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- Tachi, Misako, c/o Rinnai Corporation
Nagoya-shi, Aichi 454-0802 (JP)
- Tomiura, Hideyuki, c/o Rinnai Corporation
Nagoya-shi, Aichi 454-0802 (JP)

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(71) Applicant: **Rinnai Corporation**
Aichi-ken 454-0802 (JP)

(74) Representative: **Fenlon, Christine Lesley et al**
Haseltine Lake,
Imperial House,
15-19 Kingsway
London WC2B 6UD (GB)

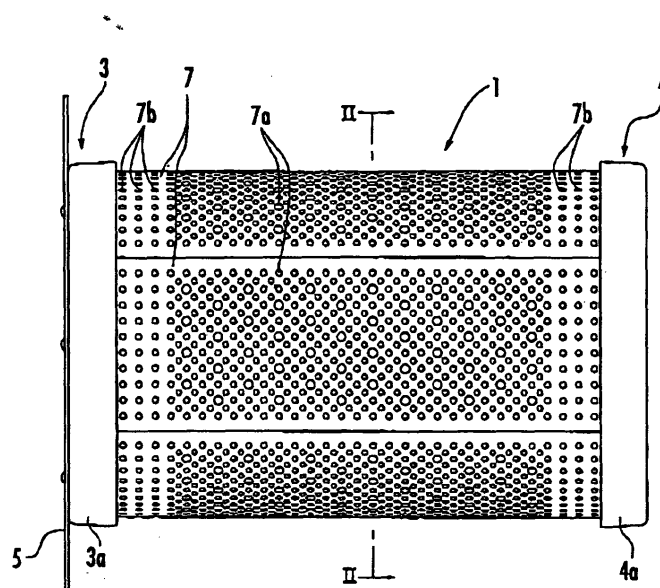
(72) Inventors:
• Takasu, Yoshihiko, c/o Rinnai Corporation
Nagoya-shi, Aichi 454-0802 (JP)

(54) Cylindrical burner

(57) In a cylindrical burner in which a heat chamber 1, which is constituted by combining plural ceramic plates 7 in a cylindrical shape, is sandwiched from both sides in an axial direction thereof by a pair of holding plates 3 and 4, a conductive film 71 is formed on an outer peripheral surface of a predetermined ceramic plate 7 and grounded via a grounding terminal 9 such that voltage is applied between a flame rod 8 and the conductive film.

The conductive film and the grounding terminal are connected surely to warrant reliability of flame detection by the flame rod. A conductive film 72 continuing to the conductive film 71 on the outer peripheral surface is formed on an end face of the predetermined ceramic plate 7. The grounding terminal 9 is provided on the holding plate 3 to be in abutment against the conductive film 72 on the end face of the predetermined ceramic plate 7.

FIG.1



Description

[0001] The present invention relates to a cylindrical burner including a heat chamber constituted by combining plural strip-shaped ceramic plates, which have a plurality of burner ports, in a cylindrical shape.

[0002] Conventionally, in this type of the cylindrical burner, the heat chamber is assembled by using a frame having plural window frames in a peripheral direction, fitting ceramic plates in the respective window frames from the outside, screwing protection frames abutting against outer surfaces in peripheral parts of the respective ceramic plates to the frame, and fixing the respective ceramic plates to the frame (e.g., see Japanese Utility Model Publication No. 44-2634).

[0003] In this cylindrical burner, the frame of a complicated structure having the plural window frames and the protection frames for the respective ceramic plates are required. Thus, there is an inconvenience in that the number of components increases, time and labor are required to assemble the cylindrical burner, and cost increases.

[0004] Thus, in Japanese Patent Laid-Open Publication No. 2004-324910, the applicant proposed a cylindrical burner including: a heat chamber constituted by combining plural strip-shaped ceramic plates, which have a plurality of burner ports, in a cylindrical shape; a coupling member that extends in an axial direction inside the heat chamber; and a pair of holding plates fixed at both ends of the coupling member, wherein the respective holding plates are set in abutment against respective end faces of the heat chamber via packings overlapping the respective end faces to sandwich the heat chamber with both the holding plates from both sides in the axial direction. According to this cylindrical burner, the frame with a complicated structure and the protection frames are made unnecessary, assembling is easy, and cost can be reduced.

