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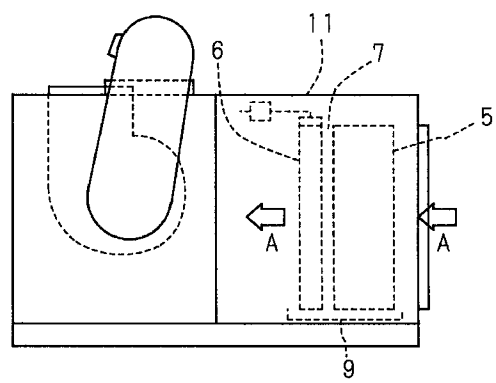
(54) Heat Exchange Coil

(57) A heat exchange coil wherein fin groups (5,6,10) composed of plural plate fins (1) parallel to each other are disposed at a specified interval in the draft direction, and pipes (2) for passing heat medium penetrate into these plural plate fins (1) plural times in the draft direction, thereby enhancing the heat transmission ability and heat exchange efficiency, and preventing drain from dispersing.

FIG. 2



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Description

BACKGROUND OF THE INVENTION

The present invention relates to a heat exchange coil used in a heat-exchanger wherein air is forcibly sent, such as an air-conditioner.

A conventional heat exchange coil used in an air-conditioner is structured as shown in FIG. 1. This coil 21 is composed by inserting pipes 24 for passing heat medium plural times in the draft direction into plural plate fins 23 disposed parallel to each other face to face. In the diagram, a hollow arrow A indicates the draft direction. The wind velocity is limited to 2.5 to 3.0 m/s in a large-sized product such as air handling unit; or the wind velocity is limited to 1.5 to 2.0 m/s in a small-sized product such as fan coil. The reason is that when the wind velocity exceeds the limits (for example, 4.5 to 5.0 m/s in a large-sized product, or 3.0 m/s in a small-sized product), the heat transmission capacity is lowered or air resistance is increased, or in the case of cooling and dehumidifying operation, the drain (condensate) may disperse leeward through the fins, whereby water may leak outside from the air-conditioner. In the coil 21 structured as shown in FIG. 1, it is hard to solve these problems. Moreover, the limitation of the wind velocity causes the air-conditioner itself to enlarge, so that the cost is increased.

In the case of heating operation, as shown in FIG. 1, it is necessary to install a humidifier 22 of various types, such as vaporization type, steam type, pan type and water spray type, in addition to the coil 21. Such humidifier 22, however, is very expensive, almost equal to the coil or more in price. Moreover, for example, in the humidifying method of vaporization type humidifier, since moisture evaporation accompanied by air contact is utilized, the effective feed water utilization rate showing how much of the water feed amount to the humidifier (= effective humidifying amount/feed water amount) is actually added to the passing air is low, and the water running out of the humidifier not utilized for humidifying is directly discarded, which is very uneconomical.

BRIEF SUMMARY OF THE INVENTION

The invention is devised to solve the above problems, and it is an object of the invention to present a heat exchange coil having high ability in high speed draft operation and capable of preventing drain from dispersing.

A heat exchange coil of the invention comprises plural fin groups disposed at a proper interval in the draft direction, each fin group including plural plate fins disposed parallel to each other face to face. In these plural plate fins, plural pipes for passing heat medium are inserted so as to be arranged in a direction orthogonal to the draft direction, and each pipe is inserted into a plate fin plural times in the draft direction. Accordingly, the air guided into the coil contacts with edges of fin groups plural times, and the front edge effect is increased, so that the heat transmission ability and heat exchange efficiency are enhanced. The drain generated by heat exchange falls down through gaps between the fin groups. It is therefore possible to prevent the drain from dispersing outside even when cooling and dehumidifying operation is done at high speed.

Herein, when the fin pitch (fin interval) on the most leeward side is smaller than the fin pitch on the windward side, a pressurizing action is applied on the windward side. As a result, the air passing through the coil does not directly pass through the windward fin groups, but is diffused to contact sufficiently therewith, so that the heat transmission effect and heat exchange efficiency are improved. Still more, by setting the windward fin pitch more than a predetermined value, pressure loss can be prevented. In this constitution, since the fin group on the most leeward side functions as heat exchanger and eliminator, it is not necessary to install an independent eliminator. Hence, the air-conditioner is reduced in size and saved in cost. Moreover, by passing heat medium in the pipe from the leeward side to the windward side, the heat transmission is elevated in the leeward fin group having smaller in the fin pitch. When the edges at least on the windward side of the plate fins are formed in zigzag, the contact area with the air increases, so that the heat exchange efficiency is enhanced.

It is another object of the invention to present a heat exchange coil functioning also as a humidifier.

The heat exchange coil of the invention further comprises means for feeding humidifying water to the fin group of the leeward side among plural fin groups disposed at a predetermined interval in the draft direction. It is therefore possible to use the coil itself as humidifier regardless of high speed or low speed. Accordingly, the coil of high performance and multiple functions can be presented. In the fin group where humidifying water is supplied, the moisture in the humidifying water contacts with the coil passing air to exchange heat, and the heat is also exchanged with the pipes and fins to which the heat of the heat medium is transferred, so that the humidifying water is likely to be evaporated. Therefore, as compared with the commercial vaporization type humidifier, the feed water utilization efficiency is high, and water can be saved, and the running cost is reduced. In heating operation, moreover, the fin group in which the humidifying water is supplied can be utilized as the humidifier, while in cooling operation this fin group can be utilized as the heat exchanger and eliminator. Therefore it is not necessary to install such expensive appliances, and the air-conditioner may be made further compact and reduced in cost.

The sectional shape of the pipe is elliptical or oval, and when the direction of its longer diameter is nearly equal to the direction, the air resistance in the coil can be decreased, and elevation of required power can be prevented. Or, by inclining the direction of the longer diameter of ellipse or oval downward in the state of installation toward the gaps among fin groups, the drain can be guided into the gaps in the direction. Further, by varying the direction of longer diameter in every file, in every rank, or individually, generation of turbulence in the coil enhances the heat exchange efficiency, and the retention time of the humidifying water is extended, so that the feed water utilization efficiency is enhanced.

Alternatively, slits are formed to corrugate the plate fins, the direction of the slits in the fin group in which humidifying water is not supplied is nearly orthogonal to the draft direction, and the direction of the slits in the fin group in which humidifying water is supplied is nearly equal to the draft direction or inclined. As a result, heat exchange in the fin group in which humidifying water is not supplied, and humidification in the fin group in which humidifying water is supplied can be done most efficiently.

Moreover, in the fin group on the most leeward side, pipes are penetrated in one or two lines in the direction orthogonal to the draft direction, and when equal to or wider than the fin width per line in other fin groups, the drain dispersion can be prevented further securely, and the heat transmission ability and humidifying ability in the most leeward side fin group can be further enhanced.

The above and further objects and features of the invention will more fully be apparent from the following detailed description with accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. 1 is a longitudinal sectional view showing a conventional heat exchange coil;

FIG. 2 is a schematic side view showing essential parts of an air-conditioner employing a heat exchange coil according to the invention;

FIG. 3 is a perspective view showing a heat exchange coil in embodiment 1;

FIG. 4 is a longitudinal sectional view in line IV-IV in FIG. 3;

FIG. 5 is a longitudinal sectional view showing another heat exchange coil;

FIG. 6 is a lateral sectional view in line V-V in FIG. 4;

FIG. 7 is a longitudinal sectional view showing a heat exchange coil according to embodiment 2;

FIG. 8 is a longitudinal sectional view showing a heat exchange coil according to embodiment 3;

FIG. 9 is a longitudinal sectional view showing a heat exchange coil according to embodiment 4;

FIG. 10 is a longitudinal sectional view showing a heat exchange coil according to embodiment 5;

FIG. 11 is a longitudinal sectional view showing a heat exchange coil according to embodiment 6;

FIG. 12 is a longitudinal sectional view showing a heat exchange coil according to embodiment 7;

FIG. 13 is a longitudinal sectional view showing a heat exchange coil according to embodiment 8;

FIG. 14 is a longitudinal sectional view showing a heat exchange coil according to embodiment 9;

FIG. 15 is a diagram showing a modified example of leeward part shown in FIG. 7;

FIG. 16 is a front view showing a heat exchange coil according to embodiment 10;

FIG. 17 is a front view showing a heat exchange coil according to embodiment 11;

FIG. 18A is a diagram showing the slit shape in a plate fin according to embodiment 12;

FIG. 18B is a sectional view showing the plate fin in line B-B in FIG. 17A;

FIG. 19 is a diagram showing another slit shape in the plate fin;

FIG. 20 is a diagram showing still another slit shape in the plate fin; and

FIG. 21 is a sectional view showing the plate fin in line X-X in FIG. 18A.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, some of the preferred embodiments of the invention are described in detail below.

Embodiment 1

FIG. 2 is a schematic side view showing essential parts of an air-conditioner employing a heat exchange coil of the invention. FIG. 3 is a perspective view showing the heat exchange coil. In the drawings, a hollow arrow A indicates the draft direction. The heat exchange coil comprises multiple plate fins 1 parallel to each other face to face, pipes 2 of U-bends or the like inserted in the multiple plate fins 1 in plural lines in the longitudinal and lateral directions, and headers 15 at inlet and outlet of heat medium communicated and coupled with both ends of each pipe 2, wherein the multiple plate fins 1 have their upper end and lower end supported respectively by an upper frame 3 and a lower frame 4 (see FIG. 4).

FIG. 4 is a schematic longitudinal sectional view along line IV-IV in FIG. 3 of the heat exchange coil of embodiment 1. FIG. 6 is a schematic lateral sectional view along line V-V in FIG. 4. This heat exchange coil is divided into a windward portion 5 (a fin group) and a leeward portion 6 (a fin group), which are disposed at a predetermined interval L so as to form a drain cut gap 7. The interval L is set appropriately depending on the draft speed, dehumidifying amount or the like so that the drain produced in the windward portion 5 may not invade into the leeward portion 6. For example, it is set at 5 to 20 mm so that the coil may not be so thick in the draft direction A. In the lower frame 4 corresponding to the drain cut gap 7, a drain discharge hole 8 is formed.

A drain pain 9 is provided beneath the lower frame 4.

As shown in FIG. 4, in one slender fin 1 in the leeward portion 6, pipes 2 are inserted in one line (or two lines as shown in FIG. 5) in the vertical direction orthogonal to the draft direction. In order to minimize the pressure loss in the windward portion 5, induce the pressurizing action more securely, improve the heat transmission ability and heat exchange efficiency with optimal, and capture the drain most securely in the leeward portion 6, the fin pitch (fin interval) E in the leeward portion 6 is preferred to be as small as possible, and it is set at, for example, 1.8 to 2.2 mm. The fin pitch P in the windward portion 5 should be equal to or larger than the fin pitch E in the leeward portion 6, and the relation is preferred to be $E < P < 2E$ as shown in FIG. 6.

The heat medium such as cold water or warm water passing through the pipes 2 is supplied from the header 15 coupled with the leeward portion 6 side end, and is discharged into the header 15 coupled with the windward portion 5 side end, and flows continuously from the leeward portion 6 to the windward portion 5.

A humidifying water feed device 11 for feeding humidifying water into the leeward portion 6 is provided above the leeward portion 6. The humidifying water feed device 11 comprises water treating means 12 such as water purifier or filter, and a permeation member 13 fitted to the upper frame 3 above the leeward portion 6. The tap water sent from a water feeder is treated in the water treating means 12 to become humidifying water such as purified water by removing chloride of lime and other impurities to prevent sticking of hard scale, and is supplied into the permeation member 13. The humidifying water supplied into the permeation member 13 is filtered, and is transmitted to the fins 1 and pipes 2 in the leeward portion 6 through humidifying water passing holes provided in the upper frame 3, thereby wetting them.

