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(71) Applicant: **IHI Corporation**
Tokyo 135-8710 (JP)

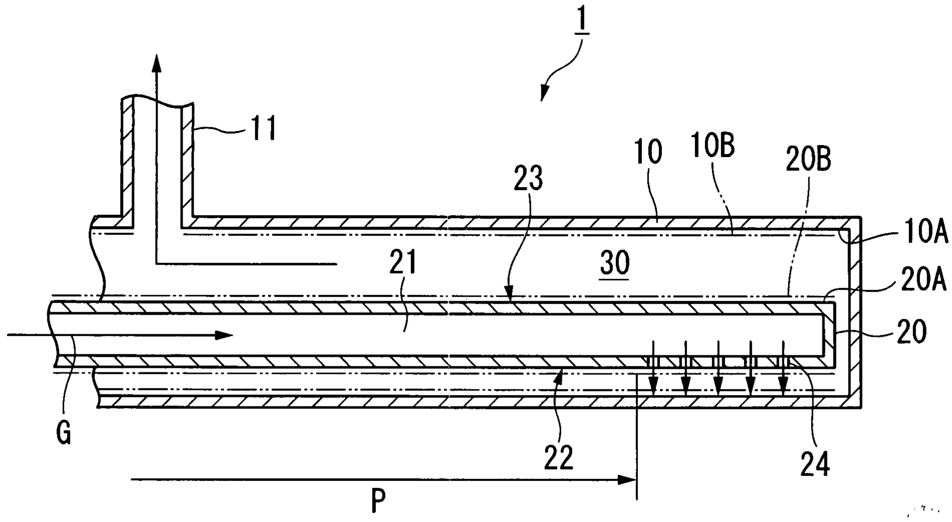
(72) Inventors:
- **KATO, Soichiro**
  Tokyo 135-8710 (JP)
- **TAKAHASHI, Katsuyoshi**
  Tokyo 135-8710 (JP)
- **MIZUTANI, Taku**
  Tokyo 135-8710 (JP)

(74) Representative: **Waldren, Robin Michael**
Marks & Clerk LLP
90 Long Acre
London
WC2E 9RA (GB)

(54) COMBUSTION HEATER

(57) The combustion heater (1) includes an inner tube (20) having a supply passage (21) for combustion gas (G) in an inner portion, and an outer tube (10) disposed to provide a separated combustion space (30) in an outer periphery of the inner tube. A hole part (24) for ejecting the combustion gas being formed on a tube wall of the inner tube and a radiation promoting surface (20B) is disposed on an outer periphery of the inner tube. This structure suppresses excess temperature increase in the inner tube and improves heating efficiency in the combustion heater.

FIG. 1A



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Description

TECHNICAL FIELD

[0001] The present invention relates a combustion heater that combusts a premixed gas of a fuel gas and combustion air. This application claims the benefit of Japanese Patent Application 2008-22976, filed in Japan on February 1, 2008, the entire disclosure of which is incorporated by reference herein.

BACKGROUND ART

[0002] Conventionally, a radiant tube burner has been manufactured in which a completely premixed gas of a fuel gas and combustion air is combusted in a heat-resistant round tube (radiator tube) to thereby use the resulting flame to cause the radiator tube to be red hot. Such a burner is used as an elongated heat source without exposure of a flame in heating furnaces and heaters. Furthermore a combustion burner is known in which combustion gas is combusted in an inner tube and a direction of flow is varied by collision of a jet of combustion gas with a shield surface disposed orthogonally thereto to thereby extract heat from the radiator tube.

[0003] In this type of combustion heater, since combustion is completed midway in the radiator tube, disadvantages include the fact that it is difficult to obtain a uniform temperature distribution along the entire tube length, and the fact that a large amount of nitrogen oxides (NOx) is produced. In Patent Literature 1, a combustion heater is disclosed which includes a porous tube having an inner section acting as a supply passage for a premixed gas and, a radiator tube disposed coaxially to the outer periphery of the porous tube. A premixed gas is ejected radially from the porous tube and forms laminar flow. In a medium of the radiator tube and the porous tube, combustion is executed on a cylindrical surface between the radiator tube and the porous tube on which the rate of flow of the premixed gas balances the flame propagation speed to thereby obtain a higher uniform temperature on the whole of the radiator tube and facilitate high heat generation and low NOx production.

[Patent Literature 1] Japanese Patent Application, First Publication No. 6-241419

DISCLOSURE OF THE INVENTION

[Problem to be Solved by the Invention]

[0004] However the conventional techniques above entail the following problems.

