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(54) Heat exchanger

(57) Heat exchanger comprising an elongated housing, a group of parallel pipes placed in the housing for passing a cooling medium therethrough, on which pipes a series of cooling plates have been arranged for cooling a medium to be cooled in the housing, wherein the housing has a round cross-section, wherein the cooling plates in their plane have a geometry composed of several plate portions, particularly plate portions having a separately distinguishable geometry. Preferably the cooling plates have a geometry composed of several rectangular plate portions originating from the same web of material and placed adjacent to each other.

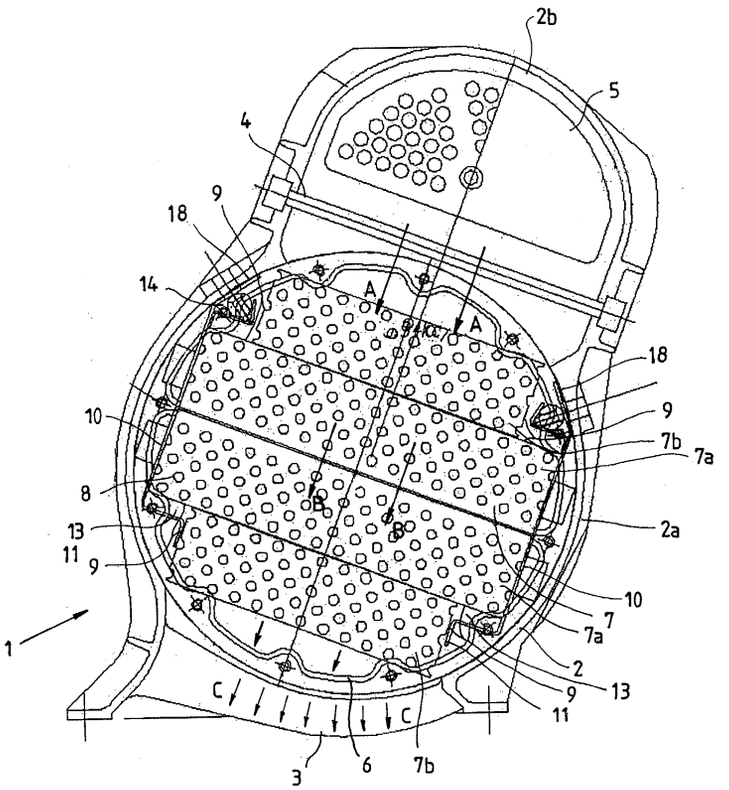


FIG. 1

EP 1 434 022 A2

Description

[0001] The invention relates to a heat exchanger, in particular a heat exchanger for cooling air, in particular combustion air for an engine. The invention further relates to a heat exchanger for combustion engines in installations, such as power stations, or larger vessels or vehicles, such as for instance seaworthy ferryboats. The heat exchanger according to the invention can be designed as charge air cooler.

[0002] For reasons of efficiency in building-in and occupation of space it may be desirable that the housings for the heat exchangers are designed having a (circular) round cross-section. On the pipes for the cooling medium purely rectangular cooling plates or rectangular cooling plates having rounded off corners that have a radius corresponding with the radius of the inner side of the housing have been arranged. The latter cooling plates are in a relatively extensive contact with the housing, as a result of which vibrations may result in increased wear. The rectangular cooling plates result in a limited pipe occupation of the cross-section of the housing.

[0003] It is an object of the invention to provide a heat exchanger, particularly as air cooler, which achieves an increased efficiency within the same inner dimensions of a round housing, in particular of a housing having a circular cross-section.

[0004] It is a further object of the invention to provide a heat exchanger, in particular as air cooler, which is easy to assemble.

[0005] From one aspect a heat exchanger is provided comprising a housing, a group of parallel pipes placed in the housing for passing a cooling medium therethrough, on which pipes a series of cooling plates has been arranged for cooling a medium to be cooled in the housing, wherein the housing has a cross-section comprising round or curved portions and the cooling plates have a circumferential edge that has one or more steps or which is stepped for locally recessing the circumferential edge of the cooling plates.

[0006] In addition to that or from another aspect a heat exchanger is provided comprising a housing, a group of parallel pipes placed in the housing for passing a cooling medium therethrough, on which pipes a series of cooling plates has been arranged for cooling a medium to be cooled in the housing, wherein the housing has a cross-section comprising round or curved portions and the cooling plates have a circumferential edge that is provided with angles which at the radial inward side of the circumferential edge include an obtuse angle of over 180 degrees.