When cooling and dehumidifying operation is done at high wind velocity exceeding, for example, 3 m/s using such a coil, the drain generated in the windward portion 5 is discharged into the drain pan 9 through the drain cut gap 7 and the drain discharge hole 8. At this time, also in the leeward portion 6, the air is cooled, and drain is generated. But the amount is small, and therefore, by eliminator-like action of the leeward portion 6, the drain is captured and held between the adjacent fins 1 of the leeward portion 6 by the surface tension. Consequently, even when receiving wind at high velocity, it does not disperse leeward (out of the drain pan 9) from the leeward portion 6, but falls into the drain pan 9 through the leeward portion 6.

Herein, to minimize the drain amount generated in the leeward portion 6, the number of lines of the pipes 2 in the leeward portion 6 is preferred to be one or two, and if more than two, the drain generation in the leeward portion 6 increases, which is not preferred.

Meanwhile, the air passing through the coil is small in resistance in the windward portion 5 because the fin pitch is large, and the pressure loss is prevented, while it is diffused by the pressurizing action of the leeward portion 6 which is smaller in fin pitch than the windward portion 5. Therefore, without passing directly through the windward portion 5, the air sufficiently contacts with the fins 1 of the windward portion 5, and heat is transferred (that is, the bypass factor is small). Still more, the leeward portion 6 is the inlet side of heat medium, and has the small fin pitch, so that the heat transmission rate is raised. In addition, since the air contacts twice, with the edge 5b of the windward side of the windward portion 5 and the edge 6a of the windward side of the leeward portion 6, and the edge effect is doubled, and therefore the heat transmission ability and heat exchange efficiency are enhanced as compared with the coil which is not divided as shown in FIG. 1. Thus, heat is exchanged with air efficiently in both the windward portion 5 and the leeward portion 6, and the coil of high ability is obtained, and it also functions as eliminator.

When the fin pitch E of the leeward portion 6 is less than 1.8 mm, the air resistance is increased in the leeward portion 6, which is not preferred. Or when the fin pitch E exceeds 2.2 mm the pressurizing force drops, and the bypass air increases in the windward portion 5, and the coil ability drops, and the drain is not securely held between the fins in the leeward portion 6, but it is easily released by the wind pressure from the fins 1 to scatter, which is not preferred. Yet, when the fin pitch P of the windward portion 5 is more than two times the fin pitch E of the leeward portion 6, the heat transmitting area and the contact air decrease, and the heat transmission ability and heat exchange efficiency are lowered, which is not preferred. Or when the fin pitch P of the windward portion 5 is not larger than the fin pitch E of the leeward portion 6, it is not preferred because the pressure loss is large.

In the case of heating operation by using this coil and heating the air, when humidifying water is supplied to the leeward portion 6 by the humidifying water feed device 11, the moisture contacts with the coil passing air to exchange heat for latent heat of vaporization thereof. In addition, heat is also exchanged with the pipes 2 and fins 1 to which the heat of the heat medium is transferred. Therefore, as compared with the vaporization and evaporation by air-liquid contact only, the humidifying water quickly is vaporized and evaporated, thereby humidifying the coil passing air. Therefore the humidifying ability and feed water effective utility rate are enhanced, and waste of water is eliminated. Still more advantageously, the humidifying water feed device 11 can be easily manufactured at low cost by using a water purifier, permeation member on the market, and so on.

Incidentally, when the humidifying water is passed into the coil not divided as shown in FIG. 1, the heat exchange ability is lowered, which is not suited to practical use. But in the invention, since the windward portion 5 and the leeward portion 6 are completely separated, so that heat and humidifying water does not interfere each other. Therefore the windward portion 6 functions as heat exchanger and the leeward portion 6 as humidifier, independently. Moreover, generally, since the heating load is smaller than the cooling load, the heating load can be covered only by the windward portion 5, and the leeward portion 6 having one or two lines of pipes 2 may be utilized as humidifier. Therefore, a practical heat exchange coil can be obtained. When using this coil also as humidifier, it can be employed regardless of the level of wind velocity.

Embodiment 2

FIG. 7 shows an embodiment in which the fin width T of the leeward portion 6 is about two times as large as the fin width S per line of the windward portion 5. The other construction is the same as that of embodiment 1 in FIG. 4, and same reference numerals are given and explanation is omitted. In this constitution, the heat transmitting area of the leeward portion 6 is increased, and hence, the coil ability and humidifying ability are enhanced. In particular, since the cold or warm water, which is heat medium, flows from the leeward portion 6 to the windward portion 5 side, the heat transmission ability is raised, and the heat exchange efficiency is improved, so that the coil ability and humidifying ability may be further greater.

Embodiment 3

In FIG. 7, the pipes 2 of the leeward portion 6 are arranged in one line, and this line is disposed in the center of the fin width T, whereas, in FIG. 8, this line is off-centered to the windward side from the center.

In embodiment 3, the heat medium flows in the pipes 2 installed at the windward side of the leeward portion 6, and the heat medium is not supplied to the leeward side thereof. Therefore the windward side of the leeward portion 6 functions as heat exchanger, eliminator and humidifier, while the leeward side functions as eliminator and humidifier. As a result, drain capturing and holding ability and humidifying ability are enhanced.

The line of the pipes 2 may be off-centered to the leeward side (FIG. 15).

Embodiment 4

In FIG. 9, holes for passing the pipes 2 in the leeward portion 6 are provided in two lines, and the pipes 2 are installed in the windward line, and the leeward line is a hole line without installing pipes 2. In this embodiment, the fin 1 on the leeward side is produced by cutting a plate produced in the same manner as that for the fin on the windward side, thereby reducing the cost.

Embodiment 5

In embodiments 1 to 4, the section of the pipes 2 is circular, but it may be also elliptical (or oval) as shown in FIG. 10. Here, the longer diameter direction of the ellipse (or oval) in the section is same as the draft direction A. The other constitution is same as in embodiment 1 shown in FIG. 4, and same reference numerals are given and explanation is omitted. In this constitution, even when the air flows at high velocity, the resistance is not large, and elevation of required power can be prevented.

Embodiment 6

In FIG. 11, same as in embodiment 5, the section of the pipes 2 is elliptical (or oval), but in the windward portion 5, its longer diameter direction is inclined to be lowered toward the drain cut gap 7 at the leeward side, and in the leeward portion 6, its longer diameter direction is inclined to be lowered at the windward side. In this way, the air led into the coil flows nearly along a parabola having the lowest point (bottom) in the drain cut gap 7 due to the shape of the pipes 2, thereby acting to move the drain downward toward the drain cut gap 7. As a result, discharge of drain in the drain cut gap 7 and prevention of drain dispersion in the leeward portion 6 can be achieved more securely. Moreover, the wind direction in the leeward portion 6 is the direction so as to arrest drop of humidifying water when humidifying. Consequently, the retention time of the humidifying water is long, and the humidifying ability and feed water utility rate are heightened.

Embodiment 7

As shown in FIG. 12, when the longer diameter direction of the section of the pipes 2 is arbitrary and irregular in the windward portion 5 and the leeward portion 6, the air flows turbulently, and the heat exchange efficiency is enhanced. When humidifying, the humidifying water is led and guided by the pipes 2 to fall zigzag. Therefore, the retention time of the humidifying water is long, and the humidifying ability and feed water utility rate are heightened, efficiently. The absolute value of the intersection angle of the longer diameter direction and the draft direction A is, for example, 45 degrees or less, whereby pressure loss is prevented.

The longer diameter direction of the pipes 2 may be different in every file, different in every rank, or free in arrangement, besides the zigzag configuration in FIG. 12.

Embodiment 8

FIG. 13 shows the fins 1 having confronting edges on both sides of the drain cut gap 7 (a leeward edge 5a of the windward portion 5 and a windward edge 6a of the leeward portion 6) in wave form (or an uneven form such as zigzag), in the windward portion 5 and leeward portion 6. As a result, the edge effect is further increased, and the heat exchange efficiency is enhanced. Moreover, besides the edges 5a and 6a, when other edges 5b and 6b are also unevened, the heat exchange efficiency is further enhanced. Such constitution can be applied to all embodiments.

Embodiment 9

FIG. 14 shows an embodiment in which one plate fin 1 is divided into three, further forming an intermediate portion 10 between the windward portion 5 and the leeward portion 6. Drain cut gaps 7 are formed between the windward portion 5 and the intermediate portion 10, and between the intermediate portion 10 and the leeward portion 6, and a drain discharge hole 8 is provided in the lower frame 4 corresponding to each drain cut gap 7. Moreover, a humidifying water feed device 11 is provided for feeding humidifying water to the leeward portion 6. The other constitution is same as that in FIG. 4.

In this constitution, since the coil passing air sequentially contacts with the edges of the windward portion 5, the intermediate portion 10, and the leeward portion 6, the edge effect is increased, and the heat exchange efficiency is further enhanced. Moreover, the intermediate portion may be divide to plural portions in the draft direction A, and the drain cut gap(s) 7 may be provided between the portions. In this case, corresponding to each drain cut gap 7, the drain discharge hole 8 may be provided in the lower frame 4. Besides, corresponding to the heating load and humidifying amount, the humidifying water feed device 11 may be provided to supply humidifying water for both the leeward portion 6 and the intermediate portion 10.

In the embodiment shown in FIG. 14, the leeward portion 6 has one or two lines of pipes 2, and the fin pitch E of minimum (preferably 1.8 to 2.2 mm). The fin pitch P of the windward portion 5 and intermediate portion 10 is equal to or larger than that of the leeward portion 6 (preferably $E < P < 2E$). Accordingly, the leeward portion 6 can be used as a heat exchanger, an eliminator and a humidifier, and drain dispersion can be prevented securely, in addition, it is possible to humidify efficiently.

The fin width T of the leeward portion 6 is preferred to be equal to or more than the fin width S of the intermediate portion 10 and windward portion 5. In this case, the line of the pipes 2 may be located in the center as shown in FIG. 7, or off-centered to the windward side as shown in FIG. 8 (or to the leeward side as shown in FIG. 15). Moreover, as shown in FIG. 9, holes may be formed in two lines, and the pipes 2 may be installed in the windward side line of holes to pass heat medium. Whereby the windward side may function as the heat exchanger, the eliminator and the humidifier, and the leeward side may function as the eliminator and the humidifier. Further, the sectional shape of the pipes 2 may be elliptical (or oval) as shown in FIGS. 10 to 12, and the edge of the fins 1 may be unevened as shown in FIG. 13.

Embodiment 10

The humidifying water feed device 11 may comprise a heater 14 for heating the humidifying water, as shown in FIG. 16. In this case, vaporization and evaporation of the humidifying water may be further promoted.

Embodiment 11

As shown in FIG. 17, instead of the constitution of comprising the heater 14, it is also preferred to compose so that a feed water pipe 17 of the humidifying water feed device 11 is wound around the header 15, wherein the humidifying water temperature is elevated by contacting with the header 15 with transmitting heat, for example.

