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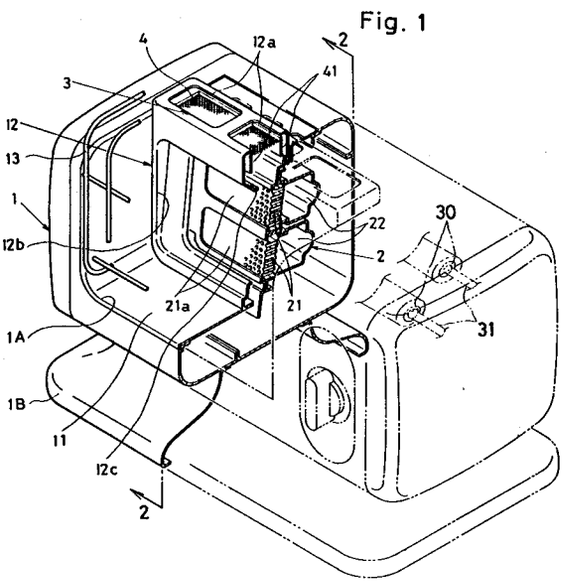
(54) An infrared stove apparatus.

(57) In an infrared stove apparatus, there is provided a stove body having a radiation window at the front and upper portions of the stove body. A frame is placed within the stove, and one open end of the frame faces to the front portion of the stove body so as to serve as a radiation opening, the other open end of the frame having a porous burner plate through which a mixture of fuel gas and air is to be released. An exhaust opening is provided at the upper lateral side of the frame to pass exhaust gas released through the porous burner plate when the mixture of fuel gas and air is ignited at the time of operation. A metallic net of a suitable mesh screen is provided within the exhaust opening to increase fluid-resistance of the exhaust gas flowing out through the exhaust opening so as to keep a uniform velocity distribution of the exhaust gas while restraining outside air from entering into the frame through the radiation opening leading to the exhaust opening.

Fig. 1



EP 0 498 103 A1

The invention relates to an infrared stove apparatus in which heating is carried out by burning a gas fuel such as natural gas or kerosine on a porous burner plate, and particularly concerns an infrared stove apparatus which is improved so as to reduce the emission of nitrogen dioxide.

Generally an infrared heater device has a casing in which a porous burner plate is enclosed to burn a gas fuel on the plate. The casing has a front opening,to which the burner plate is located to face so as to serve as a heat radiation window. The casing further has an upper exhaust opening through which exhaust gas from the burner escapes.

However, a surplus amount of air is supplied to the burner plate which causes the emission of nitrogen dioxide gas, because nitrogen in the air tends to be oxidized by the high temperature atmosphere around the burner. In order to reduce the amount of the nitrogen dioxide emitted, it has been suggested to place a reducible catalyst within the exhaust opening on the one hand. On the other hand, it has been suggested to provide a baffle plate so as to prevent excessive air from entering the burner plate through the radiation window.

In the former counterpart, the reducible catalyst employed is expensive and easily deteriorates so that it is disadvantageous in saving manufacturing cost.

In the latter counterpart, however, the baffle plate absorbs the heat radiation from the burner and sacrifices radiant heat efficiency.

Therefore, it is an object of this invention to provide an infrared stove apparatus which is capable of reducing the emission of nitrogen dioxide with a relatively simple structure.

According to the present invention, there is provided an infrared stove apparatus comprising:

a support frame having one open side to serve as a radiation opening, another open side in which a porous burner plate is disposed, said porous burner plate being adapted to release therethrough a mixture of fuel gas and air, and an exhaust opening, in use, provided at an upper lateral side of the frame to pass exhaust gas released through the porous burner plate when the mixture of fuel gas and air is burnt; and

an air-permeable member provided at the exhaust opening to increase fluid resistance of the exhaust gas flowing out through the exhaust opening so as to substantially maintain a uniform velocity distribution of the exhaust gas while restraining outside air from entering into the support frame through the radiation opening leading to the exhaust opening.

The air-permeable member works by increasing the fluid-resistance of the exhaust opening so as to restrain outside air from entering into the frame through the radiation opening and escaping through the exhaust opening, thus preventing the outside air from being introduced into the burner plate and reducing generation of nitrogen dioxide without sacrificing heat radiation from the burner plate.

The air-preamble member works by rectifying the flow of the exhaust gas escaping through the exhaust opening so as to keep a uniform velocity distribution of the exhaust gas. This enables prevention of high temperature gas from occurring in the exhaust gas, thus avoiding generation of nitrogen dioxide above the exhaust opening.

The invention will be more clearly understood from the following description, given by way of example only with reference to the accompanying drawings in which:

Fig. 1 is a perspective view of an infrared stove apparatus, but partly sectioned according to a first embodiment of the invention;

Fig. 2 is a longitudinal cross sectional view taken along the line 2-2 of Fig. 1;

Fig. 3a is a schematic diagram of the temperature distribution of exhaust gas escaping through the exhaust opening according to a prior counterpart;

Fig. 3b is a schematic diagram of the temperature distribution of exhaust gas when a metallic net is employed;

Fig. 3c is a schematic diagram of the temperature distribution of exhaust gas when a honeycomb-like ceramic plate is employed;

Fig. 4a is a schematic diagram of the distribution of oxygen concentration around the exhaust opening accoding to a prior counterpart;

Fig. 4b is a schematic diagram of the distribution of oxygen concentration around the exhaust opening when a metallic net is employed;

Fig. 4c is a schematic diagram of the distribution of oxygen concentration around the exhaust opening when a honeycomb-like ceramic plate is employed;

Fig. 5a is a schematic diagram of the entire temperature distribution of exhaust gas escaping through the exhaust opening according to a prior counterpart;

Fig. 5b is a schematic diagram of the entire temperature distribution of exhaust gas when a metallic net is employed;

Fig. 5c is a schematic diagram of the entire temperature distribution of exhaust gas when a honeycomb-like ceramic plate is employed;

Fig. 6 is a perspective view of an infrared stove apparatus according to a second embodiment of the invention;

Fig. 7 is a longitudinal cross sectional view taken along the line 7-7 of Fig. 1;

Fig. 8 is a longitudinal cross sectional view of a

support frame and an outlet frame to show how convectional air-current is established to prevent excessive temperature rise thereof; and

Fig. 9 is a longitudinal cross sectional view a honeycomb-like ceramic plate according to a modified form of the invention.

