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(54) **Folyadékhűtéses hűtőradiátor**

COOLING RADIATOR HAVING LIQUID COOLING

DESCRIPTION

1. Field of the invention

[0001] The invention relates to a cooling radiator, in particular a cooling radiator of a boiler of a transformer active part, wherein the cooling radiator is constituted with cooling elements through which cooling liquid heated on the active part flows under the effect of gravity from above via a collector or distributor pipe, a so-called collector, downwards to a lower distributor or collector, a so-called lower collector, wherein the cooled liquid passes via the lower distributor back into the transformer and wherein at least one cooling radiator is disposed remote from or directly on the transformer or its boiler.

[0002] Cooling radiators of this kind comprise, apart from the upper and lower collector, at least one sub-module of cooling elements, which are connected by respective individual distributor pipes to the upper and lower collector, wherein the sub-modules comprise pipes which are each provided at their external side with ribs.

2. Prior art

[0003] The cooling elements of transformers or other electrical devices comprise cooling elements through which oil usually flows as a cooling liquid, or a corrugated metal sheet such as is known from DE 10 2009 015 377 A. The cooling radiators comprising a plurality of such combined cooling elements, or cooling elements arranged beside or behind one another in a row, are constituted as a welded structure. In order to increase the service life, they are lacquered or galvanised by expensive dipping procedures.

[0004] In contrast with this, production is to be simplified with a simultaneous gas-tight or oil-tight connection of the cooling elements to the collectors and, in particular, the heat transfer or heat transmission is to be improved.

3. Problem of the invention

[0005] The problem of the invention, therefore, was to make available a cooling radiator, which on the one hand has a simple structure and on the other hand ensures overall an increased heat transfer with identical external dimensions of the cooling radiator. Within the meaning of the invention, this problem is solved with a cooling radiator comprising the features of claim 1. Advantageous developments of the invention are set out in the dependent claims.

4. Summary of the invention

[0006] Within the meaning of the invention, the sub-modules are disposed vertically and normal to the longitudinal direction of the collectors, wherein the pipes of the sub-modules for the air passage are disposed in parallel with a spacing from one another. A cooling radiator is thus created which, comprising a plurality of cooling elements following beside or behind one another in a row and with an air gap relative to one another, inserted in apertures of the upper collector pipe and the lower collector pipe, permits a particularly good air passage through the cooling radiator overall and at the respective cooling elements.

[0007] All the cooling elements of the cooling radiator thus contribute, preferably equally, to the heat transfer from the cooling medium, preferably oil, flowing through the cooling radiator to the ambient air flowing through

the cooling radiator. As a result, a particularly high energy dissipation of up to 38.00 kW/h, preferably of up to 39.80 kW/h, is achieved with a cooling radiator with a width of up to 540 mm, preferably up to 520 mm, and a height of up to 2 m, preferably up to 1.80 m. A cooling radiator with a height of 0.5 m up to 3.6 m is preferred. With optimised cross-sections both of the upper and the lower collector and of the pipes of the respective sub-modules, a flow rate of oil through the cooling radiator of up to 2700 kg/h, preferably up to 2800 kg/h can be achieved.

[0008] As has been confirmed by tests, the liquid, in particular oil, flowing through the pipes from top to bottom with the best cooling effect experiences the least resistance when an optimised cross-section of the cooling elements of the cooling radiator is observed. Since only the least possible resistances occur, the system can operate in free convection; no pumps are required.

[0009] The cooling radiator is thus present as a compact complete unit, which comprises as many sub-modules as desired, disposed spaced apart from one another and connected via the individual distributor pipes to the collectors. The ambient air, if need be assisted by fans/ventilators, is able to flow completely around the entire cooling radiator and its sub-modules both in the transverse and also in the longitudinal direction. The cooling or the heat dissipation/heat transfer is thus maintained very efficiently.