Embodiment 12

The plate fin 1 is structured as shown in FIG. 18A, in which multiple bridge-shaped raised slits 16 and step portions 18 are formed to make it corrugated. FIG. 18B is a sectional view alone line B-B in FIG. 18A. FIG. 19 is a sectional view alone line X-X in FIG. 18A. The step portion 18 has a concave portion on one surface of the fin and a convex portion on the other surface. The step portion 18 is formed in the longitudinal direction orthogonal to the draft direction A for preventing the water from moving leeward (stop water effect) and guiding it downward (discharge effect). In this way, the step portion 18 functions as a discharge pass, so that the drain can be discharged smoothly, thereby enhancing the drain dispersion preventing effect.

Preferably, a plurality of step portions are arranged with intervals in the draft direction A. The depth (height) H of the step portion 18 may be not smaller than a maximum dimension of water thickness T, it is desirably that $H > T$.

The most effects of stopping water and discharging water is obtained when the step portion 18 is formed continuously between the upper and lower portions of the fin 1 with straight. It may be formed discontinuously, zigzag, or meanderingly, corresponding to the degree of a desired effect. The sectional shape of the step portion 18 is not limited to the trapezoid shown in FIG. 19, and it may be various shapes such as semi-circle, square, and so on. In addition, it is variable with respect to the number, position and depth (height) H.

The direction of the slits 16 can be set freely, it may be the longitudinal direction orthogonal to the draft direction A as shown in FIG. 18A, the same lateral direction as the draft direction A as shown in FIG. 19, the oblique direction to the draft direction A as shown in FIG. 20 or others. With the plate fin 1 shown in FIG. 18A, the edge effect is increased, so that the heat transmission ability and heat exchange efficiency are enhanced. With the plate fin 1 shown in FIG. 19, the humidifying water stays in the fin 1, and hence it hardly flows down directly. With the plate fin 1 shown in FIG. 20, the humidifying water is led and guided zigzag, and thereby hardly flowing down directly.

In particular, in the windward portion 5 where humidifying water is not supplied, the direction is orthogonal to the draft direction A as shown in FIG. 18A, and in the leeward portion 6 where the humidifying water is supplied, the direction is same as the draft direction A, or the oblique direction as shown in FIG. 20. Whereby the heat transmission effect is enhanced in the portion where the humidifying water is not supplied, while, in the portion where the humidifying water is supplied, lowering of heat transmission ability and pressure loss are suppressed, and the fall distance and time of humidifying water are extended to the maximum limit, so that the feed water effective utilization rate is further enhanced. The dimensions and shape of the raised slits 18 are not limited to the illustrated example. Or, omitting the recesses 18, only the raised portions (slits 16) may be formed.

Moreover, for the purpose of giving hydrophilic property (wettability), hydrophilic coating films 31 are formed on the surfaces of the plate fin 1. The contact angle of the plate fin 1 and the water is 30° , preferably 15° . The film 31 makes the water held by the fin 1 with cooling condensation sufficiently thin films. Thus, the water receives smaller air pressure. As a result, the water hardly flows leeward with high speed coil passing air, but easily flows downward, thereby further enhancing the drain dispersion preventing effect. In addition, the contact area of the water and fin 1 is made larger, so that wetting heat transmitting surface, wetting surface coefficient and heat transmitting coefficient are made larger, thereby elevating the cooling ability of the coil passing air. When the humidifying water feed means is provided, magnification of the contact area enhances heat exchange efficiency. Since the maximum dimension of water thickness T is reduced, the depth (height) H of the step portion 18 shown in FIG. 19 can be designed to be small.

The above construction of hydrophilic coating film may be applied to the all embodiments. The means for giving hydrophilic property is not limited to coating film.

In the foregoing embodiments, it is free to change the fin pitch of the coil parts, and the number of lines of the coil parts as required. Besides, the heat medium may be also passed in the reverse direction, that is, from the windward side to the leeward side. It is also free to modify the constitution of the humidifying water feed device 11, and, for example, by omitting the water treating means 12 such as the water purifier, filter or other, the tap water may be directly supplied as the humidifying water. In such a case, by passing the humidifying water (by increase the flow rate properly) for a predetermined period after stopping of draft, the fins 1 are cleaned, and deposits of dust and hard scale may be prevented.

The heat exchange coil of the invention may be used in a small-sized air-conditioner such as a fan coil, or a large-sized air-conditioner such as an air handling unit.

Claims

1. A heat exchange coil used in a heat-exchanger wherein air is forcibly sent, comprising:

   plural fin groups (5,6,10) disposed at a specified interval in the draft direction, each of which includes plural plate fins (1) disposed parallel to each other; and
   pipes (2) penetrating through said plate fins (1) for passing heat medium.

2. A heat exchange coil of claim 1, wherein the interval of the fins at the leeward side is smaller than the fin pitch at the windward side.

3. A heat exchange coil of claim 1 or 2, further comprising humidifying water feed means (11) for feeding humidifying water to the leeward side fin groups (6).

4. A heat exchange coil of claim 1 or 2, wherein the sectional shape of said pipe (2) is elliptical or oval, and the longer diameter direction of the ellipse or oval is nearly equal to the draft direction.

5. A heat exchange coil of claim 1 or 2, wherein the sections of said pipes (2) are arranged in a plurality of files and ranks, the shape of said section is elliptical or oval, and the longer diameter direction of the ellipse or oval is different in every file, in every rank, or individually.

6. A heat exchange coil of claim 1 or 2, further comprising humidifying water feed means (11) for feeding humidifying water to the leeward side fin group (6), wherein raised slits (16) are provided to form corrugations in each plate fin (1), whose direction in the fin group (5) where humidifying water is not supplied is nearly orthogonal to the draft direction, and whose direction in the fin group (6) where humidifying water is supplied is nearly equal to the draft direction or inclined.

7. A heat exchange coil of claim 1 or 2, wherein pipes (2) are subjected to penetrate in the fin group (6) at the most leeward side in one line or two lines in the direction orthogonal to the draft direction, and the

plate fins (1) in this fin group are equal to or wider than the fin width per line of the plate fins (1) in other fin groups (5).

8. A heat exchange coil of claim 1 or 2, wherein a step portion (18) is formed for preventing water condensated by heat exchange from moving leeward, in the plate fin (1).

9. A heat exchange coil of claim 1 or 2, wherein the surface of the plate fin (1) is processed so as to have hydrophilic property.

