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(54) **Stacked-type multi-flow heat exchangers**

(57) A heat exchanger has a laminating tube group communicating between a first tank (31) and a second tank (32). The heat exchanger includes a first heat exchange portion (46), a second heat exchange portion (48), and a third heat exchange portion (47). The first heat exchange portion (46) is disposed at a downstream side of an air passing through the heat exchanger and has a first group of tubes (6) forming a first route of a heat exchange medium. The second heat exchange portion (48) is disposed at an upstream side of the air and at a back side of the first heat exchange portion (46). The second heat exchange portion has a second group of tubes (7) forming a second route of the heat exchange medium. The third heat exchange portion (47) is disposed at both the upstream and the downstream sides of the air and at adjacent to the first (46) and the second heat exchange portions (48). The third heat exchange portion (47) has a third group of tubes (8) forming a third route of the heat exchange medium.

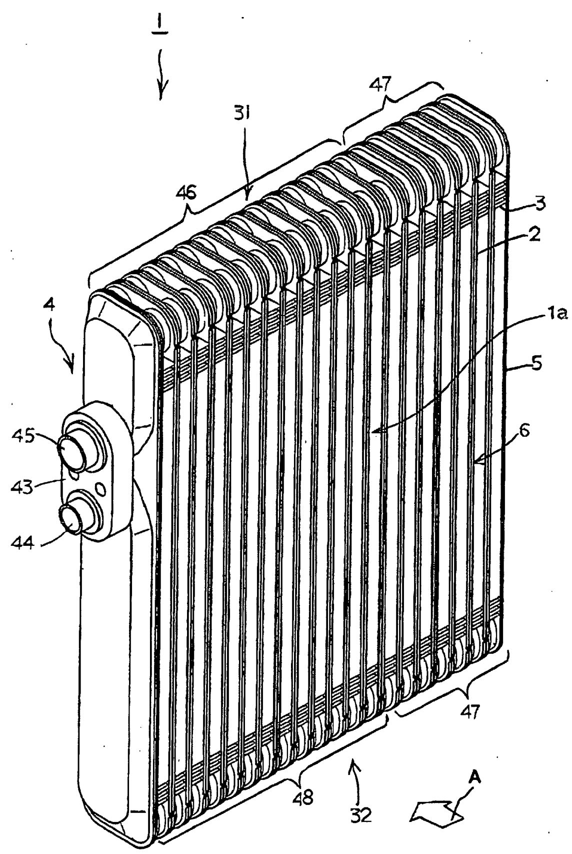

Fig. 1

EP 1 310 757 A2

Description

[0001] The present invention relates to stacked-type multi-flow heat exchangers for use in an air conditioner for vehicles.

[0002] Stacked-type multi-flow heat exchangers for use in an air conditioner for vehicles, which include a plurality of heat transfer tubes and a plurality of fins, stacked alternately, are known in the art. Such known stacked-type multi-flow heat exchangers may be used as evaporators in air conditioners for vehicles. In vehicle air conditioners there has been high demand to decrease the space of installation of the air conditioner. Therefore, thinning the depth dimension, i.e., the dimension of the direction for the passing of air, of a evaporator, and in order to decrease the space of the installation of the evaporator, providing connection portions for introducing or discharging refrigerant on one side surface of the evaporator are desirable. Moreover equalizing the air temperature passing through the evaporator is also desirable to produce a high performance air conditioner.

[0003] Therefore, in order to thin the depth dimension of the evaporator, and decrease the space of the installation of the evaporator, heat exchangers are proposed in Japanese Utility Model (Unexamined) Publication No. H7-12778 shown in Fig. 9, and Japanese Patent (Unexamined) Publication No. H9-17850 shown in Fig. 10.

[0004] As shown in Fig. 9, a heat exchanger 100 has an upper tank 102 and a lower tank 103. Upper tank 102 and lower tank 103 are communicated by a group of tubes 101. Upper tank 103 includes an upstream tank 104 and a downstream tank 105 with respect to their flow direction A', respectively. Upstream tank 104 has an inner space divided by a partitioning plate 106 into chambers 107 and 108. Likewise, downstream tank 105 has an inner space divided by a partitioning plate 109 into chambers 110 and 111. Chamber 108 of upstream tank 104 and chamber 111 of downstream tank 105 are communicated by a communicating path 112. Lower tank 103 includes an upstream tank 113 and a downstream tank 114 with respect to the air flow direction A', respectively.

[0005] In heat exchanger 100, the heat exchange medium introduced through a fluid inlet portion 115 provided at chamber 107 of upstream tank 104 passes through heat exchanger 100 as illustrated in Fig. 9, and is discharged from a fluid outlet portion 116 provided at chamber 110 of downstream tank 105.

[0006] In addition, as shown in Fig. 10, a heat exchanger 117 has an upper tank 118 and a lower tank 119. Upper tank 118 and lower tank 119 are communicated by a group of 5 tubes 120. Upper tank 118 includes an upstream tank 121 and a downstream tank 122 with respect to the air flow direction A", respectively. Upstream tank 121 has an inner space divided by a partitioning plate 123 into chambers 124 and 125. Moreover, lower tank 119 includes an upstream tank 126 and a downstream tank 127. Downstream tank 127 has an inner space divided by a partitioning plate 128 into chambers 129 and 130. Chamber 125 of upstream tank 121 and chamber 130 of downstream tank 127 are communicated by a communicating path 131.

[0007] In heat exchanger 117, the heat exchange medium introduced through a fluid inlet portion 132 provided at chamber 129 of downstream tank 127 passes through heat exchanger 117 as illustrated in Fig. 10, and is discharged from a fluid outlet portion 133 provided at chamber 124 of upstream tank 121. In heat exchanger 117, communicating path 131 projecting in the direction of the laminated group of tubes 120, and fluid inlet portion 132 and fluid outlet portion 133 are provided at one side surface of heat exchanger 117, so that the space of the installion of heat exchanger 117 is decreased. Moreover, heat exchanger 117 has a structure that does not overlap a part of the group of tubes 120, easily introducing vapor phase refrigerant due to inertial force of a vapor-liquid refrigerant and another part of the group of tubes 120 easily introducing liquid phase refrigerant in the air flow direction A". Therefore, the air temperature passing through heat exchanger 117 is equalized in an entire of the group of tubes 120.

[0008] Nevertheless, there is a demand further to achieve a thin-profile, i.e. to decrease the depth dimension of the heat exchangers (for example, decrease the depth dimension to less than or equal to 40mm).

