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(54) **Heat exchanger device and manufacturing method thereof**

(57) An heat exchanger device, constituted by at least a duct (10) for the passage of a fluid and a finned pack (11) fixed to said duct (10) for the heat exchange, includes a plurality of finned element (2), each of which has a set of tubular protrusions (4), each of which has

at least a seat (5) and a connection (6).

In an assembled condition (A) of said device (1), the connection (6) of each tubular protrusion (4) of a finned element (2) is inserted in a corresponding seat (5) of an adjacent finned element (2), to form at least the duct (10) and the finned pack (11).

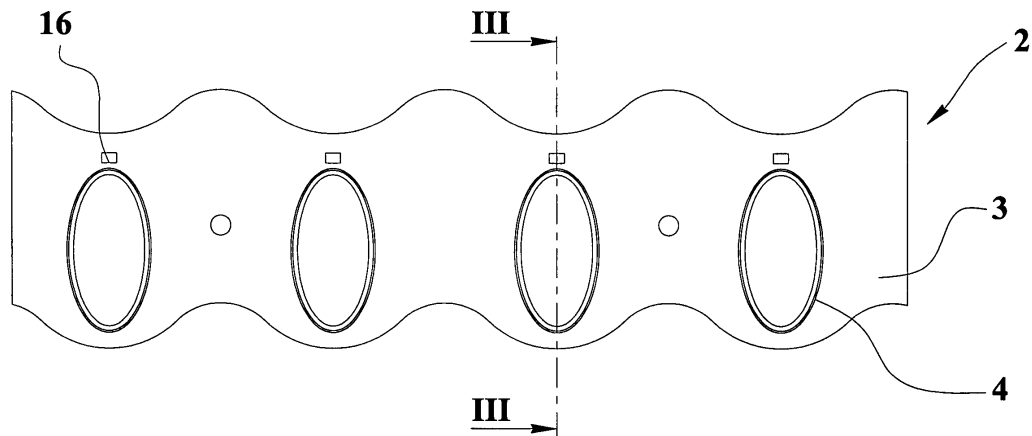


FIG.2

Description

[0001] The present invention relates to radiators and heat exchangers, and particularly it refers to a heat exchanger device and manufacturing method thereof, for transferring heat from air or gas to a fluid, for instance in wall thermal boilers for domestic use.

[0002] The known heat exchangers are constituted by a plurality of finned pipes inside which a fluid flows, that must be heated or cooled by the air or gas flow, forced to pass through the interspaces among the fins. These last ones have exchanging surfaces of suitable dimensions in order to absorb by convection the heat from the air or gas and to transfer it, by conduction, to pipes and fluid or vice versa.

[0003] The fins are generally constituted by plates having different shapes, flat or wrinkled, each of which provided with one or more holes inside which the corresponding fluid passage pipes are inserted and then blocked. The plates are assembled opportunely spaced in order to form the so-called "radiant packs" or "finned packs", crossed thus by one or more parallel pipes.

[0004] The main drawback of such known heat exchangers consists in that they, being constituted by a plurality of parts, such as pipes and fins, which must be separately manufactured and then assembled, have high production costs, due to the difficult and complicated manufacturing processes and due to the several production apparatuses manufacturing to execute said processes.

[0005] Other drawback consists in the high thermic inertia and in the low heat exchange coefficient of said exchangers because of the pipe thickness, needed to confer to these last the required resistance and stiffness for supporting the fin pack, and because of the low thermic conductivity of the joints between fin and pipe.

[0006] There are also known pipeless heat exchangers constituted by finned elements each provided with a conic protrusion; the finned packs are manufactured by inserting the protrusion of an element in that of the following element. The progressive connection of more protrusions allows realizing ducts for the passage of the liquid to be heated or cooled and the finned pack indispensable for the heat exchange.

[0007] The main drawback of said exchangers consists in that the restrained connection between the following conic protrusions of the different elements does not allow obtaining finned packages having a constant and precise joining pitch.

[0008] Other drawback consists in that the connection wet seal, being determined by the interference at the assemblage of each protrusion inside the following one, can be subject to risks liquid leakage, which may happen because of the seal loosening at the connection areas, due to the heat and mechanical stresses, to which the heat exchanger is subject.

[0009] The main object of the present invention is to propose a heat exchanger device and a manufacturing

method thereof, including finned elements regularly positioned at mutual constant and very precise distance.

[0010] Other object of the present invention is to propose a device made of material having a thin wall thickness and almost constant in all the points, in order to achieve a material saving, a weight and dimension reduction with an equal exchanged thermal energy, a diminution of heat inertia and an increase of the heat exchange coefficient.

[0011] Further object of the present invention is to propose a heat exchanger device and a manufacturing method thereof, which guarantee a perfect hydraulic and/or pneumatic seal even after high thermic and mechanical stresses.

[0012] Other object is to propose a manufacturing method of the device that allows simplifying and at the same time integrating the production and assemblage processes of the device, requiring a smaller number of manufacturing apparatuses with consequent cost reduction.

[0013] The above-mentioned objects are achieved according to the claim content.

