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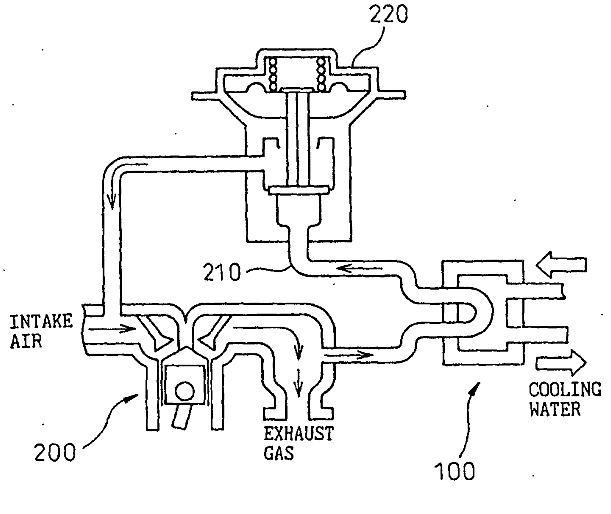
(54) **EXHAUST GAS HEAT EXCHANGER**

(57) First wings (111c) projecting in a first direction perpendicular to the flow direction of EGR gas and second wings (111c) projecting in a second direction perpendicular to the flow direction of the EGR gas and different from the first direction are provided on an inner fin (111). From a macroscopic viewpoint, the EGR gas collides with the wings (111c) and passes through the exhaust gas passage (110a) while meandering in the direction (D1) perpendicular to a longitudinal direction (D0) of the exhaust gas passage. Accordingly, the tendency that the EGR gas passes only along the portion that has no projection (111c) and that has a small flow resistance does not occur. Therefore, from the viewpoint of the entirety of the exhaust gas passage (110a), it can be considered that the EGR gas substantially uniformly collides with the projections (111c) to thereby enhance the heat transmissibility and prevent the deposition of particulate matters.

Fig.1



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Description

Technical Field

[0001] The present invention relates to an exhaust gas heat exchanging device for carrying out a heat exchange between an exhaust gas discharged from an internal combustion engine and a cooling fluid, and can be effectively applied to an EGR gas heat exchanging device (EGR gas cooler) for cooling the exhaust gas for EGR (Exhaust Gas Recirculation).

Background Art

[0002] Fig. 11 shows a prototype inner fin for an EGR gas cooler manufactured by way of trial and study. The inner fin is disposed in a tube through which the EGR gas passes, to promote a heat exchange between the EGR gas and cooling water.

[0003] In the prototypic inner fin, the inner fin is partially cut and bent to provide triangular projections, i.e., wing projections 111c which disturb the flow of the EGR gas passing in the tube to thereby swirl the EGR gas. Thus, not only can the heat transmissibility between the inner fin and the EGR gas be enhanced, but also the velocity of the flow of the gas can be increased in the vicinity of the inner fin, so that unburned matter such as particulate matter (soot) or the like that could stick to the inner fin are blown off to thereby prevent the particulate matters from being deposited on the inner fins.

[0004] However, because the prototype inner fin has a corrugated cross sectional shape when viewed in the direction of the EGR gas, the gas passage in the tube 110 is divided into a plurality of passage sections by the inner fins 111, as shown in Fig. 12. Also, because a series of projections 111c are provided on only one side of each of the passages sections divided by the inner fin 111, a large part of the EGR gas introduced in the tube 110 passes along the side (upper side in Fig. 13) of each passage section separated by the inner fin 111, that does not have a projection and, hence, has a small flow resistance.

[0005] Therefore, insufficient disturbance of the flow of the EGR gas occurs, thus leading to a lack of swirling of the gas, because the amount of the EGR gas that collides with the projections 111c is decreased. Thus, sufficient effects, i.e., enhancement of heat transmissibility and prevention of deposition of particulate matters, cannot be obtained.

Disclosure of the Invention

[0006] In view of the above problem, the object of the present invention is to enhance the heat transmissibility and to prevent a deposition of particulate matters in an exhaust gas heat exchanging device.

[0007] In order to achieve the above object, according to a first embodiment of the present invention, there is provided an exhaust gas heat exchanging device for carrying out a heat exchange between an exhaust gas discharged from an internal combustion engine and a cooling fluid, comprising an exhaust gas passage (110a) through which the exhaust gas passes; and a fin (111) that is disposed in the exhaust gas passage (110a) and that has a corrugated cross sectional shape as viewed in an exhaust gas flowing direction, wherein a plurality of projections (111c) that project in directions intersecting the exhaust gas flowing direction, are provided on the fin (111), along the flow of exhaust gas; and the projections (111c) are arranged so that the exhaust gas flows in the exhaust gas passage (110a) while meandering in a direction (D1) perpendicular to the longitudinal direction of the exhaust gas passage (110a), due to collision of the exhaust gas with the projections (111c).

[0008] Thus, the tendency that the exhaust gas passes only along the portion of the exhaust gas passage (110a) that has no projection (111c) and that has a small flow resistance does not occur, and the exhaust gas collides with the projections (111c) and flows along a meandering passage. Accordingly, from the viewpoint of the entirety of the exhaust gas passage (110a), it can be considered that the exhaust gas substantially uniformly collides with the projections (111c).

[0009] Therefore, because the swirl can be reliably generated by disturbing the flow of the exhaust gas, the heat transmissibility between the fin (111) and the exhaust gas can be enhanced, and the velocity of the flow of the gas in the vicinity of wall surfaces of the fin (111) and the exhaust gas passage (110a) can be increased to blow off unburned matters such as particulate matters or the like that stick to the wall surfaces of the fin (111) and the exhaust gas passage (110a) so as to prevent particulate matters from being deposited on the wall surfaces of the fin (111) and the exhaust gas passage (110a).

[0010] According to a second embodiment of the present invention, there is provided an exhaust gas heat exchanging device for carrying out a heat exchange between an exhaust gas discharged from an internal combustion engine and a cooling fluid, comprising an exhaust gas passage (110a) through which the exhaust gas passes; and a fin (111) that is disposed in the exhaust gas passage (110a) and that has a corrugated cross sectional shape as viewed in an exhaust gas flowing direction, wherein first projections (111c) that project in a first direction intersecting the exhaust gas flowing direction and second projections (111c) that project in a direction intersecting the exhaust gas flowing direction and different from the first direction, are provided along the flow of exhaust gas.

[0011] Thus, similar to the first embodiment of the present invention, the swirl can be reliably generated by disturbing the flow of the exhaust gas because the exhaust gas collides with the projections (111c) to thereby meander, in a direction intersecting the longitudinal direction of the exhaust gas passage (110a), in the exhaust gas passage (110a). Therefore, the heat transmissibility between the fin (111) and the exhaust gas can be enhanced and the velocity of the flow of the gas in the vicinity of the fin (111) can be increased to blow off unburned matters such as particulate matters or the like that stick to the fin (111) so as to prevent particulate matters from being deposited on the fin (111).

[0012] According to a third embodiment of the present invention, there is provided an exhaust gas heat exchanging device for carrying out a heat exchange between an exhaust gas discharged from an internal combustion engine and a cooling fluid, comprising an exhaust gas passage (110a) through which the exhaust gas passes; and a fin (111) that is disposed in the exhaust gas passage (110a) and that has a corrugated cross sectional shape as viewed in an exhaust gas flowing direction, wherein wings (111c) that have surfaces (S) that are inclined with respect to the flow of exhaust gas so that the amount of protrusion thereof from an inner wall of the exhaust gas passage (110a) increases toward the downstream side of the flow of exhaust gas, and that are arranged in a zigzag fashion, along the flow of exhaust gas, are provided on the inner wall; and a plurality of projections (110c) that are inclined with respect to the flow of exhaust gas and that are arranged in a zigzag fashion along the flow of exhaust gas, are provided on the wall surface, of the exhaust gas passage (110a), opposite to the wings (111c).