[0009] However, if the depth dimension of heat exchanger 100 shown in Fig. 9 or' heat exchanger 117 shown in Fig. 10, both of which have four refrigerant flow paths, is directly decreased, problems may arise. If the depth dimension of heat exchanger 100 or heat exchanger 117 is decreased, the cross-sectional area of a flow path of each tube is also decreased, and pressure loss of refrigerant increases. As a result, quantity of refrigerant in circulation may be reduced or the temperature of refrigerant at the introduction to heat exchanger 100 or heat exchanger 117 may be increased, and the efficiency of heat exchange may be reduced. On the other hand, if one of partitioning plates is removed from heat exchanger 100 or heat exchanger 117 and refrigerant flow paths are reduced to suppress the pressure loss, the air temperature passing through heat exchanger 100 or heat exchanger 117 may not be equalized. For example, referring to Fig. 9, if partitioning plate 109 is removed, refrigerant flowing from communicating path 112 should flow into all tubes equally. Nevertheless, the refrigerant flow path in the width direction of the tanks is lengthened equally, and flow of the refrigerant into all of the tubes is difficult due to a difference between inertial force of a vapor a refrigerant and incrutial force of a liquid refrigerant.

[0010] In addition, heat exchanger 100 shown in Fig. 9 or heat exchanger 117 shown in Fig. 10 include a communicating path having a smaller cross-sectional area along the refrigerant flow path, and the refrigerant is concentrated into the communicating path. Therefore, pressure loss is more likely to arise. Moreover, the communicating path hardly contributes to the heat exchange. Further, communicating path 131 of heat exchanger 117 shown in Fig. 10 is projected in the width direction. Therefore, in heat exchangers having a side tank for introducing or discharging the heat exchange medium in the width direction, the dimension of the width direction of heat exchangers may increase.

[0011] Therefore, a need has arisen for stacked-type multi-flow heat exchangers for use in vehicle air conditioners that overcome these and other shortcomings of the related art. A technical advantage of the present invention is to suppress the pressure loss of refrigerant, to equalize the air temperature passing through the heat exchanger, and to achieve the reduced size, especially the thin-profile of the heat exchanger, in the stacked-type multi flow heat exchangers.

[0012] According to the present invention, there is provided a heat exchanger having a tube group communicating between a first tank and a second tank, the exchanger comprising:

a first heat exchange portion, wherein said first heat exchange portion is disposed at a downstream side of air passing through said heat exchanger and has a first group of tubes, which form a first route of a heat exchange medium;
a second heat exchange portion, wherein said second heat exchange portion is disposed at an upstream side of the air passing through said heat exchanger and at a back side of said first heat exchange portion, and said second heat exchange portion has a second group of tubes, which form a second route of said heat exchange medium; and
a third heat exchange portion, wherein said third heat exchange portion is disposed at both said upstream and said downstream sides of the air passing through said heat exchanger and a adjacent to said first heat exchange portion and said second heat exchange portion, and said third heat exchange portion has a third group of tubes, which form a third route of said heat exchange medium.

[0013] Also according to the present invention there is provided a heat exchanger having a tube group communicating between a first tank and a second tank, comprising:

a first heat exchange portion, wherein said first heat exchange portion is disposed at a downstream side of air passing through said heat exchanger and has a first group of tubes, which form a first route of a heat exchange medium;
a second heat exchange portion, wherein said second heat exchange portion is disposed at the downstream side of the air passing through said heat exchanger and adjacent to said first heat exchange portion, and said second heat exchange portion has a second group of tubes, which form a second route of said heat exchange medium;
a third heat exchange portion, wherein said third heat exchange portion is disposed at both said upstream and said downstream sides of the air passing through said heat exchanger and adjacent to said first heat exchange portion and said second heat exchange portion, and said third heat exchange portion has a third group of tubes, which form a third route of said heat exchange medium;
a fourth heat exchange portion, wherein said fourth heat exchange portion is disposed at an upstream side of the air passing through said heat exchanger and at a back side of said second heat exchanger, and said fourth heat exchange portion has a fourth group of tubes, which form a fourth route of said heat exchange medium; and
a fifth heat exchange portion, wherein said fifth heat exchange portion is disposed at the upstream side of the air passing through said heat exchanger and at a back side of said first heat exchange portion, and said fifth heat exchange portion has a fifth group of tubes, which form a fifth route of said heat exchange medium.

[0014] The present invention may be more readily understood with reference to the following drawings, in which:

Fig. 1 is a perspective view of a stacked-type multi-flow heat exchanger, according to a first embodiment of the present invention;
Fig. 2 is a front view of the stacked-type multi-flow heat exchanger depicted in Fig. 1;
Fig. 3 is a top view of the stacked-type multi-flow heat exchanger depicted in Fig. 1;
Fig. 4 is a plan view of a first tube plate, a pair of which form a heat transfer tube for a first heat exchange portion and a third heat exchange portion of the stacked-type multi-flow heat exchanger depicted in Fig. 1;
Fig. 5 is a plan view of a second tube plate, a pair of which form a heat transfer tube for a second heat exchange portion of the stacked-type multi-flow heat exchanger depicted in Fig. 1;
Fig. 6 is a perspective view showing a flow of a heat exchange medium in the stacked-type multi-flow heat exchanger depicted in Fig. 1;
Fig. 7 is a side view of the stacked-type multi-flow heat exchanger depicted in Fig.1;
Fig. 8 is a perspective view showing flow of a heat exchange medium in a stacked-type multi-flow heat exchanger, which corresponds to Fig. 6, according to a second embodiment of the present invention;
Fig. 9 is a perspective view showing flow of a heat exchange medium in a known stacked-type multi-flow heat exchanger; and
Fig. 10 is a perspective view showing flow of a heat exchange medium in another known stacked-type

multi-flow hear exchanger.

[0015] Referring to Figs. 1-7, a stacked-type multi-flow heat exchanger according to a first embodiment is described. As shown in Figs. 1-3, a stacked-type multi-flow heat exchanger 1 includes a plurality of heat transfer tubes 2 and a plurality of fins 3 stacked alternately. Stacked heat transfer tubes 2 and fins 3 form heat exchanger core la. A side tank 4 is provided on the one side of heat exchanger core la, and an end plate 5 is provided on the other side of heat exchanger core la.

[0016] A group of tubes 6 comprising the plurality of heat transfer tubes 2 includes a first group of tubes 7 and a second group of tubes 8. First group of tubes 7 is stacked by the plurality of heat transfer tubes 2, and each of heat transfer tubes 2 are formed by a pair of tube plates 9 connected to each other. As shown in Fig. 4, tube plate 9 has concave portions 10 and 11 in the longitudinal direction. Concave portions 10 and 11 are partitioned by a wall 12. Projecting hollow portions 13, 14, 15, and 16 are formed on the respective corner portions of tube plate 9. By connecting the pair of tube plates 9, a pair of refrigerant routes 17 and 18 are formed in heat transfer tubes 2, as shown in Fig. 6. In addition, referring again to Fig. 4, a number of bosses 19, which project toward refrigerant flow routes 17 and 18, are formed on concave portion 10 and 11 of tube plate 9. When the pair of tube plates 9 are connected, the bosses 19 abut each other. The number of bosses 19 may increase the heat exchange efficiency and strengthen withstanding of the pressure of refrigerant. In this embodiment of the present invention, the pair of tube plates 9 are connected, and they are stacked alternately. As a result, the group of tubes 7, a first upstream tank 33, a first downstream tank 34, a second upstream tank 37, and a second downstream tank 38 are constituted. Moreover, in this embodiment, inner fins having a wave shaped cross-section may be provided in refrigerant flow routes 17 and 18 instead of bosses 19.