[0007] In addition or from another aspect the invention provides a heat exchanger comprising an elongated housing, a group of parallel pipes placed in the housing for passing a cooling medium therethrough, on which pipes a series of cooling plates has been arranged for cooling a medium to be cooled in the housing, wherein the housing in cross-section has an inner surface having round or curved portions, wherein the cooling plates in their plane have a geometry composed of several plate portions, particularly plate portions having a separately distinguishable geometry and having a different length, considered in the same direction in cross-section.

[0008] Thus a larger portion of the round cross-section of the housing can be used for pipes, whereas the influence of vibrations can remain limited.

[0009] Preferably said plate portions are polygonal, particularly quadrangular, such as rectangular or trapezium-shaped, so that in a simple manner an optimal surface occupation can be formed or composed.

[0010] Preferably the plate portions are at least partly of a different size, for optimal adjustment to the cross-sectional form of the housing.

[0011] Preferably the cooling plates have a geometry composed of at least three quadrangular, particularly rectangular, plate portions of a different size. The cooling plates can then comprise a relatively large rectangular plate portion that is situated centrally and smaller rectangular plate portions connecting to its long sides, in which way in a simple manner a useful surface enlarged in two diametrical directions can be obtained.

[0012] The cooling plate portions can be formed integrally with each other. Alternatively the cooling plates can be composed by joining said, in particular rectangular plate portions. Making the heat exchanger, particularly the joining of the pipes and cooling plates is particularly facilitated, however, when the plate portions are loosely joined, i.e. placed adjacent to each other without immediate mutual connection. The plate portions then can be kept at their places by the pipes extending through them.

[0013] Preferably the smaller plate portions are equal in dimensions.

[0014] In a particularly advantageous embodiment the central plate portion itself is formed by two rectangular plate portions, placed adjacent to each other, and which in dimension is (are) equal to the smaller plate portion(s). All plate portions can be taken from the same web of material, which not only offers advantages as to production, but also makes an easy adjustment to the cross-section to be occupied possible.

[0015] Preferably the housing cross-section is circular.

[0016] The vertices of the cooling plates preferably are situated at least near the inner circumference of the housing.

[0017] According to a further aspect of the invention, the efficiency of the heat exchanger is increased when the cooling plates abut over at least two opposite portions of their circumference against side plates extending in longitudinal direction of the housing. When the aforementioned central plate portion is present it is preferred that the central plate portion abuts the side plates with its short sides. The side plates ensure passing through and thus concentration of the medium to be

cooled to the area of the pipes.

[0018] In particular when the heat exchanger is adapted for cooling a gas, in particular air, it is advantageous when the side plates are positioned for bounding the space between the cooling plates substantially in a direction transverse to the flow direction. Preferably the gas flow direction is downwards.

[0019] The assembly of the heat exchanger is further simplified when the side plates each are provided with an accommodation space for a mounting rod, which rod extends in longitudinal direction of the housing and has been provided with first holes for attachment means, the side plates being provided with second holes in the side plates coinciding with the first holes, which second holes coincide with third holes in the housing, the attachment means extending through the first, second and third holes for attachment of the said mounting rod and thus the side plate to the housing.

[0020] The mounting of the package of cooling plates in the housing is further facilitated by a number of partitions spaced apart in longitudinal direction, having a contour comparable to the one of the cooling plates, that may or may not be assembled, and being provided with holes for passage of the pipes, the partitions being provided with means for attachment to the side plates.

[0021] From a further aspect the invention provides a heat exchanger having an elongated housing, a group of parallel pipes placed in the housing for passing a cooling medium therethrough, on which pipes a series of cooling plates have been arranged for cooling a medium to be cooled in the housing, the housing having a round cross-section and the cooling plates abutting over at least two opposite portions of their circumference against side plates extending in longitudinal direction of the housing.

[0022] Preferably the cooling plates have a geometry with opposite straight sides, the side plates abutting those sides. As already stated when the heat exchanger has been adapted for cooling a gas, in particular air, the side plates can be advantageously positioned for bounding the space between the cooling plates in substantially sideward horizontal direction.

