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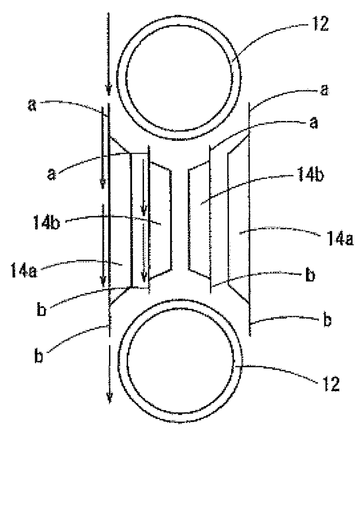
(54) **HEAT EXCHANGER**

(57) The heat exchanger includes heat transfer tubes 12, heat transfer fins 13a, which are arranged along a direction perpendicular to axes of the heat transfer tubes 12, cut-and-raised pieces 14, which are provided on a heat transfer surface of each heat transfer fin 13a. A cut, which extends along the lengthwise direction, is provided at the lower end or at the upper and lower ends of each cut-and-raised piece 14. The cuts guide condensed water generated on the surfaces of the heat transfer fins.

Fig.2



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Description

TECHNICAL FIELD

[0001] The present invention relates to the structure of a heat exchanger for an air conditioner indoor unit.

BACKGROUND ART

[0002] A cross fin coil type air heat exchanger is generally employed as a heat exchanger for an air conditioner indoor unit. In this type of heat exchanger, condensed water generated on the surface of the heat exchanger (evaporator) during cooling operation flows down along the fin surfaces of the heat exchanger by its own weight. Then, the condensed water collects in a drain pan located below the heat exchanger, and is discharged outside of the room (for example, refer to Patent Document 1).

[0003] Conventional air conditioner indoor units including such a heat exchanger is shown in Figs. 21 and 23. The air conditioner indoor unit 1 includes an air heat exchanger 32, which is folded to form a λ-shape, and a cross-flow fan 31. The indoor unit 1 draws in the air from the upper surface and the front surface of the indoor unit 1, and blows out the air diagonally downward from the bottom surface of the indoor unit 1. Also, the indoor unit 1 includes a cassette type main casing 20. The main casing 20 is installed on the wall with the back panel abut against the wall surface.

[0004] An inlet port 25 for drawing in the air is formed in the front surface and the upper surface of the main casing 20. The air heat exchanger 32 and the cross-flow fan 31 are located in the main casing 20. The air heat exchanger 32 is configured by a front heat exchanging section 32a and a rear heat exchanging section 32b. The cross-flow fan 31 is located below the front heat exchanging section 32a and the rear heat exchanging section 32b. The cross-flow fan 31 blows out the conditioned air diagonally downward through a scroll-type flow duct 30 and an outlet port 29 of the main casing 20. The lower ends of the front heat exchanging section and the rear heat exchanging section 32a, 32b are secured to and supported by drain pans 28a, 28b, respectively.

[0005] As shown in Fig. 22, the heat exchanging sections 32a, 32b each include heat transfer tubes 12, heat transfer fins 13a, cut-and-raised pieces 14, and tube plates, which are not shown. The heat transfer tubes 12 are arranged in two rows in upstream and downstream of air flow F to be displaced from each other. The heat transfer fins 13a are arranged at a predetermined pitch along the axis of the heat transfer tubes 12, and are arranged parallel to each other. The cut-and-raised pieces 14 are formed of slits or louvers, and are provided on the heat transfer surface of each heat transfer fin 13a on the upper side and the lower side of each heat transfer tube 12.

[0006] Each cut-and-raised piece 14 is formed of four rows of slits or louvers, which are arranged from upstream to downstream of the airflow F (from the left side to the right side of Fig. 22). Among the cut-and-raised pieces 14, cut-and-raised pieces 14a located in the vicinity of the side edges of each heat transfer fin 13a, 13b are longer than cut-and-raised pieces 14b located at the center of the heat transfer fins 13a, 13b.

[0007] According to the above structure, for example, if the cross-flow fan 31, which is blowing means, is actuated during cooling operation or warming operation, the air in the room is drawn in via the inlet port 25. Then, conditioned air (cool air or warm air) that has low pressure drop and has been subjected to even heat exchange is blown out from the outlet port 29 of the main casing 20 via the λ-shaped heat exchanger 32 that has a large heat exchange area and a wide air intake area. The conditioned air that is blown out in this manner flows downward so that comfortably cooled or warmed indoor environment is achieved.

[0008] In such an indoor unit of a wall-mounted type air conditioner, moisture in the air is condensed on the surface of the heat transfer fins 13a, 13b during cooling operation when the heat exchanger 32 functions as an evaporator. Then, drops of water collect between the fins and on the cut-and-raised pieces 14 and remain there.

[0009] Thus generated condensed water tends to remain on the fins and the cut-and-raised pieces 14 after the operation is stopped. Then, the remaining water causes adhesion of environmental suspended matter on the fin surface, breeding of bacteria, and corrosion of fins, and results in deterioration of the fin surface hydrophilicity or generation of smell.

[0010] As apparent from Fig. 21, the front and rear heat exchanging sections 32a, 32b are arranged substantially along the vertical direction. That is, the heat exchanging sections 32a, 32b are arranged at extremely small inclination angle with respect to the vertical axis. Thus, the condensed water generated in the heat exchanger flows downward along the fin surfaces by its own weight, and collects in the drain pans 28a, 28b.

[0011] However, since the fin pitch of the heat transfer fins 13a, 13b is actually narrow, and due to, for example, decrease in the hydrophilicity of the fin surface, the condensed water is kept retained on the fins and the cut-and-raised pieces and is hindered from flowing downward although the heat exchanger is substantially arranged along the vertical direction.

[0012] Furthermore, depending on the type of the air conditioner indoor unit, for example, a main portion 42a of a heat exchanger 42 is tilted downward by a large amount with respect to the vertical axis as shown in Fig. 23. In such a case, the gravity does not act along the longitudinal direction of the fins and the cut-and-raised pieces. In addition, the direction of the gravity and the direction of wind are opposite from each other. Thus, the behavior of the condensed water tends to become unstable, and water tends to spatter from the outlet port 49.

[0013] Fig. 23 shows the air conditioner indoor unit 1, a ceiling 3, a flow duct 40, a cross-flow fan 41, the main portion 42a of the heat exchanger 42, an upper end portion 42b of the heat exchanger 42, a ceiling panel 44, an air inlet port 45, an air outlet port 49, a main casing 50, and first to third drain pans 48a to 48c.

[0014] The above-mentioned problem occurs exactly in the same manner even if the cut-and-raised pieces 14a located in the vicinity of the side edges of each heat transfer fin 13a, 13b are split into an upper part and a lower part as shown in Fig. 24.

[0015] Patent Document 1: Japanese Laid-Open Patent Publication No. 2004-353914

DISCLOSURE OF THE INVENTION

[0016] Accordingly, it is an objective of the present invention to provide a heat exchanger suitable for an air conditioner indoor unit, which heat exchanger promotes downward flow of condensed water by a linear portion that are provided on the lower end of or on the upper and lower ends of cut-and-raised pieces to extend along the lengthwise direction.

[0017] To achieve the above objective, a first aspect of the present invention provides a heat exchanger including a heat transfer tube, heat transfer fins arranged along a direction perpendicular to an axis of the heat transfer tube to be parallel to each other, and a cut-and-raised piece provided on a heat transfer surface of each heat transfer fin. A linear portion is provided at the lower end of each cut-and-raised piece. The linear portion extends downward and guides condensed water generated on the heat transfer surface downward.

[0018] With this structure, the condensed water smoothly flows down via the linear portions without being retained between the heat transfer fins, in particular, between the cut-and-raised pieces of the heat transfer fins. Thus, adhesion of environmental suspended matter on the fin surfaces, breeding of bacteria, and corrosion of fins are prevented. Furthermore, since drainage during cooling operation is also improved, the cooling performance is improved, the ventilation resistance is reduced, and spattering of water is prevented.

[0019] In the above-mentioned heat exchanger, a linear portion, which extends upward and guides condensed water downward, is preferably provided at the upper end of each cut-and-raised piece.

[0020] With this structure, the condensed water smoothly enters the cut-and raised piece without being retained between the heat transfer fins, and in particular, at the upper end of the cut-and-raised piece. The condensed water then smoothly flows down via the linear portion, which extends downward from the lower end of the cut-and-raised piece. Thus, adhesion of environmental suspended matter on the fin surfaces, breeding of bacteria, and corrosion of fins are more effectively prevented. Furthermore, since drainage during cooling operation is also improved, the cooling performance is improved, the ventilation resistance is reduced, and spattering of water is prevented.

[0021] In the above-mentioned heat exchanger, the cut-and-raised piece is split into an upper part and a lower part, and the linear portion, which extends along a lengthwise direction and guides the condensed water downward, is preferably provided between the upper part and the lower part.

[0022] With this structure, the condensed water is guided downward by the linear portion also between the upper part and the lower part of the split cut-and-raised piece. Thus, even if the split cut-and-raised piece is employed, the condensed water is effectively discharged.

[0023] In the above-mentioned heat exchanger, each linear portion is preferably connected to the inside of the associated cut-and-raised piece.

[0024] With this configuration, the condensed water that flows along the linear portions smoothly enters the cut-and-raised pieces. Furthermore, the condensed water smoothly flows downward and out of the cut-and-raised piece and falls downward of the heat transfer fin. Thus, the condensed water is further efficiently discharged from the cut-and-raised piece.

[0025] In the above-mentioned heat exchanger, an upper end and a lower end of each cut-and-raised piece are inclined, and the linear portions are preferably provided at narrow angle portions of the upper end and the lower end of each cut-and-raised pieces.

[0026] According to the conventional structure, the inclination angle at the upper end and the lower end of the slit is large, and the upper end and the lower end are formed along the arc around each heat transfer tube. Thus, the condensed water that flows down to the slits tends to be retained in the vicinity of the upper end surface of the slits, and does not flow down for a long time after the operation of the air-conditioner is stopped.

[0027] In this respect, with this structure, the condensed water in the vicinity of the upper ends of the cut-and-raised pieces smoothly flows into the cut-and-raised pieces from the narrow angle portions of the cut-and-raised pieces, and the condensed water in the cut-and-raised pieces smoothly flows down from the narrow angle portions at the lower ends of the cut-and-raised pieces.

[0028] In the above-mentioned heat exchanger, an upper end and a lower end of each cut-and-raised piece are inclined, and the linear portion at the upper end of each cut-and-raised piece is preferably provided at a wide angle portion of the cut-and-raised piece.

[0029] Even if the linear portion at the upper end of each cut-and-raised piece is provided at the wide angle portion, substantially the same advantage is provided as the case where the linear portion is provided at the narrow angle portion.

[0030] In the above-mentioned heat exchanger, the linear portion is preferably provided at the center of the end portions of each cut-and-raised piece.

[0031] Even if the linear portion is provided at the center of the end portions of each cut-and-raised piece, substantially the same advantage as the above structure is provided. Furthermore, when the linear portion is a cut, since the position of the cut-and-raised line of the slit is displaced from the position of the cut line, the precision of the working of the cut-and-raised piece is improved and deformation of the fin surface is inhibited.

[0032] In the above-mentioned heat exchanger, the linear portions preferably extend along a step pitch of the heat transfer fins.

[0033] In this manner, when the linear portions are provided to extend along the step pitch of the heat transfer fins, the condensed water is linearly guided along the longitudinal direction. Thus, the discharge efficiency of the condensed water is improved.

[0034] In the above-mentioned heat exchanger, the linear portion at the upper end or the lower end of each cut-and-raised piece preferably extends diagonally to avoid a fin collar in which the heat transfer tube is inserted.

[0035] With this structure, since the linear portions are apart from the fin collar, interference between a mold used for press molding the fin collar and the linear portions is eliminated.

[0036] The above-mentioned heat exchanger preferably includes a drainage rib, which is located along a front edge or a rear edge of the heat transfer fins. The drainage rib is located close to or connected to the linear portion at the lower end of each cut-and-raised piece.

[0037] With this structure, the condensed water is guided to the drainage rib by the linear portion at the lower end of each cut-and-raised piece, and the condensed water is further efficiently discharged via the drainage rib.

[0038] In the above-mentioned heat exchanger, the linear portions are preferably linear cuts.

[0039] With this configuration, the condensed water that flows along the linear cuts smoothly enters the cut-and-raised pieces. Then, the condensed water in the cut-and-raised pieces smoothly flows down from the cut-and-raised pieces, and falls downward of the heat transfer fins. Thus, the condensed water is further effectively discharged from the cut-and-raised piece. Furthermore, the ventilation resistance is reduced as compared to the case where the linear portions are grooves.

[0040] In the above-mentioned heat exchanger, the linear portions are preferably grooves.

[0041] With this configuration, the condensed water that flows along the linear grooves smoothly enters the cut-and-raised pieces. Then, the condensed water in the cut-and-raised pieces smoothly flows down from the cut-and-raised pieces, and falls downward of the heat transfer fins. Thus, the condensed water is further effectively discharged from the cut-and-raised pieces.