Referring to Fig. 1 of the drawings which illustrates a first embodiment of the invention, numeral 1 designates a box-like stove body of an infrared stove apparatus within which a gas burner 2 is placed. The stove body 1 is placed on a leg stand 1B, and has an opening extending from a front portion to an upper portion of the stove body 1 to serve as a radiation window 1A. The stove body 1 is covered by a guard 13 at its radiation window 1A. In the stove body 1, is a rectangular support frame 12 generally vertically provided, the front open end 12b of which faces forward from the front portion of the stove body 1 while a rear open end of the frame 12 has a burner which has a porous ceramic burner plate 21 on which a number of small fire holes are provided in rows and columns. The burner plate 21 is somewhat slantwisely located such an angle that the outer surface 21a of the burner plate 21 looks up through the radiation window 1A. To the inner surface of the burner plate 21, is an open end of a mixing box 22 attached into which fuel gas is introduced by a nozzle 31a which is to be mixed with air within an inlet 30.

The support frame 12 is enamelled, and the upper lateral side of the frame 12 has a blank hole 12a to serve as an exhaust opening 3. Between a lower side of the frame 12 and a lower end of the radiation window 1A, a radiation plate 11 is provided. The front open end 12b of the support frame 12, which acts as a radiation opening, is inturned to define a barrier flange 12c so as to decrease the effective area of the radiation opening 12b which works by regulating outside air entry into the radiation opening 12b of the support frame 12.

Within the exhaust opening 3 provided on the upper lateral side of the frame 12, is a metallic net 4 placed by way of a flange mount 41 to act as an air-permeable member. The metallic net 4 is made of a steel alloy (JIS SUS 304) of 20-mesh screen, and 0.4 mm in thickness.

In operation, the mixture of fuel gas and air is released from the fire holes of the burner plate 21, and ignited thereon to be burned. Then, the burned gas finds a way to escape through the exhaust opening 3. During this burning process, an appropriate quantity of heat from the burner plate 21 is radiated through the window 1A to warm a room in which the stove apparatus is installed.

When the net 4 is not provided, the concentration of nitrogen dioxide (NO_2) is 13 ppm on average as shown in Fig. 3a. By providing the net 4, however, it is found that the concentration of nitrogen dioxide reduces to 8 ppm on average as shown in Fig. 3b.

When the net 4 is not provided, the exhaust gas tends to locally contains components of high temperature gas (more than 600 °C) above the exhaust opening 3 as shown in Fig. 5a. The components of high temperature gas causes nitrogen oxide in the gas to change to nitrogen dioxide when in contact with outside air 5a. In particular, the components of the high temperature gas tend to be partially generated at the left portion in the mixing box 22 because the left portion of the mixing box 22 is located remote from the nozzle 31. On the other hand, the outside air 5b tends to enter the frame 12 through the radiation opening 12b so that the oxygen concentration around the exhaust opening 3 increases (16 ~ 18 %) so as to allow contact between the nitrogen oxide and the oxygen as shown in Fig. 4a.

The net 4 works by rectifying the flow of the exhaust gas escaping through the exhaust opening 3 so as to keep a uniform velocity distribution in the exhaust gas as shown in Fig. 5b. This enables prevention of high temperature gas from occurring in the exhaust gas, thus avoiding generation of nitrogen dioxide above the exhaust opening 3 even if the exhaust gas comes to contact with outside air 5a.

The net 4 works to increase a fluid-resistance of the exhaust opening 3 so as to restrain the outside air 5b from entering into the frame 12 through the radiation opening 12b to escape through the exhaust opening 3, and thus reducing the oxygen concentration (9.5 ~ 11.5 %) as shown in Fig. 4b, and preventing the outside air 5b from being introduced to the burner plate 21 so as to reduce generation of nitrogen dioxide without sacrificing heat radiation from the burner plate 21.

In Figs. 3c, 4c and 5c, results are shown when a honeycomb-like ceramic plate 6 is employed instead of the metallic net 4. They indicates that the concentration of the nitrogen dioxide is reduced to 6 ppm on average when the honeycomb-like ceramic plate 6 is employed.

Referring to Figs. 6 through 8 in which a second embodiment of the invention is shown, like reference numerals identical to those in Figs. 6 through 8 are those in Figs. 1 and 2.

In Figs. 6 and 7, the support frame 12 is enamelled, and an upper lateral side 121 of the support frame 12 has a blank hole to serve as an exhaust opening 3. Between a lower side of the support frame 12 and a lower end of the radiation window 1A, is a radiation plate 11 provided as shown in the first embodiment of the invention. The front open end 12b of the support frame 12, which acts as a radiation opening, is inturned to define a barrier flange 12c so as to decrease the effective

area of the radiation opening 12b which works by regulating outside air entry into the support frame 12.

In this instance, the upper lateral side 121 of the support frame 12 is designed to be flush with a top plate 1C of the stove body 1. A rectangular outlet frame 41 is placed on the upper lateral side 121 of the support frame 12, and having a lower extension end 43 generally sectioned in U-shape which consists of a rear end 42, right and left ends 43a. The lower extension end 43 of the outlet frame 41 loosely fit into the exhaust opening 3 to provide an outlet gap 12d between an outer wall of the lower extension end 43 and an inner edge of the exhaust opening 3. In this situation, the rear end 42 of the lower extension end 43 is air-tightly connected to an upper end 24 of a sash 23 which is provided to fix an upper portion of the burner plate 21 in place within the stove body 1 as shown in Fig. 3. On the other hand, the right and left ends 43a are each extended downward to be connected to right and left edges 23a of the sash 23 respectively. A front side of the outlet frame 41 is somewhat overhung forward from the upper lateral side 121 of the support frame 12 to increase an opening area of the outlet frame 41.

Within the outlet frame 41, is a metallic net 4 placed to act as an air-permeable member. The metallic net 4 is a steel alloy (JIS SUS 304) of 20-mesh screen, and 0.4 mm in thickness as is the case with the first embodiment of the invention.