[0023] Now as well the side plates can each be provided with an accommodation space for a mounting rod, which rod extends in longitudinal direction of the housing and has been provided with first holes for an attachment means, the side plates being provided with second holes in the side plates coinciding with the first holes, which second holes coincide with third holes in the housing, the attachment means extending through the first, second and third holes for attachment of the said mounting rod and thus the side plate to the housing. Preferably the heat exchanger comprises a number of partitions spaced apart in longitudinal direction, having a contour comparable to the one of the cooling plates and being provided with holes for passage of the pipes, the partitions being provided with means for attachment to the side plates.

[0024] The invention further provides a heat exchanger according to the invention, adapted as (charge) air cooler for a combustion engine.

[0025] The invention furthermore provides an installation, such as a power station, provided with one or more engines having a heat exchanger according to the invention.

[0026] The invention further provides a vessel provided with a combustion engine, in particular a diesel engine, a heat exchanger according to the invention being placed between an air inlet and the combustion spaces.

[0027] The invention further provides a vehicle provided with a combustion engine, in particular a diesel engine, a heat exchanger according to the invention being placed between an air inlet and the combustion spaces.

[0028] The invention will be elucidated on the basis of an exemplary embodiment shown in the attached drawings, in which:

Figure 1 shows a cross-section of a heat exchanger according to the invention;

Figure 1A shows a detail IA in figure 1;

Figure 2 is an exploded side view of the heat exchanger of figure 1, with parts that have been left out;

Figure 3 shows a schematic isometric view of a part of the heat exchanger according to figure 1; and

Figures 4A-E show further examples of cross-sections of heat exchangers according to the invention.

[0029] The heat exchanger 1 in this example is a charge air cooler for use with for instance a diesel engine of a ferry boat, by which means air is cooled prior to it entering the combustion spaces.

[0030] The heat exchanger 1 comprises a cylindrical housing 2 having a straight circle-cylindrical housing portion 2a having a circular inner surface 6 and a housing portion 2b situated on the housing portion 2a. The housing portion 2b forms an inlet/distribution space for air to be cooled, with a distribution partition 5 provided with holes situated at the entrance. At the location of the passage 5 extending in longitudinal direction the housing portion 2b changes into housing portion 2a. At the lower side, housing portion 2a has an outlet 3 for the cooled air. By means of flanges 40, the housing 2 is attached to a cylinder block of an engine that is not shown, in order to discharge the cooled air to the engine.

[0031] In the straight circle-cylindrical inner space of the housing 2a a series of -as considered in a plane of cross-section of the housing- assembled cooling plates or segments 7 have been placed, as can also be seen in figures 2 and 3 (please note that in figure 2 the portions 7b have been left out). Said (for instance copper)

cooling plates 7 are rather thin (for instance 0.15 mm) and have been provided with holes 8, through which pipes 50 (figure 3) extend by which means a cooling medium can be passed through the heat exchanger 1. The assembled cooling plates 7 between them define a passage space for air, which descends from the direction A, and continues in between the cooling plates 7 in the direction B, to escape downwards in the direction C.

[0032] In the geometry of the cooling plates 7, three plate portions having a separately distinguishable geometry can be seen, namely two small rectangles 7b and a large rectangle. In this case the cooling plates 7 have been built up from four separate plate portions, namely two long rectangular plates 7a and two shorter plate portions 7b placed on either side of them. The arrangement is symmetrical, and as can be seen four -recessed- steps 9 have been formed in the circumferential edge of the cooling plates 7. It can be seen that in the cooling plates 7 the angles situated on the transition between the plate portions 7a and 7b are larger than 180 degrees, here 270 degrees. The plate portions 7b because of their shorter length are able to extend rather far in width direction. As a result a large surface area for the cooling plates 7 can be realised. As a result the cooling path B can be longer.

[0033] The width of the plate portions 7a and 7b is equal, as a result of which they can be cut from the same web of plate material that has been provided with holes 8.