FIG. 1
PRIOR ART

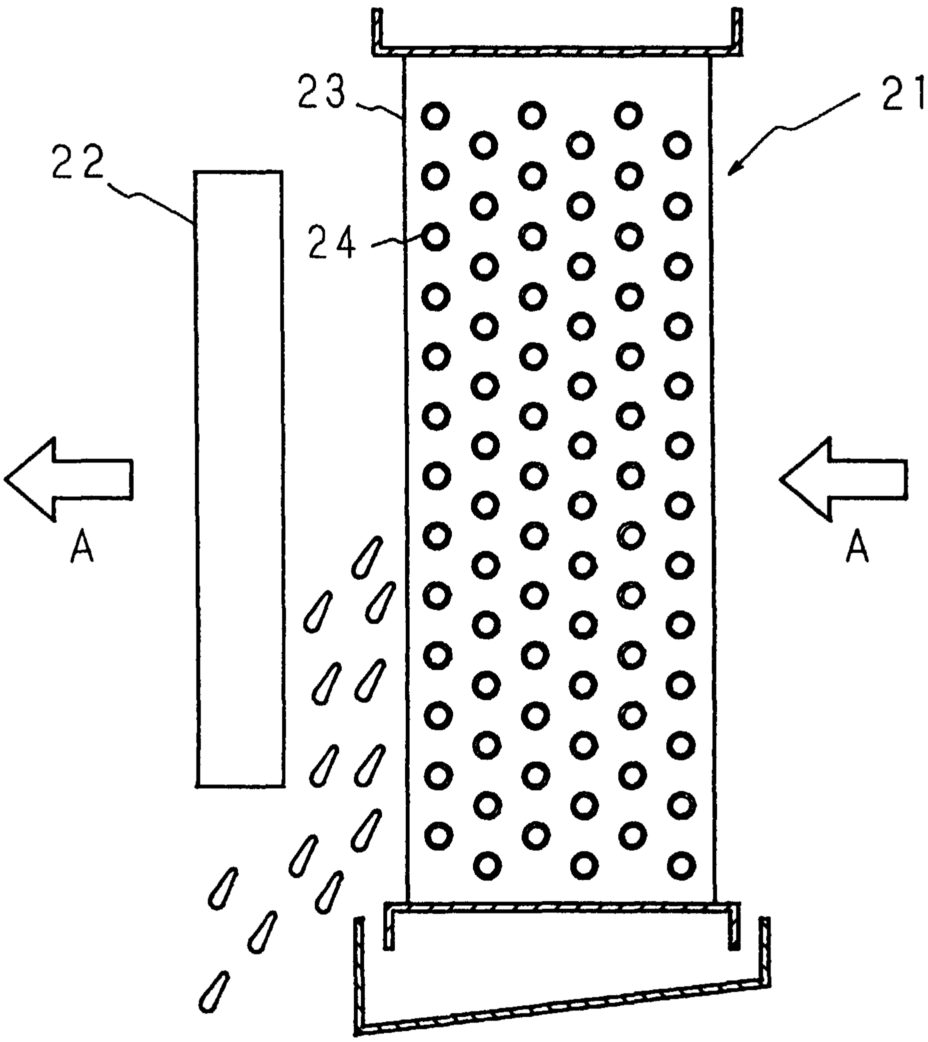


FIG. 2

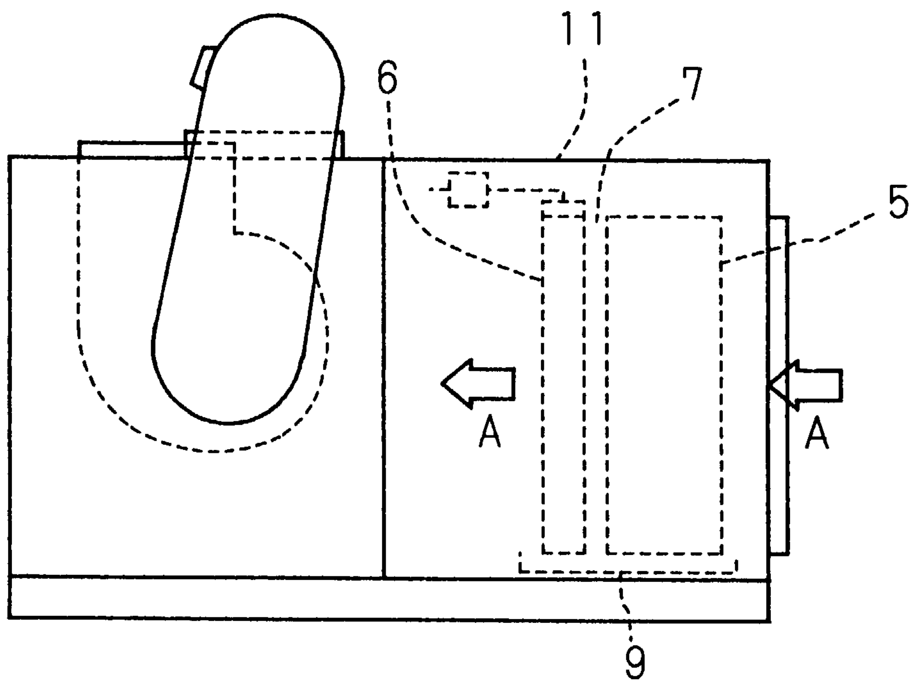


FIG. 3

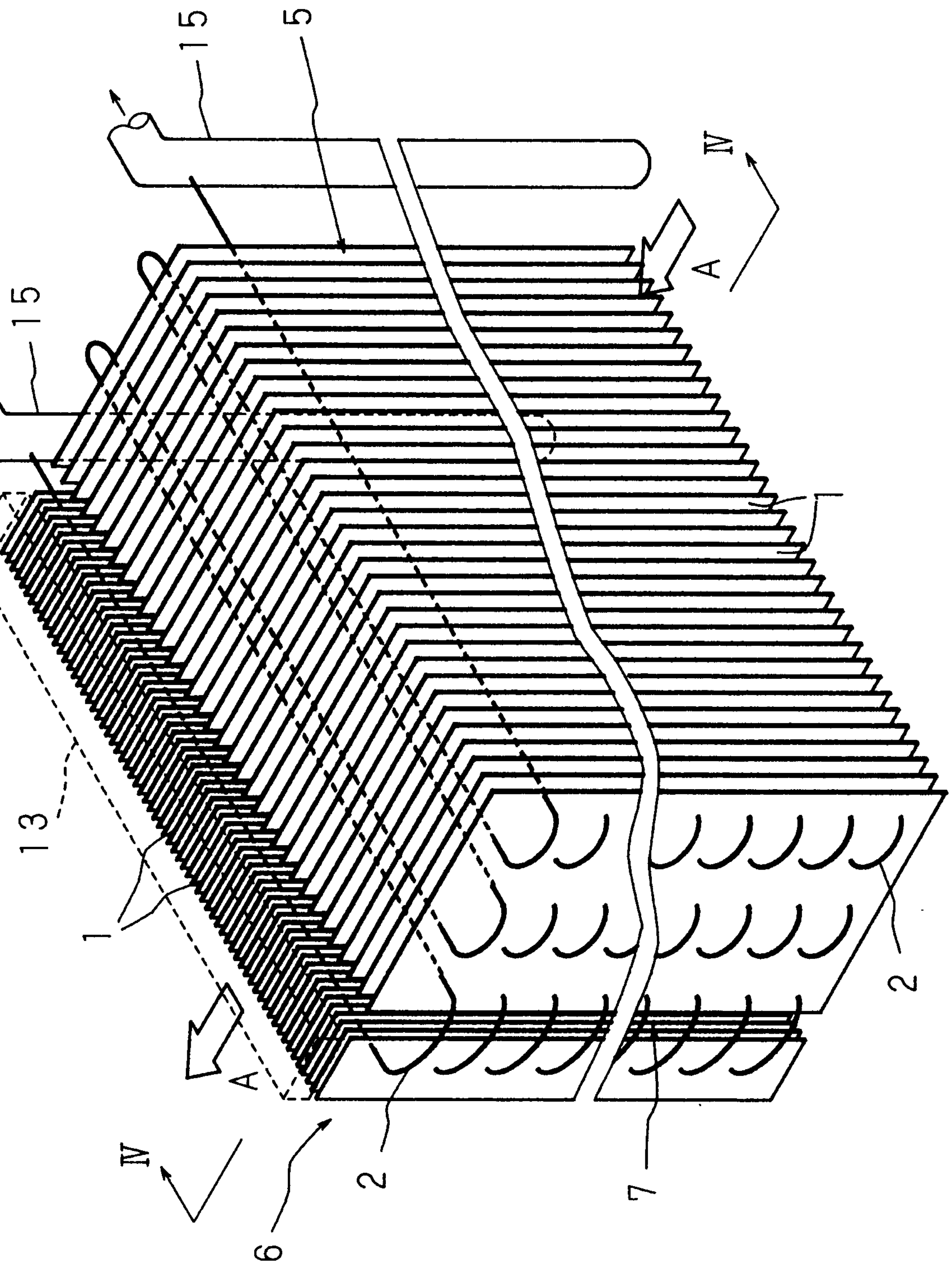


FIG. 4

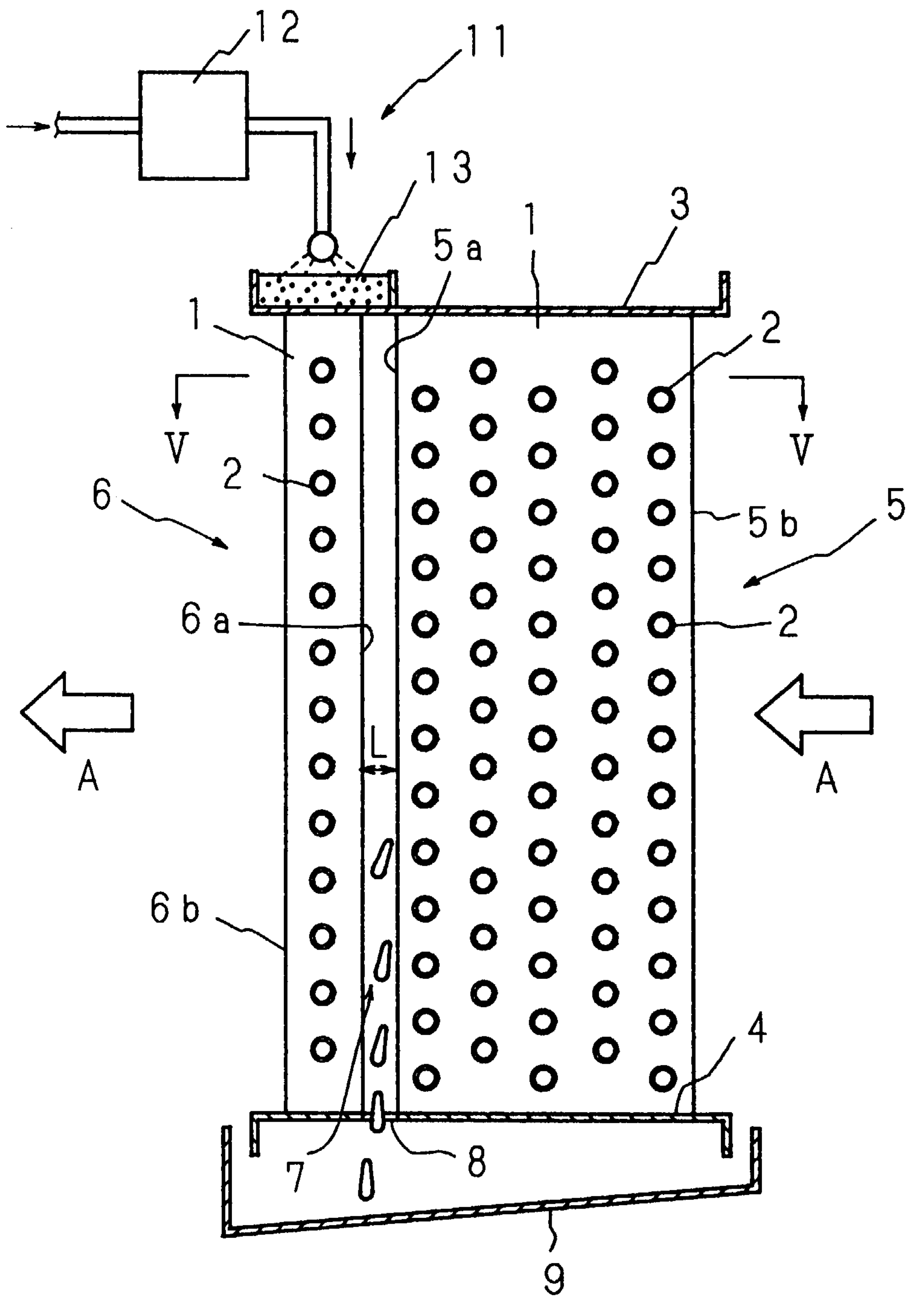


FIG. 5