[0013] Thus, similar to the first embodiment of the present invention, the swirl can be reliably generated by disturbing the flow of the exhaust gas because the exhaust gas collides with the projections (111c) to thereby meander, in a direction intersecting the longitudinal direction of the exhaust gas passage (110a), in the exhaust gas passage (110a). Therefore, the heat transmissibility between the fin (111) and the exhaust gas can be enhanced, and the velocity of the flow of the gas in the vicinity of the fin (111) can be increased to blow off unburned matters such as particulate matters or the like that stick to the fin (111) so as to prevent particulate matters from being deposited on the fin (111).

[0014] Also, the fin (111) can be prevented from being clogged, and the heat exchanging efficiency in the exhaust gas heat exchanging device can be enhanced because the heat transmissibility between the fin (111) and the exhaust gas can be enhanced, and particulate matters that adhere to the surface of the fin (111) can be blown off.

[0015] Reference numeral inside the parenthesis corresponding to each means described above shows a relationship between the above-described means and concrete means described below in embodiments.

[0016] The present invention can be more fully understood from the accompanying drawings and descriptions in the following preferred embodiments of the present invention.

Brief Description of the Drawings

[0017]

Fig. 1 is a schematic view of an EGR gas cooling device using a gas cooler according to a first embodiment of the present invention;

Fig. 2 is an external view of a gas cooler according to a first embodiment of the present invention;

Fig. 3 is a sectional view of a tube of a gas cooler according to a first embodiment of the present invention;

Fig. 4 is a perspective view of an inner fin of a gas cooler according to a first embodiment of the present invention;

Fig. 5 is a half sectional view of a tube of a gas cooler according to a first embodiment of the present invention;

Fig. 6 is an explanatory view of characteristics of a gas cooler according to a first embodiment of the present invention;

Fig. 7 is a perspective view of an inner fin of a gas cooler according to a second embodiment of the present invention;

Fig. 8 is a sectional view of a tube of a gas cooler according to a third embodiment of the present invention;

Fig. 9A is an explanatory view of characteristics of a gas cooler according to a third embodiment of the present invention, and Fig. 9B is a top view of Fig. 9A;

Fig. 10 is an external two-view drawing of a tube 110 according to a third embodiment of the present invention;

Fig. 11 is a perspective view of a prototypic inner fin of a gas cooler manufactured by way of trial and study;

Fig. 12 is a sectional view of a prototypic tube of a gas cooler manufactured by way of trial and study; and

Fig. 13 is an explanatory view of characteristics of a prototypic gas cooler manufactured by way of trial and study.

Best Mode for Carrying Out the Invention

(First Embodiment)

[0018] In the present embodiment, an exhaust gas heat exchanging device according to the present invention is applied to an EGR gas cooling device for a diesel engine. Fig. 1 is a schematic view of an EGR (Exhaust Gas Recirculation device) using an EGR gas cooling device (hereinafter called "gas cooler") 100 according to the present embodiment.

[0019] An exhaust gas recirculation pipe 210 recirculates a part of the exhaust gas discharged from an engine 200 to an intake port of the engine 200.

[0020] An EGR valve 220 is a known valve that is disposed at some midpoint in the flow of the exhaust gas in the exhaust gas recirculation pipe 210 and that adjusts the amount of the EGR gas in accordance with an operating status of the engine 200. The gas cooler 100 is disposed between an exhaust port of the engine 200 and the EGR valve 220, and carries out a heat exchange between the EGR gas and the cooling water of the engine, to thereby cool the EGR gas.

[0021] The structure of the gas cooler 100 will be described below.

[0022] Fig. 2 is an external view (partially sectional view) of the gas cooler. Tubes 110 are flat tubes each defining an exhaust gas passage 110a through which the EGR gas passes. The tubes 110 are formed by welding two plates 110b each formed into a predetermined shape by punching, as shown in Fig. 3.

[0023] Inner fins 111 to promote a heat exchange between the EGR gas and the cooling water are disposed in the tubes 110, i.e., in the exhaust gas passages 110a. As shown in Fig. 4, the inner fins 111 have two kinds of planar portions 111a, 111b that extend in a flowing direction of the EGR gas and that intersect each other, and each have a corrugated cross sectional shape when viewed in the flowing direction of the EGR gas.

[0024] Projections i.e., wings 111c each having a triangular surface S that is inclined with respect to the flow of EGR gas so that the amount of protrusion thereof from the planar portions 111a of the inner fin 111 increases toward the downstream side of the flow of exhaust gas, are provided on the planar portions 111a of the inner fin 111 that are in contact with the tube 110, i.e., the inner wall of the plate 110b, by partially cutting and bending the planar portions 111a.

[0025] The wings 111c are provided with first wings 111c projecting in a first direction (a direction from the lower side toward the upper side in Fig. 4) perpendicular to the flow direction of the EGR gas and second wings 111c projecting in a second direction (a direction from the upper side toward the lower side in Fig. 4) perpendicular to the flow direction of the EGR gas. To this end, the triangular surfaces S are arranged in a zigzag fashion, along each of the exhaust gas passages 110a divided by the inner fins 111.

[0026] Concretely, two wings 111c whose surfaces S are inclined with respect to the flow of the EGR gas, in different directions, are arranged along the flow of the EGR gas. Also, a plurality of inner fins 111 each having only two wings 111c are arranged along the flow of the EGR gas, in the tube 110, with the placement direction (up-and-down directions) being alternately inverted. Thus, the arrangement of the wings 111c mentioned above can be realized.

[0027] The inner fins 111 and the tubes 110 are formed by punching a metal (stainless steel in the present embodiment) having a high corrosion resistance. The inner fins 111 and the tubes 110 are integrally connected by welding.

[0028] In Fig. 2, a casing 120 accommodates a heat exchanging core 113 composed of a plurality of tubes 110 laminated in a minor diameter direction thereof (up-and-down directions in the drawing) and connected to one another, and is formed into a rectangular pipe defining a cooling water passage 121 around the heat exchanging core 113. The casing 120 is made of a metal (stainless in the present embodiment) having a high corrosion resistance.

[0029] A tank 122a for distributing and supplying the EGR gas to the tubes 110 is formed at an opening provided at one end in the longitudinal direction (right side in the drawing) of the casing 120. Also, a joint 122 for connecting to an EGR gas piping (not shown) is welded to the opening. On the other hand, a tank 123a for collecting and receiving the EGR gas that has been subject to a heat exchange from the tubes 110 is formed at an opening provided at the other end in the longitudinal direction (left side in the drawing) of the casing 120. Also, a join 123 for connecting to an EGR gas piping (not shown) is welded to the opening.

[0030] Core plates 124 hold the tubes 110 and separates the cooling water passage 121 from the tanks 122a, 123a. The core plates 124 and the joints 122, 123 are made of a metal (stainless steel in the present embodiment) having a high corrosion resistance.

[0031] In the casing 120, an inlet port 125, through which a cooling water is introduced to the cooling water passage 121 in the major diameter direction of the tube 110, is provided at the inflow side of the EGR gas, and an outlet port 126, through which the cooling water that has been subjected to a heat exchange is discharged in the minor diameter direction of the tube 110, is provided at the outflow side of the EGR gas.

[0032] In the present embodiment, the flowing direction of the EGR gas is identical to that of the cooling water in the casing 120. As shown in Fig. 2, projections 110d extending in the major diameter direction of the tubes 110 are provided, on the outer walls of the tubes 110, to divide the portion of the cooling water passage 121 adjacent to the inlet port 125 into relatively small spaces to thereby constitute a velocity increasing means to increase the velocity of the flow of the cooling water in the vicinity of the EGR gas inlet port and a positioning means to provide a size of clearance between the tubes 110.

[0033] In Fig. 5, projections 110e are provided to provide a size of clearance between the tubes 110 so as to reliably weld the tubes 110 to the inner fins 111. In Fig. 2, strengthening ribs 120e are provided to strengthen the casing 120.

[0034] Features of the present embodiment will be described below.

[0035] Fig. 6 is a schematic view showing the flow of the EGR gas in the passage 110a separated by the inner fins 111, in the gas cooler 100 according to the present embodiment. As is clear from Fig. 6, the present embodiment has the first wings 111c projecting in the first direction perpendicular to the flowing direction of the EGR gas and the second wings 111c projecting in the second direction perpendicular to the flowing direction of the EGR gas and different from the first direction. From a macroscopic viewpoint, the EGR gas collides with the wings 111c and passes through the exhaust gas passage 110a while meandering in the direction D1 perpendicular to a longitudinal direction D0 of the exhaust gas passage 110a.