[0034] As can also be seen in figure 3 the cooling plates are placed in the direction perpendicular to the passage direction B against side partitions or side plates 10 extending in longitudinal direction of the housing portion 2a, which partitions or plates 10 for instance have been manufactured of weldable material such as steel and which at the lower side form a step 11, which with respect to the longitudinal edges of the plate portions 7a leaves an axial space 13 free. At the upper end the side plates or side partitions 10 have been continued beyond the upper edge of the plate portions 7b, as more clearly shown in figure 1 A. The side partitions 10 here are turned to the inside at an angle of approximately 45° into edge strips 15, in which at its inner side Z- or L-shaped steel brackets 17 have been attached (for instance by welding), which can extend continuously in axial direction of the housing portion 2a and form an accommodation space 16 for continuous mounting rods 18. Below the brackets 17 axial spaces 12 have been left free. At regular distances along their length the mounting rods 18 are provided with holes 19 that are broadened at their entrance.

[0035] The holes 19 come to lie in line with larger holes 20 that have been provided in the edge strip 15 of the side plates 10, as can also be seen in figure 1A. In there it can also be seen that the housing 2a at that location has also been provided with holes 21, which come to lie in line with the holes 19 and 20. In said holes schematically shown bolts 22 can be inserted.

[0036] In the figures 2 and 3 it is shown how the assembly of pipes 50 and cooling pipes 7 has been attached to the side plates 10. Here use is made of mounting or support plates 30, which just like the cooling plates 7 have been provided with holes 31 for clamping passage of the pipes 50, and have a comparable circumferential shape having a (notional) central plate portion 30a forming a large rectangle and two smaller plate portions 30b, in this case formed as a unity with it. The support plates 30 in fact form relatively thick ribs of for instance copper, which have been placed at intermediate distances of 30 cm from each other.

[0037] At the edges the support plates 30 have been provided with protruding lips 32, which have been provided with cut-ins 33 extending from their upper and lower side.

[0038] The side plates 10 have been provided with vertical slits 24 in which the lips 30 can be inserted. The attachment of the support plate 30 to the side plate 10 then takes place by bending to different sides of the lip portions 34, as schematically shown in figure 2. After bending the lips 34, the slits 24 are further sealed by means of a suitable putty.

[0039] During mounting the pipes 50 and a series of pairs of cooling plate portions 7a and 7b secured to them and intermediate plates 30 form a unit that can be slid in into the housing portion 2a as one whole. The plate portions 7a, 7a, 7b and 7b are kept in their correct positions by the intermediate plates 30. The mounting rods 18 are accommodated in the accommodation spaces 16 for them. After sliding in the said unit into the housing portion 2b, a fitting pin at a selected position ensures correct alignment of the holes 19-21 with respect to each other, and bolts 22 are placed from the outside in the holes 19-21. In this way the mounting rod 18 and thus the side plate 10 in question is clamped against the inside of the housing portion 2a, in which way the assembly of pipes 50, cooling plates 7, partitions 30 and side plates 10 is fixedly attached in the housing 2.

[0040] Alternatively the housing 2a may have a substantially rectangular cross-section, having broadly rounded off corner areas, in which cooling plates built up from three rectangles, as discussed above, can be placed.

[0041] Figures 4A-E schematically show some alternative cross-sections of housings and cooling plates of heat exchangers according to the invention, in which in figure 4A a housing portion 22a is shown having an inner surface 26 having a substantially rectangular cross-section having curved corner areas, in which cooling plates are placed that are composed of a central, rectangular plate portion 27a and two plate portions 27b which are substantially rectangular but which are provided with two correspondingly curved corner areas -having a radius that is much smaller than the radius of the inner surface 26 of the housing at that location-.

[0042] In figure 4B the inner surface 36 of the housing portion 32a is circular and the cooling plate is built up

from a central, rectangular plate portion 37a and two plate portions 37b which are substantially rectangular but which are provided with two curved corner areas -having a radius that is much smaller than the radius of the inner surface 36 of the housing at that location-.

[0043] Figure 4C shows an oval inner surface 46 of the housing portion 42a, within which cooling plates having rectangular plate portions 47a, 47b and 47a have been placed.

[0044] In figures 4D and 4E the housing portions 52a and 62a correspond with housing portions 22a and 32a, in which the cooling plate portions 57b and 67b are now trapezium-shaped.

Claims

1. Heat exchanger comprising a housing, a group of parallel pipes placed in the housing for passing a cooling medium therethrough, on which pipes a series of cooling plates has been arranged for cooling a medium to be cooled in the housing, wherein the housing has a cross-section comprising round or curved portions and the cooling plates have a circumferential edge that has one or more steps or which is stepped for locally recessing the circumferential edge of the cooling plates.

