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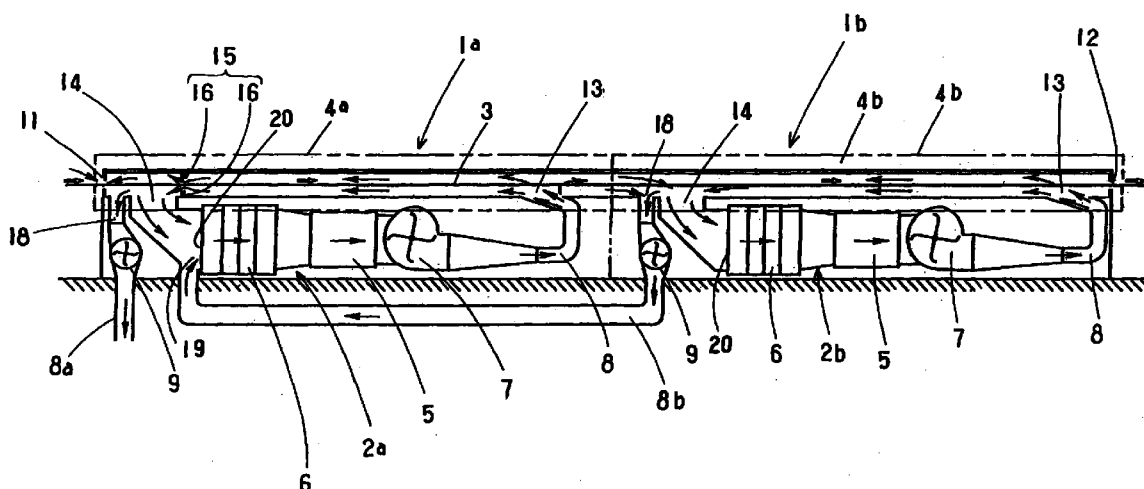
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(54) **Hot air drier for warp sizer**

(57) Along a running path of warp there are provided two hot air circulating and exhausting systems (1a,1b) for circulating air and exhausting a part of the hot air outside each comprising a drying chamber (4a,4b), through which hot air flows in the direction opposite to that of the running warp (3), and a hot air blower unit (2a,2b). An exhausted air recovering duct is provided to connect between the upstream hot air blower unit (2a) and the downstream system for sending exhausted hot air from the downstream system. Both of

the drying chambers (4a,4b) in the upstream and downstream systems are connected with each other so that the warp (3) is allowed to run through the connected portion with the chambers (4a,4b) being isolated from external air. In the drying chamber (4a) in the upstream system, there is provided an air flow resistor for reducing the cross sectional area of the passing hot air flow in a hot air path between a hot air outlet opening (13) and a hot air inlet opening (14).

**FIG.2**



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## Description

### BACKGROUND OF THE INVENTION

#### Field of the Invention

**[0001]** The present invention relates to a hot air dryer for a warp sizer for drying the warp by hot air after the warp have been sized.

#### Description of the Related Art

**[0002]** For providing warp sizer with increased production efficiency, effort has been generally made to increase the speed of the warp running through the sizer, which also necessitates to also increase a drying capacity of a drying chamber for drying a sized warp. In order to increase the drying capacity, the drying chamber is supplied with a flow of hot air passing through therein in the direction opposite to the running direction of the warp, with a relative speed of the hot air to the warp made increased, and along with this, with a temperature of the hot air elevated to be the highest possible. The hot air with an elevated temperature, however, is required to have the smallest possible thermal influence on physical properties of the warp.

**[0003]** Hence, a hot air dryer generally has two hot air circulating and exhausting systems each comprising a drying chamber and a hot air blower unit for circulating the hot air through a path in the air drying chamber and the hot air blower with a part of the hot air exhausted out of the system. The two systems are the one on an upstream side in which runs the warp so wet that the temperature of the hot air is allowed to be set high, and the one on a downstream side in which run the warp so dried to some extent that the temperature is not allowed to be set so high.