[0042] In the above-mentioned heat exchanger, the cut-and-raised pieces are preferably louvers.

[0043] With this configuration, the condensed water smoothly flows down via the linear portions, which extend from the upper end and the lower end of each cut-and-raised piece without being retained between the heat transfer fins, in particular, in the cut-and-raised piece formed of louvers. Thus, adhesion of environmental suspended matter on the fin surfaces, breeding of bacteria, and corrosion of fins are prevented. Furthermore, since drainage is also improved during cooling operation, the cooling performance is improved, the ventilation resistance is reduced, and spattering of water is prevented.

[0044] In the above-mentioned heat exchanger, the heat exchanger is preferably a heat exchanger for an air conditioner indoor unit.

[0045] According to the structure of the above inventions, in the heat exchanger for an air-conditioner indoor unit, in which condensation easily occurs on the surfaces of the heat transfer fins, condensed water generated between the heat transfer fins and in the cut-and-raised pieces during cooling operation is smoothly discharged.

BRIEF DESCRIPTION OF THE DRAWINGS

[0046]

Fig. 1 is a partial front view illustrating an air heat exchanger according to a first embodiment of the present invention;

Fig. 2 is an enlarged partial cross-sectional view illustrating the main part of the air heat exchanger;

Fig. 3 is a partial front view illustrating an air heat exchanger according to a second embodiment of the present invention;

Fig. 4 is an enlarged partial cross-sectional view illustrating the main part of the air heat exchanger;

Fig. 5 is a partial front view illustrating an air heat exchanger according to a third embodiment of the present invention;

Fig. 6 is a partial front view illustrating an air heat exchanger according to a fourth embodiment of the present invention;

Fig. 7 is a partial front view illustrating an air heat exchanger according to a fifth embodiment of the present invention;

Fig. 8 is a partial front view illustrating an air heat exchanger according to a sixth embodiment of the present invention;

Fig. 9 is a partial front view illustrating an air heat exchanger according to a seventh embodiment of the present invention;

Fig. 10 is a partial front view illustrating an air heat exchanger according to an eighth embodiment of the present invention;

Fig. 11 is a partial front view illustrating an air heat exchanger according to a ninth embodiment of the present invention;

Fig. 12 is a partial front view illustrating an air heat exchanger according to a tenth embodiment of the present invention;

Fig. 13 is a partial front view illustrating an air heat exchanger according to an eleventh embodiment of the present invention;

Fig. 14 is a partial front view illustrating an air heat exchanger according to a twelfth embodiment of the present invention;

Fig. 15 is a partial front view illustrating an air heat exchanger according to a thirteenth embodiment of the present invention;

Fig. 16 is a partial front view illustrating an air heat exchanger according to a fourteenth embodiment of the present invention;

Fig. 17 is a partial front view illustrating an air heat exchanger according to a fifteenth embodiment of the present invention;

Figs. 18(a) to 18(c) are enlarged partial cross-sectional views illustrating the main part of the air heat exchanger;

Fig. 19 is a partial front view illustrating an air heat exchanger according to a sixteenth embodiment of the present invention;

Figs. 20(a) to 20(e) are enlarged partial cross-sectional views illustrating the main part of the air heat exchanger that is common to the embodiments;

Fig. 21 is a cross-sectional view illustrating an air conditioner indoor unit including a first conventional air heat exchanger;

Fig. 22 is a partial cross-sectional view illustrating the main part of the air heat exchanger;

Fig. 23 is a cross-sectional view illustrating an air conditioner indoor unit including a second conventional air heat exchanger; and

Fig. 24 is a partial cross-sectional view illustrating the main part of a third conventional air heat exchanger.

BEST MODE FOR CARRYING OUT THE INVENTION

(First Embodiment)

[0047] Figs. 1 and 2 show the structure and operation of an air heat exchanger according to a first embodiment of the present invention suitable for an air conditioner indoor unit (refer to Figs. 21 and 23).

[0048] An air heat exchanger 32 (32b) is configured by heat transfer tubes 12, heat transfer fins 13a, 13b, cut-and-raised pieces 14, and tube plates, which are not shown. The heat transfer tubes 12 are arranged in two rows in upstream (front side) and downstream (rear side) of the airflow F, and are displaced from each other. The heat transfer fins 13a, 13b are arranged at a predetermined pitch along the axes of the heat transfer tubes 12, and are parallel to each other. The cut-and-raised pieces 14 include slits 14a, 14b and are located on the heat transfer surface of each heat transfer fin 13a on the upper side and the lower side of each heat transfer tube 12. The tube plates are located in the vicinity of the ends in the arrangement direction of the heat transfer fins 13a, 13b.

[0049] Each cut-and-raised piece 14 includes four rows of slits 14a, 14b, which are arranged from upstream to downstream of the airflow F (from the left side to the right side in the drawing). Among the cut-and-raised pieces 14, the cut-and-raised pieces 14b located in the vicinity of the side edges of each heat transfer fin 13a, 13b are longer than the cut-and-raised pieces 14a located at the center of the heat transfer fin 13a, 13b.

[0050] In the heat transfer fins 13a, 13b, the slits 14a, 14b of the cut-and-raised pieces 14 include an upper end and a lower end having a predetermined inclination angle. Linear portions, which extend upward or downward, are provided along the front edge of the slits 14a, 14b at the upper end and the lower end of the front two rows of slits 14a, 14b. Linear portions, which extend upward and downward, are also provided along the rear edge of the slits 14a, 14b at the upper end and lower end of the rear two rows of slits 14b, 14a. The linear portions guide the condensed water downward by capillary action. More specifically, the linear portions are linear cuts (a cut portion shown in Fig. 20(a)) a, b, and are connected to the inside of the slits 14a, 14b.

[0051] This structure inhibits the operation in which the condensed water flows into the slits 14a, 14b without flowing around the upper end surface of the slits 14a, 14b after the condensed water generated on the fin surfaces of the heat transfer fins 13a, 13b concentrates in the cuts a that extend from the upper end of the slits 14a, 14b. Thereafter, the condensed water smoothly flows toward the lower ends of the heat transfer fins 13a, 13b via cuts b that extend from the lower ends of the slits 14a, 14b. The condensed water then flows into drain pans (refer to 28a, 28b in Fig. 5) located below the heat transfer fins 13a, 13b through the heat transfer fins 13a, 13b.

[0052] Thus, between the fin surfaces of the heat transfer fins 13a, 13b, the condensed water is not retained at the upper end surface and the lower end surface of the cut-and-raised pieces 14. Thus, adhesion of environmental suspended matter on the fin surfaces, breeding of bacteria, and corrosion of fins are prevented. Furthermore, drainage is improved during cooling operation, thus improving the cooling performance, reducing the ventilation resistance, and preventing spattering of water.

[0053] As a result, the cross fin coil type air heat exchanger suitable for the air conditioner indoor unit as shown in Figs. 21 and 23 is easily manufactured with low costs. The heat exchanger prevents adhesion of environmental suspended matter on the fin surfaces, breeding of bacteria, and corrosion of fins, and has excellent drainage during cooling operation, thus improving the cooling performance, reducing the ventilation resistance, and preventing spattering of water.

[0054] Instead of the slits 14a, 14b, the cut-and-raised pieces 14 may be formed using, for example, louvers. Also, the shape and the number of the slits 14a, and the number of rows of the slits 14a may be changed. Furthermore, the cuts a, b may be changed to linear grooves that are shallow and narrow. Unlike the grooves, the cuts have no projecting surfaces, which is advantageous in that the ventilation resistance is hardly generated.

(Second Embodiment)

[0055] Figs. 3 and 4 show the structure of an air heat exchanger according to a second embodiment of the present invention suitable for an air conditioner indoor unit.

[0056] In the present embodiment, the split type slits 14a are employed as the cut-and-raised pieces 14 located in the vicinity of the side edges of the heat transfer fins 13a, 13b like the conventional example of Fig. 24 in the cross fin coil type air heat exchanger that is the same as the first embodiment. As shown in Fig. 4, linear cuts (linear portions) a, b, c that extend along the lengthwise direction and have a predetermined length are provided at the upper end and the lower end of the slits 14a, 14b, and at the center of the slits 14a. Here, the cut b located between the split slits 14a is connected to the cut c extending downward and the cut a extending upward. In this case also, the condensed water that flows down along the fin surfaces enter the slits 14a, 14b via the linear portions a, b, and the condensed water smoothly flows downward and out of the slits 14a, 14b via the cuts b, c. Thus, the condensed water is not retained in the slits 14a, 14b, and promptly flows downward. That is, the condensed water is smoothly discharged like the first embodiment.

(Third Embodiment)

[0057] Fig. 5 shows the structure of an air heat exchanger according to a third embodiment of the present invention suitable for an air conditioner indoor unit.

[0058] In the present embodiment, the split type slits 14a are employed as the cut-and-raised pieces 14 like the second embodiment. Unlike the second embodiment, however, the split surfaces of the split part of the slits are not inclined but extend along the horizontal direction. Linear cuts (linear portions) a, b, c that extend along the lengthwise direction and have a predetermined length are provided at the upper end and the lower end of the slits 14a, 14b, and at the center of the slits 14a. Here, the cut b located between the split slits 14a is connected to the cut c extending downward and the cut b extending upward. In this case also, the condensed water that flows down along the fin surfaces enter the slits 14a, 14b via the linear portions a, b, and the condensed water smoothly flows downward and out of the slits 14a, 14b via the cuts b, c. Thus, the condensed water is not retained in the slits 14a, 14b, and promptly flows downward. Thus, the condensed water is smoothly discharged like the second embodiment.

(Fourth Embodiment)

[0059] Fig. 6 shows the structure of an air heat exchanger according to a fourth embodiment of the present invention suitable for an air conditioner indoor unit.

[0060] In the present embodiment, in the slits 14a, 14b of the cross fin coil type air heat exchanger according to the third embodiment, linear cuts, that is, linear portions d, e, f that extend along the lengthwise direction and have a predetermined length are further provided between the laterally adjacent slits 14a, 14b.

[0061] Among the four rows of slits 14a, 14b arranged from upstream to downstream of the airflow, the linear portions d, e are provided between the first row of the split type slit 14a and the second row of the integrated slit 14b. The linear portions d, e are provided separately at two positions, which are the upper section and the lower section. Also, the linear portion f is provided between the second row of the integrated slit 14b and the third row of the integrated slit 14b. The linear portion f is formed by a single line that continues from the upper end to the lower end. Furthermore, the linear portions d, e are also provided between the third row of the integrated slit 14b and the fourth row of the split type slit 14a. The linear portions d, e are provided separately at two positions, which are the upper section and the lower section. The linear portions d, e, f all extend along the lengthwise direction. Like the third embodiment, the condensed water that flows down along the fin surfaces enter the slits 14a, 14b via the linear portions a, b, and the condensed water smoothly flows downward and out of the slits 14a, 14b via the cuts b, c. Thus, not only the condensed water promptly flows downward without being retained in the slits 14a, 14b, the condensed water that remains on the fin surfaces between the slits 14a, 14b also smoothly flows down by the cuts d, e, f located between the slits 14a, 14b. Thus, the condensed water is further smoothly discharged as compared to the third embodiment.

(Fifth Embodiment)

[0062] Fig. 7 shows the structure of an air heat exchanger according to a fifth embodiment of the present invention suitable for an air conditioner indoor unit.

[0063] In the present embodiment, the linear cuts a that extend from the upper ends of the slits 14a, 14b of the cross fin coil type air heat exchanger according to the third embodiment are not provided at the narrow angle portions, but are provided at the wide angle portions. As is known, the condensed water on the fin surfaces tends to concentrate in a lower portion of the center of each fin collar in which the associated heat transfer tube 12 is inserted. Thus, providing the linear cuts a at the wide angle portions of the upper ends of the slits 14a, 14b is advantageous in smoothly discharging the condensed water concentrating in a lower portion of the fin collars.

(Sixth Embodiment)

[0064] Fig. 8 shows the structure of an air heat exchanger according to a sixth embodiment of the present invention suitable for an air conditioner indoor unit.

[0065] Unlike the third embodiment, in which the linear cuts a, b, c are provided at the narrow angle portions and at the split portions of the slits 14a, 14b, the cuts a, b, c are provided at the upper end center and the lower end center of the slits 14a, 14b as shown in Fig. 8 in the present embodiment.

[0066] In this case also, the condensed water that flows down along the fin surfaces enter the slits 14a, 14b via the linear portions a, and the condensed water smoothly flows downward and out of the slits 14a, 14b via the cuts b, c. Thus, the condensed water is not retained in the slits 14a, 14b, and promptly flows downward. Therefore, the condensed water is smoothly discharged like the third embodiment.

[0067] In this case, when forming the cuts at the upper end center and lower end center of the slits 14a, 14b, the cuts a, b, c can be formed at positions separate from the cut positions of the fins forming the slits. This adds to the flexibility of the working, prevents deformation of the fin surfaces caused when forming the slits, and inhibits increase in the ventilation resistance.

(Seventh Embodiment)

[0068] Fig. 9 shows the structure of an air heat exchanger according to a seventh embodiment of the present invention suitable for an air conditioner indoor unit.