Since an inner tube disposed on an inner portion of the outer tube that forms the radiator tube is extremely a high temperature by the combustion gas flowing on an outer periphery thereof, there is a chance that the temperature of uncombusted gas flowing in the inner tube becomes excessively high and the uncombusted gas forms a mixture gas of fuel and an oxidizing agent, thermal damage may be wreaked result from spontaneous ignition.

Furthermore residual deformation or the like may be caused by bending of the inner tube by heat and therefore preferred combustion characteristics (heating characteristics) may not be obtained.

[0005] The present invention is proposed in view of the points above and has the object of providing a combustion heater which suppresses excessive temperature increase in an inner tube and which improves heating efficiency.

[Means for Solving the Problem]

[0006] The present invention is configured in the manner below in order to achieve the above object.

A combustion heater according to the present invention includes an inner tube having a supply passage for combustion gas in an inner portion, and an outer tube disposed to provide a separated combustion space in an outer periphery of the inner tube. A hole part for ejecting the combustion gas is formed on a tube wall of the inner tube. A radiation promoting surface is disposed on an outer periphery of the inner tube.

Since the combustion heater according to the present invention promotes emission of heat as radiant heat (heat emission) from the inner tube which is heated and undergoes temperature increase, excessive temperature increase in the inner tube can be suppressed. Furthermore since the outer tube is heated by radiant heat emitted from the inner tube, heating efficiency by the outer tube can be improved. When the inner tube has a low temperature, since the heat transfer amount resulting from radiation is small, almost no damage is caused due to heating of combustion gas (uncombusted gas) in the supply passage (heat transfer by radiant heat is proportional to the fourth power of the temperature).

[0007] The radiation promoting surface preferably adopts a configuration in which a coated surface is provided on an outer peripheral surface of the inner tube.

In this manner, the present invention facilitates formation of a radiation promoting surface by coating a radiation promoting material in the form of a coating, paint or the like on an outer peripheral surface of an inner tube.

[0008] Furthermore in the present invention, a configuration is preferably adopts in which a radiation promoting surface is provided on an inner peripheral surface of the outer tube.

In this manner, in the present invention, radiant heat from the inner tube (radiation promoting surface) and radiant heat from the flame in the combustion space can be effectively absorbed by the outer tube to thereby further improve heating efficiency through the outer tube.

[0009] In the above configuration, a configuration is preferably adopts in which a radiation promoting surface is a coated layer provided on the inner peripheral surface.

In this manner, the present invention facilitates formation of a radiation promoting surface by coating a radiation promoting material in the form of a coating, paint or the like on an inner peripheral surface of the outer tube.

The radiation promoting surface may be configured by using the radiation promoting material to form an inner tube and an outer tube other than the coated layer.

The radiation promoting surface is preferably formed using a ceramic binder.

[0010] The present invention preferably adopts a configuration in which a heat transfer member is provided to connect the inner tube and the outer tube in the combustion space and to transfer heat between the outer tube and the inner tube.

In this manner, in the present invention, since heat in the inner tube can be transferred to the outer tube through the heat transfer member, excessive temperature increase in the inner tube can be suppressed and the heat efficiency through the outer tube can be improved.

[0011] In the present invention, a configuration is preferably adopted in which the outer peripheral surface of the inner tube has a first region in which a distance to the inner peripheral face of the outer tube is shortest, and a second region in which the distance is longer than the first region, and the hole part is disposed in the first region and forms a stagnation point for combustion gas on an inner peripheral surface of the outer tube.

In this combustion heater, formation and maintenance of a stable flame is facilitated (in other words, without causing cost increases) by igniting (lighting) combustion gas in the periphery of a stagnation point where the flow speed is approximately zero. In the conventional example, a gas flow speed must be increased to form a stagnation point. Consequently a discharge route for combustion gas cannot be ensured completely maintained and there is the possibility that the flame will extend to the inner peripheral surface of the outer tube and that a flame will only be formed on both axial ends sides. In contrast, the present invention forms and retains a stable flame on an inner peripheral face of the outer tube facing a hole part by providing a hole part in the second region in which the distance to the inner peripheral face of the outer tube is short. Furthermore a discharge route for combustion gases can be ensured between the inner peripheral face of the outer tube and the second region including the region on the opposite side to the first region.

Furthermore in the present invention, since the flame is formed and retained at a stagnation point on the inner peripheral face of the outer tube, efficient heating is enabled through the outer tube.

[0012] The inner tube is preferably disposed with an eccentric position to the outer tube and preferably adopts a configuration in which the hole part is formed in an outer peripheral face positioned in an eccentric direction of the inner tube.

In this manner, the present invention easily forms the first region in which the distance between the inner peripheral face of the outer tube and the outer peripheral face of the inner tube is short.