[0005] Incidentally, although not the cylindrical burner, there is known a burner including a flat combustion plate consisting of a ceramic plate, wherein, in order to give electrical conductivity to the combustion plate to make flame detection by a flame rod possible, a conductive film is formed on an outer surface of the ceramic plate and a grounding terminal connected to this conductive film is provided to apply a voltage between the flame rod provided to be opposed to the outer surface of the ceramic plate and the conductive film (see, for example, Japanese Patent Laid-Open No. 11-351521). In the cylindrical burner, it is also desired that a conductive film is formed on an outer peripheral surface of at least one predetermined ceramic plate among the plural ceramic plates constituting the heat chamber, a grounding terminal connected to the conductive film is provided to apply a voltage between flame rod provided to be opposed to the outer peripheral surface of the predetermined ceramic plate and the conductive film, and flame detection by the flame rod is performed.

[0006] In this case, it is conceivable to set the grounding terminal in direct contact with the conductive film on the outer peripheral surface of the ceramic plate. However, when the outer peripheral surface of the ceramic plate is formed as an arc-shaped curved surface to make an outer peripheral surface of the heat chamber cylindrical, the conductive film on the outer peripheral surface and the grounding terminal are connected less stably. It is also conceivable to form the grounding terminal with a spring material to secure stability of the contact between the conductive film and the grounding terminal. However, elasticity of the spring material is lost in a short time under high temperature due to combustion of the burner to easily cause connection failure between the conductive film and the grounding terminal.

[0007] In view of the problems described above, embodiments of the invention seek to improve the cylindrical burner of the prior application and preferably to provide a cylindrical burner in which a conductive film and a grounding terminal on an outer peripheral surface of a ceramic plate are connected surely to make it possible to warrant reliability of flame detection by a flame rod.

[0008] The invention preferably provides a cylindrical burner including: a heat chamber constituted by combining plural strip-shaped ceramic plates, which have a plurality of burner ports, in a cylindrical shape; a coupling member that extends in an axial direction inside the heat chamber; and a pair of holding plates fixed to both ends of the coupling member, the heat chamber being sandwiched from both sides in the axial direction by both the holding plates by setting the respective holding plates in abutment against end faces of the heat chamber via packings overlapping the respective end faces, wherein a conductive film is formed on an outer peripheral surface of at least one predetermined ceramic plate among the plural ceramic plates and a grounding terminal connected to the conductive film is provided to apply a voltage between a flame rod provided to be opposed to the outer peripheral surface of the predetermined ceramic plate and the conductive film, and a conductive film continuing to the conductive film on the outer peripheral surface is formed on one end face of the predetermined ceramic plate and a grounding terminal is provided on one holding plate corresponding to the one end face so as to be in abutment against the conductive film on the one end face of the predetermined ceramic plate through a through hole formed in a packing.

[0009] Preferably, the heat chamber is pressed by both the holding plates from both the sides in the axial direction and the grounding terminal provided on the one holding plate is pushed against the conductive film on the one end face of the predetermined ceramic plate by a pressing force of the holding plates to come into contact with the conductive film surely even if the grounding terminal is not formed of a spring material. Therefore, the grounding terminal is advantageously connected to the conductive film on the outer peripheral surface surely via the conductive film on the one end

face of the predetermined ceramic plate. Thus, reliability of flame detection by the flame rod is warranted.