[0069] In the present embodiment, the integrated slits 14a, 14b are employed as the cut-and-raised pieces 14 located in the vicinity of the side edges of the heat transfer fins 13a, 13b. In the cross fin coil type air heat exchanger according to the first embodiment, in which the cuts a, b are provided at the upper ends and the lower ends of the slits 14a, 14b, the cuts a at the upper ends of the slits are omitted.

[0070] Although this structure inhibits, as compared to the first embodiment, the operation in which the condensed water generated on the fin surfaces flow into the slits 14a, 14b without flowing around the upper end surfaces of the slits 14a, 14b, the condensed water is inhibited from flowing in from the top of the slits since the cuts are not formed at the upper ends of the slits 14a, 14b. Also, when forming the fin collars or the like, at least the upper cuts a do not interfere with fin collars 15 in which the heat transfer tubes 12 are inserted.

(Eighth Embodiment)

[0071] Fig. 10 shows the structure of an air heat exchanger according to an eighth embodiment of the present invention suitable for an air conditioner indoor unit.

[0072] In the present embodiment, diagonal split type slits 14a are employed as the cut-and-raised pieces 14 located in the vicinity of the side edges of the heat transfer fins 13a, 13b. The cuts a at the upper ends of the slits are omitted from the structure of the cross fin coil type air heat exchanger according to the second embodiment, in which the linear cuts (linear portions) a, b, c that extend along the lengthwise direction and have a predetermined length are provided at the upper ends and the lower ends of the slits 14a, 14b and at the center of the slits 14a.

[0073] Although this structure inhibits, as compared to the second embodiment, the operation in which the condensed water flows into the slits 14a, 14b without flowing around the upper end surfaces of the slits 14a, 14b after the condensed water generated on the fin surfaces concentrates in the upper cuts a of the slits 14a, 14b, the condensed water is inhibited from flowing in from the top of the slits since the cuts are not formed at the upper ends of the slits 14a, 14b. Also, when forming the fin collars or the like, at least the upper cuts a do not interfere with the fin collars 15 in which the heat transfer tubes 12 are inserted. Also, since the split section of the slits is formed diagonally, the condensed water is promoted to flow from the upper part to the lower part of the split section.

(Ninth Embodiment)

[0074] Fig. 11 shows the structure of an air heat exchanger according to a ninth embodiment of the present invention suitable for an air conditioner indoor unit.

[0075] In the present embodiment, parallel split type slits 14a are employed as the cut-and-raised pieces 14 located in the vicinity of the side edges of the heat transfer fins 13a, 13b. Like the seventh embodiment, the cuts a at the upper ends of the slits are omitted from the structure of the cross fin coil type air heat exchanger according to the third embodiment, in which the linear cuts (linear portions) a, b, c that extend along the lengthwise direction and have a predetermined length are provided at the upper ends and the lower ends of the slits 14a, 14b and the center of the slits 14a.

[0076] Although this structure inhibits, as compared to the third embodiment, the operation in which the condensed water flows into the slits 14a, 14b without flowing around the upper end surfaces of the slits 14a, 14b after the condensed water generated on the fin surfaces concentrates at the cuts a at the upper side of the slits 14a, 14b, the condensed water is inhibited from flowing in from the top of the slits. Also, when forming the fin collars or the like, at least the upper cuts a do not interfere with the fin collars 15 in which the heat transfer tubes 12 are inserted.

(Tenth Embodiment)

[0077] Fig. 12 shows the structure of an air heat exchanger according to a tenth embodiment of the present invention suitable for an air conditioner indoor unit.

[0078] In the present embodiment, the parallel split type slits 14a are employed as the cut-and-raised pieces 14 located in the vicinity of the side edges of the heat transfer fins 13a, 13b. The linear cuts a at the upper end of the slits are omitted from the structure of the cross fin coil type air heat exchanger according to the sixth embodiment, in which the linear cuts (linear portions) a, b, c that extend along the lengthwise direction and have a predetermined length are provided at the upper ends and the lower ends of the slits 14a, 14b and at the center of the slits 14a.

[0079] Although this structure inhibits, as compared to the sixth embodiment, the operation in which the condensed water flows into the slits 14a, 14b without flowing around the upper end surface of the slits 14a, 14b after the condensed water generated on the fin surfaces concentrates in the cuts a on the upper side of the slits 14a, 14b, the condensed water is inhibited from flowing in from the top of the slits. Also, when forming the fin collars or the like, at least the upper cuts a do not interfere with the fin collars 15 in which the heat transfer tubes 12 are inserted.

(Eleventh Embodiment)

[0080] Fig. 13 shows the structure of an air heat exchanger according to an eleventh embodiment of the present invention suitable for an air conditioner indoor unit.

[0081] In the present embodiment, the integrated slits 14b are employed as the cut-and-raised pieces 14 located at the center of the heat transfer fins 13a, 13b, and the parallel split type slits 14a are employed as the cut-and-raised pieces 14 located in the vicinity of the side edges of the heat transfer fins 13a, 13b. All the cuts a, b, c except the cuts b at the center of the parallel split type slits 14a extend diagonally to avoid the fin collars 15 in which the heat transfer tubes 12 are inserted in the structure of the cross fin coil type air heat exchanger according to the second embodiment, in which the linear cuts (linear portions) a, b, c that extend along the lengthwise direction and have a predetermined length are provided at the narrow angle portions of the upper ends and the lower ends of the slits 14a, 14b and at the center of the split portion of the slits 14a.

[0082] Like the second embodiment, regardless of the existence of the fin collars 15, when the cut portions a, b, c that extend along the lengthwise direction are provided in the heat transfer fins 13a, 13b, a mold used for press molding the fin collars 15 might interfere with the cuts a, b, c.

[0083] According to the present embodiment, since the distance between the cuts a, b, c and the fin collars 15 is sufficient, the interference between the cuts and the mold is prevented. Thus, the flexibility in the working of the fins is improved, and the molding accuracy is also improved. Also, as is known, the condensed water on the fin surfaces tends to concentrate in a lower portion of the center of the fin collars 15. In this respect, according to the present embodiment, since the cuts a on the upper ends of the slits 14a, 14b are inclined, the condensed water is easily collected by the cuts a, and the condensed water easily flows into the slits 14a, 14b.

(Twelfth Embodiment)

[0084] Fig. 14 shows the structure of an air heat exchanger according to a twelfth embodiment of the present invention suitable for an air conditioner indoor unit.

[0085] In the present embodiment, the integrated slits 14b are employed as the cut-and-raised pieces 14 located at the center of the heat transfer fins 13a, 13b, and the parallel split type slits 14a are employed as the cut-and-raised pieces 14 located in the vicinity of the side edges of the heat transfer fins 13a, 13b. All the cuts a, b, c except the cuts b at the center of the parallel split type slits 14a extend diagonally to avoid the fin collars 15 in which the heat transfer tubes 12 are inserted in the structure of the cross fin coil type air heat exchanger according to the third embodiment, in which the linear cuts (linear portions) a, b, c that extend along the lengthwise direction and have a predetermined length are provided at the upper ends and the lower ends of the slits 14a, 14b and at the center of the slits 14a.

[0086] Like the third embodiment, regardless of the existence of the fin collars 15, when the cut portions a, b, c that extend along the lengthwise direction are provided in the heat transfer fins 13a, 13b, the mold used when press molding the fin collars 15 might interfere with the cuts a, b, c.

[0087] According to the present embodiment, since the distance between the cuts a, b, c and the fin collars 15 is sufficient, the interference between the cuts and the mold is prevented. Thus, the flexibility in the working of the fins is improved, and the molding accuracy is also improved. Also, as is known, the condensed water on the fin surfaces tends to concentrate in a lower portion of the center of the fin collars 15. In this respect, according to the present embodiment, since the cuts a at the upper ends of the slits 14a, 14b are inclined, the condensed water is easily trapped by the cuts a, and the condensed water easily flows into the slits 14a, 14b.

(Thirteenth Embodiment)

[0088] Fig. 15 shows the structure of an air heat exchanger according to a thirteenth embodiment of the present invention suitable for an air conditioner indoor unit.

[0089] In the present embodiment, the integrated slits 14b are employed as the cut-and-raised pieces 14 located at the center of the heat transfer fins 13a, 13b, and the diagonal split type slits 14a are employed as the cut-and-raised pieces 14 located in the vicinity of the side edges of the heat transfer fins 13a, 13b. The cuts a at the upper ends of the slits are omitted in the structure of the cross fin coil type air heat exchanger according to the eleventh embodiment, in which, while the linear cuts (linear portions) a, b, c that extend along the lengthwise direction and have a predetermined length are provided at the upper ends and the lower ends of the slits 14a, 14b and at the center of the slits 14a, all the cuts a, b, c except the cuts at the center of the split type slits 14a extend diagonally to avoid the fin collars 15.

[0090] Although this structure inhibits, as compared to the tenth embodiment, the operation in which the condensed water flows into the slits 14a, 14b without flowing around the upper end surfaces of the slits 14a, 14b after the condensed water generated on the fin surfaces concentrates in the upper cuts a of the slits 14a, 14b, the mold used in press molding the fin collars 15 does not interfere with the cuts a.

(Fourteenth Embodiment)

[0091] Fig. 16 shows the structure of an air heat exchanger according to a fourteenth embodiment of the present invention suitable for an air conditioner indoor unit.

[0092] In the present embodiment, the integrated slits 14b are employed as the cut-and-raised pieces 14 located at the center of the heat transfer fins 13a, 13b, and the parallel split type slits 14a are employed as the cut-and-raised pieces 14 located in the vicinity of the side edges of the heat transfer fins 13a, 13b. The cuts a at the upper end of the slits are omitted from the structure of the cross fin coil type air heat exchanger according to the twelfth embodiment, in which, while the linear cuts (linear portions) a, b, c that extend along the lengthwise direction and have a predetermined length are provided at the upper ends and the lower ends of the slits 14a, 14b and at the center of the slits 14a, all the cuts a, b, c except the cuts at the center of the split type slits 14a extend diagonally to avoid the fin collars 15.

[0093] Although this structure inhibits, as compared to the eleventh embodiment, the operation in which the condensed water flows into the slits 14a, 14b without flowing around the upper end surfaces of the slits 14a, 14b after the condensed water generated on the fin surfaces concentrates in the upper cuts a of the slits 14a, 14b, the mold used for press molding the fin collars 15 does not interfere with the cuts a.

(Fifteenth Embodiment)

[0094] Fig. 17 shows the structure of an air heat exchanger according to a fifteenth embodiment of the present invention suitable for an air conditioner indoor unit.

[0095] In the present embodiment, the integrated slits 14b are employed as the cut-and-raised pieces 14 located at the center of the heat transfer fins 13a, 13b, and the diagonal split type slits 14a are employed as the cut-and-raised pieces 14 located in the vicinity of the side edges of the heat transfer fins 13a, 13b. Drainage ribs 16a, 16b are provided along the front edge of the front row of the fins 13a and along the rear edge of the rear row of the fins 13b in the structure of the cross fin coil type air heat exchanger according to the thirteenth embodiment, in which the linear cuts (linear portions) b, c that extend diagonally downward are provided only at the narrow angle portions at the lower ends of the slits 14a, 14b. The ribs 16a, 16b have a recess on one of the fin surfaces and a projection on the other fin surface. Furthermore, the linear cuts c that extend from the narrow angle portions at the lower ends of the slits 14a, 14b are connected or close to the ribs 16a, 16b.

[0096] In this case, as the ribs 16a, 16b, for example, ribs having a semicircular cross-section shown in Fig. 18 (a), ribs having a triangular cross-section shown in Fig. 18(b), or ribs having a rectangular cross-section shown in Fig. 18(c) may be employed. With this structure, the interference between the mold used for press molding the fin collars and the cuts is eliminated, and the condensed water in the slits 14a located in the vicinity of the side edges of the heat transfer fins 13a, 13b is smoothly discharged downward via grooves of the ribs 16a, 16b.

(Sixteenth Embodiment)

[0097] Fig. 19 shows the structure of an air heat exchanger according to a sixteenth embodiment of the present invention suitable for an air conditioner indoor unit.

[0098] In the present embodiment, the integrated slits 14b are employed as the cut-and-raised pieces 14 located at the center of the heat transfer fins 13a, 13b, and the parallel split type slits 14a are employed as the cut-and-raised pieces 14 located in the vicinity of the side edges of the heat transfer fins 13a, 13b. The drainage ribs 16a, 16b are provided along the front edge of the front row of the fin 13a and along the rear edge of the rear row of the fin 13b in the cross fin coil type air heat exchanger according to the fourteenth embodiment, in which the linear cuts (linear portions) c, b that extend diagonally downward to avoid the fin collars 15 and has a predetermined length are provided only at the narrow angle portions at the lower ends of the slits 14a, 14b. The ribs 16a, 16b have a recess on one of the fin surfaces and a projection on the other fin surface. The linear cuts that extend from the narrow angle portions at the lower ends of the slits 14a, 14b are connected or close to the ribs 16a, 16b.