[0010] A preferred proposal makes provision such that the pipes and also the collectors, preferably the upper collector and the lower collector, as well as the individual distributor pipes are made from a material processable by extrusion, such as in particular aluminium or aluminium alloys, magnesium or similar lightweight metals suitable for extrusion. These materials on the one hand have good heat transfer properties and on the other hand are corrosion-resistant due to forming oxide layers, so that that lacquering or such coating or surface treatment is not necessary, and they can also be produced easily, i.e. preferably extruded with any desired geometry.

[0011] The apertures required for the connection of the individual components of the cooling radiator are preferably produced in a precise manner by milling or laser processing, so that exact joints for the micro-jointing can be achieved preferably by laser welding with a gas-tight or oil-tight connection.

[0012] It is preferable if each sub-module comprises up to 12, preferably up to 10 pipes. A cooling radiator is thus created, the effective surface whereof can be adapted to the properties required of the cooling radiator, the ambient air being able to flow around said effective surface with particularly straightforward means and, if need be, completely.

[0013] In this connection, it is also preferable if the pipes of the respective sub-modules have a flattened, preferably rectangular cross-section, in particular a rectangular cross-section with rounded corners. It is particularly preferable if such pipes comprise at least one inner web, preferably two inner webs. The width of the pipes preferably amounts to up to 130 mm, preferably up to 120 mm. It is particularly preferable if the spacing of the pipes with respect to one another per sub-module amounts to up to 30 mm, preferably up to 27 mm. A cooling radiator is thus created which on the one hand enables a sufficient through-flow of cooling media such as oil through the pipes of each sub-module and on the other hand makes pipes with sufficient dimensional stability available. Finally, an optimised air passage through the cooling radiator overall is brought about by the selection of the preferred spacing between the pipes, as a result of which the cooling capacity can be optimised.

[0014] Moreover, it is preferable if the ribs provided on the external side of the pipes are longitudinal ribs, which extend preferably over the total length of the pipes, i.e. essentially over the total length of the cooling radiator. It is particularly preferable if up to 15, most preferably up to 12 longitudinal ribs are provided per pipe. In this connection, it is particularly preferable if the longitudinal ribs have a height, i.e. an extension from the external side of the pipe outwards, of up to 15 mm, preferably up to 12 mm. The spacing of the longitudinal ribs from one another should amount to up to 25 mm, preferably up to 20 mm, in order not only thus to ensure an effective surface for the cooling radiator with a high thermal radiation, but at the same time also to optimise the transfer of the heat from the cooling medium into the ambient air flowing around and flowing through the cooling radiator.

[0015] In a further embodiment of the invention, it is preferable if up to 10, preferably up to 8 sub-modules are provided in the cooling radiator. These sub-modules, which are each connected to one another by an upper and a lower individual distributor pipe, thus offer a particularly large effective area with a compact design of the cooling radiator at the same time.

[0016] In this connection, it is also preferable if at least the upper collector, preferably also the lower collector, has a rectangular cross-section, preferably with a size of 20 x 80 mm. It is also most preferable if at least the upper collector, preferably both the upper and the lower collector, are disposed at an end of the individual distributor pipes and does not therefore hinder the air flow flowing in particular from bottom to top through the cooling radiator along the sub-modules. Solely as a result of the arrangement of the upper collector removed from the centre of the individual distributor pipes to their end, an air admission to the cooling radiator and an air exit from the cooling radiator improved by 38% was demonstrably able to be achieved.

[0017] A preferred embodiment provides for the prefabricated construction of the cooling radiator, wherein the upper and the lower collectors are disposed in a longitudinal extension and comprise an arbitrary number of apertures lying spaced apart behind one another as viewed over the length thereof, in the case of oval pipes as a cooling element correspondingly shape-adapted elongated holes provided normal to the longitudinal extension. The cooling elements are inserted, forming a sub-module, into apertures of individual distributor pipes connected to the upper and the lower collector, said distributor pipes having a rectangular or square format, which the collectors also advantageously have. The sub-modules comprising the upper and the lower individual distributor with the inserted cooling elements are connected, preferably laser-welded, to the collectors in an oil-tight manner with their individual distributor pipes running normal to the collectors and, with one of their apertures, being in a flow connection with an aperture of the collectors, and more precisely such that the collectors bridge the sub-modules disposed normal thereto, either centrally or preferably displaced to the side and on the ends of the individual distributor pipe.

