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(54) **ARRANGEMENT FOR EXCHANGING HEAT AND CLIMATISER THAT INCLUDES SAID ARRANGEMENT**

ANORDUNG ZUM WÄRMETAUSCHEN UND DER ANORDUNG ENTHALTENDES KLIMAAGGREGAT

DISPOSITIF POUR ECHANGER CHALEUR THERMIQUE ET CLIMATISEUR AVEC UN TEL DISPOSITIF

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Description

[0001] This invention relates to an arrangement for exchanging heat according to the preamble of claim 1 and to an air climatiser that includes said arrangement. Such an arrangement is known from US-A-6 338 256.

BACKGROUND OF THE INVENTION

[0002] Heat exchangers are known, such as the type called radiators, in which the fluid to be cooled is passed through a plurality of low-flow conduits that are in contact with a current of air generated by a jet fan that projects the current onto the aforesaid conduits.

[0003] The fluid conduits used in a radiator can be plates or pipes that usually have exterior fins or other elements for increasing the heat-dissipation surface area.

[0004] Patent JP59142379 discloses a heat exchanger whose heat-exchange efficiency is increased by attaching to the exterior surface of the conduit that carries the fluid a thin plate bent into a star shape, leaving the front side and the rear part of said plate open. The interior spaces forming the aforesaid plate, bent and attached to the periphery of the pipe, form passages through which flows air that comes into contact with the conduit containing the fluid. The area of contact of the air with the conduit that contains the fluid is thus increased, thereby achieving greater heat-exchange efficiency.

[0005] The heat exchangers described have the disadvantage of their heat-exchange efficiency being in practice very limited, making them useful only when the fluid-temperature jumps sought are small (as in the case of the heat exchangers used to cool fluids from engines and/or components that give off heat).

[0006] Thus, when it is necessary to reduce the temperature of the fluid very considerably, it becomes necessary to use refrigeration pumps that use expensive and hazardous substances and have a very high energy consumption (as is the case with conventional cooling systems using water and other industrial fluids).

DESCRIPCIÓN OF THE INVENTION

[0007] The objective of the present invention is to resolve the disadvantages mentioned above by developing an arrangement for exchanging heat and a climatiser based on the aforesaid arrangement, which have very low energy consumption, are very simple and very highly effective.

[0008] In accordance with a first aspect of the present invention, an arrangement for exchanging heat is provided according to claim 1.

[0009] Thanks to these characteristics, the arrangement for exchanging heat of the present invention has a very high heat-exchange efficiency, basically due to the fact that the forced-impulsion piping of gas enables a very significant increase both of the time devoted to heat-exchange between the gas and the fluid as well as the gas pressure and contact surface area of said gas on the fluid conduits mounted inside the forced-impulsion piping.

[0010] Indeed, due to this being a forced-impulsion system in which the flow of gas is drawn in and taken from an inlet to an outlet, the length or route of the piping conduit and, therefore, also of the fluid conduits inside it can be considerable, being limited solely by the power of the aspirator connected to the aforesaid gas pipe. Thus, unlike what happens in the exchangers of the state of the art in which the route or length of the fluid conduits is physically limited, in the exchanger of the present invention the length of the fluid conduits and, therefore, the contact time between the gas and fluid conduits can be very considerable, and so it can take up or lose a larger amount of heat.

[0011] Furthermore, as the fluid conduits are mounted inside the forced-impulsion gas pipes, both the pressure and the contact surface area of said gas with the fluid conduits is enormously increased.

[0012] In this invention, conduit is taken to mean a channel or tubular element that serves as a passageway or outlet for a fluid, gas or liquid. Preferably, said channel or tubular element will have projecting elements (such as fins) on its outer surface in order to facilitate the exchange of heat.

[0013] Similarly, fluid will be taken to mean a liquid or gas capable of exchanging heat with the gas that is circulating through the second set of pipes of the exchanger.

[0014] Aspirator is taken to mean any machine or appliance that uses vacuum to draw out gases.

[0015] Preferably, the gas of the arrangement for exchanging heat is air, since it is an easy and safe fluid to handle and, advantageously, said fluid is a liquid that circulates through the interior of said first conduit. Alternatively, the gas of the exchanger can, instead of air, be an inert gas with refrigerating power, such as nitrogen.

[0016] It is important to stress that when the exchanger of the present invention uses air as a gas exchanger, it has the advantage of permitting the fluid in the first conduit to be heated or cooled and, at the same time, obtaining ducted cold or warm air that can be used for climatising premises. The equipment can thus find a dual use in industry or in households; as heat exchanger and as climatiser (heating/cooling) of premises.

[0017] Also preferably, the liquid fluid of the exchanger is water, with said water being for industrial or domestic use.

Water has the advantage of being an innocuous and easily obtained fluid.

[0018] Thanks to the presence of the aforesaid plurality of interconnected fluid conduits mounted inside the gas circuit, the contact or heat-exchange time between the gas and the fluid conduits can be enormously increased without the space occupied by the exchanger increasing significantly.

[0019] The enclosed chamber facilitates the single-support installation of several independent conduit circuits that can share the same gas inlet and outlet and, therefore, a single aspirator. The flow of fluid that exchanges heat can thus be increased and, with it, the performance of the exchanger, without this involving higher energy consumption and costs or resulting in an exchanger or larger volume.

[0020] Advantageously, the arrangement includes means for controlling the flow of gas that passes through said second conduit and/or means for controlling the flow of fluid that passes through said first conduit. The temperature of the gas or fluid to be cooled or heated can thus be modulated easily.