[0017] A second group of tubes 8 is stacked by the plurality of heat transfer tubes 2, and each of heat transfer tubes 2 are formed by a pair of tube plates 20 connected to each other. As shown in Fig. 5, tube plate 20 has concave portions 21 and 22 in the longitudinal direction. Concave portions 21 and 22 are partitioned by a wall 23. Projecting hollow portions 24, 25, 26, and 27 are formed on the respective corner portions of tube plate 20. Projecting hollow portions 24 and 26, and projecting hollow portions 25 and 27 communicate with each other respectively. By connecting the pair of tube plates 20, a pair of refrigerant flow routes 28 and 29 are formed in heat transfer tubes 2, as shown in Fig. 6. Nevertheless, because projecting hollow portions 24 and 26, and projecting hollow portions 25 and 27 communicate with each other, respectively, the heat exchange medium flows in the same direction in refrigerant flow routes 28 and 29. In addition, referring again to Fig. 5, a number of bosses 30, which project toward refrigerant flow routes 28 and 29, are formed on concave portion 21 and 22 of tube plate 20. When the pair of tube plates 20 are connected, the bosses 30 abut each other. The number of bosses 30 may increase the heat exchange efficiency and strengthen withstanding of the pressure of refrigerant. In this embodiment of the present invention, the pair of tube plates 20 are connected, and they are stacked alternately. As a result, the second group of tubes 8, an upper communicating tank 35, and a lower communicating tank 39 are constituted. Moreover, in this embodiment, inner fins having a wave shaped cross-section may be provided in refrigerant flow routes 28 and 29 instead of bosses 30.

[0018] As shown in Figs 1-3, and 6, an upper tank 31 is provided on an upper portion of the group of tubes 6 and a lower tank 32 is provided on a lower portion of the group of tubes 6. In this specification, "upper" or "lower" is described for the purpose of understanding the invention. Therefore, "upper" or "lower" may be reversed in the present invention. Upper tank 31 includes first upstream tank 33, first downstream tank 34, and upper communicating tank 35. First upstream tank 33 and first downstream tank 34 are provided with respect to the air flow direction A, respectively. Upper communicating tank 35 communicates with first downstream tank 34. A partitioning plate 36 is provided between first upstream tank 33 and upper communicating tank 35.

[0019] Lower tank 32, which communicates with upper tank 31 via the group of tubes 6, includes second upstream tank 37, second downstream tank 38, and lower communicating tank 39. Second upstream tank 37 and second downstream tank 38 are provided with respect to the air flow direction A, respectively. Lower communicating tank 39 is communicated with second upstream tank 37. A partitioning plate 40 is provided between second downstream tank 38 and lower communicating tank 39.

[0020] A heat exchange medium introducing route 41 and a heat exchange medium discharging route 42 are formed in side tank 4, which is provided on one side of heat exchanger 1. Introducing route 41 is communicated with second downstream tank 38. Discharging route 42 communicates with first upstream tank 33. As shown in Figs. 1 and 7, a flange 43 is attached to side tank 4 and is connected to an expansion valve (not shown). A heat exchange medium inlet port 44 and a heat exchange medium outlet port 45 are provided at flange 43.

[0021] Referring to Fig. 6, a heat exchange medium route in heat exchanger 1 is 3 described. A heat exchange medium, for example refrigerant, is introduced into introducing route 41 from inlet port 44, and flows into second downstream tank 38. Subsequently, the heat exchange medium flows into first downstream tank 34 via refrigerant flow route 17 of the first group of tubes 7. Refrigerant flow route 17 between second downstream tank 38 and first downstream tank 34 constitutes a first heat exchange portion 46. The heat exchange medium flowing out of first downstream tank 34 flows into upper communicating tank 35, and flows into lower communicating tank 39 via refrigerant flow routes 28 and 29 of the second group of tubes 8. Refrigerant flow routes 28 and 29 between upper communicating tank 35 and lower communicating tank 39 constitute a second heat exchange portion 47. Moreover, the heat exchange medium flowing out of lower communicating tank 39 flows into second upstream tank 37, and flows into first upstream tank 33 via refrigerant flow route 18 of the first group of tubes 7. Refrigerant flow route 18 between second upstream tank 37 and first upstream tank 33 constitutes a third heat exchange portion 48. The heat exchange medium flowing out of first upstream tank 33 is discharged from outlet port 45 via discharging route 42. Specifically, in heat exchanger 1, first heat exchange portion 46 is provided at the downstream side of the air flow direction A, and third heat exchange portion 48 is provided at the upstream side of the air flow direction A. Moreover, second heat exchange portion 47 communicating between first heat exchange portion 46 and third heat exchange portion 48 is provided opposite side of inlet port 44 and outlet port 45 and adjacent to first heat exchange portion 46 and third heat exchange portion 48.

[0022] In the first embodiment of the present invention, refrigerant flow route 17 provided at the downstream side of the air flow direction A constitutes first heat exchange portion 46, and refrigerant flow route 18 provided at the upstream side of the air flow direction A constitutes third heat exchange portion 48. Moreover, refrigerant flow routes 28 and 29 constitute second heat exchange portion 47. In this embodiment, even if heat exchanger 1 is of thin-profile, at least three heat exchange portions are provided. Therefore, while a cross-sectional area of the refrigerant route per one heat exchanger portion is ensured, the length of the refrigerant route in each tank in the longitudinal direction is reduced. Consequently, the pressure loss of the heat exchange medium flowing in heat exchanger 1 may be reduced or eliminated, and occurrence of the temperature differential of the heat exchange medium between each tube constituting each heat exchanger portion may be reduced or eliminated. In addition, in heat exchanger 1, second heat exchange portion 47 functions as a communicating portion between third heat exchange portion 48 at the upstream side of the air flow direction A and first heat exchange portion 46 at the downstream side of the air flow direction A. As a result, reduction of the pressure loss at the communicating portion, second heat exchange portion 47, may be achieved, and the dimension of the width direction of heat exchanger 1 may be reduced without decreasing the heat exchange performance.