**[0004]** In such a hot air dryer for warp sizer with the above constitution, an attempt is made to supply an exhausted air from the downstream side hot air circulating and exhausting system to the hot air blower unit on the upstream side to re-use the exhausted air for increasing energy efficiency. Such a hot air dryer comprises, for example, as shown in Fig. 1, two hot air circulating and exhausting systems 1a and 1b on an upstream and downstream sides, respectively, each individually provided with a hot air blower unit 2a or 2b, and a drying chamber 4a or 4b through which runs warp 3. Each of the hot air blower units 2a and 2b is formed with a steam heater 6, an electric heater 5, a blower 7, and a duct 8 through which the hot air is carried. In addition, there are provided an exhausting duct 8a for exhausting a part of the hot air in the hot air circulating and exhausting system 1a through an exhausting fan 9a, and an exhausted air recovering duct 8b that sends exhausted air from an exhausting outlet 18 of the hot air circulating and exhausting system 1b to the steam heater 6 in the system 1a through the exhausting fan 9b.

By the air recovering duct 8b, the exhausted air from the hot air circulating and exhausting system 1b, with a lower moisture content and lower relative humidity than the hot air in the system 1a, is introduced into the hot air circulating and exhausting system 1a.

**[0005]** In such a hot air dryer in a related art, the exhausted air introduced into the hot air circulating and exhausting system 1a on the upstream side from the system 1b on the downstream side increases the volume of air flow in the hot air blower unit 2a on the upstream side. This increases the volume of the hot air flow blown out into the drying chamber 4a with a resulting increase in air velocity. The increased air velocity induced negative pressure near warp exit 12 of the drying chamber 4a to cause a phenomenon of allowing external air to flow into the drying chamber 4a. This further caused loss in thermal energy and a nonuniform temperature distribution in the drying chamber 4a that results in a nonuniformly dried the warp 3. In addition, the increased air velocity caused a strong turbulent flow near warp entrance 11 on the upstream side of the drying chamber 4a to cause large amounts of hot air to flow out of the drying chamber 4a. Along with this, there was also caused large amounts of external air to flow into the drying chamber to further produce loss in thermal energy.

**[0006]** Accordingly, it is an object of the present invention to provide a hot air dryer for warp sizer having a high production efficiency together with lowered energy consumption and providing no nonuniformly dried warp.

### SUMMARY OF THE INVENTION

**[0007]** The hot air dryer for warp sizer according to the present invention comprises two hot air circulating and exhausting systems disposed on an upstream side and a downstream side along a running path of warp, respectively, each system comprising a drying chamber and a hot air blower unit for circulating a hot air between the drying chamber and the hot air blower so that the hot air flows in the direction opposite to the running direction of the warp in the drying chamber with a part of the hot air being exhausted outside the system, and an exhausted air recovering duct connecting the hot air circulating and exhausting system on the downstream side to the hot air blower unit in the system on the upstream side for sending exhausted air from the system on the downstream side to the hot air blower unit in the system on the upstream side. Both of the drying chambers in the systems on the upstream and downstream sides are connected with each other so that the warp is allowed to run through a connected portion with the connected portion of the chambers being isolated from external air, and an air flow resistor for reducing a cross sectional area of the passing hot air flow is provided in a hot air path between a hot air outlet opening and a hot air inlet opening in the drying chamber in the

system on the upstream side.

**[0008]** The hot air blower unit may include a heater for heating the hot air and a blower for sending the hot air heated by the heater to the drying chamber, and the heater in the hot air blower unit in the system on the upstream side is provided with a hot air intake to which the exhausted air recovering duct is connected.

**[0009]** The air flow resistor may be provided near the hot air inlet opening, and the air flow resistor may be provided so that the cross sectional area of the passing hot air flow is made freely adjustable.

**[0010]** In the hot air dryer according to the present invention, the exhausted air from the hot air circulating and exhausting system on the downstream side is recovered in the hot air blower unit in the system on the upstream side, mixed with the hot air circulating in the system on the upstream side, and blown out in the drying chamber on the upstream side as the hot air flowing in the drying chamber in the direction opposite to the running direction of the warp. At this time, the flow of the hot air is throttled down to reduce the cross section thereof by the flow resistor to receive an increased resistance to the hot air flow. This reduces the flow of the hot air passing through the drying chamber with an accompanied pressure increase in the downstream portion of the air flow resistor in the running direction of the warp. Since both of the drying chambers on the upstream and downstream sides are connected with the connected portion being isolated from the external air, a part of the hot air blown out in the drying chamber on the upstream side flows toward the drying chamber on the downstream side under a pressure lower than that of the drying chamber on the upstream side to circulate in the hot air circulating and exhausting system on the downstream side or to be recovered from the exhaust air recovering duct into the hot air blower unit on the upstream side. Moreover, the reduction of the flow of the hot air passing through the drying chamber also reduces the turbulence near the warp entrance to reduce both of the hot air flowing out of the warp entrance and the external air flowing therein, which further reduces heat loss.