[0014] The characteristics of the present invention are underlined in the following with particular reference to the attached drawings, in which:

- figure 1 show a front schematic and partial view of the heat exchanger device of the present invention;
- figure 2 shows a top view of the figure 1 device;
- figure 3 shows a partial section view according to line III-III of figure 2;
- figure 4 shows a partial view of the figure 1 device in a condition prior to the device assemblage;
- figure 5 shows a top view of the figure 4 device;
- figure 6 shows a front view of the figure 1 device at different subsequent assemblage phases;
- figure 7 shows a cross section view of a variant of figure 1 device in association with connection pipes;
- figure 8 shows a section view according to line VI-II-VIII of figure 7;
- figure 9 shows a section view according to line IX-IX of figure 8;
- figure 10 shows an enlarged and partial top view of a finned element of a variant of the figure 1 device;
- figure 11 shows a top view of a variant of the figure 1 device in a shearing condition prior to the device assemblage;
- figure 12 shows a top view of a finned element of figure 11 device.

[0015] With reference to figures 1 to 6, numeral 1 indicates a heat exchanger device substantially constituted by a plurality of finned elements 2, each of which including a set of tubular protrusions 4, for instance four, each of which having a seat 5 and a connection 6.

[0016] In an assembled condition A of said device 1, the connection 6 of each tubular protrusion 4 of a finned element 2 is inserted in a corresponding seat 5 of an

adjacent finned element 2, in order to form a duct 10 for the fluid passage and a finned pack 11 for the heat exchanger.

[0017] The inner portion of the seat 5 has tubular shape and is complementary to the external portion of the connection 6, for a precise and firm coupling. The length S 1 of the seat 5 is greater than the length S2 of the connection 6, in such way that in assembled condition A a plain portion 3 of a finned element 2 mates a shoulder means 12 carried out on the connection 6 of an adjacent finned element 2 in assembled condition A. Particularly, said shoulder means 12 mate a first rounded portion 7, carried out at an inner edge of the seat 5.

[0018] The first rounded portion 7 and a second rounded portion 8 carried out on each connection 6 at his free edge, make easier the insertion of each connection 6 in the corresponding seat 5.

[0019] Each tubular protrusion 4 further has baffle means 15, in order to increase the turbulence of the fluid flow inside the duct 10 and to improve in this way the heat exchange between said fluid and the duct 10 walls.

[0020] In the preferred embodiment the baffle means 15 consist of an annular inner extension of the free edge of the connection 6.

[0021] As shown in figure 10, the refolded protrusion may consist of a diaphragm mean having a plurality of borders positioned almost orthogonal with respect to the direction of the fluid flow.

[0022] The tubular protrusions 4 of each finned element 2 have cross section with circular or oval or elliptical or polygonal shape.

[0023] In the preferred embodiment the ends of the adjacent finned elements 2 are in single body and particularly they are carried out from a continuous strip 20 having undulated or straight edges. Each finned element 2 of the continuous strip 20 has the set of tubular protrusions 4 positioned on the opposite side of the strip 20, with respect to the set of tubular protrusions 4 of the adjacent finned element 2 adjacent. In this way, in the assembled condition A of the device 1, in which the continuous strip 20 is folded on its own like a bellow, the tubular protrusions 4 are reciprocally connected, by inserting the external connections 6 in the respective inner seats 5 and the finned elements 2 are positioned reciprocally facing and parallel.

[0024] The tubular protrusions are carried out by continuous drawing process of the strip 20 through dies and counter-dies, provided with a number of punches equal to the number of tubular protrusions 4 of each finned element 2.

[0025] The finned elements 2 are made of material with high thermal conductivity, for instance copper or aluminum or steel and relative alloys, having constant thickness, ranging between 0,1 and 1 mm.

[0026] To guarantee the wet seal of ducts 10 the tubular protrusions 4 are reciprocally blocked through a welding material, which is inserted, for instance by brazing, into the connections between each attack 6 and

seat 5.

[0027] The welding material is inserted in the shape of rods 17 in passage holes 16 carried out on each finned element 2, in proximity of each tubular protrusion 4, in such way that the material can penetrate, by melting, in the connections between the tubular protrusions 4.

[0028] It is opportune to underline that the particular connection between the tubular protrusions 4 allows carrying out ducts 10 for the passage of the liquid to be heated or cooled and mutually connecting the finned element 2, in order to form packs 11 having fins regularly positioned at a mutual constant and very precise distance.

[0029] According to the number of finned element 2 and according to the pitch and number of tubular protrusions 4 of each finned element 2, it is possible to manufacture heat exchanger devices 1 having different dimensions, in order to satisfy the different user demands.

[0030] Figures 7 to 9 show a variant of the heat exchanger device in which each portion of the continuous strip 20 has a plurality of auxiliary tubular protrusions 24, fit to carry out, in the assembled condition A of the device 1, a plurality of auxiliary ducts 25 to obtain a further separate hydraulic circuit, for instance for sanitary water. The figures of the exchanger device variant also show connection ducts 18 which join the tubular protrusions 4 of the external finned elements of the finned package 11 to realize a continuous duct for the fluid and they show fittings 19, of known type, for connecting the device 1 to an other apparatus, for instance a circulation pump.