When the inner tube is disposed in an eccentric position to the outer tube, a configuration is preferably adopted in which a plurality of inner tubes is disposed at an interval in a peripheral direction about the axial center of the outer tube.

In this manner, in the present invention, a plurality of flames can be formed and retained at an interval in a peripheral direction with respect to the inner peripheral face of the outer tube, and thereby more efficient heating is possible.

Furthermore in the present invention, a configuration can be adopted in which the inner tube and the outer tube are disposed concentrically.

[0013] The present invention preferably adopts a configuration in which a supporting member supports a distal end of the inner tube, that is cantilever supported at a base end, between the inner tube and the outer tube, and maintains an interval between the outer peripheral surface of the inner tube and the inner peripheral surface of the outer tube. The supporting member may be tabular, or may be rod-shaped and suspended between the outer tube and the inner tube.

In this manner, in the present invention, it is possible to prevent production of a vibration in the distal end of the inner tube which results in loss of a fixed interval between the outer peripheral face of the inner tube and the inner peripheral face of the outer tube at a base end and a distal end and thereby ensure a fixed interval between the first region forming the hole part and the inner peripheral surface of the outer tube. Consequently, stagnation points can be continuously formed in a stable manner and thereby formation and maintenance of a stable and continuous flame is possible.

[0014] The present invention preferably adopts a configuration in which a stagnation point formation member is provided facing the hole part along an axial direction of the combustion space to thereby form a stagnation point of combustion gases ejected from the hole part.

Thus in the combustion heater according to the present invention, formation and maintenance of a stable flame is facilitated (in other words, without causing cost increases) by igniting (lighting) combustion gas in the periphery of a stagnation point formed on a surface of the stagnation point formation member and where the flow speed is approximately zero. In the conventional example, a high gas flow speed is required to form the stagnation point and consequently a discharge route for combustion gas cannot be maintained and there is the possibility that the flame will extend to the inner peripheral surface of the outer tube and that a flame will only be formed on both axial ends. In contrast, the present invention forms and retains a stable flame on the surface of the stagnation point formation member facing the hole part and a discharge route for exhaust gases can be maintained in a region in which the inner tube and the stagnation point formation member are not facing.

[0015] A configuration is preferably adopted in which

the stagnation point formation member is disposed coaxially to the outer tube, and the inner tube includes a plurality of hole parts oriented toward the central axis and disposed around the central axis.
In this manner, in the present invention, a stable flame and a stagnation point for combustion gases can be formed and maintained around the central axis of the outer tube and thereby enable heating of the outer tube while suppressing the temperature distribution.

[0016] In the present invention, a configuration is preferably adopted which includes a supporting member which supports a distal end of the stagnation point formation member and the inner tube, that is cantilever supported at a base end, with the outer tube, and maintains an interval between the outer peripheral surface of the inner tube and the stagnation point formation member, and the inner peripheral surface of the outer tube. The supporting member may be tabular, or may be rod-shaped and suspended between the outer tube and the inner tube.
In this manner, in the present invention, it is possible to prevent production of a vibration in the distal end of the inner tube and the stagnation point formation member which results in loss of a fixed interval between the outer peripheral face of the stagnation point formation member and the inner tube, and the inner peripheral face of the outer tube at a base end and distal end. A fixed interval can be ensured between the hole parts and the inner peripheral surface of the outer tube and the stagnation point formation member. Consequently, stagnation points can be continuously formed in a stable manner and thereby formation and maintenance of a stable and continuous flame is possible.

[0017] In the present invention, a configuration is preferably adopted in which the supporting member is disposed further towards the distal end than the hole part positioned furthest towards the distal end, and has a size which covers the whole combustion space.
In this manner, in the present invention, CO production resulting from retention and non-combustion of combustion gas in the low-temperature distal end of the outer tube can be avoided.

[0018] The supporting plate preferably adopts a configuration of freely displacing in an axial direction relative to the outer tube.
In this manner, in the present invention, even when there is a large difference in the amount of thermal expansion particularly in an axial direction because of a temperature difference between the inner tube and the outer tube, since the supporting plate displaces relative to the outer tube, deformation or the like of the supporting plate does not occur and an interval between the outer peripheral face of the inner tube and the inner peripheral face of the outer tube can be maintained.

[0019] In the present invention, a configuration is preferably adopted in which a second hole part for ejecting combustion gases is provided at a position separated from the stagnation point in the inner tube.
In this manner, in the present invention, propagation of a flame, that is formed and retained at a stagnation point, is enable into the combustion gas ejected from the second hole part. Consequently, in the present invention, the pressure loss resulting from use of a porous body can be avoided. Furthermore since the introduced amount of heat can be increased without increasing the length of the inner tube and the outer tube, it is possible to prevent an increase in the size of the device resulting for example from increasing the length of the inner tube and outer tube. In the present invention, since pressure loss can be suppressed, application is possible to low-pressure city gas lines.

