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Remarks:

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(54) **Heat exchanger having extended heat transfer surface around fastening points**

(57) A heat exchanger for an oil cooler comprises at least two heat exchanger members, each enclosing a respective first channel (12), wherein a second channel

(7) is formed between the at least two heat exchanger members (10, 10'). At least one of the heat exchanger members presents through hole providing access from outside the heat exchanger to the second channel.

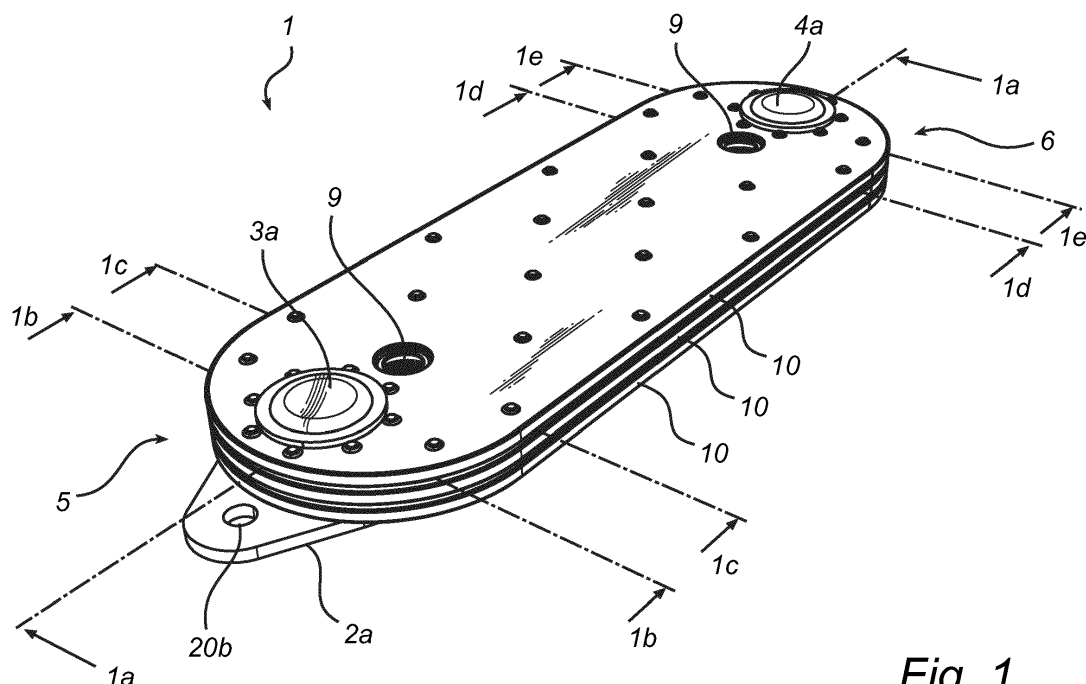


Fig. 1

Description

Technical Field

[0001] The present disclosure relates to heat exchangers, and more particularly to heat exchangers which are suitable for use as oil coolers in heavy vehicles.

[0002] The disclosure relates particularly to a so-called single flow integrated (SFI) type plate heat exchanger, i.e. a heat exchanger wherein one of the fluid circuits is integrated in the plate bundle and the heat exchanger is essentially immersed in the other fluid circuit, which is typically enclosed by a cavity in which the heat exchanger is mounted.

[0003] The disclosure is, however also applicable to so-called two (or more) flow integrated heat exchangers, i.e. heat exchangers where all fluid circuits are integrated in the plate bundle, and which thus do not need to be mounted in an enclosed cavity.

Background

[0004] A heat exchanger for use as an oil cooler in e.g. heavy vehicles may be formed from a plurality of parallel plates, which may be stacked, such that parallel channels are formed between the plates. Typically, every second one is arranged to carry a flow of cooling medium, and the other channels are arranged to carry a flow of heat-emitting medium. The plates may be brazed together to form a single heat-exchanger unit.

[0005] The basic principle for forming such a heat exchanger is disclosed in e.g. WO90/13394A1 and WO2004027334A1.

[0006] A single flow integrated type heat exchanger is a heat exchanger which carries one medium inside it, and is essentially immersed in the other medium.

[0007] When in use, the heat exchanger is typically arranged in a cavity, through which the cooling medium is caused to flow, while heat-emitting medium is fed through an inlet opening of the heat exchanger, through the channels for the heat-emitting medium, after which the cooled heat-emitting medium is extracted through an outlet opening of the heat exchanger. Hence, the channels for the cooling medium are at least partially open to the cavity.

[0008] JP 2005337528A discloses a heat exchanger making use of protrusions or a circular ridge around the oil channel of an oil cooler for an automobile in order to eliminate the washers otherwise used between the heat exchanger sheets to provide structural integrity of the heat exchanger in the areas which are subjected to an elevated force resulting from the oil pressure.

[0009] In heat exchangers of the present type, it is desirable to increase the efficiency of the heat exchanger, such that more cooling can be achieved with a smaller and/or lighter heat exchanger.

[0010] However, when designing heat exchangers, it is necessary to consider both strength aspects of the

heat exchanger itself and also mounting aspects, including the shape of the space where the heat exchanger is to be mounted, and the position of ports and inlet/outlet for the medium to be cooled and the cooling medium, respectively.

[0011] Hence, there is a need for further technical development with a view to providing increased freedom in the design of heat exchangers while maintaining or increasing the strength and efficiency of the heat exchanger.

Summary

[0012] It is a general object to provide a heat exchanger and a heat exchanger system which alleviate or eliminate the drawbacks of the prior art.

[0013] It is a particular object to provide a heat exchanger and a heat exchanger system having allowing freedom in design while at the same time maintaining or increasing the strength and efficiency of the heat exchanger.

[0014] It is a further object to provide a heat exchanger system which is lighter and/or more compact.

[0015] The invention is defined by the appended independent claims with embodiments being set forth in the dependent claims, in the drawings and in the following description.

[0016] According to a first aspect, there is provided a plate type heat exchanger for an oil cooler, comprising at least two heat exchanger members, each enclosing a respective first channel, an inlet port, for feeding a medium to the first channels, and an outlet port, for extracting the medium from the first channels. A second channel is formed between the at least two heat exchanger members. A medium present in the second channel is isolated from a medium present in the first channel. At least one of the heat exchanger members presents a through hole or through recess extending from one face of the heat exchanger member, through the first channel, to a second, opposite face of the heat exchanger member and providing access from outside the heat exchanger to the second channel.

[0017] It is understood that, as is conventional in heat exchangers, the first and second channels are isolated from each other and thus not in communication with each other.

[0018] With the above heat exchanger, it is possible to increase the effective heat exchanger area. Bolts for attaching the heat exchanger to a wall of the cavity in which the heat exchanger is arranged engage a mounting plate at the rear side of the heat exchanger and may be accessible through the through hole. Alternatively, or as a complement, a recess may be provided to accommodate for a protrusion in a wall of the cavity.

