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(54) LINER COOLANT FLOW PILOT FEATURE

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(56) References cited:

WO-A2-2009/000799

CN-A- 104 895 693

CN-U- 207 437 209

CN-U- 213 331 295

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Description

TECHNICAL FIELD

[0001] The present invention relates generally to systems for cooling an engine system.

BACKGROUND OF THE RELATED ART

[0002] In an engine system, one or more cylinders of a cylinder block of the engine generate heat as combustion occurs. To avoid overheating, a cooling system circulates a coolant fluid around the various cylinders in a liner (for example, a coolant fluid jacket, a water jacket, etc.). In one of various arrangements of liners, a liner may surround the various cylinders, allowing coolant fluid to flow around the cylinders from a coolant fluid source (for example, a radiator). As the coolant fluid flows around the cylinders, heat from each cylinder is transferred to the coolant fluid, which flows back to the coolant fluid source to dissipate the heat and complete a coolant fluid circuit. The shape of the liner can affect the efficiency of the coolant fluid and the flow characteristics of the coolant fluid. CN104895693 discloses a coolant liner with a transition region between the coolant inlet and the coolant jacket.

CONTENT OF THE INVENTION

[0003] In one set of embodiments, a coolant liner comprises a first flow surface to direct coolant fluid toward a cylinder of an engine and a transition region coupled to the first flow surface. The transition region includes a convex portion having a first radius of curvature and a concave portion having a second radius of curvature. The concave portion is coupled to the convex portion at an inflection point. A second flow surface is coupled to the transition region to direct coolant fluid around the cylinder.

[0004] In some embodiments, the first radius of curvature is greater than the second radius of curvature.

[0005] In some embodiments, the second radius of curvature is greater than the first radius of curvature.

[0006] In some embodiments, the first radius of curvature is substantially equal to the second radius of curvature.

[0007] In some embodiments, a ratio of the first radius of curvature to the second radius of curvature is between approximately 1.3 and approximately 2.5.

[0008] In some embodiments, the coolant liner further comprises: a curved portion coupled to the second flow surface; and a base portion coupled to the curved portion.

[0009] In some embodiments, a height of the second flow surface extending between the base portion and the concave portion is between approximately 8 mm and approximately 10 mm.

[0010] In some embodiments, a distance between the first flow surface and the base portion is between approx-

imately 12 mm and approximately 13 mm. In another set of embodiments, a coolant liner comprises a first flow surface to direct coolant fluid toward the cylinder. The first flow surface defines a first tangent line tangent to the first flow surface. A transition region is coupled to the first flow surface. The transition region includes a convex portion having a first vertex defining a second tangent line tangent to the convex portion at the first vertex. A concave portion is coupled to the convex portion at an inflection point. The concave portion has a second vertex defining a third tangent line tangent to the concave portion at the second vertex. A second flow surface is coupled to the transition region to direct coolant fluid around the cylinder.

[0011] In another set of embodiments, A coolant liner, comprising:

a first flow surface to direct a coolant fluid toward a cylinder of an engine, the first flow surface defining a first tangent line tangent to the first flow surface;

a transition region coupled to the first flow surface, the transition region comprising:

a convex portion having a first vertex, the first vertex defining a second tangent line tangent to the convex portion at the first vertex;

a concave portion coupled to the convex portion at an inflection point, the concave portion having a second vertex, the second vertex defining a third tangent line tangent to the concave portion at the second vertex;

a first angle defined by the first tangent line and the second tangent line; and

a second angle defined by the second tangent line and the third tangent line; and

a second flow surface coupled to the transition region to direct the coolant fluid around the cylinder.

[0012] In some embodiments, the first angle is greater than the second angle.

[0013] In some embodiments, the second angle is greater than the first angle.

[0014] In some embodiments, the first angle is substantially equal to the second angle.

[0015] In some embodiments, a ratio of the first angle to the second angle is between approximately 1.075 and approximately 2.0. In yet another set of embodiments, a system comprises an engine with at least one engine cylinder and a liner positioned around the at least one engine cylinder. The liner includes a first flow surface to direct coolant fluid toward the at least one engine cylinder. The first flow surface defines a first tangent line tangent to the first flow surface. A transition region is coupled

to the first flow surface. The transition region includes a convex portion having a first radius of curvature and a first vertex. The first vertex defines a second tangent line tangent to the convex portion at the first vertex. A concave portion is coupled to the convex portion at an inflection point and includes a second radius of curvature and a second vertex. The second vertex defines a third tangent line tangent to the concave portion at the second vertex. A first angle is defined by the first tangent line and the second tangent line, and a second angle is defined by the second tangent line and the third tangent line. A second flow surface is coupled to the transition region to direct coolant fluid around the at least one engine cylinder.

[0016] According to the claimed invention, the convex portion extends from the first flow surface and curves downward relative to the first flow surface.

[0017] According to the claimed invention the concave portion curves upward relative to the first flow surface and is coupled to the second flow surface.

[0018] In some embodiments, the first flow surface is substantially horizontal.

[0019] In some embodiments, the second flow surface is substantially vertical.

[0020] In some embodiments, the second flow surface is coupled to a curved portion and the curved portion is coupled to a base portion, the curved portion configured to direct the coolant fluid from the second flow surface to the base portion.

[0021] In some embodiments, the base portion is coupled to a bottom portion, the base portion configured to direct the coolant fluid to the bottom portion.