[0036] Therefore, the tendency that the exhaust gas passes only along the portion of the exhaust gas passage 110a that has no projection 111c and that has a small flow resistance does not occur. As described above, the EGR gas collides with the projections 111c and flows along the meandering passage. Accordingly, from the viewpoint of the entirety of the exhaust gas passage 110a, it can be considered that the EGR gas substantially uniformly collides with the projections 111c.

[0037] Therefore, because the swirl can be reliably generated by disturbing the flow of the exhaust gas, the heat transmissibility between the inner fins 111 and the EGR gas can be enhanced and the velocity of the flow of the gas in the vicinity of wall surfaces of the inner fins 111 and the tubes 110 can be increased, to blow off unburned matters such as particulate matters or the like that stick to the wall surfaces of the inner fins 111 and the tubes 110, so as to prevent particulate matters from being deposited on the wall surfaces of the inner fins 111 and the tubes 110.

(Second Embodiment)

[0038] In the first embodiment, a plurality of inner fins 111 each having only two wings 111c are arranged along the flow of the EGR gas, in the tube 110, with the placement direction (up-and-down directions) being alternately inverted, to thereby realize the arrangement of the wings 111c. However, in the present embodiment, as shown in Fig. 7, the first wings 111c projecting in the first direction perpendicular to the flowing direction of the EGR gas and the second wings 111c projecting in the second direction perpendicular to the flowing direction of the EGR gas and different from the first direction are provided on an offset type inner fin in which the planar portions 111b, i.e., portions of the inner fin 111 that are in substantially parallel with the minor diameter direction of the tube 110 are arranged in a zigzag fashion.

[0039] In the present embodiment, the single inner fin 111 can constitute an inner fin. Therefore, the manhours needed to produce the gas cooler 100 can be reduced.

(Third Embodiment)

[0040] In the present embodiment, as shown in Fig. 8, projections 110c are formed, by partially punching the plates 110b toward the inside of the exhaust gas passage 110a, on the plates 110b that separate the exhaust gas passage 110a from the cooling water passage 121 to define the exhaust gas passage 110a.

[0041] As shown in Fig. 9(a), the projections 110c that are inclined with respect to the flow of exhaust gas and that are arranged in a zigzag fashion along the flow of exhaust gas, are provided on the wall surface, of the exhaust gas passage 110a, opposite to the wings 111c. Also, as shown in Fig. 9(b), the wings 111c and the projections 110c are alternately positioned when viewed in a direction perpendicular to the longitudinal direction of the exhaust gas passage 110a. Fig. 10 is an external two-view drawing of the tube 110 according to the present embodiment.

[0042] Accordingly, similar to the first embodiment, the EGR gas collides with the wings 111c and passes through the exhaust gas passage 110a while meandering in the direction perpendicular to the longitudinal direction of the exhaust gas passage 110a.

[0043] Therefore, the tendency that the exhaust gas passes only along the portion of the exhaust gas passage 110a that has no wing 111c and that has a small flow resistance does not occur, and the EGR gas collides with the projections 111c and flows along the meandering passage. Accordingly, from the viewpoint of the entirety of the exhaust gas passage 110a, it can be considered that the EGR gas substantially uniformly collides with the wings 111c.

[0044] Thus, because the swirl can be reliably generated by disturbing the flow of the exhaust gas, the heat transmissibility between the inner fin 111 and the EGR gas can be enhanced, and the velocity of the flow of the gas in the vicinity of wall surfaces of the inner fin 111 and the tubes 110 can be increased to blow off unburned matters such as particulate matters or the like that stick to the wall surfaces of the inner fin 111 and the tubes 110 so as to prevent particulate matters from being deposited on the wall surfaces of the inner fin 111 and the tubes 110.

[0045] In the present embodiment, an angle 1 which the wing 111c forms with a streamline of the EGR gas is identical to an angle 2 which the projection 110c forms with the streamline of the EGR gas. However, the present embodiment is not limited thereto.

[0046] In the present embodiment, the amount of protrusion of the projection 110c is smaller than that of the wing 111c. However, the present embodiment is not limited thereto.

(Another Embodiment)

[0047] In the above-described embodiments, the wing 111c is substantially in the form of a triangle. However, the present invention is not limited thereto. Another shape such as a rectangle or a hemisphere (dome) may be adopted.

[0048] In the above-described embodiments, the exhaust gas heat exchanging device according to the present invention is applied to the gas cooler 100. However, another heat exchanger such as a heat exchanger disposed in a muffler to collect the thermal energy of the exhaust gas may be applied to the gas cooler 100.

[0049] In the above-described embodiments, the wing 111c is formed by partially cutting and bending the inner fin 111. However, the present invention is not limited thereto. The wing 111c may be formed on a planar member independent of the inner fin 111c, and the planar member on which the wing 111c is formed may be connected to the inner fin 111 by connecting means such as welding.

[0050] Although the present invention has been described in detail with embodiments thereof, it should be understood by those skilled in the art that various other changes and modifications may be made therein and thereto without departing from the spirit and the scope of the invention.

Claims

1. An exhaust gas heat exchanging device for carrying out a heat exchange between an exhaust gas discharged from an internal combustion engine and a cooling fluid, comprising

an exhaust gas passage (110a) through which the exhaust gas passes; and

a fin (111) that is disposed in the exhaust gas passage (110a) and that has a corrugated cross sectional shape as viewed in an exhaust gas flowing direction, wherein

a plurality of projections (111c) that project in directions intersecting the exhaust gas flowing direction, are provided on the fin (111), along the flow of exhaust gas; and

the projections (111c) are arranged so that the exhaust gas flows in the exhaust gas passage (110a) while meandering in a direction (D1) perpendicular to the longitudinal direction of the exhaust gas passage (110a), due to collision of the exhaust gas with the projections (111c).

2. An exhaust gas heat exchanging device for carrying out a heat exchange between an exhaust gas discharged from an internal combustion engine and a cooling fluid, comprising

an exhaust gas passage (110a) through which the exhaust gas passes; and

a fin (111) that is disposed in the exhaust gas passage (110a) and that has a corrugated cross sectional shape as viewed in an exhaust gas flowing direction, wherein

first projections (111c) that project in a first direction intersecting the exhaust gas flowing direction and second projections (111c) that project in a direction intersecting the exhaust gas flowing direction and different from the first direction, are provided along the flow of exhaust gas.

3. An exhaust gas heat exchanging device according to claim 1 or 2, wherein

the projections (111c) have surfaces (S) that are inclined with respect to the flow of exhaust gas, so that the amount of protrusion thereof from the fin (111) increases toward the downstream side of the flow of exhaust gas, and are arranged in a zigzag fashion, along the flow of exhaust gas.

4. An exhaust gas heat exchanging device for carrying out a heat exchange between an exhaust gas discharged from an internal combustion engine and a cooling fluid, comprising

an exhaust gas passage (110a) through which the exhaust gas passes; and

a fin (111) that is disposed in the exhaust gas passage (110a) and that has a corrugated cross sectional shape as viewed in an exhaust gas flowing direction, wherein

wings (111c) that have surfaces (S) that are inclined with respect to the flow of exhaust gas so that the amount of protrusion thereof from an inner wall of the exhaust gas passage (110a) increases toward the downstream side of the flow of exhaust gas, and that are arranged in a zigzag fashion, along the flow of exhaust gas, are provided on the inner wall; and

a plurality of projections (110c) that are inclined with respect to the flow of exhaust gas and that are arranged in a zigzag fashion along the flow of exhaust gas, are provided on the wall surface, of the exhaust gas passage (110a), opposite to the wings (111c).

5. An exhaust gas heat exchanging device according to claim 4, wherein the wings (111c) and the projections (110c) are alternately arranged as viewed in a direction perpendicular to the longitudinal direction of the exhaust gas passage (110a).

