:

- a first wave which corresponds to an alternative embodiment where the bends of the fin plate extend with a wavy configuration according to direction Z, and
- a second wavy shape which corresponds to the wavy path, a result of considering the configuration resulting from the application of a section to the fin body

according to a transverse plane P_T .

[0033] To distinguish one wavy shape from another, the term "longitudinal wavy shape" will be used in the description for the first wavy shape, or it will be associated with direction Z. For the second wavy shape, either the term "longitudinal" is excluded or the wavy shape is associated with transverse section P_T .

[0034] According to the invention, *the fin body is characterized in that the wavy path according to the transverse section PT has a channel width s_{ch} to plate height h_{out} ratio in the interval of [0.15-0.5], wherein $s_{ch} = s - e$ and $h_{out} = h + e$.*

[0035] It has been found that in this range of values, the efficiency of heat transfer between the hot gas circulating through a planar heat exchange tube housing the fin body and a liquid coolant circulating on the outside of the same tube is higher than the efficiency of the same tubes when they incorporate fins configured according to the state of the art for the same conditions.

[0036] Efficiency (Eff) is defined as:

$$Eff = \frac{T_{ig} - T_{og}}{T_{ig} - T_{ic}}$$

where T_{og} is the gas outlet temperature, T_{ig} is the gas inlet temperature, and T_{ic} is the liquid coolant inlet temperature.

[0037] Making use of this definition, in a series of experiments performed with a collection of tubes representing the state of the art, it has been verified that efficiency values of about 92% have been obtained under specific conditions, such as flow rate, temperature, and geometric parameters that are common to all the experiments, where this value is shown as a barrier that has not been overcome, and making use of a configuration according to the invention, these values increase at least by about 3% until reaching an increase of 5% giving rise to an efficiency of 97%, values which are not possible in any of the tubes of the state of the art while maintaining similar pressure drop values. It is observed that these increases mean surpassing even more than 50% of the percentage up to the theoretical limit of 100%. Exceeding by 3% the efficiency barrier established at 92% entails an efficiency improvement which was not expected by only modifying the shape of the fin body.

Description of the Drawings

[0038] The foregoing and other features and advantages of the invention will become more apparent based on the following detailed description of a preferred embodiment given only by way of illustrative and non-limiting example in reference to the attached drawings.

Figure 1 shows a first embodiment according to a perspective view of a fin body having a wavy config-

uration according to direction Z and with a wavy path according to the transverse section of straight parallel segments.

Figure 2 shows a heat exchange tube housing the fin body according to the first embodiment and according to a perspective view.

Figure 3 shows a plan view of the first embodiment to more clearly show the wavy configuration according to direction Z.

Figure 4 shows a second embodiment according to a perspective view of a fin body having a wavy configuration according to direction Z and with a wavy path according to the transverse section of straight oblique segments. This same figure shows an enlarged area of the plate to allow identifying some parameters of its configuration.

Figure 5 shows the same detail of the enlarged area of the preceding drawing with a higher level of detail to more clearly distinguish the wavy path as well as the dimensions with respect to same.

Detailed Description of the Invention

[0039] According to the first inventive aspect, the present invention relates to a fin body suitable for being inserted in a heat exchange tube having a planar configuration. The heat exchange tube with the fin body is particularly suitable for heat exchangers which transfer heat energy between a hot gas and a liquid coolant. It is indicated as suitable because the use of the fin body is not limited to this application, such that the fluids transferring heat energy may be other fluids.

[0040] In the operating mode, the heat exchange tube is housed in a chamber through which the liquid coolant flows. The hot gas flows through the inside of the heat exchange tube and transfers part of the heat energy to the tube, and the heat exchange tube in turn transfers the same heat energy to the liquid coolant. Heat transfer from the hot gas to the tube is considerably increased due to the increase of the exchange surface due to the presence of the fin body.

[0041] The fin body, once inserted in the exchange tube and attached thereto, gives rise to a set of channels (CH) extending along the longitudinal direction X-X' of the tube, guiding the hot gas flow, generating turbulence and offering a larger exchange area.

[0042] The configuration of the channels (CH) increases the area of exchange with the hot gas but also increases the pressure drop, so the configuration that these channels must have in order to increase efficiency without a significant pressure drop is not obvious.

[0043] Figure 1 shows a first embodiment of the invention, where the fin body (1) is configured from a metal sheet having a thickness e , which metal sheet has been stamped between two molds having a complementary shape.

[0044] The fin body (1) is in the form of a plate having a height h_{out} , this height being obtained by means of a

plurality of bends of the metal sheet. The front part, according to the orientation used in Figure 1, corresponds to any transverse section P_T with respect to the plate along coordinate Z, and shows a profile according to a first wavy shape which, in this drawing, is shown with a thick line, with the thickness e of the sheet giving rise to the fin body.