**[0011]** The air exhausted from the hot air circulating and exhausting system on the downstream side is sent to the hot air inlet of the heaters of the hot air blower unit on the upstream side for being recovered. The recovered exhausted air is heated to be the hot air and blown out in the drying chamber in the hot air circulating and exhausting system on the upstream side. The hot air is disturbed to cause turbulence after passing through the air flow resistor. However, by providing the air flow resistor near the hot air inlet opening where the hot air flow is naturally in turbulent state, the influence of the turbulence on the warp that disturbs the running thereof is made the slightest possible.

**[0012]** Furthermore, by allowing the air flow resistor to provide a cross sectional area for passing the hot air flow made freely adjustable, resistance to an air flow

passing through the air flow resistor is adjusted to vary the volume of the hot air flow passing through the drying chamber. This further changes the pressure in the drying chamber downstream the air flow resistor in the running direction of the warp to allow the volume of the hot air, which flows into the drying chamber on the downstream side, to be adjusted.

## BRIEF DESCRIPTION OF THE DRAWINGS

### **[0013]**

Fig. 1 is a cross sectional view showing an example of a hot air dryer for warp sizer in a related art;

Fig. 2 is a cross sectional view showing an embodiment of a hot air dryer for warp sizer according to the present invention; and

Fig. 3 is an enlarged cross sectional view showing another example of an air flow resistor in the embodiment of the hot air dryer shown in Fig. 2.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0014]** An embodiment of the present invention will be explained below with reference to drawings. Figure 2 is a view showing an embodiment of a hot air dryer for warp sizer in which two hot air circulating and exhausting systems 1a and 1b are connected along the running direction of warp 3. The hot air circulating and exhausting systems 1a and 1b are provided with hot air blower units 2a and 2b, and drying chambers 4a and 4b through which a number of threads of sized warp 3 are made to pass in a form of a sheet, respectively. Here, both of the drying chambers 4a and 4b are connected with each other in a portion drawn by a chain double-dashed line shown in the middle of the figure with the connected portion being isolated from the external air.

**[0015]** Each of the hot air blower units 2a and 2b comprises a steam heater 6, an electric heater 5, a blower 7, and a duct 8 for carrying the hot air. Each duct 8 is provided in the downstream portion of each of the drying chambers 4a and 4b and connected to the downstream portion of each blower 7 that sends the hot air from the steam heater 6 and the electric heater 5. A top of each duct 8 is opened as a hot air outlet opening 13 in the downstream portion of each of the drying chambers 4a and 4b toward the upstream portion in the running direction of the warp 3. In the upstream portion of each of the drying chambers 4a and 4b, there is positioned a hot air inlet opening 14 of each of the hot air blower units 2a and 2b.

**[0016]** In the hot air circulating and exhausting system 1a, positioned on the upstream side to the running direction of the warp 3, there is provided near the hot air inlet opening 14 an exhausting outlet 18 of the exhausting duct 8a that exhausts a part of the hot air through an exhausting fan 9a. Further, in the hot air circulating and

exhausting system 1b positioned on the downstream side, there is provided an exhausted air recovering duct 8b at an exhausting outlet 18 provided near the hot air inlet opening 14. The exhausted air recovering duct 8b has a supplied air outlet 19 at the downstream end thereof, which connects, through an exhausting fan 9b, the exhausted air recovering duct 8b to a hot air intake 20 of the steam heater 6 in the hot air circulating and exhausting system 1a positioned on the upstream side. The exhaust air is sent in the exhaust air recovering duct 8b through an exhausting fan 9b from the exhausting outlet 18 to the steam heater 6 in the hot air circulating and exhausting system 1a and made circulated therein.

**[0017]** Each of the drying chambers 4a and 4b are formed in a hollow rectangular solid. At an upstream end of the drying chamber 4a and at a downstream end of the drying chamber 4b, warp entrance 11 and warp exit 12 are formed, respectively. In the embodiment, a whole downstream end of the system 1a on the upstream side is connected to a whole upstream end of the system 1b on the downstream side. However, it may be possible to connect only a downstream end of the drying chamber 4a and an upstream end of the drying chamber 4b.