6. An exhaust gas heat exchanging device according to claim 5, wherein the projections (110c) are made integral with a member that constitutes the exhaust gas passage (110a).

7. An exhaust gas heat exchanging device according to claim 4 or 5, wherein the projections (110c) are formed by punching a member that constitutes the exhaust gas passage (110a).

8. An exhaust gas heat exchanging device according to claim 2, wherein the second projections project in a direction opposite to the first direction in which the first projections project.

9. An exhaust gas heat exchanging device according to claim 1, 2 or 4, wherein the projections are each substantially in the form of a triangle in which the height of the projections increases toward the downstream side of the flow of exhaust gas.

Fig.1

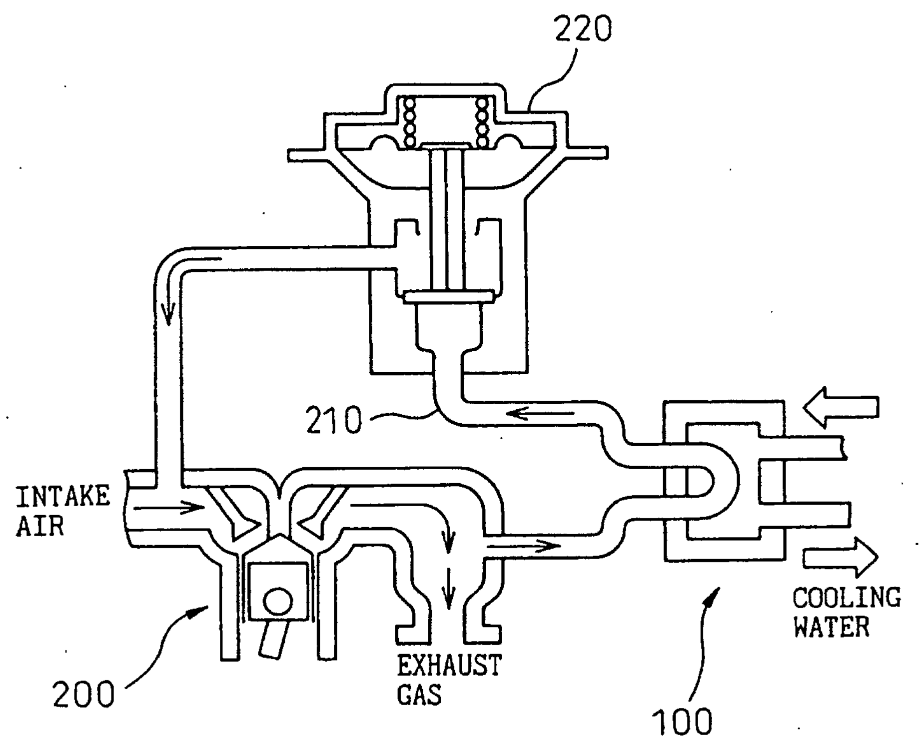


Fig. 2

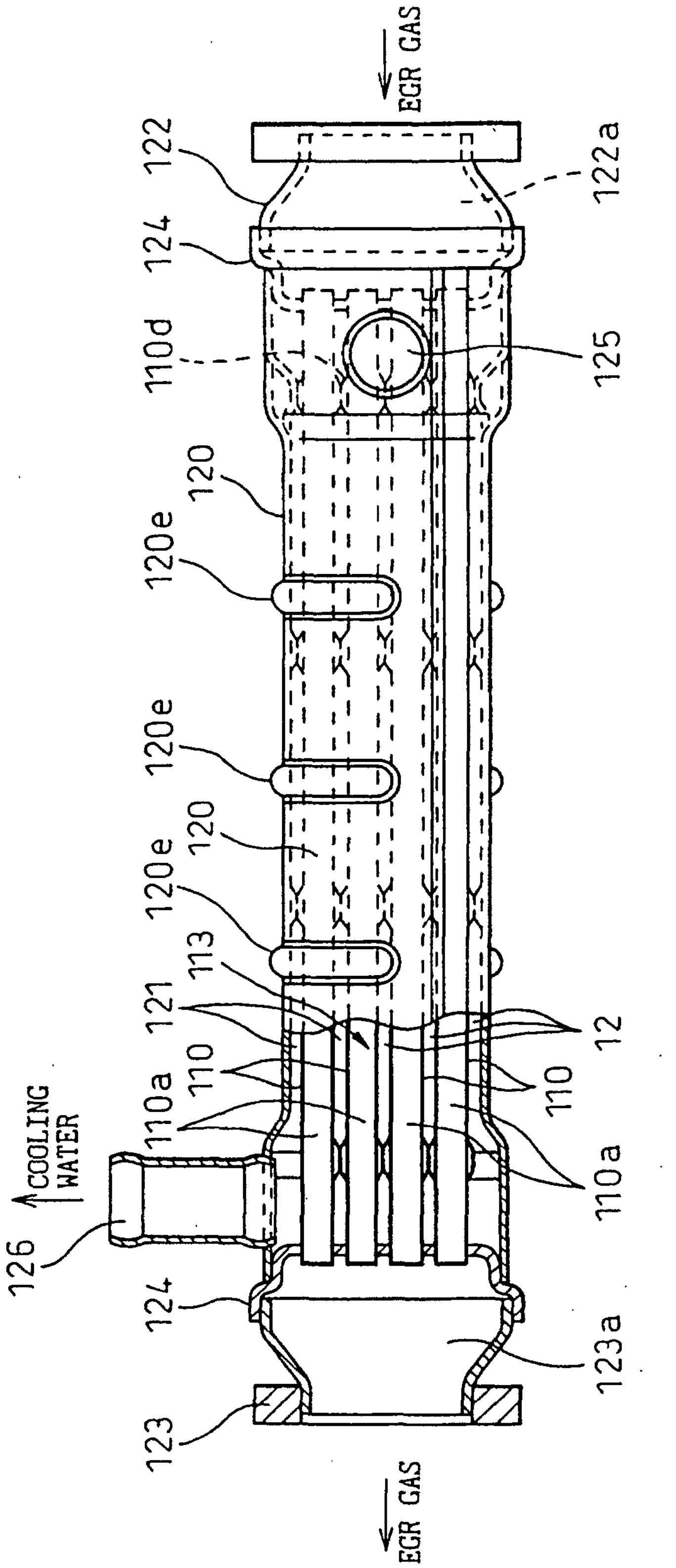

EGR GAS
122
122a
124
110d
125
120
120e
120e
120
120e
113
121
12
110
110a
110
110a
COOLING WATER
126
124
123a
123
EGR GAS