[0023] In addition, the refrigerant flow route in heat exchanger 1 is formed of first heat exchange portion 46, second heat exchange portion 47, and third heat exchange portion 48, and is arranged in this order. Therefore, the heat exchange medium having a higher temperature may flow into third heat exchange portion 48 compared with that flowing into other heat exchange portions. Nevertheless, the heat exchange medium having a lower temperature flows into first heat exchange portion 46 and first heat exchange portion 46 is provided at the downstream side of the air flow direction A, at the back side of third heat exchange portion 48. Therefore, if the air passing through third heat exchange medium 48 is not sufficiently heat-exchanged, the air may pass through first heat exchange portion 46, and the air may be sufficiently heat-exchanged at first heat exchange portion 46. Consequently, the occurrence of the temperature differential of the air passing through heat exchanger 1 maybe reduced or eliminated.

[0024] Moreover, in heat exchanger 1, if the heat exchange medium is introduced from upper tank 31, the heat exchange medium is discharged from lower tank 32, as a necessity. On the contrary, if the heat exchange medium is introduced from lower tank 32, the heat exchange medium is discharged from upper tank 31. Specifically, heat exchange medium introducing route 41 and heat exchange medium discharging route 42 at side tank 4 may be disposed in relation to the vertical position. Therefore, if heat exchanger 1 is of thin profile, each cross-sectional area of introducing route 41 and discharging route 42 at side tank 4 may be sufficiently ensured, and the pressure loss of the heat exchange medium in side tank 4 may be reduced or eliminated.

[0025] Referring to Fig. 8, a stacked-type multi-flow heat exchanger 50 according to a second embodiment is described. In the following explanation, the same reference numbers are used to represent the same parts of stacked-type multi-flow heat exchanger 1 as shown in Figs. 1-7, and the explanation of the same parts is omitted. As shown in Fig. 8, in the second embodiment of the present invention, a partitioning plate 51 is disposed in first downstream tank 34, and a partitioning plate 52 is disposed in second upstream tank 37.

[0026] Therefore, a refrigerant flow route is formed in heat exchanger 50, as follows. In heat exchanger 50, the heat exchange medium introducing heat exchange medium introducing route 41 flows into second downstream tank 38, and flows into first downstream tank 34 via a refrigerant flow route 17a of the first group of tubes 7. Refrigerant flow route 17a between second downstream tank 38 and first downstream tank 34 constitutes first heat exchange portion 53. Moreover, because a partitioning plate 51 is disposed in first downstream tank 34 and partitions upper communicating tank 35 and first downstream tank 34, the heat exchange medium flowing out of first downstream tank 34 flows into second downstream tank 38 via refrigerant flow route 17b. Refrigerant flow route 17b between first downstream tank 34 and second downstream tank 38 constitutes a second heat exchange portion 54. Subsequently, the heat exchange medium flowing out of lower tank 32 flows into lower communicating tank 39, and flows into upper communicating tank 35 via refrigerant flow routes 28 and 29.

Refrigerant flow routes 28 and 29 between lower communicating tank 39 and upper communicating tank 35 constitute a third heat exchange portion 55.

[0027] Subsequently, the heat exchange medium flowing out of upper communicating tank 35 flows into an area of first upstream tank 33 at an opposite side of inlet port 44 and outlet port 45 that is partitioned by partitioning plate 36, and flows into second upstream tank 37 via a refrigerant flow route 18a. Refrigerant flow route 18a between first upstream tank 33 and second upstream tank 37 constitutes a fourth heat exchange portion 56. Moreover, the heat exchange medium flown out of second upstream tank 37 flows into an area of first upstream tank 33 at a side of inlet port 44 and outlet port 45 that is partitioned by partitioning plate 36 via a refrigerant flow route 18b. Refrigerant flow route 18b between second upstream tank 37 and first upstream tank 33 constitutes a fifth heat exchange portion 57. The heat exchange medium flowing out of first upstream tank 33 discharged from heat exchanger I through discharging route 42.

[0028] In the second embodiment of the present invention, similar to the function of the first embodiment, the pressure loss of the heat exchange medium in heat exchanger may be reduced or eliminated, and the occurrence of temperature differential of the air between heat transfer tubes constituting each heat exchange portion of heat exchanger 1 may be reduced or eliminated, In addition, heat exchange medium having a higher temperature flows into fourth heat exchange portion 56 and fifth heat exchange portion 57. Nevertheless, the heat exchange medium having a lower temperature flows into second heat exchange portion 54 and first heat exchange portion 53 relatively adjacent to inlet port 44 is provided at the downstream side of the air flow direction A, i.e. at the back side of fourth heat exchange portion 56 and fifth heat exchange portion 57. Consequently, the occurrence of temperature differential of the air passing through heat exchanger 1 may be suppressed or eliminated.

[0029] As described above, according to the embodiments of the present invention, if heat exchanger 1 is of thin profile, at least three heat exchange portions are provided. Therefore, while a cross-sectional area of the refrigerant route per one heat exchanger portion is ensured, the length of the refrigerant route in each tank in the longitudinal direction is reduced. Consequently, the pressure loss of the heat exchange medium flowing in heat exchanger 1 may be reduced or eliminated, and occurrence of the different temperature of the heat exchange medium between each heat transfer tube constituting each heat exchanger portion may be reduced or eliminated.

Claims

1. A heat exchanger having a tube group communicating between a first tank and a second tank, the exchanger comprising:

   a first heat exchange portion, wherein said first heat exchange portion is disposed at a downstream side of air passing through said heat exchanger and has a first group of tubes, which form a first route of a heat exchange medium;
   a second heat exchange portion, wherein said second heat exchange portion is disposed at an upstream side of the air passing through said heat exchanger and at a back side of said first heat exchange portion, and said second heat exchange portion has a second group of tubes, which form a second route of said heat exchange medium; and
   a third heat exchange portion, wherein said third heat exchange portion is disposed at both said upstream and said downstream sides of the air passing through said heat exchanger and a adjacent to said first heat exchange portion and said second heat exchange portion, and said third heat exchange portion has a third group of tubes, which form a third route of said heat exchange medium.

2. The heat exchanger of claim 1, wherein said first heat exchange portion and said second heat exchange portion are provided at a heat exchange medium inlet and outlet side, and said third heat exchange portion is provided at an opposite side of said heat exchange medium inlet and outlet side, and wherein the heat exchange flow route of said heat exchanger is formed of said first route of said first heat exchange portion, said third route of said third heat exchange portion, and said second route of said second heat exchange portion, in this order.