[0010] Incidentally, in assembling the burner, after combining the plural ceramic plates in a cylindrical shape to preliminarily assemble the heat chamber, a preliminary assembly of the heat chamber is bound such that the ceramic plates are not disarranged. In this state, the holding plates are mounted at both the ends of the heat chamber. In the preliminary assembling of the heat chamber, a jig having a recess with a diameter matching an outer diameter of the heat chamber is used to insert ends of the plural ceramic plates in the recess of the jig in a peripheral direction to thereby combine the plural ceramic plates in a cylindrical shape. Then, when the ends of the ceramic plates are inserted in the recess of the jig, corner sections of outer peripheral surfaces and end faces of the ceramic plates may hit an inner wall surface of the recess to be rubbed by the inner wall surface. Here, if the corner section of the one end face and the outer peripheral surface of the predetermined ceramic plate is edged, when the corner section is rubbed, the conductive film at the corner section, which makes the conductive film on the outer peripheral surface and the conductive film on the end face continuous, peels off easily. This tends to cause connection failure between the conductive film on the outer peripheral surface and the conductive film on the end face, that is, connection failure between the conductive film on the outer peripheral surface and the grounding terminal.

[0011] In order to resolve such inconvenience, it is desirable to chamfer the corner section of the one end face and the outer peripheral surface of the predetermined ceramic plate. Consequently, it is possible to secure a large coupling area of the conductive film in the corner section and the ceramic plate. Therefore, the conductive film in the corner section peels off less easily and the connection failure between the conductive film on the outer peripheral surface and the grounding terminal is prevented effectively.

[0012] In addition, in order to prevent the inconvenience, a sunken section may be formed in a part of the corner section of the one end face and the outer peripheral surface of the predetermined ceramic plate such that the conductive film on the outer peripheral surface and the conductive film on the one end face are made continuous at least in this sunken section. Consequently, even if the corner section of the predetermined ceramic plate comes into abutment against the inner wall surface of the recess of the jig, the sunken section does not come into abutment against the inner wall surface of the recess. Thus, it is impossible that the sunken section is rubbed and the conductive film in this part peels off. Therefore, the connection failure between the conductive film on the outer peripheral surface and the grounding terminal is prevented surely.

[0013] Incidentally, when the conductive film is formed only on the one end face of the predetermined ceramic plate, it is necessary to manage directionality

of the heat chamber in a process of mounting a holding plate such that the holding plate having the grounding terminal is mounted on the one end face side. This causes trouble in mounting the holding plate. Therefore, in order to make it unnecessary to manage directionality, it is desirable to form a conductive film, which continues to the conductive film on the outer peripheral surface, on the other end face of the predetermined ceramic plate as well.

[0014] For a better understanding of the present invention and to show how it may be carried into effect, reference shall now be made, by way of example, to the accompanying drawings, in which:

FIG. 1 is a plan view of a cylindrical burner according to a first embodiment of the invention;

FIG. 2 is a sectional view cut along line II-II in FIG. 1; FIG. 3(a) is a sectional view cut along line III-III in FIG. 2;

FIG. 3(b) is an enlarged sectional view of a part encircled by an alternate long and short dash line b in FIG. 3(a); and

FIG. 4 is a perspective view of a main part of a modification of a ceramic plate on which a conductive film is formed.

[0015] A cylindrical burner of the embodiment shown in FIG. 1 includes a heat chamber 1 of a cylindrical shape, a coupling member 2 (see FIG. 2 and FIG. 3(a)) that extends in an axial direction inside the heat chamber 1, and a pair of holding plates 3 and 4 fixed to both ends of the coupling member 2 to sandwich the heat chamber 1 from both sides in the axial direction. The holding plate 3 on one end side includes an attaching plate section 5 fixed to the holding plate 3 by spot welding or the like. In the attaching plate section 5, the cylindrical burner is attached to the inside of a body of a machine such as a water heater or a heater.

[0016] As shown in FIG. 3(a), the holding plates 3 and 4 are set in abutment against respective end faces of the heat chamber 1 via respective packings 6 overlapping the respective end faces. Cylindrical flange sections 3a and 4a bending inwardly in the axial direction are formed in outer peripheries of the respective holding plates 3 and 4 to prevent the packings 6 from deviating in a radial direction. Note that a diameter of the flange sections 3a and 4a expands inwardly in the axial direction such that work for mounting the respective holding plates 3 and 4 on the heat chamber 1 is facilitated.