[0019] The second channel may be open from a direction which is parallel with the main plane of the heat exchanger members. For example, the second channel may be open at short ends of the heat exchanger.

[0020] Hence, it is possible to position bolts holes or recesses more freely over the effective area ("footprint") of the heat exchanger, and thus to make use of a larger portion of the space available for the heat exchanger. The heat exchanger members may present a respective through hole or through recess, wherein the through holes or through recesses may be substantially aligned with each other.

[0021] The through hole or through recess may be spaced from all peripheral edges of the heat exchanger member.

[0022] The "through hole or through recess being spaced from all peripheral edges of the heat exchanger member" effectively means that the medium flowing in the second first channel may flow around the through hole or through recess.

[0023] An edge defining the through hole or through recess may intersect an edge of the heat exchanger at a respective point of intersection, the through hole or through recess may present a central angle, the legs of which presenting a respective tangent point at the respective point of intersection, and the central angle may be less than about 180 degrees, less than about 135 degrees or less than about 90 degrees.

[0024] Hence, the through hole or through recess may be positioned at an edge portion of the heat exchanger.

[0025] Heat exchanger plates of two separate heat exchanger members, which heat exchanger plates face each other, may present at least one respective protrusion, arranged in the immediate vicinity of the through hole or through recess and/or of an oil port, and the protrusions may abut each other.

[0026] Such protrusions provide increased strength while minimizing the negative impact on the heat transfer surface. This may be particularly advantageous when combined with the through holes or through recesses as described above, since additional heat transfer surface will be made available around the oil ports.

[0027] The heat exchanger plates facing each other may present a plurality of abutting protrusions.

[0028] At least one of the protrusions may be formed as a ridge.

[0029] At least two of the protrusions may have different shapes.

[0030] The abutting protrusions may be joined with each other. Joining may be achieved by e.g. welding, brazing, soldering or glue.

[0031] The heat exchanger may further comprise a third heat exchanger member, arranged adjacent one of the two heat exchanger members, and having a through hole or through recess which is aligned with the other through holes or through recesses along a normal of a main plane of the heat exchanger, wherein at least one washer may be arranged between the third heat exchanger member and said one of the two heat exchanger members.

[0032] The heat exchanger may further comprise a mounting flange, which presents a recess positioned so

as to receive at least one of the protrusions. Such a mounting flange may be used with any heat exchanger presenting protrusions, also without the presence of through holes or recesses.

[0033] The at least two heat exchanger members may present a respective through hole or through recess, and the respective through holes or through recesses may at least partially overlap each other, thus forming a set of overlapping through holes or through recesses. The heat exchanger may further comprise at least one mounting member presenting a mounting hole which may be accessible through the overlapping through holes or through recesses.

[0034] In the alternative, less than all heat exchanger members of the heat exchanger may present a respective through hole or through recess.

[0035] A through hole or through recess of one of the heat exchanger members may be smaller than an overlapping through hole or through recess of another one of the heat exchanger members.

[0036] All heat exchanger members may present a respective through hole or through recess, and the through holes or through recesses may be substantially aligned with each other along a normal of a main plane of the heat exchanger members, thus forming a set of aligned through holes or through recesses.

[0037] A first set of aligned through holes or through recesses may be arranged at a first angle relative to a longitudinal centre line through a center of an associated first oil port and a first distance from the centre of the first oil port, and a second set of aligned through holes or through recesses may be arranged at a second angle relative to the longitudinal centre line and a second distance from the centre of the first oil port.

[0038] The first and second distances may be substantially equal. The first and second angles may differ by about 180 degrees. In one alternative, the first and second angles may differ by less than 180 degrees, less than about 135 degrees or less than about 90 degrees. In another alternative, the first and second angles may differ by more than 180 degrees, more than about 225 degrees or more than about 270 degrees.

[0039] A first set of aligned through holes or through recesses may be arranged on a first side of a longitudinal centre line through centers of oil ports of the heat exchanger and a second set of aligned through holes or through recesses may be arranged on a second side of the longitudinal centre line.

[0040] A transversal line running through the centers of both sets of aligned through holes or through recesses may be substantially perpendicular to the longitudinal centre line.

[0041] A transversal line running through the centers of both sets of aligned through holes or through recesses may present an angle of less than about 90 degrees to the centre line, or less than about 75 degrees, or less than about 60 degrees or less than about 45 degrees.

[0042] It is understood that a heat exchanger may have

multiple pairs of sets of aligned through holes or through recesses, where the transversal line of one pair may be substantially perpendicular to the longitudinal centre line, while transversal line of another pair may present an angle which is less than about 90 degrees to the longitudinal centre line.

[0043] One or more of the transversal lines may intersect an oil port. In one embodiment, a transversal line may run through the center of an oil port.

[0044] At least one of the heat exchanger members may present at least two through holes or through recesses providing access from outside the heat exchanger to the second channel.

[0045] According to a second aspect, there is provided a heat exchanger for an oil cooler, comprising at least three stacked heat exchanger members each enclosing a respective first channel. A respective second channel is formed between two adjacent ones of said heat exchanger members. An oil port extends through the heat exchanger members and connects the respective first channels. Heat surfaces of a first pair of adjacent heat exchanger members, which heat surfaces face each other and form an associated second channel, present at least one respective protrusion, arranged in the immediate vicinity of the oil port, and wherein the protrusions abut each other. A second pair of adjacent heat exchanger members is separated by at least one substantially planar member, such as a washer, extending about a substantial part of a circumference of the oil port.

[0046] According to a third aspect, there is provided an oil cooling system, comprising a cavity having a liquid cooling medium inlet and a liquid cooling medium outlet, an oil inlet for oil to be cooled and an oil outlet for cooled oil, and a heat exchanger, as described above, said heat exchanger being substantially enclosed in said cavity.

[0047] The second channel may be at least partially formed by the cavity in which the heat exchanger is arranged.

[0048] According to a fourth aspect, there is provided a method for cooling oil in a vehicle using an oil cooling system as described above, the method comprising causing oil to be cooled to flow from the oil inlet through the first channel to the oil outlet, and causing liquid cooling medium to flow from the cooling medium inlet through the second channel to the cooling medium outlet.

Description of the Drawings

[0049]

Fig. 1 is a schematic perspective view of a heat exchanger for an oil cooling system.

Figs 1a-1c are sectional views along of the heat exchanger of Fig. 1.

Figs 2a-2d are partial sectional views of alternative embodiments of heat exchanger members.

Figs 3a-3b are sectional views of alternative embodiments of heat exchangers for oil coolers.

Figs 4a-4b are diagrammatic views of oil cooling systems.

Figs 5a-5d are schematic perspective views of alternative embodiments of heat exchanger members.

Figs 6a-6b schematically illustrate a pair of heat exchanger members according to an alternative embodiment.

Fig. 7 is a schematic sectional view of a portion of a heat exchanger according to another architecture.