5. Brief description of the figures

[0018] The invention is explained below in greater detail by reference to eight figures, in which preferred embodiments of the invention are represented. In the figures:

Figure 1 shows a front view of a cooling radiator according to invention,

Figure 2 shows an end view of a cooling radiator from figure 1,

Figure 3 shows a view from above onto the cooling radiator from figures 1 and 2,

Figure 4 shows an individual distributor pipe for a cooling radiator according to the invention,

Figure 5 shows a section of a collector of a cooling radiator according to the invention,

Figure 6 shows a cross-section through a pipe of a sub-module in a first embodiment,

Figure 7 shows a cross-section through a pipe of a sub-module in a second embodiment,

Figure 8 shows a perspective representation of the cooling radiator according to the invention in a view from top to bottom.

Detailed description of the figures

[0019] Figure 1 shows a front view of a completely prefabricated cooling radiator 1 prepared for installation into or removal from a transformer. Cooling radiator 1 comprises an upper collector pipe 2 and a lower collector pipe 3, which can be connected to the transformer (not represented) by means of respective flanges 2a, 3a to constitute a closed oil circuit with the transformer. Connected between upper collector 2 and lower collector 3 is a plurality of sub-modules 4, which each extend vertically and normal to the longitudinal direction of collector pipes 2, 3 in the plane of the drawing. Individual distributor pipes 5 are in turn assigned to sub-modules 4, said individual distributor pipes being connected liquid-tight to collector pipes 2, 3 and the pipes of sub-modules 4 in order thus to provide the passage of the cooling medium such as oil through entire cooling radiator 1. Finally, measurement sensors 20, 21 are connected to upper collector 2 and respectively lower collector 3, in order to detect the through-flow quantity as well as the entrance and exit temperature of the cooling medium through cooling radiator 1.

[0020] Figure 2 shows cooling radiator 1 from figure 1 in a side view, as viewed from the right, and thus shows the front or first sub-module 4. A large number of these successive sub-modules 4, which are disposed with clearance from one another and are connected to upper collector 2 and lower collector 3, form cooling radiator (1) from figure 1. From a combined view of figures 1 and 2, it can be seen that ambient air can flow completely around cooling radiator 1 and its sub-modules 4, and the elements constituted as oval pipes 6 in the example of embodiment (see figure 6). The heated cooling liquid (oil) flowing in from the consumer in the direction of the upper arrow of figure 1 is thus cooled particularly effectively on its path downwards. There, the cooling liquid passes in the direction of the lower arrow back to the consumer (boiler; active part of the transformer). Cooling radiator 1 can be connected to the consumer, optionally with the interposition of pipelines, by means of flanges 2a, 3a of collectors 2, 3.

[0021] Figure 3 shows cooling radiator 1 from figures 1 and 2 in a view from above. Sub-modules 4 with the cooling elements inserted in individual distributor pipes 5 are disposed normal and vertical with respect to upper collector 2 and are bridged by collector 2 lying in the centre of sub-modules 4. Sub-modules 4 each comprise five pipes 6 with an essentially rectangular cross-section connected by a common individual distributor pipe 5. A spacing 22 for the passage of cooling air through respective sub-modules 4 is in turn provided between pipes 6.

[0022] Figure 4 shows, as a single unit, an individual distributor pipe 5 viewed from its side comprising apertures 23. A liquid-tight and gas-tight connection of individual distributor pipe 5 to pipes (not represented) for the passage of the cooling medium takes place via apertures 23.

[0023] Figure 5 shows, as a single unit, a collector 2 viewed from its side comprising apertures 24. The connection and gas- and liquid-tight welding of upper collector 2 to individual distributor pipes 5 (not represented) takes place via apertures 24.

