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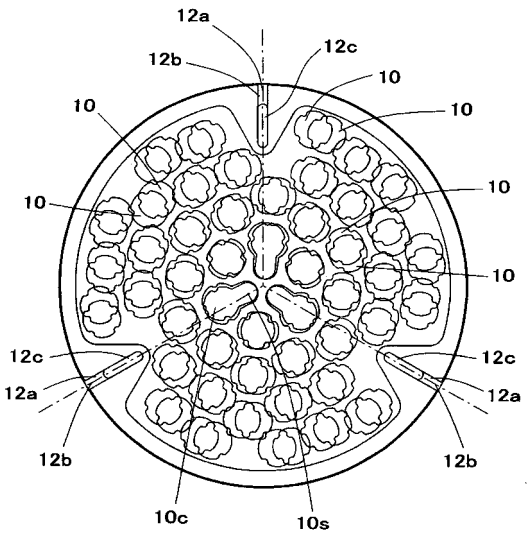
(54) HEATER FOR GENERATING HOT AIR AND INSULATOR FOR ITS ELECTRIC HEATING WIRE

(57) The present invention relates to a heater being connected with a blower, to discharge high-temperature hot air, and an insulator installed within said heater. An insulator segment comprises a plate member provided with a multitude of gas venting holes (10, 10,...), of which peripheral portion is formed with fitting portions (12a, 12b) which can fix said insulator segments and receive electrodes. A multitude of said insulator segments are piled one on top of another in a gas flow direction, thereby constituting an insulator. The gas venting holes of the adjacent insulator segments piled together are arranged in slightly shifted positions respectively, and said fitting portions (12a, 12b) for fixing and/or wiring electrode are arranged to coincide from each other. Furthermore, between the adjacent insulator segments where the gas venting holes are shifted in position from each other, is arranged spacer insulator, which comprises a frame member having only a peripheral section in which fitting portions (12c) for fixing and/or wiring electrode are disposed at same position as those of insulator segments, so that a set of insulators for electric heating wire has been made. By wiring up nichrom wire in the gas venting holes of said set of insulators is twisted the nichrome wire by the insulator segments, and held and secured surely.

FIG. 4



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Description

Technical Field

[0001] The present invention relates to a heater as connected to a blower for generating hot air and an insulator for supporting electric heating wire as nichrome wire wired up in said heater.

Background Art

[0002] The attached drawings Figs.10 and 11 show a conventional type of insulator and heater. Fig.10 is a perspective view explanatory of the insulator, and Fig.11 is a perspective view explanatory of the side of the heater.

[0003] The insulator 50 as illustrated in Fig.10 is the so-called perforated insulator of a cylindrical shape, having a multitude of through-holes 52, 52 ... extending axially to receive heating wire such as nichrome wire respectively.

[0004] Blasts run through said through-holes 52 in an axial direction D (the direction of flowing gas) so as to get heated. Each of said through-holes 52 has neither protruding bulges nor projections formed on the inner wall.

[0005] Proper numbers of said insulators 50 are arranged axially within the heater for generating hot air with the respective through-holes 52 being piled one on top of another in a manner that the holes may meet each other.

[0006] Fig.11 shows a heater 60 for generating hot air as arranged inside said insulator 50.

[0007] Four insulators 50 are fixedly arranged to extend axially (in the direction of flowing gas D) in series inside of a heater casing 65 including an intake vent 61 at the right hand of the drawing and an exhaust vent 62 at the left hand of same. The number of the insulators 50 being arranged is depended upon the capacity of the heater used. In arranging the insulators 50, the through-holes 52 are disposed in position to coincide with each other respectively. Then, as shown by the alternated long and short dashes line, the nichrome wire is wired up within the through-holes 52 to run from the side of the intake vent 61 to the side of the exhaust vent 62, and then, to be shifted from the side of the exhaust vent 62 to the side of the intake vent 61. The use of even numbered through-holes 52 of the insulator 50 enables both ends of the nichrome wire to rest in the intake vent side.

[0008] Each of the insulators 50 is fixedly secured by a long-shank bolt 66 and a nut 67. These bolts and nuts are fixed in two to four positions of any of the through-holes 52 as provided in the insulators 50.

[0009] A temperature sensor such as thermocouple for preventing unusual overheat (not shown) may be disposed any of the through-holes 52 positioned in the central portion. In this event, it can be carried out by inserting said sensor into the central portion of the nichrome wire wound helically.

[0010] A sensor T of sensing exhaust temperature can be inserted from the outside of the heater casing 65 into a section before the insulator which is positioned in the outermost exhaust vent side of the heater casing 65.

[0011] Furthermore, in the past, the applicant of the present invention proposed an invention of an insulator or the so-called "ring insulator" in the Japanese Utility Model Application Laid-Open No.1-34790. Said ring insulator is composed of a cylinder-shaped element of an axially short length, having insertion hole for inserting temperature sensors formed in the central portion, of which outer periphery in the central portion provides a plural of heating wire inserting portions for wiring up nichrome wire as formed by means of a radically compartmented frame.

[0012] Use is made of a plurality of said ring insulators laying one on top of another in proportion to the desired capacity. However, its structure does not allow the use of an exhaust temperature of over 500°C. Thus, the ring insulator cannot be used for insulator for generating hot air in accordance with the present invention.

[0013] In other words, this ring insulator belongs to a different category from that of the insulator for use in the heater for generating high temperature (over 800°C) hot air in accordance with the present invention. The reason is that with the insulator for heater for generating hot air at high temperature of more than 800°C, more than a certain height of wind velocity (heating of an air being heated at a degree in the neighborhood of a critical temperature for heat resistance requires elevation of the efficiency of the heat exchange by increasing the wind velocity) and the uniformity of the air flow passing through the through-holes are needed. Therefore, it is essential that the flowing gas to be heated is passed through an empty space of a certain narrowness (passage) to send the flowing gas into a forcible contact with wound nichrome wire. In the case of said ring insulator, it is considered that since the nichrome wire is supported only by the compartmented frame, the air flow which is to hit the heating wire can not be rendered uniform. A failure to keep the air flow constant may induce a difference between the surface temperatures of the heating wires laid in the through-holes. This may conceivably prevent the increase of the whole heat exchange efficiency so that the heating wire will become limited in its maximum temperature.

[0014] The problematic points of the above-mentioned examples of the conventional typed elements will be described in the following.

[0015] The heating wire laid in the insulator is stretched in a direction in which the electric heating wire is loaded with a force by an acute increase of the flowing gas (the change of the velocity of the flowing gas passing through the through-holes) or by the gravitation (the gaps (pitches) between the adjacent electric heating wires wound helically may get inconsistent to each other) to such an extent that the air flow passing through the through-holes will be subjected to variation by unusual overheat, which

may make it impossible to discharge the high-temperature heated air safely for a long period of time.

[0016] When a high-temperature heated air at a temperature of over 800°C is emitted, the surface of the electric heating wire will run a temperature of over 900°C, and additionally, the electric heating wire may flounce out of the exhaust vent side of the insulator under the influence of the flowing gas pressure. And, with an exhaust vent mounted so as to point downward, there may increase the risk of the electric heating wire being more stretchable or flouncing out of the exhaust vent by the addition of gravity. The incidental phenomenon such as the outbound action of the electric heating wire can be considered to also be prompted by the vibration of the electric heating wire incidental to a magnetic field which is exerted when the electric heating wire is charged with electricity.

[0017] The electric heating wire may also vibrate with the mechanical vibration except the magnetic field. Such vibration, when occurred, may subject the nichrome wire and the through-holes to frictional contact with each other, thus leading to the oxide layers of the electric heating wire coming off (being ground) or the inner wall face of the insulator being ground, and the resultant chips may fly outside in the form of dust, so as not only to affect the environment, but also to result in destruction of the electric heating wire if the dust collected inside the through-holes.

[0018] If the electric heating wire is not sufficiently held by the insulator, they are easily subjected to the mechanical or magnetic vibrations. The fact is, the electric heating wire simply rests within the through-holes of the insulator but not held or fixed by the insulator.

[0019] Some of the conventional prior art included a preventive means against outbound action as formed at the end of the exhaust vent of the insulator in order to prevent the heating wire from flouncing out as set forth. However, the provision of said preventive means against outbound action involves no means for holding or fixing the electric heating wire mounted in the through-holes of the insulator. Said prior art, therefore, failed to solve evils resulting from the variation in the pitches of the electric heating wire due to the air flow passing through the through-holes or heating, or other troubles brought about by the vibration.

[0020] The fixing of a plurality of insulators is achieved by tightening up long-shank bolts and nuts to a few (2 to 4) through-holes. However, such processed through-holes make it difficult for gas being heated to pass therethrough, which does not allow miniaturization of the insulator.

[0021] A temperature sensor, such as thermocouple, for prevention of unusual over heat is disposed in the internal center of a helical winding of nichrome wire received by a through-hole as positioned in the central portion. However, the temperature sensor is an obstacle to smooth flow of a gas into the through-holes, wherein an air flow passing through the through-holes may decrease so that the electric heating wire resting inside said through-holes is liable to become overheated as compared with other electric heating wire in other through-holes. Thus, the temperature as sensed by the temperature sensor may always appear to be somewhat high. Therefore, a complete control of temperature can not be achieved. For the sake of the security of the electric heating wire, the maximum temperature usable has no choice but to be set at a rather low level experientially on the safe side, accordingly.

[0022] A temperature sensor for exhaust gas is inserted by its cords from the outside of the heater casing 65 at exhaust vent side portion. Said cords are in the way or have no good appearance.