[0021] Also advantageously, the arrangement includes means for moistening the outer surface of said first conduit while said gas is being drawn in. This promotes an additional fluid-refrigerating effect produced by the evaporation that takes place on the surface of the conduit, so that the performance of the exchanger can be further enhanced.

[0022] In accordance with a second aspect of the present invention a climatiser is provided that includes the claimed arrangement for exchanging heat when using air as gas exchanger.

[0023] In the present invention, climatiser is taken to mean an appliance that climatises, that is, an appliance that brings an enclosed space to the temperature, air humidity and sometimes also pressure conditions needed for the health or comfort of those occupying them.

[0024] The climatiser of the present invention has the advantage over other climatisers of the state of the art that, by using the arrangement for exchanging heat of the invention, it does not as of necessity require conventional refrigeration or heat pumps to cool or heat the air.

[0025] Thus, the climatiser of the present invention can, for example, heat or cool air at a very low energy cost, using only the arrangement for exchanging heat claimed above.

[0026] For example, where the arrangement is used in an industry to cool a process fluid, it has been found that the high energy efficiency of the appliance enables channelled air to be obtained at a temperature close to that of the process fluid when it comes into the exchanger. Thus, at the same time as the fluid is cooling, warm air is obtained to climatise a premises at the plant itself.

[0027] Also, although it is less usual, the industry may also have available at one of its plants a low-temperature fluid that may be very useful for cooling the air in some specific working zone in which much heat is generated (a cooking room, for example). In these cases, the fluid will be used in the exchanger of the present invention to cool the air in that room down to a temperature that will always be a little above that of the aforesaid fluid but that will in any case enable partial refrigeration to be provided.

[0028] Advantageously, the fluid the climatiser uses is water that can be used both for cooling and heating air. That water can be of industrial origin, as noted above, or it can be household water from a well. By way of example, if the exchanger of the present invention uses well water that is usually at a temperature below ambient temperature, said exchanger will be able to produce refrigerated air for a dwelling, premises or office at a temperature close to that of the well water and, therefore, it can replace the conventional climatiser that uses a refrigeration pump.

[0029] Optionally, the climatiser of the present invention may, in addition to the exchanger, have to include means for heating or cooling the water that circulates through said exchanger. This option will be particularly useful where the climatiser is to be used in a dwelling, plant or offices to produce warm air or refrigerated air at a predetermined temperature. In such cases the water that is used will first have to be heated up to a preset value in order to produce the aforesaid warm or cold air.

[0030] Preferably the energy necessary for heating or cooling the water of the exchanger will be from renewable sources, such as solar energy (solar/photovoltaic panels), etc. The climatiser will thus permit climatisation of an enclosed space up to the desired temperature value, in a manner that fully respects the environment and using only water, air and energy from renewable sources.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] For a better understanding of all that has been set out some drawings are attached that show, schematically and solely by way of non-restrictive example, a practical case of embodiment.

[0032] In said drawings:

Figures 1a and 1b show two perspective views of a preferred embodiment of the arrangement for exchanging heat in which the conduits are included in an enclosed chamber.

Figure 2 shows a perspective view of the interior of the conduits included in the chamber of the exchanger of Figure 1.

Figure 3 is a schematic view of the exchanger of Figure 1, showing the circuit of gas and fluid conduits.

Figure 4 provides a schematic plan view of the conduits of the exchanger of Figure 1.

DESCRIPTION OF A PREFERRED EMBODIMENT

[0033] Figures 1a and 1b show two perspective views of a preferred embodiment of the arrangement 1 of the present invention.

[0034] In the arrangement 1 of the embodiment described, the gas 2 and fluid 3 conduits have been included inside an enclosed chamber 4 whose outer casing 5 has two inlets 6a, 6b for air 2 and a tubed outlet 7 connected to an aspirator 8 that draws the air 2 from the aforesaid inlets 6 to the aforesaid outlet 7. As the same figures show, the casing 5 of the chamber 4 also has an inlet 9 and outlet 10 provided for the fluid 3.

[0035] Figure 2 shows a view of the interior of the chamber 4 without the outer casing 5, in which it can be observed that the fluid 3 flows through a plurality of vertical finned conduits 11 arranged in two rows, one upper and one lower, interconnected by means of collectors 12, which are also finned. The conduits 11 and collectors 12 of each row are integrated into supports 13 that allow circulation of the aspired gas 2 and, once covered with the outer casing, form the gas conduits 14 of the arrangement 1.

[0036] As Figure 3 shows, the two rows of conduits 11 and their corresponding supports 13 are interconnected so as to form a circuit 15 of gas 2 and fluid 3 conduits from the inlet 6a to the outlet 7 connected to the aspirator 8. In the embodiment described, a second gas 3 inlet 6b has been provided that supplies the flow of the pipe 14 as it passes through the second row of fluid conduits 11. That second inlet 6b allows the heat-exchange performance to be optimised still further.

[0037] Figure 4 shows a schematic plan view of the chamber 4 in which two independent circuits 15a, 15b of conduits 11, 14 for gas 2 and fluid 3 can be observed, arranged in a battery. The two circuits 15 share the same inlets 6a, 6b and outlet 7 for gas and, therefore, also the same aspirator 8. The flow of fluid 3 that exchanges heat can thus be increased and, therewith, the output of the exchanger, without this involving greater equipment energy consumption and cost. However, as the same Figure 4 shows, in order correctly to direct and distribute the flow of aspired gas 2 from the inlet 6a between the two conduits 14, a balance pipe 16 is fitted inside the chamber 4.

[0038] There follows a description of the operation of the exchanger of the present invention on the basis of a specific practical example in which the user has a source of hot water 3 at 60°C that he wishes to cool, and a source of air 2 at an ambient temperature of 17°C.