Fig. 8 is a schematic view of a heat exchanger member according to another embodiment.

Figs 9a-9c schematically illustrate a mounting flange.

15 Description of Embodiments

[0050] Fig. 1 is a schematic view of a heat exchanger 1 for an oil cooling system. The heat exchanger is intended to be mounted as illustrated in Figs 4a-4b, i.e. substantially longitudinally in a cavity 8, which may be partially formed by an engine block of a vehicle. The heat exchanger 1 has oil ports 3, 4, which are connected by a first channel 12 and coolant openings 5, 6, which allow coolant to flow through respective second channels 7 of the heat exchanger 1. The first and second channels 12, 7 are completely separated, such that fluids passed through them do not contact each other.

[0051] Each of the first channels 12 is defined by a pair of joined together heat exchanger plates 17, 18 forming a heat exchanger member 10. The heat exchanger plates may be joined together by e.g. welding, brazing, soldering or glue. Edges of the heat exchanger plates may be folded relative to each other as illustrated in Figs 2a-2d. This applies both to peripheral edges and to edges at through holes or through recesses 9, 11 and/or oil ports 3, 4.

[0052] The heat exchanger 1 may further have mounting flanges 2a, 2b intended for fixating the heat exchanger 1 to a wall of the cavity 8. The mounting flanges 2a, 2b may have holes for oil ports 3, 4 and/or bolt holes 20a, 20b.

[0053] At each oil port 3, 4, there is formed an inlet/outlet channel, which may extend through all heat exchanger members 10 to connect the oil ports 3, 4 to the respective first channels 12. The side of the heat exchanger opposite to the port side (upper side in Fig. 1) may be provided with an oil channel cover 3a, 4a, which closes the inlet/outlet channel.

[0054] Referring particularly to Figs 1a, 1c and 1d, the heat exchanger 1 may have through-going holes 9 providing access to the mounting flange 2a, 2b. The diameter of the through-going holes 9 may be larger than the diameter of the associated bolt hole 20a, 20b, such that a fastening device (e.g. a screw, bolt or rivet (not shown)) can be introduced through the through-going hole and allow a head portion of the fastening device to engage the mounting flange 2a, 2b.

[0055] As is shown in Figs 1 and 1a, protrusions 170,

180 from the heat exchanger plates 17, 18 may be provided around the oil ports 3, 4 and also around the through holes 9. A protrusion 170 of one of the heat exchanger plates 17 of a first heat exchanger member 10 may be aligned with a corresponding protrusion 180 of a heat exchanger plate 18 of a second, adjacent heat exchanger member 10, such that the protrusions 170, 180 contact each other. The protrusions 170, 180 may be joined with each other through e.g. welding, brazing, soldering or glue. Protrusions may be provided by stamping or punching the material forming the heat exchanger members. Alternatively, material may be added to the surface of the heat exchanger member to form the protrusions.

[0056] Referring to Figs 2a-2d, various ways of connecting the edges of the heat exchanger plates 17, 18 are disclosed.

[0057] In Fig. 2a, the edges of both the upper plate 17 and the lower plate 18 are folded about 90 degrees, such that the edge portions overlap along a thickness direction of the heat exchanger member. In the particular embodiment shown, the lower plate extends beyond the upper plate, such that the vertical portion of the lower plate 18 is outside the vertical portion of the upper plate 17. The plates are thus joined in a plane which is substantially perpendicular to a main plane of the heat exchanger member.

[0058] In Fig. 2b, the edges of both the upper plate 17 and the lower plate 18 are bent such that the plates are joined in a plane which is substantially parallel with the main plane of the heat exchanger member.

[0059] In Fig. 2c, the edges of both the upper plate 17 and the lower plate 18 are folded about 90 degrees, such that the edge portions overlap along a thickness direction of the heat exchanger member. In the particular embodiment shown, the upper plate 17 extends beyond the lower plate 18, such that the vertical portion of the upper plate 17 is outside the vertical portion of the lower plate 18. The plates are thus joined in a plane which is substantially perpendicular to a main plane of the heat exchanger member.

[0060] In Fig. 2d, the upper plate 17 is substantially unbent, whereas the lower plate 18 is bent such that a wall extending substantially perpendicular to the main plane of the heat exchanger member is formed entirely of the lower plate 18. The edge of the lower plate 18 is further bent to enclose an edge of the upper plate 17.

[0061] It is noted that while all of the edge configurations disclosed in Figs 2a-2d may be used for forming peripheral edges of the heat exchanger members, it is also possible to use the edge configurations disclosed in Figs 2a-2d to form edges of a through hole 9 or accommodation recess 11 as described herein. Furthermore, one of the configurations may be used for the peripheral edges while another configuration is used for the through holes and/or for the accommodation recess. It is also possible to use different configurations for the through holes and/or for through holes and accommodation recess.

[0062] Referring to Fig. 3a, there is disclosed an embodiment where an accommodation recess 11 is provided. In this embodiment, the recess is formed by through holes in two uppermost heat exchanger members 10. The through hole of the uppermost heat exchanger member is slightly larger than the through hole of the second-to-uppermost heat exchanger member. It is recognized that through holes forming an accommodation recess may be provided in as many of the heat exchanger members as is necessary to accommodate for e.g. a protrusion in the cavity 8 where the heat exchanger is to be positioned.

[0063] Referring to Fig. 3b, there is disclosed an embodiment where protrusions 170, 180 are used together with washers 19 at the same set of aligned through holes (access holes, accommodation recesses) or oil ports. A combination of protrusions and washers can be used to optimize e.g. a weight to strength ratio of the heat exchanger by using washers between some pairs of heat exchanger members 10, while protrusions are used between other pairs of heat exchanger members. For example, washers 19 may be used where the forces affecting the heat exchanger members are very large, while protrusions 170, 180 may be used where the heat exchanger members are subjected to less severe forces.

[0064] It is possible to alternate between washers and protrusions, such that washers are used for every second joint while protrusions are used for the other joints, as illustrated at the left hand portion of Fig. 3b.

[0065] Alternatively, or as a complement, it is possible to use washers for more than two adjacent heat exchanger members, while protrusions are used for one or a few of the heat exchanger members.

[0066] Referring to Figs 4a-4b, there is illustrated how the freedom in design can be improved by making use of the present disclosure.

[0067] In Fig. 4a, the incoming coolant flow F_c and the outgoing coolant flow move in substantially the same direction. Bolt holes 9 are provided on both sides of a longitudinal centre line of the heat exchanger 1. However instead of being aligned along a line which is perpendicular to the centre line, the bolt holes 9 are aligned along a line, which present an angle β different than 90° relative to the longitudinal centre line. The angle may be less than about 80° , less than about 70° , less than about 60° , less than about 50° , less than about 40° , or less than about 30° . At least one oil 3, 4 port may also be aligned on the same line as the bolt holes 9.