[0023] In this connection, the object of the present invention is to provide an insulator for use with heater, wherein there will be no risk of variation in pitch of electric heating wire, that the electric heating wire suffers less from the influence of magnetic-field induction vibration or mechanical vibration, that if the exhaust vent for heated air is pointed to any direction, the electric heating wire can be held or fixed effectively, in particular, even in the case of the exhaust vent pointed downward, the outbound action of the electric heating wire can be avoided, so that stable exhaust of the high temperature hot air can be performed for a long period of time, and a heater for use with said insulator for generating high-temperature hot air.

[0024] Though the insulator in accordance with the present invention has been developed as those which may emit heated air at more than 800°C, it may naturally be used as the one of a low capacity devoting to emission of heated air at a low temperature.

Disclosure of Invention

[0025] For solution of said tasks, a first invention provides an insulator for electric heating wire for use in hot air generating heater, comprising insulator segments (A, B) and spacer insulators (C), wherein said insulator segments (A, B) each comprises a plate member provided with a multitude of gas venting holes (10, 10, ...), and one or more than two fitting portions (12a, 12b) formed in the peripheral portion thereof for fixing said insulator segments and/or wiring electrode, so that a plurality of said insulator segments (A, B) may be piled one on top of another in a gas flow direction, in which the gas venting holes (10, 10,...) of some or all of the adjacent insulator segments as piled together are slightly shifted from each other, and said fitting portions (12a, 1.2b) for fixing and/or wiring electrode are arranged to coincide with each other respectively, and further between the adjacent insulator segments, where the gas venting holes are shifted in position from each other, is arranged spacer insulator (C), which comprises a frame member having only a peripheral section in which one or more than two fitting portions (12c) for fixing and/or wiring electrode are disposed at same position as those of insulator segments (A, B),

so that a set of insulators for electric heating wire (G1, G2, G3) has been completed, in the gas venting holes of which can be wired up the electric heating wire such as nichrome wire.

[0026] In the first invention, since the gas venting holes of the adjacent insulator segments are slightly shifted from each other in position, electric heating wire is not wired up linearly but slightly staggered or twisted in position, to ensure that the electric heating wire will be definitely held or fixedly retained by means of both insulator segments. In this stage, if the insulator segments with the gas venting holes slightly shifted from each other in position are arranged directly adjacent to each other, the electric heating wire is difficult to wire up properly, which can be solved, however, by interposing the spacer insulator between both insulator segments. This technical concept figured out by the inventor of the present invention was the fruit of his hardest work that each of the electric heating wire being wired up can be held or fixedly retained by displacing from each other the gas venting holes of the adjacent insulator segments with the spacer insulator interposed therebetween.

[0027] The arrangement as set forth makes it possible to hold or fixedly retain the electric heating wire with the insulator segments, and to avoid stretching or deflection (variation in pitch) under air pressure or gravity, and the outbound action of the electric heating wire, and to get the electric heating wire immune from a harmful influence of mechanical vibration and magnetic-field induction vibration as well.

[0028] More specifically, the spacer insulator is arranged such that heated air within many gas venting holes is mixed in the empty space of the spacer insulator (the static pressure becomes constant), and even if the applied heat within a specific gas venting hole is slanted (variation in pressure), the heated air can be mixed and incorporated within said empty space in such a manner that the slant heating or variation in pressure of the gas may be released.

[0029] The air flow passing through the gas venting holes can always be made constant by the spacer insulator. This may avoid any variation in pitch of the electric heating wire to cover a weak point of the electric heating wire tends to lower in its mechanical strength concurrently with the temperature rise. Furthermore, the electric heating wire is slightly shifted from or twisted with each other in position by the use of the spacer insulator to give electric heating wire a tension to ensure that the outbound action of the electric heating wire as incidental to a high temperature will be prevented.

[0030] The harmful influences of the abrasive action between the electric heating wire and the insulator due to the vibration of the electric heating wire resulting from the turbulent flow of the heated air and the magnetic or mechanical vibration may have been all solved.

[0031] Namely, the electric heating wire is so twisted at the spacer insulator that they are definitely held or fixedly retained by the insulator segments, thus resulting in solution of the problem of the friction between the electric heating wire and the insulator under vibration, as compared with the prior art. Referring to the abrasive action, as above mentioned, the electric heating wire and the gas venting holes are put into a frictional contact with each other by their own vibrations in a fashion that the oxide layer of the electric heating wire or the inner wall face of the gas venting holes are scraped down into dusts to cause a harmful influence on the environment, or the breaking of the electric heating wire for the worst when the dusts collected within the gas venting holes. Fortunately, however, said problems are removal.

[0032] A second invention relates to an insulator for heating wire of a heater for generating hot air as defined in the first invention, characterized in that hollow portions (10s) are formed in one or more than two gas venting holes (10c) provided in the central portion of the insulator segments (A, B) and receiving a temperature sensor.

[0033] With the second invention, the provision of the hollow portion (10s) in one or more than two gas venting holes (10c) as positioned in the central portion may permit the temperature sensor to fit into said hollow portion to ensure that the temperature sensor will be disposed appropriately in the desired position, so that the maximum critical temperature (unusual over heat temperature) of the wired-up nichrome wire can be sensed or measured more properly. Additionally, in case of inclusion of more than two hollow portions, a sensor of sensing the temperature of exhausts and a sensor of sensing unusual over heat to prevent it can be arranged together, for example, at the intake vent side of the heater.

[0034] A third invention relates to an insulator for electric heating wire of the hot air generating heater as defined in the first or second invention, characterized in that a plurality of raised sections or raised bulges (11, 11,...), which can support the electric heating wire on the inner wall of the gas venting holes respectively, are provided in a direction of flowing gas so that the wound-up electric heating wire may be supported in a manner to maintain a gap between the electric heating wire and the inner wall of the gas venting hole.

[0035] Thanks to the third invention, the wound electric heating wire being wired up within the gas venting holes of the insulator can be retained with a certain gap kept between the electric heating wire and the inner wall of the gas venting holes by virtue of said raised bulge. Therefore, the heat exchange efficiency between the electric heating wire and the heated air will be improved, and the electric heating wire will not be affected by dusts as collected on the inner wall, and have less risk of breakage.

[0036] A fourth invention relates to a hot air generating heater of a substantially tubular shape which is provided with an air intake vent (31) connectable with a fan via piping at one end and an exhaust vent of discharging hot air at the other end, wherein the insulators for electric heating wire (G1, G2, G3) as defined in any one of said first to third invention are spaced at equal intervals, so

as to independently enable supply of electric power to the electric heating wires belonging to the respective sets of insulators.

[0037] In the fourth invention, proper installation of one set or plural sets of insulators for electric heating wire may ensure formation of a heater of desired capacity.

[0038] If plural sets of insulators for electric heating wire are installed, electric power may be supplied to each set of insulators independently. In this structure, the surface loading (W) of the electric heating wire may be varied more properly than in a single circuitry of conventional type, so that a heater of a smaller volume, specifically, of a short length in the direction in which gas flows can be provided to obtain the same exhaust temperature with the same capacity as in the conventional type.

[0039] That is, the temperature of gas supply is low at the intake vent side, getting higher as the exhaust vent is more approached. This may change the surface loading of the electric heating wire in a proper manner, namely the volume of the electric heating wire is changed to such an extent that an overall heater can be made compact, avoiding a wasteful use of expensive materials, thus, into contribution to an energy-saving measure.

[0040] In other words, by making different from each other the surface loadings of the electric heating wire of the respective sets when power supply is effected, the heater can be made in a more suitable shape, so that the heat at a suitable temperature may be applied to a gas being heated, that is, a gas at a temperature close to the heat-resistant temperature of the electric heating wire may be produced to ensure that the heat exchange efficiency will turn out high, thus making it possible to produce a gas at a temperature close to the heat-resistant temperature of the electric heating wire, which may lead to contribution to the energy-saving.

[0041] As a determined interval is kept between adjacent sets of insulators, and a certain size of an empty space is formed as well, heated gas will be so well mixed or incorporated that the gas being heated may be prevented from being lop-sided or variant in its temperature.

[0042] In case more than two hollow portions which may receive the temperature sensor are provided as insulator segments, no less than two temperature sensors can be inserted from the intake vent side. For example, both of the exhaust temperature sensor and the sensor preventive against over heat (maximum temperature) can be installed from the intake vent side. This, therefore, may avoid the necessity of installing the exhaust temperature sensor from the outside of the heater casing at the exhaust vent side, as in the conventional types.

[0043] A fifth invention relates to a insulator segment (A, B), which constitutes a set of the insulators for electric heating wire (G1, G2, G3) as defined in the first to the third invention, wherein the insulator segment (A, B) comprises a plate member having a multitude of gas venting holes (10, 10,...), on the peripheral portion of which are formed one or more than two fitting portions (12a, 12b).

[0044] A sixth invention relates to a spacer insulator (C) comprising a frame member disposed in one or more than two positions of a set of insulators for electric heating wire (G1, G2, G3) as defined in the first to the third invention, wherein one or more than two fitting portions (12c) for fixing insulator segments and/or wiring electrode are solely formed on the periphery, of which central portion constitutes an empty space (14).

[0045] The insulator segments in accordance with the fifth invention and the spacer insulator in accordance with the sixth invention may constitute a set of insulators for electric heating wire as defined in any one of the first to third invention.

Brief Description of Drawings

[0046]

Fig.1 is a front view of an insulator segment A in accordance with the present invention, as viewed from the direction in which gas flows;

Fig.2 is a front view of an insulator segment B in accordance with the present invention, as viewed from the direction in which gas flows;

Fig.3 is a front view of a spacer insulator C in accordance with the present invention, as viewed from the direction in which gas flows;

Fig.4 is a see-through front view showing a state of said insulator segments A, insulator segment B, and spacer insulator C piled one on top of another in a direction in which gas flows;

Fig.5 is a see-through side view explanatory of the structure of a heater for generating hot air in accordance with the present invention;

Fig. 6 is a partially enlarged view of a gas venting holes located in the central portions of the insulator segments A and B;

Fig.7 is a front view of the insulator segments in accordance with another embodiment of the present invention, as viewed from a direction in which gas flows;

Fig.8 is a front view of a spacer insulator in accordance with another embodiment, as viewed from a direction in which gas flows;

Fig. 9 is a see-through front view showing a state of the insulator segment as shown in Fig.7 and the spacer insulator as showing in Fig.8 piled one on top of the other in a direction in which gas flows;

Fig.10 is a perspective view explanatory of the insulators for electric heating wire for use in a high-temperature hot air generating heater of prior art; and

Fig.11 is a see-through side view explanatory of the high-temperature hot air generating heater of prior art.