[0039] The specific example just posited can arise in real life, whether in industry or in the home. In the case of industry, the hot water 3 could be residual water from industrial processes in which heat is generated, while in the case of a household it could be the water from the mains itself, which in the case of hot countries close to deserts habitually ranges between 40°C and 60°C, thereby making the sanitary use of such water 3 difficult and uncomfortable for purposes such as taking a bath, etc.

[0040] In order to cool the water 3, a certain flow of water 3 is made to circulate through the finned pipes 11 of the arrangement 1 while the aspirator 8 draws in the ambient air 2 and takes it through the conduits 14 and to the outlet 7. The exchange of heat takes place inside the aforesaid conduits 14 for forced air 2, in which the aspired air 2 comes into contact under pressure with the outer surface of the finned pipes 11 that contain the hot water 3, absorbing its heat.

[0041] The results of the tests carried out by simulating the specific example in question are set in the table that follows.

Table: Results of exchanger test

	Inlet to the arrangement	Outlet from the arrangement
Temperature of the water (°C)	60	18
Temperature of the air (°C)	17	50
Flow of water (l/h)	200	200
Electricity consum. aspirator (kW)	0.3	

[0042] As can be observed in the table above, the efficacy of the arrangement 1 of the present invention is surprisingly high, since it enables a large flow of water 3 cooled to 18°C to be obtained. Furthermore, this is achieved with a very simple design and very low energy consumption that allows savings of nearly 100% of the energy consumption of the conventional equipment that uses water refrigeration pumps.

[0043] It is also important to stress that, simultaneously with the refrigerated water 3 the exchanger provides air 2 at 50°C that can be used to climatise an enclosed space. The equipment of the present invention can therefore have an arrangement 1 function and a climatiser 1 function.

[0044] Accordingly, the hot water 3 generated in industry can be cooled without altering its composition in order to

achieve values that allow it to be reused. That same industry could then take advantage of the warm air 2 obtained in order to climatise, for example, the offices zone.

[0045] Similarly, in hot countries the water 3 from the mains can be cooled until it attains values that allow it to be used comfortably and without problems for sanitary purposes, while the warm air 2 that is generated can be put to other uses or expelled to the exterior.

[0046] If in the specific case in hand the user wishes to reduce the temperature of the water to below 18°C, the arrangement 1 could be attached to a conventional refrigeration system. The user could thus benefit from the efficiency and energy saving of the equipment of the present invention.

[0047] As has been observed, another option for achieving water 3 at below the inlet temperature of the air 2 would be to attach inside the chamber 4 a liquid-spraying system that would allow use to made of the additional cooling effect produced by the evaporation of a liquid on the outer surface of the conduits 11.

[0048] In the example described, the arrangement 1 was used for cooling water 3 and heating air 2; as noted, however, said arrangement 1 could also be used for heating water 3 and cooling air 2. In this case the user should have a supply of air 2, or any other gas, at a high preset temperature to supply the desired heat to said water 3. The energy required to heat said air or gas 2 could come from renewable sources.

Claims

1. An arrangement for exchanging heat that comprises a heat exchanger that includes at least a first conduit (11) through which a fluid (3) circulates, and means for generating a continuous flow of gas (2) that exchanges said heat with said fluid (3), said heat exchanger including at least a second conduit (14) through which said gas (2) circulates, with said second conduit (14) carrying inside it the first conduit (11) through which the fluid (3) circulates, said means for generating the continuous flow of gas including an aspirator (8) whose inlet is connected to said second conduit (14) in such a way that said gas (2) is drawn in and led through said second conduit (14) from an inlet (6a,6b) to an outlet (7) **characterised in that** it includes a plurality of second interconnected conduits forming the second conduit (14) through which said gas (2) circulates from the inlet (6a,6b) to the outlet (7) and a plurality of interconnected conduits (11) forming the first conduit through which the fluid (3) circulates, said fluid interconnected conduits (11) passing through the interior of said second interconnected conduits (14), and **in that** it includes an enclosed chamber (4) that has inside it the plurality of second interconnected conduits (14) forming at least two independent gas (2) circuits (15a,15b) mounted in battery, with said enclosed chamber (4) including at least one gas (2) inlet (6a) that supplies the second interconnected conduits (14) of the two circuits (15a, 15b), and at least one gas (2) outlet (7) that connects the second interconnected conduits (14) of the two circuits (15a,15b) with the inlet of the aspirator (8).

2. An arranqement in accordance with claim 1, **characterised in that** said gas is air (2).

3. An arrangement in accordance with claim 2, **characterised in that** said fluid is a liquid (3).

4. An arrangement according to either of claims 2 or 3, **characterised in that** said fluid is water (3).

5. An arrangement according to any of claims 1, 2 and 4, **characterised in that** it includes means for controlling the flow of gas (2) that passes through said second conduit (14).

6. An arrangement according to any of claims 1, 2, 4 and 5, **characterised in that** it includes means for controlling the flow of fluid (3) that passes through said conduit (11).

7. An arrangement according to any of the preceding claims, **characterised in that** it includes means for moistening the outer surface of said first conduit (11) while said gas (2) is aspired.

8. Climatiser **characterised in that** it includes an arrangement (1) in accordance with claim 2.

9. Climatiser in accordance with claim 8, **characterised in that** the fluid of the arrangement (1) is water (3).

10. Climatiser in accordance with claim 9, **characterised in that** it includes means for heating the water (3) that circulates through said arrangement (1).