DESCRIPTION OF THE DRAWINGS

[0022] The details of one or more implementations are set forth in the accompanying drawings and the description below. Other features, aspects, and advantages of the disclosure will become apparent from the description, the drawings, and the claims, in which:

FIG. 1 is an illustration of a portion of a coolant liner, according to a particular embodiment.

FIGS. 2A-B illustrate a side view of a cross-section of a transition region of the coolant liner of FIG. 1, according to a particular embodiment.

FIG. 3 is an illustration of a velocity profile of coolant fluid flowing through the coolant liner of FIG. 1, according to a particular embodiment.

DETAILED DESCRIPTION OF EMBODIMENTS

[0023] Following below are more detailed descriptions of various concepts related to, and implementations of, methods, apparatuses, and systems for directing coolant fluid through a coolant fluid liner of an engine system. The various concepts introduced above and discussed in greater detail below may be implemented in any of

numerous ways, as the described concepts are not limited to any particular manner of implementation. Examples of specific implementations and applications are provided primarily for illustrative purposes.

I. Overview

[0024] In an engine cooling system, a liner may surround the various cylinders, allowing coolant fluid to flow around the cylinders from a cooling fluid source (for example, a radiator). As the coolant fluid flows around the cylinders, heat from each cylinder is transferred to the coolant fluid, which flows back to the cooling fluid source to dissipate the heat and complete a coolant fluid circuit.

The shape of the liner can affect the efficiency of the coolant fluid and the flow characteristics of the coolant fluid. In some instances, the flow characteristics of the coolant fluid can change the shape of the liner via erosion.

[0025] Implementations herein relate to a cooling system to direct coolant fluid efficiently in a coolant liner and reduce or eliminate instances where the coolant fluid erodes the liner. Embodiments of the cooling system described herein include a transition region with a concave portion, a convex portion, and an inflection point between the concave portion and convex portion. Coolant fluid flows along a first flow surface that is substantially horizontal relative to a top portion of the coolant liner before reaching the convex portion. The coolant fluid then flows along the convex portion and then the concave portion before reaching a second flow surface that is substantially vertical relative to the top portion of the coolant liner.

[0026] The various embodiments of the system described herein provide benefits that can be applied to engine cooling systems. The transition region provides for coolant flow that can cool a cylinder block more efficiently than an engine cooling system without such a transition region. Additionally, the transition region can prevent erosion of the liner, thereby increasing a useful life of the liner.

II. Coolant Liner Flow Path Structure

[0027] FIG. 1 is an illustration of a portion of a coolant liner 100, according to a particular embodiment. The coolant liner 100 is configured to direct a coolant fluid (e.g., refrigerant, water, etc.) around one or more cylinders in an engine system to cool the one or more cylinders. The coolant fluid flows within the coolant liner 100 and does not directly contact the one or more cylinders. Accordingly, the coolant liner 100 is constructed from a material that can transfer heat from the one or more cylinders to the coolant fluid flowing through the coolant liner. Examples of materials from which the coolant liner 100 can be constructed include, but are not limited to, aluminum, cast iron, or other materials with suitable heat transfer properties.

[0028] The coolant liner 100 includes a top portion 110, a first wall portion 108 extending from the top portion 110

and a second wall portion 114 extending from the top portion 110. A first flow surface 102 is positioned opposite the top portion 110 and is substantially horizontal (e.g., within fifteen degrees of perfectly horizontal relative to the top portion 110). The top portion 110, the first wall portion 108, the second wall portion 114, and the first flow surface 102 define a coolant fluid flow path through which the coolant fluid flows in the coolant liner 100. A transition region 104 is coupled to the first flow surface 102 and a second flow surface 106 and is configured to direct the coolant fluid from the first flow surface 102 to the second flow surface 106. The second flow surface 106 is substantially vertical (e.g., within fifteen degrees of perfectly vertical relative to the top portion 110) and directs the coolant fluid around the coolant liner 100 and to a bottom portion 112. The bottom portion 112 is configured to direct the coolant fluid around a cylinder of an engine. The transition region 104 is further described with respect to FIGS. 2A-2B.

[0029] FIGS. 2A-B illustrate a side view of a cross-section of the transition region 104 of the coolant liner 100 of FIG. 1, according to a particular embodiment (with angular representations shown in FIG. 2A but not FIG. 2B). The transition region 104 includes a convex portion 202 coupled to, and extending from, the first flow surface 102. The convex portion 202 extends from the first flow surface 102 in substantially the same direction as the first flow surface 102 before curving downward relative to the first flow surface 102. In other words, the convex portion curves away from the first flow surface 102. A concave portion 204 is coupled to the convex portion 202 at an inflection point 206. The concave portion 204 curves upward relative to the first flow surface 102. In other words, the concave portion 204 curves toward the first flow surface 102. When viewed in cross-section as shown, the transition region 104 resembles an "S" shape. The concave portion 204 and convex portion 202 are configured to efficiently direct the coolant fluid from the first flow surface 102 to the second flow surface 106 and prevent the coolant fluid from damaging the second flow surface 106 via erosion. The shape of the transition region 104 prevents turbulent flow of the coolant fluid (which can lead to erosion) at the second flow surface 106 by gradually changing the direction of the flow of the coolant fluid from substantially horizontal (e.g., along the first flow surface 102) to substantially vertical (e.g., along the second flow surface 106).