In operation, the mixture of fuel gas and air is released from the fire holes of the burner plate 21 is ignited thereon to be burned, and finds a way to escape through the exhaust opening 3 and the outlet frame 41. During this burning process, an appropriate quantity of heat from the burner plate 21 is radiated through the window 1A to warm a room in which the stove body 1 is installed.

As shown in Fig. 8, the outlet gap 12d works to positively pass convectional air-current 71 established during the operation so as to prevent temperature of the frames 41, 12 from being excessively risen.

With the increased fluid-resistance subjected to the exhaust gas passing through the metallic net 4, it is possible to prevent the outside air 5b from entering the outlet frame 41 through its overhung portion as shown in Fig. 7.

In Fig. 9, a modified form of the air-permeable member is shown in which a honeycomb-like ceramic plate 6 is employed instead of the metallic net 4. In this instance, when the honeycomb-like ceramic plate 6 is used, it is indicated that the concentration of the nitrogen dioxide is reduced to 6 ppm on average.

It is noted that the thickness and the mesh of the net may be appropriately selected depending on requirements.

It is further appreciated that the metallic net may be in the form of a double-layer screen.

Various changes in the construction and arrangements of the parts may be made without departing from the spirit and scope of the invention as defined in the following claims.

Claims

1. An infrared stove apparatus comprising:
   a support frame having one open side to serve as a radiation opening, another open side in which a porous burner plate is disposed, said porous burner plate being adapted to release therethrough a mixture of fuel gas and air, and an exhaust opening, in use, provided at an upper lateral side of the frame to pass exhaust gas released through the porous burner plate when the mixture of fuel gas and air is burnt; and an air-permeable member provided at the exhaust opening to increase fluid resistance of the exhaust gas flowing out through the exhaust opening so as to substantially maintain a uniform velocity distribution of the exhaust gas while restraining outside air from entering into the support frame through the radiation opening leading to the exhaust opening.

2. An infrared stove according to claim 1 further comprising a stove body having a radiation window at front and upper portions thereof wherein said support frame is placed within the stove body so as to have its said one open side facing to the front portion of the stove body.

3. An infrared stove according to claim 1 or 2 wherein said air-permeable member is provided within the exhaust opening.

4. An infrared stove according to claim 1 or 2 further comprising an outlet frame placed on the upper lateral side of the support frame, the outlet frame having a lower end which is loosely fit into the exhaust opening to provide an outlet gap therebetween, in use, to pass convectional air-current through the outlet gap, a front side of the outlet frame being overhung forward from the upper lateral side and said one open side of the support frame, an opening area of the outlet frame thereby being larger than said exhaust opening; and wherein said air permeable member is provided within said outlet frame.

5. An infrared stove apparatus according to any

preceding claim, wherein the air-permeable member is a metallic net.

6. An infrared stove apparatus according to claim 5, wherein the metallic net is made from a steel alloy.

7. An infrared stove apparatus according to claim 5 or 6, wherein the metallic net is 20-mesh screen, and 0.4 mm in thickness.

8. An infrared stove apparatus according to any one of claims 1 to 4, wherein the air-permeable member is a honeycomb-like ceramic plate.