[0099] In this case, as the drainage ribs 16a, 16b, for example, ribs having a semicircular cross-section shown in Fig. 18(a), ribs having a triangular cross-section shown in Fig. 18(b), or ribs having a rectangular cross-section shown in Fig. 18(c) are employed. With this structure, the interference between the mold used for press molding the fin collars and the cuts is eliminated, and the condensed water in the slits 14a located in the vicinity of the side edges of the heat transfer fins 13a, 13b is smoothly discharged downward via the grooves of the ribs 16a, 16b.

(Other modifications of linear portions that improve inflow and discharge of condensed water)

[0100] Besides the cut shown in Fig. 20(a), for example, a minute space shown in Fig. 20(b), a marked microgroove shown in Fig. 20(c), a microslit shown in Fig. 20(d), or a microlouver shown in Fig. 20(e) may be employed as the linear portions a to c of the above embodiments. In these cases, minute gaps draw in the surrounding condensed water by capillary phenomenon, and the condensed water is smoothly discharged.

(Various types of applications)

[0101] The heat exchangers of the above embodiments are optimal for, for example, the cross fin coil type air heat exchanger for an air conditioner indoor unit shown in Figs. 21 and 23. More specifically, the air conditioner indoor unit is easily manufactured with low costs that prevents adhesion of environmental suspended matter on the surfaces of the heat transfer fins, breeding of bacteria, and corrosion of the fins, improves drainage during cooling operation, improves the cooling performance, reduces ventilation resistance, and prevents spattering of water. The heat exchangers of the present invention may be applied to other cooling apparatuses.

Claims

1. A heat exchanger comprising a heat transfer tube, a plurality of heat transfer fins arranged along a direction perpendicular to an axis of the heat transfer tube to be parallel to each other, and a cut-and-raised piece provided on a heat transfer surface of each heat transfer fin, the heat exchanger being **characterized in that:**

a linear portion is provided at the lower end of each cut-and-raised piece, wherein the linear portion extends downward and guides condensed water generated on the heat transfer surface downward.

2. The heat exchanger according to claim 1, **characterized in that** a linear portion, which extends upward and guides condensed water downward, is provided at the upper end of each cut-and-raised piece.

3. The heat exchanger according to claim 1 or 2, **characterized in that** each cut-and-raised piece is split into an upper part and a lower part, and the linear portion, which extends along a lengthwise direction and guides the condensed water downward, is provided between the upper part and the lower part.

4. The heat exchanger according to any one of claims 1 to 3, **characterized in that** each linear portion communicates with the interior of the associated cut-and-raised piece.

5. The heat exchanger according to any one of claims 1 to 4, **characterized in that** an upper end and a lower end of each cut-and-raised piece are inclined, and the linear portions are provided at narrow angle portions of the upper end and the lower end of each cut-and-raised piece.

6. The heat exchanger according to any one of claims 2 to 4, **characterized in that** an upper end and a lower end of each cut-and-raised piece are inclined, and the linear portion at the upper end of each cut-and-raised piece is provided at a wide angle portion of the cut-and-raised piece.

7. The heat exchanger according to any one of claims 1 to 4, **characterized in that** the linear portion is provided at the center of the end portions of each cut-and-raised piece.

8. The heat exchanger according to any one of claims 1 to 7, **characterized in that** the linear portions extend along a step pitch of the heat transfer fins.

9. The heat exchanger according to any one of claims 1 to 7, **characterized in that** the linear portion at the upper end or the lower end of each cut-and-raised piece extends diagonally to avoid a fin collar in which the heat transfer tube is inserted.

10. The heat exchanger according to any one of claims 1 to 9, **characterized by** a drainage rib, which is located along a front edge or a rear edge of the heat transfer fins, wherein the drainage rib is located close to or connected to the linear portion at the lower end of each cut-and-raised piece.

11. The heat exchanger according to any one of claims 1 to 10, **characterized in that** the linear portions are linear cuts.

12. The heat exchanger according to any one of claims 1 to 10, **characterized in that** the linear portions are linear grooves.

13. The heat exchanger according to any one of claims 1 to 12, **characterized in that** the cut-and-raised pieces are louvers.

14. The heat exchanger according to any one of claims 1 to 13, **characterized in that** the heat exchanger is a heat exchanger for an air conditioner indoor unit.

Fig.1

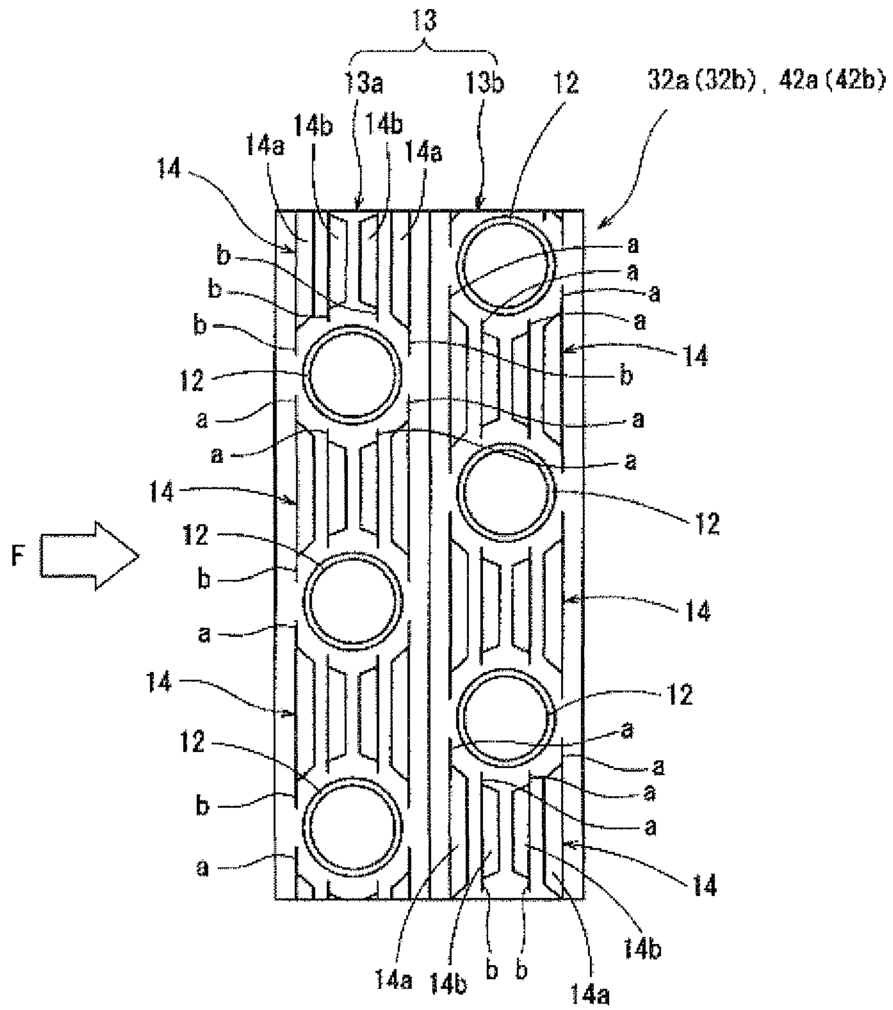
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Fig.2

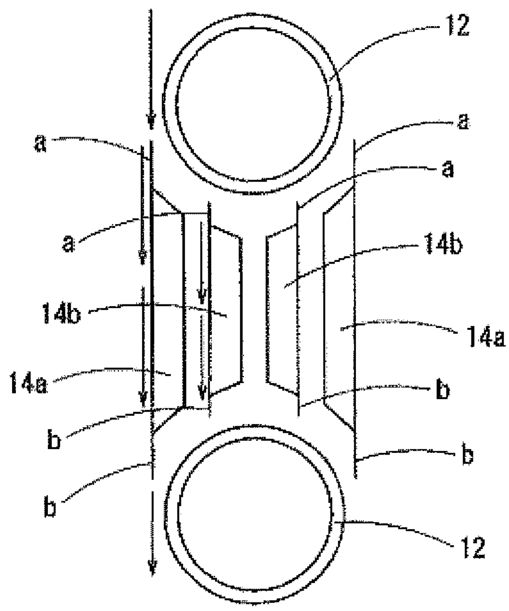

Fig.3

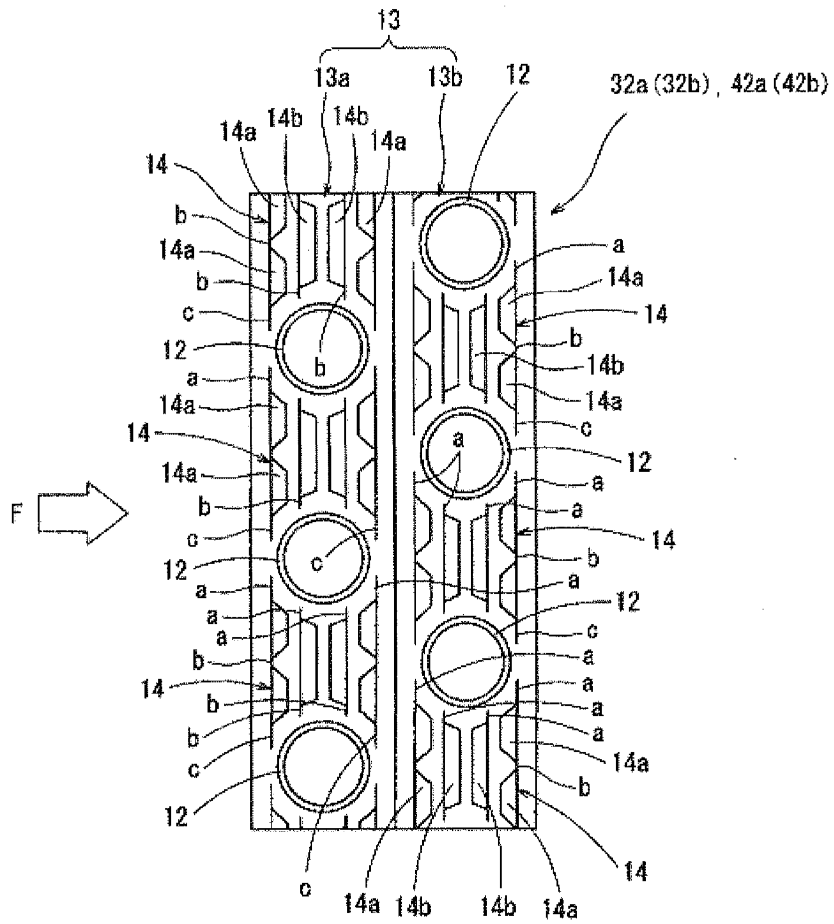
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Fig.4

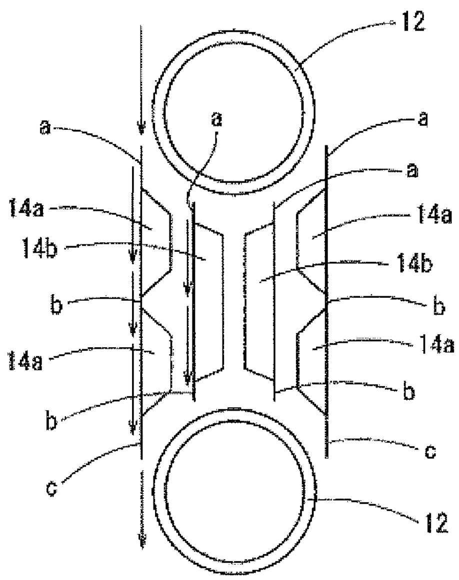
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Fig.5