[0030] The convex portion 202 is defined by a first radius of curvature, and the concave portion 204 is defined by a second radius of curvature. In some embodiments, the first radius of curvature is larger than the second radius of curvature. The second radius of curvature may also be larger than the first radius of curvature. In some implementations, the first radius of curvature is approximately equal to the second radius of curvature. In an example embodiment, the first radius of curvature is approximately (e.g., within plus or minus one millimeter) nine millimeters (mm) and the second radius of curvature

is approximately five mm.

[0031] The transition region 104 can also be defined by various angles related to tangent lines associated with the transition region 104. For example, the transition region 104 also includes a first tangent line 208 that is tangent to the first flow surface 102 at the intersection between the first flow surface 102 and the convex portion 202. A second tangent line 210 is tangent to the convex portion 202 at a vertex of the convex portion 202 (e.g., the point at which the convex portion 202 transitions from a positive slope to a negative slope), and a third tangent line 212 that is tangent to the concave portion 204 at a vertex of the concave portion 204 (e.g., the point at which the concave portion 204 transitions from a positive slope to a negative slope). An angle a is defined as the angle between the first tangent line 208 and the second tangent line 210. An angle b is defined as the angle between the second tangent line 210 and the third tangent line 212. The value of the angle a decreases as the vertex of the convex portion 202 moves toward the first tangent line 208, and the value of the angle a increases as the vertex of the convex portion 202 moves away from the first tangent line 208. The value of the angle b increases as the vertex of the concave portion 204 moves away from the first tangent line 208, and the value of the angle b decreases as the vertex of the concave portion 204 moves toward the first tangent line 208. In some embodiments, the angle a is larger than the angle b . The angle a can also be approximately equal to (e.g., within plus or minus five degrees) angle b . In some implementations, the angle a is smaller than the angle b . In an example embodiment, the angle a is approximately fifty-three degrees and the angle b is approximately thirty-five degrees.

[0032] The concave portion 204 is coupled to the second flow surface 106 to direct the coolant fluid toward the bottom portion 112. The second flow surface 106 is coupled to a curved portion 214 positioned opposite the concave portion 204. The curved portion 214 is configured to direct the coolant fluid that flows down the second flow surface 106 along a base portion 216 and toward the bottom portion 112.

[0033] The first flow surface 102 is positioned at a height H above the base portion 216. The transition region 104 reduces the height H to a smaller height h above the base portion 216 at the intersection between the concave portion 204 and the second flow surface 106. In some embodiments, the height H is typically between twelve and thirteen mm and the height h is between nine and ten mm. The reduction in height from H to h by the transition region 104 provides for efficient flow of the coolant fluid. The efficient flow is accomplished by reducing the turbulence of the coolant fluid flow as compared to a coolant liner that does not include the transition region 104 (e.g., coolant fluid flowing in a liner without the transition region 104 would encounter a second flow surface directly coupled to a first flow surface). The reduction in turbulence prevents the coolant fluid from damaging the second flow surface 106 as the coolant fluid flows around

the transition between the concave portion 204 and the second flow surface 106. Reducing turbulence of the flow of the coolant fluid also provides for more uniform distribution of the coolant fluid around the coolant liner than a coolant fluid that has a more turbulent flow (e.g., a coolant fluid that flows through a coolant liner that does not include the transition region 104).

III. Example Coolant Fluid Flow

[0034] FIG. 3 is an illustration of a velocity profile 300 of coolant fluid flowing through the coolant liner 100 of FIG. 1, according to a particular embodiment. The velocity profile 300 indicates the velocity of the coolant fluid as the coolant fluid flows around a first cylinder and a second cylinder in the coolant liner 100 (e.g., the lines around the elements in FIG. 3 indicate flow, and the shading of the lines indicate velocity, with darker lines generally indicating a lower velocity). The velocity profile 300 includes a first cylinder profile 302, a second cylinder profile 312, and a coolant inlet profile 322. The first cylinder profile includes a first coolant outlet profile 304, a second coolant outlet profile 306, a first upper portion 308, and a first lower portion 310. The second cylinder profile includes a third coolant outlet profile 314, a fourth coolant outlet profile 316, a second upper portion 318, and a second lower portion 320.

[0035] Generally, the coolant fluid flows through a coolant inlet and enters the coolant liner 100. The coolant fluid flows around the coolant liner 100 to cool a cylinder and out one of the outlets associated with the cylinder. In coolant liners that do not include the transition region 104 as described, the coolant fluid does not flow entirely around the lower portions of the cylinders, leaving a "dead zone" where the cylinder may not be effectively cooled by the coolant fluid. Such "dead zones" are typically found in locations corresponding to the first lower portion 310 and the second lower portion 320. In contrast, and as shown in FIG. 3, the first lower portion 310 and the second lower portion 320 show the coolant fluid flowing around the first lower portion 310 and the second lower portion 320. Accordingly, the transition region 104 promotes circulation of the coolant fluid around the entire coolant liner 100 to eliminate "dead zones."

IV. Construction of Example Embodiments

[0036] While this specification contains many specific implementation details, these should not be construed as limitations on the scope of what may be claimed but rather as descriptions of features specific to particular implementations. Certain features described in this specification in the context of separate implementations can also be implemented in combination in a single implementation. Conversely, various features described in the context of a single implementation can also be implemented in multiple implementations separately or in any suitable subcombination. Moreover, although features

may be described as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can, in some cases, be excised from the combination, and the claimed combination may be directed to a subcombination or variation of a subcombination.