Fig.3

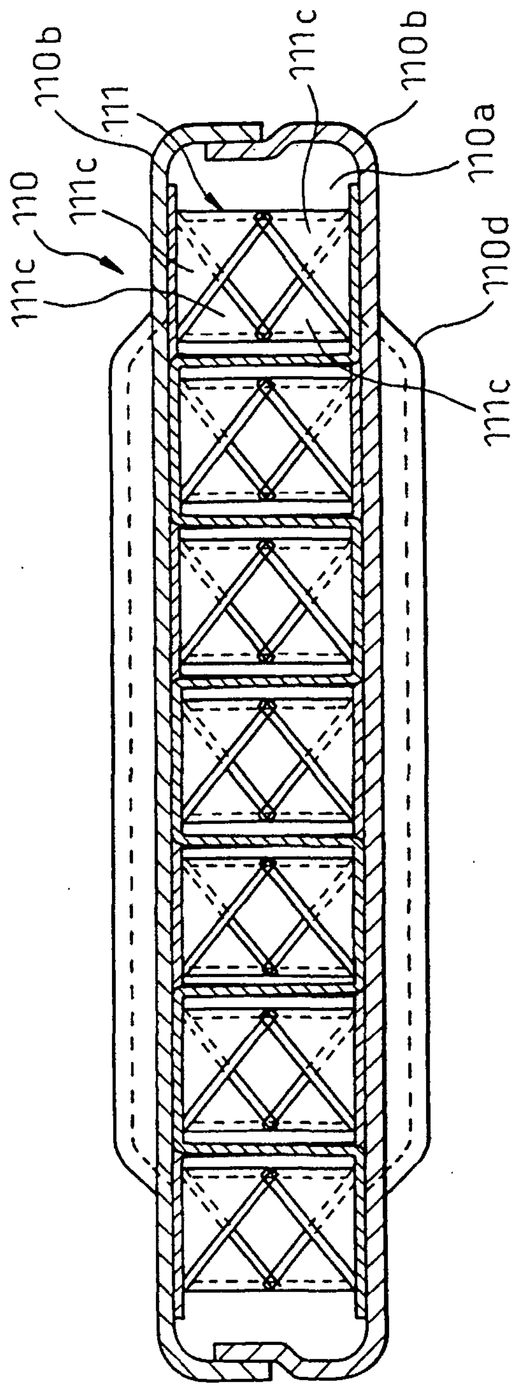
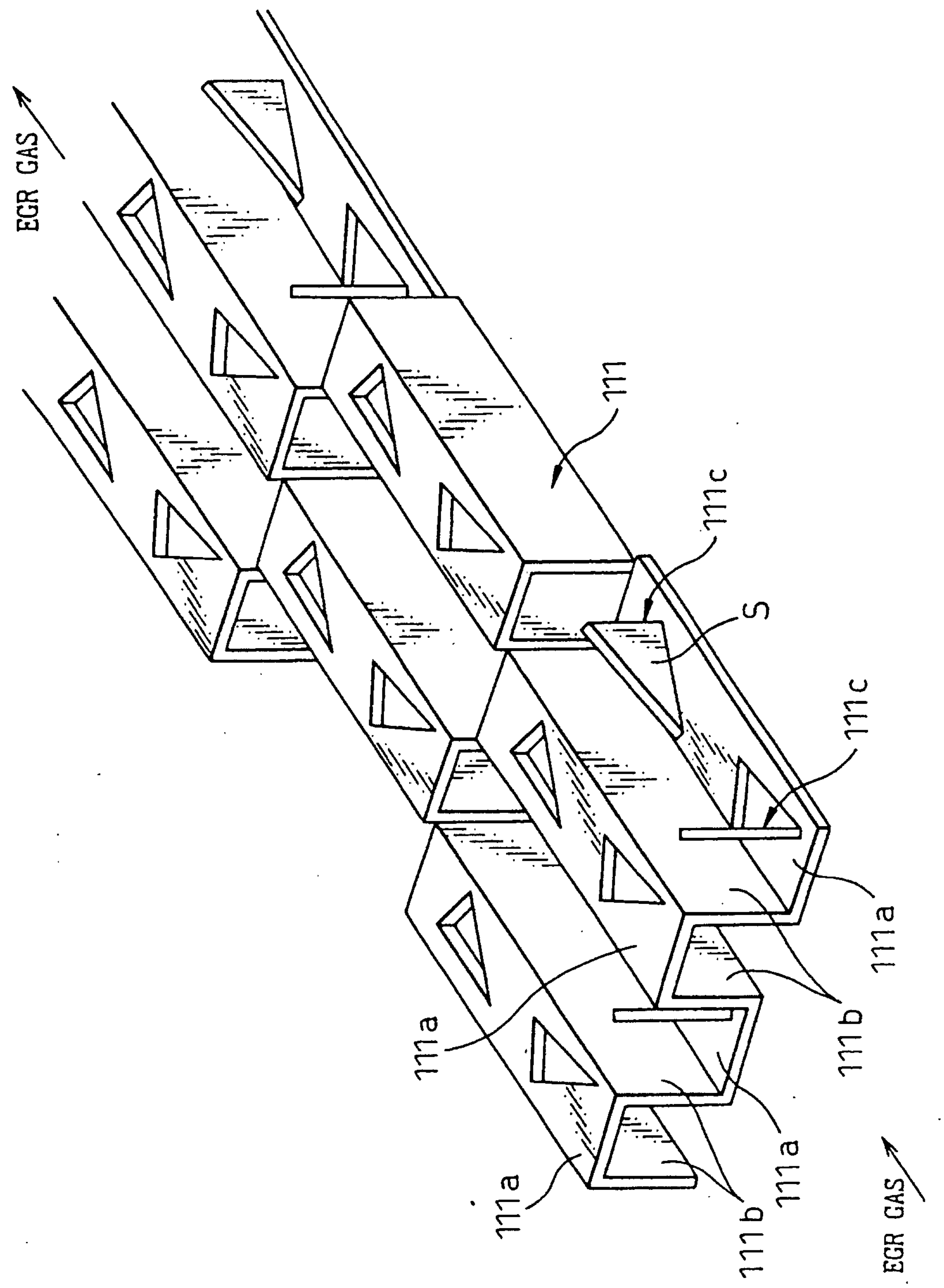


Fig.4


EGR GAS
111
111c
S
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111a
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111a
EGR GAS