[0047] Signs in the drawing: (A) (B) (20)...Insulator segment, (C)(40)...Spacer insulator, (10)(21)...Gas venting hole, (10s)...Hollow portion, (11)...Raised bulge, (12a, 12b, 12c) (22a, 22b, 22c) (22x, 22y, 22z) (12c)

(42)...Fitting portion, (14) (44)...Empty space, (16) (46)...Frame-like member, (30)...Main body of heater, (31)... Intake vent, (32) ... exhaust vent, (G1) (G2) (G3)...Insulator for electrically heated wire.

Best Mode for Carrying Out the Invention

[0048] Description of the best mode for carrying out the invention will be made with reference to the attached drawings in the following.

[0049] Figs.1 to 3 are front views showing three different types of insulator segments constituting a set of insulators for electric heating wire in accordance with the present invention, as viewed from a direction in which gas flows. Fig. 1 shows an insulator segment A, Fig.2 an insulator segment B, and Fig.3 a spacer insulator C. Fig. 4 is a see-through front view showing a state of said three different types of insulator segments piled one on top of another in a direction in which gas flows, and Fig.5 is a see-through side view explanatory of a state of three sets of said insulators for electric heating wires contained within a hot air generating heater.

[0050] Firstly the insulator segment A as shown in Fig. 1 consists of a plate member, circular as viewed from the front, in the form of a disk, and having a certain thickness; the thickness measuring about 10mm, its outer diameter about 84mm; and made of ceramic of thermally insulation properties.

[0051] The entire surface of the insulator segment A has a multitude of gas venting holes 10 consisting of through-holes, which are circular in cross section, sprawling out from its central portion to the peripheral portion in all directions. There are provided a temperature sensor-fitting portion 10s consisting of a hollow portion for receiving a temperature-sensor (not shown) in central three gas venting holes 10c. Said temperature-sensor fitting portion 10s is formed in a fashion to expand the site on the center side of the insulator segment A of the through-holes as gas venting holes 10c. These temperature-sensor fitting portions 10s, 10s, 10s may receive three temperature-sensors.

[0052] In the peripheral portion of the insulator segment A are circumferentially and almost equally spaced three sections wanting gas venting holes 10, which sections are respectively formed with the fitting portions 12a for wiring up an electrode terminal at the end of the electric heating wire such as nichrome wire in order to fixedly secure the insulator segments A to each other. Said fitting portions 12a, which consist of notches of a certain width and a determined length to extend from the outer periphery of the insulator segment A to the center of the insulator segment A, are spaced substantially at equal intervals in a circumferential direction. That is, these fitting portions 12a are formed to sit at every 120-degrees interval around the center. The fitting portion 12a as formed on the upper part in Fig.1 is placed in a position swerving from a center line Y by 4 degrees (α) anticlockwise.

[0053] The inner diameter of the gas venting hole is approximately 7 . 7mm, and the inner wall of the gas venting hole 10 has four protruding or raised bulges extending in a direction in which gas flows, as discussed afterward. Additionally, the central gas venting hole 10c of the insulator segment A is formed with three raised bulges alone as the sensor fitting portion 10s is provided there.

[0054] The insulator segment B as shown in Fig.2 is substantially identical to said insulator segment A in structure except a single point that the fitting portion 12b is different in position alone for fixing the insulator segments and for wiring the electrode terminal at the end of the electric heating wire. Namely, the upper fitting portion 12b as shown in Fig.2 is formed in a position deviating from the center line Y by 9 degrees (β) anticlockwise. Consequently, it follows that these three fitting portions 12b are arranged deviating by 5 degrees (β-α) anticlockwise respectively in their positions from the fitting portion 12a of said insulator segment A. The other structures are totally one and the same as those of said insulator segment A.

[0055] Fig.3 shows a spacer insulator C as a segment for constituting a set of insulators for electric heating wire, its thickness and outer diameter being substantially identical to those of said insulator segments A and B, but many different gas venting holes are all missing there, the center portion provides an empty space 14, which spacer insulator C being constituted by a frame member 16 consisting of a frame in the form of a circle as viewed from the front, said frame member 16 having expanding portions 18 of each being put in three positions as spaced at equal intervals and extending toward the center portion, and said three expanding portions 18 including fitting portions 12c in the form of a slot respectively. These specific fitting portions 12c are circumferentially spaced at equal intervals (a 120-degrees interval around the center), so that the fitting portions 12c are located in alignment with the fitting portions 12a, 12b as formed in said insulator segments A and B. Therefore, when the insulator segments A and B, and the spacer insulator C are piled one on top of another, the fitting portions 12a, 12b, 12c can be placed in alignment with each other.

[0056] Fig.4 is a see-through front view of a state of said insulator segments A, B and spacer insulator C piled one on top of another, in which the positional relation between the gas venting holes 10, 10 and the positional relation between the fitting portions 12a, 12b, 12c is quite obvious.

[0057] As can be seen from the drawing, with said three types of insulator segments as piled one on top of another, the fitting portions 12a, 12b, 12c for fixing said segments and/or wiring electrode are arranged in one and the same positions respectively, while the insulator segments A and B, and the gas venting holes 10 are slightly discrepant in position from each other. Namely, one gas venting hole of the segment may deviate from the other gas venting hole of the segment in position by five (5) degrees around the center common between the insulator segments.

[0058] Furthermore, it is optional with users to determine that either insulator segment A or B is to be arranged in either this side or that, but the spacer insulator C needs to be disposed between the insulator segments A and B. By piling a proper number of insulator segments A and B, and spacer insulators C one on top of another can be formed a set of insulators for electric heating wire,

[0059] In said set of insulators for electric heating wire thus arranged, the some or all of the adjacent gas venting holes of the insulator segments are discrepant, via the spacer insulator, from each other in position, so that the electric heating wire such as nichrome wire being wired up in this gas venting holes tend to be twisted by the insulator segments A and B when wired up, to ensure that the electric heating wire will be definitely fixed and retained. This may prevent the vertical movement of the electric heating wire even when the gas venting holes of the insulator are pointed in a vertical direction, or there is no risk of the electric heating wire' s flinging out of the gas venting holes of the electric heating wire under venting gas pressure, and being affected by the vibration as well.

[0060] Fig. 5, showing an example of said insulators for electric heating wire as used, is a see-through side view illustrating a state of three (3) sets of insulators for electric heating wires as wired up inside the hot air generating heater.

[0061] The main body 30 of the hot air generating heater is made of stainless in the form of a cylinder, wherein the gas intake vent 31 is formed in the lower portion at the right hand in the drawing, and connected to a blower via piping. There is provided hot air exhaust vent 32 at the left hand of the main body 30. The main body 30 receives 3 sets of insulators for electric heating wires G1, G2, G3 as fixedly secured therein. Each of the insulators G1, G2, G3 is constituted of said insulator segments A (shown by rightward slanted lines), insulator segments B (shown by leftward slanted lines), and spacer insulators (shown by lattice slanted lines) piled one on top of another.

[0062] A set of insulators for electric heating wire G1 at the left side of the exhaust vent side is constituted of a combination of two insulator segments A as shown in Fig.1 in coincidence with the position of the fitting portion 12a on the leftmost side, one spacer insulator C as shown in Fig.3 at the neighboring side on the right with the position of the fitting portion 12c placed in agreement with the fitting portion 12a of the insulator segment A, one insulator segment B as shown in Fig.2 at the neighboring side on the right with the position of the fitting portion 12b placed in agreement with the fitting portion 12c of the spacer insulator C, one spacer insulator C, one insulator segment A, one spacer insulator C, and two insulator segments B, totaling nine all in all.

[0063] In the same way as the abovementioned, a set of insulators for electric heating wire G2 is constituted of a combination of two insulator segments A, one spacer insulator C, one insulator segment B, one spacer insulator C, and two insulator segments A, totaling seven segments as told, laid one on top of another sequentially from left to right.

[0064] Furthermore, a set of insulators for electrically heated wire G3 is likewise constituted of two insulator segments B, ,one spacer insulator C, one insulator segment A, one spacer insulator C, and two insulator segments B, totaling seven in all, laid one on top of another sequentially from left to right.

[0065] As discussed above, while each of the insulators G1, G2, G3 includes a combination of two insulator segments A or B of the same type at both sides thereof, adjacent different segments A, B are put in position, in the intermediate section, in such a manner that the spacer insulator C is interposed between said insulator segments. This arrangement may get the gas venting holes 10, 10, ... of the insulator segments A, B slightly deviated from each other in position, and definitely maintain the electric heating wire by subjecting same to twisting.

[0066] The combination method for insulator segments is optional. A two-piece combination does not always needs to be laid at both ends; use may be wholly made of a combination of insulator segments A and B laid one on top of another with one spacer insulator C interposed therebetween alternately. Alternatively, the insulator segments A and B may be stuck by twos respectively with one spacer insulator C interposed between said insulator segments in each combination. Additionally, two spacer insulators C laid one on top of the other may be interposed between the insulator segments A and B, and the insulator segments A and B may be combined respectively in a different number from each other so that said two combinations may be joined together via the spacer insulator C. The combination method for three different types of the segments can be used in a complete free manner, except that the interposition of the spacer insulator C between the insulator segments A and B is essential, because the electric heating wire would be hard to wire up without the interposition of the spacer insulator C.