[0068] In Figs 4a, 4b, there is defined a longitudinal centre line through the centers of the oil ports. Angle β is thus an absolute angle for the position of each set of aligned through holes. A difference angle θ between the holes may be defined. Where the holes are aligned along a single line through the centre of the oil port, the difference angle θ will be 180 degrees.

[0069] In Fig. 4b, there is illustrated an embodiment where the incoming coolant flow F_c arrives at an angle to the longitudinal centre line of the heat exchanger 1,

and where the outgoing coolant flow F_c is substantially parallel with the longitudinal centre line. First and second pairs of bolt holes 9 may be provided such that the angle β at the centre of an oil port, between the lines along which the respective pair of bolt holes 9 are aligned differ between the pairs of bolt holes 9. If desired, further such sets of aligned through holes or bolt holes may be provided at a respective oil port, e.g. 3, 4 or 5 sets of through holes or bolt holes.

[0070] Referring to Figs 5a-5d, there are illustrated various protrusion/ridge patterns which may be used in connection with oil ports 3, 4 and/or access holes/accommodation recesses.

[0071] Referring to Figs 6a-6b, there is illustrated how the protrusion/ridge pattern may differ between a pair of joined together heat exchanger members 10. As illustrated, a first ridge 180' of a first heat exchanger plate 18' may extend in a first direction, while a second ridge 170' of a second heat exchanger member 17' may extend in a second, different direction. The first and second directions may be substantially mutually perpendicular. However any angle between 0° and 90° may be provided between the ridges of the adjacent heat exchanger members 10.

[0072] Fig. 7 shows a heat exchanger formed by a plurality of heat exchanger members 10''a, 10''b, each of which is formed as a substantially tubular member. Each member may be formed by rolling or folding a piece of sheet metal or by extrusion. In either case, the forming of the tubular member may be followed by a flattening step and/or by insertion of an additional flange structure to increase heat transfer.

[0073] The heat exchanger may be formed as illustrated by a plurality of identical heat exchanger members. Fig. 8 illustrates an embodiment, wherein the through hole 9' intersects the edge portion of the heat exchanger member 10^{IV}. The through hole presents a central angle c , the legs of which presenting a respective tangent point which may coincide with the intersection between the respective edge portion and the hole edge. The central angle may be less than about 180 degrees, less than about 135 degrees or less than about 90 degrees. In this connection "central" is to be seen as the geometric centre where the hole is substantially circular or substantially elliptic, or as the centre of gravity of the through hole where the through hole is asymmetric.

[0074] Figs 9a-9c schematically illustrate a mounting flange 2', which is adapted for use with the heat exchanger as disclosed herein. The mounting flange presents a port hole 21 extending through the mounting flange 2' for introduction or extraction of the heat emitting medium, or cooling medium, where applicable. The mounting flange 2' also presents one or more recesses 23a, 23b, 23c, 23d, 23e, 23f, 23g, 23h, which are adapted for receiving a protrusion, which is formed in the heat exchanger plate, in the area covered by the mounting flange 2'. With such a mounting flange, it is possible to provide a heat exchanger, wherein all heat exchanger members are iden-

tical, thus eliminating the need for providing a different outermost heat exchanger member, which would fit tightly with the mounting flange.

[0075] The mounting flange may further comprise one or more fastening holes 22. The mounting flange may be formed of a single plate, wherein the recesses are formed as recesses, which may be provided as blind holes or through holes. In the disclosed embodiment, the mounting flange 2' is formed of two separate material plates 24, 25, where a first material plate 24 may be formed with only port hole 21 and fastening holes 22, whereas the other plate is formed also with through holes forming the recesses 23a, 23b, 23c, 23d, 23e, 23f, 23g, 23h. When the material plates forming the mounting flange 2' may be of different materials. For example, one of the materials, e.g. the first plate 24, may be selected for optimum strength, while the other, e.g. the second plate 25, may be selected to fit with the brazing process.

Claims

1. A plate type heat exchanger for an oil cooler, comprising:

at least two heat exchanger members (10) each enclosing a respective first channel (12);
an inlet port, for feeding a medium to the first channels, and

an outlet port, for extracting the medium from the first channels, wherein a second channel (7) is formed between the at least two heat exchanger members (10), a medium present in the second channel being isolated from a medium present in the first channel, and the second channel being arranged to communicate with a space in which the heat exchanger is enclosed;

wherein at least one of the heat exchanger members presents a through hole or through recess (9, 11) extending from one face of the heat exchanger member, through the first channel, to a second, opposite face of the heat exchanger member and providing access from outside the heat exchanger to the second channel (7),

characterised in that

heat exchanger plates of two separate heat exchanger members, which heat exchanger plates face each other, present at least one respective protrusion (170, 180; 170', 180'), arranged in the immediate vicinity of the through hole (9, 11) and/or of an oil port (3, 4), and wherein the protrusions abut each other.

2. The heat exchanger as claimed in claim 1, wherein the heat exchanger plates facing each other present a plurality of abutting protrusions.

3. The heat exchanger as claimed in claim 1 or 2 wherein at least one of the protrusions is formed as a ridge.
4. The heat exchanger as claimed in any one of claims 1-3, wherein at least two of the protrusions have different shapes. 5
5. The heat exchanger as claimed in any one of claims 1-4, wherein the abutting protrusions are joined with each other. 10
6. The heat exchanger as claimed in any one of claims 1-5, wherein the heat exchanger comprises:
 - a third heat exchanger member, arranged adjacent one of the two heat exchanger members, and having a through hole or through recess which is aligned with the other through holes or through recesses along a normal of a main plane of the heat exchanger members, 15
 - wherein at least one washer is arranged between the third heat exchanger member and said one of the two heat exchanger members. 20
7. The heat exchanger as claimed in any one of claims 1-6, further comprising a mounting flange (2'), which presents a recess positioned so as to receive at least one of the protrusions. 25
8. The heat exchanger as claimed in any one of the preceding claims, wherein at least two heat exchanger members present a respective through hole or through recess, and wherein said respective through holes or through recesses at least partially overlap each other, thus forming a set of overlapping through holes or through recesses. 30 35
9. The heat exchanger as claimed in claim 8, further comprising at least one mounting member presenting a mounting hole which is accessible through the overlapping through holes or through recesses. 40
10. The heat exchanger as claimed in any one of claims 1-9, wherein less than all heat exchanger members of the heat exchanger present a respective through hole or through recess. 45
11. The heat exchanger as claimed in any one of the preceding claims, wherein the through holes or through recesses are substantially aligned with each other along a normal of a main plane of the heat exchanger members, thus forming a set of aligned through holes or through recesses. 50
12. The heat exchanger as claimed in any one of the preceding claims, wherein at least one of the heat exchanger members presents at least two through holes or through recesses (9, 11) providing access 55

from outside the heat exchanger to the second channel (7).