Fig. 1

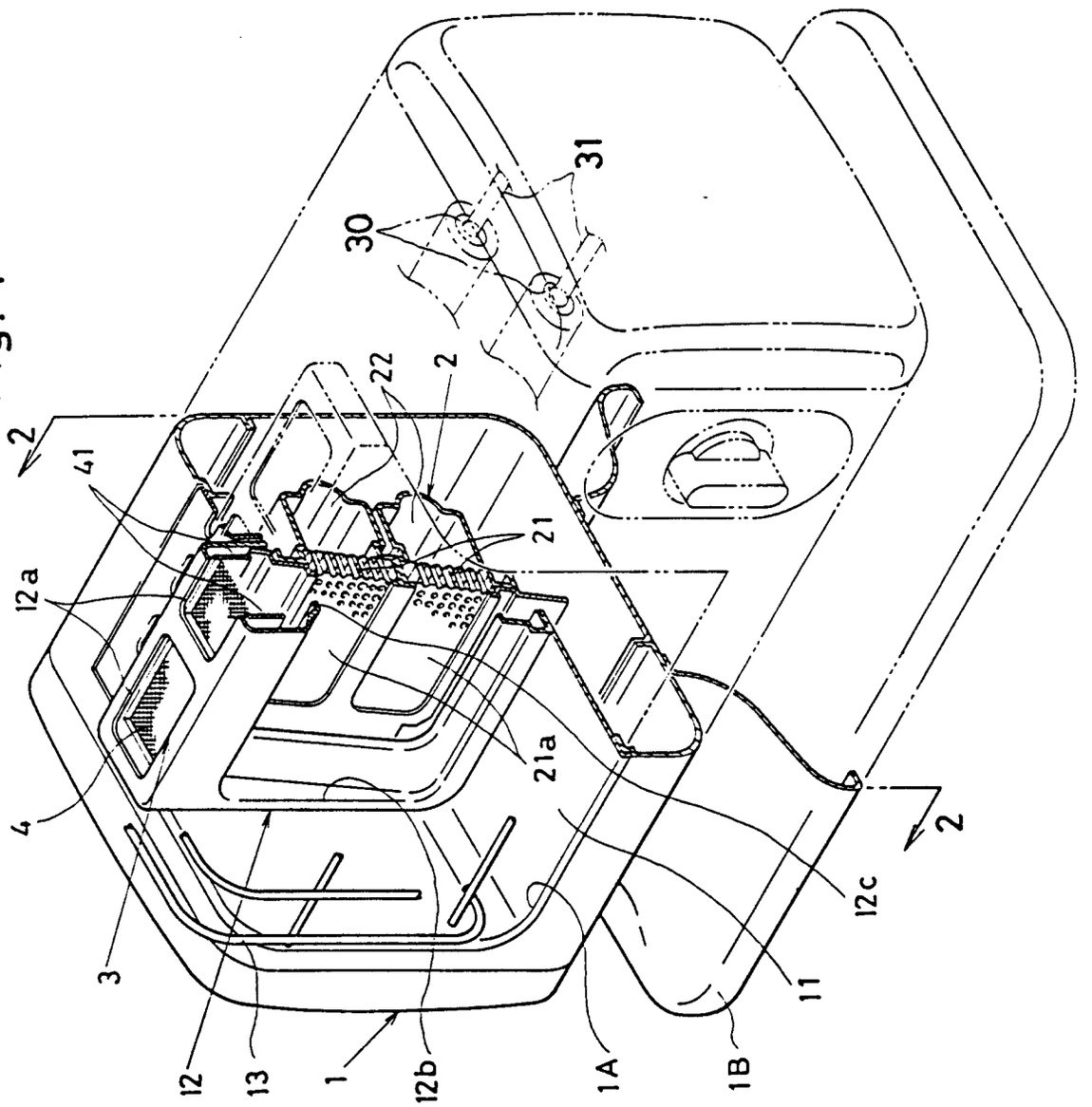


Fig. 2

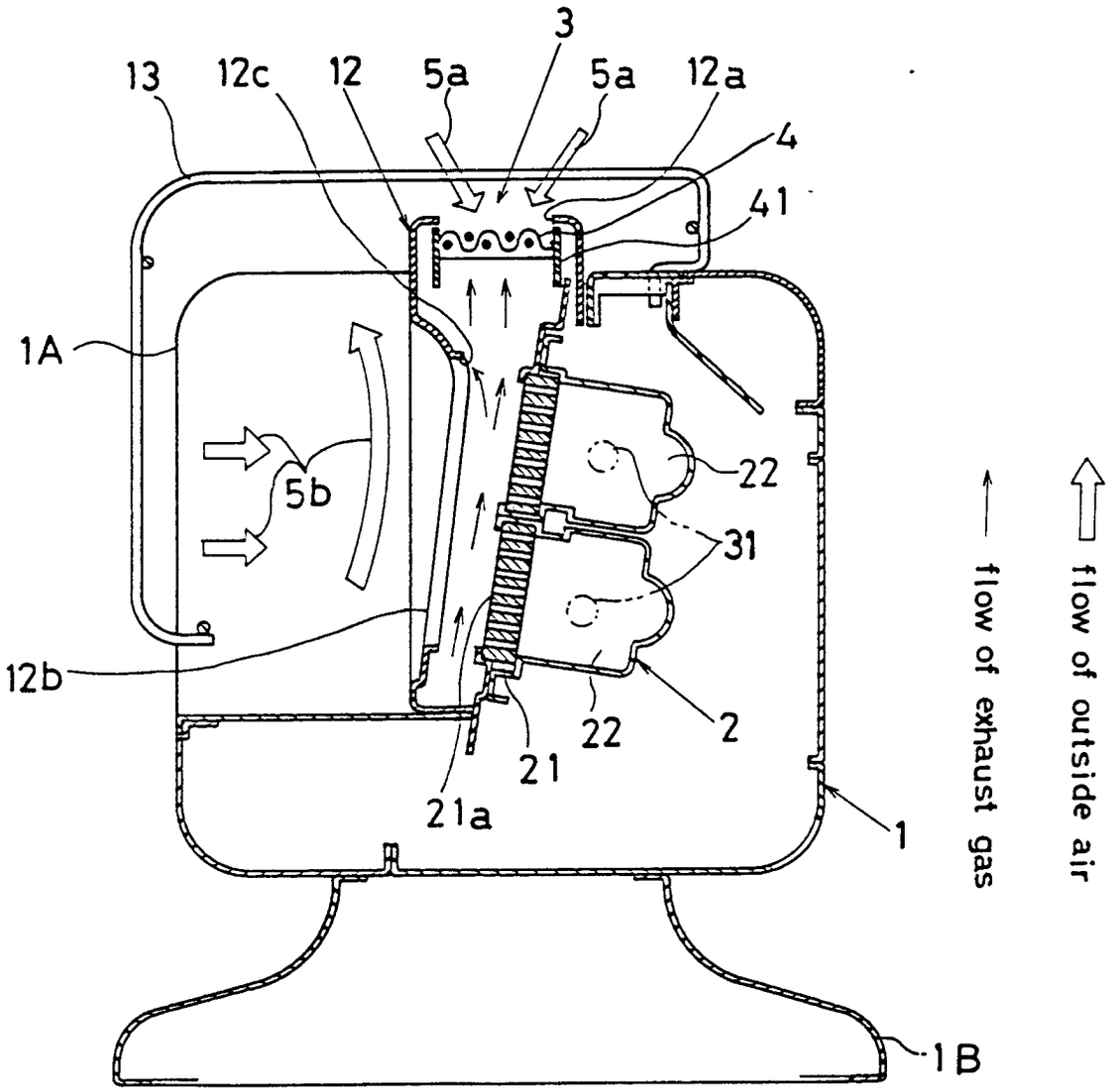

3
13
12c
12
5a
5a
12a
4
41
1A
5b
22
31
12b
2
22
21
21a
1
1B
flow of outside air
flow of exhaust gas