3. A heat exchanger having a tube group communicating between a first tank and a second tank, comprising:

   a first heat exchange portion, wherein said first heat exchange portion is disposed at a downstream side of air passing through said heat exchanger and has a first group of tubes, which form a first route of a heat exchange medium;
   a second heat exchange portion, wherein said second heat exchange portion is disposed at the downstream side of the air passing through said heat exchanger and adjacent to said first heat exchange portion, and said second heat exchange portion has a second group of tubes, which form a second route of said heat exchange medium;
   a third heat exchange portion, wherein said third heat exchange portion is disposed at both said upstream and said downstream sides of

the air passing through said heat exchanger and adjacent to said first heat exchange portion and said second heat exchange portion, and said third heat exchange portion has a third group of tubes, which form a third route of said heat exchange medium;

a fourth heat exchange portion, wherein said fourth heat exchange portion is disposed at an upstream side of the air passing through said heat exchanger and at a back side of said second heat exchanger, and said fourth heat exchange portion has a fourth group of tubes, which form a fourth route of said heat exchange medium; and

a fifth heat exchange portion, wherein said fifth heat exchange portion is disposed at the upstream side of the air passing through said heat exchanger and at a back side of said first heat exchange portion, and said fifth heat exchange portion has a fifth group of tubes, which form a fifth route of said heat exchange medium.

4. The heat exchanger of claim 3, wherein said first heat exchange portion and said fifth heat exchange portion are provided at a heat exchange medium inlet and outlet side, and said third heat exchange portion is provided at an opposite side of said heat exchange medium inlet and outlet side, and wherein the heat exchange flow route of said heat exchanger is formed of said first route of said first heat exchange portion, said second route of said second heat exchange portion, said third route of said third heat exchange portion, said fourth route of said fourth heat exchange portion, and said fifth route of said fifth heat exchange portion, in that order.