[0045] Figure 5 shows a significantly enlarged first wavy shape according to an embodiment which allows viewing in greater detail the geometric aspects of a transverse section P_T of an embodiment.

[0046] This first wavy shape according to the transverse section P_T defines a path (T) having a zigzag configuration. The path (T) follows the midplane of the metal sheet, and it is shown in Figure 5 with a discontinuous line.

[0047] The bends of the metal sheet are demarcated between a first plane P_1 and a second plane P_2 limiting the main faces of the fin body (1) in the form of a plate.

[0048] In the first embodiment, the first wavy shape shows vertices (1.2) at the ends corresponding to the contact points of the sheet with the planes P_1 and P_2 . The vertices (1.2) are connected by means of segments (1.1). These segments (1.1) have a straight central part perpendicular to planes P_1 and P_2 , and the ends (1.3) of these segments (1.1) directly connecting with the vertices (1.2) are curved ends. A way of expressing that the straight central part is perpendicular to planes P_1 and P_2 is by asserting that such central parts are parallel to the normal to any of the planes P_1 and P_2 .

[0049] As a result, the path (T) of the first wavy shape is periodic and allows defining a characteristic distance which, in this description, is referred to as characteristic width (s), and corresponds to half the period of the path (T) of the first wavy shape.

[0050] It can be observed in Figure 5 that the characteristic width (s) of any path (T) of the first wavy shape according to how it has been defined can be measured as the distance between two consecutive points of the intersection between the path (T) of the first wavy shape and a midplane P_M located at a distance $h/2$ from plane P_1 or P_2 .

[0051] The thickness reduces the characteristic width by an amount of $e/2$ on each of the sides of the channel (CH), giving rise to a smaller channel width s_{ch} . Although the configuration of the wavy path (T) of Figure 5 is different from the wavy path (T) of the first example, the definitions and ratios between distances defined by the wavy path (T) and the dimensions of the channels reduced by the thickness of the metal sheet are likewise valid.

[0052] The present invention is characterized by a first mode of configuring this first embodiment, where the channel width (s_{ch}) to plate height (h_{out}) ratio is in the interval of [0.15-0.5]. It has been found that in this interval, efficiency exceeds the value by 3.7% with respect to the best designs of the state of the art.

[0053] A narrower range, i.e., the interval of [0.3-0.45], has been found, where the efficiency (Eff) of the ex-

change tube (2) to which there has been incorporated the fin body (1) configured according to this interval exceeds the value by 4.5% with respect to the best designs of the state of the art.

[0054] An even narrower interval of [0.35-0.36] has been found, where the efficiency (Eff) of the exchange tube (2) is maximum, even being 5% greater than that obtained by the best designs of the state of the art.

[0055] These conditions imposed on the channel width (s_{ch}) to plate height (h_{out}) ratio are valid for any of the configurations of the fin body (1) that will be described based on other embodiments.

[0056] In this same Figure 1, a second wavy shape extending along direction Z is seen. The second wavy shape can be represented, for example, by the curve defining any of the vertices (1.2) when they extend along direction Z. This curve can be considered a generatrix of the surface defined by the metal sheet of the fin body (1). Two wavy paths (T) corresponding to two different transverse planes P_T therefore give rise to two directrices which, together with the generatrix defined above, allow generating the surface established by the bent sheet of the fin body (1).

[0057] According to another embodiment, the fin body (1) only shows the first wavy shape given that the bends are straight according to direction Z.

[0058] According to another embodiment, a straight segment parallel to any of the planes (P_1 , P_2) is placed in the position of the vertices (1.2) for increasing the welding area with the tube intended for housing the fin body (1).

[0059] Figure 2 shows a heat exchange tube (2) housing a fin body (1) like the embodiment described and shown in Figure 1. The heat exchange tube (2) has a planar configuration and shows a planar lower wall and a planar upper wall connected on both sides through a curved wall, in this embodiment in the form of a circular half-arc according to the transverse section. According to another embodiment not shown in the drawings, the heat exchange tube (2) has straight side walls of the tube, resulting in it having a section with a rectangular configuration.

[0060] The heat exchange tube (2) extends according to a longitudinal direction which is identified as X-X'. Once the fin body (1) has been housed, the direction Z along which the plurality of bends extends is parallel to direction X-X' of the heat exchange tube (2).

[0061] The heat exchange tube (2) shows a first planar inner face (2.1) which is shown in the lower part according to the orientation of Figure 2, and a second planar inner face (2.2) located opposite the first planar inner face (2.1). These two faces (2.1, 2.2) are in contact with the fin body (1) and they are also the contact sites where they are attached to one another by brazing.