Fig. 3a

Fig. 3b

Fig. 3c

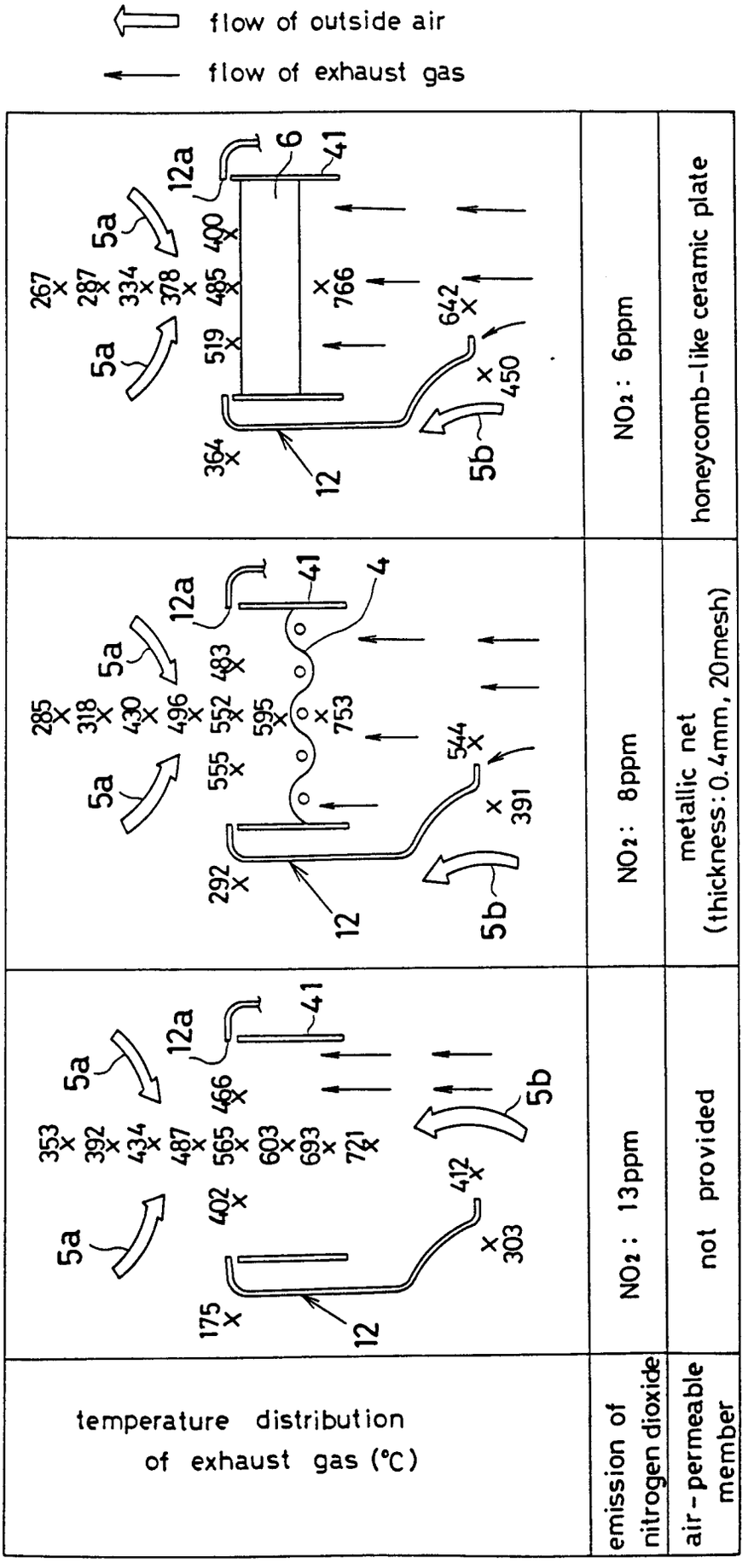


Fig. 4a

Fig. 4b

Fig. 4c

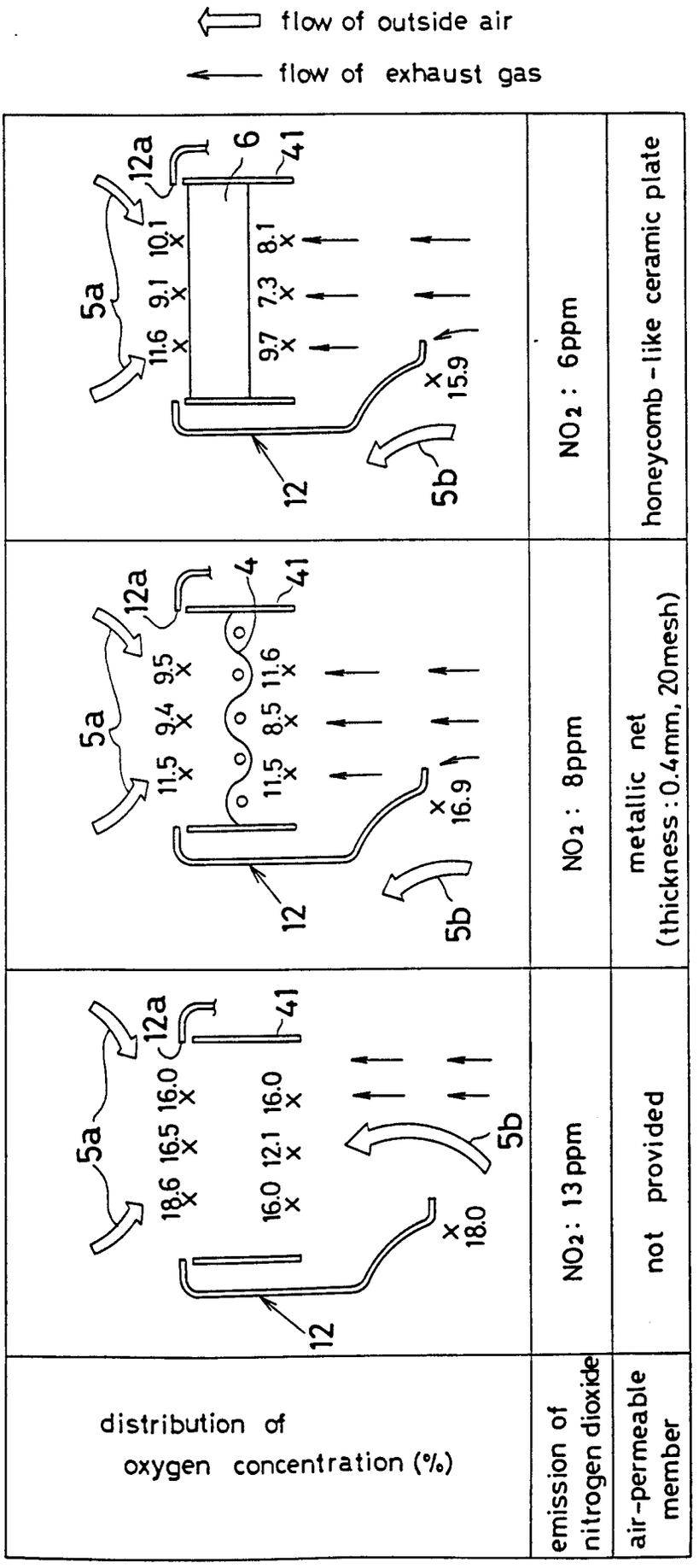


Fig. 5a

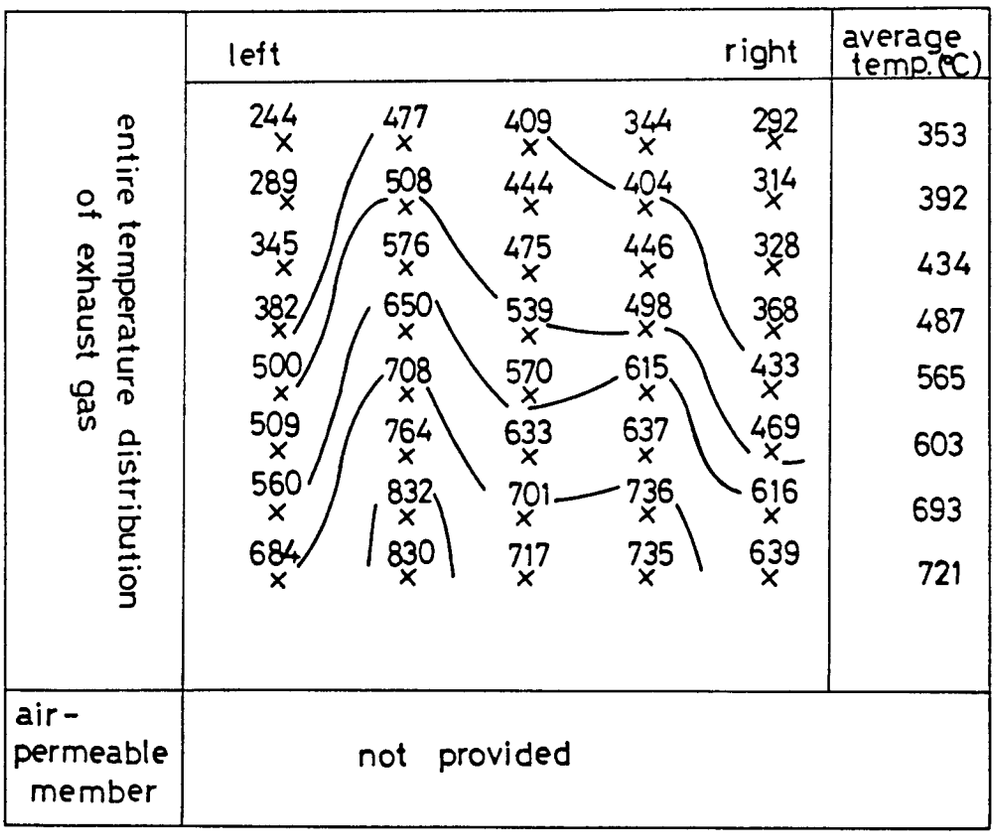

left
right
average temp.(°C)
entire temperature distribution of exhaust gas
244 477 409 344 292 353
289 508 444 404 314 392
345 576 475 446 328 434
382 650 539 498 368 487
500 708 570 615 433 565
509 764 633 637 469 603
560 832 701 736 616 693