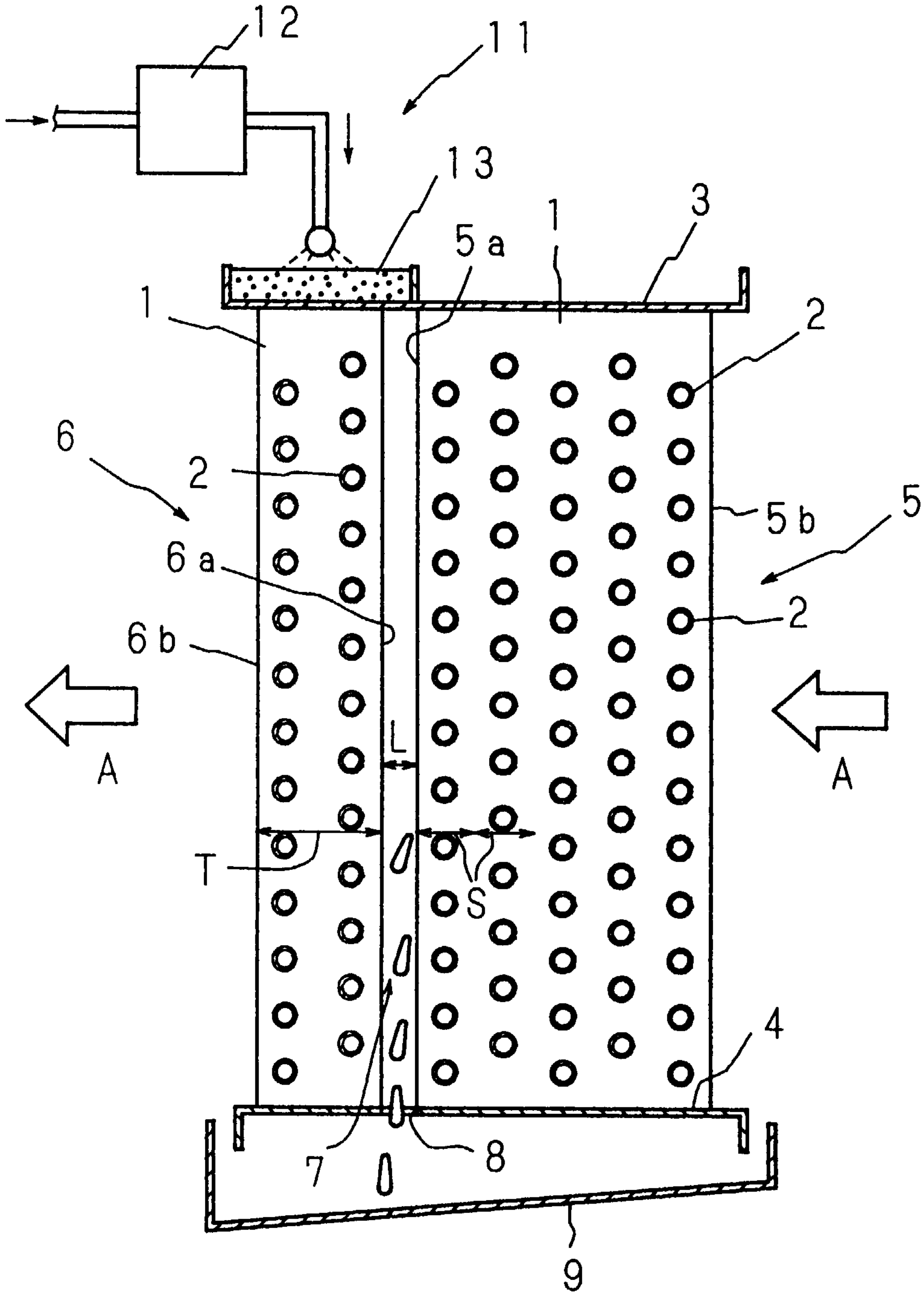


FIG. 6

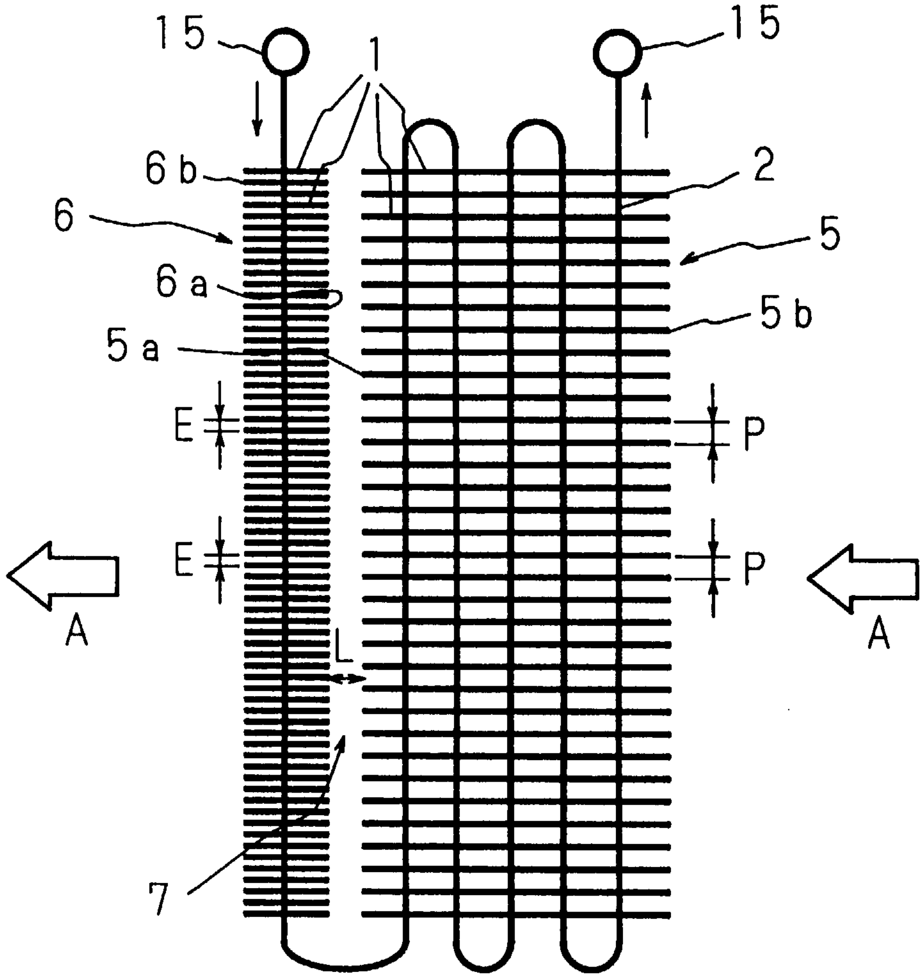


FIG. 7

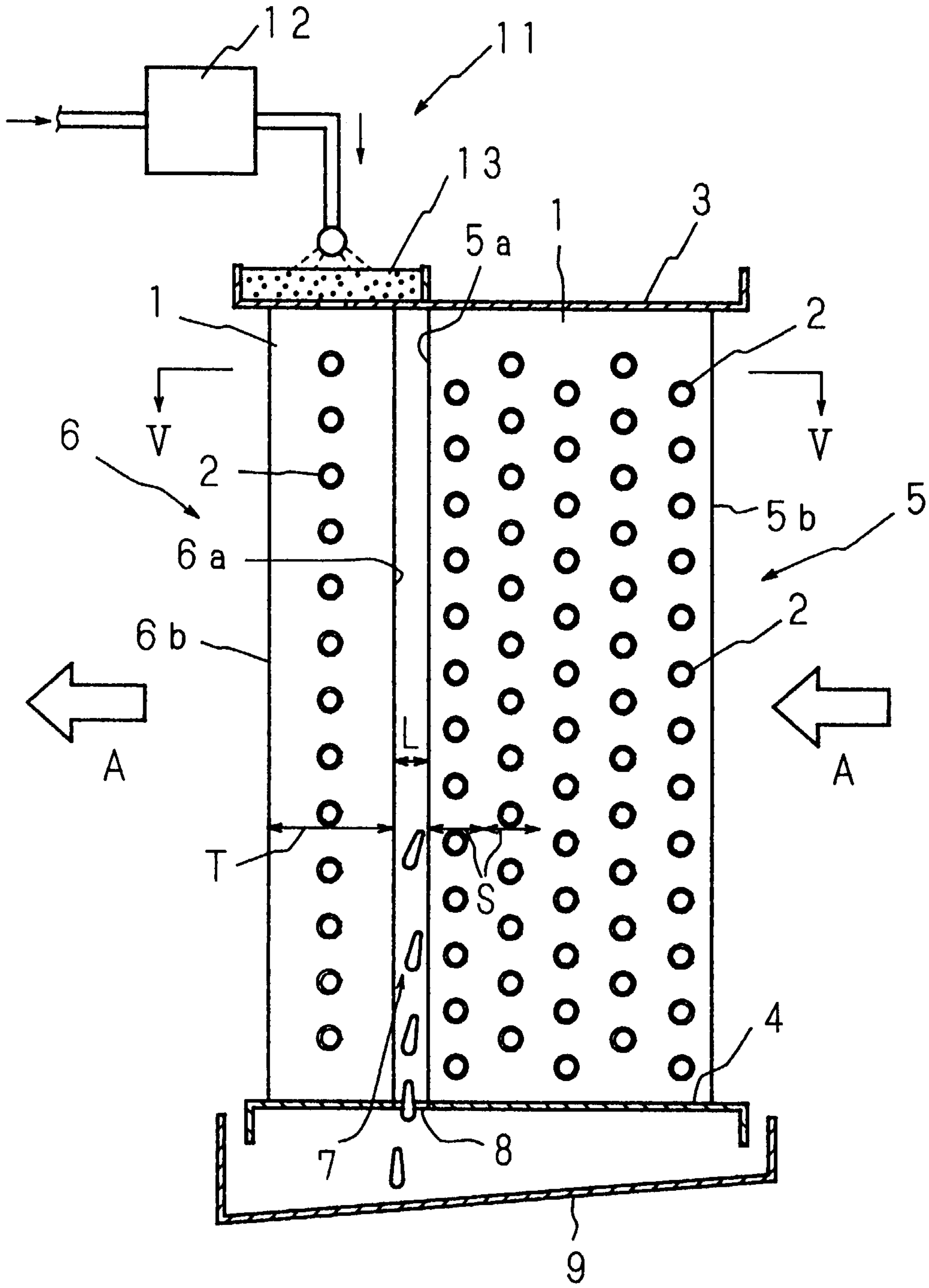


FIG. 8

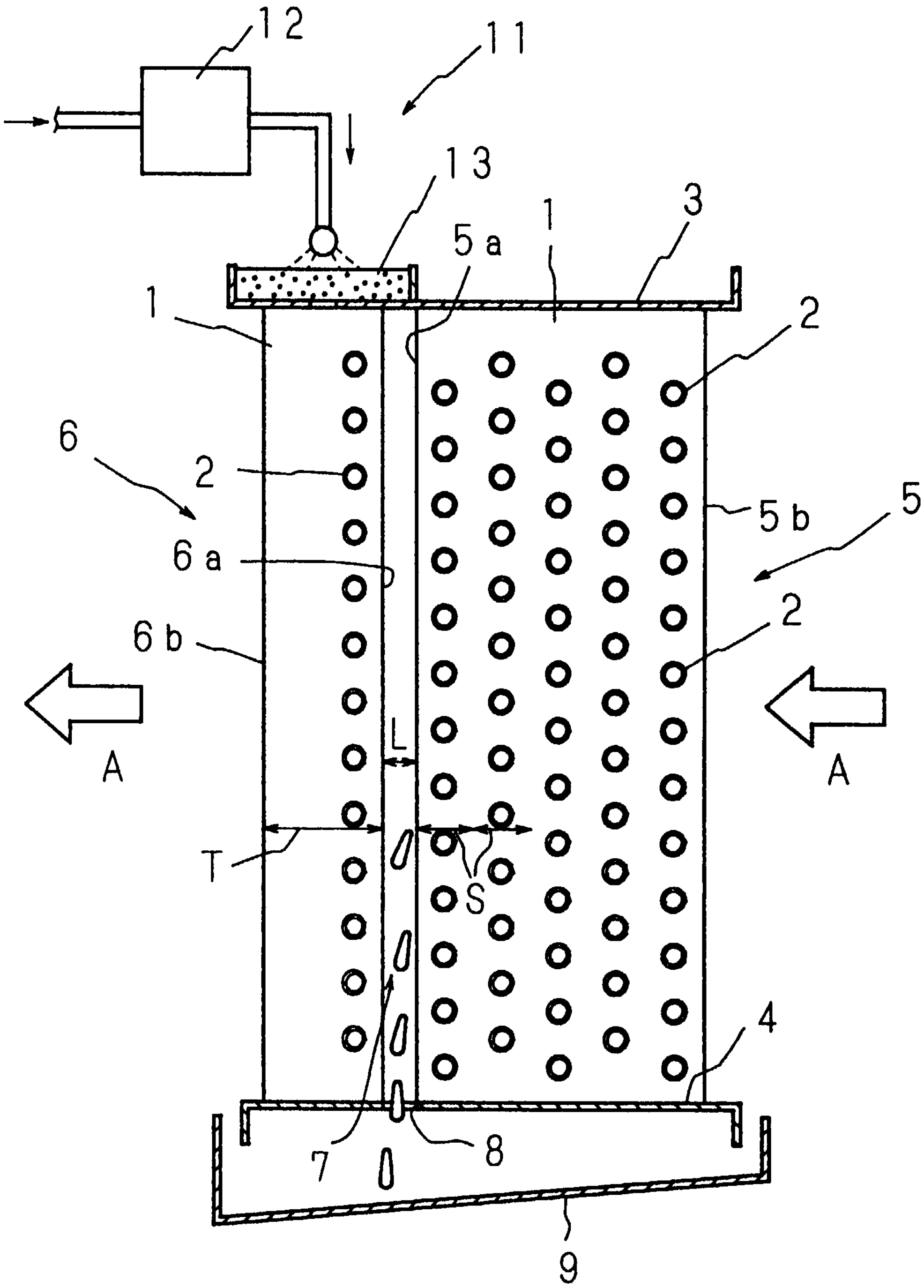


FIG. 9