[0020] The second hole part preferably adopts a configuration in which the second hole part is disposed on both sides sandwiching the first region or is disposed alternately with the hole part along the first region, or a configuration in which the second hole part is disposed on both sides sandwiching a region facing the stagnation point formation member and is disposed alternately with the hole part along the facing region.
In this manner, the present invention enables formation and maintenance of a flame and equal distribution of flame propagation of the flame.

[0021] Furthermore the present invention preferably adopts a configuration in which the supply passage in the inner tube is closed at the distal end.
In this manner, the present invention provides a small low-cost combustion heater that supplies combustion gas from a base end and enables discharge of exhaust gases.

[Effects of the Invention]

[0022] According to the combustion heater of the present invention, excessive temperature increase in the inner tube is suppressed and heating efficiency can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023]

FIG. 1A is a front sectional view of a combustion heater 1 according to a first embodiment.
FIG. 1B is a side sectional view of a combustion heater 1 according to a first embodiment.
FIG. 2A is a plan view of the inner tube seen from a first region side.
FIG. 2B is side sectional view of a combustion heater including an inner tube.
FIG. 3A is a front sectional view of a combustion heater 1 according to a third embodiment.
FIG. 3B is a side sectional view of the combustion heater according to the third embodiment.
FIG. 4 is a detailed view of the principal components of a combustion heater according to a fourth embodiment.

FIG. 5 is a pattern diagram of an outer tube and inner tube according to a fifth embodiment.

FIG. 6A is a front sectional view of a combustion heater according to a sixth embodiment.

FIG 6B is a side sectional view of the combustion heater according to the sixth embodiment.

FIG 6C is an enlarged view of the principal components of the combustion heater according to the sixth embodiment.

FIG. 7A is a front sectional view of a combustion heater according to a seventh embodiment.

FIG 7B is a side sectional view of the combustion heater according to the seventh embodiment.

FIG. 7C is an enlarged view of the principal components of the combustion heater according to the seventh embodiment.

FIG. 7D is an enlarged view of the principal components of the combustion heater according to the seventh embodiment.

FIG 8A is a front sectional view of a combustion heater according to an eighth embodiment.

FIG. 8B is a side sectional view of the combustion heater according to the eighth embodiment.

FIG. 8C is an enlarged view of the principal components of the combustion heater according to the eighth embodiment.

FIG. 9 is a detailed view of the principal components of a combustion heater disposing the inner tube and the outer tube in a concentric orientation.

BEST MODES FOR CARRYING OUT THE INVENTION

[0024] The aspects of the embodiments of a combustion heater according to the present invention will be described below making reference to FIG. 1 to FIG. 8. Since each figure used in the description below depicts each member with a size enabling recognition thereof, suitable modification may be made to the dimensions of each member.

(First Embodiment)

[0025] FIG. 1A is a front sectional view of a combustion heater 1 according to a first embodiment and FIG. 1B is a side sectional view.

The combustion heater 1 schematically includes an outer tube 10 acting as a radiation tube made from a heat-resistant metal and closed at a distal end, and a heat-resistant metal inner tube 20 cantilever-supported by a support means (not shown) at a base end (left side of FIG. 1A), disposed in an inner portion of the outer tube 10 and having a supply passage 21 for combustion gas G in an inner portion.

[0026] A combustion gas G includes a premixed gas of fuel and air or a premixed gas of fuel and an oxygen-containing gas. The fuel includes methane, propane or the like. Furthermore a liquid fuel may be used by providing a position for prevaporization.

[0027] The outer tube 10 has a round cylindrical shape with a bottom closed at a distal end and is connected at the base end with a discharge tube 11 which discharges combusted gas. A radiation promotion layer (radiation promotion surface) 10B for promoting radiation is formed on the inner peripheral face 10A of the outer tube 10. The radiation promotion layer 10B will be described below.

[0028] The inner tube 20 has a round cylindrical shape with a bottom closed at a distal end in the same manner as the outer tube 10 and is connected at the base end with a premixed gas supply mechanism (not shown) for supplying the combustion gas G above. For example, the whole premixed gas may be supplied with an air excess ratio of 1.0 - 1.6.

The inner tube 20 is disposed eccentrically on an inner side of the outer tube 10 near the distal end to thereby form a combustion space 30 between the outer peripheral face 20A and the inner peripheral face 10A of the outer tube 10. A radiation promotion layer (radiation promotion surface) 20B is formed in the same manner as the radiation promotion layer 10B above on the outer peripheral surface 20A facing the combustion space 30 of the inner tube 20.