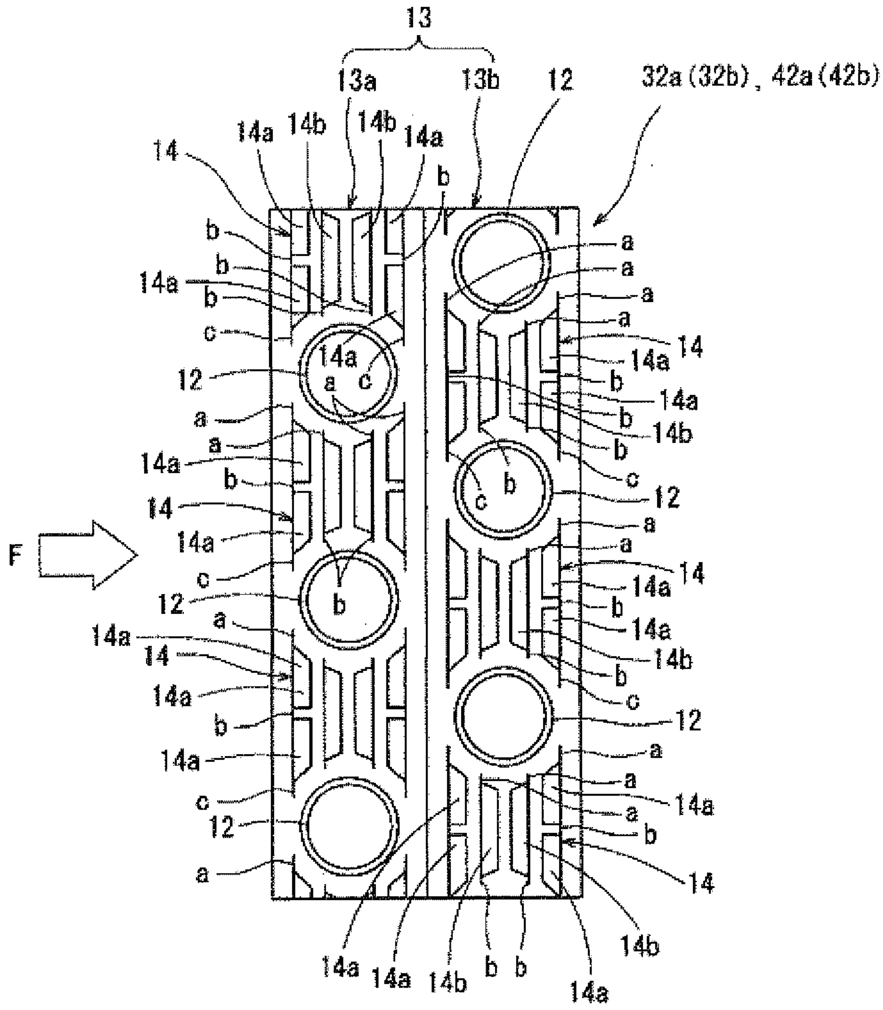

Fig.6

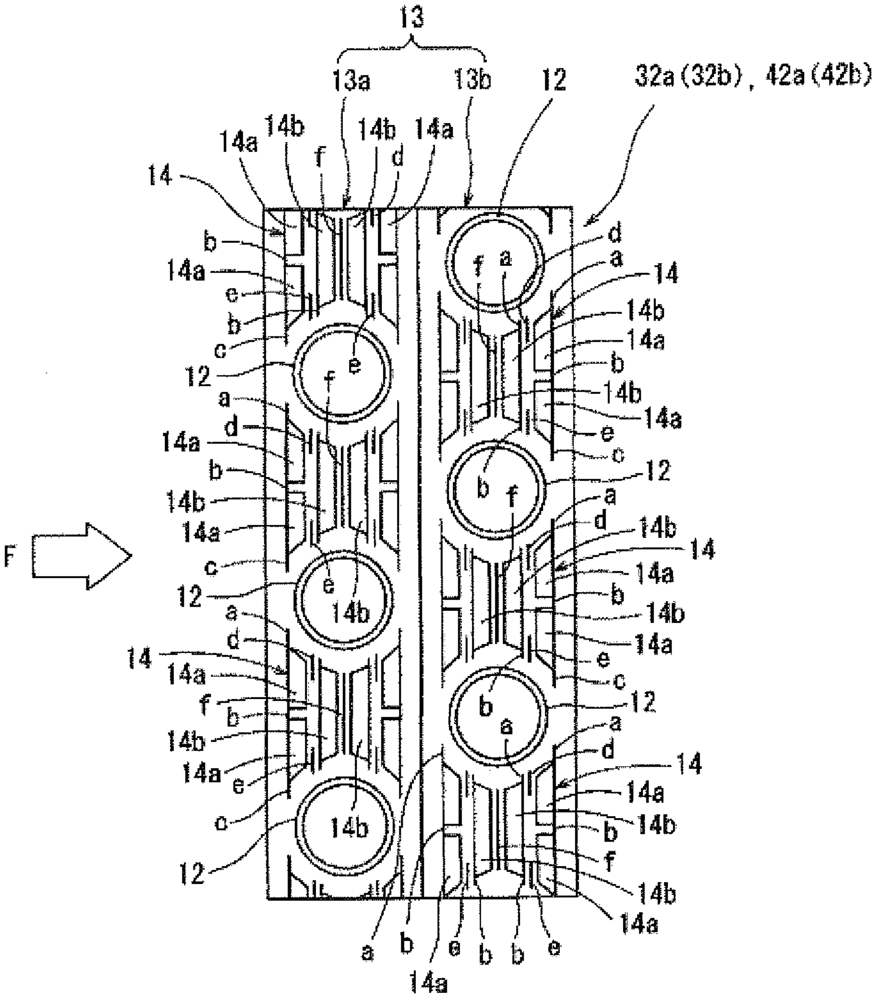

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Fig.7

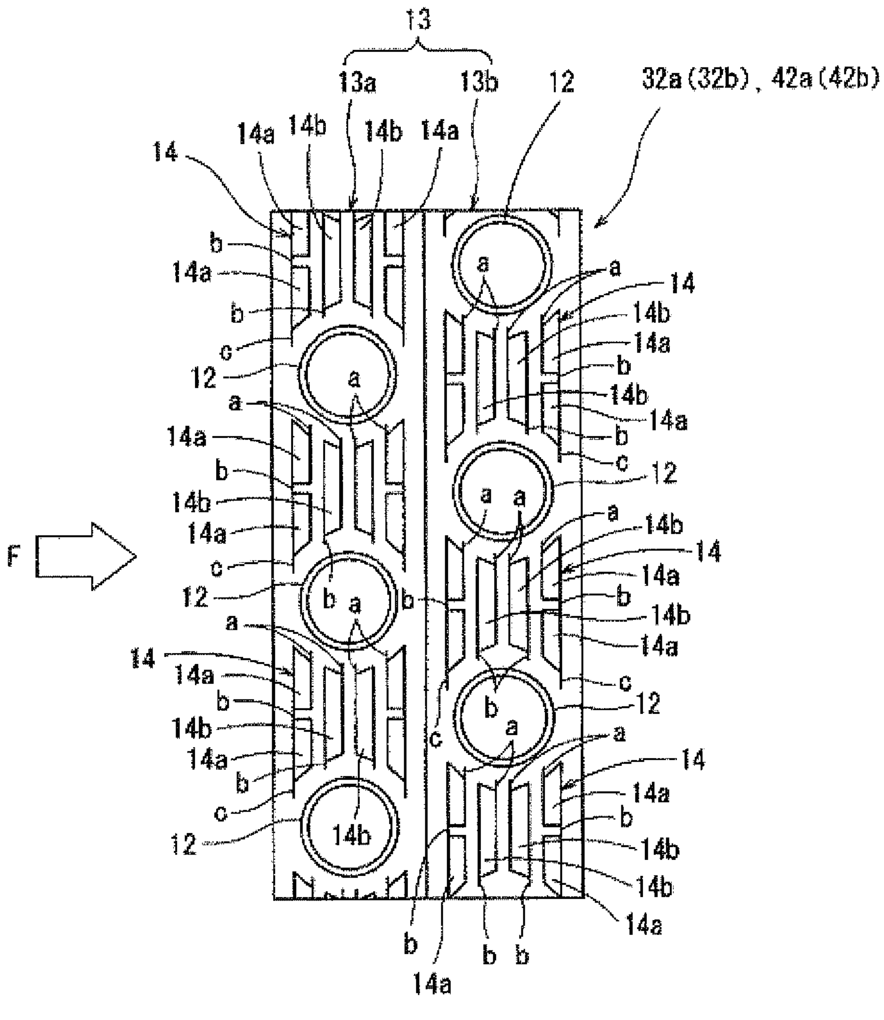
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Fig.8

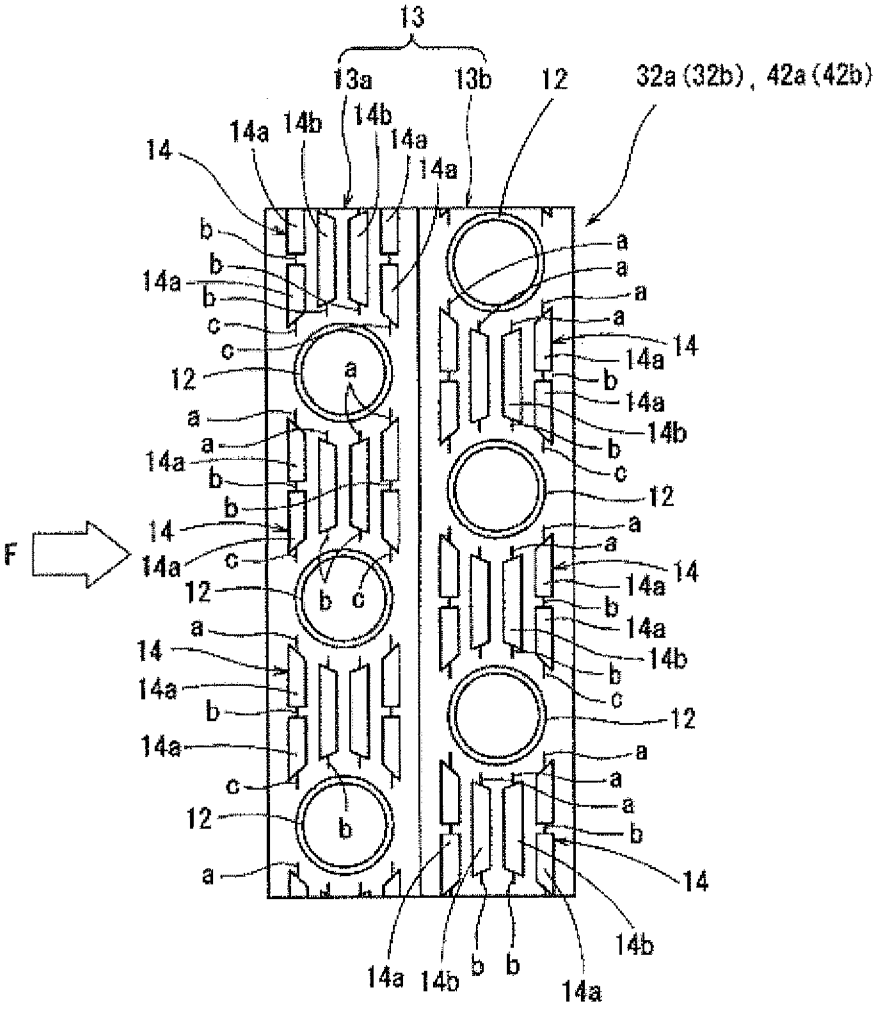
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Fig.9

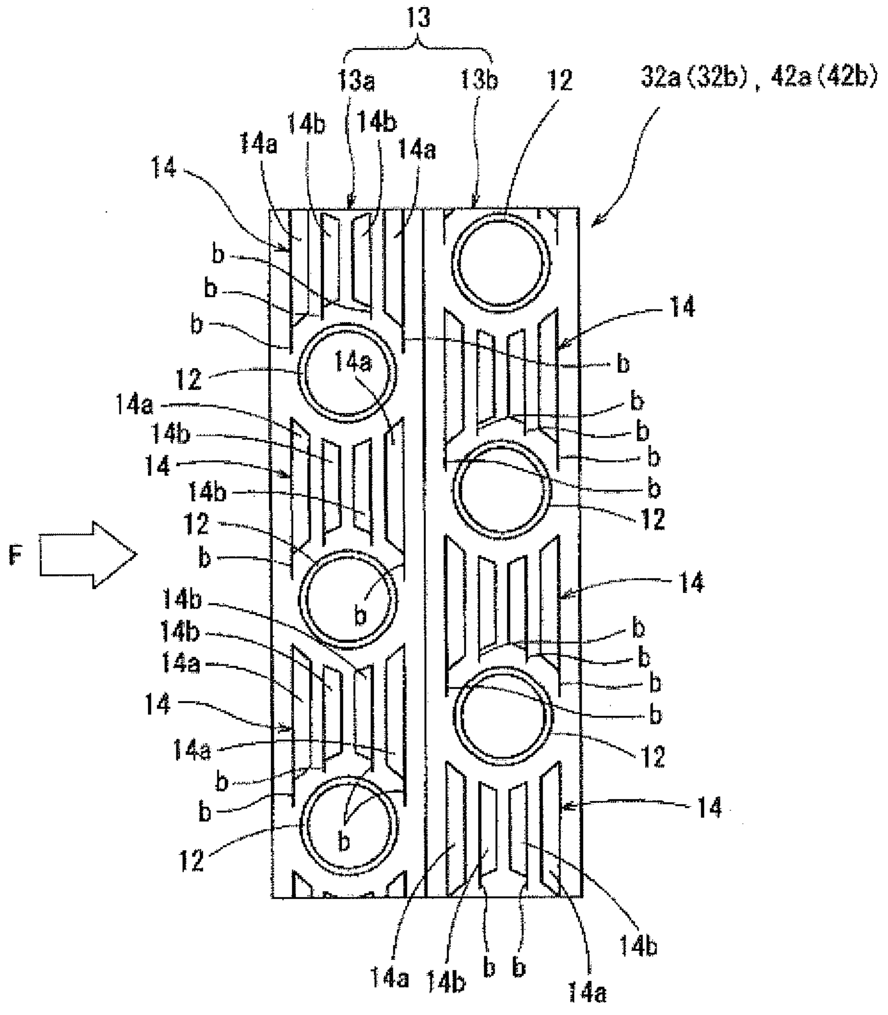
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Fig.10