[0024] Figure 6 shows a cross-section through a pipe 6 with an essentially rectangular cross-section and rounded corners. Longitudinal ribs 7 disposed equidistant from one another are disposed on the external side of pipe 6, but at least on the longitudinal sides of pipe 6, by means of which longitudinal ribs the effective area of pipe 6, i.e. the contact surface of pipe 6 with the ambient air flowing around pipe 6, is markedly increased. An inner web 8 inside pipe 6 is also provided for stabilisation of pipe 6.

[0025] Figure 7 shows a second embodiment of a pipe 6 according to the invention as part of a sub-module of a cooling radiator according to the invention. Pipe 6 again has an essentially rectangular cross-section with rounded corners, wherein cooling ribs 7 with identical spacing from one another are disposed on each longitudinal side of pipe 6. The height of ribs 7, i.e. their extension from the external side of pipe 6 outwards, is also identical over the entire circumference of pipe 6 in order thus to create constant heat transfer conditions over pipe 6. In order to stabilise pipe 6 and to divide its cross-section into three chambers of essentially identical size, inner webs 8a, 8b are provided, which extend over the total length of pipe 6.

[0026] Finally, figure 8 shows a perspective overall view of a cooling radiator 1 according to the invention in a view from top to bottom. Cooling radiator 1 comprises an upper collector pipe 2 and a lower collector pipe 3, to which eight individual distributor pipes 5 are connected. These individual distributor pipes 5 are in turn connected to seven pipes 6, over the total length whereof longitudinal ribs 7 extend. In order to ensure the air passage of the cooling air through cooling radiator 1 in an essentially unhindered manner, both upper collector 2 and lower collector 3 at disposed offset from the central arrangement on individual distributor pipes 5 (see fig. 3) to the end regions of individual distributor pipes 5.

List of reference numbers

[0027]

1	cooling radiator
2	upper collector
2a	flange
3	lower collector
3a	flange
4	sub-module
5	individual distributor pipe
6	pipe
7	longitudinal ribs
8	inner web
20	measurement sensor
21	measurement sensor
22	spacing between pipes

23 aperture in individual distributor pipe

24 aperture in collector

FOLYADÉKHŰTÉSES HŰTŐRADIÁTOR

Szabadalmi igénypontok

1. Hűtőradiátor (1), amely egy felső gyűjtőt (2) és egy alsó gyűjtőt (3), valamint egy hűtőelemekből álló legalább egy részmodult (4) tartalmaz, amelynek hűtőelemei mindenkori egyedi elosztócsöveken (5) keresztül a felső gyűjtővel (2), illetve az alsó gyűjtővel (3) vannak összekötve, ahol a részmodulok (4) olyan csövekkel (6) rendelkeznek, amelyek külső oldalukon bordákkal (7) vannak ellátva, ***azzal jellemezve***, hogy a részmodulok (4) a gyűjtők (2, 3) hosszirányára merőlegesen és keresztirányban vannak elrendezve, és hogy a részmodulok (4) csövei (6) a levegőátáramláshoz egymástól bizonyos távolságra (22) párhuzamosan vannak elrendezve.

2. Az 1. igénypont szerinti hűtőradiátor (1), ***azzal jellemezve***, hogy legalább a részmodulok (4) csövei (6) alumíniumból vagy alumíniumötvözetből vannak.

3. Az előző igénypontok bármelyike szerinti hűtőradiátor (1), ***azzal jellemezve***, hogy mindegyik részmodul (4) legfeljebb tizenkét, előnyösen legfeljebb tíz csövet (6) tartalmaz.

4. Az előző igénypontok bármelyike szerinti hűtőradiátor (1), ***azzal jellemezve***, hogy a részmodulok (4) csövei (6) lelapított, előnyösen derékszögű négyszög alakú, előnyösen lekerekített sarkú keresztmetszettel rendelkeznek.

5. Az előző igénypontok bármelyike szerinti hűtőradiátor (1), ***azzal jellemezve***, hogy a csövek (6) legalább egy belső válaszfallal (8), előnyösen két belső válaszfallal (8) rendelkeznek.