[0031] The figures 11 and 12 show a further variant of the heat exchanger device in which the adjacent finned element 2, that are in a single body, are carried out, after the drawing process of the tubular protrusions 4, by longitudinally shearing a continuous strip 20, which has a width approximately double with respects to the width of the single finned element 2 of figure 5. In this way, it is possible to produce at the same time two heat exchanger device 1 from a single strip 20 and with finned element 2 having an undulated profile, for instance lower, fit for contacting the heat source and an upper rectilinear profile fit to be licked, for instance, by burnt smokes flowing out. Such finned element 2, with equal dimensions, thus have a greater exchange area with respect to the undulated finned element of figure 2, allowing increasing the exchanger device performance, subtracting a greater quantity of heat from the burnt smokes and lowering the outlet temperature thereof.

[0032] The manufacturing method of the heat exchanger device 1 of the present invention provides:

- to carry out on alternate sides of a continuous strip 20 sets of tubular protrusions 4, each of which of a respective finned element 2;
- to obtain at each tubular protrusion 4 at least a seat 5 and a connection 6;

- to fold the continuous strip 20 at the joints between two adjacent finned element 2, by inserting the connections 6 of an element in the respective seat 5 of the other element;
- to weld each connection between the tubular protrusions 4 obtaining an assembled condition A of the device 1.

[0033] The method further provides to carry out on each tubular protrusion 4 baffle means 15 and rounded portions, first 7 and second 8, respectively at the inner corner of seat 5 and at the free edge of the connection 6.

[0034] The method provides to carry out the plurality of tubular protrusions 4, each of which provided with the seat 5, the connection 6, the baffle means 15 and the rounded portions 7, 8, by means of a single drawing on the strip 20.

[0035] The welding of the tubular protrusions 4 is obtained by the fusion of rods 17 made of welding material, which are inserted in suitable passage holes 16, carried out on each finned element 2 of the strip 20, in correspondence of each tubular protrusion 4. Particularly, the manufacturing method provides to insert the device 1, assembled and provided with rods 17 positioned inside holes 16 and above the respective tubular protrusions 4, in an oven in such way that the welding material of sticks pour by melting on the tubular protrusions 4 and by capillarity it penetrate inside the slits formed by the joint of each connection 6 with the related seat 5, sealing these last and reciprocally blocking the finned elements 2.

[0036] A variant of the manufacturing method of the heat exchanger device 1, provides:

- to carried out on the alternate sides of the continuous strips 20 set of staggered tubular protrusions 4;
- to obtain from said strip 20, by shearing, two separate strip portions 21, each one constituted by finned element 2 of a correspondent exchanger device 1;
- to fold the strip portions 21 at the joints between two adjacent finned element 2.

[0037] It is important to underline that said manufacturing method allows producing at the same time two heat exchanger device, using a die having dimensions almost equal to the dimensions of the die used for obtaining the preferred embodiment of the exchanger device. This allows to double the production without modifying the speed of the press, which operates the punch, and to carry out finned element 2 without production of off-cuts, therefore optimizing the strip use.

[0038] The main advantage of the present invention is that to provide a heat exchanger device and a manufacturing method thereof, including finned elements regularly positioned at mutual constant and very precise distance.

[0039] Other advantage of the present invention is to

provide a device made of material having a thin wall thickness and almost constant in all the points, in order to achieve a material saving, a weight and dimension reduction with an equal exchanged thermal energy, a diminution of heat inertia and an increase of the heat exchange coefficient.

[0040] Further advantage of the present invention is to provide a heat exchanger device and a manufacturing method thereof, which guarantee a perfect hydraulic and/or pneumatic seal even after high thermic and mechanical stresses.

[0041] Other advantage is that to provide a manufacturing method of the device that allows simplifying and at the same time integrating the production and assembly processes of the device, requiring a smaller number of manufacturing apparatuses with consequent cost reduction.

Claims

1. Heat exchanger device, constituted by at least a duct (10) for the passage of a fluid and a finned pack (11) fixed to said duct (10) for the heat exchange, said device (1) being **characterized in that** includes a plurality of finned element (2), each of which has a set of tubular protrusions (4), each of which has at least a seat (5) and a connection (6); in an assembled condition (A) of said device (1), the connection (6) of each tubular protrusion (4) of a finned element (2) is inserted in a corresponding seat (5) of an adjacent finned element (2), to form at least the duct (10) and the finned pack (11).
2. Device according to claim 1 **characterized in that** the ends of the adjacent finned elements (2) are in single body.
3. Device according to claim 2 **characterized in that** the finned element (2) are carried out from a continuous strip (20).
4. Device according to claim 3 **characterized in that** each finned element (2) of the continuous strip (20) has the set of tubular protrusions (4) positioned on the opposite side of the strip (2) with respect to the set of tubular protrusions (4) of the adjacent finned element (2).
5. Device according to claim 3 **characterized in that** in the assembled condition (A) of the device (1) the continuous strip (20) is folded on its own as a bellow, in such way to connect the tubular protrusions (4) of the finned element (2) and to position these last reciprocally facing and parallel.
6. Device according to claim 1 **characterized in that** the inner portion of the seat (5) has tubular form and

is complementary to the external portion of the connection (6).