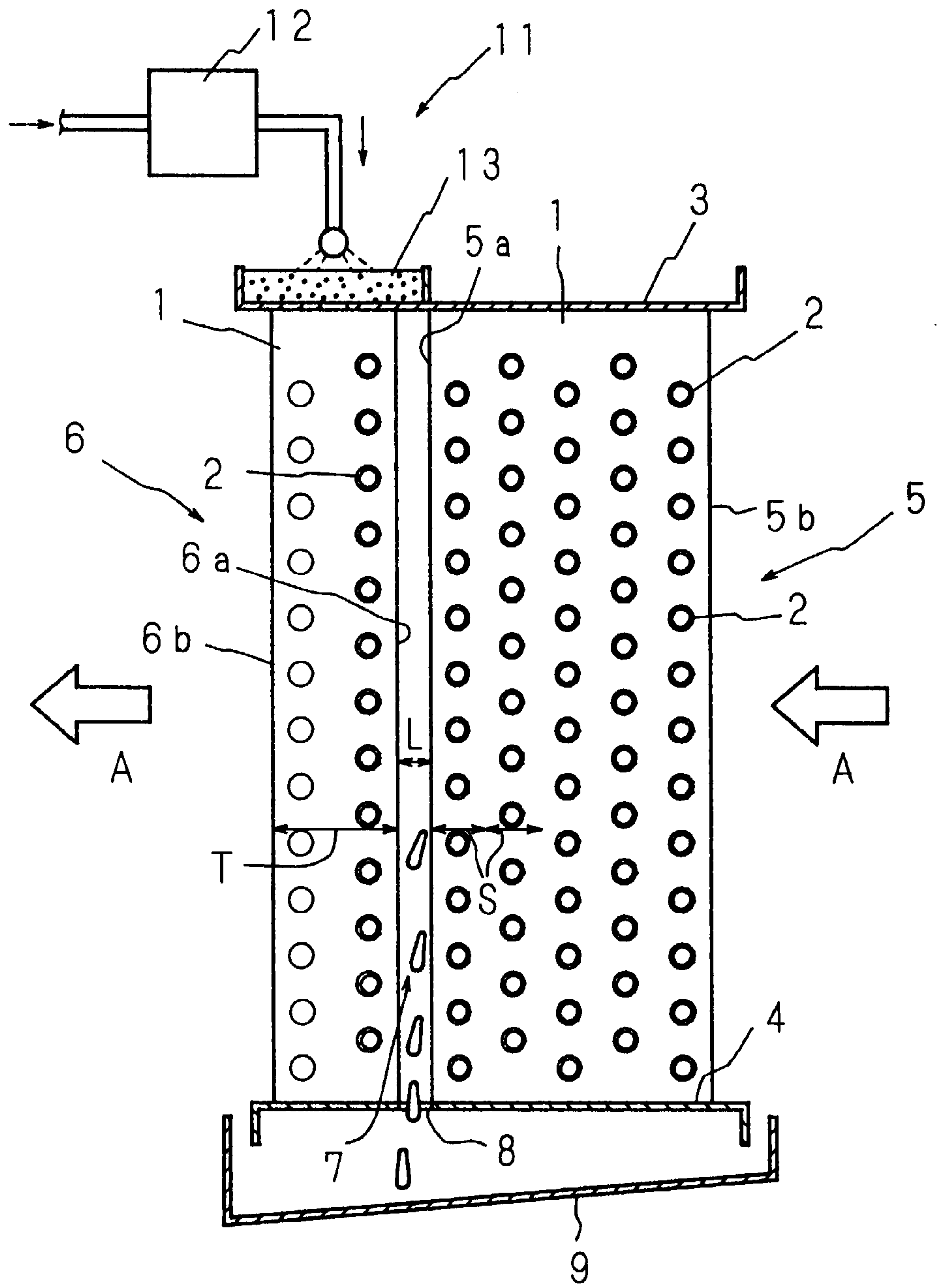


FIG. 10

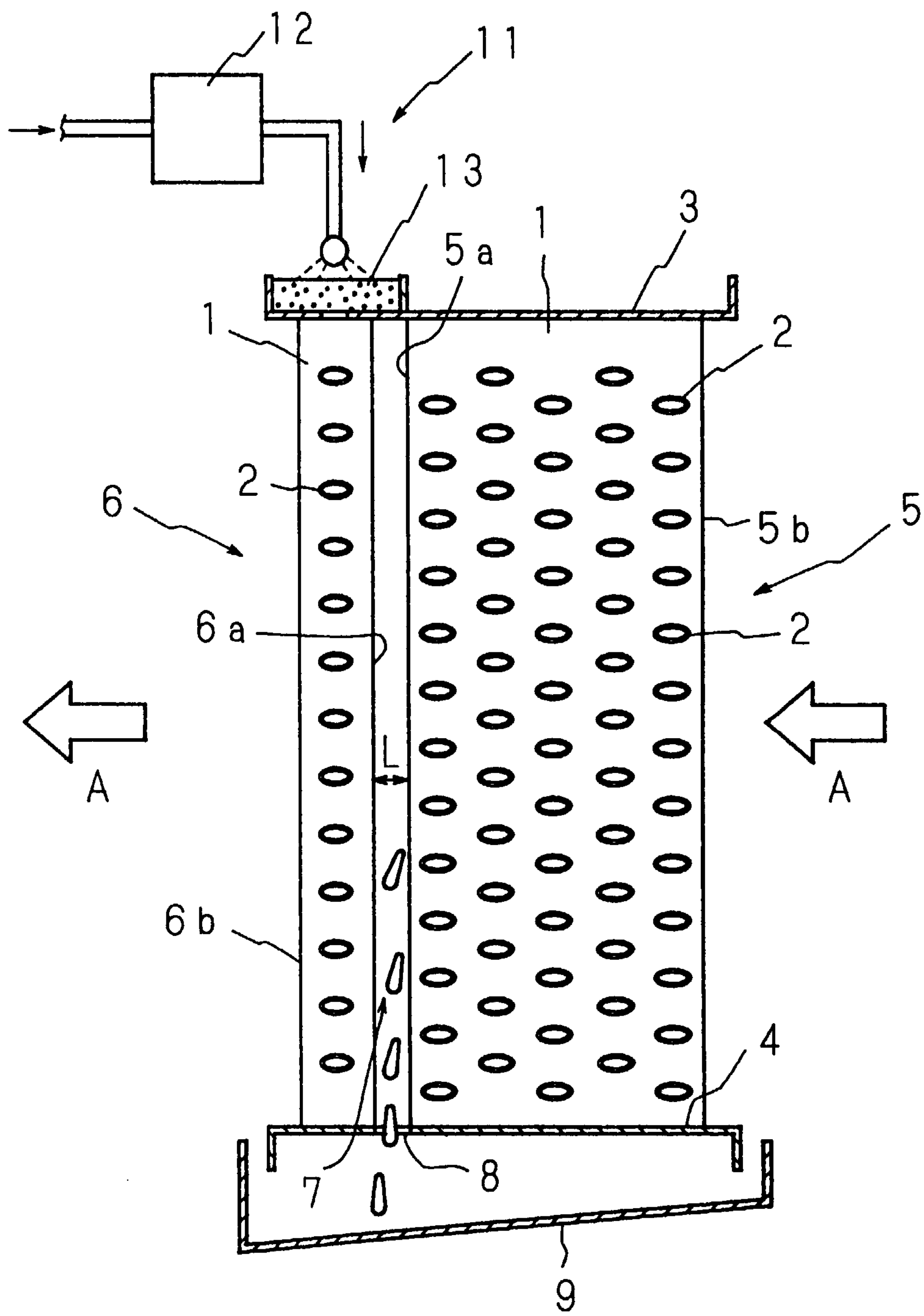


FIG. 11

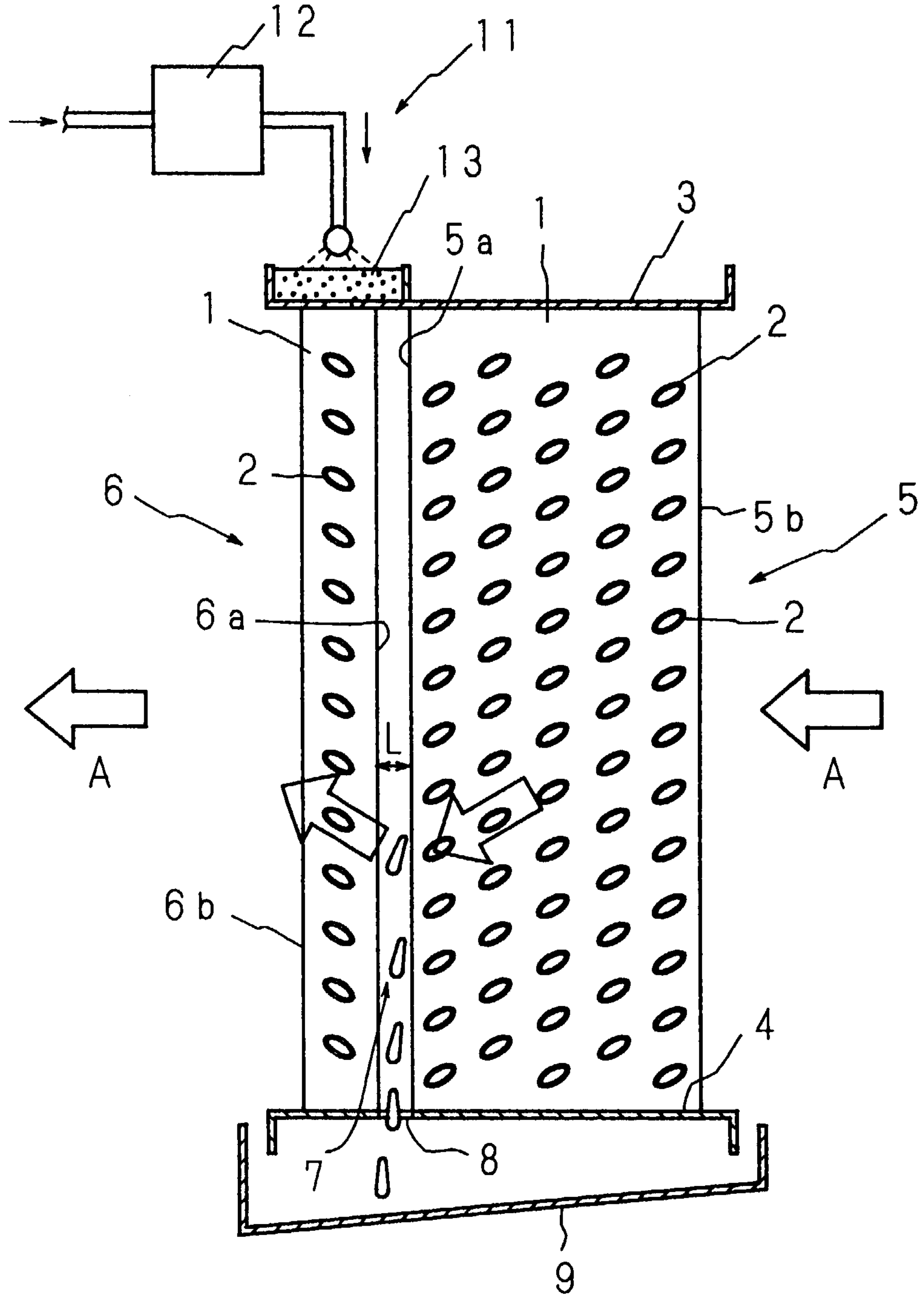


FIG. 12

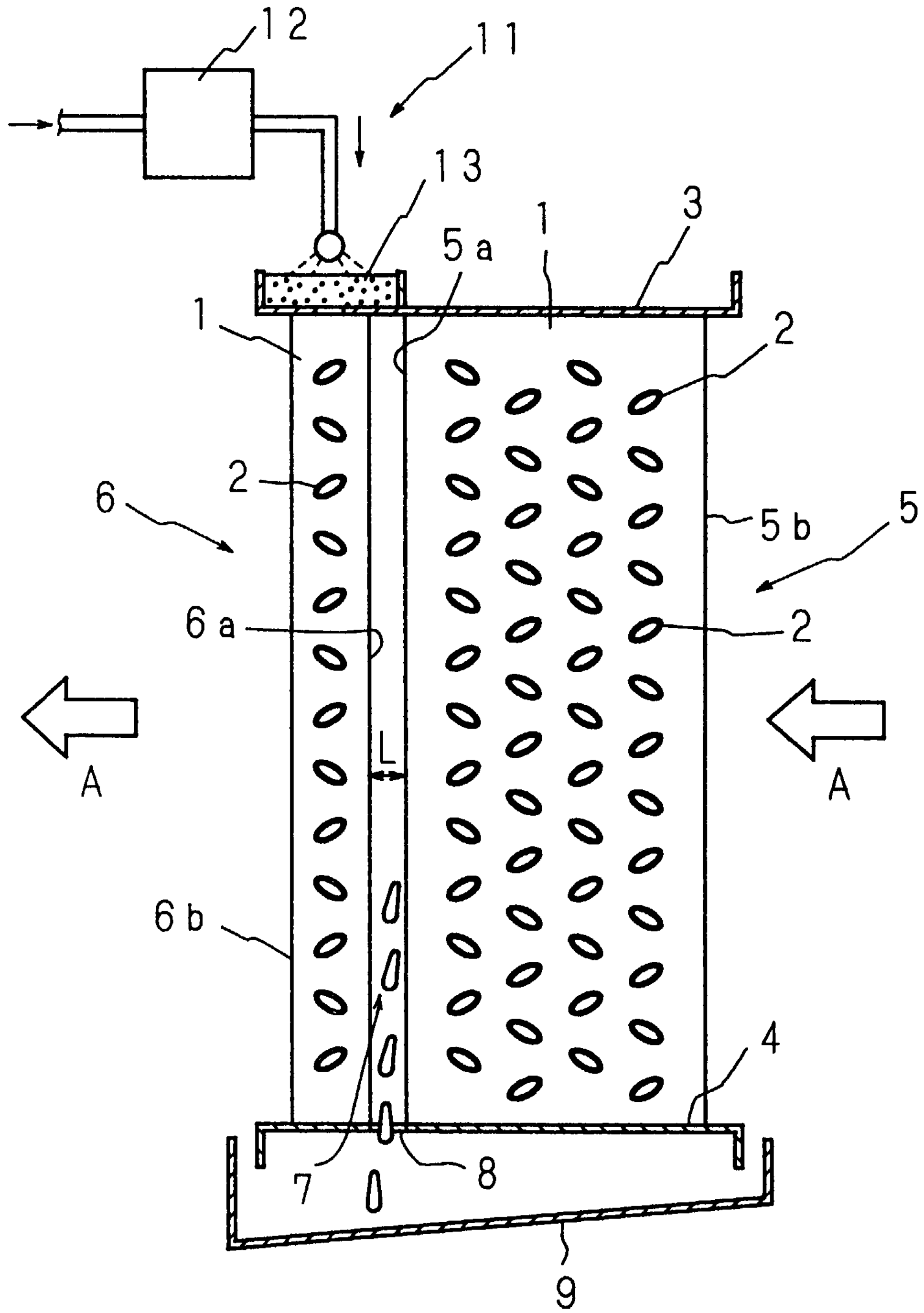


FIG. 13

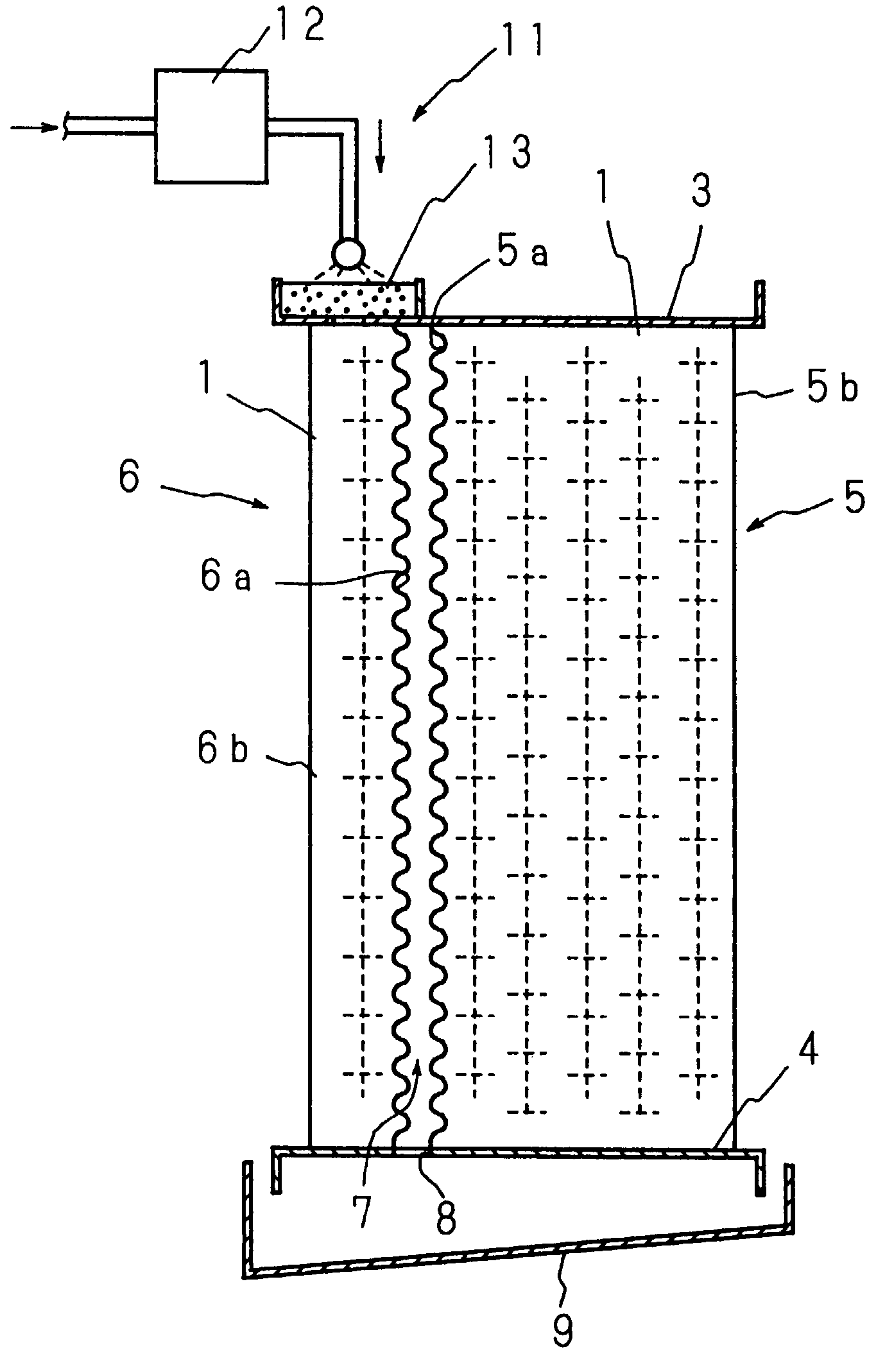