2. Heat exchanger, particularly according to claim 1, comprising an elongated housing, a group of parallel pipes placed in the housing for passing a cooling medium therethrough, on which pipes a series of cooling plates has been arranged for cooling a medium to be cooled in the housing, wherein the housing in cross-section has an inner surface having round or curved portions, wherein the cooling plates in their plane have a geometry composed of several plate portions, particularly plate portions having a separately distinguishable geometry.

3. Heat exchanger, particularly according to claim 1 or 2, comprising a housing, a group of parallel pipes placed in the housing for passing a cooling medium therethrough, on which pipes a series of cooling plates has been arranged for cooling a medium to be cooled in the housing, wherein the housing has a cross-section comprising round or curved portions and the cooling plates have a circumferential edge that is provided with angles which at the radial inward side of the circumferential edge include an obtuse angle of over 180 degrees.

4. Heat exchanger according to claim 1, 2 or 3, wherein the plate portions having a distinguishable geometry are substantially polygonal, particularly quadrangular, such as rectangular or trapezium-shaped.

5. Heat exchanger according to any one of the preceding claims, wherein the said plate portions are at least partially of different sizes.

6. Heat exchanger according to any one of the preceding claims, wherein the plate portions originate from the same web of material and are placed adjacently.

7. Heat exchanger according to any one of the preceding claims, wherein the cooling plates have a geometry composed of at least three quadrangular, preferably rectangular, plate portions of which at least two are of a different size.

8. Heat exchanger according to claim 7, wherein the cooling plates comprise a centrally situated, relatively large rectangular plate portion and smaller, preferably equal, quadrangular plate portions connecting to its long sides.

9. Heat exchanger according to claim 8, wherein the central plate portion itself is formed by two rectangular plate portions placed adjacent to each other, and which in dimension is (are) equal to the smaller plate portion(s).

10. Heat exchanger according to any one of the preceding claims, wherein the cooling plates per se are composed by joining said plate portions, particularly loosely joining them, wherein the plate portions are preferably held by the pipes extending through them.

11. Heat exchanger according to any one of the preceding claims, wherein the housing has a circulating round or curved inner surface, which preferably is circularly circumferential.

12. Heat exchanger according to any one of the preceding claims, wherein the vertices of the cooling plates are situated at least near the inner surface of the housing.

13. Heat exchanger according to any one of the preceding claims, wherein the cooling plates abut over at least two opposite portions of their circumference against side plates extending in longitudinal direction of the housing.

14. Heat exchanger according to claim 8 and 13, wherein the central plate portion abuts the side plates with the short sides.

15. Heat exchanger according to claim 13 or 14, adapted for cooling a gas, particularly air, wherein the side plates are positioned for bounding the space between the cooling plates substantially in a direction transverse to the gas flow direction, wherein the gas flow direction preferably is downwards.

16. Heat exchanger according to claim 14 or 15, wherein the side plates are each provided with an accommodation space for a mounting rod, which extends in longitudinal direction of the housing and has been provided with first holes for an attachment means, wherein the side plates are provided with second holes in the side plates coinciding with the first holes, which second holes coincide with third holes in the housing, wherein the attachment means extend through the first, second and third holes for attachment of the mounting rod in question and thus the side plate to the housing.

17. Heat exchanger according to claim 16, comprising a number of partitions spaced apart in longitudinal direction, having a contour comparable to the one of the cooling plates -that may or may not be assembled- and provided with holes for passage of the pipes, wherein the partitions are provided with means for attachment to the side plates.

18. Heat exchanger according to any one of the preceding claims, adapted as air cooler for a combustion engine.

19. Vehicle provided with a combustion engine, particularly a diesel engine, wherein a heat exchanger according to claim 18 has been placed between an air inlet and the combustion spaces.

20. Vessel provided with a combustion engine, particularly a diesel engine, wherein a heat exchanger according to claim 18 has been placed between an air inlet and the combustion spaces.

21. Vehicle according to claim 20, wherein an air compressor has been placed between the air inlet and the heat exchanger.