7. Device according to claim 1 **characterized in that** the length (S1) of the seat (5) is greater than the length (S2) of the connection (6). 5
8. Device according to claim 1 **characterized in that** each tubular protrusion (4) has rounded portions first (7) and second (8), respectively at an inner edge of the seat (5) with the respective finned element (2) and at the free edge of the connection (6). 10
9. Device according to claim 7 **characterized in that** the connection (6) has a shoulder mean (12), fit for mating the first rounded portion (7) of a seat (5) in the assembled condition (A). 15
10. Device according to claim 1 **characterized in that** each tubular protrusion (4) has baffle means (15) to increase the turbulence of the liquid flow inside the duct (10). 20
11. Device according to claim 10 **characterized in that** the baffle means (15) of each tubular protrusion (4) include at least a diaphragm mean provided with a plurality of borders and fixed to a free edge of the connection (6). 25
12. Device according to claim 10 **characterized in that** the baffle means (15) of each tubular protrusion (4) include at least an inner extension of the free edge of the connection (6). 30
13. Device according to claim 1 **characterized in that** the tubular protrusion (4) has a cross section with a circular or oval or elliptical or polygonal shape. 35
14. Device according to claim 1 **characterized in that** the tubular protrusions (4) are reciprocally blocked by welding material. 40
15. Device according to claim 14 **characterized in that** the finned elements (2) have at least a hole (16) carried out in proximity of each tubular protrusion (4), and fit for housing a related rod (17) of the welding material. 45
16. Device according to any of the preceding claims **characterized in that** is made of material with high thermic conductivity having almost constant thickness, ranging between 0,1 and 1 mm. 50
17. Device according to any of the preceding claims **characterized in that** is made of copper or its alloys or aluminum or its alloys. 55
18. Manufacturing method of a heat exchanger **char-**

acterized in that provides:

- to carry out on alternate sides of a continuous strip (20) sets of tubular protrusions (4), each of a respective finned element (2);
 - to obtain, in correspondence of each tubular protrusion (4), at least a seat (5) and a connection (6);
 - to fold the continuous strip (20) in correspondence of the joints between two following finned elements (2), inserting each connection (6) of an element in the respective seat (5) of the other element;
 - to weld each connection between the tubular protrusions (4) obtaining an assembled condition (A) of the device (1).
19. Method according to claim 18 **characterized in that** provides to associate on each tubular protrusion (4) baffle means (15) of a fluid.
 20. Method according to claim 18 **characterized in that** provides to carry out on each tubular protrusion (4) rounded portions first (7) and second (8), respectively at an inner edge of the seat (5) and at the free edge of the connection (6).
 21. Method according to claims 18, 19 and 20 **characterized in that** provides to carry out at least a tubular protrusion (4) by a single drawing process.
 22. Method according to claim 18 **characterized in that** provides to reciprocally weld the tubular protrusions (4) by the fusion of rods (17) of welding material, inserted inside passage holes (16), carried out on the continuous strip (20), at each tubular protrusion (4).
 23. Method according to claim 22 **characterized in that** provides to perform the welding of the tubular protrusions (4) by inserting each finned pack (11) inside an oven, with the rods (17) of welding material positioned above the respective tubular protrusions (4).
 24. Method according to claim 18 **characterized in that** provides:
 - to carry out on the alternate sides of the continuous strip 20 sets of staggered tubular protrusions 4;
 - to obtain from said strip 20 by shearing at least two separate strip portions 21, each constituted by finned elements 2 of a correspondent exchanger device 1;
 - to fold the strip portions 21 in correspondence of the joints between two finned element 2.