13. A heat exchanger for an oil cooler, comprising:

at least three stacked heat exchanger members (10) each enclosing a respective first channel (12);
 wherein a respective second channel (7) is formed between two adjacent ones of said heat exchanger members (10);
 wherein an oil port extends through the heat exchanger members and connects the respective first channels (12);
 wherein surfaces of a first pair of adjacent heat exchanger members, which surfaces face each other and form an associated second channel, present at least one respective protrusion (170, 180; 170', 180'), arranged in the immediate vicinity of the oil port, and wherein the protrusions abut each other;
 wherein a second pair of adjacent heat exchanger members is separated by at least one substantially planar member, such as a washer, extending about a substantial part of a circumference of the oil port.

14. An oil cooling system, comprising:

a cavity (8) having a liquid cooling medium inlet (60) and a liquid cooling medium outlet (50);
 an oil (4) inlet for oil to be cooled and an oil outlet (3) for cooled oil; and
 a heat exchanger (10, 10'), as claimed in any one of the preceding claims, said heat exchanger being substantially enclosed in said cavity (8), and
 wherein the second channel is at least partially formed by the cavity.

15. A method for cooling oil in a vehicle using an oil cooling system as claimed in claim 14, the method comprising:

causing oil to be cooled to flow from the oil inlet (4) through the first channel (12) to the oil outlet (3), and
 causing liquid cooling medium to flow from the cooling medium inlet (60) through the second channel (7) to the cooling medium outlet (50).

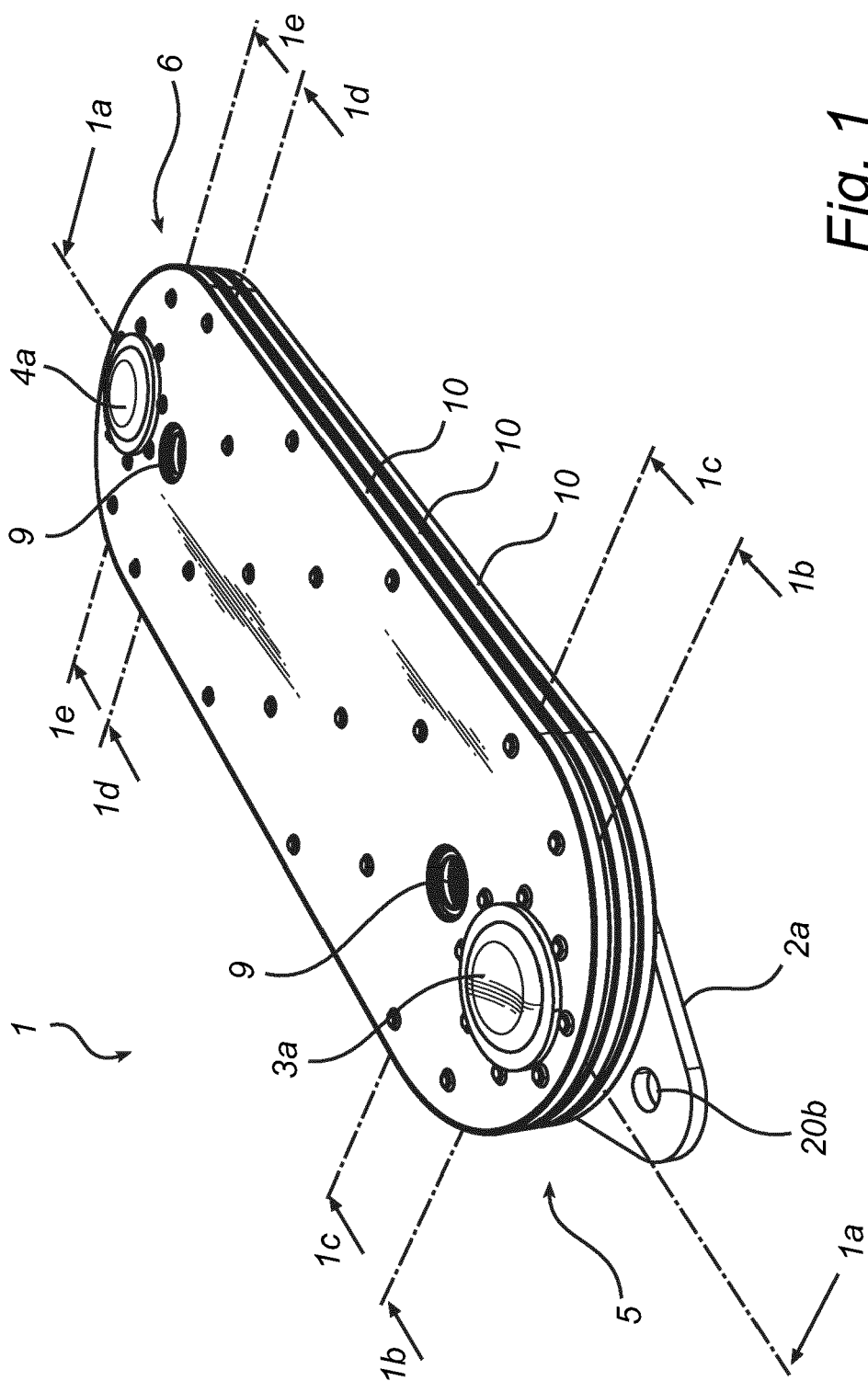
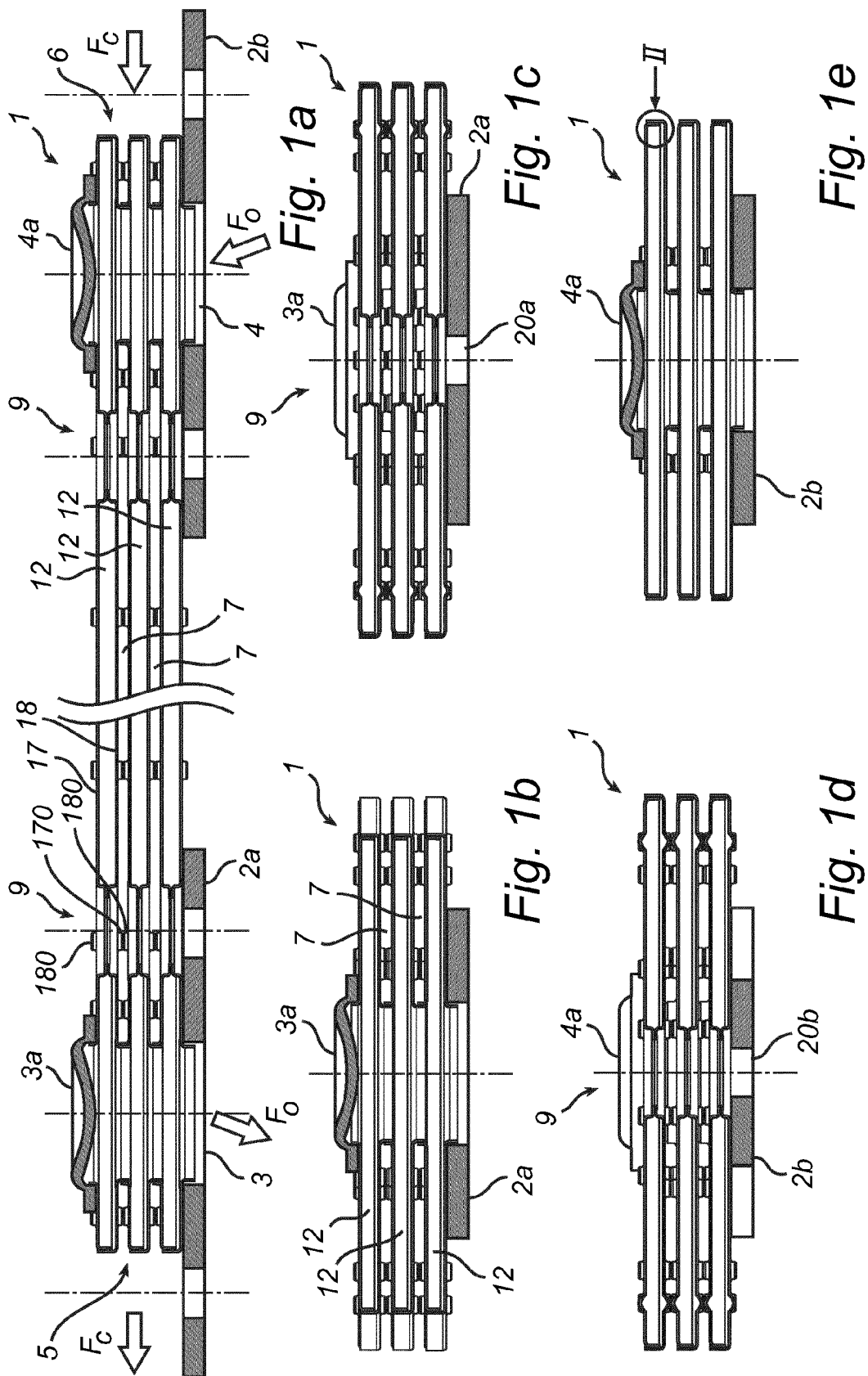


