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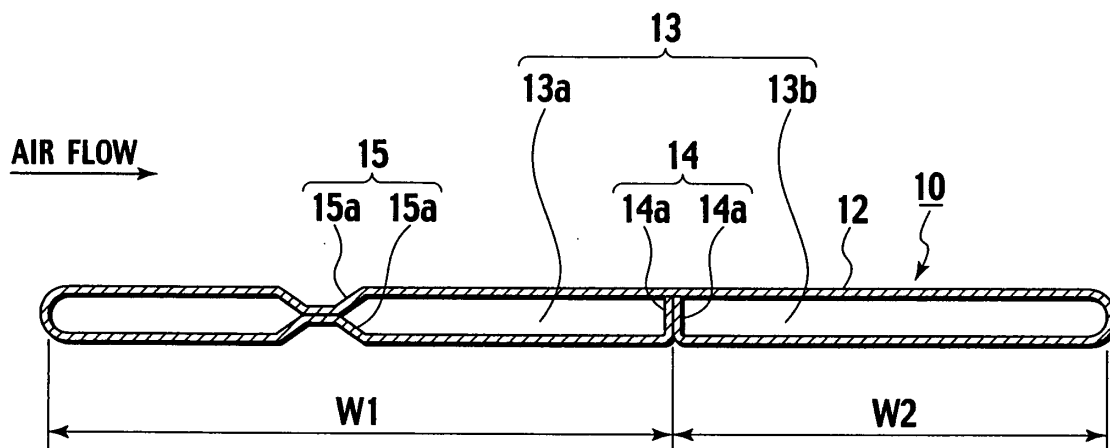
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(54) **TUBE FOR HEAT EXCHANGER**

(57) Disclosed is a heat exchanger tube (10) which is arranged so that air flow passes in an external circumference along a width direction thereof, and in which an internal passage (13) is divided by a partition wall (14) into an upstream side passage (13a) located on the up-

stream side of an air flow and a downstream side passage (13b) located on the downstream side of the air flow. The partition wall (14) is provided in the location such that a width (W1) of the upstream side passage (13a) is wider and a width (W2) of the downstream side passage (13b) is narrower.

FIG. 3



Description

TECHNICAL FIELD

[0001] The present invention relates to a heat exchanger tube which exchanges heat between air flowing in an outer circumference and coolant flowing in an internal passage.

BACKGROUND ART

[0002] As a conventional heat exchanger tube of this kind, there is the one disclosed in the Patent Document 1. This heat exchanger tube includes an external wall portion having a flat elliptical shape in cross section, and a partition wall for partitioning a passage within the external wall portion into two. The partition wall is set to a location such that an upstream side passage and a downstream side passage have the same width dimension, and is provided with two partition pieces which face one another. The heat exchanger tube having this kind of structure is fabricated from a single plate material, for example, in the following way. Both ends of a thin and long plate material in the width direction are folded to form the partition pieces, the plate material is then bended into a flat elliptical shape, and the partition pieces on both ends are faced to each other. Thereafter, the fabrication completes as the surfaces faced to each other by the bending are joined together by brazing or the like.

[0003] A heat exchanger is fabricated using the heat exchanger tube formed as above. The heat exchanger is installed such that an air flow passes the outer circumference along the width direction of the heat exchanger tube, and heat is exchanged between an air flow passing along the outer circumference and the coolant flowing inside along the upstream side passage and downstream side passage. Since the passage is divided into two by the partition wall, the heat exchanger tube is robust against a pressing force in the direction of crushing the passages and is highly pressure resistant.

Patent Document 1: Japanese Patent Laid-Open Publication No. Heisei 10-305341

DISCLOSURE OF THE INVENTION

[0004] Incidentally, the heat exchanger efficiency of the coolant flowing in the passages is different depending on upstream and downstream positions of an air flow passing along the outer circumference. However, in the conventional heat exchanger tube described above, the partition wall was set without consideration of heat exchanger efficiency of the coolant, and therefore, in terms of heat exchanger efficiency, the conventional heat exchanger tube was less than the best as a heat exchanger tube having a partition wall.

[0005] Therefore, an objective of the present invention is to provide a heat exchanger which includes a partition wall and is able to achieve an improvement of heat ex-

changer efficiency.

[0006] In order to achieve the above-mentioned objective, a heat exchanger tube according to the present invention is arranged in a direction across an air flow such that air flows in an external circumference along with a width direction of the heat exchange tube, and comprises an upstream side passage located on an upstream side of the air flow, a downstream side passage located on a downstream side of the air flow, and a partition wall for partitioning the upstream side passage and the downstream side passage, wherein the partition wall is arranged such that a width of the upstream side passage is larger than a width of the downstream side passage.

[0007] According to the above-mentioned structure, heat exchanger efficiency of a coolant flowing in the passages shows a pattern where the heat exchanger efficiency becomes highest in an uppermost stream location of the air flow, decreases gradually towards the downstream side, and remains low in downstream locations past the center location. In addition, the partition wall does not exist in a location where the heat exchanger efficiency is high so that a coolant flows in the entire tube and is used for heat exchange, and the partition wall is located at a position where the heat exchanger efficiency is approximately lowest. Hence, an improvement of the heat exchanger efficiency of the heat exchanger tube as a whole is achieved.

[0008] In the heat exchanger tube described above, the upstream side passage may be provided with a projecting portion which projects from at least one side of an external wall portion.

[0009] According to this structure, although the upstream side passage has a larger width and is thus less resistant to pressure than the downstream side passage, the projecting portion enhances pressure resistance of the upstream side passage. Therefore, pressure resistance of the heat exchanger tube as a whole is improved. Moreover, the projecting portion increases the inner circumference area of the upstream side passage and the surface area of the external wall portion thereof, and, at the same time, a coolant flow is disturbed by the projecting portion, which contributes to an improvement of heat exchange efficiency.

[0010] In the heat exchanger tube described above, the projecting portions may be provided in a plurality of locations with intervals therebetween along a longitudinal direction.