[0067] In combining the insulator segments, it is necessary for the fitting portions 12a, 12b, 12c of the relative segments to be disposed in alignment with each other. This may enable each set of insulators for electric heating wire to be fixed, and the terminal 35 of the electrode terminal 33 of the electric heating wire to be disposed together at the right section of the gas intake vent 31 side.

[0068] Said electrode terminal 33 is constituted of a metallic plate for an additional application to fixing of the insulator segments. Fig.5 shows only one electrode terminal 33 for the purpose of brief illustration, but it is actually provided in three spots of each of the fitting portions.

[0069] Furthermore, with the insulator segments A and B, the value of deviation between the gas venting holes in position must be established within a certain range in consideration of the pressure loss which may occur in the wiring of the electric heating wire, and the passage

of gas. That is, said embodiment provided that the deviation between the gas venting holes in position be about 5 degrees around the center, but either deviation of over 5 degrees or under 5 degrees is available. In short, a deviation range is admissible within which the nichrome wire can be properly maintained and fixed by the gas venting holes of the insulator segments, and the pressure loss of the venting gas can be extenuated as much as practicable.

[0070] The effects have been obtained that the positional deviation of the gas venting holes ensures the definite maintenance of the electric heating wire, and the interposition of the spacer insulator may preclude any harmful influence on the wiring of the electric heating wire. Concurrently with said advantages, the existence of the empty space 14 can help lessen the variation of temperature rise of the venting gas within the gas venting holes of the insulator segments A and B, prevent the excessive rise of temperature of the electric heating wire within some of the gas venting holes, and any possible breakage of the electric heating wire as well.

[0071] In said hot air generating heater are there contained three sets of insulators for electric heating wire G1, G2, G3, as aforementioned, wherein the nichrome wire received by said insulators can be independently supplied with electric power.

[0072] For example, in accordance with the present embodiment, the nichrome wire as wired up in the insulator G3 in the neighborhood of the intake vent 31 are supplied with a power of about 5 - 7W/cm^2 (watt density) to heat gas from the atmospheric temperature to about a temperature of about 400°C, then, the nichrome wire as received by the insulator G2 are supplied with a power of about 4 - 6W/cm^2 to apply heat to the gas to 400 - 600°C, and finally, the nichrome wire as received by the insulator G3 as positioned most closed to the exhaust vent side are supplied with about 2 - 4W/cm^2 to generate hot air of over 800°C.

[0073] A heater of a conventional type as shown in Fig. 11 was structurally wasteful in that the same electrically heated wire are laid to reciprocate between the intake vent and the exhaust vent in the insulator, so that the surface loading of the electric heating wire must be set adaptable to the site excitable at the highest temperature.

[0074] In another conventional type of the heater with a continuous maximum exhaust temperature of 800°C and a capacity of 12kw, the length L1 of the heater casing in a direction of exhaust (See Fig.11. However, the heater in Fig.11 is not of a type of a capacity of 12kw but of less capacity) is about 725mm, while in the heater of the present invention with a continuous maximum exhaust temperature of 800°C and a capacity of 12kw, much the same as those of the conventional one, the length L2 of the heater casing in a direction of exhaust (See Fig.5) can be reduced to 346mm, half the length in the conventional type. This fact clearly tells that the heater in accordance with the present invention is capable of achieving very high heat exchange efficiency.

[0075] Fig.6 is a front view showing an enlargement of some of the gas venting holes positioned centrally of the insulator segment A or B. Each of the gas venting holes 10 consists of a circular through-hole with an inner diameter of 7.7mm, and is formed with four bulges 11 as spaced in equal intervals in a direction of the inner wall in which gas flows. Said bulges 11 act to retain the electrically heated wire such as wound nichrome wire with a regular gap maintained between said wire and the inner wall in the gas venting holes 10 so that the venting gas may get in contact with the inner and outer faces of the wound electric heating wire with the consequence that an effective heat transmission may be carried out between the electric heating wire and the venting gas, thus resulting in acquisition of higher heat efficiency.

[0076] The central gas venting hole 10c is formed with a temperature sensor fitting portion 10s consisting of a hollow portion with the wall face of the gas venting hole expanded at the central spot side of the insulator segment. After combination of a set of the insulators for electric heating wire, a temperature sensor such as a thermocouple is inserted from the end of the heater at the inlet side into said temperature sensor fitting portion 10s to ensure that the temperature measurement will be conducted at a desired position.

[0077] Fig.7 is a front view of an insulator segment 20 in accordance with another embodiment of the present invention, as viewed from the direction in which gas flows, and Fig.8 is a front view of a spacer insulator 40 in accordance with another embodiment of the present invention.

[0078] The insulator segment 20 as shown in Fig.7 is a plate member in the form of a disk, having a regular thickness, like the insulator segments A and B in accordance with the previous embodiment. It is made from ceramics with thermal insulation properties, its size measuring about 10mm in thickness, 66mm in outer diameter, a little smaller than the insular segments A and B in accordance with the previous embodiment. Said insulator segment 20 is restricted to a single type, wherein the provision of the fitting portion on the peripheral section makes it possible to slightly displace the gas venting holes 21 in position.

[0079] The insulator segment 20 is provided with a multitude of gas venting holes 21, 21 ... consisting of round through-holes with a circular shape in cross section as sprawling from the center portion toward substantially the whole directions on its whole surface. Two central gas venting holes 21c, 21c are formed with temperature sensor fitting portions 21s, 21s consisting of the hollow portions for fitting the temperature sensor (not shown) respectively. This particular temperature sensor fitting portion 21s is intended for expanding the site of the through-hole (gas venting hole 21c) at the central side of the insulator segment 20. Two temperature sensors can be installed by means of these two temperature sensor fitting portions 21s.

[0080] The peripheral section of the insulator segment

20 is formed with a set of three fitting portions (22a, 22b, 22c) for securing said insulator segment 20 mutually and laying the electrode terminal at the end of electric heating wire such as nichrome wire as spaced at equal intervals, namely at 120 degrees intervals around the center respectively, and additionally, another set of three fitting portions (22x, 22y, 22z) as spaced at equal intervals, namely at 120 degrees intervals respectively around the center. And said two sets of fitting portions (22a, 22b, 22c) and (22x, 22y, 22z) are placed in positions swerving by an angle of 65 degrees (γ) anticlockwise respectively.

[0081] When two insulator segments 20 are stuck together in a fashion that the fitting portions (22a, 22b, 22c) of one insulator segment 20 and the fitting portions (22x, 22y, 22z) of the other insulator segment 20 are placed in agreement with each other, the positions of the respective fitting portions may coincide with each other by disposing the fitting portion 22a of one insulator segment 20 and the fitting portion 21x of the other insulator segment 20 in alignment with each other so as to bring the respective positions of the fitting portions into coincidence with each other, and the positions of the gas venting holes 21, 21, ... will slightly shift from each other, namely by an angle of five (5) degrees around the center in the present embodiment.

[0082] The fitting portions in the present embodiment are made in the shape of an elongated notch extending circumferentially at an angle, specifically, of around 45 degrees (δ) to a center line Y from the periphery of the insulator segment 20.

[0083] However, said angle is quite optional, and may be set freely, accordingly.

[0084] The gas venting hole 21 has an inner diameter of about 7.7mm, and is formed with four bulges on the inner wall for supporting electric heating wire in a direction in which gas flows, which is the same as that of said insulator segments A, B.

[0085] Fig.8 shows a spacer insulator 40, its thickness and outer diameter being substantially identical to those of said insulator segment 20. However, the spacer insulator 40 is provided with none of many different gas venting holes, but formed with a central empty space 44, and a frame member 46 consisting of a frame of a circular shape as viewed from the front, said frame member 46 including expansion portions 48 spaced in equal intervals at three points and provided with fitting portions 42 in the form of elongated holes respectively. These fitting portions 42 are circumferentially formed at equal intervals at an angle of 120 degrees around the common center, and may be placed in position to coincide with the fitting portions (22a, 22b, 22c) or fitting portions (22x, 22y, 22z) of the insulator segment 20 as shown in Fig.7, which fitting portions 42 consisting of elongated holes which can meet up with the notches acting as fitting portions of the above insulator segment 20. Consequently, by bringing two insulator component pieces 20, 20 in agreement with the fitting holes 20a and the fitting hole 20x, the gas venting holes 21, 21, ... may come to deviate from each other by 5 degrees, and the spacer insulator 40 may be arranged between both the insulator segments 20, 20, and the fitting portions (42, 42, 42) of the spacer insulator 40 may be arranged in position to coincide with the fitting portions (22a, 22b, 22c) and the fitting portions (22x, 22y, 22z) of the insulator segments 20, 20.

[0086] Fig.9 is a see-through front view of a state of said insulator segments 20, 20 and the spacer insulator 40 piled together, which shows the positional relation between the gas venting holes 21, 21,... and the positional relation between the fitting portions (22a, 22b, 22c)(22x, 22y, 22z)(42, 42, 42).

[0087] As seen from the drawing, with three sheets of insulator segments and spacer insulator as piled together, the fitting portions for fixing said segments and/or wiring of electrode (22a, 2b, 22c) (22x, 22y, 22z) (42, 42, 42) are arranged in position to coincide with each other. Then, in this case, the gas venting holes 21, 21,... of the insulator segments 20, 20 are slightly shifted from each other in position. Namely, the gas venting holes of one and the other segments are shifted from each other in position by an angle of five (5) degrees around the center common between said insulator segments.

[0088] Furthermore, it is optional with users to place the insulator segments 20, 20 either at this side or that, except that the spacer insulator needs to be arranged between these insulator segments 20, 20. Following said procedure, a set of insulators for electric heating wire may be completed by laying a proper number of the insulator segments 20, 20,... and the spacer insulators one on top of another.