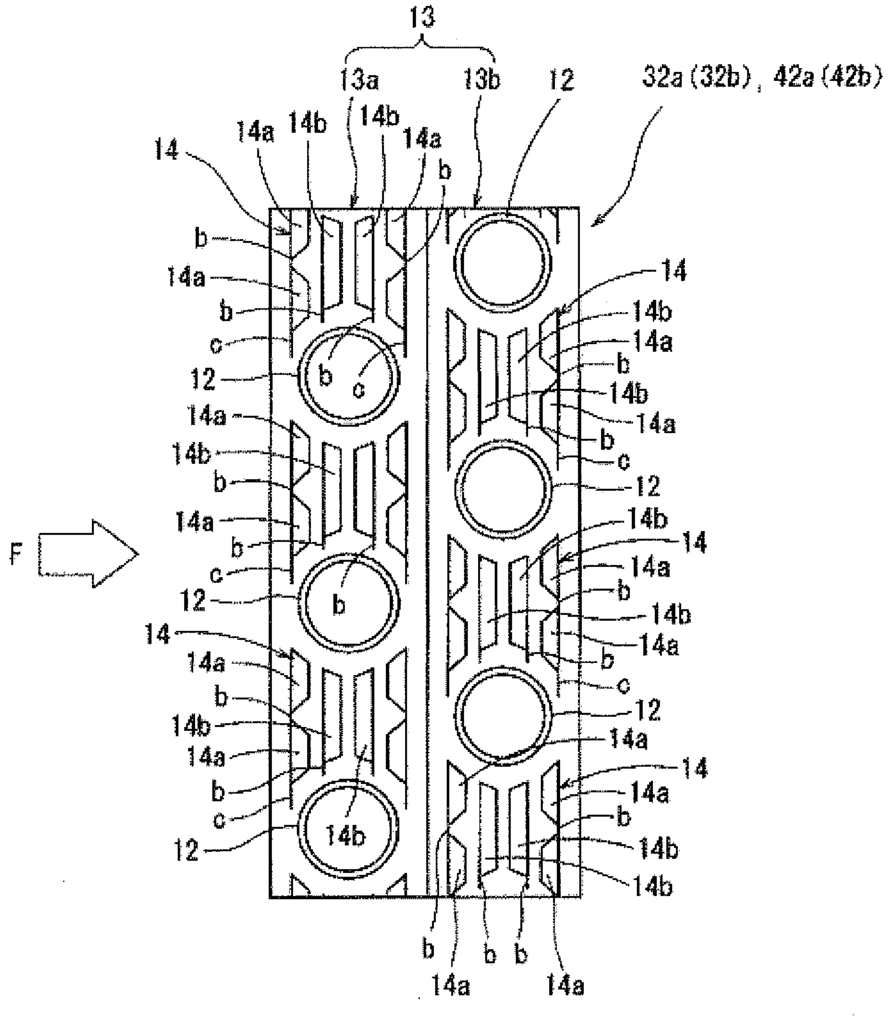

Fig.11

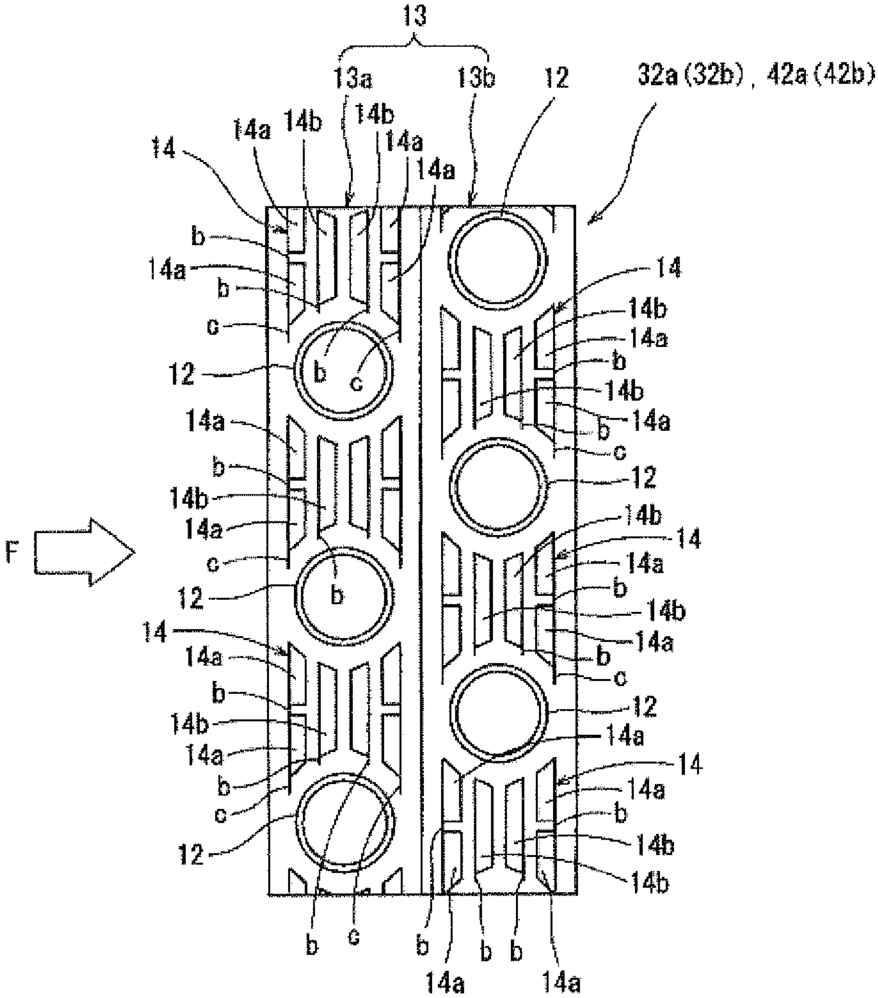

Fig.12

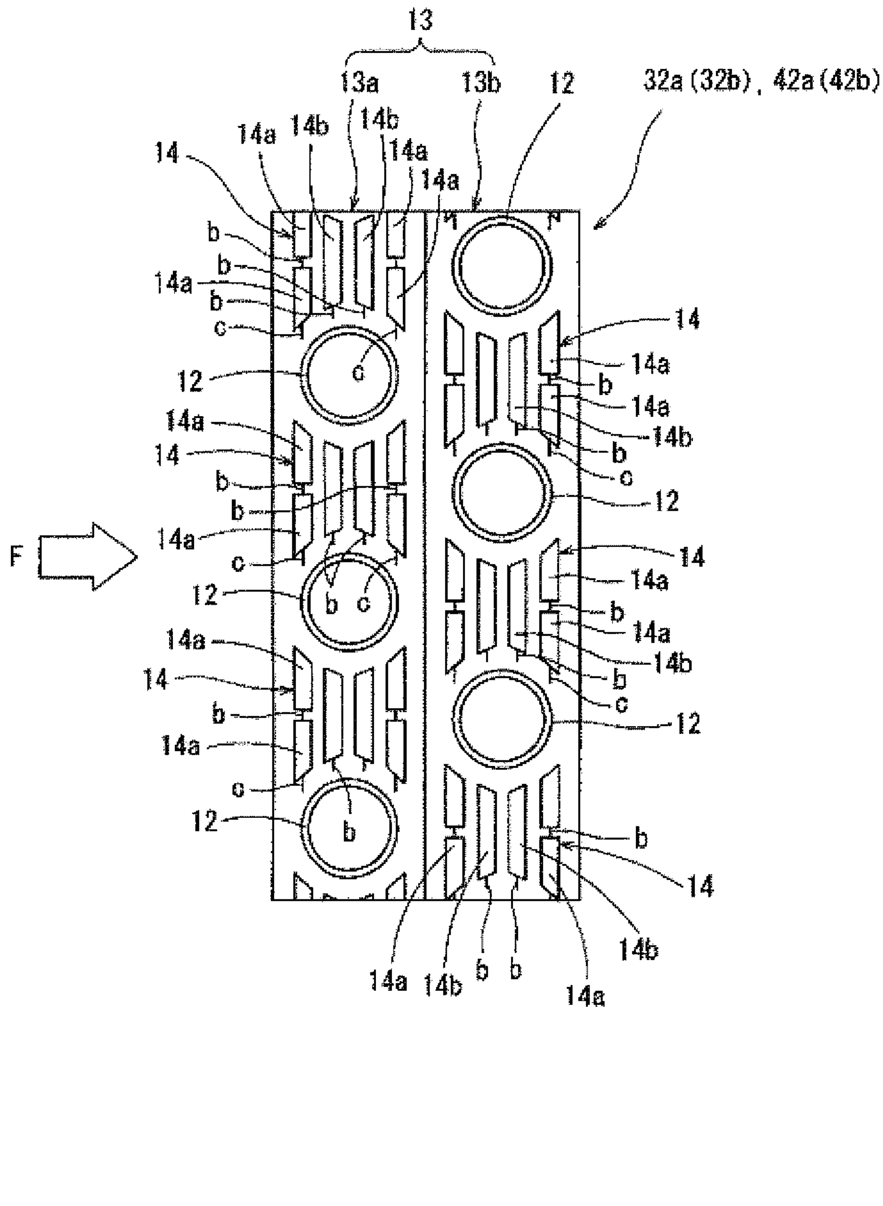

Fig.13

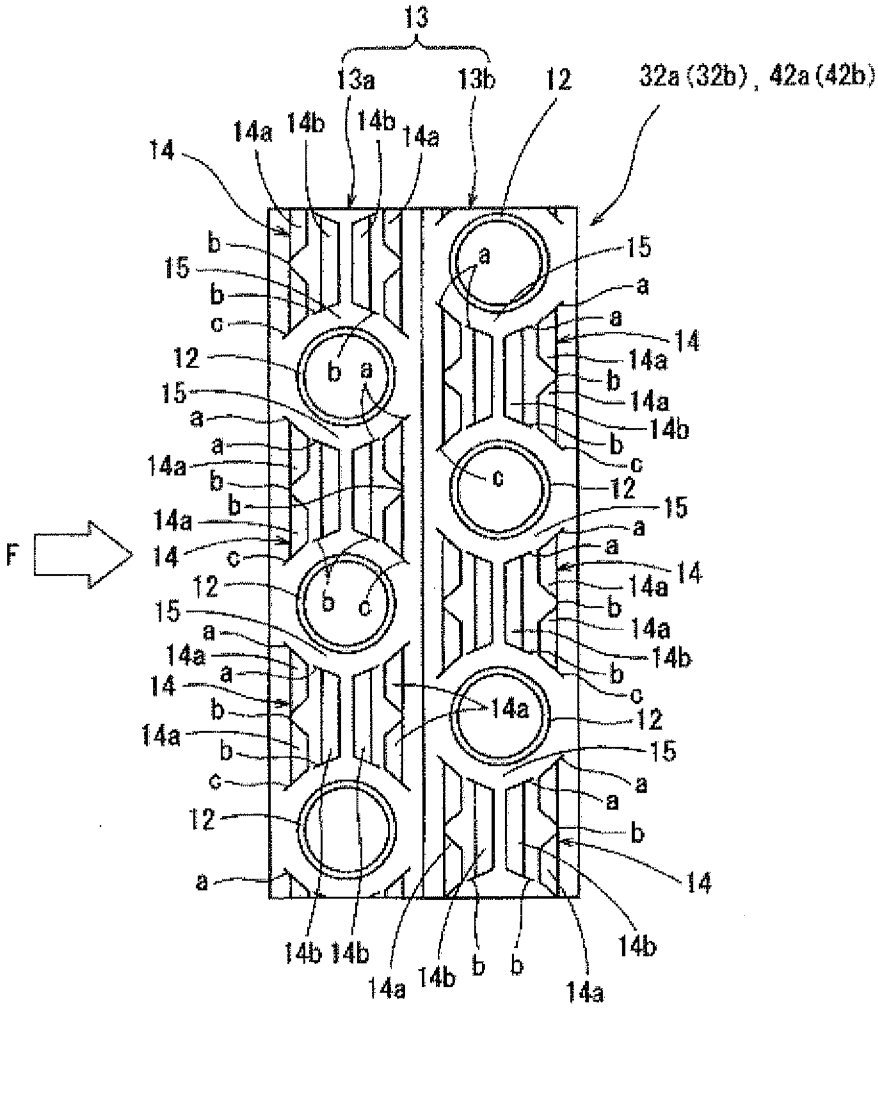

Fig.14

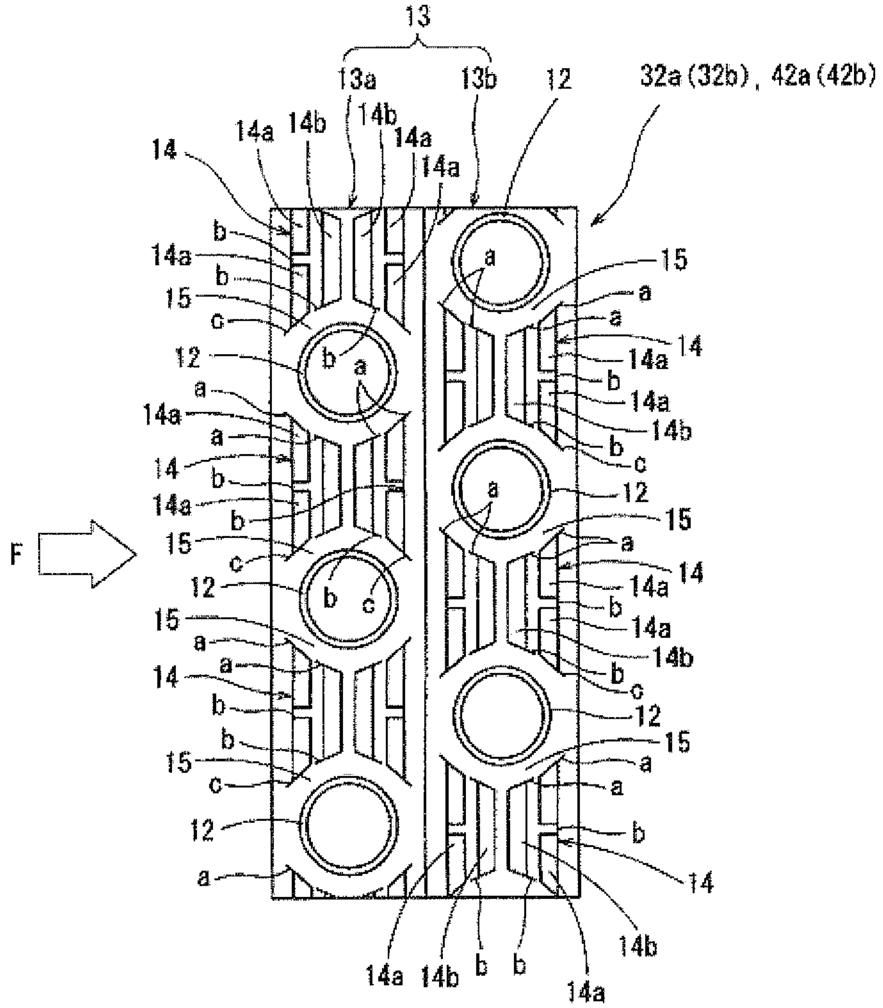
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Fig.15