[0011] According to the above structure, a coolant flowing in the upstream side passage is agitated by the projecting portions in the plurality of locations, and heat exchange is enhanced. Hence, an improvement of heat exchange efficiency is achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIG. 1 is a cross-sectional view of a first embodiment

of the present invention, illustrating how a heat exchanger tube is arranged within an air flow passage. FIG. 2 is a perspective view of the first embodiment of the present invention, illustrating the entire heat exchanger tube.

FIG. 3 is a cross-sectional view of the first embodiment of the present invention, taken along the line 3-3 in FIG. 2.

FIG. 4 is a view showing the first embodiment of the present invention, illustrating characteristics of heat exchanger efficiency of the heat exchanger tube.

FIG. 5 is a schematic view of the first embodiment of the present invention, illustrating a manufacturing apparatus of the heat exchanger tube.

FIG. 6 is a perspective view of the first embodiment of the present invention, illustrating a main portion of the manufacturing apparatus.

FIGS. 7(a) to 7(f) are perspective views of the first embodiment of the present invention, illustrating respective steps of forming the heat exchanger tube.

FIG. 8 is the perspective view of a second embodiment of the present invention, illustrating a main portion of a heat exchanger tube.

FIG. 9 is the perspective view of a third embodiment of the present invention, illustrating a main portion of the heat exchanger tube.

FIG. 10 is the perspective view of a fourth embodiment of the present invention, illustrating a main portion of the heat exchanger tube.

FIG. 11 is the perspective view of a fifth embodiment of the present invention, illustrating a main portion of the heat exchanger tube.

BEST MODE FOR CARRYING OUT THE INVENTION

[0013] Hereinbelow, details of a heat exchanger tube according to embodiments of the present invention will be described based on the drawings.

[0014] As shown in FIG. 1, a heat exchanger 1 is arranged in an air flow passage 3 of an air conditioning unit 2. The heat exchanger 1 is provided with a plurality of heat exchanger tubes 10 arranged in parallel with one another with an interval therebetween, and a pair of headers 11 fixed to both ends of each of the plurality of the heat exchanger tubes 10. The coolant flowed into the headers 11 is to be discharged from the headers 11 via the heat exchanger tube 10 along a predetermined path. Each of the heat exchanger tubes 10 is arranged along with the direction across the air flow such that the air flow within the air flow passage 3 passes the external circumference along the width direction of the heat exchanger tube 10.

[0015] As illustrated in FIGS. 2 and 3, the heat exchanger tube 10 includes an external wall portion 12 of which cross section has a flat elliptical shape, and a partition wall 14 which partitions a passage 13 within the external wall portion 12 into two. The passage 13 is partitioned by the partition wall 14 into an upstream side

passage 13a located on the upstream side of the air flow, and a downstream side passage 13b located on the downstream side of the air flow. The partitioning position by the partition wall 14 is set to a location so that a width W1 of the upstream side passage 13a is wider, and a width W2 (< W1) of the downstream side passage 13b is narrower. Moreover, the partition wall 14 includes a pair of partition pieces 14a and 14a which are integrally connected to both ends of the external wall portion 12 in the width direction thereof, respectively, and brazing is performed between both partition pieces 14a and 14a, and between the end surface of each of the partition pieces 14a and 14a and the inner surface of the external wall portion 12.

[0016] A projecting portion 15 is provided in approximately the center of the upstream side passage 13a in the width direction thereof. The projecting portion 15 includes a pair of projecting pieces 15a provided at positions facing each other from both sides in the external wall 12, the end surfaces of both projecting pieces 15a and 15a are brought into contact with each other, and the contact portion is brazed. The projecting portion 15 is continuously provided in an approximately entire area in the longitudinal direction of the heat exchanger tube 10.

[0017] Next, manufacturing steps of the heat exchanger tube 10 are described. As shown in FIG. 5, a manufacturing apparatus 20 is provided with a first bending roller portion 12, a coating roller portion 22, a drying portion 23, and a second bending roller portion 24. The first bending roller 21 bends both end portions of, for example, a long aluminum material (see FIG. 7(a)) 25 wrapped into a roller shape, in order to form the partition pieces 14a and 14a, and bend two locations in the center to form the projecting pieces (beads) 15a and 15a (see FIGS. 7(b) and 7(c)). As shown in FIG. 6, the coating roller portion 22 includes a material accommodating portion 26 for accommodating a mixture of flux, a brazing filler metal, and binder, a first transfer roller 27, a second transfer roller 28, and a transfer sheet 29. Thereafter, a mixed coating material 1 of flux, a brazing filler metal, and binder is applied to the end surfaces of the partition pieces 14a and 14a on both sides and two projecting portions 15a and 15a formed by the first bending roller portion 21 (see FIGS. 6 and 7(d)). The drying portion 23 volatilizes the binder contained in the mixed coating material a which has been coated on the material 25. The second bending roller portion 24 bends the material 25 bent into a predetermined shape into a shape of the heat exchanger tube 10 (see FIGS. 7(e) and 7(f)). The heat exchanger tube 10 provisionally assembled as a constituent of the heat exchanger 1 is heat-treated in a heating furnace, thus brazing the portions where the mixed coating material a has been applied.

[0018] In the heat exchanger tube 10 having the above structure, heat is exchanged between an air flow passing along the air flow passage 3 and the coolant flowing along the internal passage 13. As shown in FIG. 4, the heat exchanger efficiency shows a pattern where it is highest

in the uppermost stream position of the air flow, gradually declines towards the downstream side, and remains low at a downstream location or after past the center location. In the above-described heat exchanger tube 10, the partition wall 14 does not exist in the location where heat exchanger efficiency is high and the coolant flows in the entire tube for heat exchange, while the partition wall 14 is positioned in the location where the heat exchanger efficiency is reduced to approximately the lowest level. Therefore, an improvement of heat exchanger efficiency of the heat exchanger tube 10 as a whole is achieved.