Fig. 1



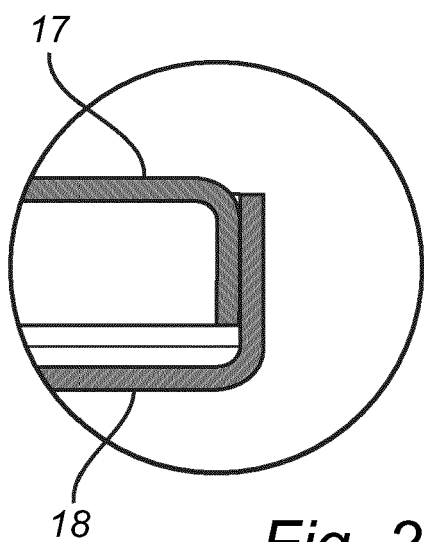


Fig. 2a

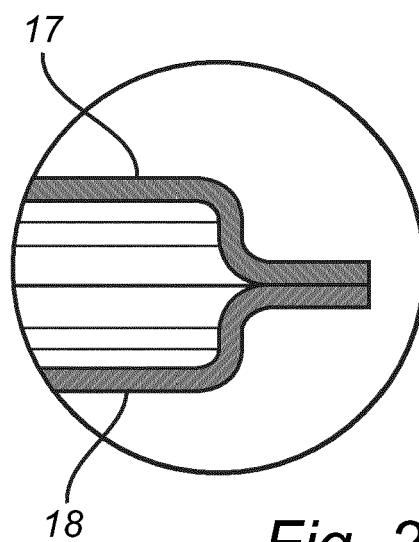


Fig. 2b

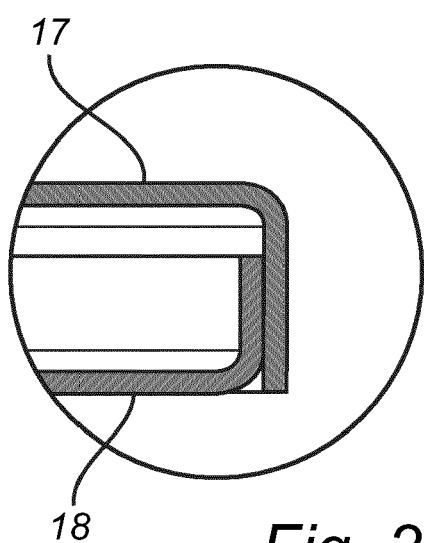


Fig. 2c

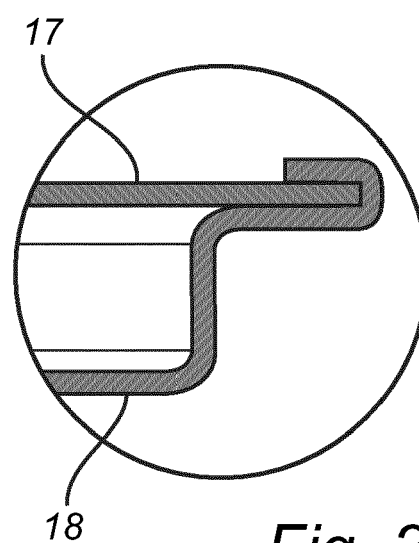
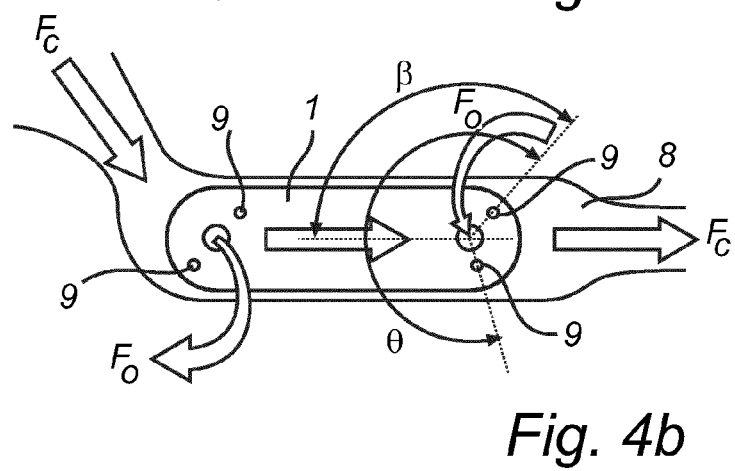