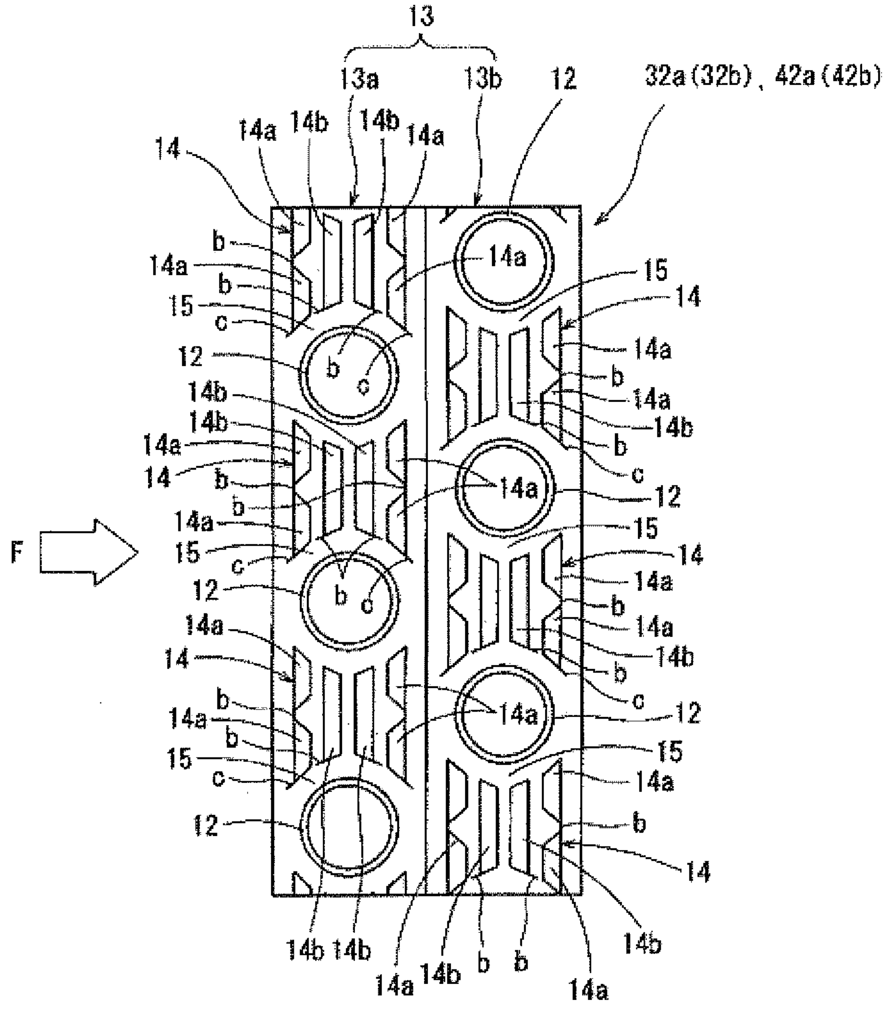
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Fig.16

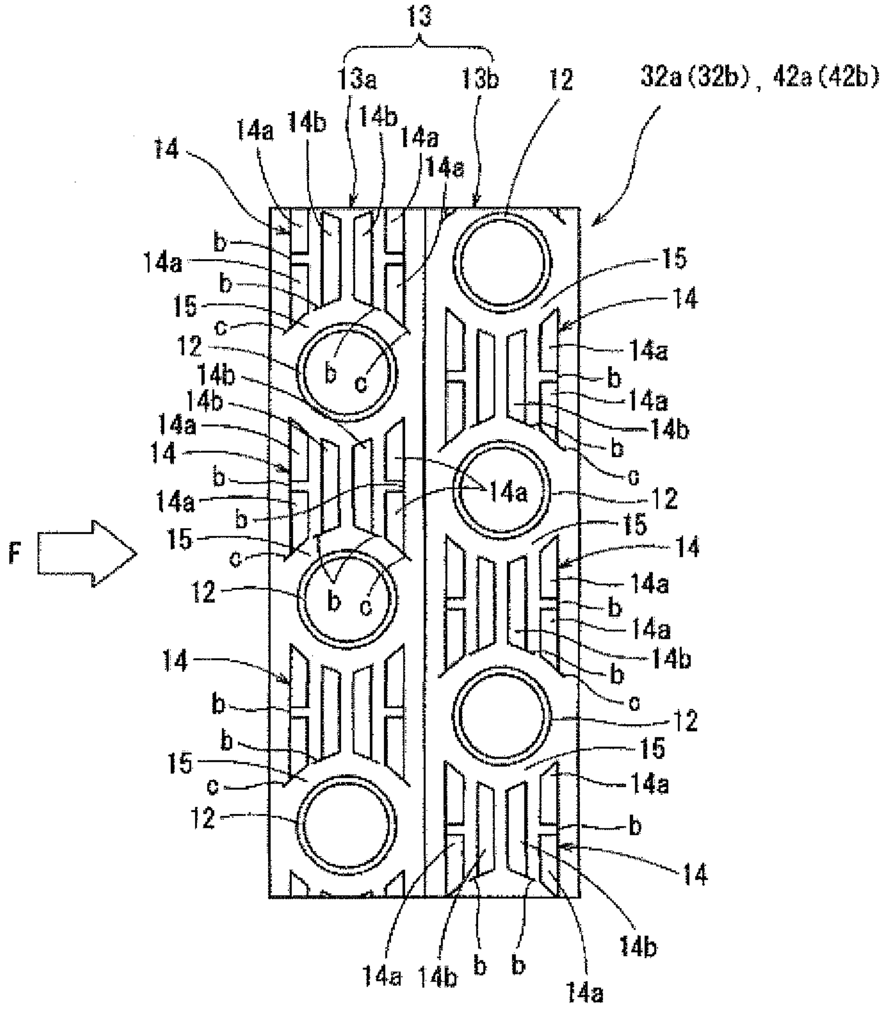
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Fig.17

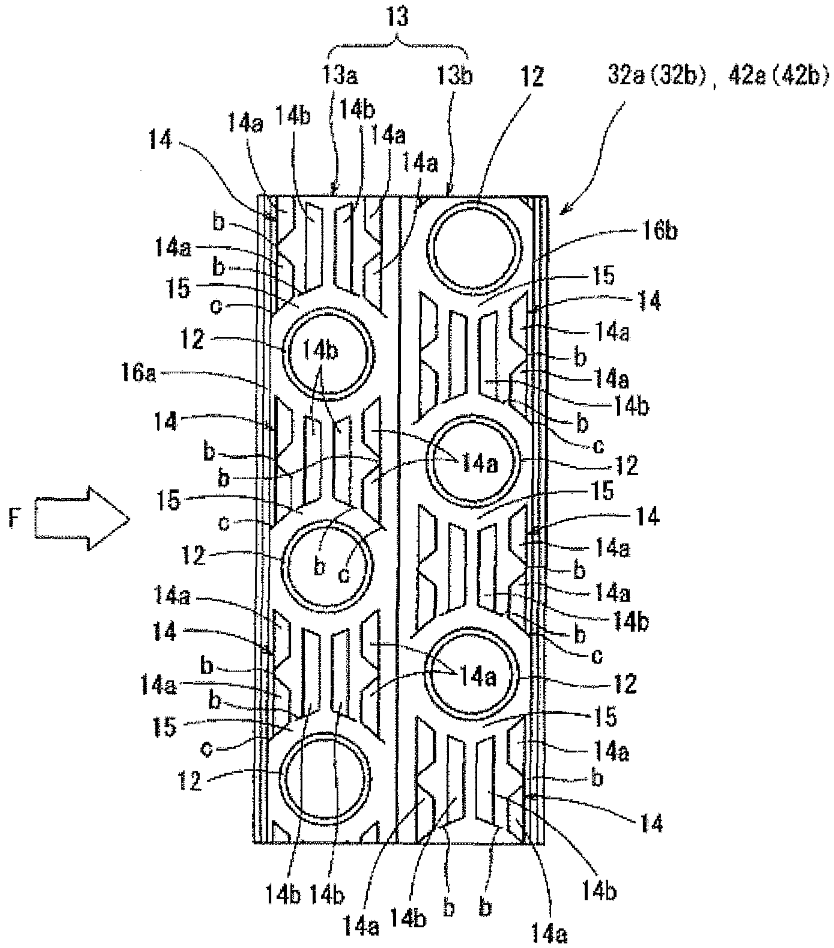
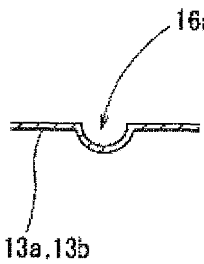
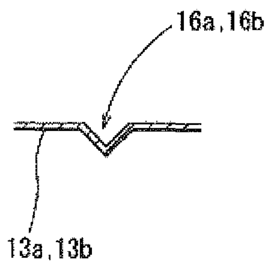


Fig.18(a) Fig.18(b) Fig.18(c)





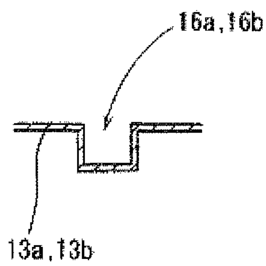


Fig.19

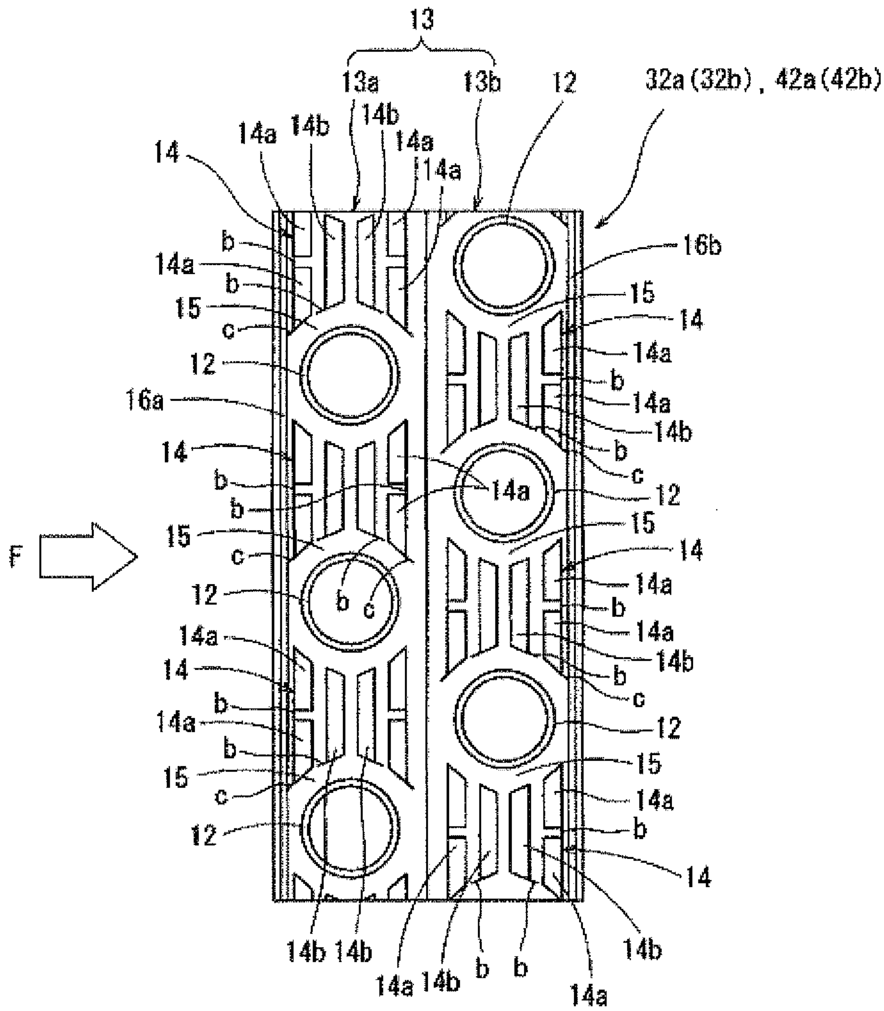


Fig.20(a) Fig.20(b) Fig.20(c) Fig.20(d) Fig.20(e)