[0037] As utilized herein, the term "substantially," "approximately," and similar terms are intended to have a broad meaning in harmony with the common and accepted usage by those of ordinary skill in the art to which the subject matter of this disclosure pertains. It should be understood by those of skill in the art who review this disclosure that these terms are intended to allow a description of certain features described and claimed without restricting the scope of these features to the precise numerical ranges provided. Accordingly, these terms should be interpreted as indicating that insubstantial or inconsequential modifications or alterations of the subject matter described and claimed are considered to be within the scope of the invention as recited in the appended claims.

[0038] The terms "coupled," "attached," and the like, as used herein, mean the joining of two components directly or indirectly to one another. Such joining may be stationary (e.g., permanent) or moveable (e.g., removable or releasable). Such joining may be achieved with the two components or the two components and any additional intermediate components being integrally formed as a single unitary body with one another, with the two components, or with the two components and any additional intermediate components being attached to one another.

[0039] Also, the term "or" is used in its inclusive sense (and not in its exclusive sense) so that when used, for example, to connect a list of elements, the term "or" means one, some, or all of the elements in the list. Conjunctive language such as the phrase "at least one of X, Y, and Z," unless specifically stated otherwise, is otherwise understood with the context as used in general to convey that an item, term, etc. may be either X, Y, Z, X and Y, X and Z, Y and Z, or X, Y, and Z (i.e., any combination of X, Y, and Z). Thus, such conjunctive language is not generally intended to imply that certain embodiments require at least one of X, at least one of Y, and at least one of Z to each be present, unless otherwise indicated.

[0040] Although only a few embodiments have been described in detail in this disclosure, those skilled in the art who review this disclosure will readily appreciate that many modifications are possible (e.g., variations in sizes, dimensions, structures, shapes, and proportions of the various elements, values of parameters, mounting arrangements, use of materials, colors, orientations, etc.) without materially departing from the novel teachings and advantages of the subject matter described herein. For example, elements shown as integrally formed may be constructed of multiple components or elements, the position of elements may be reversed or otherwise varied,

and the nature or number of discrete elements or positions may be altered or varied.

Claims

1. A coolant liner, comprising:

a first flow surface (102) to direct a coolant fluid toward a cylinder of an engine;
a transition region (104) coupled to the first flow surface, the transition region comprising:

a convex portion (202) extending from the first flow surface and curving downward relative to the first flow surface, the convex portion having a first radius of curvature; and
a concave portion (204) coupled to the convex portion at an inflection point, the concave portion having a second radius of curvature and curving upward relative to the first flow surface; and

a second flow surface (106) coupled to the concave portion of the transition region to direct the coolant fluid around the cylinder.

2. The coolant liner of claim 1, wherein the first radius of curvature is greater than the second radius of curvature, or wherein the second radius of curvature is greater than the first radius of curvature, or wherein the first radius of curvature is substantially equal to the second radius of curvature, or wherein when the first radius of curvature is greater than the second radius of curvature, a ratio of the first radius of curvature to the second radius of curvature is between approximately 1.3 and approximately 2.5.

3. The coolant liner of claim 2, further comprising:

a curved portion coupled to the second flow surface; and
a base portion coupled to the curved portion.

4. The coolant liner of claim 3, wherein a height of the second flow surface extending between the base portion and the concave portion is between approximately 8 mm and approximately 10 mm.

5. The coolant liner of claim 4, wherein a distance between the first flow surface and the base portion is between approximately 12 mm and approximately 13 mm.

6. The coolant liner of claim 1, wherein the first flow surface defines a first tangent line tangent to the first flow surface;

wherein the convex portion has a first vertex, the first vertex defining a second tangent line tangent to the convex portion at the first vertex; wherein the concave portion has a second vertex, the second vertex defining a third tangent line tangent to the concave portion at the second vertex;

the coolant liner further comprising:

a first angle defined by the first tangent line and the second tangent line; and
a second angle defined by the second tangent line and the third tangent line.

7. The coolant liner of claim 6, wherein the first angle is greater than the second angle, or wherein the second angle is greater than the first angle, or wherein the first angle is substantially equal to the second angle, or wherein when the first angle is greater than the second angle, a ratio of the first angle to the second angle is between approximately 1.075 and approximately 2.0.

8. A system comprising:

an engine including at least one engine cylinder; and
the coolant liner of claim 1, wherein the coolant liner is positioned around the at least one engine cylinder.

9. The system of claim 8, wherein the first flow surface is substantially horizontal.

10. The system of claim 9, wherein the second flow surface is substantially vertical.

11. The system of any one of claims 9 or 10, wherein the second flow surface is coupled to a curved portion and the curved portion is coupled to a base portion, the curved portion configured to direct the coolant fluid from the second flow surface to the base portion.

12. The system of claim 11, wherein the base portion is coupled to a bottom portion, the base portion configured to direct the coolant fluid to the bottom portion.

13. The system of claim 8, wherein the coolant liner further comprises:

a first tangent line defined by the first flow surface, the first tangent line tangent to the first flow surface;
a first vertex defined by the convex portion, the first vertex defining a second tangent line tangent to the convex portion at the first vertex;

a second vertex defined by the concave portion, the second vertex defining a third tangent line tangent to the concave portion at the second vertex;
 a first angle defined by the first tangent line and the second tangent line; and
 a second angle defined by the second tangent line and the third tangent line.