Fig.5

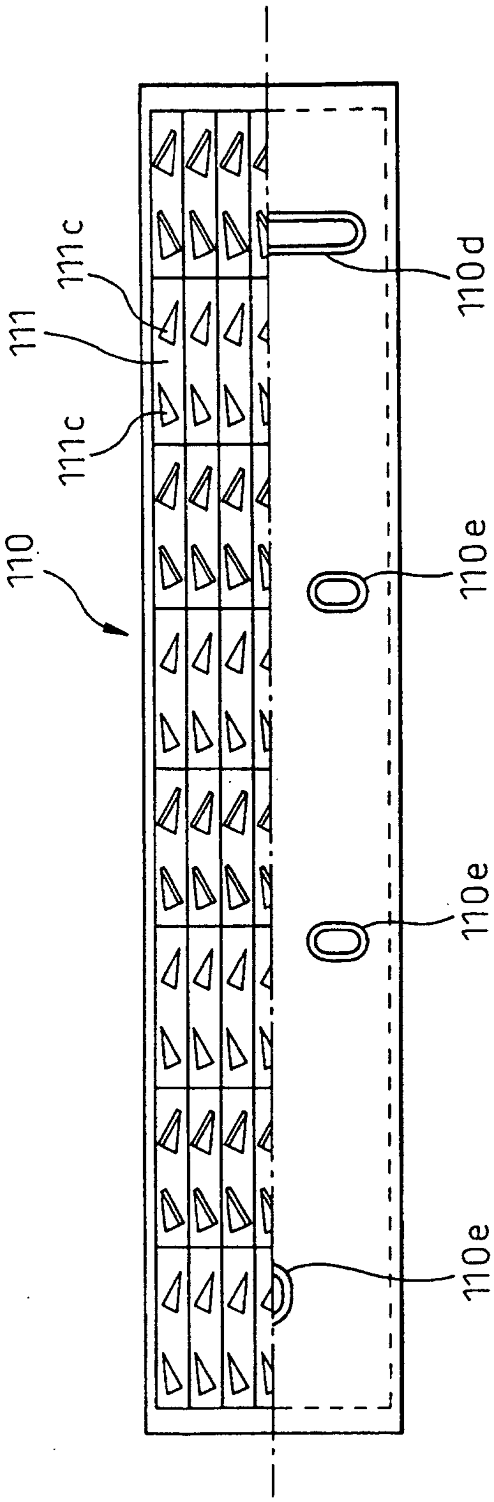


Fig.6

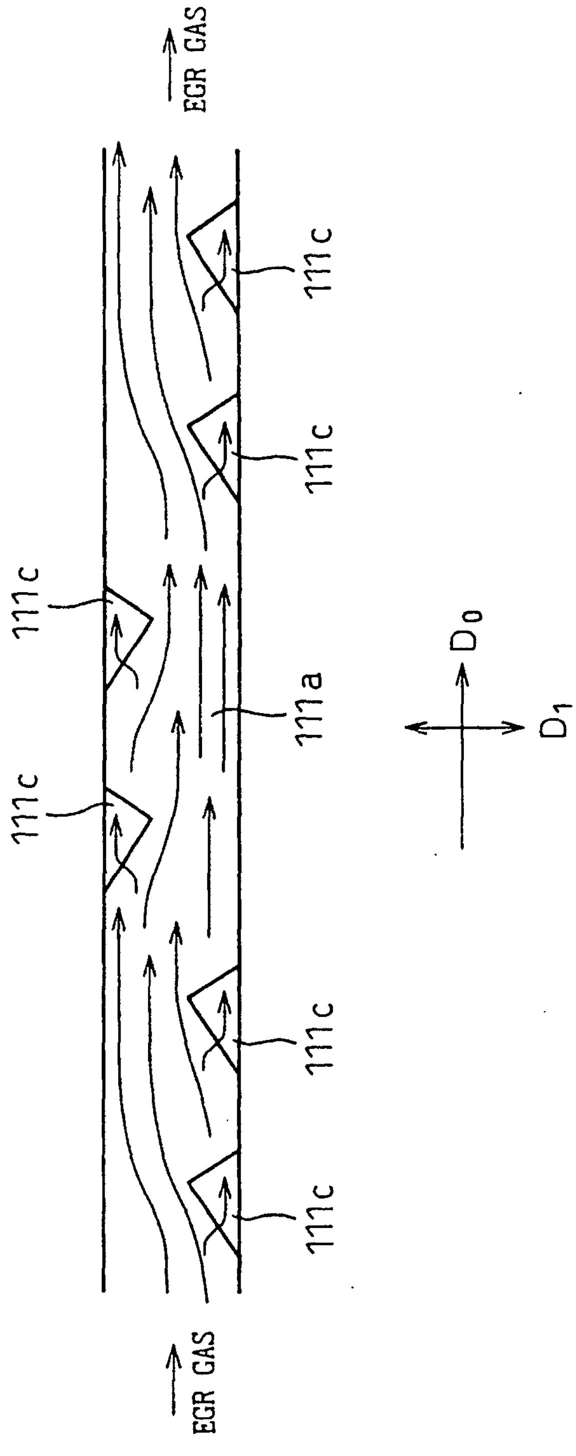


Fig. 7

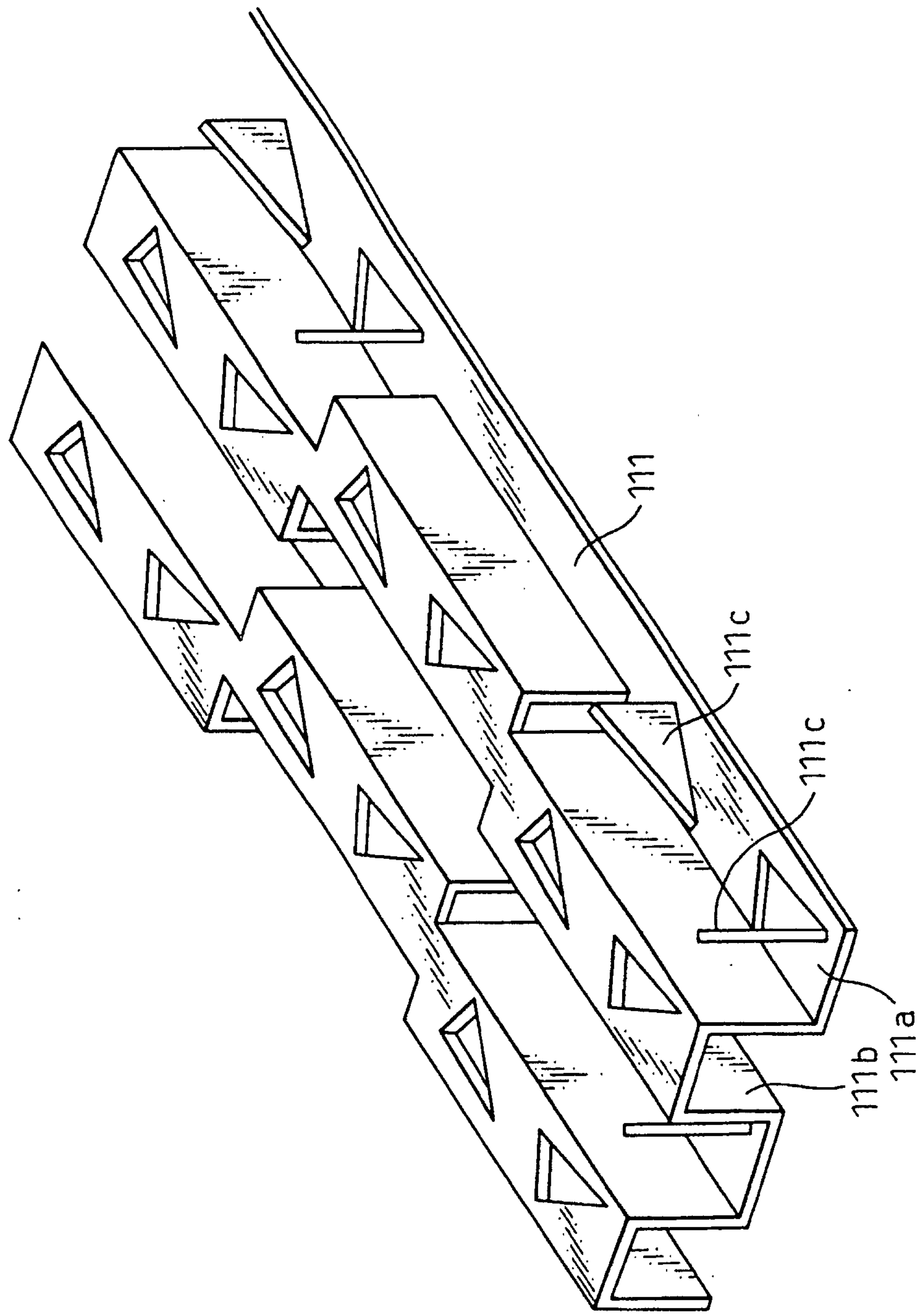


Fig. 8

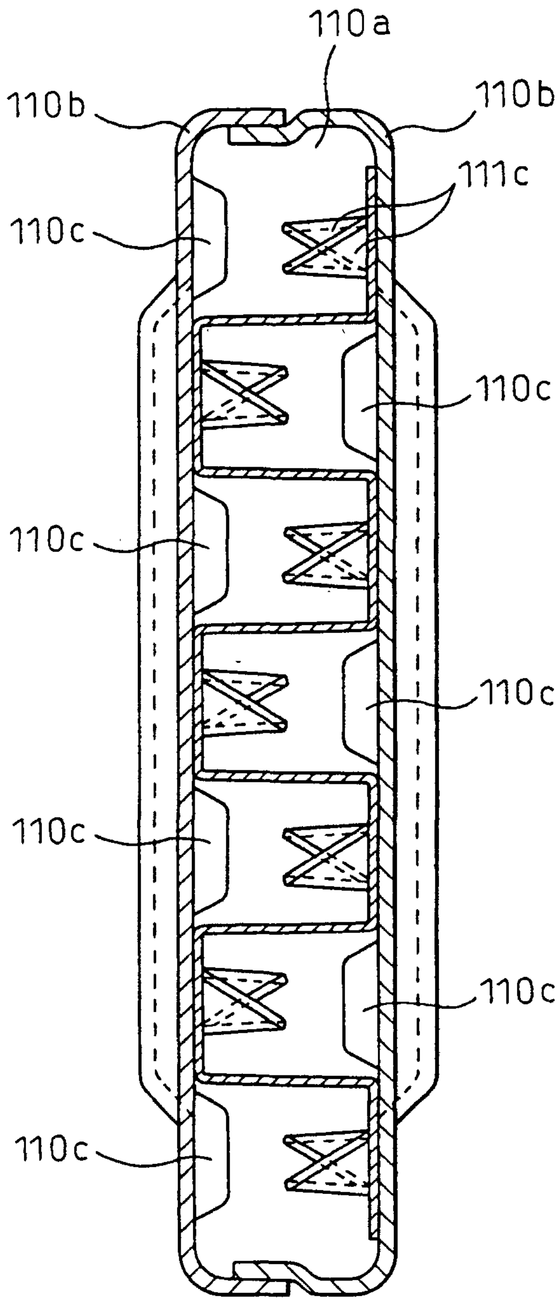


Fig.9A

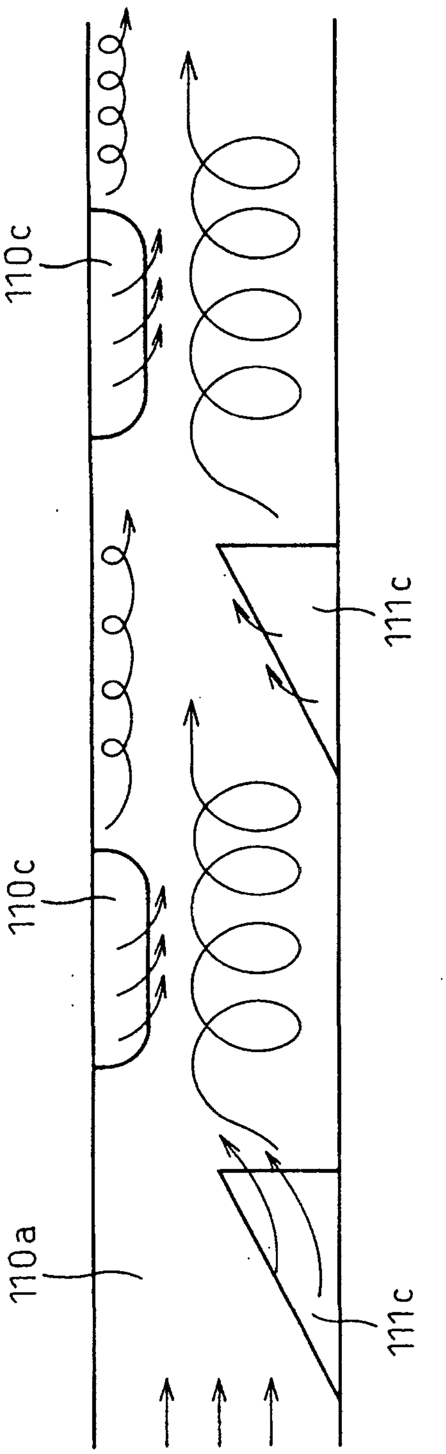


Fig.9B

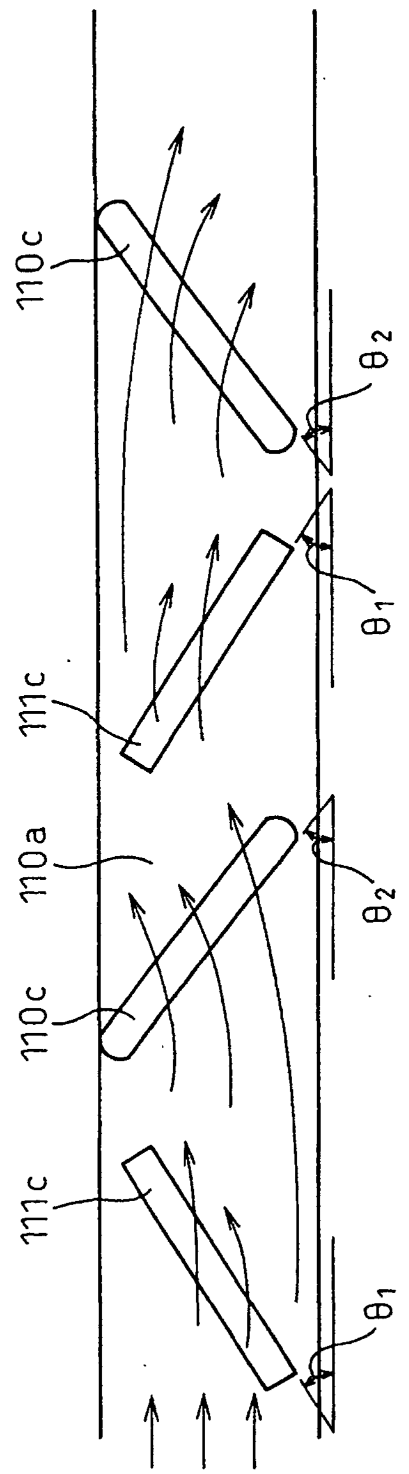


Fig.10

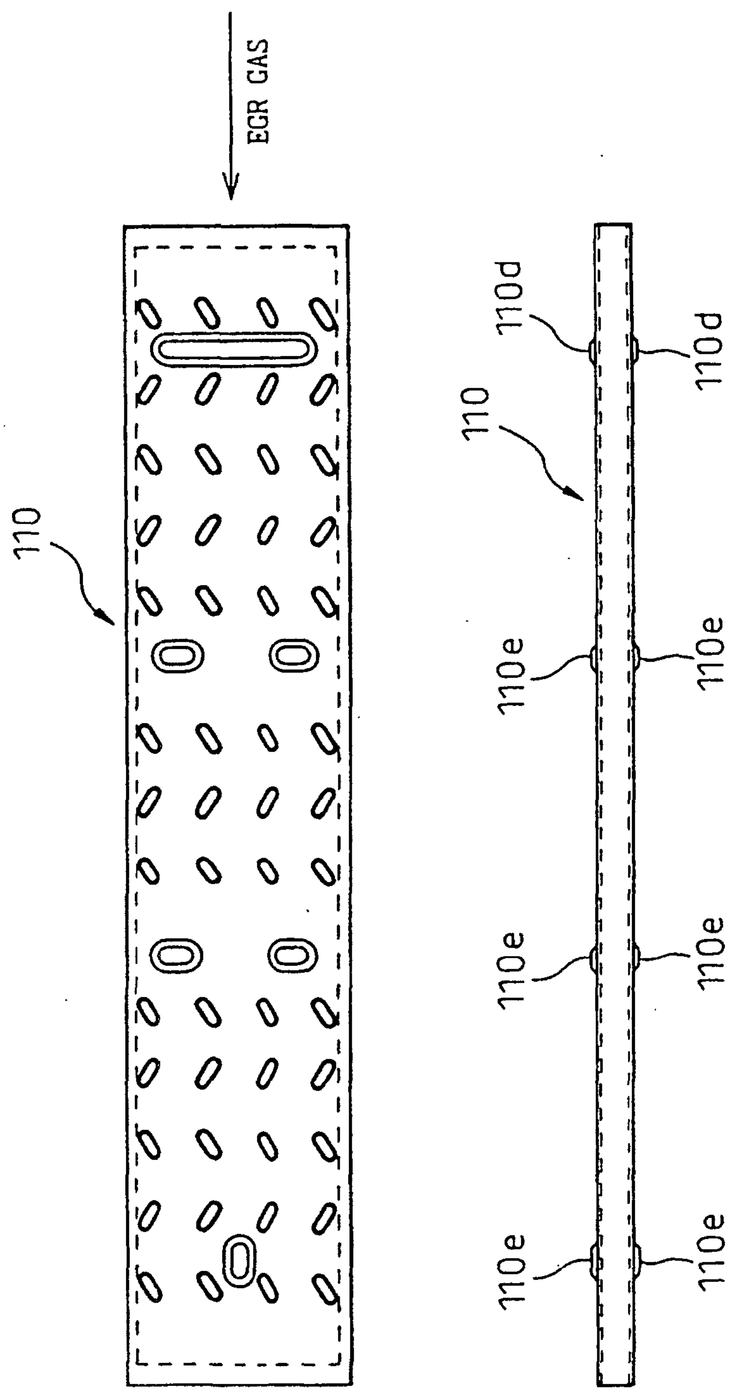


Fig.11

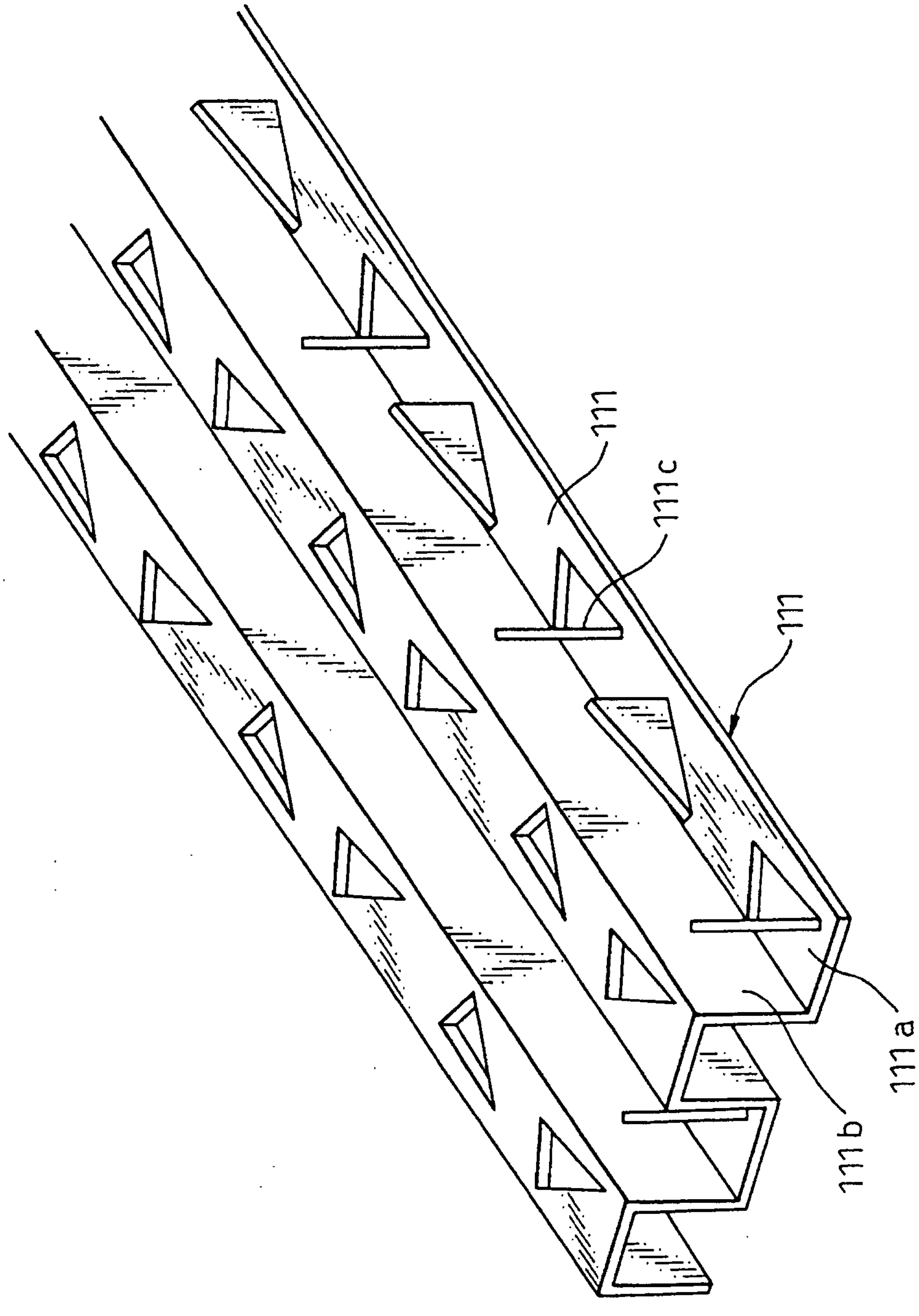


Fig.12

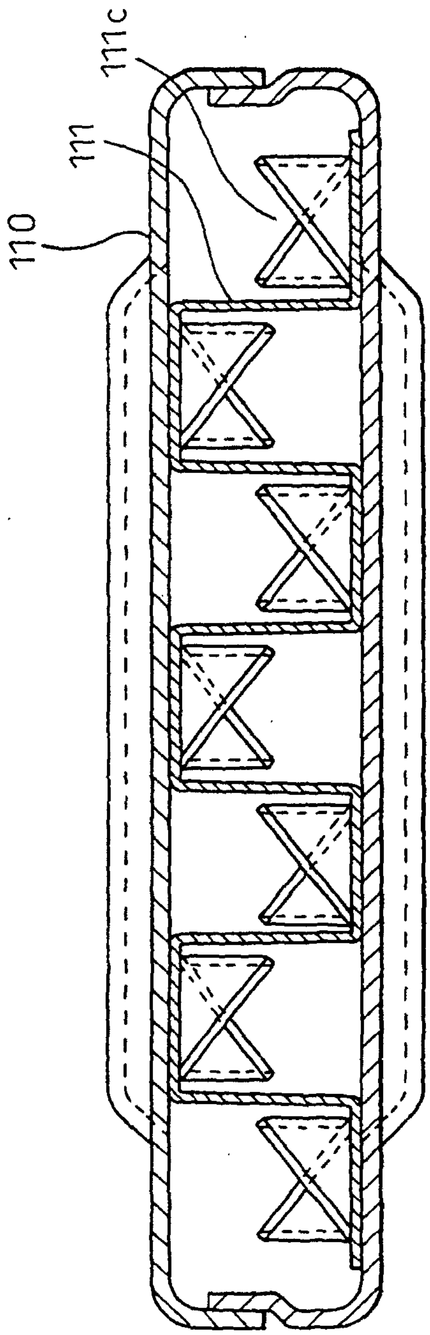
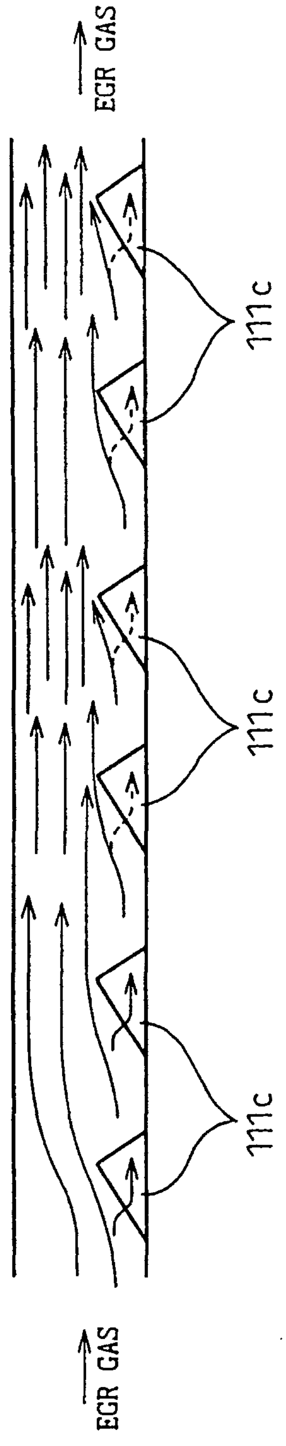


Fig.13



List of reference number

110a···exhaust gas passage

111···fin

111c···projection

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/07566

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F28F3/06, F02M25/07

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)