[0019] In the first embodiment, since the projecting portion 15 is provided in the upstream side passage 13a, the upstream side passage 13a having a larger width than that of the downstream side passage 13b has a structure which is highly pressure resistant. Hence, pressure resistance of the heat exchanger tube as a whole can be maintained. In addition, providing the projecting portion 15 increases the internal circumference area of the upstream side passage 13a and the surface area of the outer wall portion 12 of the upstream side passage 13a, which thus contributes to an improvement of heat exchanger efficiency.

[0020] FIG. 8 shows a second embodiment of the present invention, and is a partial perspective view of a heat exchanger tube 30. As shown in FIG. 8, in the heat exchanger tube 30 according to the second embodiment of the present invention, provided is projecting portions 31 in a plurality of locations separated from each other with an interval therebetween, instead of a projecting portion provided continuously in the longitudinal direction of the heat exchanger tube as described in the first embodiment.

[0021] According to the second embodiment, a coolant flowing in an upstream side passage 13a is agitated and disturbed by the projecting portions 31 in a plurality of locations, thus enhancing heat exchange. Accordingly, heat exchange efficiency is improved.

[0022] FIG. 9 shows a third embodiment of the present invention, and is a partial perspective view of a heat exchanger tube 32. As shown in FIG. 9, the heat exchanger tube 32 according to the third embodiment is common to the heat exchanger tube of the second embodiment in terms of having a plurality of projecting portions 33 with an interval therebetween, but is different in that the projecting portions 33 of the heat exchanger tube 32 have an elliptic shape instead of the long and thin rectangular shape as described in the second embodiment.

[0023] In the third embodiment, a coolant flowing in an upstream side passage 13a is also agitated by the projecting portions 33 in the plurality of locations and heat exchange efficiency is enhanced.

[0024] FIG. 10 shows a fourth embodiment of the present invention, and is a partial perspective view of a heat exchanger tube 34. As shown in FIG. 10, projecting portions 35 of the heat exchanger tube 34 according to the fourth embodiment are elliptic similarly to those of the third embodiment, but the projecting portions 35 are

provided so that the orientations of the elliptic shape thereof are angled with regard to the longitudinal direction of the heat exchanger tube 34.

[0025] In the fourth embodiment, a coolant flowing in an upstream side passage 13a is agitated by the projecting portions 35 in a plurality of locations and heat exchange is enhanced. Therefore, heat exchanger efficiency is improved.

[0026] FIG. 11 shows the fifth embodiment of the present invention, and is a partial perspective view of a heat exchanger tube 36. As shown in FIG. 11, projecting portions 37 of the heat exchanger tube 36 according to the fifth embodiment of the present invention have an elliptic shape similarly to those of the third and fourth embodiments described above, but are different in that the elliptic shapes in different orientations are provided alternately, in which the long diameter of the elliptic shape is oriented in the same direction to the longitudinal direction of the heat exchanger tube 36, or the long diameter of the same is oriented in an angled direction against the longitudinal direction of the heat exchanger tube 36.

[0027] In the fifth embodiment, a coolant flowing in an upstream side passage 13a is agitated by the projecting portions 37 in the plurality of locations and heat exchange is enhanced. Hence, heat exchanger efficiency is improved.

[0028] In each of the above embodiments, although each of the projecting portions 15, 31, 33, 35 and 37 is formed of the pair of projecting pieces 15a (or those not shown) provided in the opposite locations in the external wall portion 12 which form the upstream side passage 13a, it may be formed of only a projection piece projecting towards the inside from either one of the locations in the external wall portion 12. In addition, in each of the embodiments, the projecting pieces 15a and 15a (or those not shown) on both sides are formed to have the same height which is approximately a half of the width of the upstream side passage 13a, but the projecting pieces may be formed so that one of the projecting pieces may be higher than the half of the width and the other may be shorter than the half of the width.

Industrial Applicability

[0029] According to the present invention, heat exchanger efficiency is highest in the uppermost stream location of an air flow, gradually decreases towards the downstream side, and remains low in downstream locations past a center location. In addition, a partition wall does not exist in a location where the heat exchanger efficiency is high so that a coolant flows in the entire tube and is used for heat exchange, and the partition wall is located at a position where the heat exchanger efficiency is approximately lowest. Hence, an improvement of the heat exchanger efficiency of the heat exchanger tube as a whole is achieved.

Claims

1. A heat exchanger tube arranged in a direction across an air flow such that air flows in an external circumference along with a width direction of the heat ex- 5
change tube, the heat exchanger tube comprising:

 an upstream side passage located on an up-
 stream side of the air flow;
 a downstream side passage located on a down- 10
 stream side of the air flow; and
 a partition wall for partitioning the upstream side
 passage and the downstream side passage,

 wherein the partition wall is arranged such that a 15
 width of the upstream side passage is larger than a
 width of the downstream side passage.
2. The heat exchanger tube according to claim 1,
 wherein the upstream side passage is provided with 20
 a projecting portion which projects from at least one
 side of an external wall portion.
3. The heat exchanger tube according to claim 2,
 wherein the projecting portions are provided at a plu- 25
 rality of locations with intervals therebetween along
 a longitudinal direction.
4. The heat exchanger tube according to claim 3,
 wherein the projecting portion is formed into a rec- 30
 tangular shape.
5. The heat exchanger tube according to claim 3,
 wherein the projecting portion is formed into an el- 35
 liptic shape.