[0029] The radiation promotion layers 10B, 20B are formed by a coated layer coated by thermal-spraying onto an inner peripheral surface 10A or outer peripheral surface 20A using a ceramic binder for example. The coated layer uses a material which is heat resistant to a temperature of approximately 800°C. Furthermore high adhesion and durability can be enabled by using thermal spraying to form the radiation promotion layers 10B, 20B.

[0030] The outer peripheral surface 20A of the inner tube 20 has a first region 22 at which a distance to the inner peripheral surface 10A of the outer tube 10 is shortest, and a second region 23 at which the distance is longer than the first region 22. More specifically, on the outer peripheral surface 20A, the first region (bus line) 22 which has the shortest distance to the inner peripheral surface of 10A of the outer tube 10 is formed in an axial direction in an eccentric orientation in the inner tube 20 (in FIG. 1, refer to lower section of FIG. 1B), and in other regions, the second region 23 is formed which has a longer distance to the inner peripheral surface 10A than the first region 22.

[0031] In the first region 22, a plurality of hole parts 24 (five in this example) spaced at an interval along the first region 22 and positioned on the distal end of the inner tube 20 pierce the tube wall along an axial direction. An ignition apparatus (not shown) is provided in proximity to a position facing the hole parts 24 of the outer tube 10.

The outer peripheral surface 20A disposed further towards the base end (left side of FIG. 1A) than the region forming the hole parts 24 is a preheating region P for preheating the combustion gas G of the supply passage 21 using combusted gases (flame).

[0032] Next, the combustion operation in the combustion heater 1 will be described.

Combustion gas G supplied from the premix gas supply mechanism to the supply passage 21 of the inner tube 20 is ejected from the hole part 24 towards the inner peripheral surface 10A of the outer tube 10.

Since the hole part is provided to the first region 22 at which a distance to the inner peripheral surface 10A of the outer tube 10, combustion gas G which is ejected from the hole part 24 collides with the inner peripheral surface 10A of the outer tube 10, forms a stagnation point S on the inner peripheral surface 10A corresponding to each hole part 24, and is branched distribution along the inner peripheral surface 10A at each stagnation point S.

[0033] An ignition apparatus ignites the combustion gas G in proximity to a stagnation point S to thereby form a flame. The combustion gas G branching at a stagnation point S flows from the proximity to the first region 22 which has a small sectional area into the combustion space which is on the opposite side to the first region 22 and has a large sectional area. Further, as shown in FIG 1B, a flame F is formed on both sides of the inner tube 20 of the combustion space 30.

Since the flow speed of the gas at the stagnation point S is zero at this time, a resulting flame is stably retained as a result of the circulating flow formed in proximity to the jet towards the stagnation point S.

[0034] The combustion gas flows through the combustion space 30 and is discharged from a discharge tube 11. However heat exchange with the combustion gas (uncombusted gas) G occurs with the tube wall of the inner tube 20 in the preheating region P of the inner tube 20 in the section from the combustion space 30 to the discharge tube 11.

In this manner, the combustion gas G in the supply passage 21 is ejected from the hole part 24 in a high-temperature pre-heated state and thereby increases the stability of the flame F. Thus even when the gas G is ejected into the confined combustion space 30, uncombusted components are not produced and stable combustion is enabled.

[0035] Although the inner tube 20 in particular reaches a high temperature as a result of the heat of the combustion gas and the heat of the flame F, since the radiation promotion layer 20B is provided on the outer peripheral surface 20A of the inner tube 20, emission of heat (radiation) of radiant heat is promoted by increasing the thermal emissivity of the inner tube 20. On the other hand, since the radiation promotion layer 10B is also provided on the inner peripheral surface 10A of the outer tube 10, absorption of radiant heat from the flame F and radiant heat from the inner tube 20 is promoted.

[0036] In the aspects of the present embodiments as described above, emission of heat from the inner tube 20 as radiant heat is promoted by the radiation promotion layer 20B of the inner tube 20. Consequently excessive temperature increase of the inner tube 20 can be suppressed and a large part of the heat in the inner tube 20 can be used for heating (preheating) of the combustion gas G in an inner section since the radiation capacity falls even at a low temperature thereby a heating characteristic is maintained. Consequently, a preheating temperature for the combustion gas G can be regulated by regulating the structure (material, thickness, distribution and the like) of the radiation promotion layer 20B.