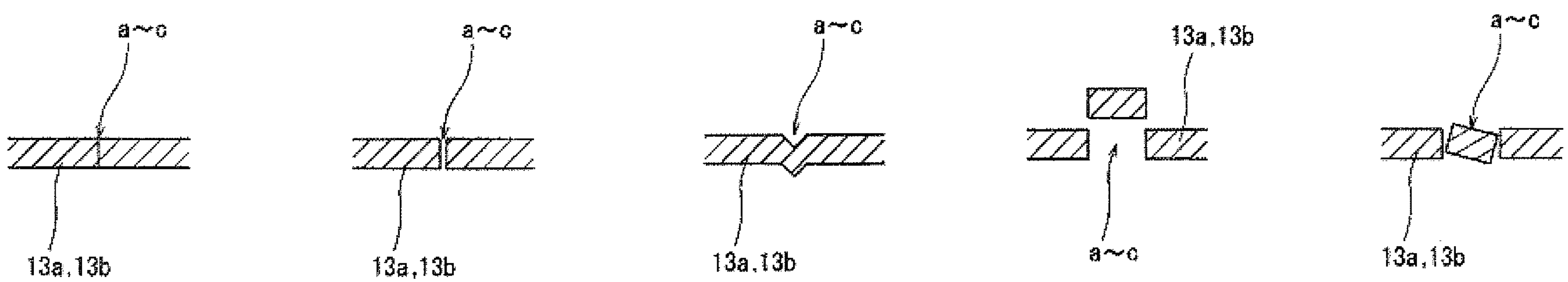


Fig.21

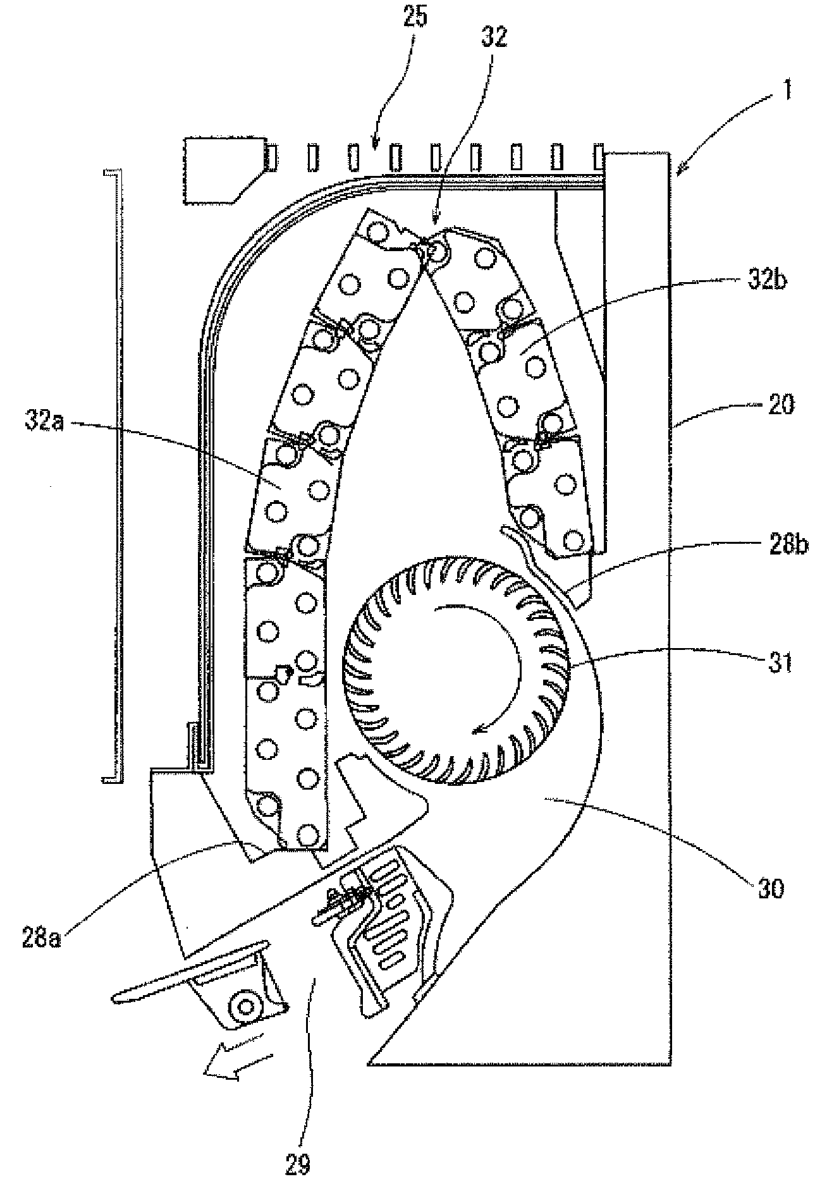
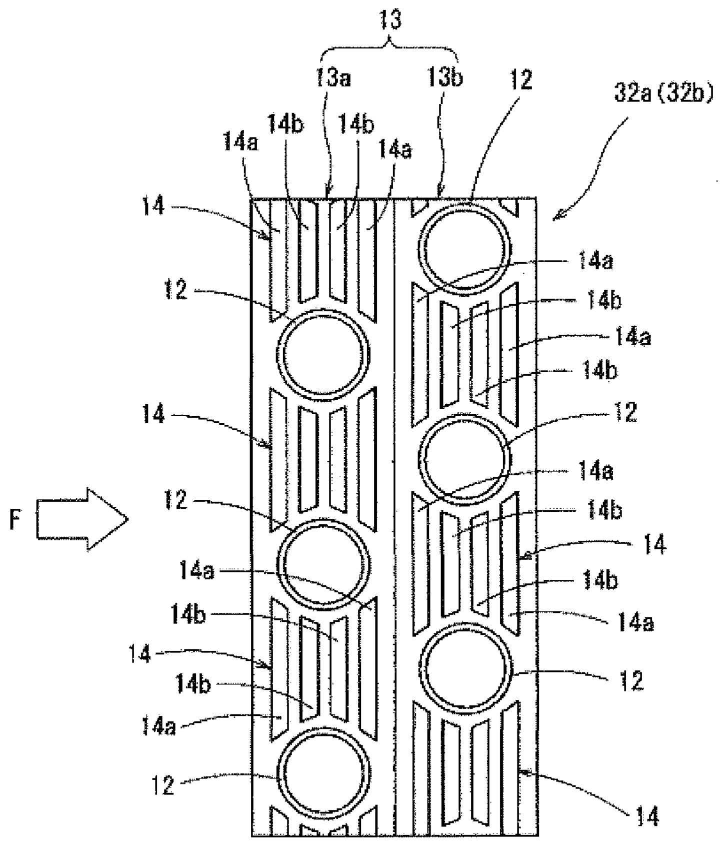


Fig.22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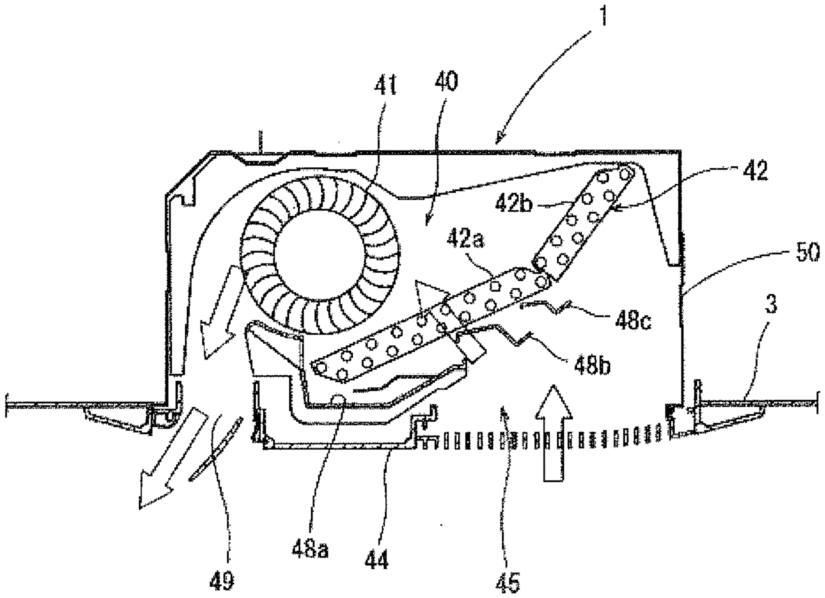
12
14

Fig.23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48b
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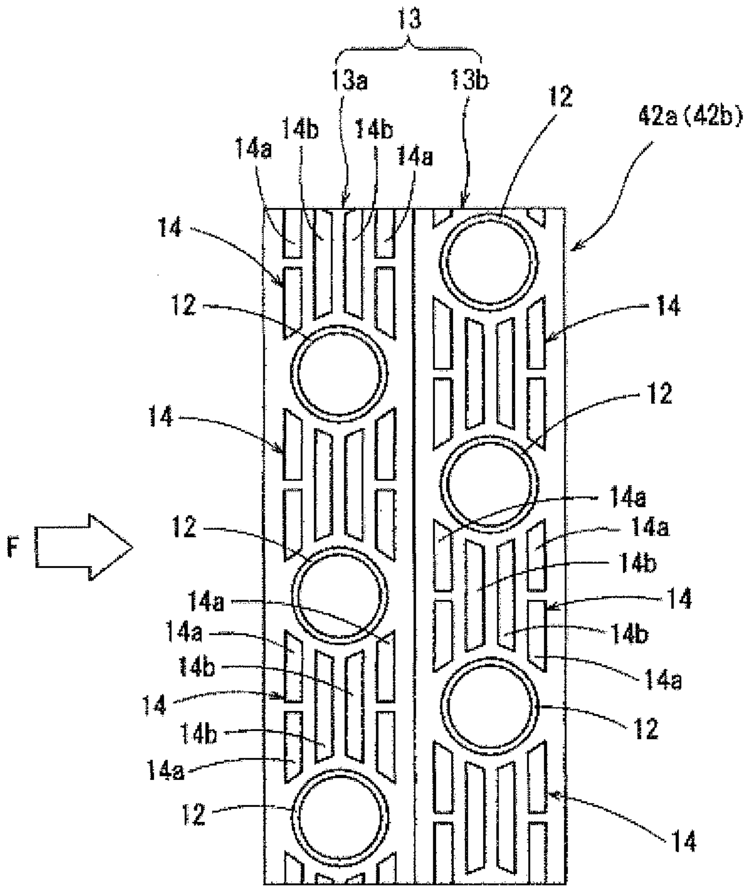
Fig.24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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/054072

A. CLASSIFICATION OF SUBJECT MATTER
F28F1/32(2006.01)i, *F24F1/00*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F28F1/32, F24F1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2008
Kokai Jitsuyo Shinan Koho	1971-2008	Toroku Jitsuyo Shinan Koho	1994-2008

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 10-332291 A (Mitsubishi Heavy Industries, Ltd.), 15 December, 1998 (15.12.98), Par. Nos. [0006], [0007], [0009] to [0015]; Fig. 1 (Family: none)	1,2,4-6,14 3,7-13
Y	JP 55-12302 A (Hitachi, Ltd.), 28 January, 1980 (28.01.80), Description, page 2, upper right column, line 13 to page 3, upper right column, line 3; Figs. 2 to 7 (Family: none)	3,7,8

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search
24 March, 2008 (24.03.08)

Date of mailing of the international search report
08 April, 2008 (08.04.08)

Name and mailing address of the ISA/
Japanese Patent Office

Facsimile No.

Authorized officer

Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/054072

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2003-294384 A (Matsushita Electric Industrial Co., Ltd.), 15 October, 2003 (15.10.03), Par. Nos. [0009] to [0015], [0017]; Figs. 1 to 6 (Family: none)	9
Y	WO 2006/057234 A1 (Daikin Industries, Ltd.), 01 June, 2006 (01.06.06), Par. Nos. [0046] to [0048], [0051]; Figs. 2 to 3 (Family: none)	10
Y	JP 2006-38311 A (Daikin Industries, Ltd.), 09 February, 2006 (09.02.06), Par. Nos. [0026] to [0066]; Figs. 2 to 5 (Family: none)	11-13

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REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2004353914 A **[0015]**