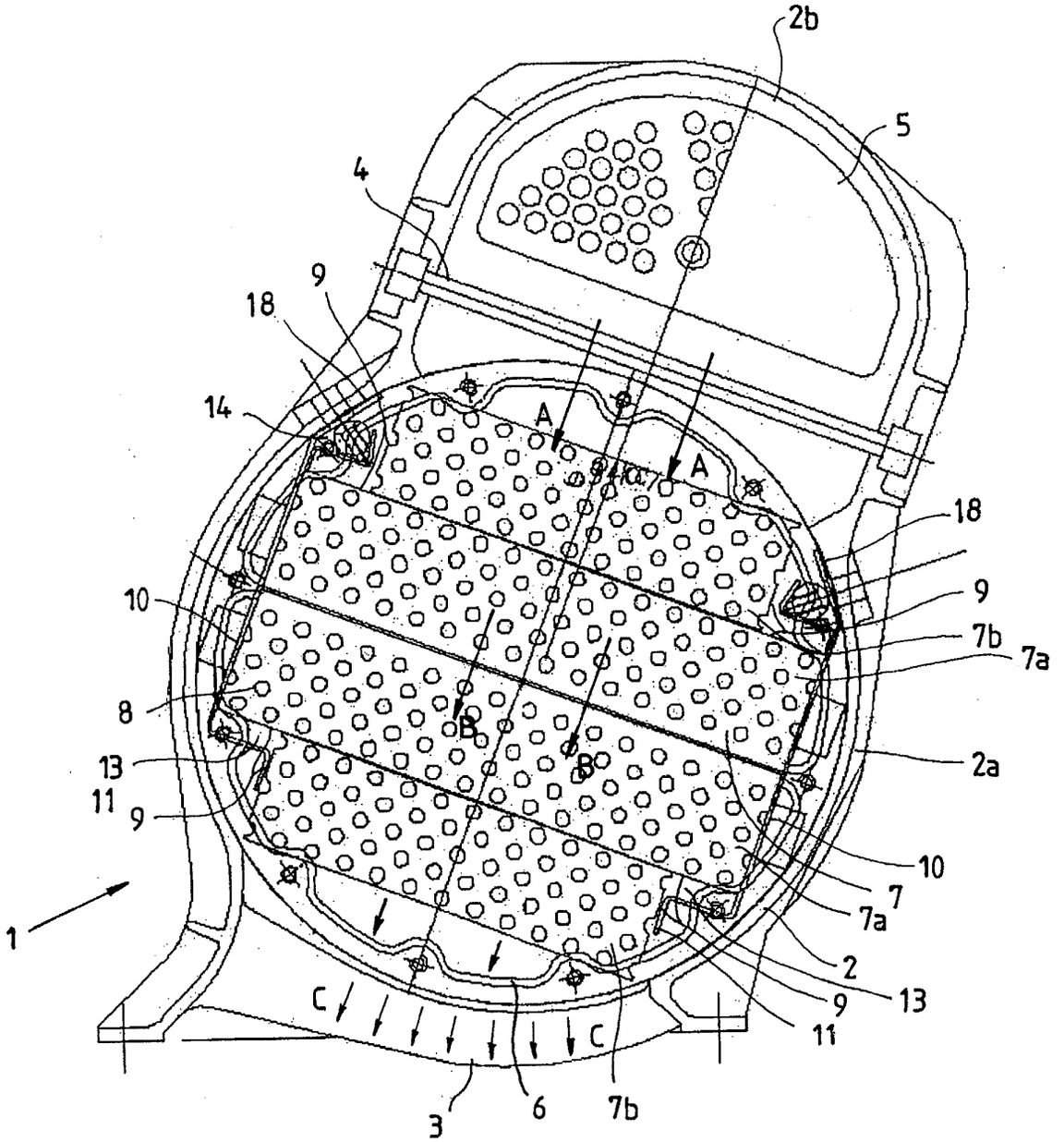
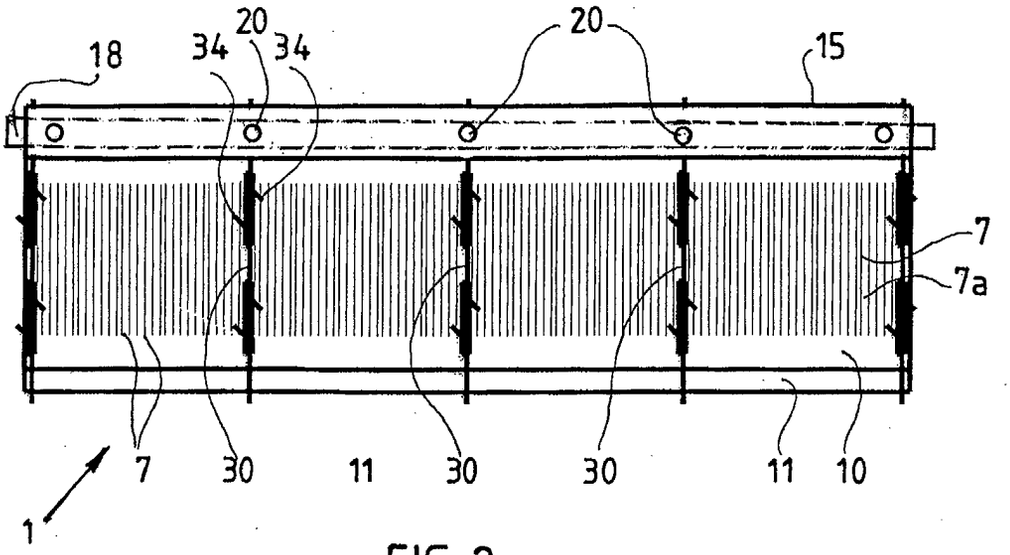