11. Climatiser in accordance with claim 9, **characterised in that** it includes means for cooling the water (3) that circulates through said arrangement (1).

12. Climatiser according to either of claims 10 and 11, **characterised in that** the energy necessary for heating or cooling said water (3) comes from renewable sources.

Patentansprüche

1. Anordnung zum Austauschen von Wärme, die einen Wärmetauscher umfasst, der mindestens Folgendes aufweist: eine erste Rohrleitung (11), durch welche ein Fluid (3) zirkuliert, und Mittel zum Erzeugen einer kontinuierlichen Gasströmung (2), die die Wärme mit dem Fluid (3) austauscht, wobei der Wärmetauscher mindestens eine zweite Rohrleitung (14) aufweist, durch welche das Gas (2) zirkuliert, wobei die zweite Rohrleitung (14) in ihrem Inneren die erste Rohrleitung (11) trägt, durch welche das Fluid (3) zirkuliert, wobei die Mittel zum Erzeugen der kontinuierlichen Gasströmung einen Sauglüfter (8) aufweisen, dessen Eintrittsöffnung auf eine solche Weise mit der zweiten Rohrleitung (14) verbunden ist, dass das Gas (2) angesaugt und von einer Eintrittsöffnung (6a, 6b) durch die zweite Rohrleitung (14) zu einer Austrittsöffnung (7) geführt wird, **dadurch gekennzeichnet, dass** die Anordnung Folgendes aufweist: mehrere miteinander verbundene zweite Rohrleitungen, die die zweite Rohrleitung (14) bilden, durch welche das Gas (2) von der Eintrittsöffnung (6a, 6b) zu der Austrittsöffnung (7) zirkuliert, und mehrere miteinander verbundene Rohrleitungen (11), die die erste Rohrleitung bilden, durch welche das Fluid (3) zirkuliert, wobei die miteinander verbundenen Fluid-Rohrleitungen (11) durch das Innere der zweiten miteinander verbundenen Rohrleitungen (14) verlaufen, und **dadurch**, dass die Anordnung eine gekapselte Kammer (4) aufweist, die in ihrem Inneren die mehreren zweiten miteinander verbundenen Rohrleitungen (14) aufweist, die mindestens zwei als Batterie montierte unabhängige Gas-(2)-Kreise (15a, 15b) bilden, wobei die gekapselte Kammer (4) mindestens eine Gas-(2)-Eintrittsöffnung (6a), die die zweiten miteinander verbundenen Rohrleitungen (14) der beiden Kreise (15a, 15b) versorgt, und mindestens eine Gas-(2)-Austrittsöffnung (7) aufweist, die die zweiten miteinander verbundenen Rohrleitungen (14) der beiden Kreise (15a, 15b) mit der Eintrittsöffnung des Sauglüfters (8) verbindet.

2. Anordnung nach Anspruch 1, **dadurch gekennzeichnet, dass** es sich bei dem Gas um Luft (2) handelt.

3. Anordnung nach Anspruch 2, **dadurch gekennzeichnet, dass** es sich bei dem Fluid um eine Flüssigkeit (3) handelt.

4. Anordnung nach Anspruch 2 oder 3, **dadurch gekennzeichnet, dass** es sich bei dem Fluid um Wasser (3) handelt.

5. Anordnung nach einem der Ansprüche 1, 2 und 4, **dadurch gekennzeichnet, dass** sie Mittel zum Regeln der die zweite Rohrleitung (14) passierenden Gasströmung (2) aufweist.

6. Anordnung nach einem der Ansprüche 1, 2, 4 und 5, **dadurch gekennzeichnet, dass** sie Mittel zum Regeln der die Rohrleitung (11) passierenden Fluid-(3)-Strömung aufweist.

7. Anordnung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** sie Mittel zum Anfeuchten der Außenfläche der ersten Rohrleitung (11) während des Ansaugens des Gases (2) aufweist.

8. Klimatisiervorrichtung, **dadurch gekennzeichnet, dass** sie eine Anordnung (1) nach Anspruch 2 aufweist.

9. Klimatisiervorrichtung nach Anspruch 8, **dadurch gekennzeichnet, dass** es sich bei dem Fluid der Anordnung (1) um Wasser (3) handelt.

10. Klimatisiervorrichtung nach Anspruch 9, **dadurch gekennzeichnet, dass** sie Mittel zum Erwärmen des durch die Anordnung (1) zirkulierenden Wassers (3) aufweist.

11. Klimatisiervorrichtung nach Anspruch 9, **dadurch gekennzeichnet, dass** sie Mittel zum Kühlen des durch die Anordnung (1) zirkulierenden Wassers (3) aufweist.

12. Klimatisiervorrichtung nach Anspruch 10 oder 11, **dadurch gekennzeichnet, dass** die zum Erwärmen oder Kühlen des Wassers (3) notwendige Energie aus emeuerbaren Quellen stammt.