**[0018]** The hot air dryer for warp sizer according to the embodiment is provided with an air flow resister 15 in a hot air path between the hot air inlet opening 14 and the hot air outlet opening 13 in the drying chamber 4a on the upstream side. The air flow resister 15 locally reduces the cross sectional area of the passing hot air flow to increase a resistance to the passing hot air flow. In the embodiment, the air flow resister 15 is constituted by two resister plates 16 provided on upper and lower walls near the hot air inlet opening 14 in the drying chamber 4a. The width of each of the two resister plates 16 is approximately equal to an inner width of the drying chamber 4a.

**[0019]** Next, operation and action of the hot air dryer for warp sizer according to the embodiment will be explained. First, a number of threads of the warp 3 arranged in a sheet-like form are sized in an unillustrated warp sizing device. Thereafter, the sized warp 3 is introduced from the warp entrance 11 into the drying chamber 4a to pass through between the upper and lower resister plates 16 while running inside the drying chamber 4a. The warp 3 further runs through inside the chambers 4a and 4b and finally goes out from the warp exit 12 in dried state.

**[0020]** At this time, in the hot air circulating and exhausting system 1a positioned on the upstream side in the running direction of the warp 3, the hot air heated by the steam heater 6 and the electric heater 5 of the hot air blower unit 2a is blown out by the blower 7 into the drying chamber 4a from the hot air outlet opening 13, flows in the drying chamber 4a in the direction opposite to the running direction of the sheet-like warp 3, passes through between the upper and lower resister

plates 16 of the air flow resister 15, and returns to the hot air blower unit 2a through the hot air inlet opening 14. In the vicinity of the hot air intake 20 of the hot air blower unit 2a, the exhausted air from the hot air circulating and exhausting system 1b flowed through the hot air recovering duct 8b is mixed with the hot air returned from the hot air inlet opening 14. The mixed hot air is then heated by the heaters 5 and 6 before being blown out into the drying chamber 4a by the blower 7 to circulate along a hot air flowing path in the hot air circulating and exhausting system 1a.

**[0021]** Also in the hot air circulating and exhausting system 1b on the downstream side, the hot air heated by the steam heater 6 and the electric heater 5 is blown out by the blower 7 inside the drying chamber 4b from the hot air outlet opening 13 through the duct 8, flows in the drying chamber 4b in the direction opposite to the running direction of the sheet-like warp 3, and returns to the hot air blower unit 2b again through the hot air inlet opening 14.

**[0022]** In addition, a part of the hot air circulating in the hot air circulating and exhausting system 1b is exhausted from the exhausting outlet 18 provided near the hot air inlet opening 14 of the hot air blower unit 2b, but returned to the hot air circulating and exhausting system 1a through the exhaust air recovering duct 8b. Here, since the warp 3 in the hot air circulating and exhausting system 1a is so sufficiently wet as to be little affected by heat, the temperature of the hot air at the hot air outlet opening 13 in the system 1a on the upstream side is set higher than that at the hot air outlet opening 13 in the system 1b on the downstream side.

**[0023]** In the embodiment, in the downstream vicinity of the hot air inlet opening 14 in the drying chamber 4a, there are provided two resister plates 16 as the air flow resister 15. This throttles down the hot air flow in the drying chamber 4a to reduce the cross section thereof, which increases pressure in the drying chamber 4a in the downstream portion in the running direction of the warp 3 to the air flow resister 15. In addition, the volume of the hot air flow passing through and flowing out of the drying chamber 4a is reduced to further reduce the velocity of the hot air flow, which calms down the turbulent state of the hot air near the warp entrance 11 to reduce both of hot air flowing out of the warp entrance 11 and external air entering into there. This allows the hot air to conserve more heat and to be recovered with the conserved heat from the hot air inlet opening 14 for circulating in the hot air circulating and exhausting system 1a on the upstream side, resulting in realization of significantly high thermal efficiency.

**[0024]** A part of the hot air flowing in the drying chamber 4a is exhausted from the exhausting outlet 18 provided between the warp entrance 11 and the hot air inlet opening 14, by which the air circulating in the hot air dryer for warp sizer is gradually changed to exhaust moisture in the warp 3 after being sized.