[0062] In this same embodiment, the heat exchange tube (2) shows a plurality of punched spots (2.3) which assure the position of the fin body (1) with respect to the heat exchange tube (2) before carrying out the welding

step. The punched spots (2.3) generate inner projections or protrusions which coincide with some channels (CH) of the bends of the fin body (1).

[0063] In this same Figure 2, the channels (CH) formed by the bends of the fin body (1) are identified. The first wavy shape identified on the transverse section generates, in an alternating manner, a channel (CH) closed by the lower inner face (2.1) and a channel (CH) closed by the upper inner face (2.2).

[0064] Figure 3 shows a plan view of the same fin body (1), where the second wavy shape identified, for example, by the path of the vertices (1.2) of the bends of the metal sheet according to a projection on the horizontal plane, is shown along direction Z.

[0065] According to one embodiment, the longitudinal wavy path has an r/p ratio between the minimum characteristic radius (r) of the wavy shape, defined as the minimum radius of curvature measured in a projection according to a plane parallel to plane P_1 or P_2 , and the pitch (p) that is smaller than 2, defined as the entire length of a wave of the wavy shape also measured on the same plane, more preferably in the interval of [0.2-1], and more preferably in the interval of [0.4 and 0.5]. Both measurements are depicted in Figure 3. This Figure 3 shows the longitudinal wavy path where the wavy shape has an area of tangency between the concave curve segment and the convex curve segment. In this area of tangency, the radius becomes infinite (it is an inflection point), hence the curvature becomes maximum when the radius is minimum, and it is in this region where the radius is minimum, where the figure shows the limitation of said minimum characteristic radius (r).

[0066] In the embodiment shown in Figure 3, the longitudinal wavy path is configured by the concatenation of curved segments with a constant radius, alternating the curvature on both sides according to the projection on the horizontal plane of the fin body (1).

[0067] Figure 4 shows a perspective view of a fin body (1) according to a second embodiment, where the bends of the metal sheet are configured such that the path (T) of the first wavy shape defined through the transverse section P_T is different from that of the first embodiment.

[0068] The wavy path (T) shows a periodic wave configuration formed by segments (1.1) connected by alternately located vertices (1.2). As a result, the bends of the plate of the fin body (1) are limited between an upper plane (P_1) and a lower plane (P_2), and where the wavy path (T) has in its intermediate part straight and oblique segments.

[0069] A rectangle has been depicted with a thick dotted line on the perspective view of the fin body (1), said rectangle identifying a portion of the drawing that has been enlarged in the top right part. The thickness e of the metal sheet and the manner in which the path (T) of the first wavy shape is configured according to the transverse section according to the plane P_T can be seen in this enlarged area. Given that the thickness e is small, Figure 5 shows in greater detail the path (T) of the first

wavy shape with a discontinuous line.

[0070] The path (T) is mainly formed by the straight and oblique intermediate parts of the segments (1.1) connected by vertices (1.2). These straight intermediate parts are connected at the vertex (1.2) by means of a curved portion (1.3). In the enlarged portion of Figure 4, two consecutive straight intermediate parts have been prolonged by means of respective dotted lines so as to identify the angle of inclination of these oblique surfaces of the bend which, once inserted in the heat exchange tube (2), give rise to channels (CH) having an essentially triangular configuration.

[0071] The trace of the midplane (P_M) where the characteristic width (s) can be determined is identified with a discontinuous line both in the fin body (1) and in the enlarged area.

[0072] In this embodiment, the attachment between the fin body (1) and the inner face (2.1, 2.2) of the heat exchange tube (2) is performed through the generatrix that goes through the vertex of the bend (V) coinciding with the vertex (1.2) of the wavy path (T). The vertex of the bend (V) is distinguished from the vertex (1.2) of the path (T) as graphically shown in Figure 5. If the attachment is performed by means of brazing, there will be a meniscus (M) on each side of the vertex (1.2) as schematically shown on the right side of the enlarged area. The position of the upper inner face (2.2) of the heat exchange tube (2) is schematically shown by means of a discontinuous line and the meniscus (M) of molten metal giving rise to the fin body (1) being welded by brazing to the heat exchange tube (2) is shown by means of a blackened region. As a result, the configuration of the channels (CH) formed by a fin body (1) such as the one of this embodiment has a triangular shape with the vertices of the triangle rounded according to a curved portion (1.3).

[0073] The presence of the meniscus (M) gives rise to an increase of the contact area for improving attachment between the fin body (1) and the heat exchange tube (2), and also a higher heat transfer by conduction through said meniscus (M).

[0074] It has been found that this configuration gives rise to higher efficiency values, particularly when the channel width (s_{ch}) to plate height (h_{out}) ratio is in the interval of [0.35-0.36], and to a minimum pressure drop.