6. Az előző igénypontok bármelyike szerinti hűtőradiátor (1), ***azzal jellemezve***, hogy a csövek (6) szélessége legfeljebb 130 mm-t, előnyösen 120 mm-t tesz ki.

7. Az előző igénypontok bármelyike szerinti hűtőradiátor (1), ***azzal jellemezve***, hogy a csövek (6) távolsága egy-egy részmodulnál (4) legfeljebb 30 mm-t, előnyösen legfeljebb 27 mm-t tesz ki.

8. Az előző igénypontok bármelyike szerinti hűtőradiátor (1), ***azzal jellemezve***, hogy a csövek (6) hosszanti bordákkal (7), előnyösen legfeljebb tizenöt, különösen előnyösen legfeljebb tizenkét hosszanti bordával (7) rendelkeznek.

9. A 8. igénypont szerinti hűtőradiátor (1), ***azzal jellemezve***, hogy a hosszanti bordák (7) 15 mm-ig terjedő, előnyösen 12 mm-ig terjedő magassággal rendelkeznek.

10. A 8. vagy 9. igénypont szerinti hűtőradiátor (1), ***azzal jellemezve***, hogy a hosszanti bordák (7) egymástól való távolsága legfeljebb 25 mm-t, előnyösen legfeljebb 20 mm-t tesz ki.

11. Az előző igénypontok bármelyike szerinti hűtőradiátor (1), ***azzal jellemezve***, hogy a hűtőradiátorban (1) legfeljebb tíz, előnyösen legfeljebb nyolc részmodul (4) van elhelyezve.

12. Az előző igénypontok bármelyike szerinti hűtőradiátor (1), ***azzal jellemezve***, hogy a hűtőradiátor (1) szélessége legfeljebb 540 mm-t, előnyösen legfeljebb 520 mm-t tesz ki.

13. Az előző igénypontok bármelyike szerinti hűtőradiátor (1), ***azzal jellemezve***, hogy a hűtőradiátor (1) magassága 0,5-3,60 métert, előnyösen legfeljebb 2,00 métert tesz ki.

14. Az előző igénypontok bármelyike szerinti hűtőradiátor (1), ***azzal jellemezve***, hogy az olaj átáramló mennyisége a hűtőradiátoron (1) keresztül legfeljebb 2700 kg/h, előnyösen legfeljebb 2800 kg/h.

15. Az előző igénypontok bármelyike szerinti hűtőradiátor (1), ***azzal jellemezve***, hogy a hűtőradiátoron (1) keresztüli energiaelvezetés mértéke legfeljebb 38,00 kW/h, előnyösen legfeljebb 39,80 kW/h.

16. Az előző igénypontok bármelyike szerinti hűtőradiátor (1), ***azzal jellemezve***, hogy legalább a felső gyűjtő (2) egy derékszögű négyszög alakú, előnyösen 20 x 80 mm méretű keresztmetszettel rendelkezik.

17. Az előző igénypontok bármelyike szerinti hűtőradiátor (1), ***azzal jellemezve***, hogy legalább a felső gyűjtő (2) előnyösen mind a felső gyűjtő (2), mind pedig az alsó gyűjtő (3) az egyedi elosztócsövek (5) egyik végén van elrendezve.