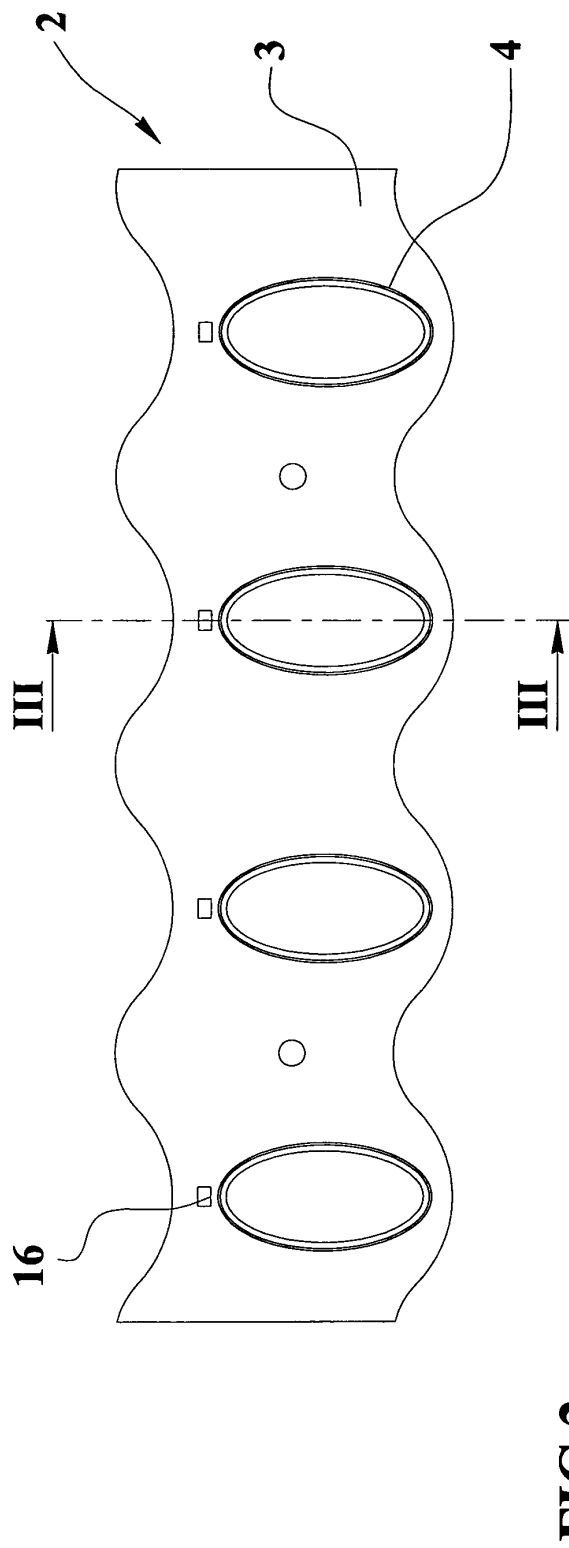
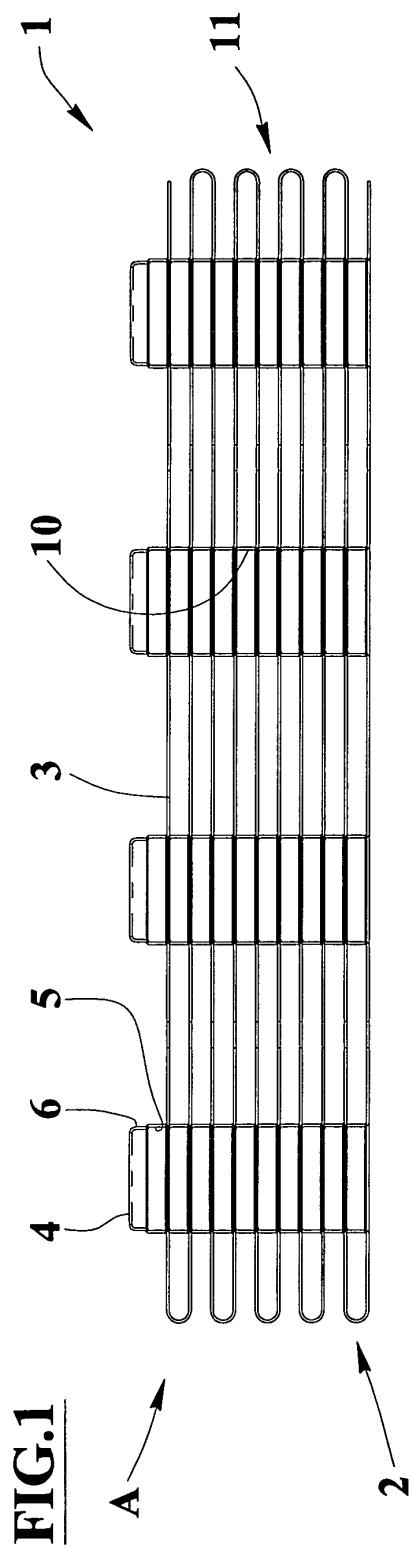