[0089] In the set of the insulators for electric heating wire as constructed through said process, some or all of adjacent gas venting holes of the insulator segments are slightly shifted from each other as above-mentioned. Therefore, in the event that the electric heating wire such as nichrome wire is wired up in the gas venting holes, the electric heating wire will be definitely fixed for retention by means of the insulator segments. This arrangement makes it possible to prevent the electric heating wire from moving in a vertical direction even when the gas venting holes of the insulator are leveled in a vertical direction, or to preclude the electric heating wire from running out of the gas venting holes under the influence of the pressure of venting gas, or to get the electric heating wire immune from any baneful effect due to vibration.

[0090] A high-temperature hot air generating heater may be constituted by containing one or more than two sets of the insulators in said heater, as in said first embodiment.

[0091] The best embodiments have been described as above, but the design change can be achieved in the present invention as follows.

[0092] The shape and size of the insulator segment and the spacer insulator may be designed properly as needed.

[0093] In said embodiments, the contours of said members are made circular as viewed from the front, but it

may be made oval, four-sided, or polygonal. In this case, however, it is necessary that the main body of the heater be made in a form adaptable to any of said changed forms.

[0094] The outer diameter can be optionally established in size. Referring to the thickness, both of the insulator segment and the spacer insulator were 10 mm thick, but may be made more or less than 10 mm. Furthermore, both of the members may not be of a uniform thickness but different thicknesses respectively.

[0095] The gas venting holes in which the electric heating wire is wired up are in the form of a circle in cross section in any of said embodiments, but they may be made in the form of a four-sided with four round corners.

[0096] In said embodiments, the inner diameters of the gas venting holes provided in the insulator segment are all the same, but the inner diameters of the gas venting holes as positioned in the center portion may be made slightly larger than the inner diameters of the gas venting holes provided in the peripheral portion.

[0097] A single temperature sensor fitting portion may be provided in one gas venting hole as positioned in the center of the insulator segment, or more than two temperature sensor fitting portions may be installed as needed.

[0098] The structure of the fitting portion for fixing insulator segments and/or wiring electrode as provided on the peripheral portions of the insulator segment and the spacer insulator may be designed freely at user's discretion.

[0099] With the insulator segment, the fitting portion consists of a notch, but may be of an elongated hole type. Alternatively, the fitting portion of the spacer insulator may be constituted of an elongated hole.

[0100] Additionally, the fitting portion may consist of a mere small hole, into which wires are inserted to fix a set of insulators at both ends thereof to provide terminals of the nichrome wire. Of course, said set of insulators can be fixed with long-shank bolts and nuts using this small hole.

[0101] In the present invention, a long belt-shaped plate 33 (see Fig. 5) is used as a fixing means by the use of this fitting portion. Said plate 33 simultaneously plays an additional role of an electrode terminal of the nichrome wire. Here, if three-phase power supply is used, three plates are basically to be used, and if a large power output is used, six or nine plates 33 will preferably required in terms of the circuit configuration. In case of single-phase, four or six plates may be used. The number of the fitting portion may depend on the number of the plate used accordingly.

[0102] This specific belt-like plate is long enough to extend from a set of insulators for electric heating wire being fixed to an electrode 35 at the right end of the intake vent 31. The plate 33 is, for example, provided with a notch at a site positioned at both ends of a set of insulators. A proper bend of the notch area of the plate ensures fixation of the insulator segments.

[0103] This fixing means of the insulator segments can be embodied in various manners by the use of said fitting portions.

[0104] The inner diameters of a multitude of gas venting holes provided in the insulator segments can be appropriately established as needed.

[0105] If the insulator segment is of a four-sided shape as viewed from the front, the gas venting holes can be shifted slightly in a vertical, horizontal, or slanted direction.

[0106] In said embodiments, adjoining insulator segments are shifted from each other by an angle of five (5) degrees around the center, but more or less than 5 degrees are practicable, if only it would ensure that the nichrome wire will be retained for fixation in a proper way. That is, the amount of angle around the center is too large may cause a large amount of deviation of the gas venting holes positioned in the peripheral portion to invite not only difficulty in wiring nichrome wire but also hindrance in the way of the flowing gas into a pressure loss, while a too small angle around the center may cause a small amount of deviation of the gas venting holes positioned in the center portion to decrease fixing effect for retention of nichrome wire. Therefore, it is essential that the amount of angle around the center be made proper in consideration of the above matter.

[0107] With said embodiments, the gas venting holes of adjoining insulator segments are shifted in position by an angle of 5 degrees around the center, but the shifting amount of the gas venting holes positioned in the internal side in angle around the center may be made larger than that of the gas venting holes as formed in the outside portion. This ensures that a shift of the gas venting holes at the internal side will be adjusted for correction when on a small scale.

[0108] Though the number of the raised bulges provided on the inner wall of the gas venting hole of the insulator segment may be set freely, it is preferable that 3 to 4 bulges be sufficient enough to sustain nichrome wire wound helically. The bulge runs continuously across the inner wall of the gas venting hole in a direction in which gas flows, but an intermittent extension is also applicable.

[0109] Only one set of insulators for electrically heated wire (insulator segment and spacer insulator) contained in the inside of the high-temperature hot air generating heater is workable, but preferably, provision of more than two sets would be better, and furthermore, best if more than two insulators for electric heating wire are arranged at equal intervals.

[0110] The interval between the insulators for electric heating wire may be set freely, where, its size is preferably larger than the thickness of one piece of spacer insulator.

[0111] The main body of said heater is of a cylindrical shape in appearance, but its outline may be adapted for that of the insulator used. The gas intake vent as formed in the lower area at the right side may be removed to the

right end surface of the main body.

[0112] As described above, the present invention is variable in design,

Claims

1. An insulator for electric heating wire for use in hot air generating heater, comprising insulator segments (A, B) and spacer insulators (C), wherein said insulator segments (A, B) each comprises a plate member provided with a multitude of gas venting holes (10, 10,...), and one or more than two fitting portions (12a, 12b) formed in the peripheral portion thereof for fixing said insulator segments and/or wiring electrode, so that a plurality of said insulator segments (A, B) may be piled one on top of another in a gas flow direction, in which the gas venting holes (10, 10,...) of some or all of the adjacent insulator segments as piled together are slightly shifted from each other, and said fitting portions (12a, 12b) for fixing and/or wiring electrode are arranged to coincide with each other respectively, and further between the adjacent insulator segments, where the gas venting holes are shifted in position from each other, is arranged spacer insulator (C), which comprises a frame member having only a peripheral section in which one or more than two fitting portions (12c) for fixing and/or wiring electrode are disposed at same position as those of insulator segments (A, B), so that a set of insulators for electric heating wire (G1, G2, G3) has been completed, in the gas venting holes of which can be wired up the electric heating wire such as nichrome wire.

2. An insulator for electric heating wire for use in hot air generating heater as defined in claim 1, **characterized in that** a hollow portion (10s) of receiving a temperature sensor is formed in one or more than two gas venting holes (10c) provided in the central portion of the insulator segment (A, B).

3. An insulator for electric heating wire for use in hot air generating heater as defined in claim 1 or 2, **characterized in that** a plurality of raised bulges (11, 11,...) of supporting electric heating wire are provided on the inner wall of the gas venting hole to ensure that wound electric heating wire will be retained within the gas venting holes, with a gap between the former and the inner wall of the latter.

4. A hot air generating heater having a gas intake vent (31) connectable with a blower via piping and provided in one end portion, and an exhaust vent (32) of discharging hot air as provided in the other end portion, wherein one or more than two sets of insulators (G1, G2, G3) as defined in any one of claims 1 to 3 are contained within said heater to line up at determined intervals so as to independently apply electric power to different electric heating wires of the respective sets of insulators.

5. An insulator for electric heating wire, which is an insulator segment (A, B) constituting a set of insulators for electric heating wire (G1, G2, G3) as defined in any one of claims 1 to 3, said insulator segment comprising a plate member provided with a multitude of gas venting holes (10, 10,...), of which peripheral portion is formed with one or more than two fitting portions (12a, 12b) for fixing and/or wiring electrode.

6. An insulator for electric heating wires, which is a spacer insulator (C) comprising a frame member, said spacer insulator having one or more than two fitting portions for fixing and/or wiring electrode alone formed on the peripheral portion, an empty space (14) formed in its central portion, and being put in one or more than two positions inside of a set of insulators for electric heating wire (G1, G2, G3) as defined in any one of claims 1 to 3.