[0017] As shown in FIG. 2, the heat chamber 1 is constituted by combining plural (e.g., six) strip-shaped ceramic plates 7, which have a plurality of burner ports 7a, in a cylindrical shape. Note that the burner ports 7a are not formed in parts closer to ends of the ceramic plates 7. However, dummy burner ports 7b of a blank hole shape are formed in the parts closer to the ends of the ceramic plates 7 due to a reason relating to manufacturing such as uniformization of a shrinking percent-

age at the time of baking of the ceramic plates 7.

[0018] Referring to FIG. 3(a), a gas inlet 5a is opened in a central part of the attaching plate section 5. The coupling member 2 is formed in a square cylindrical shape. The coupling member 2 is fixed to an inner surface in a peripheral edge of the gas inlet 5a of the attaching plate 5 at one end by spot welding or the like. Therefore, the holding plate 3 on one end side is fixed to one end of the coupling member 2 in the attaching plate section 5. A large number of through holes 2a are formed in a peripheral surface of the coupling member 2. Mixed gas of fuel gas flowing in from the gas inlet 5a and primary air is supplied into the heat chamber 1 via these through holes 2a and blows out from burner ports 7a of the respective ceramic plates 7 to burn. Here, the coupling member 2 functions as a distributing pipe for distributing the mixed gas into the heat chamber 1 uniformly.

[0019] A cap 2b is fastened to the other end of the coupling member 2. A projected portion 2c, which is fit into an inner periphery of the holding plate 4 on the other end side formed in an annular shape, is formed in this cap 2b. In assembling the burner, first, the plural ceramic plates 7 are combined in a cylindrical shape to preliminarily assemble the heat chamber 1. In the preliminary assembling of the heat chamber 1, a jig having a recess with a diameter matching an outer diameter of the heat chamber 1 is used to insert the ends of the plural ceramic plates 7 in the recess of the jig in a peripheral direction to thereby combine the plural ceramic plates 7 in a cylindrical shape. Next, the preliminarily assembled heat chamber 1 is bound by an appropriate binding tool such as a band such that the ceramic plates 7 are not disarranged. In this state, the coupling member 2 is inserted into the heat chamber 1 to set the holding plate 3 on the one side in abutment against one end face of the heat chamber 1 via the packing 6. Next, the holding plate 4 on the other end side is set in abutment against the other end face of the heat chamber 1 via the packing 6. In this case, the projected portion 2c is inserted into the inner periphery of the holding plate 4. Finally, the projected portion 2c is crushed inwardly in the axial direction. Consequently, the holding plate 4 is caulked and fixed to the coupling member 2 in a state in which the holding plate 4 is pressed inwardly in the axial direction. Thus, the heat chamber 1 is sandwiched firmly between both the holding plates 3 and 4.

[0020] A flame rod 8, which is opposed to an outer peripheral surface of a predetermined ceramic plate 7, that is, a #1 ceramic plate 7 in FIGS. 3A and 3B, is arranged outside the heat chamber 1. As shown in FIG. 3(b), a conductive film 71 is formed on the outer peripheral surface of the #1 ceramic plate 7. The conductive film 71 is grounded via a grounding terminal 9, one pole of a DC power supply 10 is grounded, and the other pole of the DC power supply 10 is connected to the flame rod 8 via a current detector 11 to apply a voltage between the flame rod 8 and the conductive film 71. Flames due

to gas jetted from the burner ports 7a are formed on the outer peripheral surface of the #1 ceramic plate 7. When the flames touch the flame rod 8, an electric current (flame current) flows between the flame rod 8 and the conductive film 71 via the flames. This flame current is detected by the current detector 11, whereby flame detection for the burner is performed. Note that the conductive film 71 is formed by, for example, bake-finishing conductive ceramics such as perovskite metal oxide on the ceramic plate 7.