Fig. 1

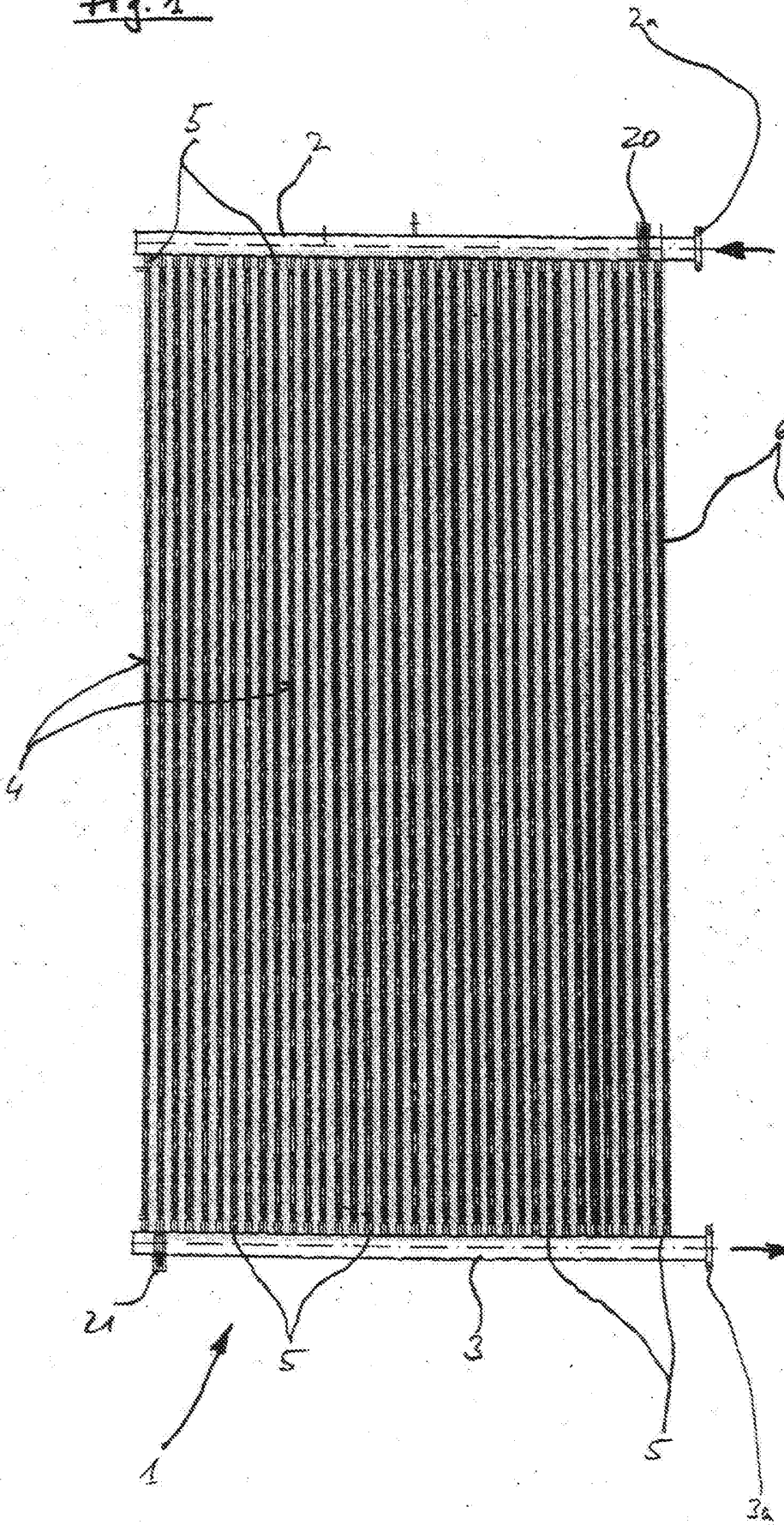

Fig. 2

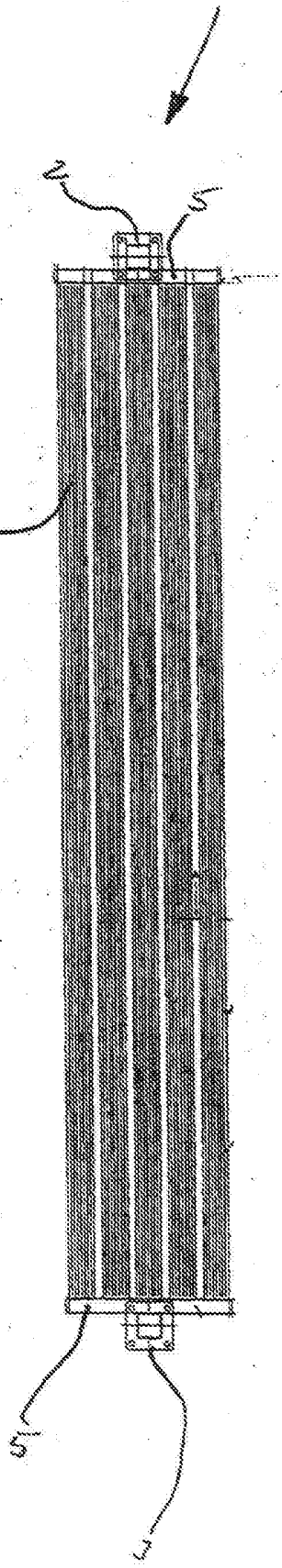

Fig. 3