FIG. 1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34
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15
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7a
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11
30
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10
1

FIG. 2

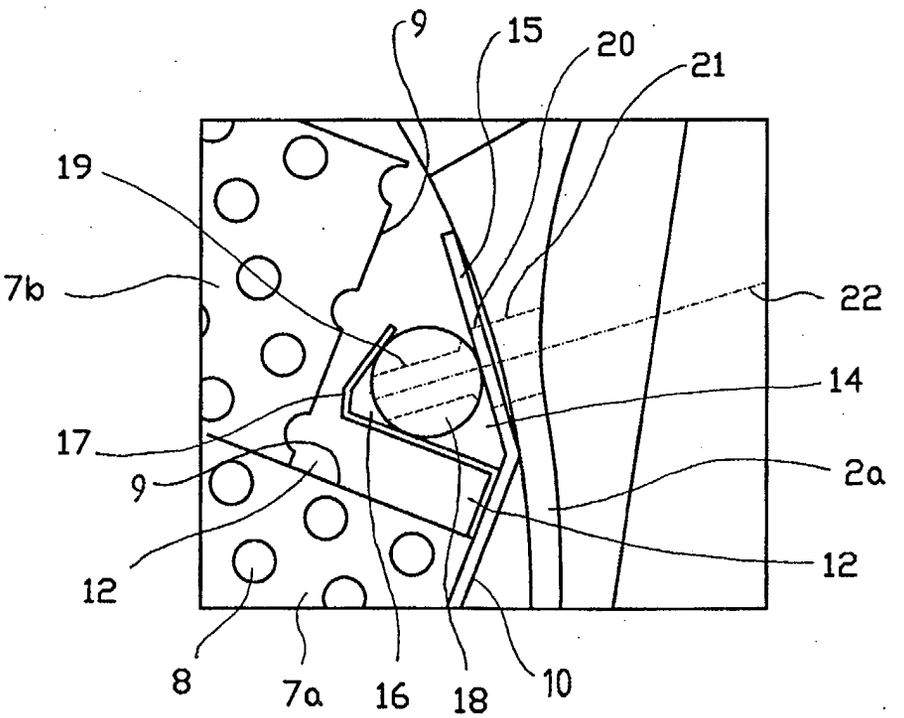
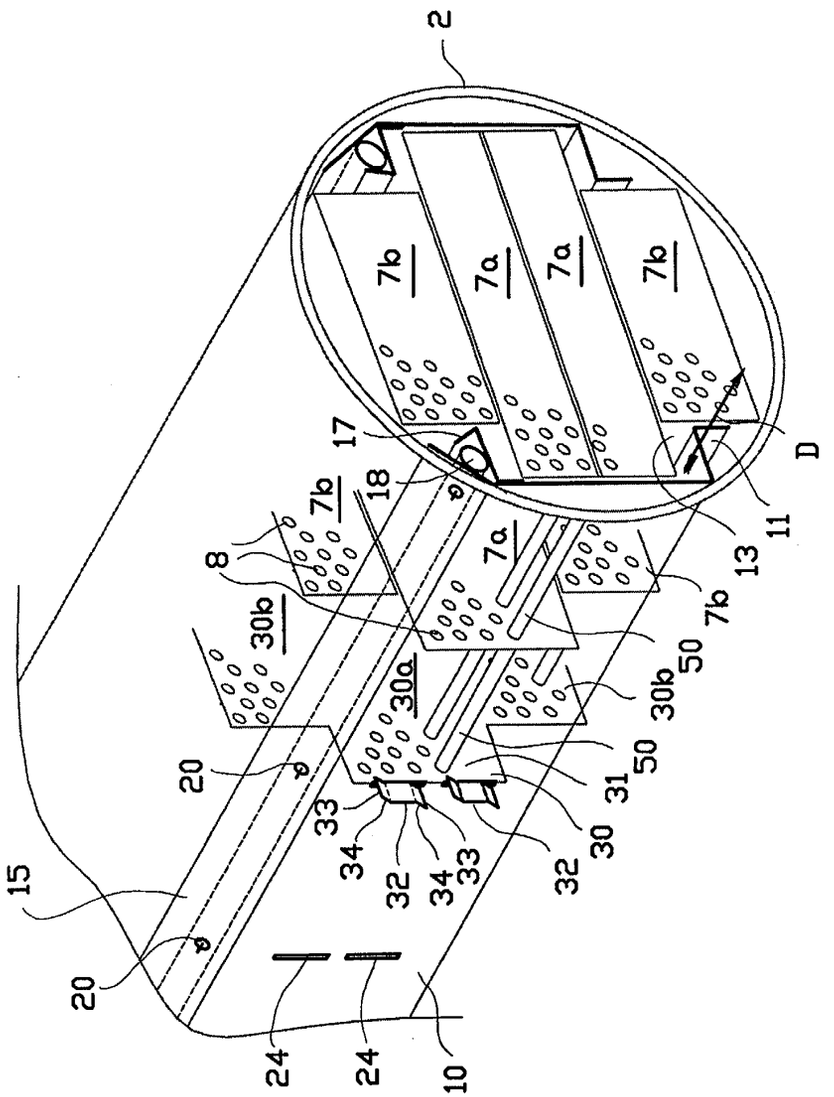