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FIG. 1

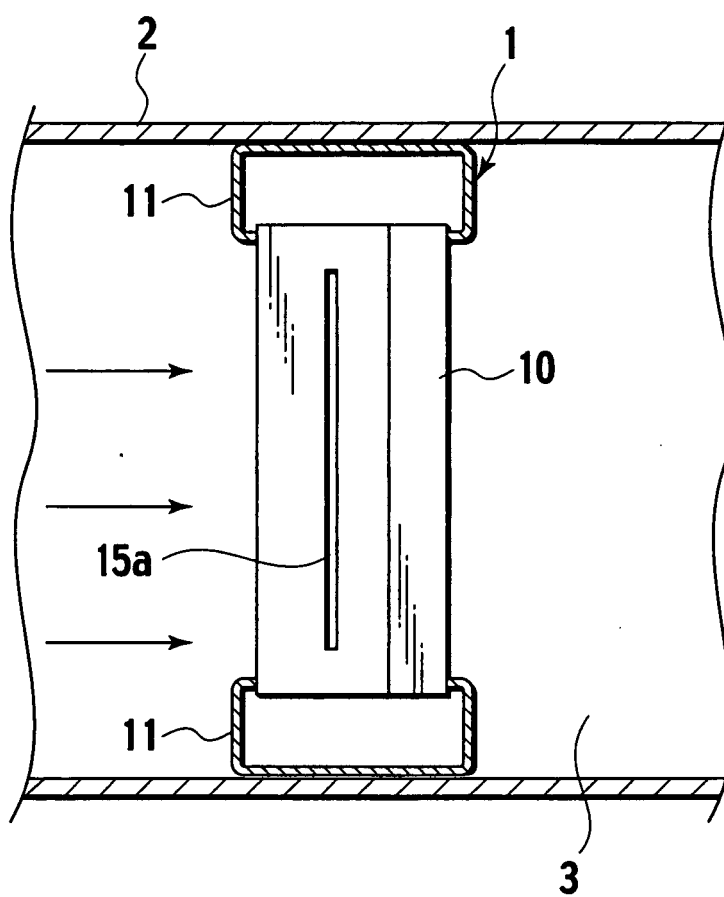


FIG. 2

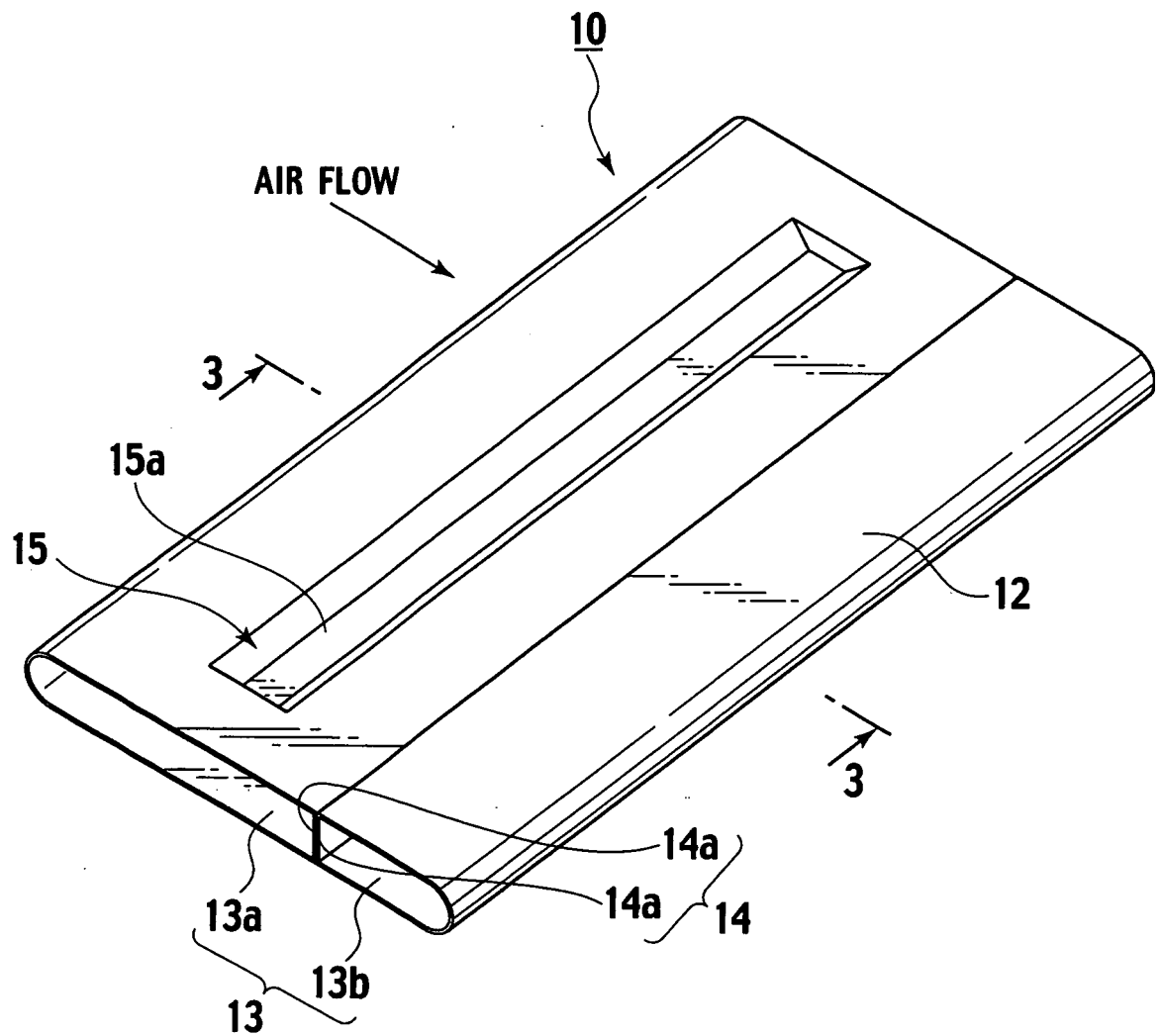


FIG. 3

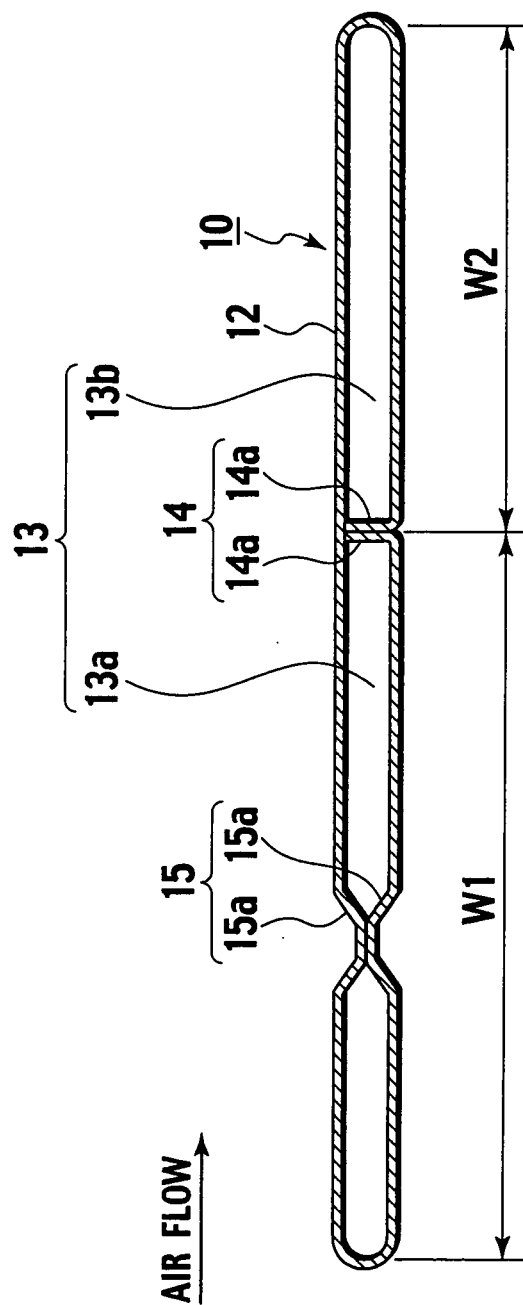


FIG. 4

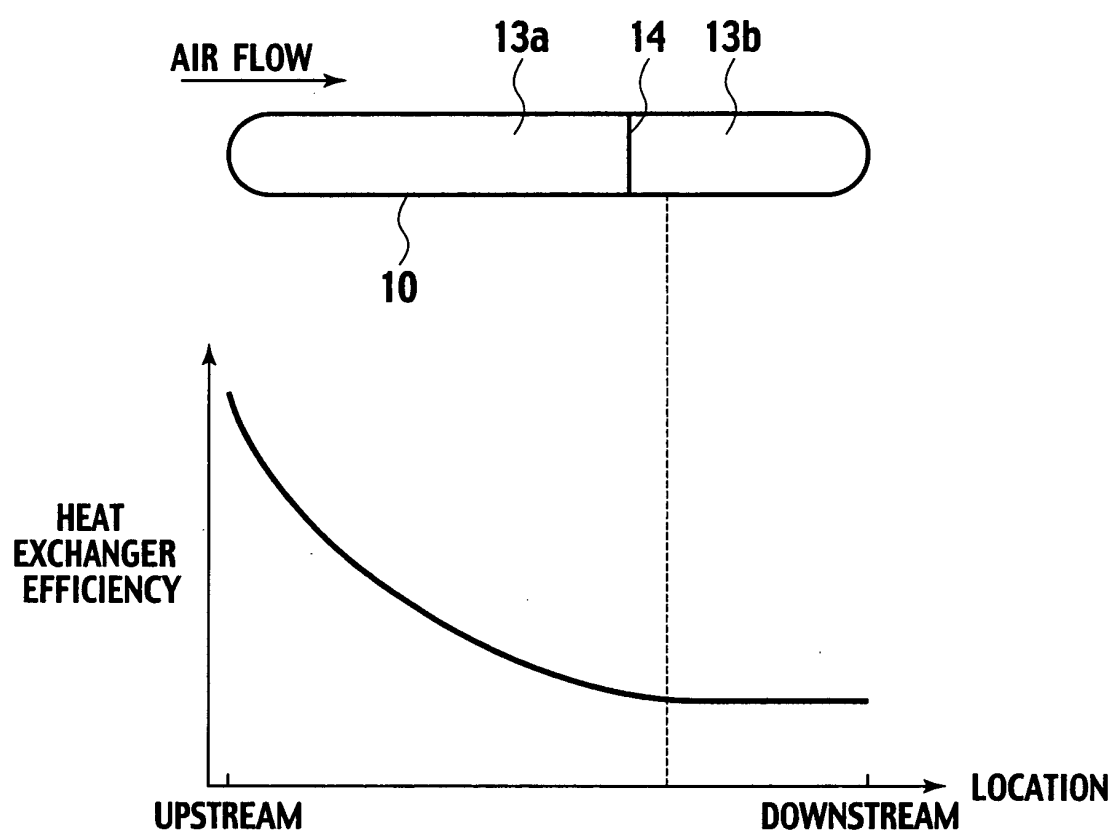


FIG. 5

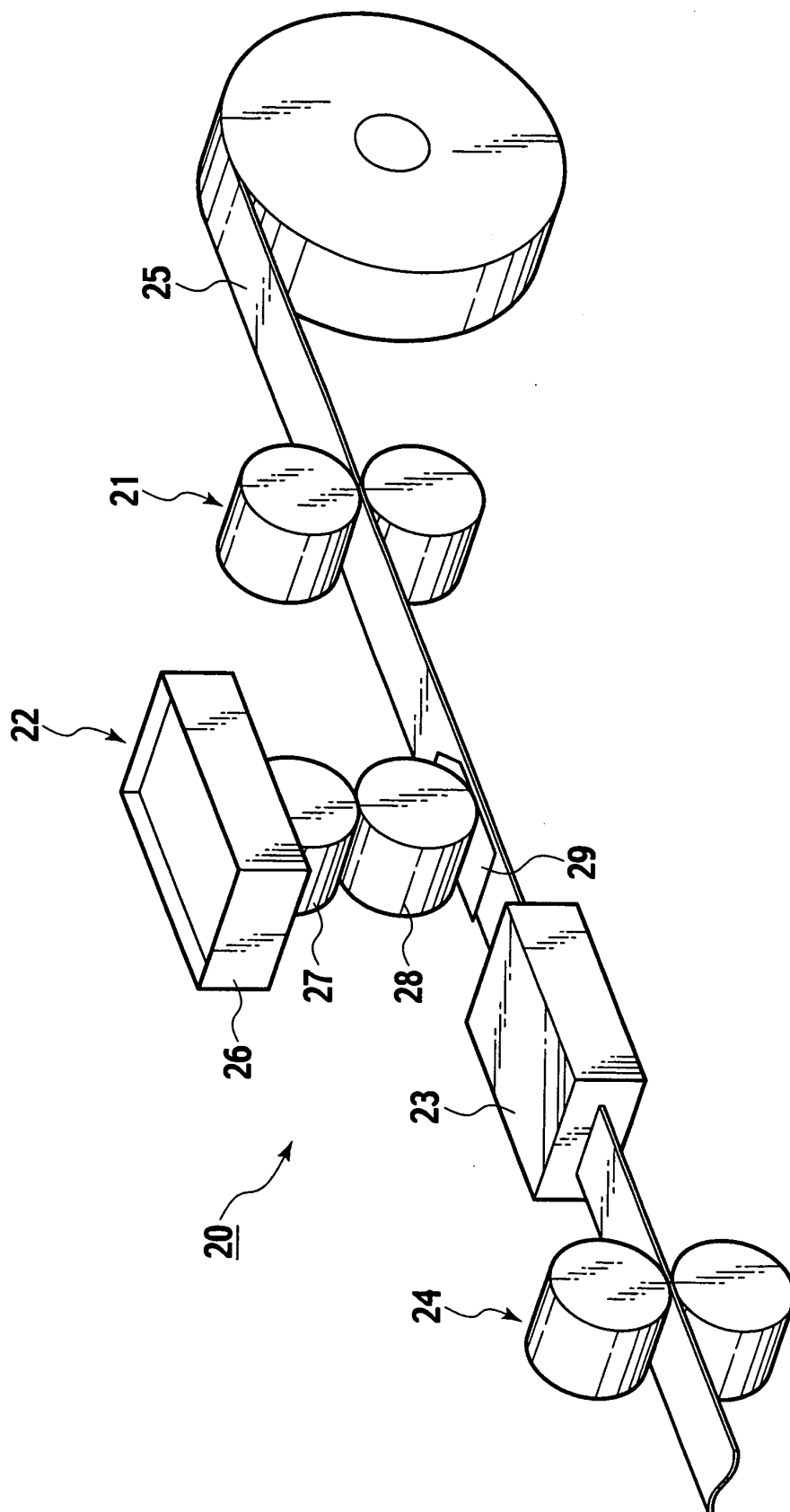


FIG. 6

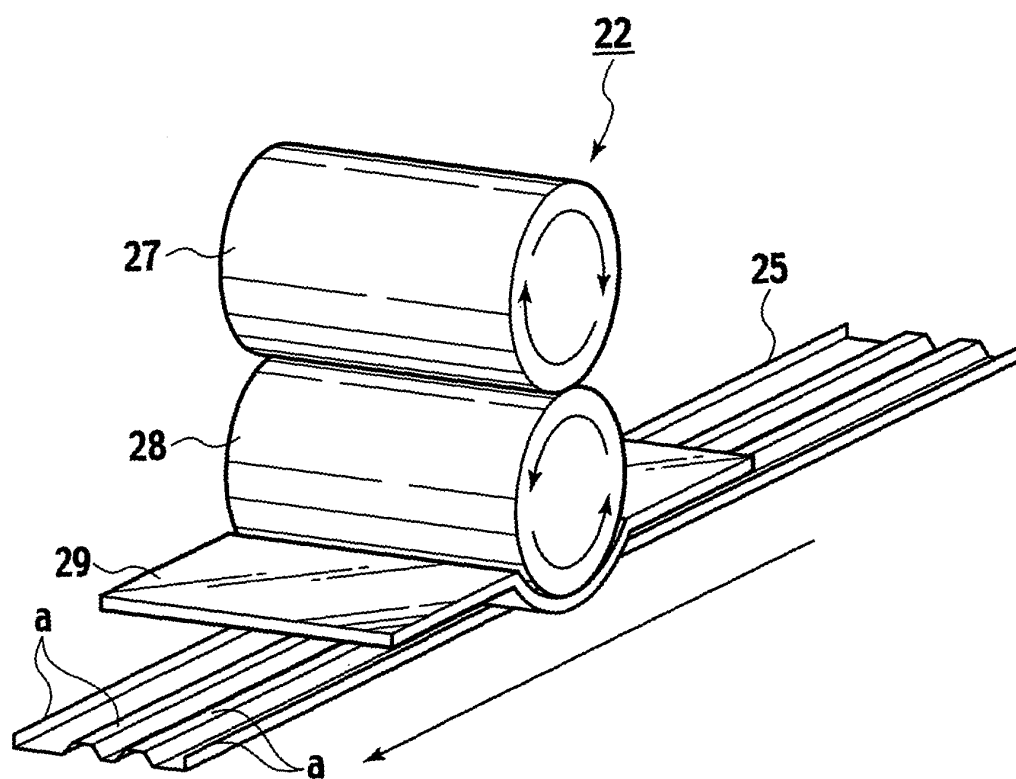


FIG. 7

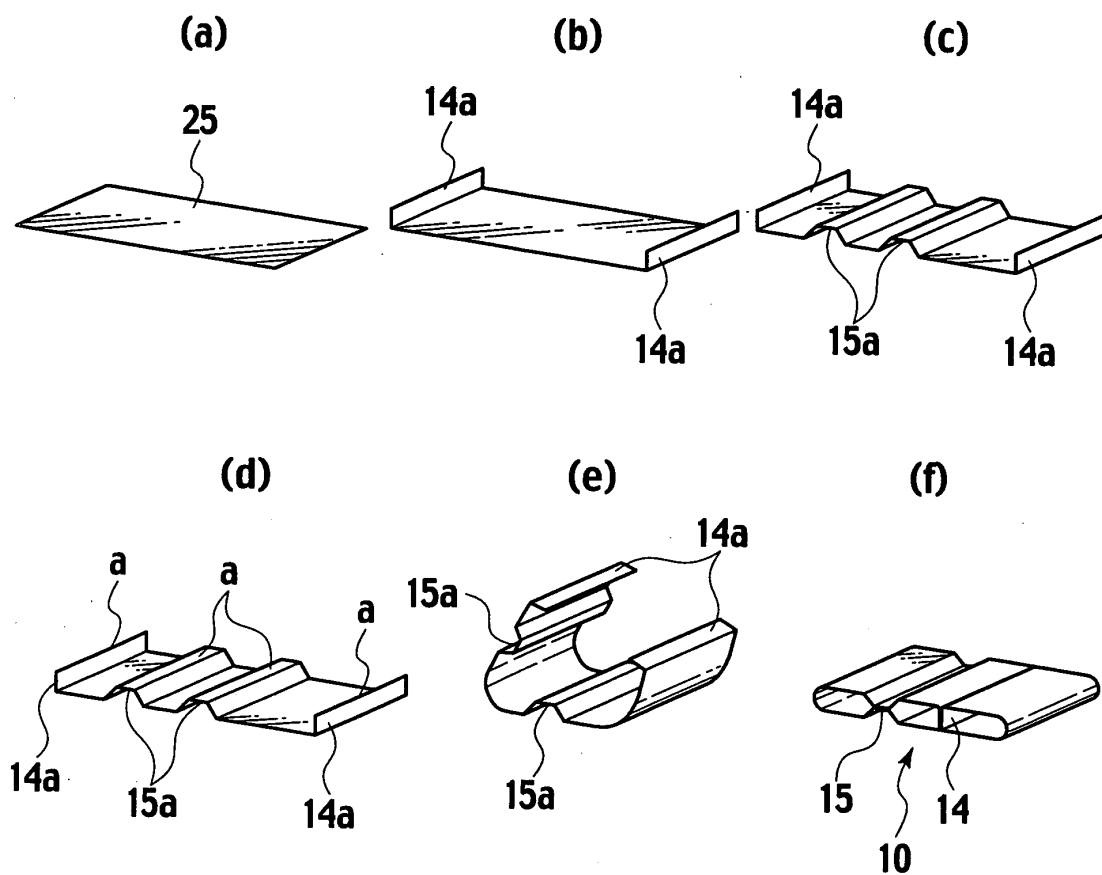