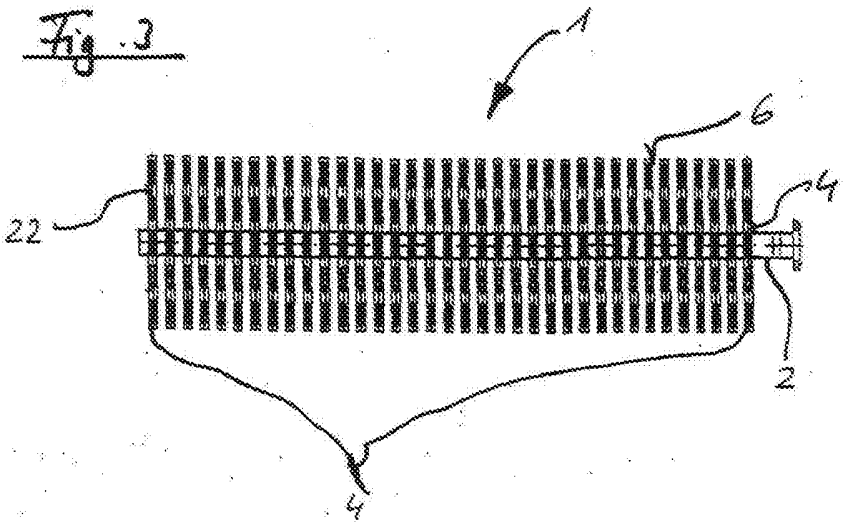

Fig. 4

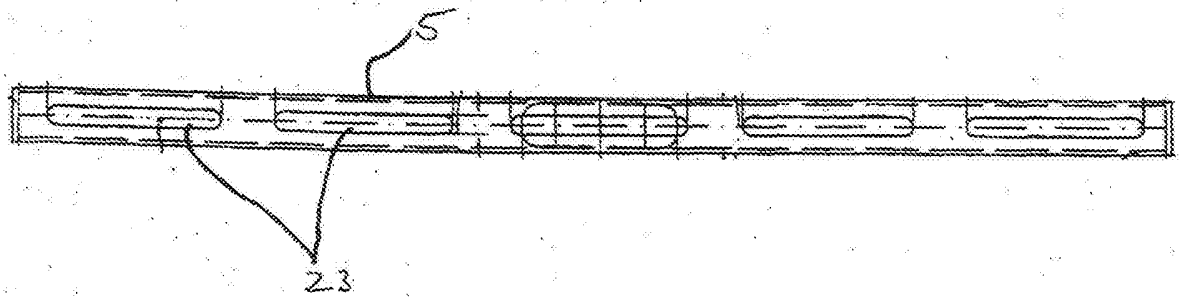

Fig. 5

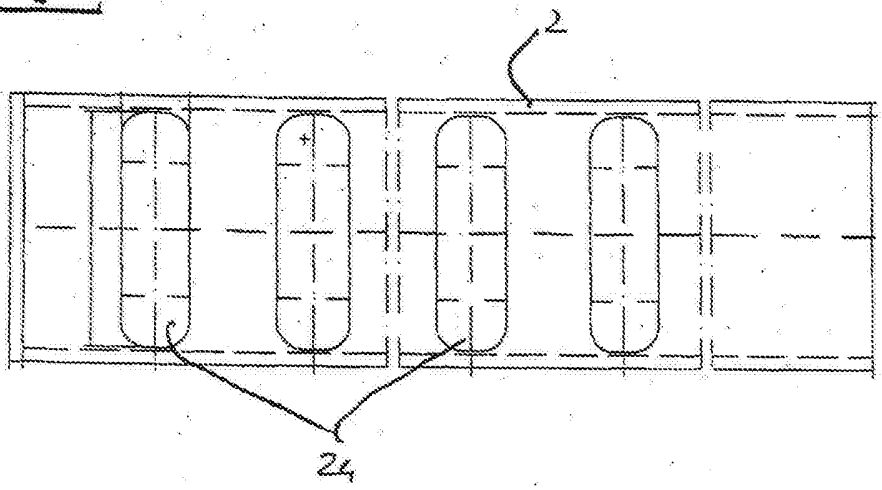