Revendications

1. Dispositif d'échange de chaleur comprenant un échangeur de chaleur contenant au moins un premier conduit (11)

à travers lequel un fluide (3) circule, et un moyen de production d'un flux continu de gaz (2) qui échange ladite chaleur avec ledit fluide (3), ledit échangeur de chaleur contenant au moins un deuxième conduit (14) à travers lequel ledit gaz (2) circule, ledit deuxième conduit (14) portant dans sa partie intérieure le premier conduit (11) à travers lequel le fluide (3) circule, ledit moyen de production d'un flux continu de gaz comprenant un aspirateur (8) dont l'entrée est reliée audit deuxième conduit (14) de manière que ledit gaz (2) est aspiré et conduit à travers ledit deuxième conduit (14) à partir d'une entrée (6a, 6b) vers une sortie (7), **caractérisé en ce qu'**il comprend une pluralité de deuxièmes conduits interconnectés formant le deuxième conduit (14) à travers lequel ledit gaz (2) circule à partir de l'entrée (6a, 6b) vers la sortie (7), et une pluralité de conduits interconnectés (11) formant le premier conduit à travers lequel le fluide (3) circule, lesdits conduits (11) interconnectés par du fluide traversant la partie intérieure desdits deuxièmes conduits interconnectés (14), et **en ce qu'**il comprend une chambre fermée (4) qui comporte dans sa partie intérieure la pluralité des deuxièmes conduits interconnectés (14) formant au moins deux circuits (15a, 15b) indépendants de gaz (2) montés en batterie, ladite chambre fermée (4) comprenant au moins une entrée (6a) de gaz (2) alimentant les deuxièmes conduits interconnectés (14) des deux circuits (15a, 15b), et au moins une sortie (7) de gaz (2) raccordant les deuxièmes conduits interconnectés (14) des deux circuits (15a, 15b) avec l'entrée de l'aspirateur (8).

2. Dispositif selon la revendication 1, **caractérisé en ce que** ledit gaz est de l'air (2).

3. Dispositif selon la revendication 2, **caractérisé en ce que** ledit fluide est un liquide (3).

4. Dispositif selon la revendication 2 ou 3, **caractérisé en ce que** ledit fluide est de l'eau (3).

5. Dispositif selon l'une quelconque des revendications 1, 2 et 4, **caractérisé en ce qu'**il comprend un moyen de régulation de l'écoulement de gaz (2) traversant ledit deuxième conduit (14).

6. Dispositif selon l'une quelconque des revendications 1, 2, 4 et 5, **caractérisé en ce qu'**il comprend un moyen de régulation de l'écoulement de fluide (3) traversant ledit deuxième conduit (11).

7. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**il comprend un moyen d'humidification de la surface extérieure dudit premier conduit (11) pendant que ledit gaz (2) est aspiré.

8. Climatiseur **caractérisé en ce qu'**il comprend un dispositif (1) selon la revendication 2.

9. Climatiseur selon la revendication 8, **caractérisé en ce que** le fluide du dispositif (1) est de l'eau (3).

10. Climatiseur selon la revendication 9, **caractérisé en ce qu'**il comprend un moyen de chauffage de l'eau (3) circulant à travers ledit dispositif (1).

11. Climatiseur selon la revendication 9, **caractérisé en ce qu'**il comprend un moyen de refroidissement de l'eau (3) circulant à travers ledit dispositif (1).

12. Climatiseur selon l'une des revendications 10 et 11, **caractérisé en ce que** l'énergie nécessaire pour chauffer ou pour refroidir ladite eau (3) provient de sources renouvelables.