684 830 717 735 639 721
air-permeable member
not provided

Fig. 5b

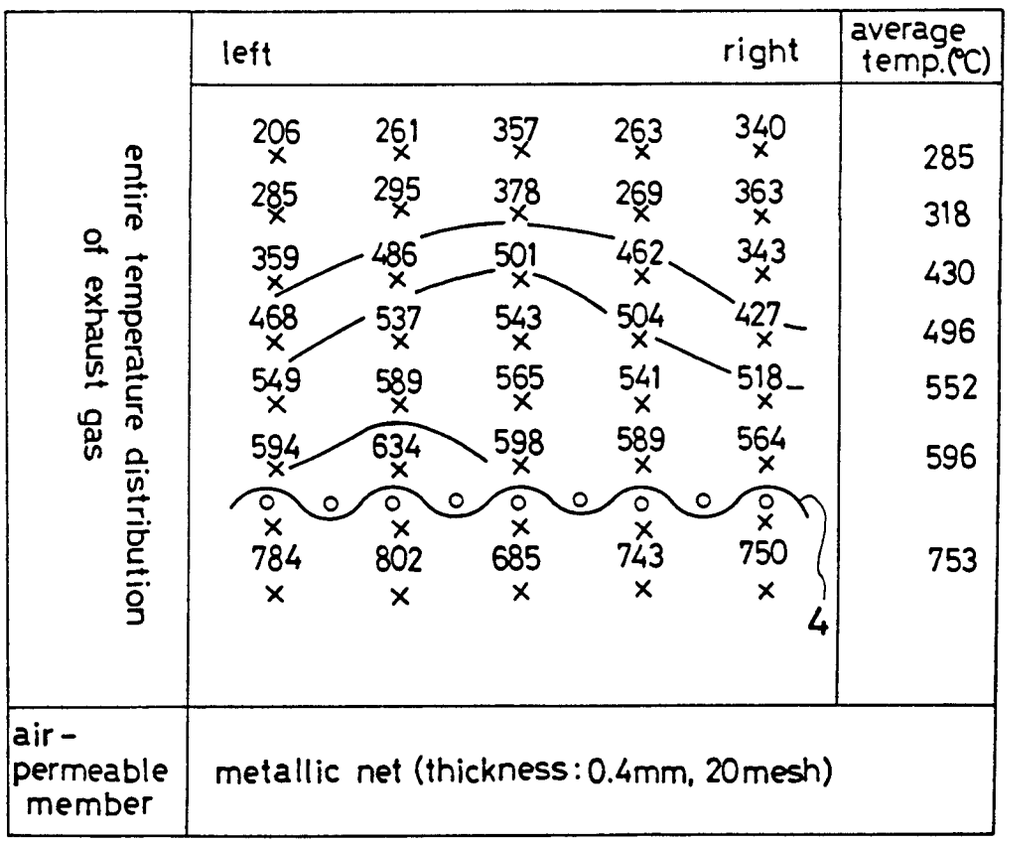

entire temperature distribution of exhaust gas
left
right
average temp.(℃)
206 261 357 263 340
285
285 295 378 269 363
318
359 486 501 462 343
430
468 537 543 504 427
496
549 589 565 541 518
552
594 634 598 589 564
596
784 802 685 743 750
753
4
air-permeable member
metallic net (thickness: 0.4mm, 20mesh)