Fig. 6

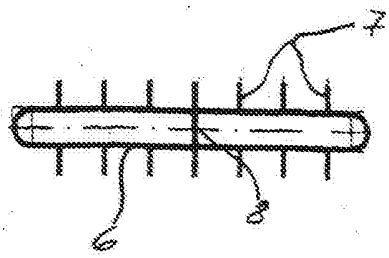

Fig. 7

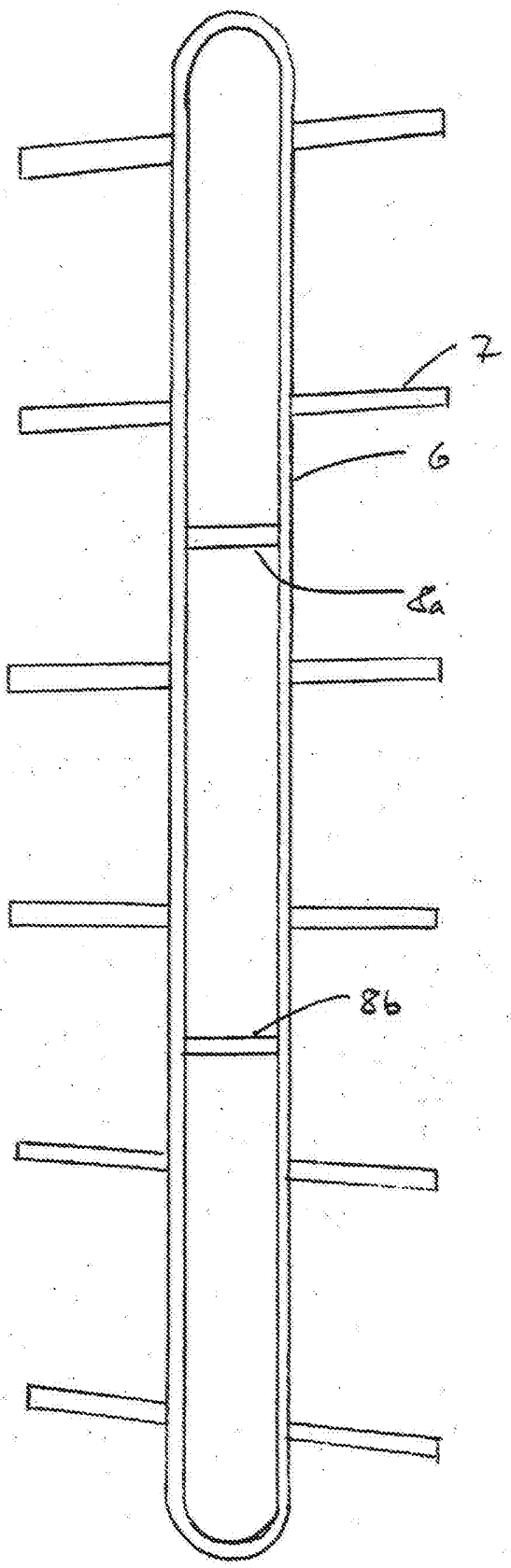

Fig. 8