**[0025]** According to the embodiment of the hot air

dryer for warp sizer, the downstream end of the drying chamber 4a and the upstream end of the drying chamber 4b are connected with external air being isolated, by which no external air is allowed to flow into the downstream end of the drying chamber 4a to cause no loss in heat quantity. In addition, the air flow resister 15 provided near the hot air inlet opening 14 in the hot air flow path between the hot air inlet opening 14 and the hot air outlet opening 13 in the drying chamber 4a increases the hot air pressure in the downstream portion of the air flow resister 15 in the drying chamber 4a to allow a part of the hot air blown out from the hot air outlet opening 13 to flow into the drying chamber 4b. This can prevent low temperature hot air in the drying chamber 4b from flowing into the downstream end of the drying chamber 4a from the upstream end of the chamber 4b. As a result, the downstream end of the drying chamber 4a can be prevented from causing nonuniform temperature distribution therein that causes the warp to be nonuniformly dried, by which the warp can be prevented from being provided with a deteriorated quality.

**[0026]** The air flow resister 15 causes turbulence of the hot air flow. The turbulence due to the air flow resister 15, however, has little influence on the warp 3 because the air flow resister 15 is provided near the hot air inlet opening 14 where the hot air flow is naturally in turbulent state.

**[0027]** The part of the hot air blown out of the hot air outlet opening 13 in the hot air circulating and exhausting system 1a on the upstream side and flowing into the drying chamber 4b is returned to the hot air circulating and exhausting system 1b on the downstream side. A part of this is further returned to the system 1a on the upstream side again by the exhaust air recovering duct 8b. In this way, the exhausted air from the system 1b on the downstream side is recovered without any loss to result in realization of significantly high thermal efficiency.

**[0028]** The resister plates 16 are for reducing a cross sectional area of the passing hot air flow. For achieving this purpose, one of them may be provided only on either the upper or the lower wall of the drying chamber 4a. Further, it may not be necessary to provide it over the whole width of the drying chamber 4a. In addition, for the resister plates 16 provided both on the upper and lower walls of the drying chamber 4a, the resister plates 16 may not necessarily be provided with the same height.

**[0029]** The resister plates 16 of the air flow resister 15 may be provided with the height thereof further made variable as shown in Fig. 3, by which the resistance to the air flow can be made adjustable. The air flow resister 15 comprises, for example, a pair of the resister plates 16 each attached to a bracket 20. The resister plate 16 is provided with a vertical slot 21 so that the resister plate 16, secured to the bracket 20 with a bolt and nut 22, is allowed to be adjustable in the direction of height.

**[0030]** With this structure, by changing the position

of the attached resister plate 16 in the direction of height depending on the condition of the warp, the resistance to the hot air flow can be adjusted to prepare the pressure and hot air flow in the drying chamber in optimum conditions.

**[0031]** In the hot air dryer for warp sizer according to the present invention, the exhausted air from the hot air circulating and exhausting system on the downstream side is recovered in the hot air circulating and exhausting system on the upstream side, and both of the drying chambers on the upstream and downstream sides are connected with each other with external air being isolated for preventing the external air from flowing into the drying chambers to improve thermal efficiency. In addition the air flow resister is provided in the drying chamber on the upstream side to reduce the amount of the hot air passing through the drying chamber on the upstream side, calm down turbulence in the flow near the warp entrance for preventing the external air from entering into the warp entrance, and further improve thermal efficiency. The air flow resister thus provided further brings about a pressure increase in the drying chamber on the upstream side, which prevents the hot air in the drying chamber on the downstream side, with a temperature not so high, from entering into the drying chamber on the upstream side and causing nonuniform temperature distribution in the drying chamber. This can prevent the warp from being nonuniformly dried due to the nonuniform temperature distribution in the drying chamber.

**[0032]** While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details can be made therein without departing from the spirit and scope of the invention.