Patentansprüche

1. Kühlmittelaufbuchse, umfassend:

eine erste Strömungsfläche (102), um ein Kühlmittelfluid zu einem Zylinder eines Motors zu lenken,
 eine Übergangsregion (104), die an die erste Strömungsfläche gekoppelt ist, wobei die Übergangsregion Folgendes umfasst:

einen konvexen Abschnitt (202), der sich von der ersten Strömungsfläche aus erstreckt und relativ zur ersten Strömungsfläche abwärts gekrümmt ist, wobei der konvexe Abschnitt einen ersten Krümmungsradius aufweist, und
 einen konkaven Abschnitt (204), der an einem Biegungspunkt an den konvexen Abschnitt gekoppelt ist, wobei der konkave Abschnitt einen zweiten Krümmungsradius aufweist und relativ zur ersten Strömungsfläche aufwärts gekrümmt ist, und

eine zweite Strömungsfläche (106), die an den konkaven Abschnitt der Übergangsregion gekoppelt ist, um das Kühlmittelfluid um den Zylinder zu lenken.

2. Kühlmittelaufbuchse nach Anspruch 1, wobei der erste Krümmungsradius größer als der zweite Krümmungsradius ist oder wobei der zweite Krümmungsradius größer als der erste Krümmungsradius ist oder wobei der erste Krümmungsradius im Wesentlichen gleich dem zweiten Krümmungsradius ist oder wobei, wenn der erste Krümmungsradius größer als der zweite Krümmungsradius ist, ein Verhältnis des ersten Krümmungsradius zu dem zweiten Krümmungsradius zwischen ungefähr 1,3 und ungefähr 2,5 liegt.

3. Kühlmittelaufbuchse nach Anspruch 2, ferner umfassend:

einen gekrümmten Abschnitt, der an die zweite Strömungsfläche gekoppelt ist, und
 einen Basisabschnitt, der an den gekrümmten Abschnitt gekoppelt ist.

4. Kühlmittelaufbuchse nach Anspruch 3, wobei eine Höhe der zweiten Strömungsfläche, die sich zwischen dem Basisabschnitt und dem konkaven Abschnitt erstreckt, zwischen ungefähr 8 mm und ungefähr 10 mm beträgt.

5. Kühlmittelaufbuchse nach Anspruch 4, wobei ein Abstand zwischen der ersten Strömungsfläche und dem Basisabschnitt zwischen ungefähr 12 mm und ungefähr 13 mm beträgt.

6. Kühlmittelaufbuchse nach Anspruch 1, wobei die erste Strömungsfläche eine erste Tangente definiert, die die erste Strömungsfläche tangiert,

wobei der konvexe Abschnitt einen ersten Scheitelpunkt aufweist, wobei der erste Scheitelpunkt eine zweite Tangente definiert, die den konvexen Abschnitt an dem ersten Scheitelpunkt tangiert,
 wobei der konkave Abschnitt einen zweiten Scheitelpunkt aufweist, wobei der zweite Scheitelpunkt eine dritte Tangente definiert, die den konkaven Abschnitt an dem zweiten Scheitelpunkt tangiert,
 wobei die Kühlmittelaufbuchse ferner Folgendes umfasst:

einen ersten Winkel, der durch die erste Tangente und die zweite Tangente definiert ist, und
 einen zweiten Winkel, der durch die zweite Tangente und die dritte Tangente definiert ist.

7. Kühlmittelaufbuchse nach Anspruch 6, wobei der erste Winkel größer als der zweite Winkel ist oder wobei der zweite Winkel größer als der erste Winkel ist oder wobei der erste Winkel im Wesentlichen gleich dem zweiten Winkel ist oder wobei, wenn der erste Winkel größer als der zweite Winkel ist, ein Verhältnis des ersten Winkels zum zweiten Winkel zwischen ungefähr 1,075 und ungefähr 2,0 beträgt.

8. System, umfassend:

einen Motor, der mindestens einen Motorzylinder beinhaltet, und
 die Kühlmittelaufbuchse nach Anspruch 1, wobei die Kühlmittelaufbuchse um den mindestens einen Motorzylinder herum positioniert ist.

9. System nach Anspruch 8, wobei die erste Strömungsfläche im Wesentlichen horizontal liegt.

10. System nach Anspruch 9, wobei die zweite Strömungsfläche im Wesentlichen vertikal liegt.

11. System nach einem der Ansprüche 9 oder 10, wobei die zweite Strömungsfläche an einen gekrümmten Abschnitt gekoppelt ist und der gekrümmte Abschnitt an einen Basisabschnitt gekoppelt ist, wobei der gekrümmte Abschnitt dafür gestaltet ist, das Kühlmittelfluid von der zweiten Strömungsfläche zu dem Basisabschnitt zu lenken.

12. System nach Anspruch 11, wobei der Basisabschnitt an einen unteren Abschnitt gekoppelt ist, wobei der Basisabschnitt dafür gestaltet ist, das Kühlmittelfluid zu dem unteren Abschnitt zu lenken.