FIG. 1

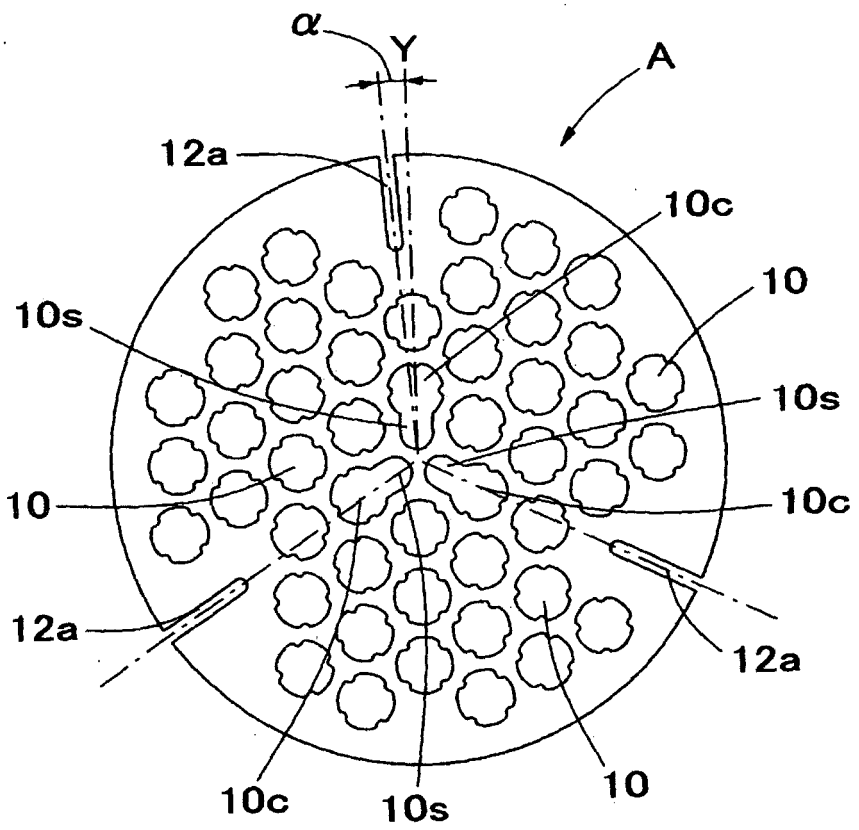


FIG. 2

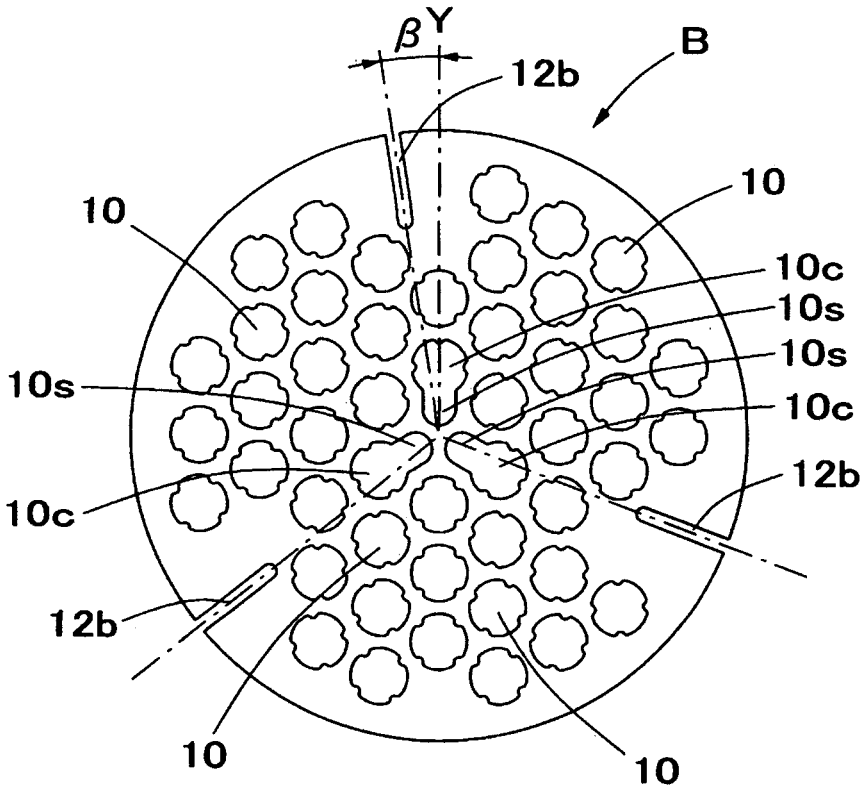


FIG. 3

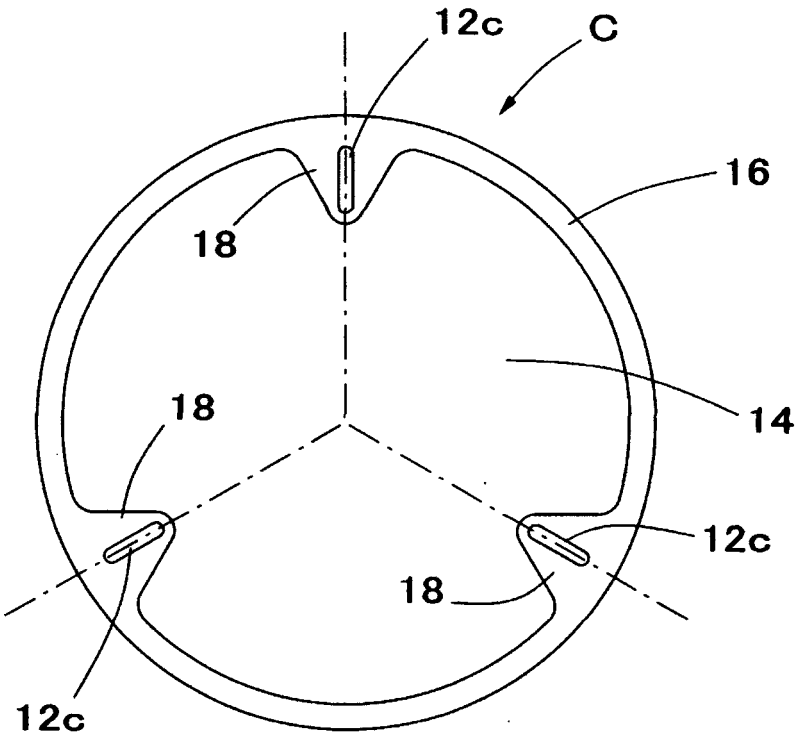


FIG. 4

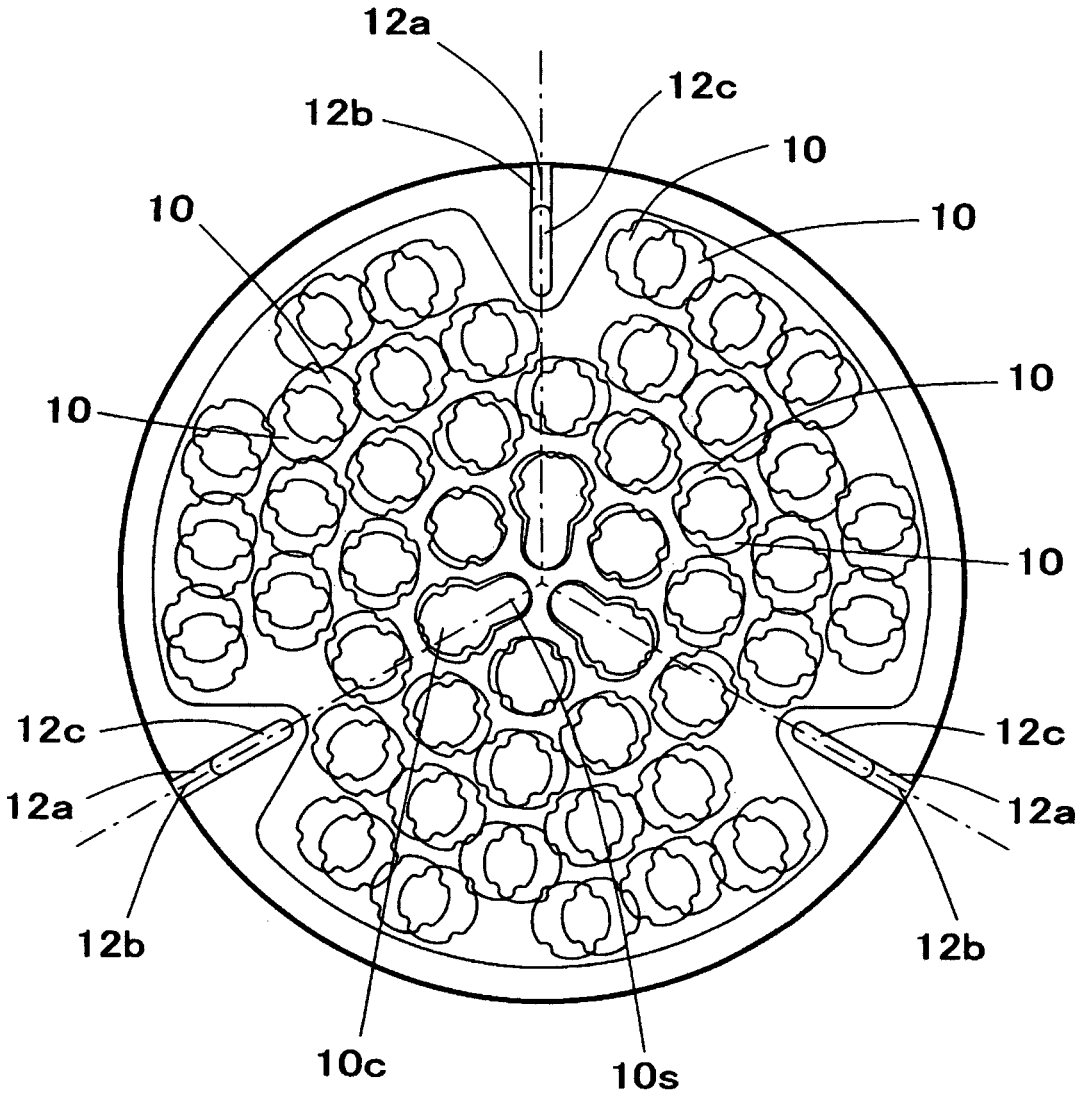


FIG. 5