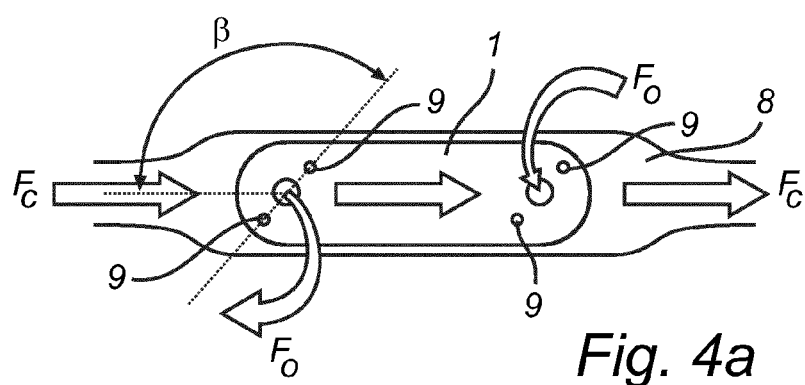
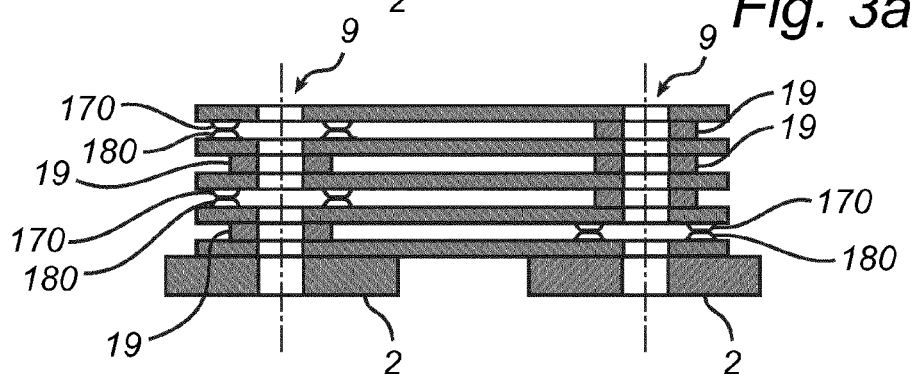
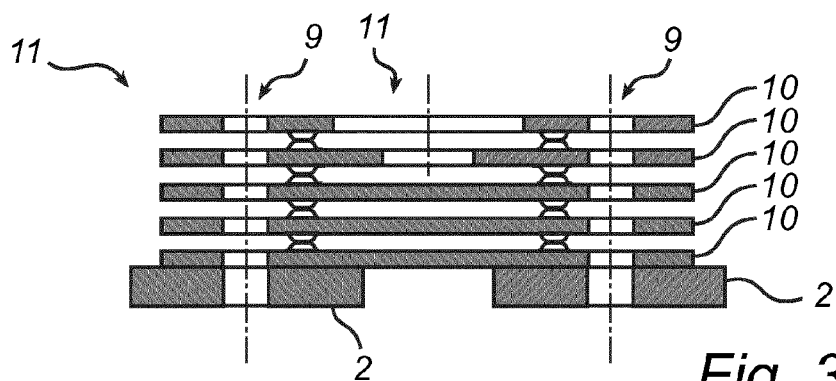


Fig. 2d



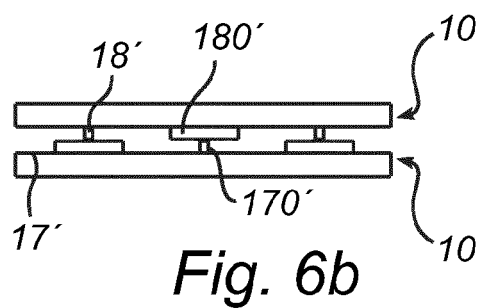
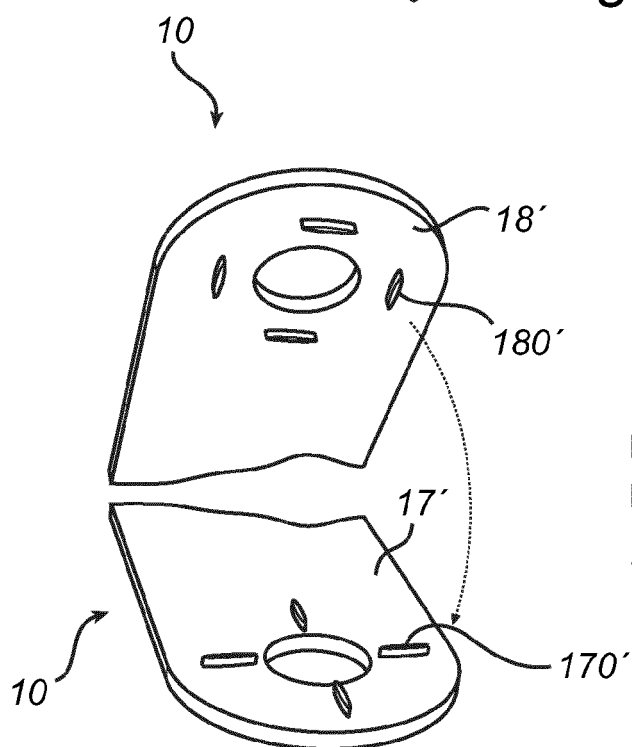
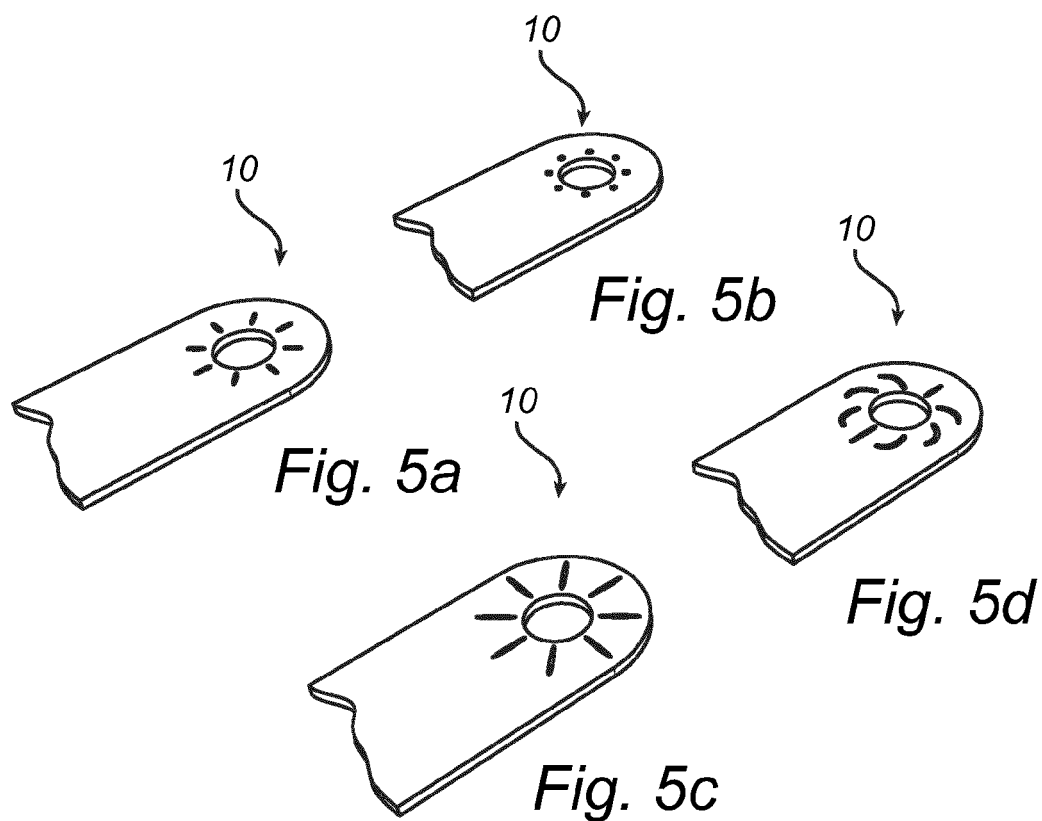