13. System nach Anspruch 8, wobei die Kühlmittelaufbuchse ferner Folgendes umfasst:

eine erste Tangente, die durch die erste Strömungsfläche definiert ist, wobei die erste Tangente die erste Strömungsfläche tangiert, einen ersten Scheitelpunkt, der durch den konvexen Abschnitt definiert ist, wobei der erste Scheitelpunkt eine zweite Tangente definiert, die den konvexen Abschnitt an dem ersten Scheitelpunkt tangiert, einen zweiten Scheitelpunkt, der durch den konkaven Abschnitt definiert ist, wobei der zweite Scheitelpunkt eine dritte Tangente definiert, die den konkaven Abschnitt an dem zweiten Scheitelpunkt tangiert, einen ersten Winkel, der durch die erste Tangente und die zweite Tangente definiert ist, und einen zweiten Winkel, der durch die zweite Tangente und die dritte Tangente definiert ist.

Revendications

1. Chemise de refroidissement, comportant :

une première surface d'écoulement (102) servant à diriger un liquide de refroidissement vers un cylindre d'un moteur ;

une région de transition (104) raccordée à la première surface d'écoulement, la région de transition comportant :

une partie convexe (202) s'étendant depuis la première surface d'écoulement et allant en s'incurvant vers le bas par rapport à la première surface d'écoulement, la partie convexe ayant un premier rayon de courbure ; et

une partie concave (204) raccordée à la partie convexe au niveau d'un point d'inflexion, la partie concave ayant un deuxième rayon de courbure et allant en s'incurvant vers le haut par rapport à la première surface d'écoulement ; et

une deuxième surface d'écoulement (106) raccordée à la partie concave de la région de transition servant à diriger le liquide de refroidissement autour du cylindre.

2. Chemise de refroidissement selon la revendication 1, dans laquelle le premier rayon de courbure est supérieur au deuxième rayon de courbure, ou dans laquelle le deuxième rayon de courbure est supérieur au premier rayon de courbure, ou dans laquelle le premier rayon de courbure est sensiblement égal au deuxième rayon de courbure, ou dans laquelle, quand le premier rayon de courbure est supérieur au deuxième rayon de courbure, un rapport entre le premier rayon de courbure et le deuxième rayon de courbure est compris entre approximativement 1,3 et approximativement 2,5.

3. Chemise de refroidissement selon la revendication 2, comportant par ailleurs :

une partie incurvée raccordée à la deuxième surface d'écoulement ; et

une partie de base raccordée à la partie incurvée.

4. Chemise de refroidissement selon la revendication 3, dans laquelle une hauteur de la deuxième surface d'écoulement s'étendant entre la partie de base et la partie concave est comprise entre approximativement 8 mm et approximativement 10 mm.

5. Chemise de refroidissement selon la revendication 4, dans laquelle une distance entre la première surface d'écoulement et la partie de base est comprise entre approximativement 12 mm et approximativement 13 mm.

6. Chemise de refroidissement selon la revendication 1, dans laquelle la première surface d'écoulement définit une première ligne tangente qui est tangente par rapport à la première surface d'écoulement ;

dans laquelle la partie convexe a un premier sommet, le premier sommet définissant une deuxième ligne tangente qui est tangente par rapport à la partie convexe au niveau du premier sommet ;

dans laquelle la partie concave a un deuxième sommet, le deuxième sommet définissant une troisième ligne tangente qui est tangente par rapport à la partie concave au niveau du deuxième sommet ;

la chemise de refroidissement comportant par ailleurs :

un premier angle défini par la première ligne tangente et la deuxième ligne tangente ; et

- un deuxième angle défini par la deuxième ligne tangente et la troisième ligne tangente.
7. Chemise de refroidissement selon la revendication 6, dans laquelle le premier angle est supérieur au deuxième angle, ou dans laquelle le deuxième angle est supérieur au premier angle, ou dans laquelle le premier angle est sensiblement égal au deuxième angle, ou dans laquelle, quand le premier angle est supérieur au deuxième angle, un rapport entre le premier angle et le deuxième angle est compris entre approximativement 1,075 et approximativement 2,0. 5 10
8. Système comportant : 15
- un moteur comprenant au moins un cylindre de moteur ; et
- une chemise de refroidissement selon la revendication 1, dans lequel la chemise de refroidissement est positionnée autour dudit au moins un cylindre de moteur. 20
9. Système selon la revendication 8, dans lequel la première surface d'écoulement est sensiblement horizontale. 25
10. Système selon la revendication 9, dans lequel la deuxième surface d'écoulement est sensiblement verticale. 30
11. Système selon l'une quelconque des revendications 9 ou 10, dans lequel la deuxième surface d'écoulement est raccordée à une partie incurvée et la partie incurvée est raccordée à une partie de base, la partie incurvée étant configurée pour diriger le liquide de refroidissement depuis la deuxième surface d'écoulement vers la partie de base. 35
12. Système selon la revendication 11, dans lequel la partie de base est raccordée à une partie inférieure, la partie de base étant configurée pour diriger le liquide de refroidissement vers la partie inférieure. 40
13. Système selon la revendication 8, dans lequel la chemise de refroidissement comporte par ailleurs : 45
- une première ligne tangente définie par la première surface d'écoulement, la première ligne tangente étant tangente par rapport à la première surface d'écoulement ; 50
- un premier sommet défini par la partie convexe, le premier sommet définissant une deuxième ligne tangente qui est tangente par rapport à la partie convexe au niveau du premier sommet ; 55
- un deuxième sommet défini par la partie concave, le deuxième sommet définissant une troisième ligne tangente qui est tangente par rapport

à la partie concave au niveau du deuxième sommet ;

un premier angle défini par la première ligne tangente et la deuxième ligne tangente ; et

un deuxième angle défini par la deuxième ligne tangente et la troisième ligne tangente.