[0037] The radiant heat enables heating of the outer tube 10 and improves the heating efficiency through the outer tube 10. In particular, in the present embodiment, since the radiation promotion layer 10B is also provided on the inner peripheral surface 10A of the outer tube 10, the heat of the combustion space 30 is effectively absorbed by the outer tube 10 and the heating efficiency through the outer tube 10 is further improved.

In the present embodiment, since combustion gas G is ejected from the hole part 24 formed on the tube wall of the inner tube 20 and the flame F is retained at the stagnation point S, cost increases caused by provision of a porous tube can be avoided and formation of a stable flame can be facilitated even when varying a flow amount. In addition, in the present embodiment, merely increasing the number of holes 24 enables an increase in the combustion amount. Thus manufacturing costs for the combustion heater 1 can be suppressed by use of few components and a simple structure. There is no need to considerably increase the supply pressure of the combustion gas G such as when using a porous tube, and application to low-pressure city gas lines is sufficiently enabled. Furthermore in the present embodiment, a stable flame F can be formed and retained in a simple manner and at a low cost by forming the outer peripheral surface 20A of the inner tube 20 and the first region 22 which has a short distance to the inner peripheral surface 10A of the outer tube 10 with a simple configuration in which the inner tube 20 is disposed eccentrically with respect to the outer tube 10.

[0038] When a porous tube is used and the supply pressure of gas is increased, there is the possibility that the flame extends to the outer tube and will not be maintained, and that the discharge route for combusted gas will not be retained. However in the present embodiment, a sufficient discharge route is retained in the combustion space 30 facing the region (second region) opposite to the first region 22.

[0039] In the present embodiment, since a stagnation point S is formed on an inner peripheral face 10A of the outer tube 10 and the flame F is maintained along the inner peripheral surface 10A, extraction of heat is not impeded such as when a tube-shaped flame is separated from the outer tube 10, and heating efficiency through the outer tube 10 is improved.

(Second Embodiment)

[0040] Next, a second embodiment of the combustion heater 1 will be described making reference to FIG 2.

In the figure, those components which are the same as the components of the first embodiment shown in FIG. 1 are denoted by the same reference numerals and description thereof will not be repeated.

The point of difference of the second embodiment from the first embodiment is that a second hole part for reducing gas pressure loss is provided separately to the hole part 24.

[0041] FIG. 2A is a plan view of the inner tube 20 seen from the first region 22 and FIG 2B is side sectional view of the combustion heater 1 including the inner tube 20.

As shown in FIG 2A, in the tube wall of the inner tube 20, a hole part 24 is provided in the first region 22 and in addition a second hole part 25 is provided alternating with the hole part 24 along the first region 22 on both sides sandwiching the first region 22.

As shown in FIG 2B, combustion gas G is ejected from the second hole part 25 towards a position separated from the stagnation point S.

The second hole part 25 is provided at a position of stable propagation of a flame F formed at the stagnation point S in combustion gas G ejected from the second hole part 25.

In other respects, the configuration is the same as the first embodiment and includes that the radiation promotion layer 20B is provided on the outer peripheral surface 20A of the inner tube 20 and that the radiation promotion layer 10B is provided on the inner peripheral surface 10A of the outer tube 10.

[0042] In the combustion heater 1 having the above configuration, the same operation and effect as the first embodiment is obtained and a flame F which is formed and maintained at a stagnation point S can be propagated in combustion gas G ejected expelled from the second hole part 25 to thereby facilitate of combustion gas under an increased flow rate. As a result, in the present embodiment, pressure loss caused for example by use of a porous body can be avoided. Furthermore the introduced amount of heat can be increased without increasing the length of the inner tube and the outer tube to increase the flow amount. As a result, it is possible to prevent an increase in the size of the device resulting for example from increasing the length of the inner tube 20 and outer tube 10. In the present invention, since pressure loss can be suppressed, application is possible to low-pressure city gas lines.

In the present embodiment, since the hole part 24 and the second hole part 25 are disposed alternately along the first region 22, and the second hole part 25 is disposed on both sides sandwiching the first region 22, formation and maintenance of a flame F and flame propagation are produced in a stable state with an substantially equal distribution.

(Third Embodiment)

[0043] Next, a third embodiment of the combustion heater 1 will be described making reference to FIG 3.

In the figure, those components which are the same as the components of the first embodiment shown in FIG. 1 are denoted by the same reference numerals and description thereof will not be repeated.

The point of difference of the third embodiment from the first embodiment resides in the provision of a supporting plate on the distal end of the inner tube 20.