## Claims

1. A hot air dryer for warp sizer comprising two hot air circulating and exhausting systems(1a, 1b) disposed on an upstream side and a downstream side along a running path of warp(3), respectively, each system(1a,1b) comprising a drying chamber(4a,4b) and a hot air blower unit(2a,2b) for circulating a hot air between the drying chamber(4a,4b) and the hot air blower unit(2a,2b) so that the hot air flows in the direction opposite to the running direction of the warp(3) in the drying chamber(4a,4b) with a part of the hot air being exhausted outside the system(1a,1b), and an exhausted air recovering duct(8b) connecting the hot air circulating and exhausting system(1b) on the downstream side to the hot air blower unit(2a) in the system(1a) on the upstream side for sending exhausted air from the system(1b) on the downstream side to the hot air blower unit(2a) in the system(1a) on the upstream side,

and characterized by:

both of the drying chambers(4a,4b) in the systems(1a,1b) on the upstream and downstream sides are connected with each other so that the warp(3) is allowed to run through a connected portion with the connected portion of the chambers(4a,4b) being isolated from external air, and an air flow resister(15) for reducing a cross sectional area of the passing hot air flow is provided in a hot air path between a hot air outlet opening(13) and a hot air inlet opening(14) in the drying chamber(4a) in the system(1a) on the upstream side.

2. A hot air dryer for warp sizer as claimed in claim 1, wherein the hot air blower unit(2a, 2b) comprises a heater(6) for heating the hot air and a blower(7) for sending the hot air heated by the heater(6) to the drying chambers(4a,4b), the heater(6) being provided with a hot air intake(20), and the exhausted air recovering duct(8b) being connected to the hot air intake(20) of the heater(6) in the hot air blower unit(2a) in the system(1a) on the upstream side.
3. A hot air dryer for warp sizer as claimed in claim 1 or claim 2, wherein the exhausted air recovering duct(8b) is provided with an exhausting fan(9) for recovering a specified amount of the exhausted air.
4. A hot air dryer for warp sizer as claimed in claim 1, 2 or claim 3, wherein the drying chamber (4a) in the system (1a) on the upstream side is provided with an exhausting duct (8a) near the hot air inlet opening (14) for exhausting a part of the hot air.
5. A hot air dryer for warp sizer as claimed in any preceding claim, wherein the air flow resister (15) is provided near the hot air inlet opening (14).
6. A hot air dryer for warp sizer as claimed in any preceding claim, wherein the air flow resister (15) is provided so that the cross sectional area of the passing hot air flow is made freely adjustable.