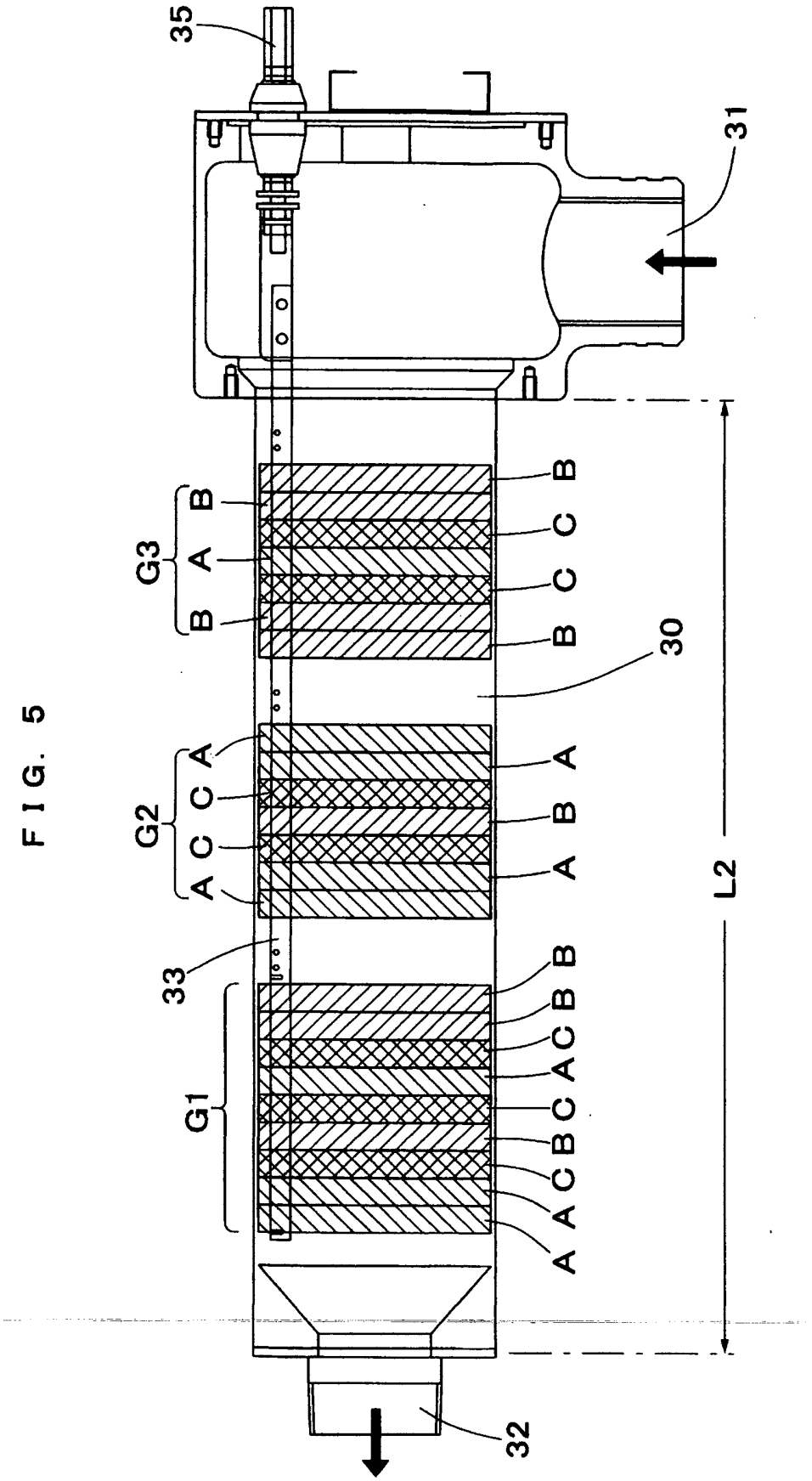


FIG. 6

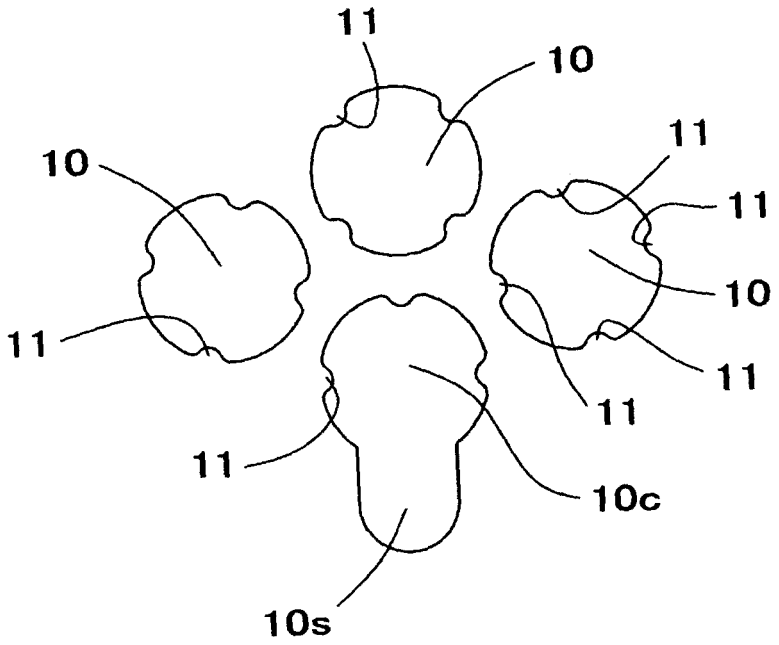


FIG. 7

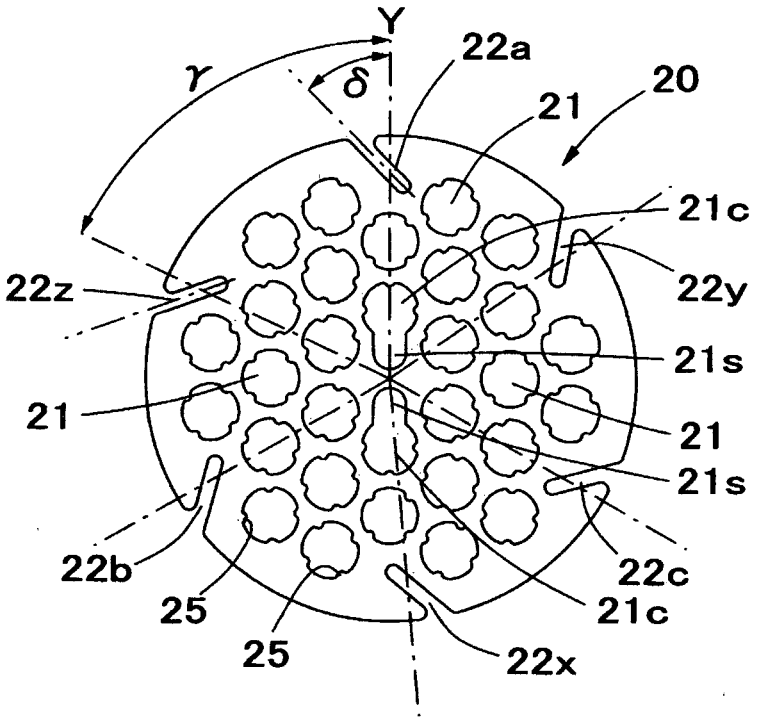


FIG. 8

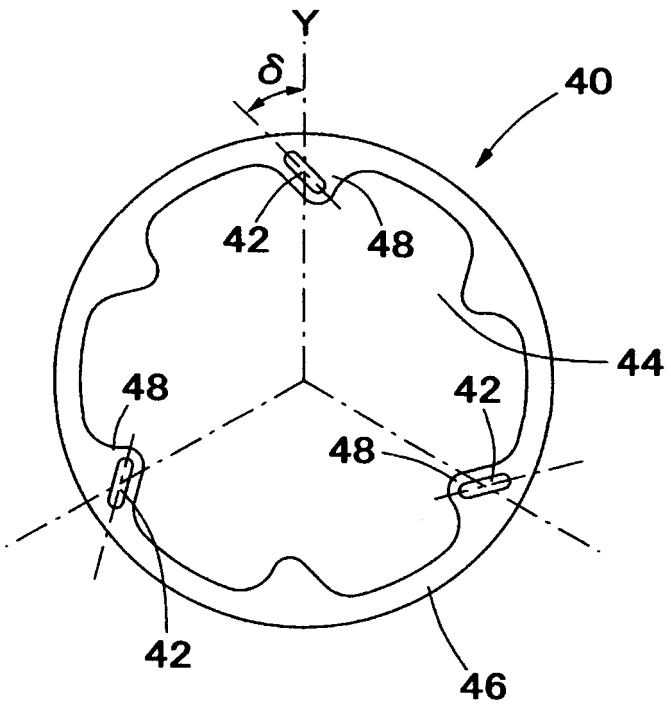
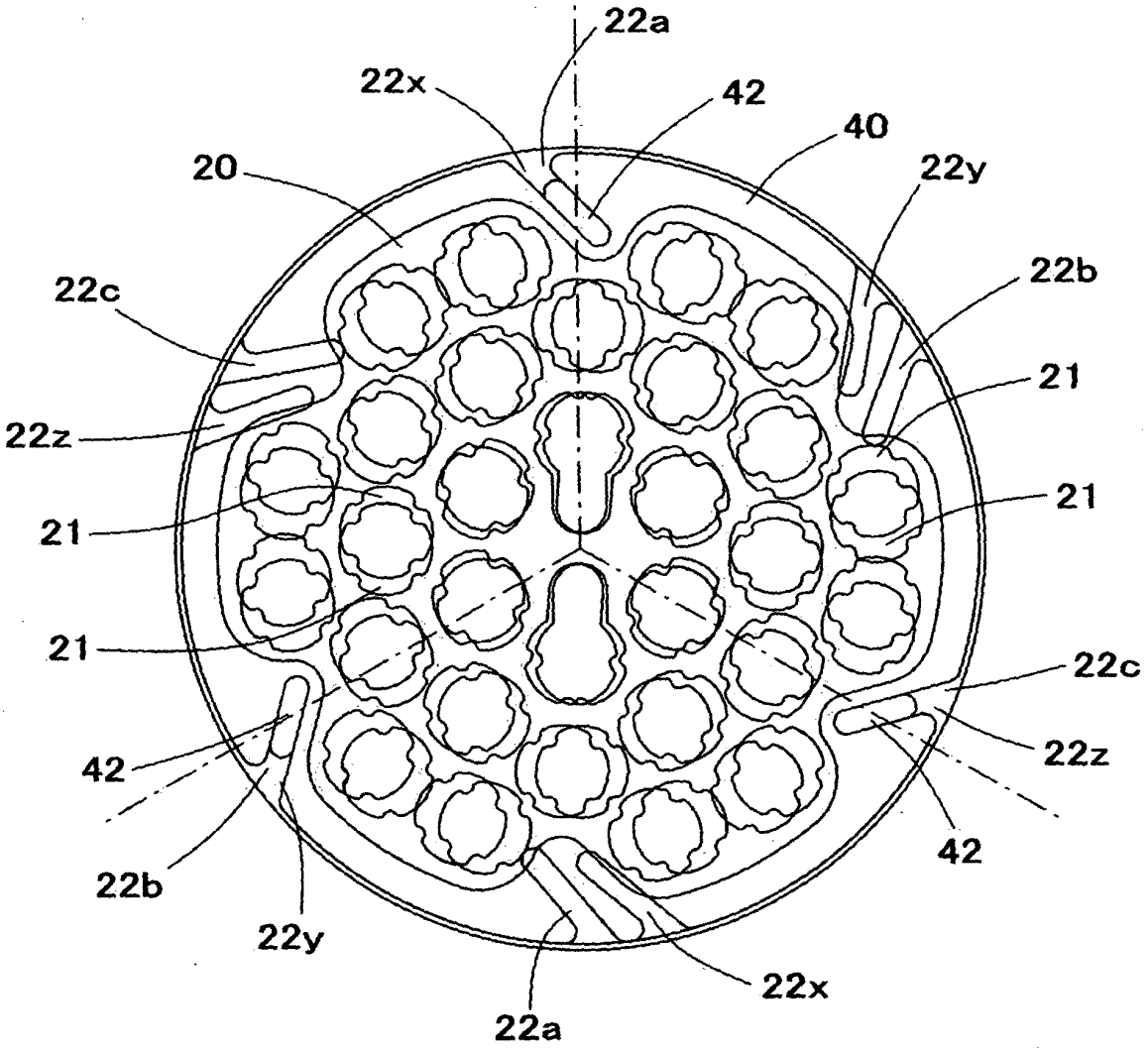