FIG.3

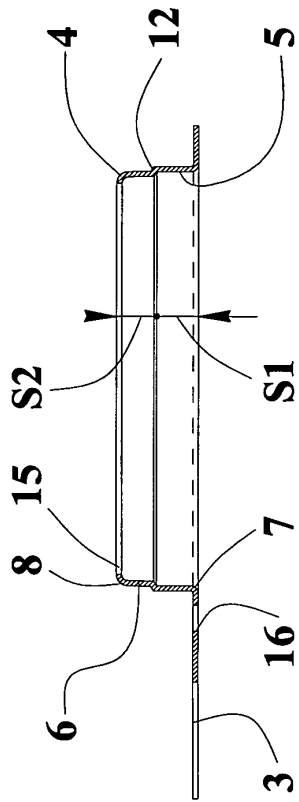


FIG.4

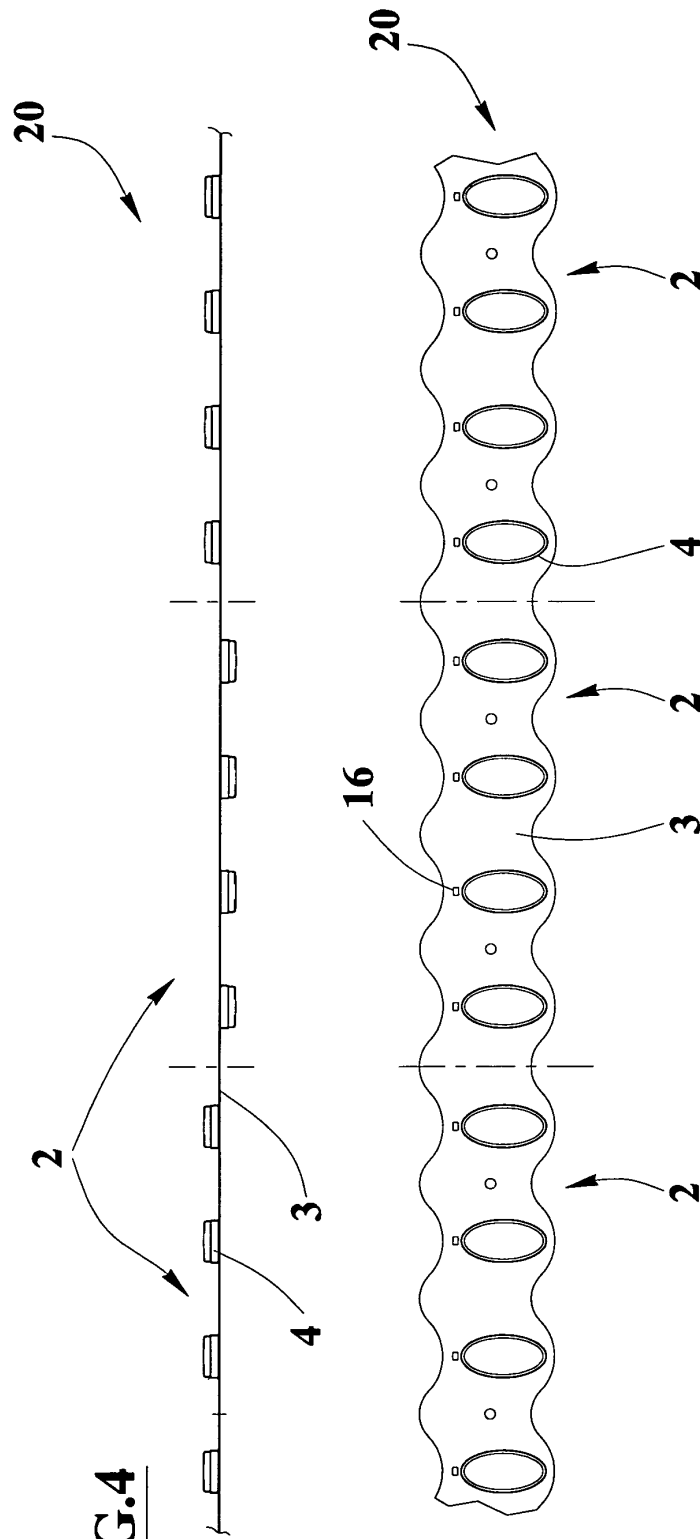
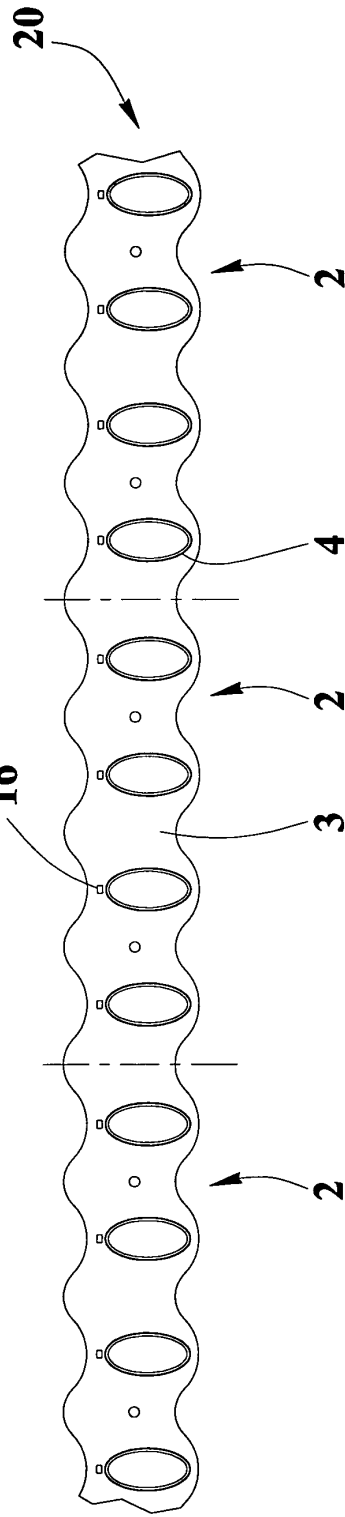