FIG. 14

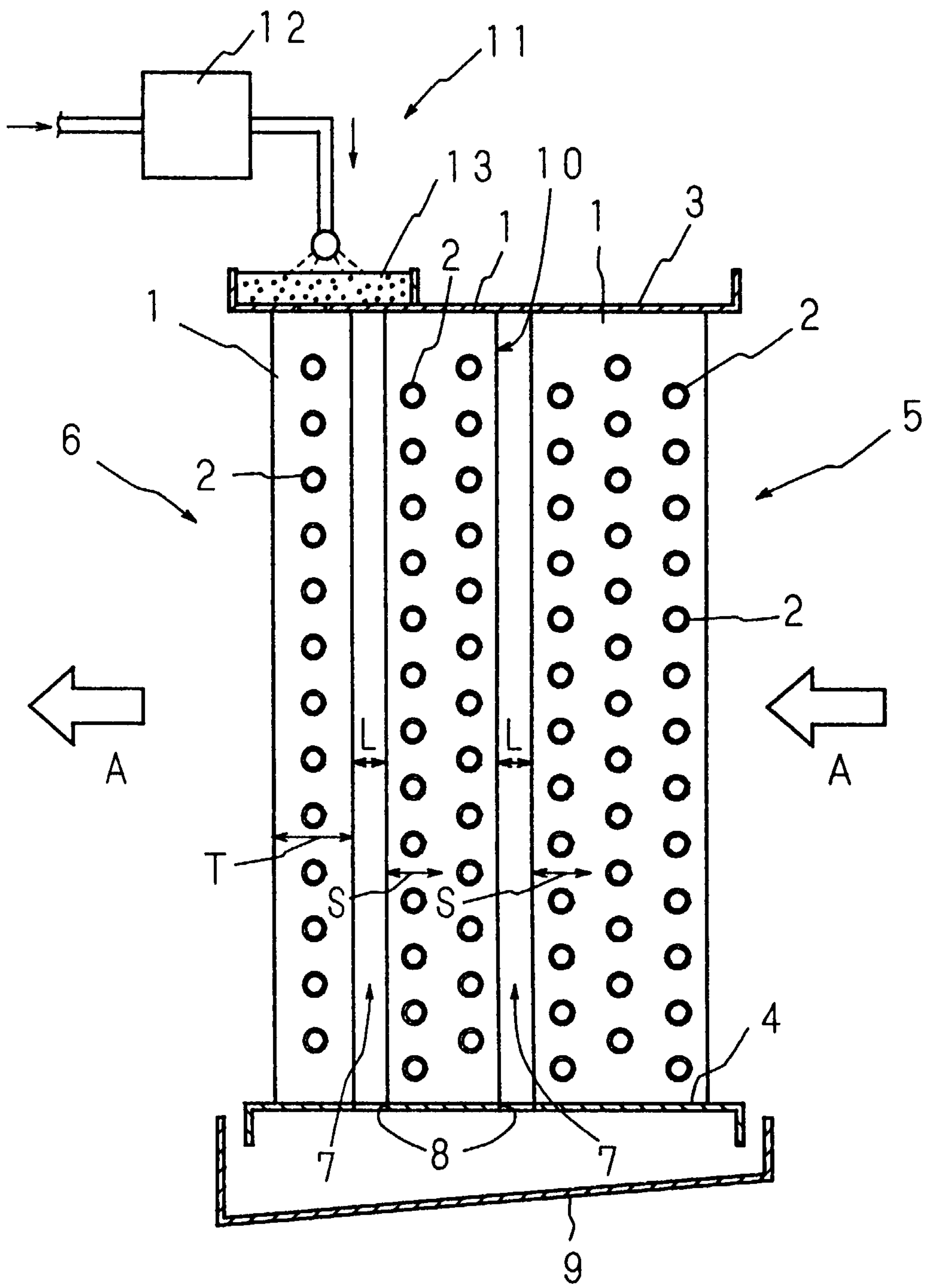


FIG. 15

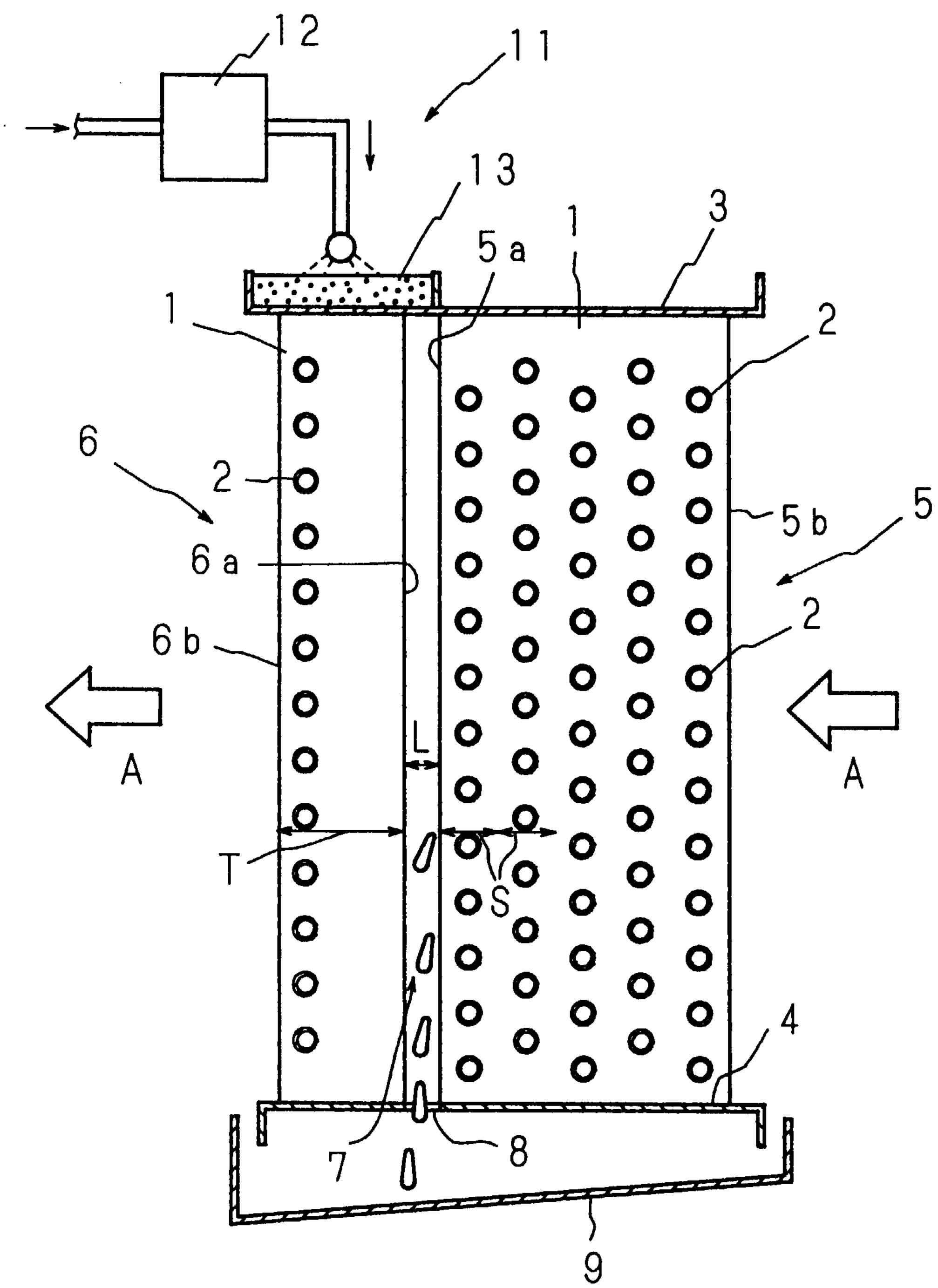


FIG. 16

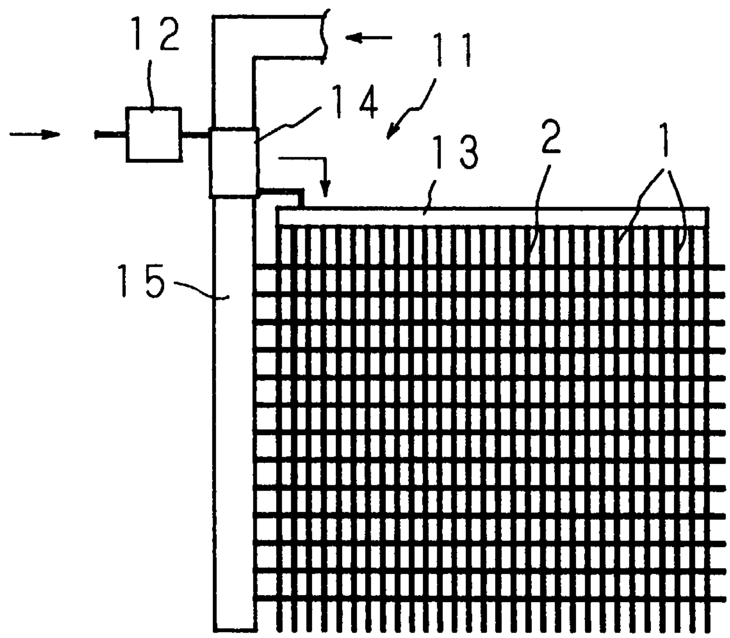


FIG. 17

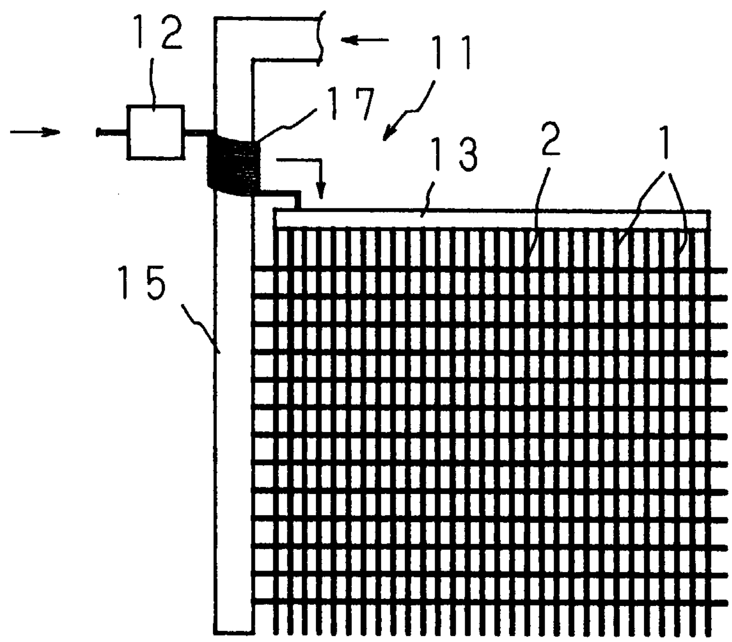