[0075] Another aspect of the invention relates to a heat exchange tube (2) having a planar configuration and extending along a longitudinal direction X-X' and with at least two planar inner faces (2.1, 2.2), parallel to and facing one another, said tube comprising a fin body (1) according to any of the embodiments described above housed therein, wherein the fin body (1) is oriented such that:

- the first plane (P_1) coincides with a first inner face (2.1) of the heat exchange tube (2),
- the second plane (P_2) coincides with a second inner face (2.2) facing the first inner face (2.1) of the heat

exchange tube (2), and

- the direction Z of the fin body (1) extends parallel to the longitudinal direction X-X' of the heat exchange tube (2); and wherein

the fin body (1) is attached by welding to the planar inner faces (2.1, 2.2) of the heat exchange tube (2) forming channels (CH).

[0076] According to another embodiment, the tube (2) is formed by the consecutive stacking of stamped and stacked sheets (this configuration of heat exchangers is identified as stacked coolers). According to the invention, a tube configuration formed by the stacking of sheets gives rise to an inner space with planar faces parallel to and spaced apart from one another which is also occupied by the fin body (1) according to any of the described embodiments.

[0077] A specific way to perform attachment by brazing for any of the described examples of heat exchange tubes (2) and fin body (1) is by means of a nickel brazing sheet which is interposed between the fin body (1) and the inner face (2.1, 2.2) of the heat exchange tube (2) before being passed through the oven.

Claims

1. A fin body (1) to be housed inside a heat exchange tube (2) having a planar configuration, which heat exchange tube is from among the exchange tubes extending along a longitudinal direction X-X' and comprising two planar inner faces (2.1, 2.2) parallel to and facing one another;
the fin body (1) is configured in the form of a plate and formed from a metal sheet having a thickness e , bent into a plurality of consecutive bends extending according to a direction Z, wherein the direction Z is intended for being parallel to the longitudinal direction X-X' of the heat exchange tube (2) housing it, and wherein;
the bends are configured by alternating between a first plane (P_1) and a second plane (P_2) parallel to the first plane (P_1), and with both planes being spaced from one another, wherein the first plane (P_1) and the second plane (P_2) are intended to coincide with the planar inner faces of the heat exchange tube (2) parallel to and facing one another;
the bends, according to a transverse section (P_T) with respect to direction z, show a periodic zigzag wavy path (T), wherein
 - said wavy path (T) comprises segments (1.1), the segments (1.1) being connected by vertices (1.2) located in the peaks of maximum amplitude;
 - the characteristic width (s) is half the wavelength of the wavy path (T) and the characteristic height (h) is the distance between peaks of max-

imum amplitude of the wavy path (T),

characterized in that the wavy path (T) according to the transverse section (P_T) has a channel width (s_{ch}) to plate height (h_{out}) ratio in the interval of [0.15-0.5], wherein $s_{ch} = s - e$ and $h_{out} = h + e$.

2. The body (1) according to claim 1, wherein the channel width (s_{ch}) to plate height (h_{out}) ratio is in the interval of [0.3-0.4].
3. The body (1) according to any of the preceding claims, wherein the channel width (s_{ch}) to plate height (h_{out}) ratio is in the interval of [0.35-0.36].
4. The body (1) according to any of the claims, wherein the segments (1.1) connected by vertices (1.2) are straight.
5. The body (1) according to any of the preceding claims, wherein the segments (1.1) connected by vertices (1.2) are oblique with respect to the normal to any of the planes (P_1 , P_2).
6. The body (1) according to any of the preceding claims, wherein the segments (1.1) are connected with the vertices (1.2) by means of curved portions (1.3).
7. The body (1) according to any of the preceding claims, wherein the zigzag transverse section (P_T) extends according to direction Z following a longitudinal wavy path.
8. The body (1) according to claim 7, wherein the longitudinal wavy path has a minimum characteristic radius (r) to pitch (p), r/p , ratio in the range of [0.2, 2], more preferably in the range of [0.2-1], and more preferably in the range of [0.4, 0.5].
9. The body (1) according to claim 8, wherein the longitudinal wavy path is configured by the concatenation of curved segments with a constant radius, alternating the curvature on both sides according to the projection on the horizontal plane of the fin body (1).
10. A heat exchange tube (2) having a planar configuration and extending along a longitudinal direction X-X' and with at least two planar inner faces (2.1, 2.2), parallel to and facing one another, said tube comprising a fin body (1) according to any of the preceding claims housed therein, wherein the fin body (1) is oriented such that:
 - the first plane (P_1) coincides with a first inner face (2.1) of the heat exchange tube (2),
 - the second plane (P_2) coincides with a second

inner face (2.2) facing the first inner face (2.1)
of heat exchange tube (2), and
- the direction Z of the fin body (1) extends parallel to the longitudinal direction X-X' of the heat exchange tube (2); and wherein

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the fin body (1) is attached by welding to the planar inner faces (2.1, 2.2) of the heat exchange tube (2) forming channels (CH) .