Fig. 5c

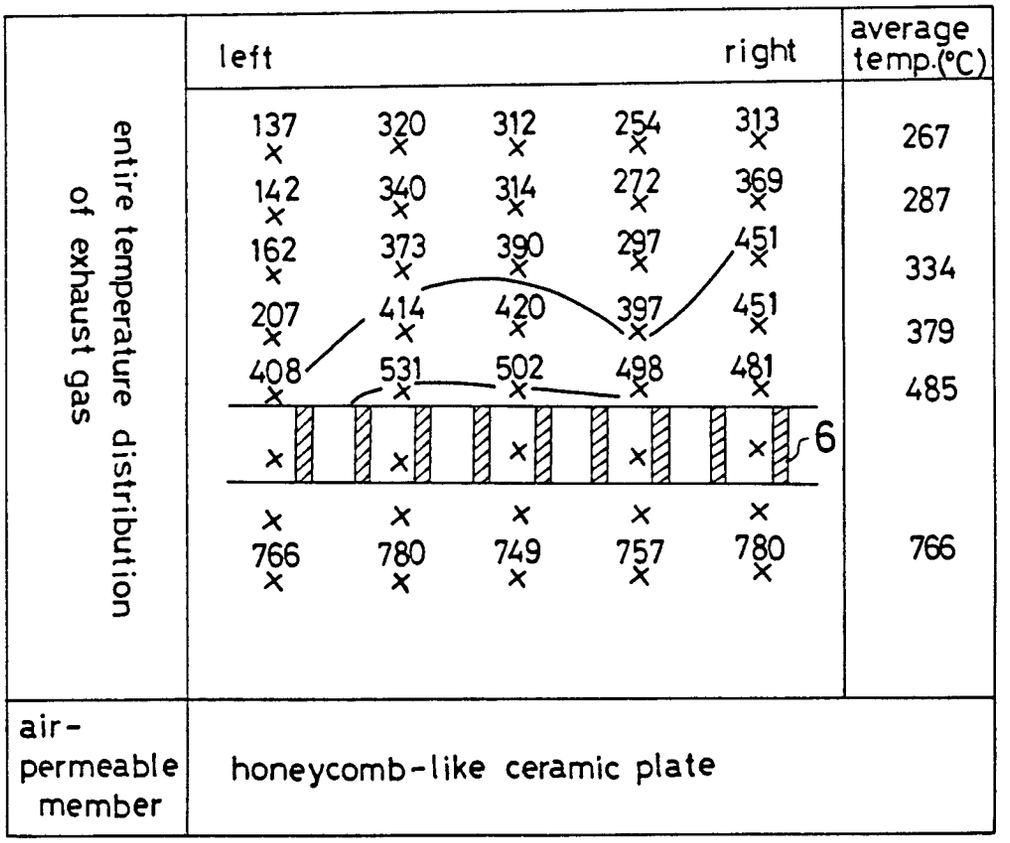

entire temperature distribution of exhaust gas
left
right
average temp.(°C)
137 320 312 254 313
267
142 340 314 272 369
287
162 373 390 297 451
334
207 414 420 397 451
379
408 531 502 498 481
485
6
766 780 749 757 780
766
air-permeable member
honeycomb-like ceramic plate