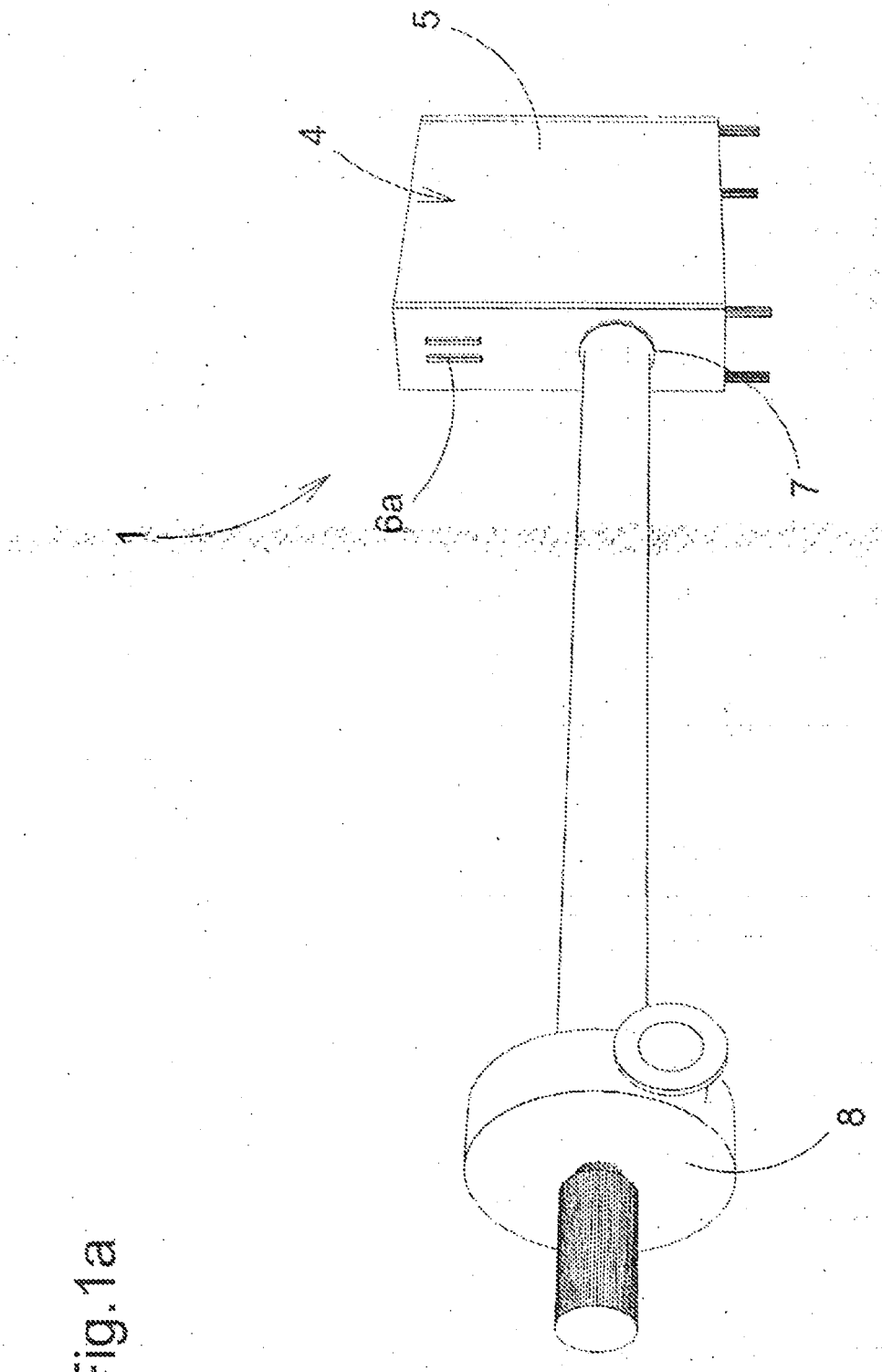


Fig.1a

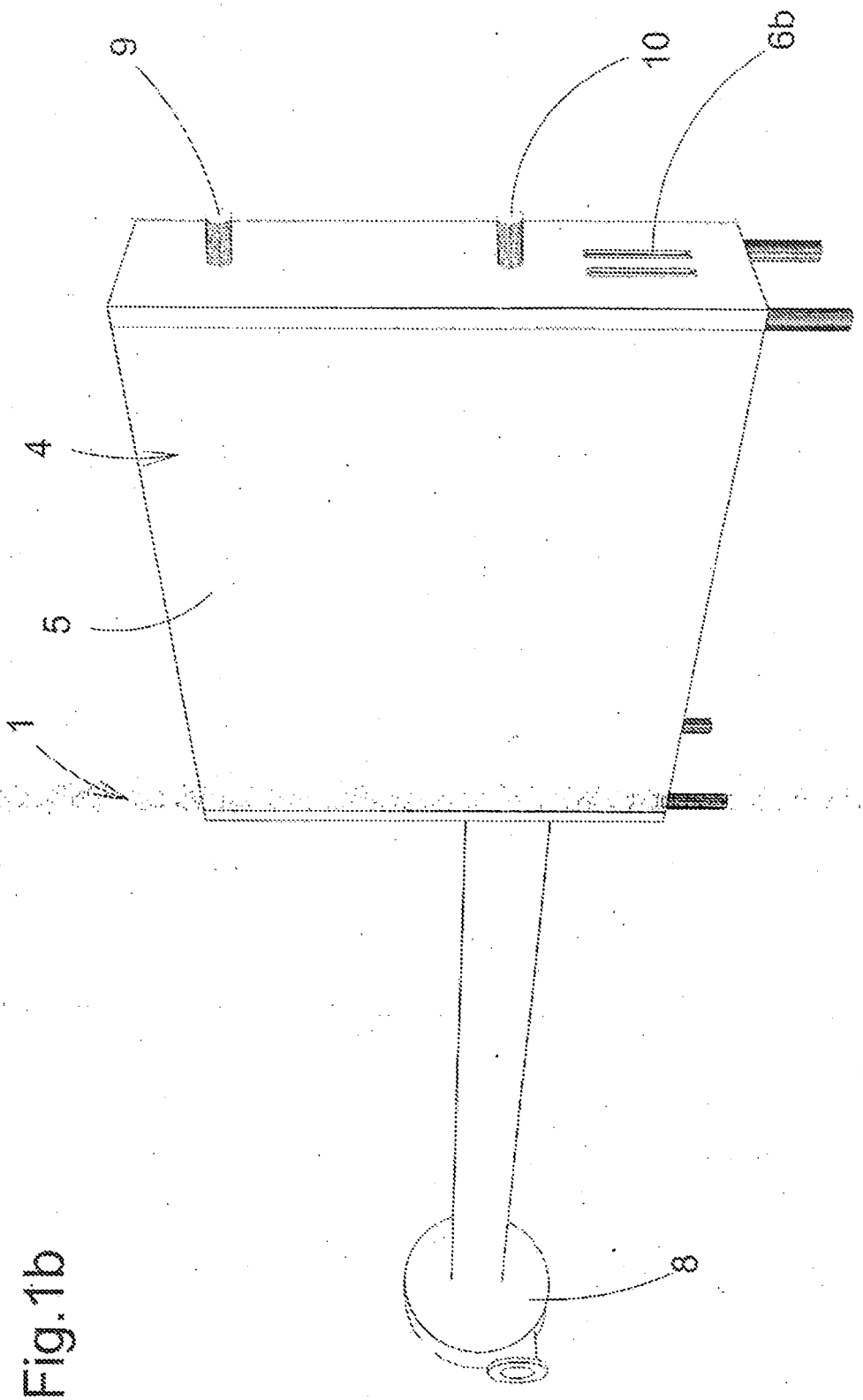


Fig.1b