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- 11.** The heat exchange tube (2) according to claim 10, wherein at least one attachment between the fin body (1) and the heat exchange tube (10) is by brazing and it is established between a vertex (1.2) of the fin body (1) and an inner face (2.1, 2.2) of the heat exchange tube (2) with a concave welding meniscus (M) curving towards any of the adjacent spaces.

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- 12.** A heat exchanger comprising at least one heat exchange tube (2) according to claim 10 or 11.

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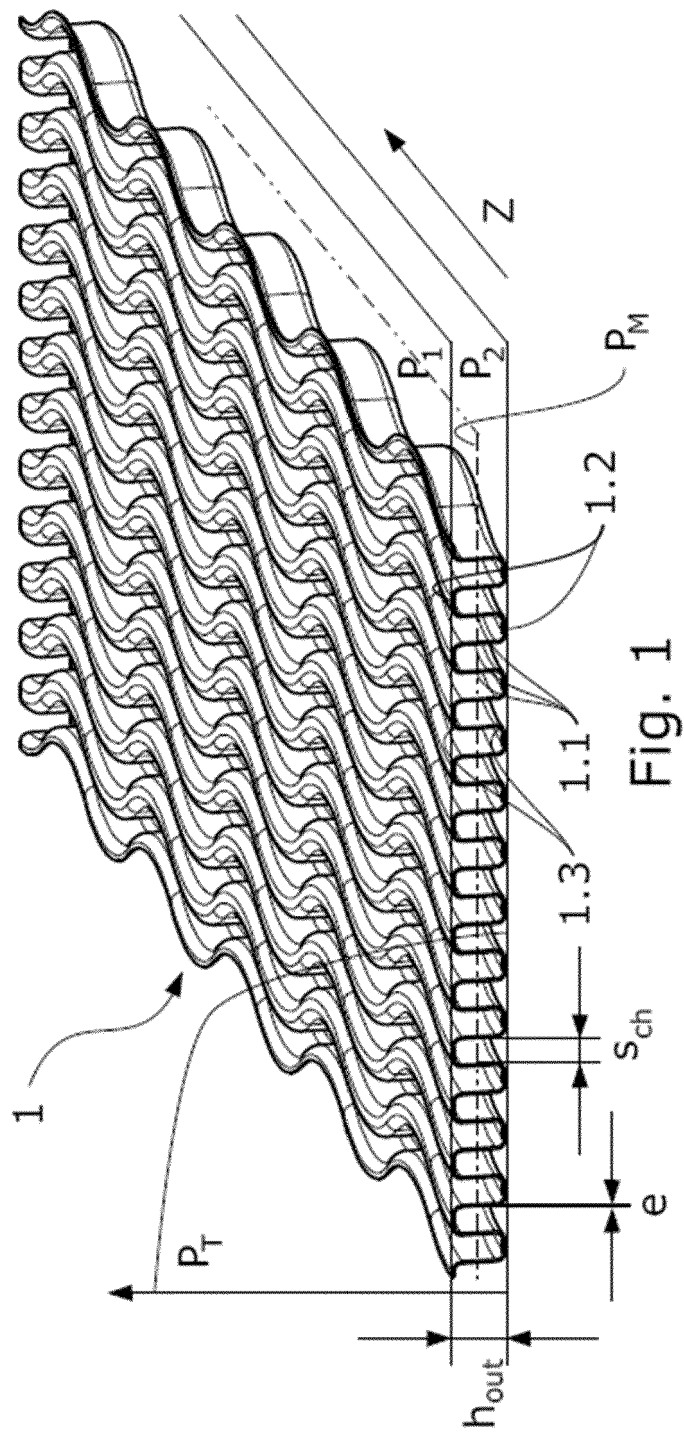
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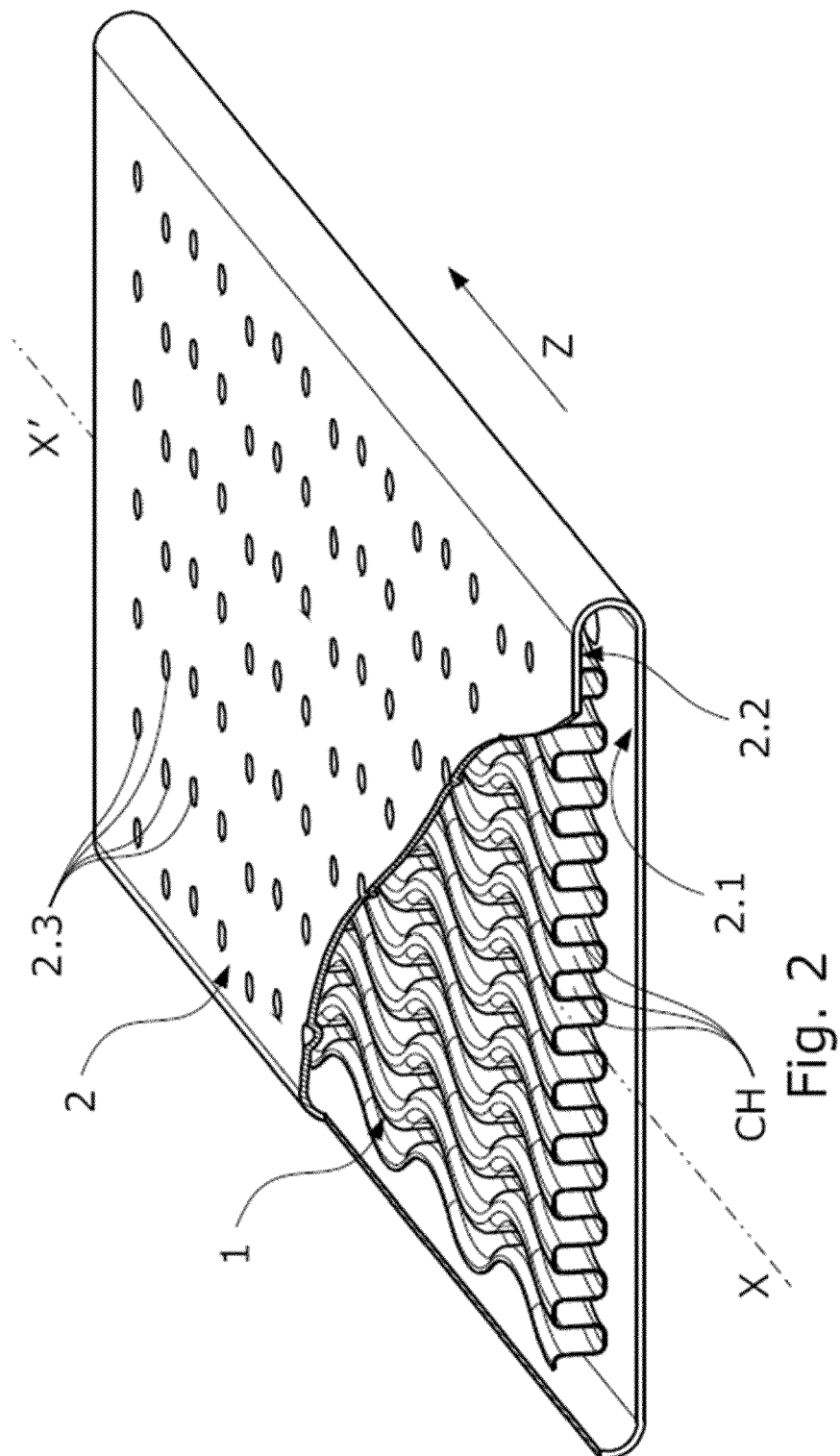
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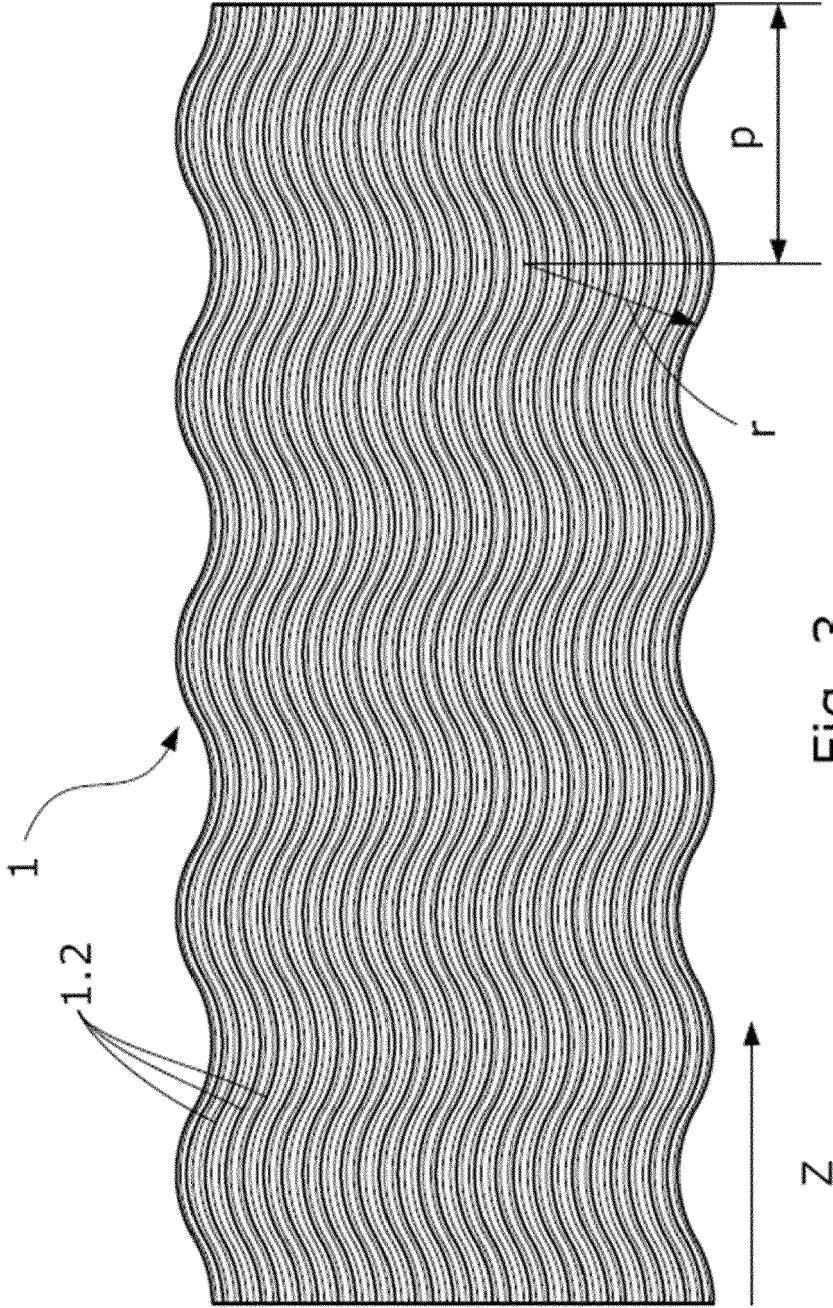