[0021] Here, when the grounding terminal 9 is set in direct contact with the conductive film 71 on the outer peripheral surface of the #1 ceramic plate 7, since the outer peripheral surface of the ceramic plate 7 is an arc-shaped curved surface, the conductive film 71 and the grounding terminal 9 are in contact with each other less stably. In addition, since the outer peripheral surface of the ceramic plate 7 is heated by combustion of the burner, it is difficult in terms of heat resistance to form the grounding terminal 9 with a spring material for stabilization of the contact. Thus, in this embodiment, a conductive film 72 continuing to the conductive film 71 on the outer peripheral surface is formed on an end face on one end side of the #1 ceramic plate 7 to set the grounding terminal 9, which is provided in the holding plate 3 on one end side, in contact with this conductive film 72. The grounding terminal 9 is constituted by a metal piece bending in a trapezoidal shape that is fixed to the attaching plate section 5 of the holding plate 3 by spot welding or the like. A through hole 6a corresponding to the grounding terminal 9 is formed in the packing 6 such that the grounding terminal 9 is set in abutment against the conductive film 72 on the end face of the #1 ceramic plate 7 through the through hole 6a. Note that the grounding terminal 9 is grounded via the attaching plate section 5.

[0022] Here, the end face of the ceramic plate 7 is flat and, as described above, the heat chamber 1 is pushed from both the sides in the axial direction by both the holding plates 3 and 4 and sandwiched between both the holding plates 3 and 4. The grounding terminal 9 provided on the holding plate 3 on one end side is pushed against the conductive film 72 on the one end face of the #1 ceramic plate 7 to be in contact with the conductive film 72 surely even if the grounding terminal 9 is not formed of a spring material. Therefore, the grounding terminal 9 is connected to the conductive film 71 on the outer peripheral surface surely via the conductive film 72 on the one end face of the #1 ceramic plate 7. Thus, reliability of flame detection by the flame rod 8 is warranted.

[0023] Note that, when the conductive film 72 is formed only on the one end face of the #1 ceramic plate 7, it is necessary to manage directionality of the heat chamber 1 in a process of mounting the holding plate 3 such that the holding plate 3 is mounted on the one end face side. This causes trouble in mounting the holding plate 3. Therefore, in order to make it unnecessary to

manage directionality, it is desirable to form a conductive film, which continues to the conductive film 71 on the outer peripheral surface, on the other end face of the #1 ceramic plate as well. When the conductive film 72 is formed on both the end faces of the #1 ceramic plate 7, the grounding terminal 9 may be provided on both the holding plates 3 and 4. In addition, in this embodiment, the separate grounding terminal 9 is fixed to the attaching plate section 5 of the holding plate 3. However, it is also possible to form the grounding terminal 9 integrally with the attaching plate section 5.

[0024] Incidentally, when the ends of the ceramic plates 7 are inserted in the recess of the jig in the preliminary assembling of the heat chamber 1, corner sections of outer peripheral surfaces and end faces of the ceramic plates 7 may hit an inner wall surface of the recess to be rubbed by the inner wall surface. In addition, when the holding plate 3 is mounted, the corner sections of the outer peripheral surfaces and the end faces of the ceramic plates 7 may be rubbed by the flange section 3a of the holding plate 3. Here, if the corner section of the one end face and the outer peripheral surface of the #1 ceramic plate 7 is edged, when the corner section is rubbed, the conductive film at the corner section, which makes the conductive film 71 on the outer peripheral surface and the conductive film 72 on the end face continuous, peels off easily. This tends to cause connection failure between the conductive film 71 on the outer peripheral surface and the conductive film 72 on the end face, that is, connection failure between the conductive film 71 on the outer peripheral surface and the grounding terminal 9.