FIG. 5



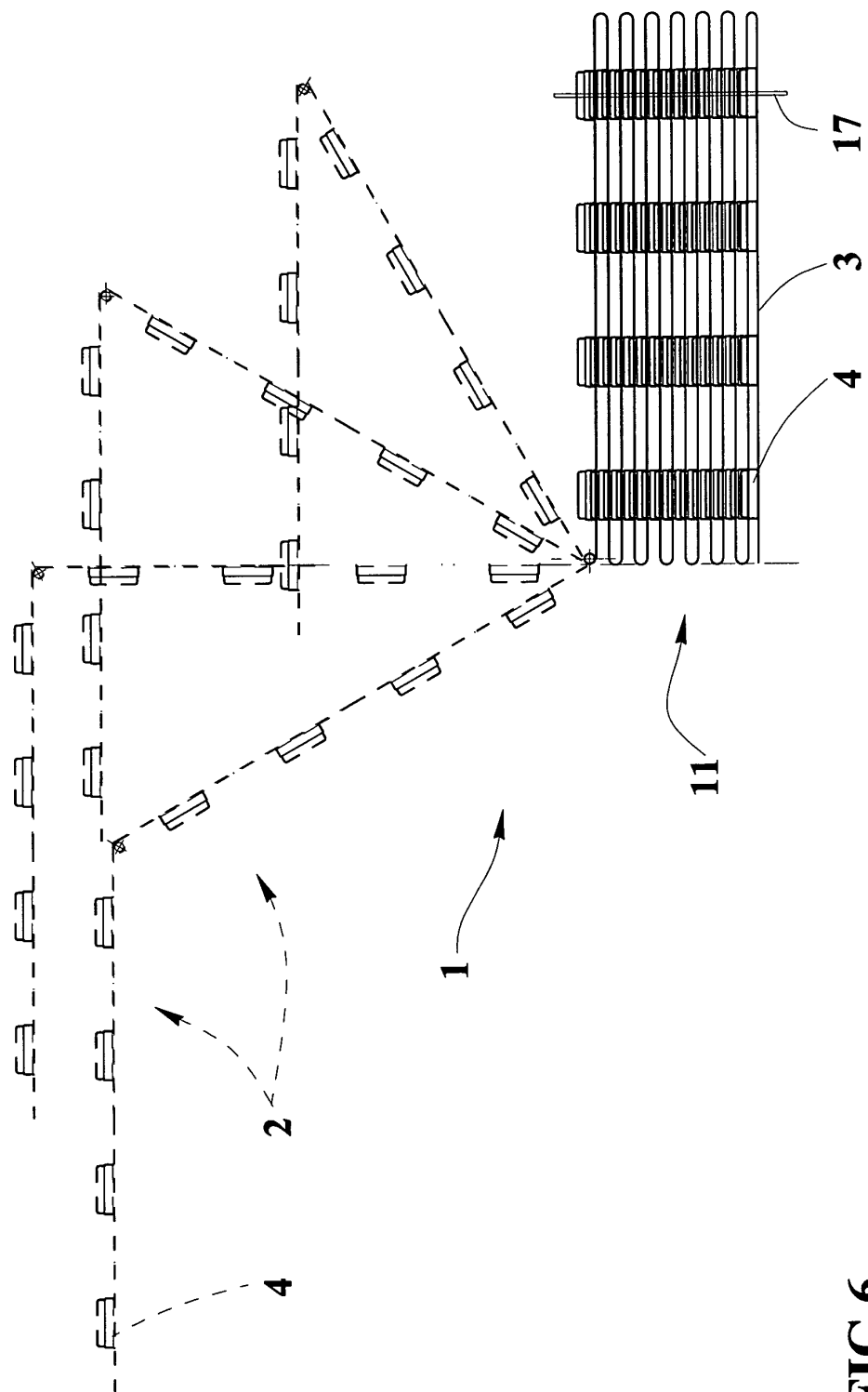


FIG.6

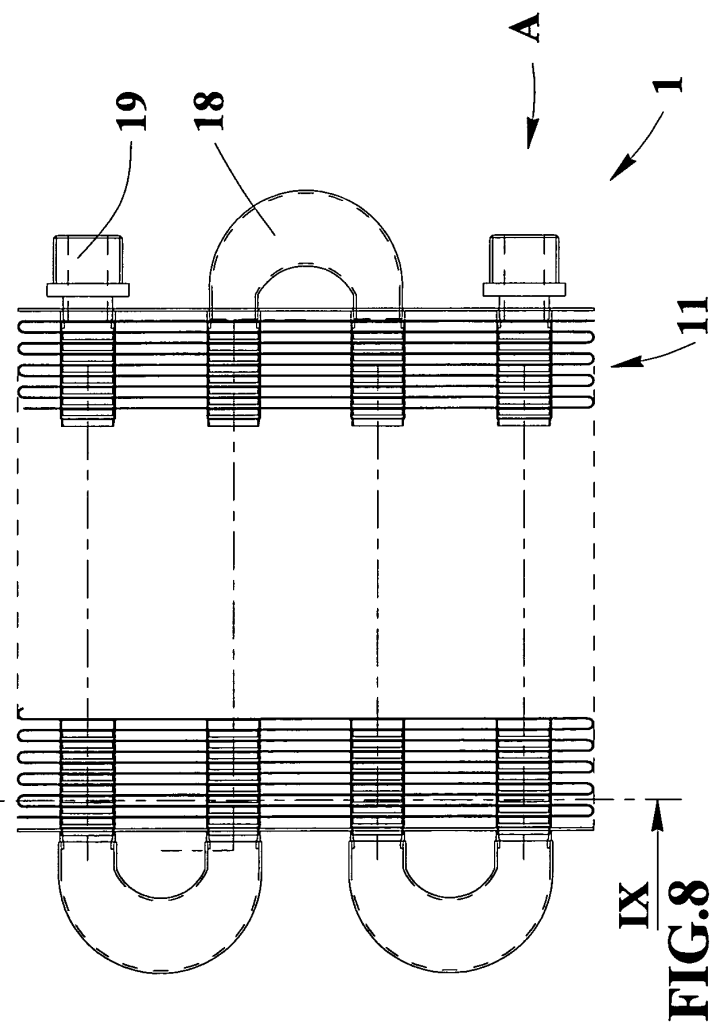