FIG.1

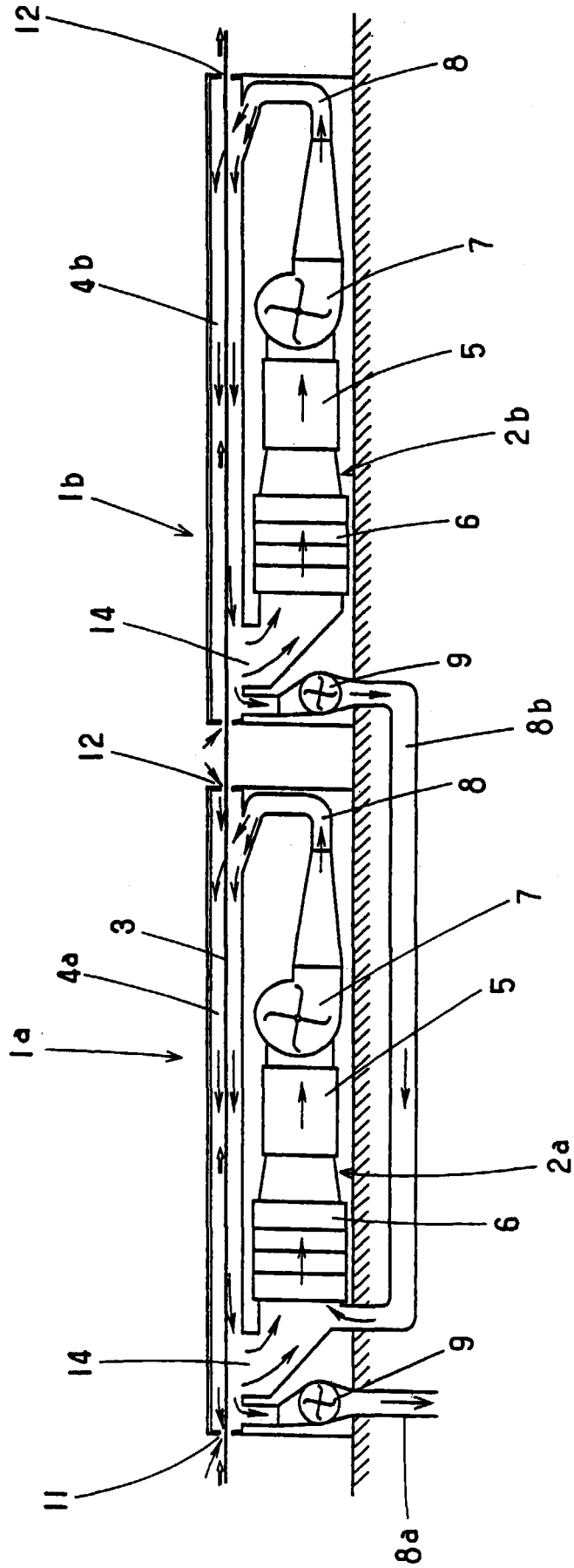
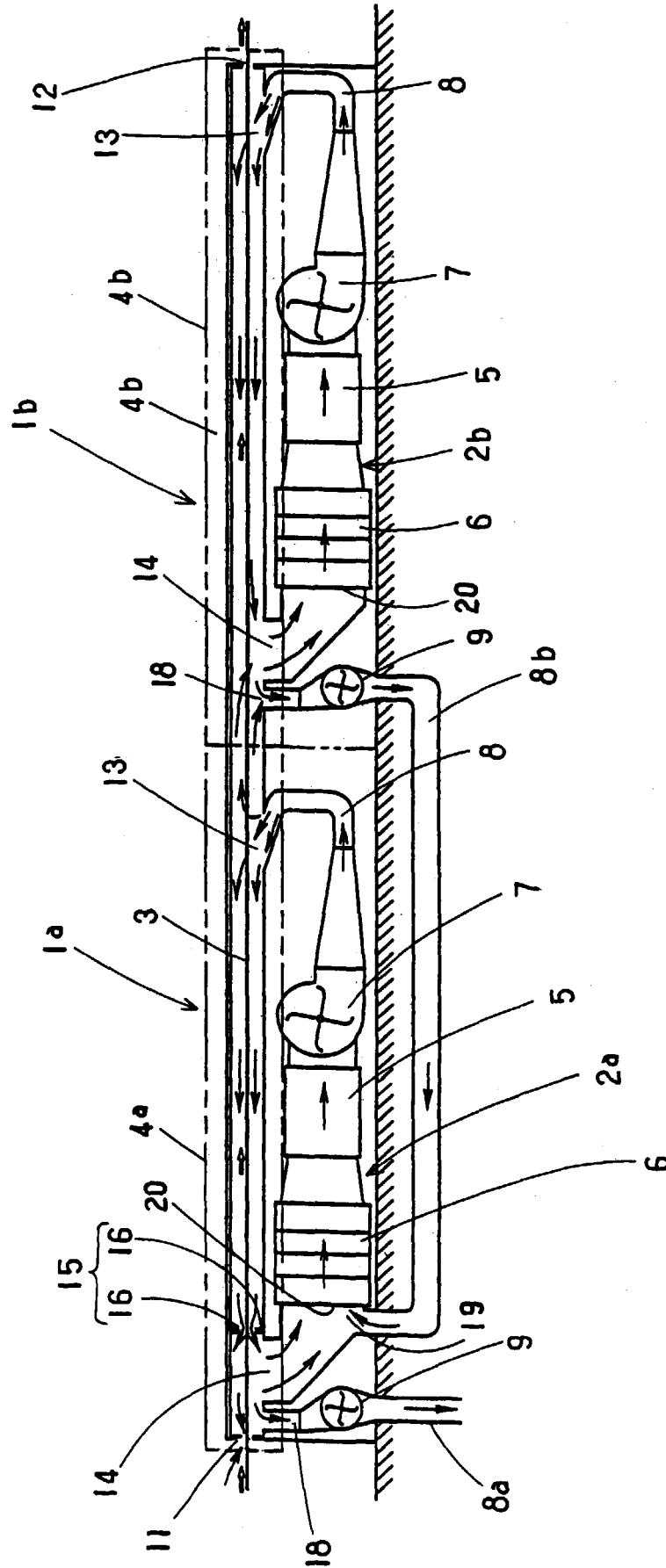


FIG.2



**FIG.3**