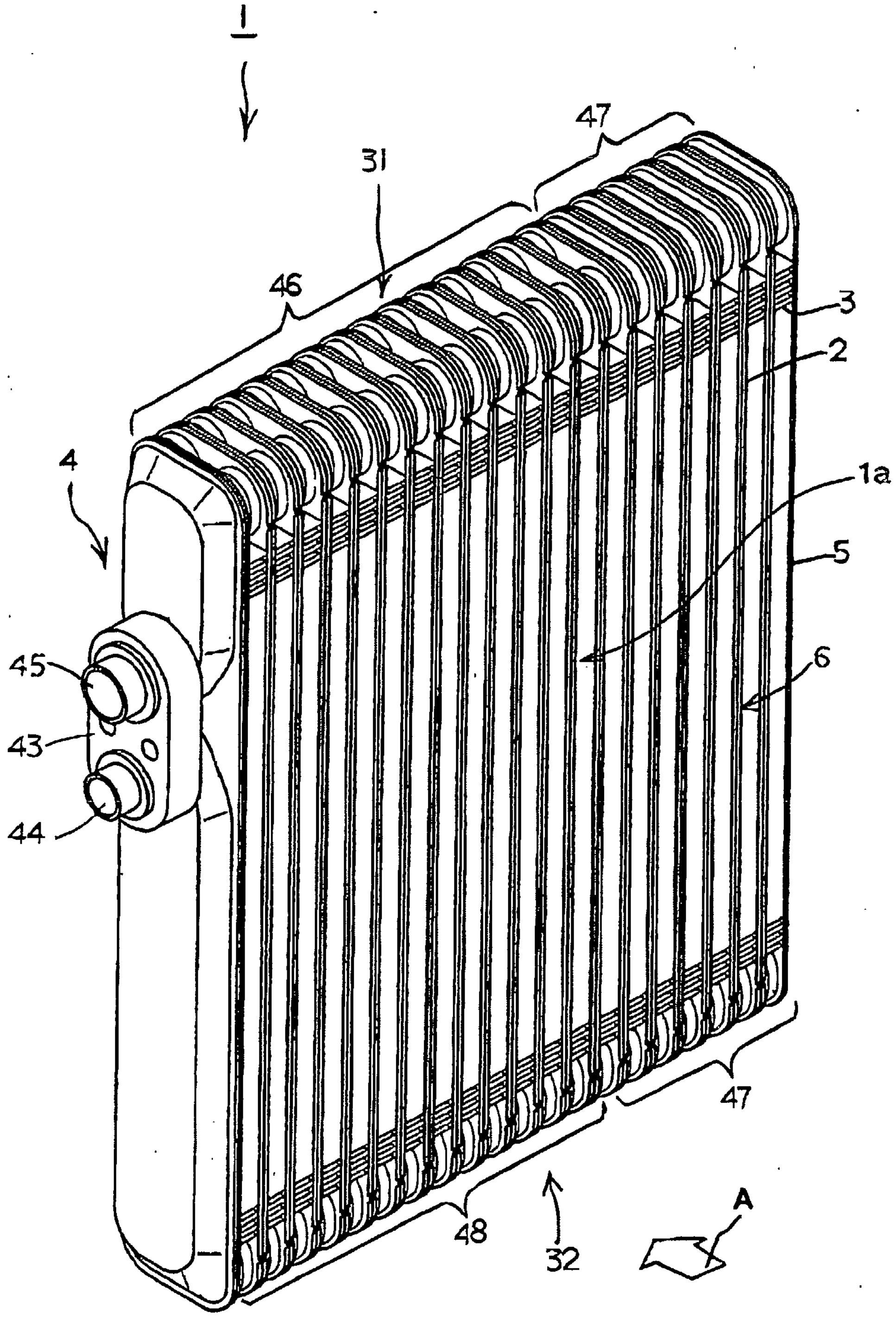

Fig. 1

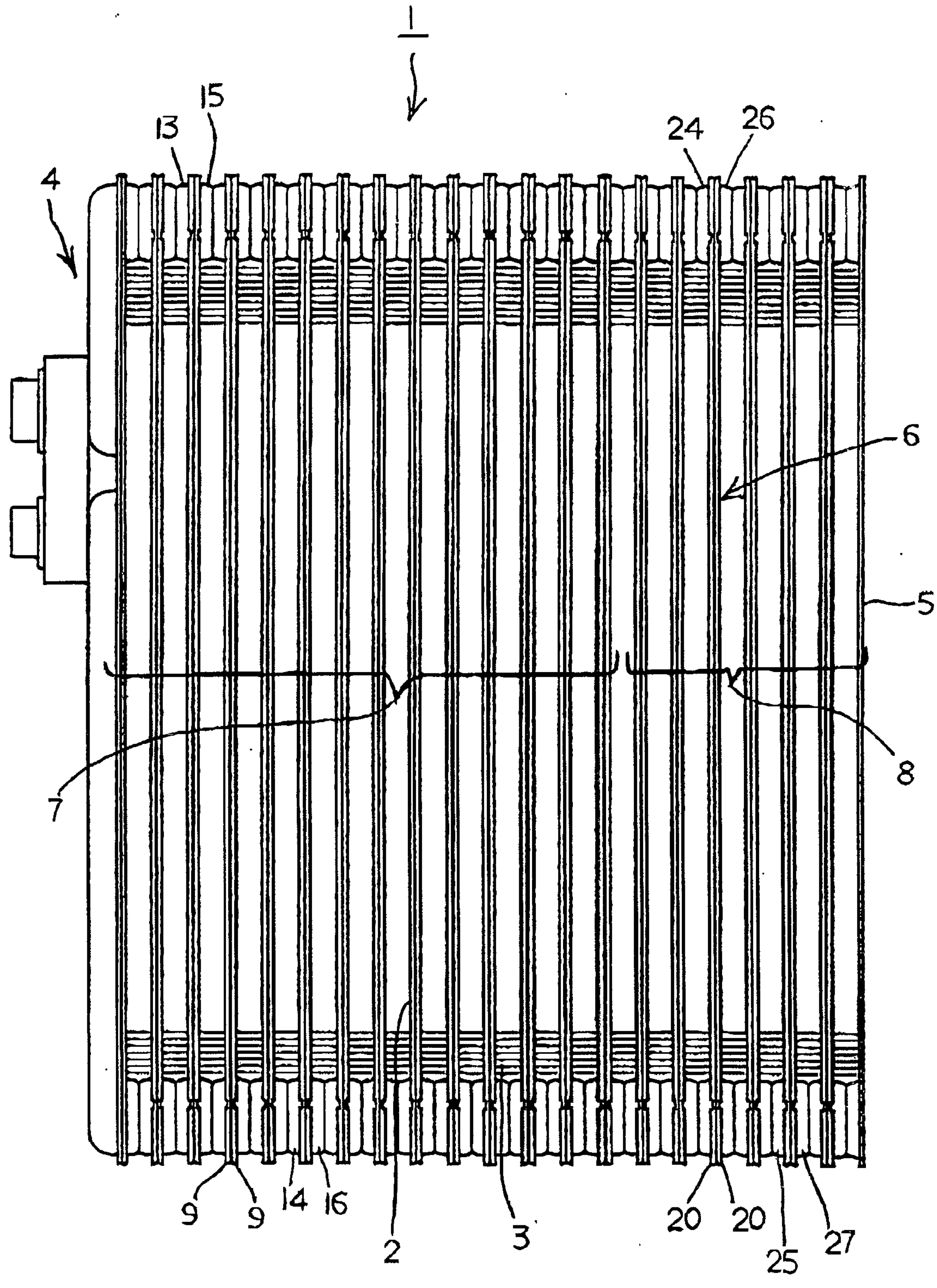

Fig. 2

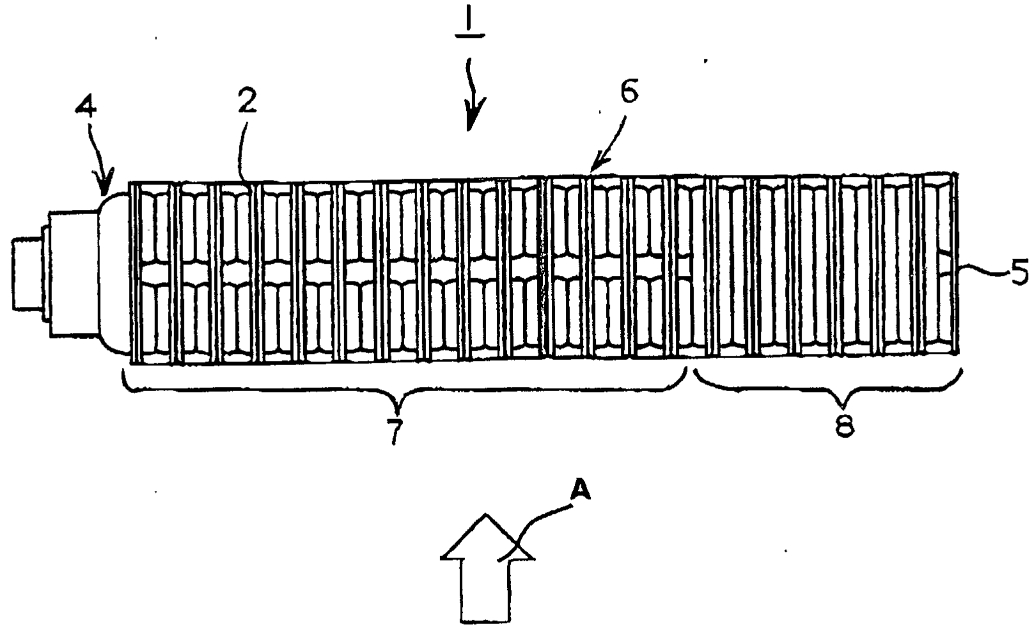

Fig. 3

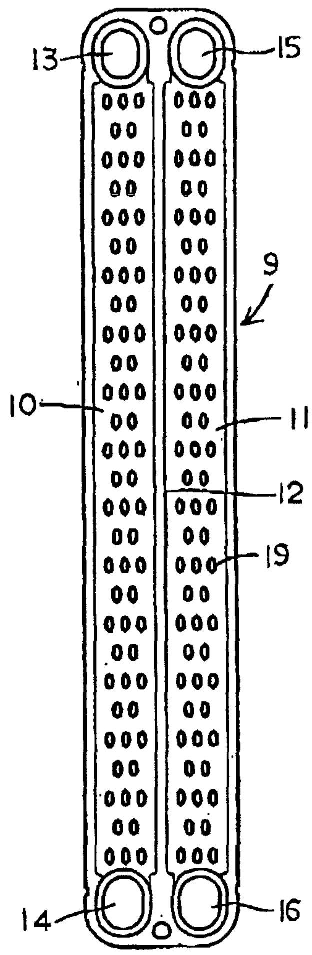