[0044] As shown in FIG. 3A, a supporting plate (supporting member) 40 formed from a heat-resistant metal or the like in a direction which is orthogonal to the axial direction is provided further towards a distal end than the hole part 24 of the inner tube 20. As shown in FIG. 3B, the supporting plate 40 is engaged and fixed to the outer peripheral surface 20A of the inner tube 20 by a through hole 40A and is supported to freely displace in an axial direction on the inner peripheral face 10A of the outer tube 10 by an outer peripheral surface 40B.

That is to say, the supporting plate 40 is integrally formed with the inner tube 20 to have a dimension which enables closure of the whole combustion space 30 and is provided to freely displace in an axial direction with reference to the outer tube 10.

In other respects, the configuration is the same as the first embodiment and includes the provision of the radiation promotion layer 20B on the outer peripheral surface 20A of the inner tube 20 and the provision of the radiation promotion layer 10B on the inner peripheral surface 10A of the outer tube 10 (however in the partial enlarged view shown in FIG. 3A and in FIG. 3B, the radiation promotion layers 10B, 20B are omitted).

[0045] In the combustion heater 1 having the above configuration, the same operation and effect as the first embodiment is obtained, and since distal end side of the inner tube 20 which is cantilever supported on a base end side is supported by the supporting plate 40, a fixed interval can be maintained between the outer peripheral surface 20A of the inner tube 20 (that is to say, the first region 22) and the inner peripheral surface 10A of the outer tube 10. Furthermore even when the high-temperature inner tube 20 undergoes thermal expansion by reason of a temperature difference between the outer tube 10 and the inner tube 20, deformation or bending can be prevented since the supporting plate 40 which is integrally formed with the inner tube 20 can displace in an axial direction relative to the inner peripheral surface 10A of the outer tube 10.

[0046] Combustion gas G which is ejected from the hole part 24 which is positioned further towards a distal end side collides with the inner peripheral surface 10A of the opposed outer tube 10, forms a stagnation point S on the inner peripheral surface 10A at each hole part 24, and branches along the inner peripheral surface 10A at the stagnation point S. However since the combustion space 30 which is opposed to the first region 22 is closed by the supporting plate 40, combustion gas G which is branched towards the supporting plate 40 collides with the supporting plate 40 and then is introduced into the combustion space 30 facing the opposite side (second region 23) to the first region 22. Consequently, ignition of the peripheral combustion gas G is facilitated by a flame which is retained at the stagnation point S.

[0047] Further, in the present embodiment, since the combustion space 30 is partitioned by the supporting plate 40, it is possible to avoid a situation in which the combustion gas G accumulates in an uncombusted state in the distal end portion of the outer tube 10 which has a relatively low temperature and results in production of CO.
In the above embodiment, although the supporting member is configured as a tabular supporting plate 40, the invention is not limited in this respect, and for example, it may employ a supporting member which includes a ring member supported to freely displace in an axial direction on the inner peripheral surface 10A of the outer tube 10 and a rod member which connects the ring member and the inner tube 20.

(Fourth Embodiment)

[0048] Next, a fourth embodiment which is a modification of the third embodiment above will be described making reference to FIG 4.
In the figure, those components which are the same as the components of the third embodiment shown in FIG. 3 are denoted by the same reference numerals and description thereof will not be repeated.
[0049] As shown in FIG 4, in the present embodiment, a supporting plate 41 is respectively provided on the outer peripheral surface 20A of the outer tube 20 on both sides in the direction of alignment of the hole parts 24 to sandwich the stagnation point S which corresponds to the hole part 24, and is further towards the base end side than the supporting plate 40. The supporting plate 41 has a dimension which closes the combustion space 30 facing the first region 22. More specifically, each supporting plate 41 does not close the whole of the combustion space 30 like the supporting plate 40, but covers only the combustion space 30 in proximity to the first region 22 so that combustion gas G ejected from the hole part 24 can flow into the combustion space 30 on the opposite side, and be discharged from the discharge tube 11. Furthermore each supporting plate 41 protrudes from the tube wall of the inner tube 20 towards the outer tube 10 only on the periphery of the first region 22 so that the position of the inner tube 20 is maintained with respect to the outer tube 10, and is formed in a fan shape for example supported on the inner peripheral surface 10A.
In other respects, the configuration is the same as the third embodiment and includes the provision of the radiation promotion layer 20B on the outer peripheral surface 20A of the inner tube 20 and the provision of the radiation promotion layer 10B on the inner peripheral surface 10A of the outer tube 10.
[0050] In the combustion heater 1 having the above configuration, the same operation and effect as the third embodiment is obtained, and combustion gas G ejected from each hole part 24 collides with the supporting plate 41 and then is introduced into the combustion space 30 facing the opposite side (second region 23) to the first region 22. Consequently, more effective ignition of the peripheral combustion gas G is facilitated by a flame which is retained at the stagnation point S.