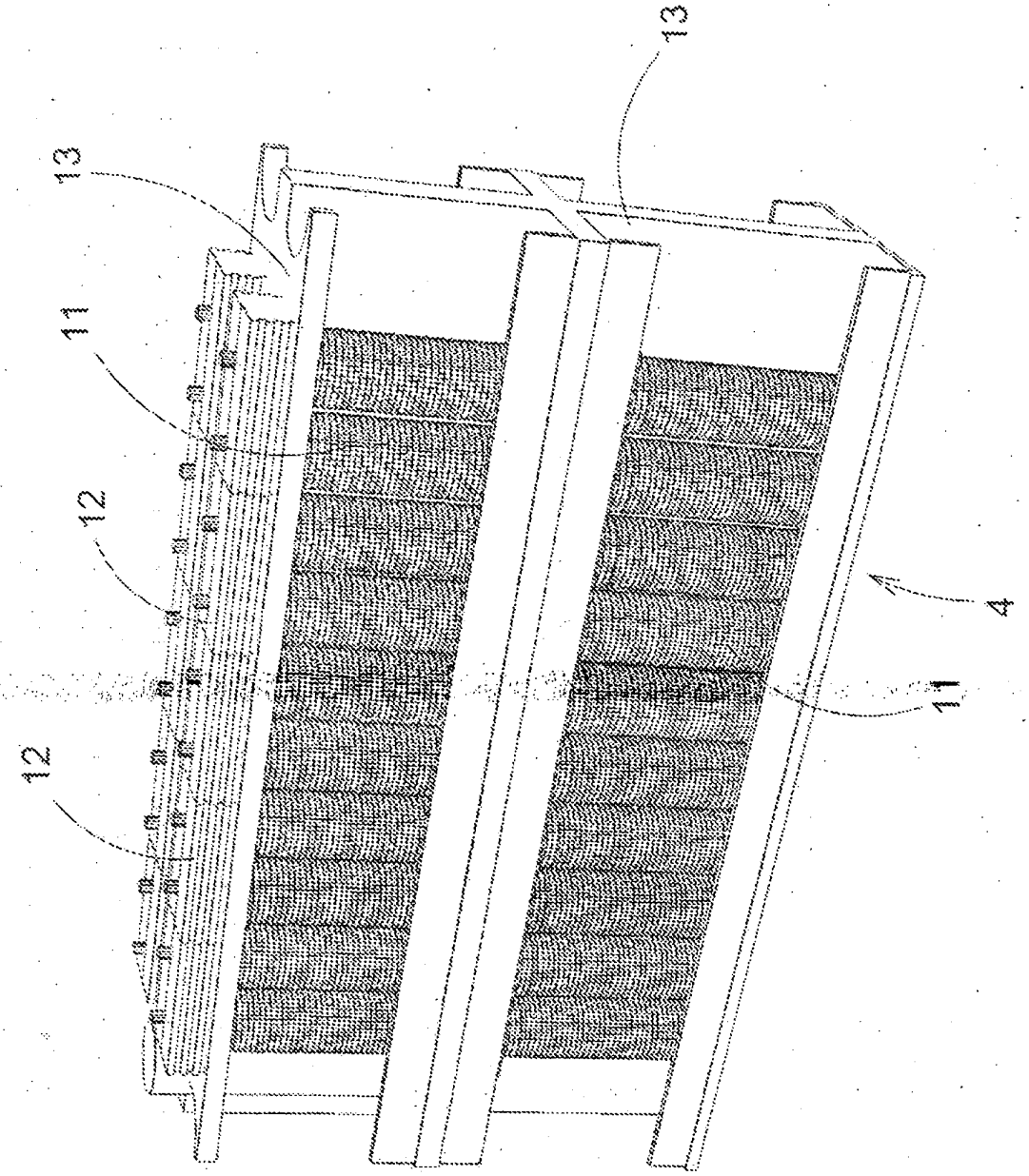


Fig.2

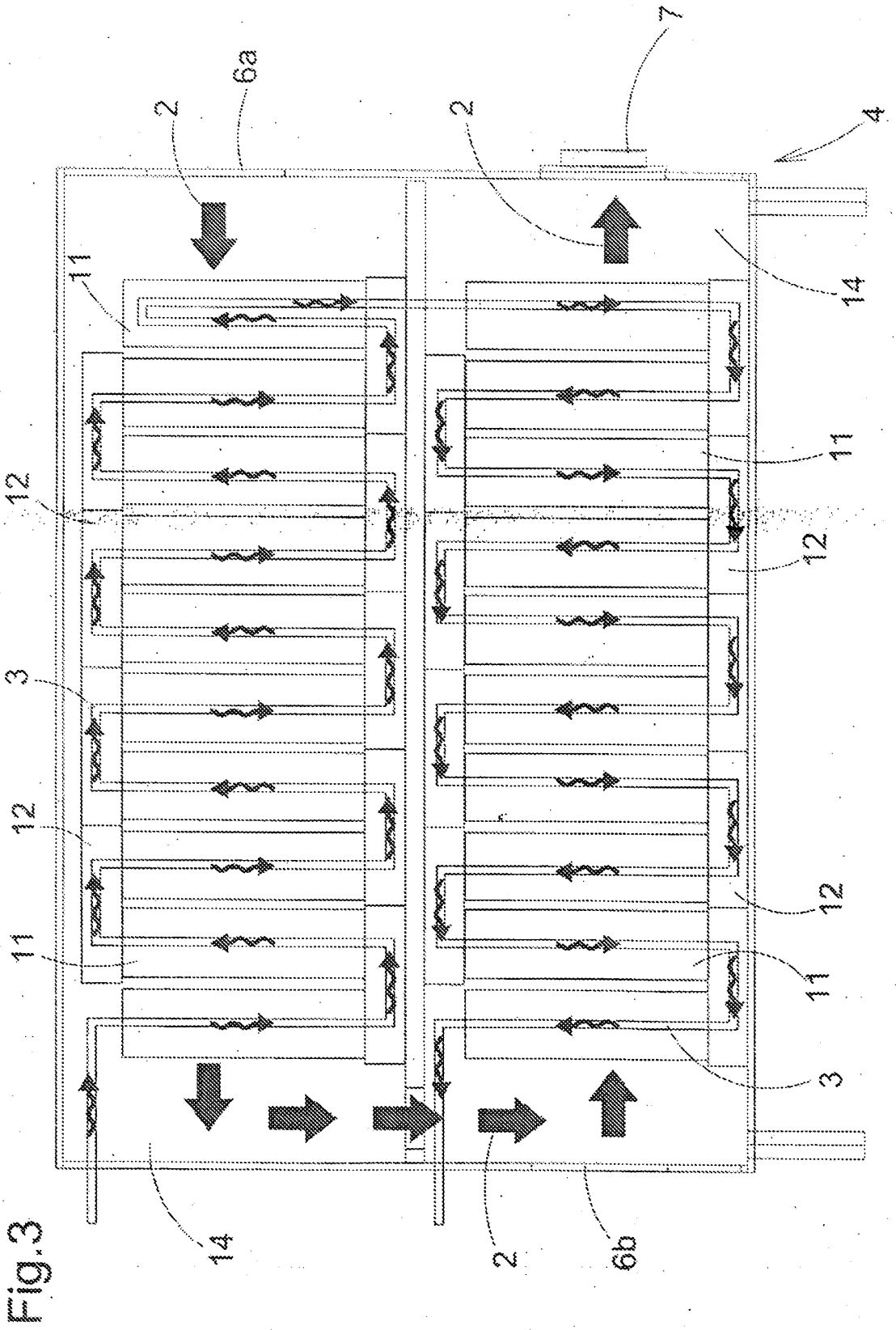


Fig.3

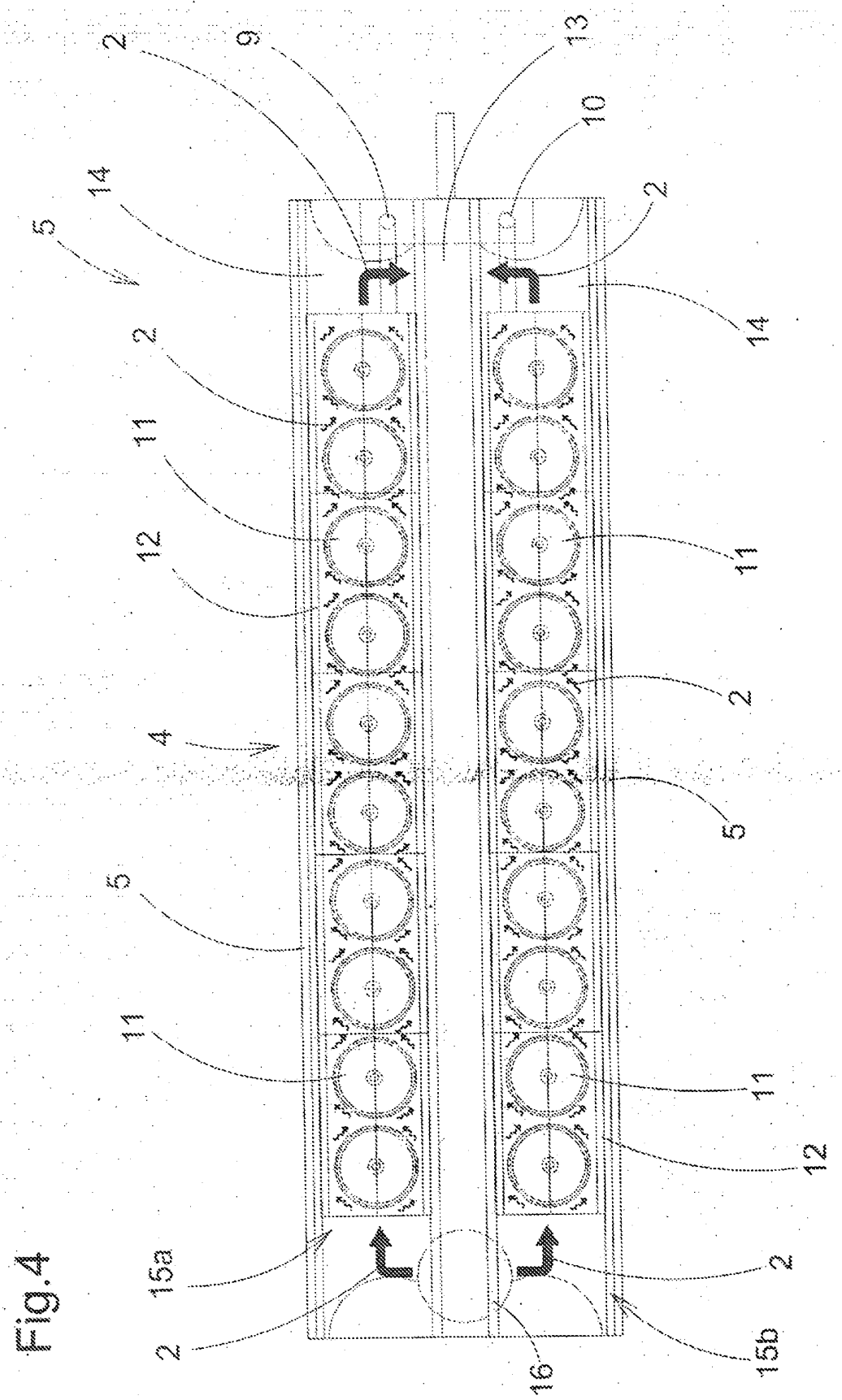


Fig.4

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 6338256 A **[0001]**
- JP 59142379 B **[0004]**