Fig. 4

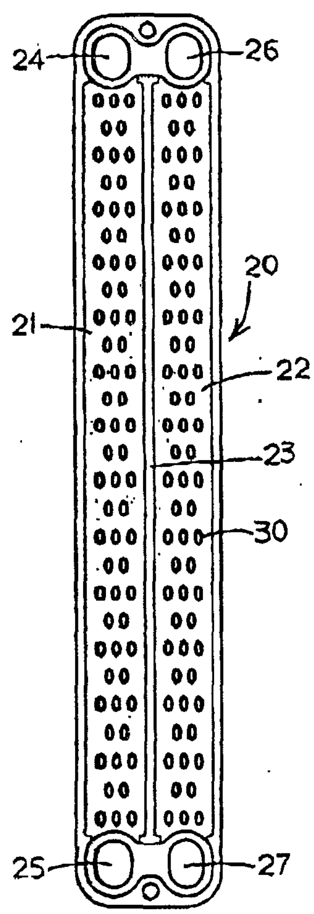

Fig. 5

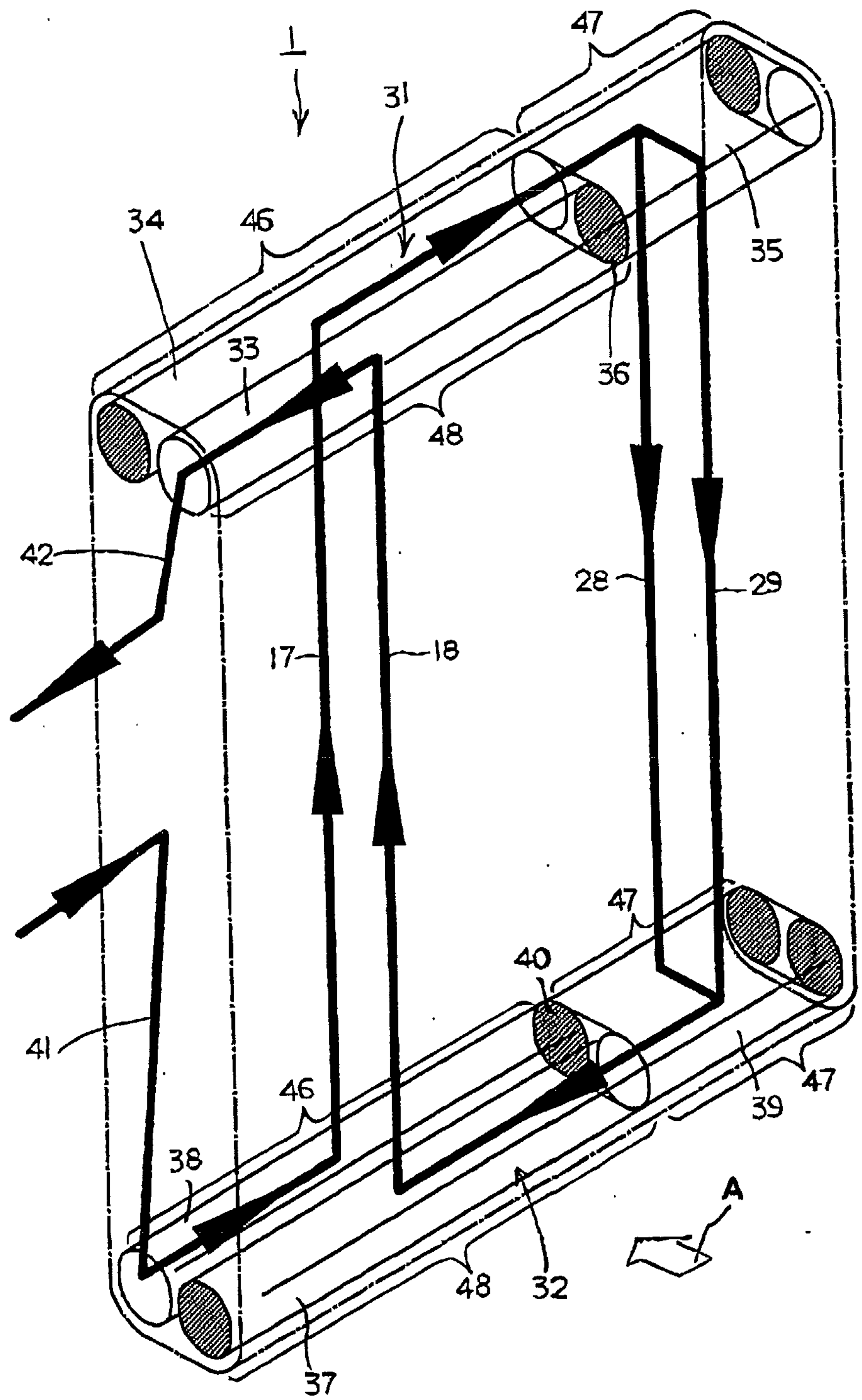

Fig. 6

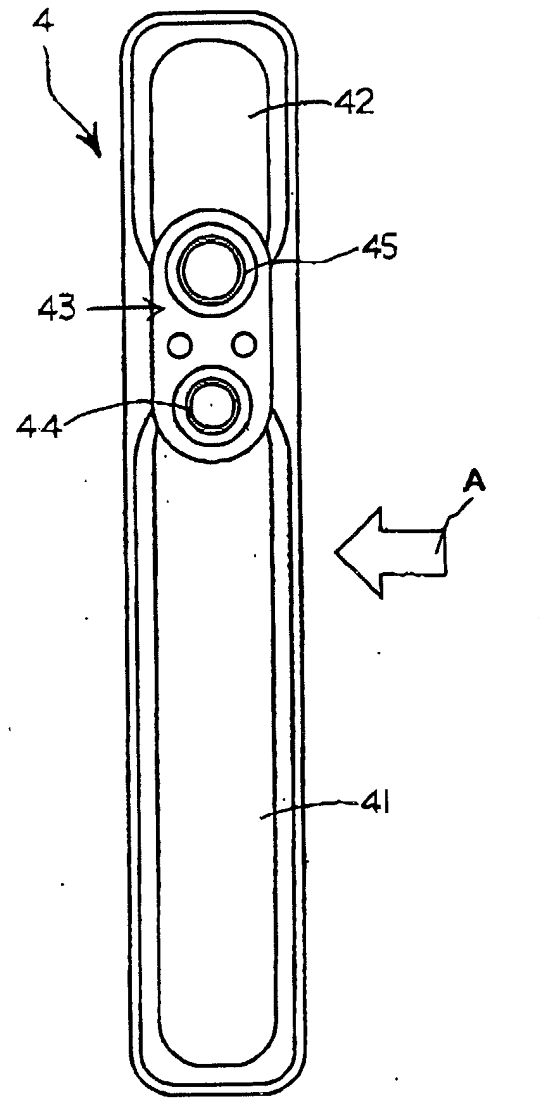

Fig. 7

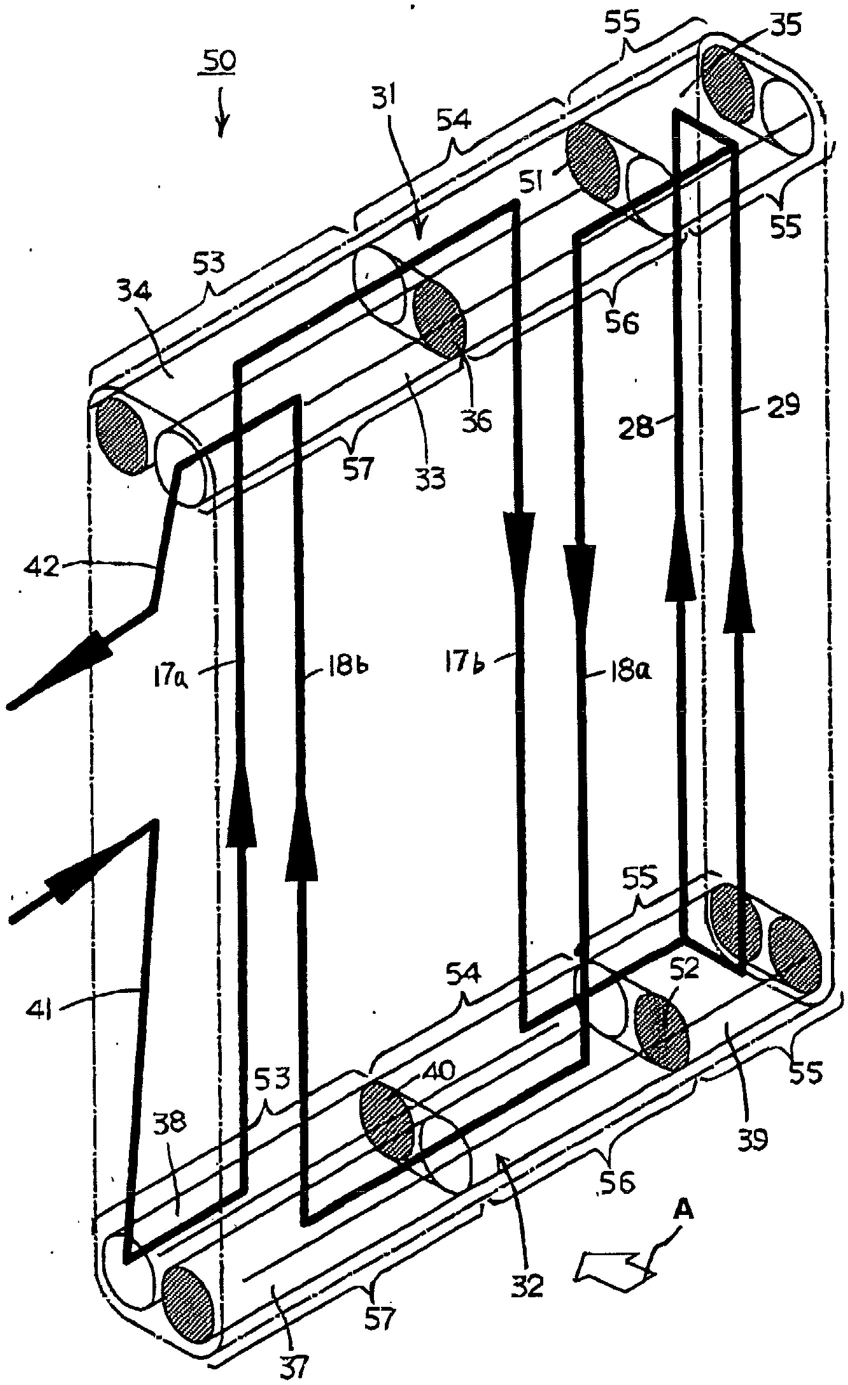