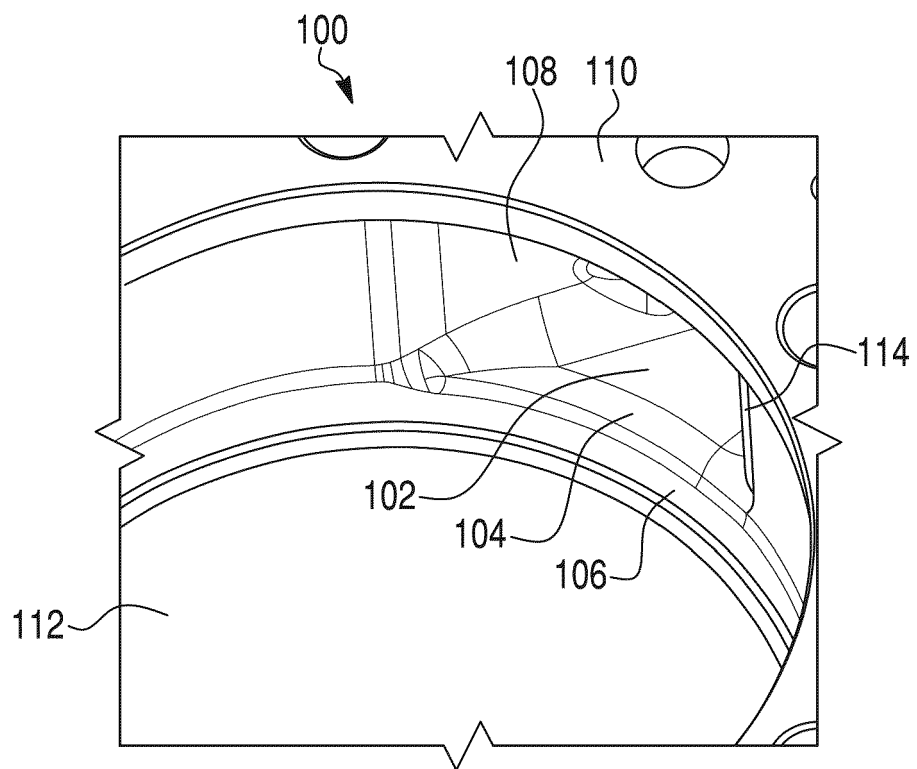


FIG. 1

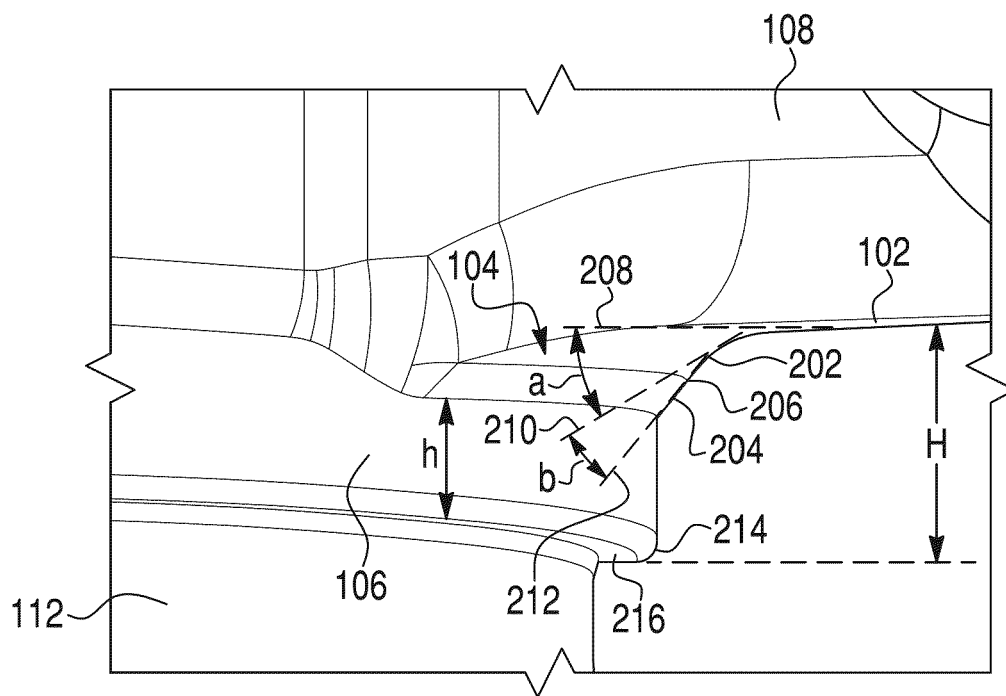


FIG. 2A

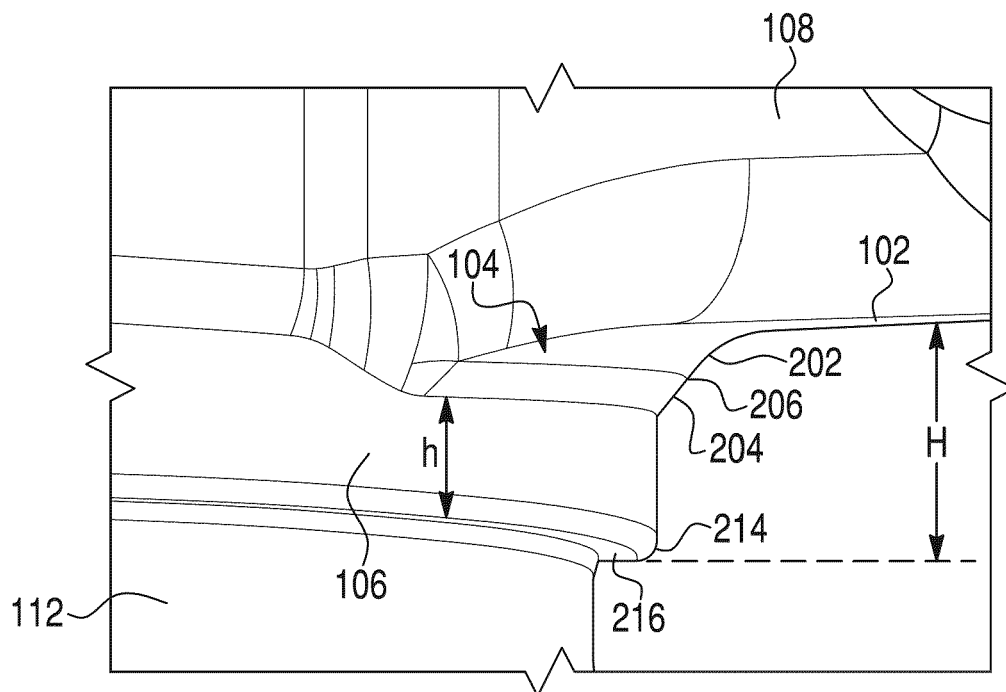