[0025] Thus, in this embodiment, as clearly shown in FIG. 3(b), the corner section of the end face and the outer peripheral surface of the #1 ceramic plate 7 is chamfered to form a rounded R-shaped chamfered part 7c. Consequently, because of the chamfered part 7c, it is possible to secure a large coupling area of a conductive film 73 in the corner section with respect to an area of the ceramic plate 7. Therefore, it is difficult to peel off the conductive film 73 in the corner section and the connection failure between the conductive film 71 on the outer peripheral surface and the grounding terminal 9 is prevented effectively. Note that, since it is disadvantageous to mold only the #1 ceramic plate 7 with a dedicated mold different from that for the other ceramic plates 7 in terms of cost, all the ceramic plates 7 are molded using a mold of an identical shape. Therefore, the chamfered part 7c is also formed in corner sections of the ceramic plates 7 other than the #1 ceramic plate 7. The chamfered part 7c may be formed in a slope shape. However, if the chamfered part 7c is formed in the R shape as in this embodiment, the chamfered part 7c slides better when the chamfered part 7c comes into abutment against the inner wall surface of the recess of the jig or the flange section 3a of the holding plate 3. Thus, the conductive film 73 in the corner section is prevented from peeling off more effectively.

[0026] In order to prevent the connection failure between the conductive film 71 on the outer peripheral surface and the grounding terminal 9 due to the peeling-off of the conductive film in the corner section, as shown in FIG. 4, a sunken section 7d may be formed in a part of the corner section of the end face and the outer peripheral surface of the #1 ceramic plate 7 such that the conductive film 71 on the outer peripheral surface and the conductive film 72 on the end face are made continuous at least in this sunken section 7d. Consequently, even if the corner section of the #1 ceramic plate 7 comes into abutment against the inner wall surface of the recess of the jig or the flange section 3a of the holding plate 3, the sunken section 7d does not come into abutment against the inner wall surface of the recess of the jig or the flange section 3a of the holding plate 3. This ensures that a conductive film 74 of the sunken section 7d, which makes the conductive film 71 on the outer peripheral surface and the conductive film 72 on the end face continuous, does not peel off. Therefore, the connection failure between the conductive film 71 on the outer peripheral surface and the grounding terminal 9 is prevented surely.

[0027] Note that, as shown in FIG. 4, it is needless to mention that the conductive film 71 on the outer peripheral surface and the conductive film 72 on the end face maybe made continuous in parts other than the sunken section 7d. In addition, in FIG. 4, the sunken section 7d is formed in a central part of the corner section of the #1 ceramic plate 7. However, the sunken section 7d maybe formed in any part of the corner section. In FIG. 4, the burner ports 7a are not shown for simplification of illustration.

Claims

1. A cylindrical burner comprising:

- a heat chamber constituted by combining plural strip-shaped ceramic plates, which have a plurality of burner ports, in a cylindrical shape;
- a coupling member that extends in an axial direction inside the heat chamber; and
- a pair of holding plates fixed to both ends of the coupling member,

the heat chamber being sandwiched from both sides in the axial direction by both the holding plates by setting the respective holding plates in abutment against end faces of the heat chamber via packings overlapping the respective end faces, wherein

a conductive film is formed on an outer peripheral surface of at least one predetermined ceramic plate among the plural ceramic plates and a grounding terminal connected to the conductive film is provided to apply voltage between a flame rod provided

to be opposed to the outer peripheral surface of the predetermined ceramic plate and the conductive film, and

a conductive film continuing to the conductive film on the outer peripheral surface is formed on one end face of the predetermined ceramic plate and a grounding terminal is provided on one holding plate corresponding to the one end face so as to be in abutment against the conductive film on the one end face of the predetermined ceramic plate through a through hole formed in a packing.

2. The cylindrical burner according to claim 1, wherein the corner section of the one end face and the outer peripheral surface of the predetermined ceramic plate is chamfered.
3. The cylindrical burner according to claim 1, wherein a sunken section is formed in a part of the corner section of the one end face and the outer peripheral surface of the predetermined ceramic plate and the conductive film on the outer peripheral surface and the conductive film on the one end face are made continuous at least in this sunken section.
4. The cylindrical burner according to any one of claims 1 to 3, wherein a conductive film, which continues to the conductive film on the outer peripheral surface, is formed on the other end face of the predetermined ceramic plate as well.