Fig. 6a

Fig. 6b

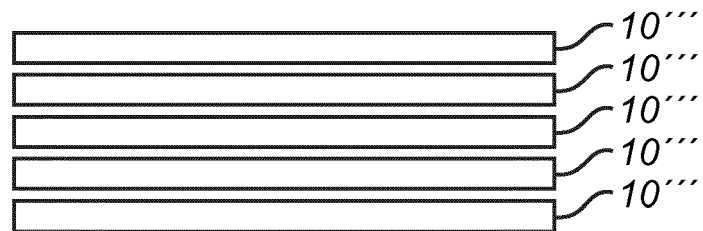


Fig. 7

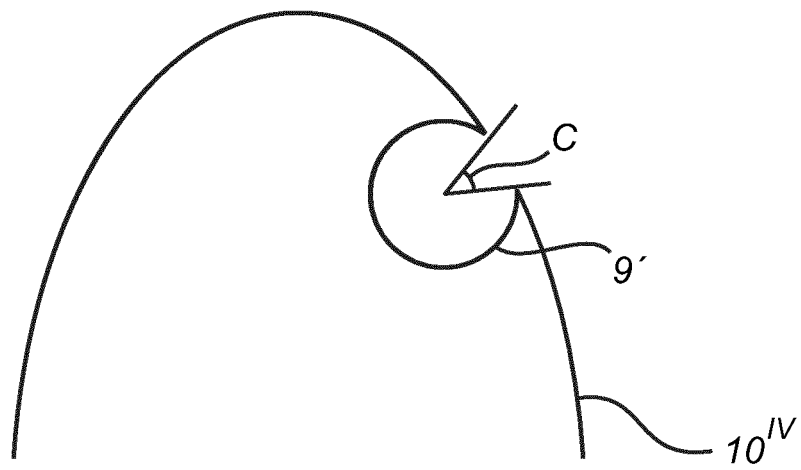


Fig. 8

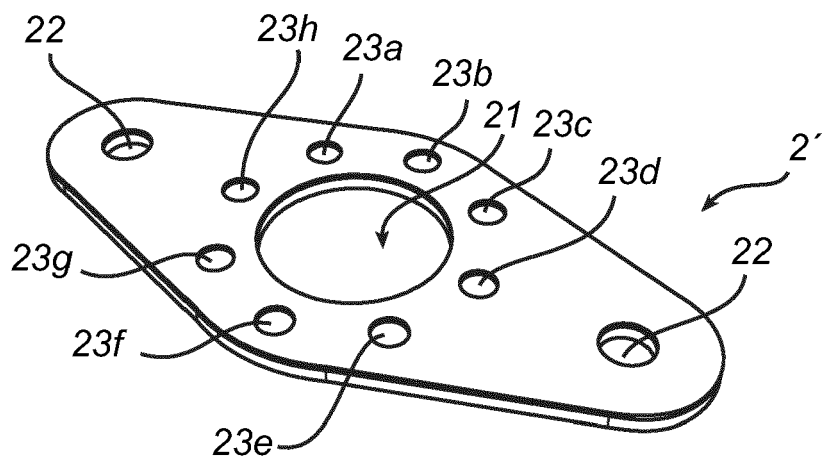


Fig. 9a

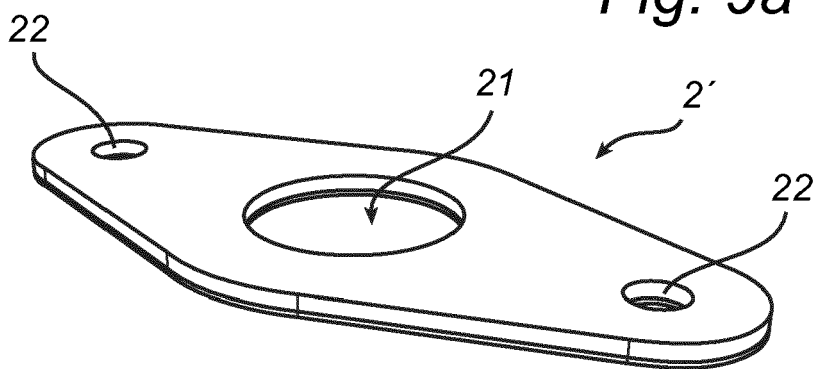


Fig. 9b

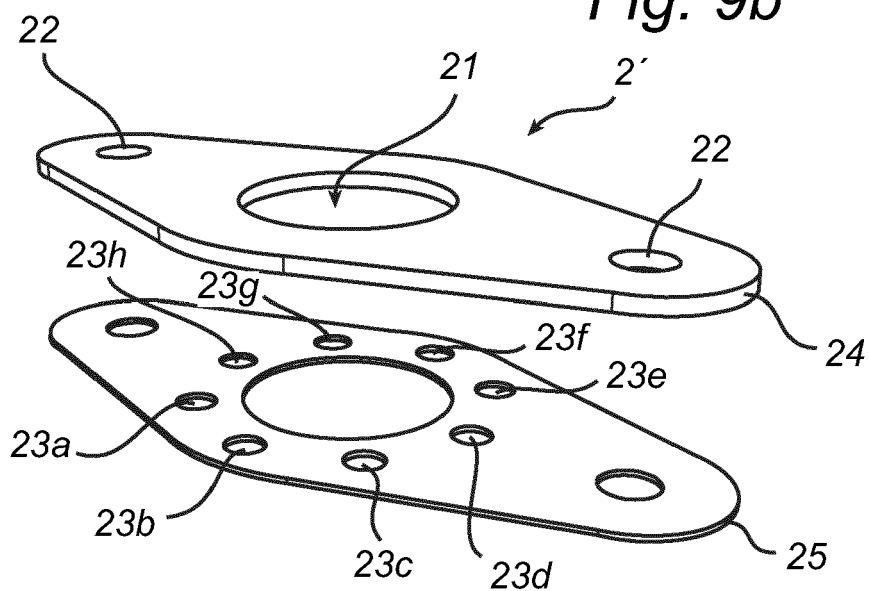


Fig. 9c

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 9013394 A1 [0005]
- WO 2004027334 A1 [0005]
- JP 2005337528 A [0008]