FIG. 8

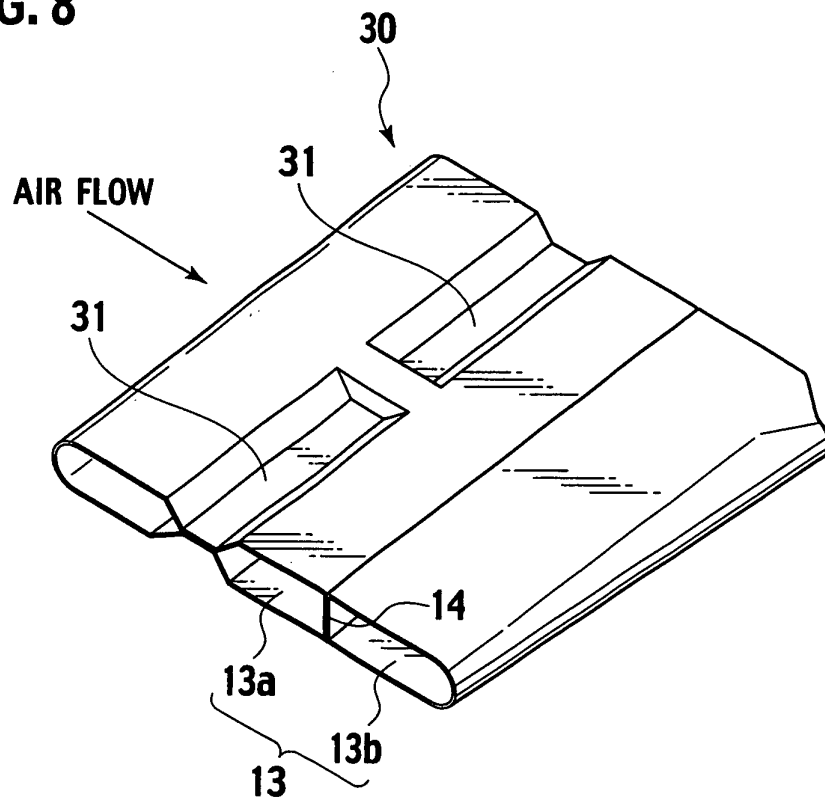


FIG. 9

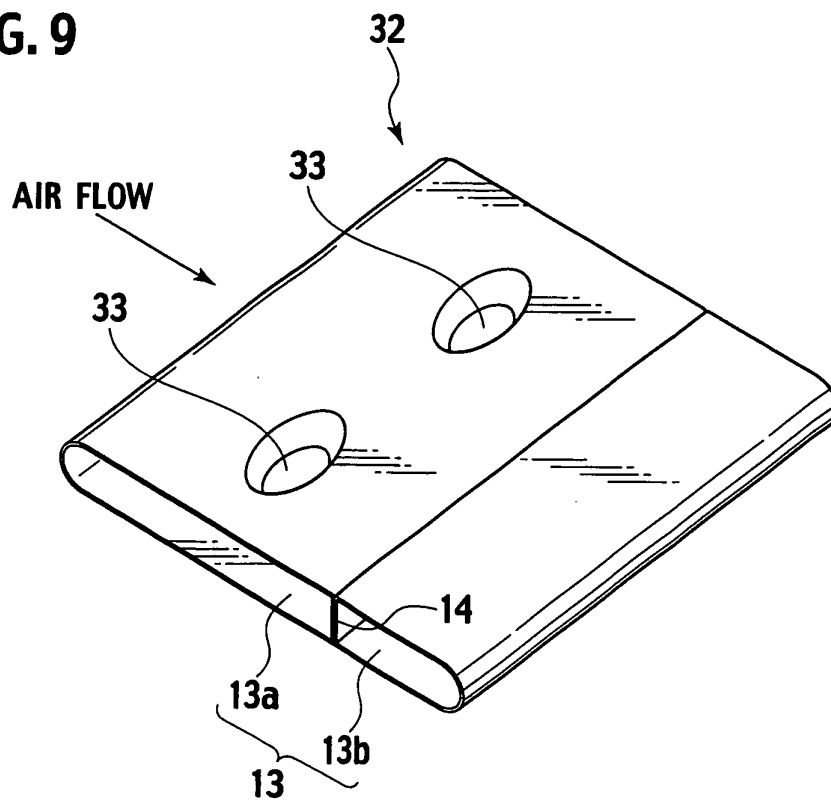


FIG. 10

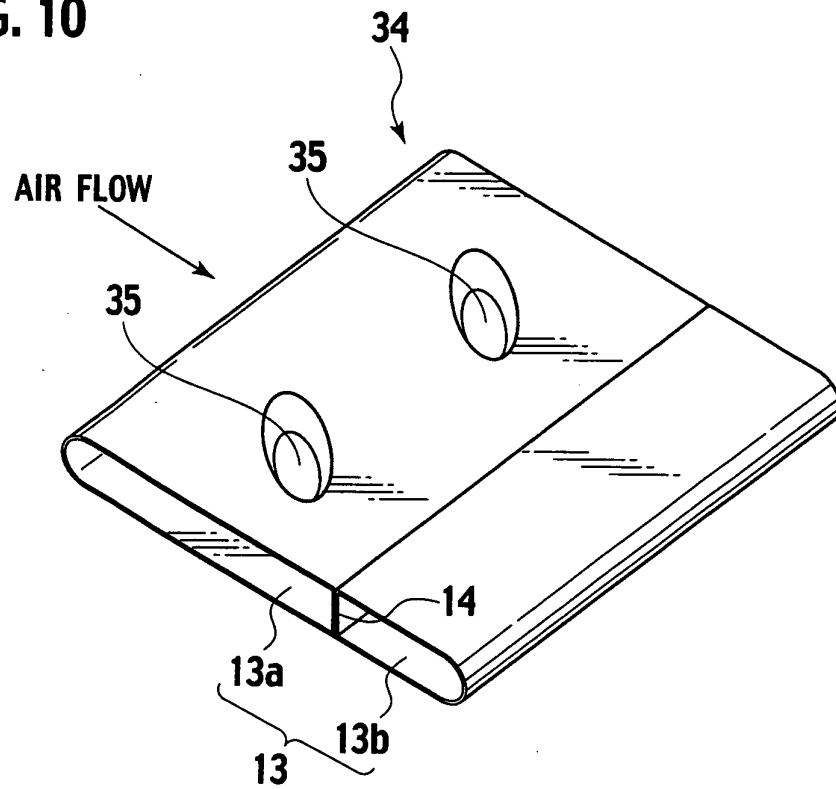
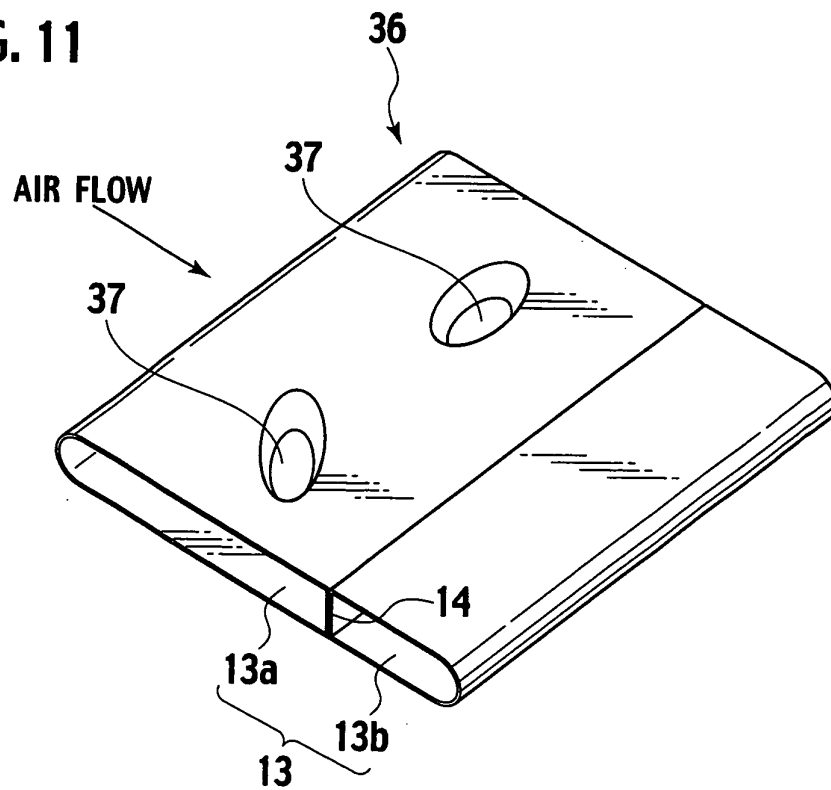


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/308299

A. CLASSIFICATION OF SUBJECT MATTER

F28F1/02 (2006.01), **F28D1/053** (2006.01)

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)

F28D1/053, **F28F1/02**

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 1996-2006

Kokai Jitsuyo Shinan Koho 1971-2006 Toroku Jitsuyo Shinan Koho 1994-2006

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.
Y	JP 10-305341 A (Calsonic Corp.), 17 November, 1998 (17.11.98), Par. Nos. [0014], [0022] to [0024]; Figs. 1, 2, 4 (Family: none)	1-5
Y	JP 4-73592 A (Matsushita Electric Industrial Co., Ltd.), 09 March, 1992 (09.03.92), Page 2, upper right column, lines 15 to 18; page 3, upper left column, lines 3 to 16; Fig. 2 (Family: none)	1-5

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

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Date of the actual completion of the international search
08 May, 2006 (08.05.06)

Date of mailing of the international search report
16 May, 2006 (16.05.06)

Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/308299

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 10-197174 A (Zexel Corp.), 31 July, 1998 (31.07.98), Claim 3; Par. Nos. [0022], [0042], [0043], [0060], [0070]; Figs. 3, 7, 15 & EP 0859209 A1 & WO 1998/009124 A1 & CN 1199458 A	2-5

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 10305341 A [0003]