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FIG.1

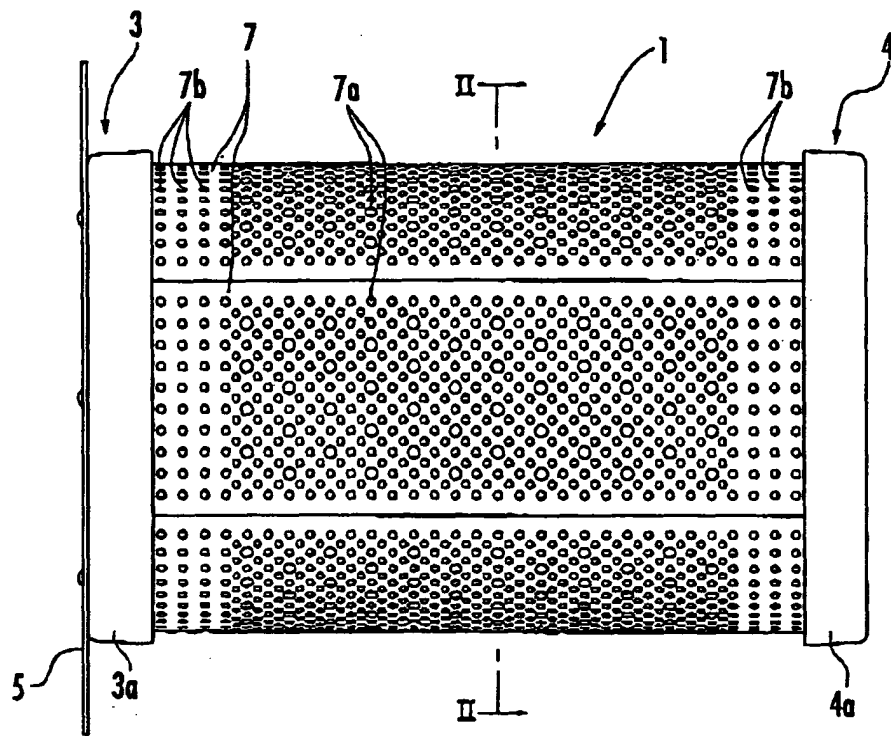


FIG.2

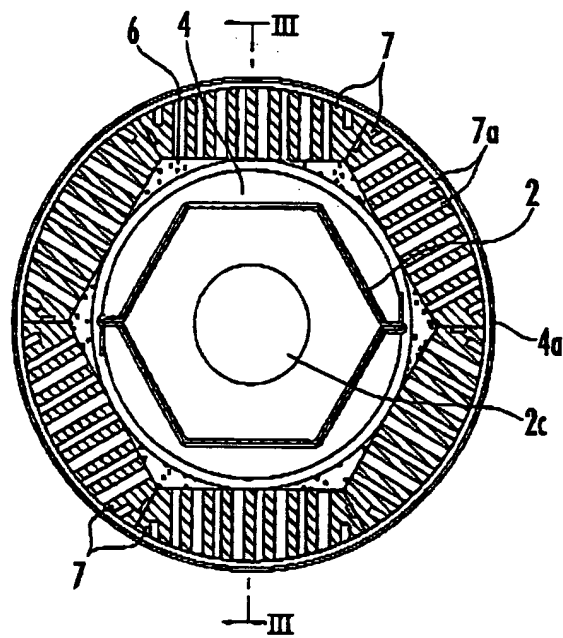


FIG.3 (a)