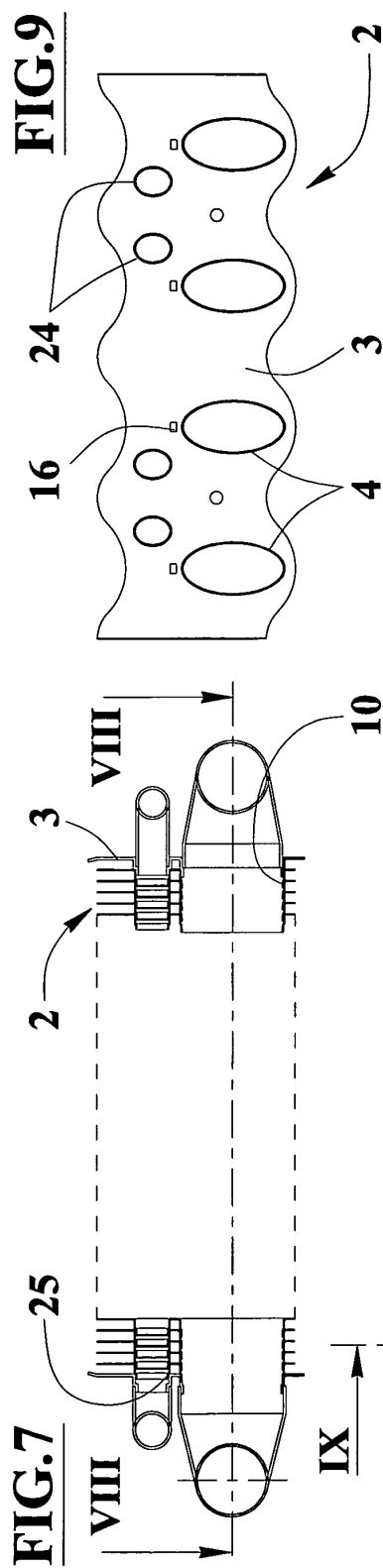


FIG.11

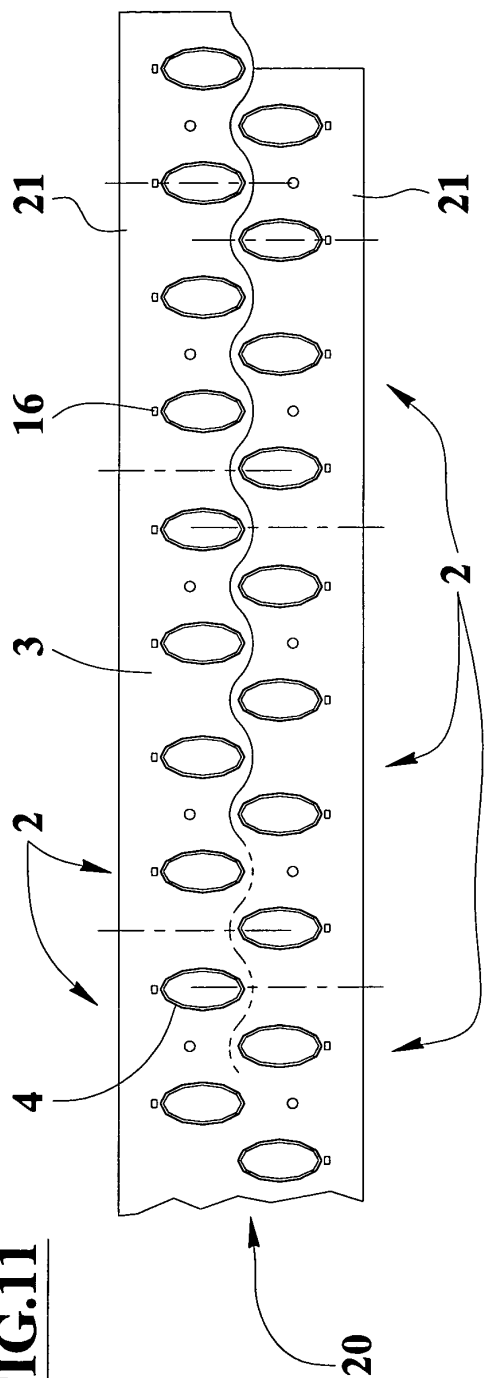


FIG.12