FIG. 9


22a
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22y
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FIG. 10

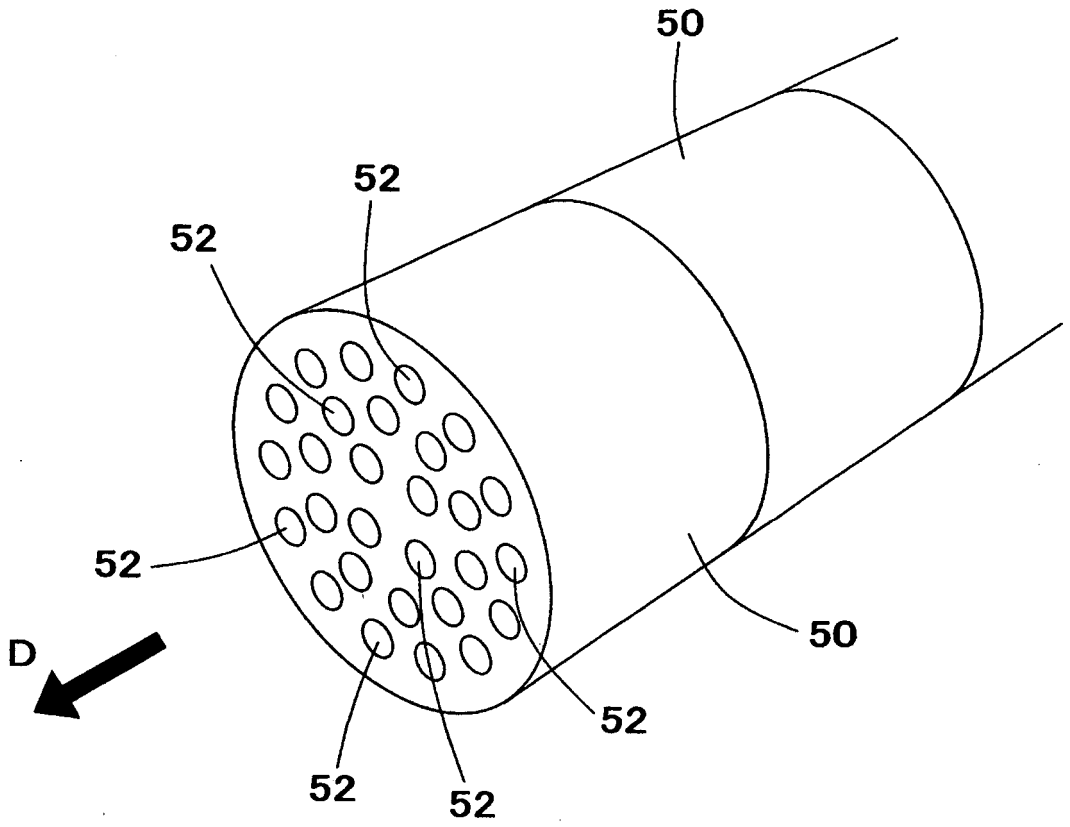
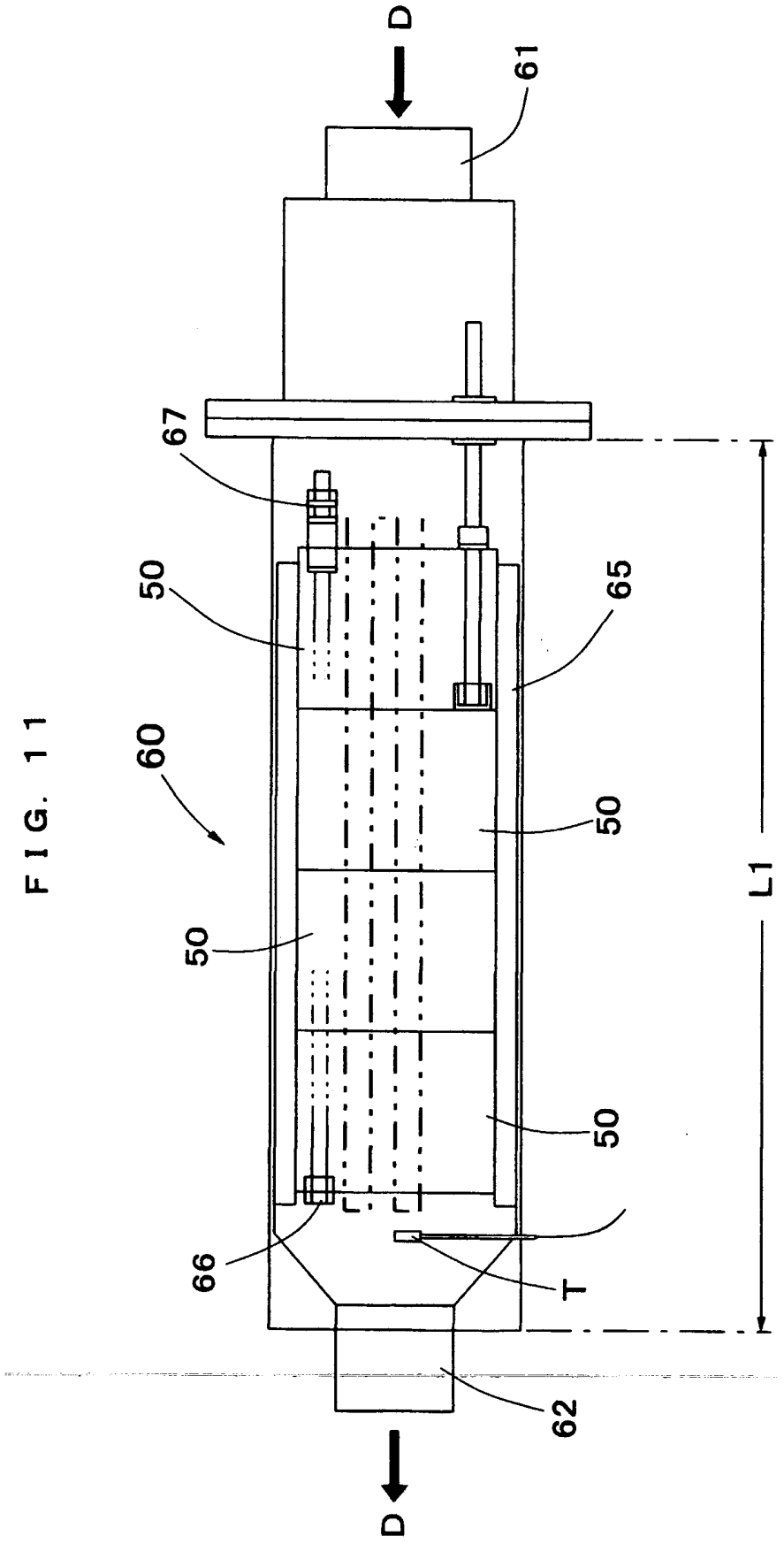


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/001660

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F24H3/08

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] F24H3/08

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 1996-2004
Kokai Jitsuyo Shinan Koho 1971-2004 Toroku Jitsuyo Shinan Koho 1994-2004

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.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 71727/1974(Laid-open No. 542/1976) (Mitsubishi Electric Corp.), 06 January, 1976 (06.01.76), Full text (Family: none)	1-6
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 96112/1971(Laid-open No. 50284/1973) (Murata Mfg. Co., Ltd.), 30 June, 1973 (30.06.73), Full text (Family: none)	1-6

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

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"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	Date of mailing of the international search report
12 April, 2004 (12.04.04)	27 April, 2004 (27.04.04)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2004)

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Patent documents cited in the description

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