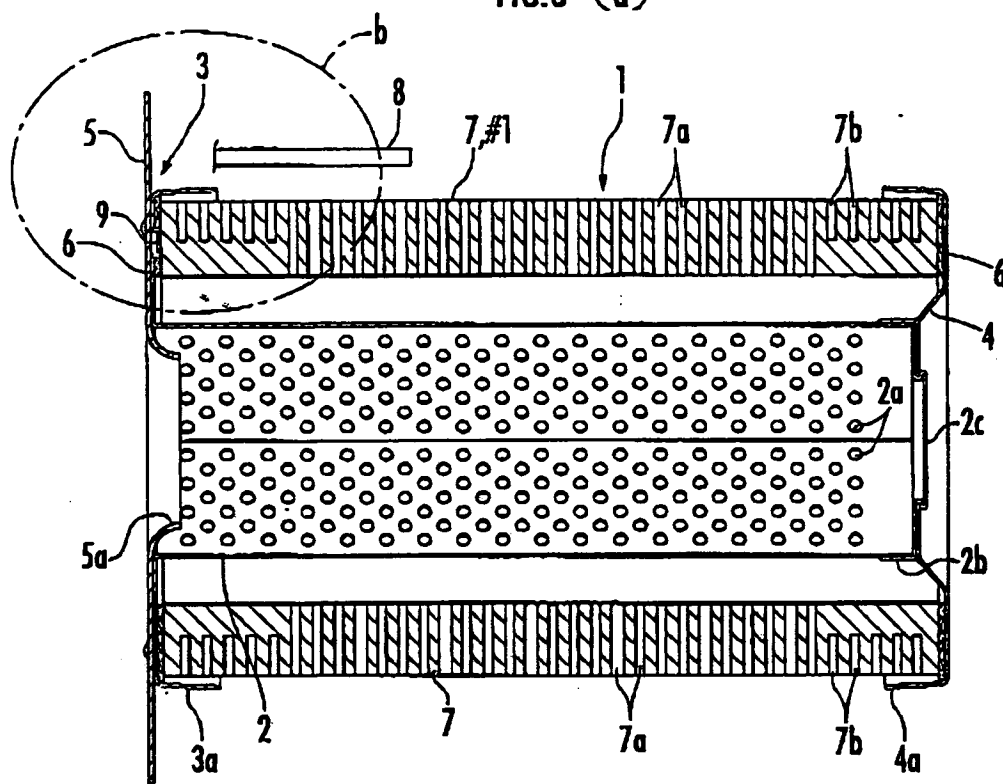


FIG. 3 (b)

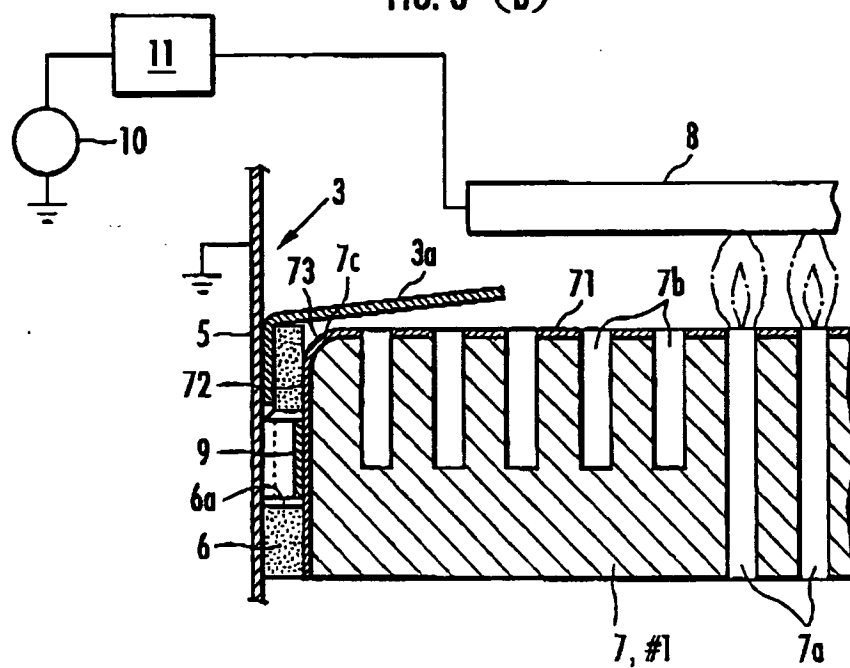


FIG. 4