Int.Cl[7] F28F3/06, F02M25/07

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

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Kokai Jitsuyo Shinan Koho	1971-2002	Jitsuyo Shinan Toroku Koho	1996-2002

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 2000-97578 A (Modine Mfg. Co.), 04 April, 2000 (04.04.00), & EP 974804 A & DE 19833338 A & US 6293337 B	1-9
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 45659/1988(Laid-open No. 151082/1989) (Ishikawajima-Harima Heavy Industries Co., Ltd.), 18 October, 1989 (18.10.89), (Family: none)	1-9
Y	JP 2-49512 Y2 (Tokyo Radiator Mfg. Co., Ltd.), 26 December, 1990 (26.12.90), (Family: none)	1-9

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

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search 13 September, 2002 (13.09.02)	Date of mailing of the international search report 01 October, 2002 (01.10.02)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP02/07566

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 25124/1984(Laid-open No. 139182/1985) (Mitsubishi Motors Corp.), 14 September, 1985 (14.09.85), (Family: none)	3,9
Y	JP 58-27337 Y2 (Toshiba Netsu-Kigu Kabushiki Kaisha), 14 June, 1983 (14.06.83), (Family: none)	4-7
Y	JP 11-108458 A (Noritz Corp.), 23 April, 1999 (23.04.99), (Family: none)	9
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 131933/1985(Laid-open No. 39183/1987) (Nippon Radiator Kabushiki Kaisha), 09 March, 1987 (09.03.87), (Family: none)	9

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