FIG. 2B

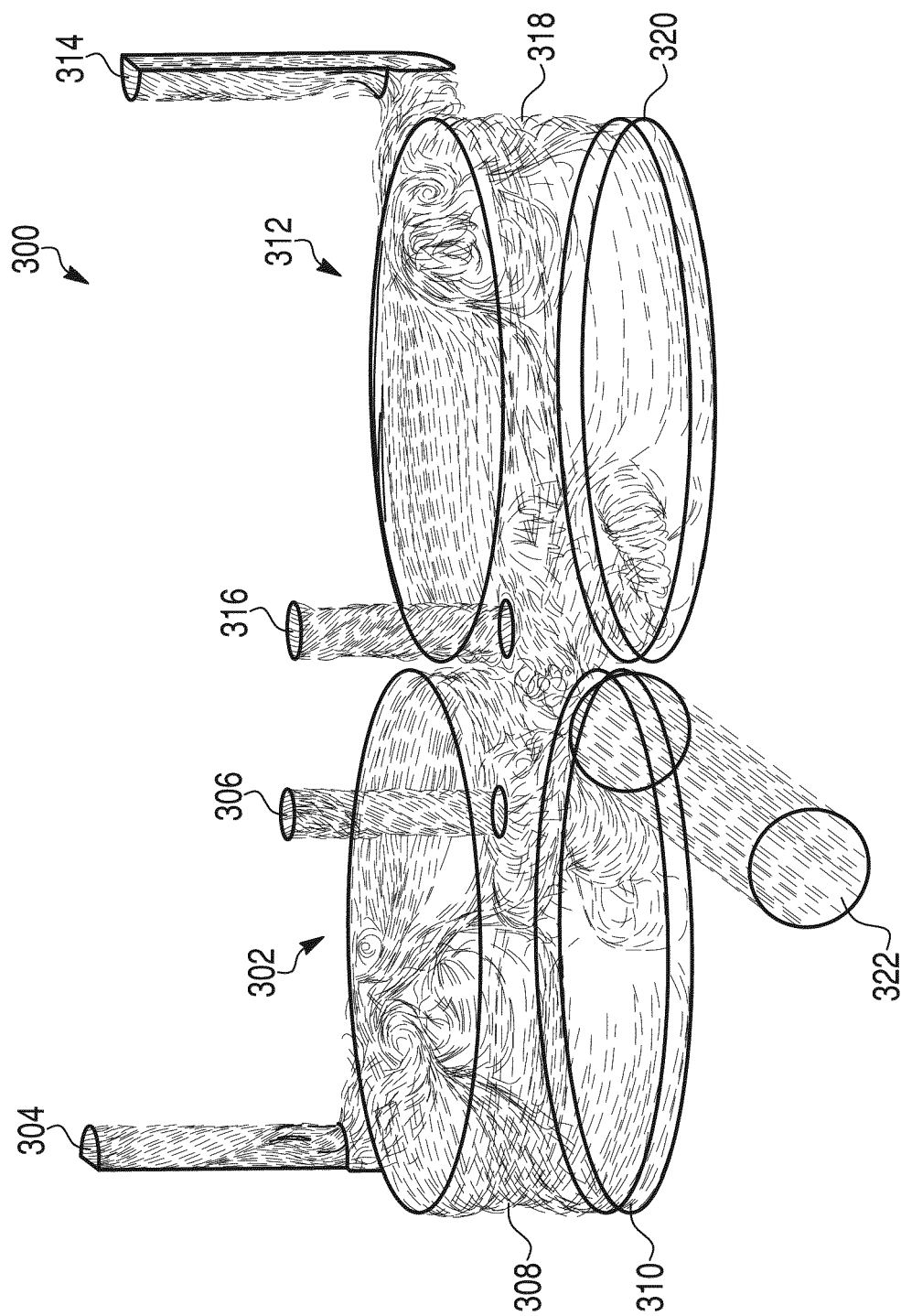


FIG. 3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 104895693 [0002]