Fig. 3

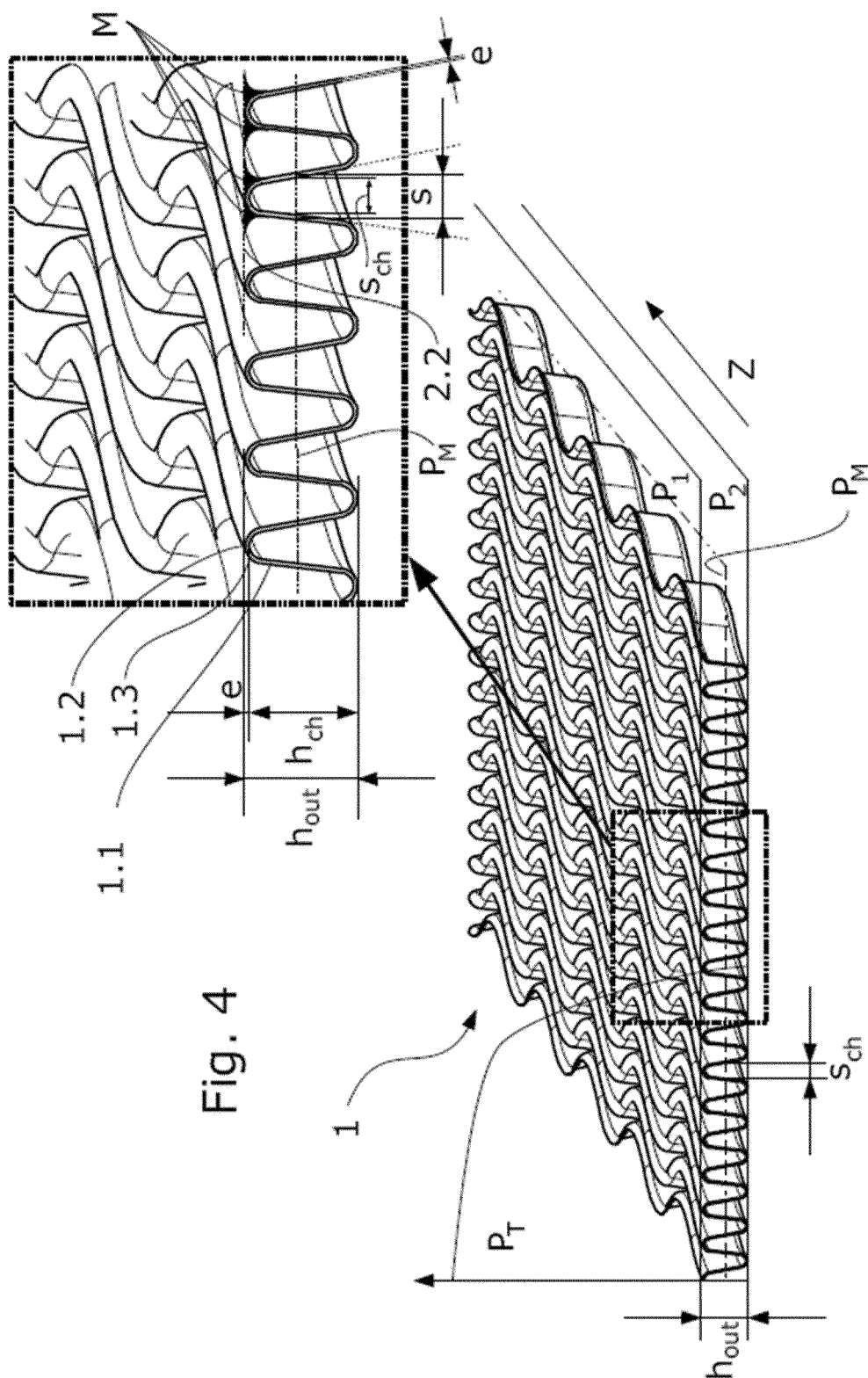
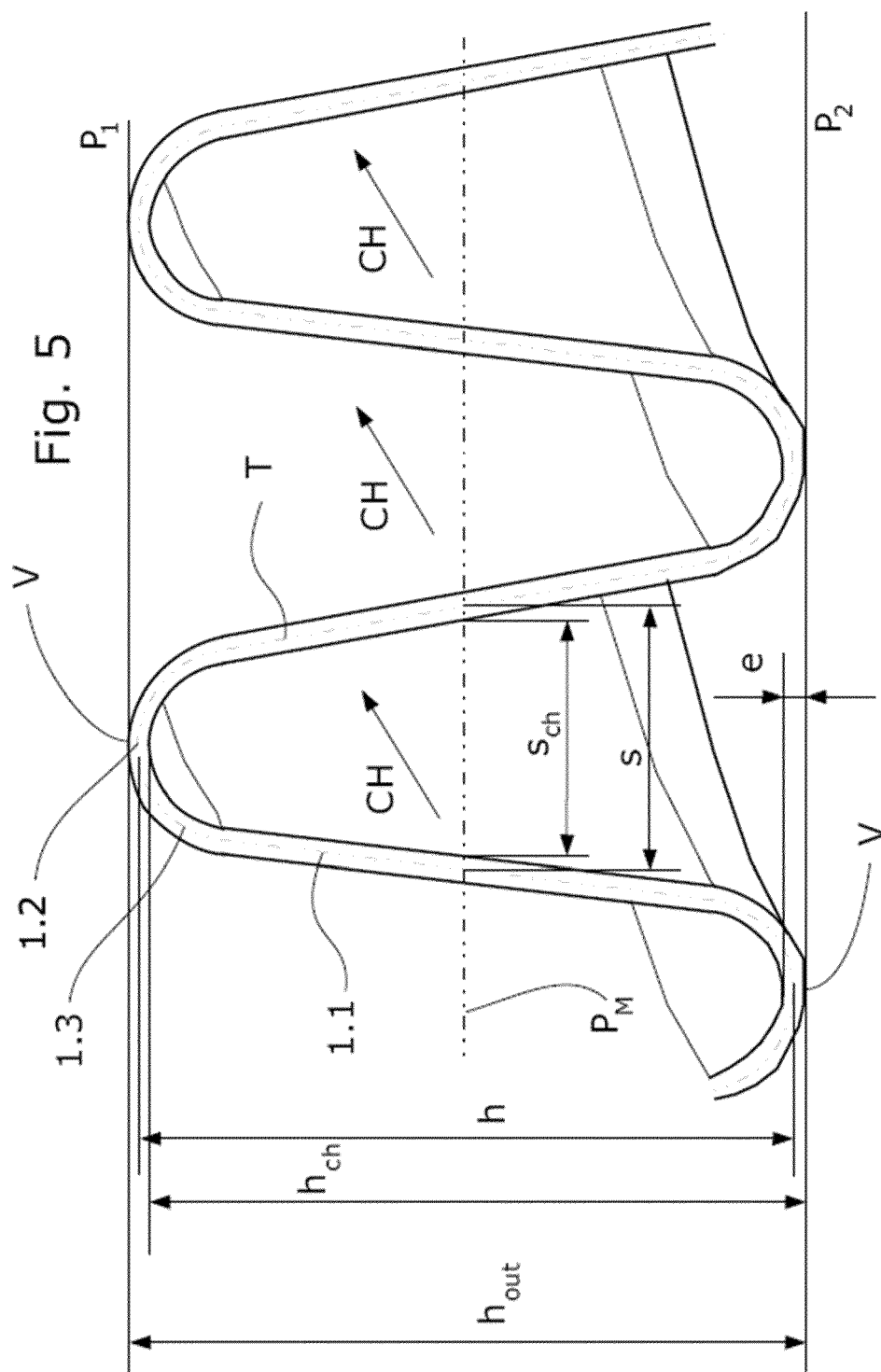


Fig. 4





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Place of search Munich		Date of completion of the search 30 April 2019	Examiner Mellado Ramirez, J
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