9
15
20
21
19
7b
22
14
17
9
2a
12
12
8
7a
16
18
10

FIG. 1A


2
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7a
7a
7b
17
18
7b
8
7a
7b
13
11
D
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50
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32
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24
10

FIG. 3

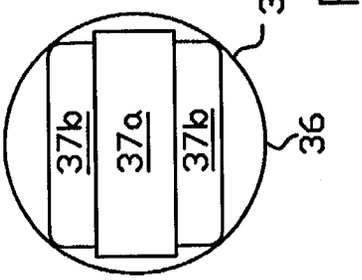

FIG. 4B

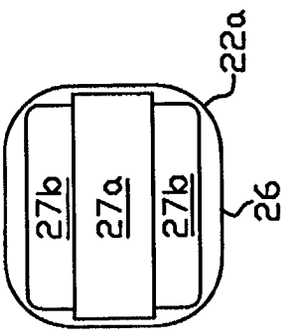

FIG. 4A

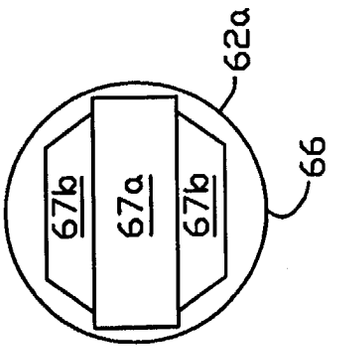

FIG. 4E

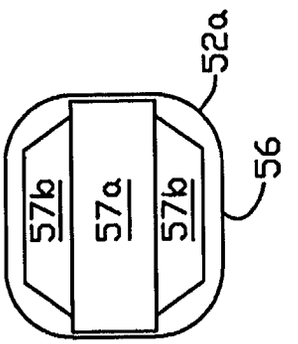

FIG. 4D

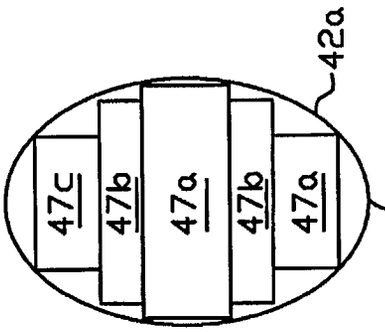

FIG. 4C