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Fig. 8

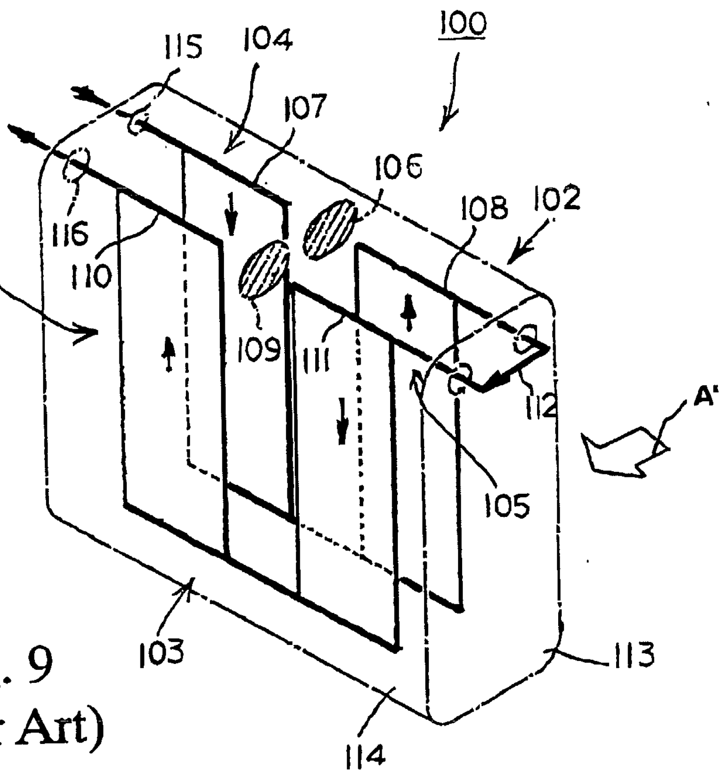

Fig. 9
(Prior Art)

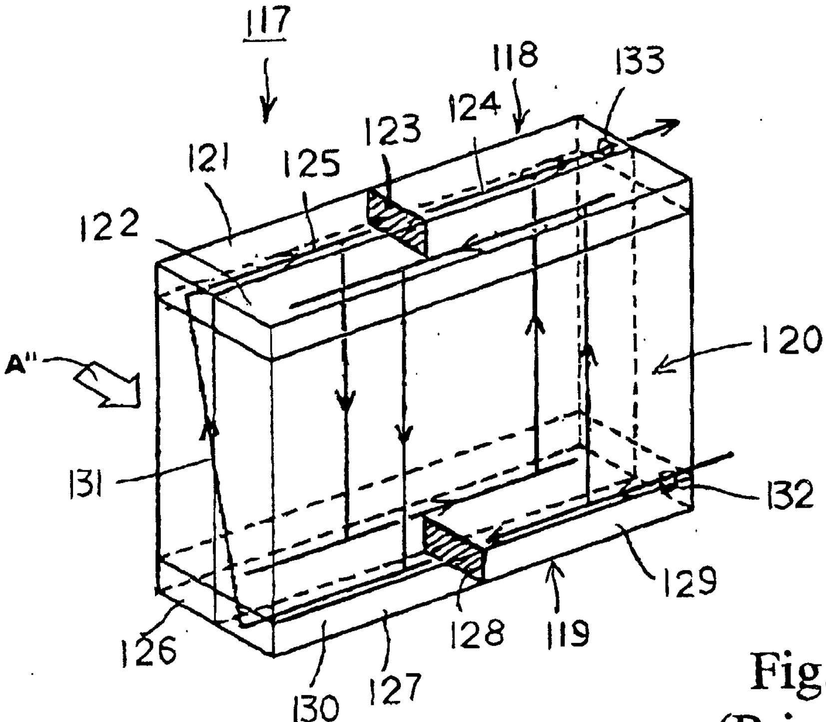

Fig. 10
(Prior Art)