Fig. 6

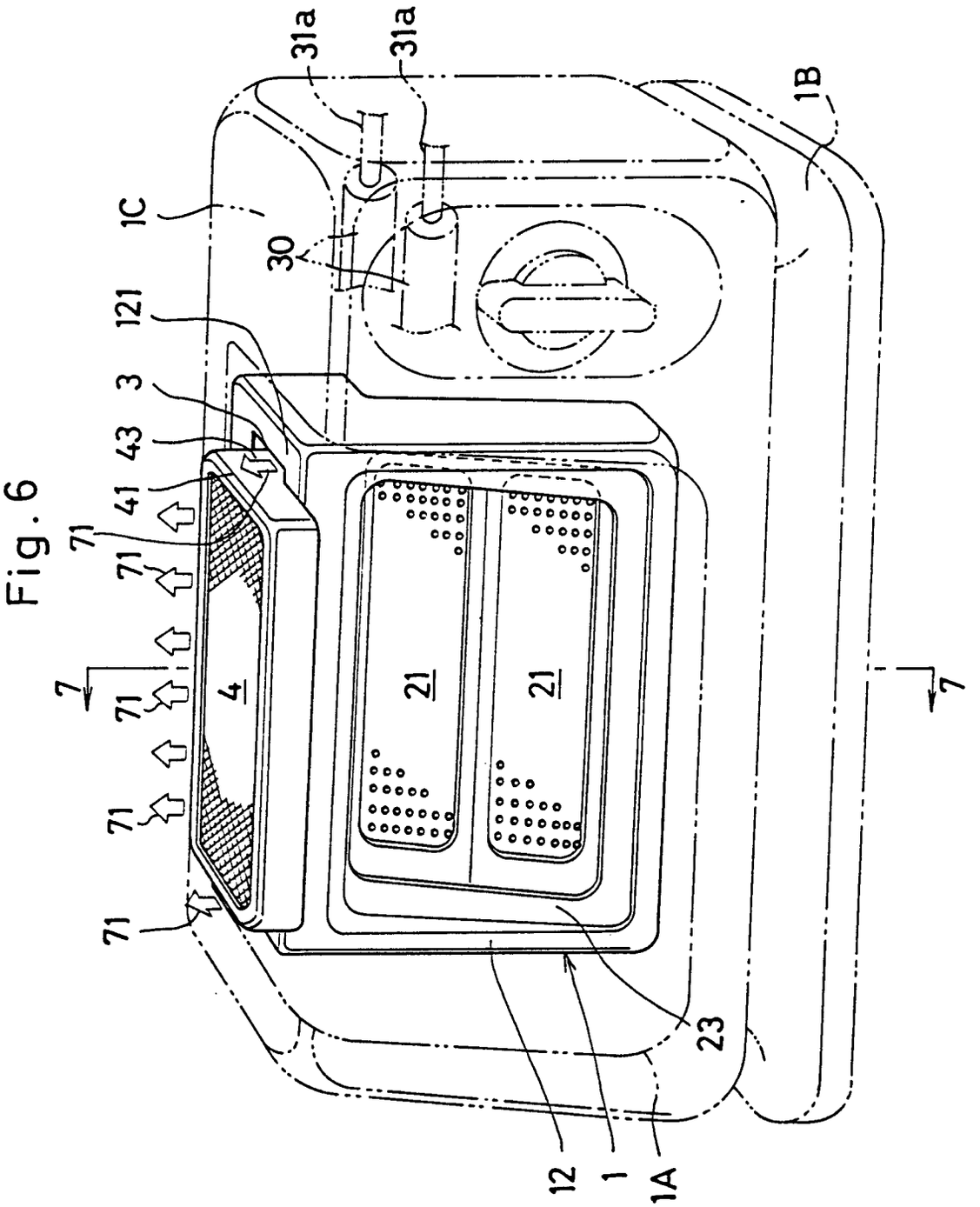


Fig. 7

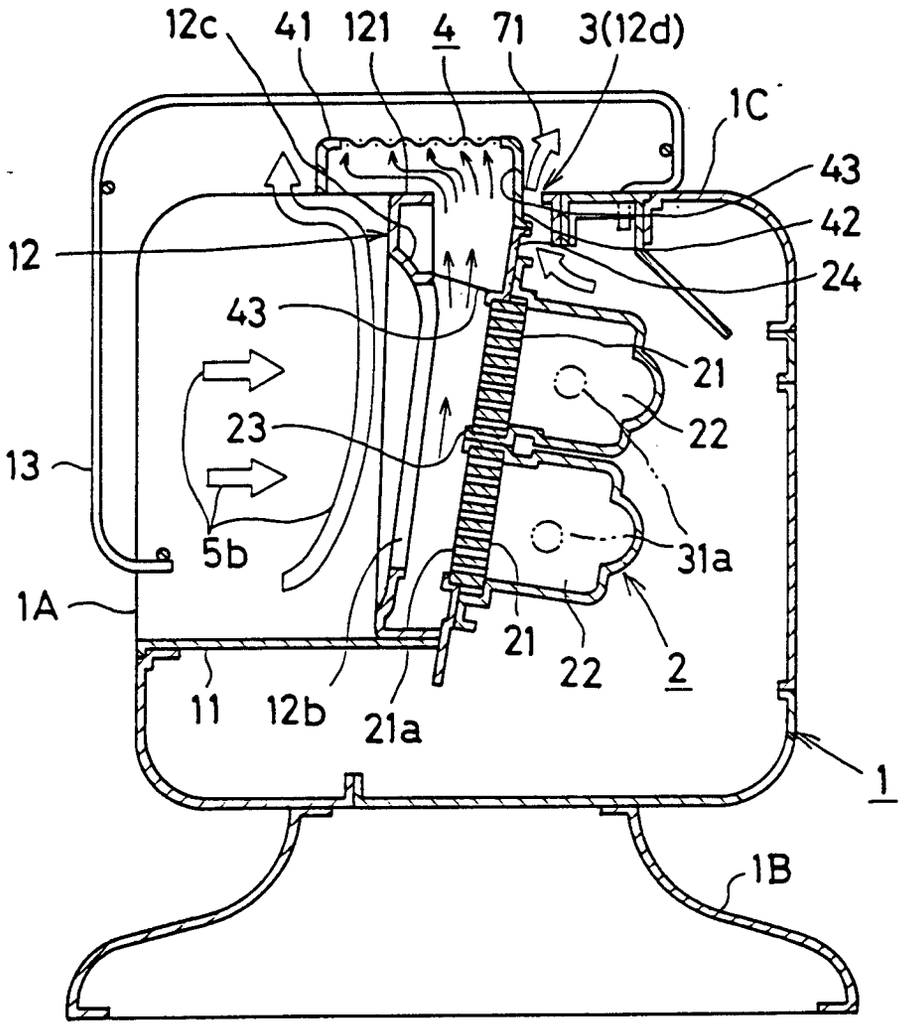

12c
41
121
4
71
3(12d)
1C
43
42
24
12
43
21
23
22
13
5b
31a
1A
21
22
2
11
12b
21a
1
1B

Fig. 8

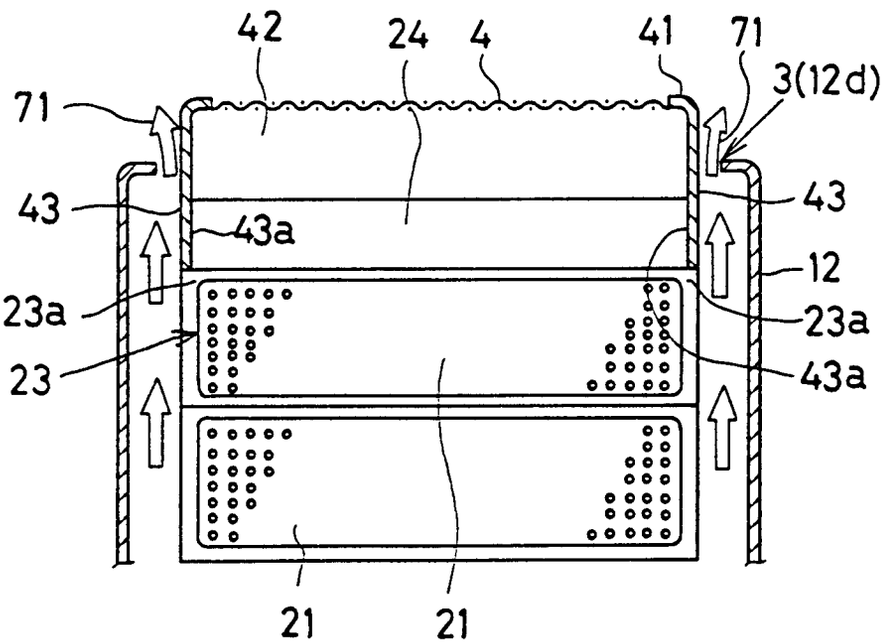
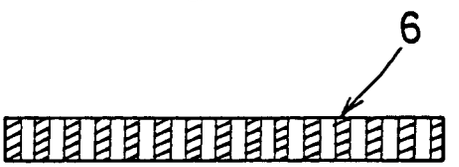


Fig. 9



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 30 7173

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	US-A-1 884 746 (KLINE) * the whole document * ---	1-3,5	F24C 3/04 F24C15/00
Y	US-A-2 841 133 (SCHWANK) * the whole document * ---	1-3,5	
A	US-A-3 203 413 (HARTZELL) * claim 1; figure * -----	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F24C
F23M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	04 MAY 1992	VANHEUSDEN J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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