FIG. 18A

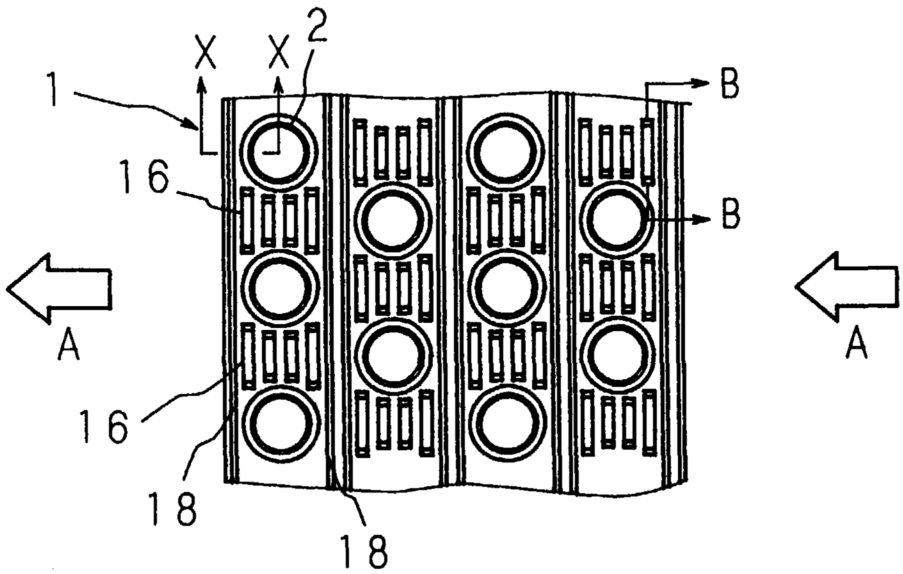
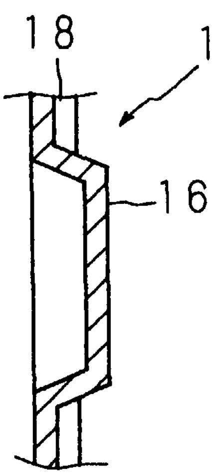


FIG. 18B



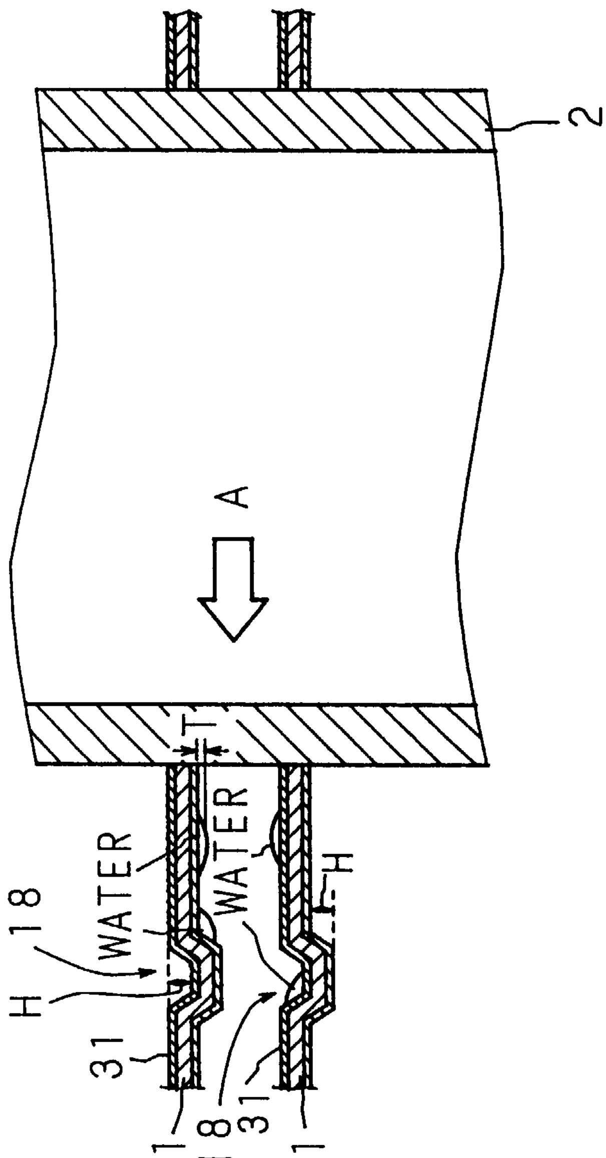


FIG. 19

FIG. 20

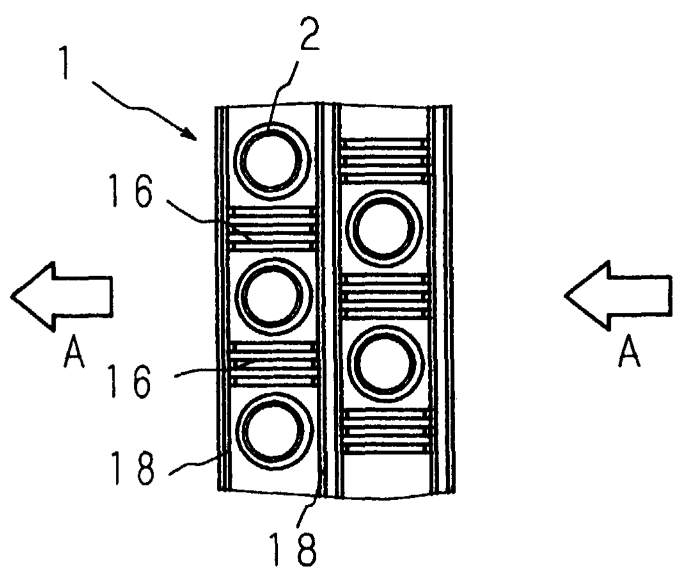


FIG. 21