(Fifth Embodiment)

[0051] Next, a fifth embodiment of the combustion heater 1 will be described making reference to FIG. 5.
FIG. 5 is a schematic view of an outer tube 10 and inner tube 20 according to a fifth embodiment.
As shown in the figure, an inner tube 20 in the combustion heater 1 according to the present embodiment is provided at an interval in a peripheral direction about the central axis of the outer tube 10 in the combustion space 30 in the outer tube 10. The plurality of inner tubes 20 (in FIG. 5, six are provided at an interval of 60°) is respectively disposed in an eccentric orientation to the outer tube 10. Furthermore in each inner tube 20, a plurality of hole parts 24 (not shown in FIG. 5) is formed at an interval in an axial direction and is positioned in the first region 22 at which the distance between the outer peripheral surface 20A and the inner peripheral surface 10A of the outer tube 10 is shortest.
In other respects, the configuration is the same as the first embodiment and includes the provision of the radiation promotion layer 20B on the outer peripheral surface 20A of the inner tube 20 and the provision of the radiation promotion layer 10B on the inner peripheral surface 10A of the outer tube 10.
[0052] In the combustion heater 1 having the above configuration, combustion gas G is respectively ejected from (the hole parts of) the plurality of inner tubes 20 and a stagnation point is formed on the inner peripheral surface 10A of the outer tube 10 to thereby form a stable plurality of flames about the axis along the inner peripheral surface of the outer tube 10 by ignition of the combustion gas G.
Therefore in addition to obtaining the same operation and effect as the first embodiment, the present embodiment enables heating of the outer tube 10 to a higher temperature.

(Sixth Embodiment)

[0053] Next, a sixth embodiment of the combustion heater 1 will be described making reference to FIG. 6.
In the figure, those components which are the same as the components of the first embodiment shown in FIG. 1 are denoted by the same reference numerals and description thereof will not be repeated.
Although all of the first to the fifth embodiments were configured by formation of a stagnation point S on the inner peripheral face 10A of the outer tube 10, the sixth embodiment will describe formation on the surface of a bluff body (stagnation point and circulating flow formation member).
[0054] As shown in FIG. 6A, the combustion heater 1 according to the present embodiment includes a plurality

of inner tubes 20 and a bluff body (stagnation point and circulating flow formation member) 50 that are formed from a heat-resistant metal, that are cantilever supported by a supporting member (not shown) at a base end (the left end of FIG. 6A) in the combustion space 30 of the outer tube 10 and that is provided with a supply passage 21 for combustion gas G therein.

[0055] As shown in FIG. 6B, a plurality of inner tubes 20 is disposed at an interval about the central axis of the outer tube 10 (in FIG. 6, six are provided at an interval of 60°).

Each inner tube 20 includes a plurality of hole parts 24 (five in the figure) radially provided in the tube wall at intervals along an axial direction at a position facing the bluff body 50 at the distal end and oriented towards the central axis of the outer tube 10.

[0056] The axial line of the bluff body 50 is aligned with the central axis of the outer tube 10 and the circumference thereof is surrounded by inner tubes 20. A concave curve 50A formed about the axis of the inner tube 20 is formed in an axial direction at a position facing each inner tube 20 (hole part 24).

In other respects, the configuration including the provision of the radiation promotion layer 20B on the outer peripheral surface 20A of the inner tube 20 and the provision of the radiation promotion layer 10B on the inner peripheral surface 10A of the outer tube 10 (however in FIG. 6B and in FIG. 6C, the radiation promotion layers 10B, 20B are omitted) is the same as the first embodiment.

[0057] In the combustion heater 1 having the above configuration, as shown in FIG. 6C, combustion gas G supplied to the supply passage 21 of the inner tube 20 is ejected from the respective hole parts 24 towards the concave curve 50A of the bluff body 50.

The combustion gas G ejected from the hole parts 24 collides with the facing concave curve 50A of the bluff body 50 and forms a stagnation point S on the concave curve 50A at each hole part 24 and branches along the concave curve 50A at the stagnation point S.

[0058] An ignition apparatus ignites the combustion gas G in proximity to the stagnation points S to thereby a flame is formed and maintained at the stagnation point S. Since the flow speed of the gas at the stagnation point S at this time is approximately zero, the flame formed by circular flow in the periphery of the jet towards stagnation point S is stably maintained at the stagnation point S.

The combustion gas G which has branched at the stagnation point S flows from the proximity of the bluff body 50 which has a high gas pressure into the combustion space 30 of the inner peripheral surface 10A side of the outer tube 10 which is the opposite side to the bluff body 50 with respect to the inner tube 20.

[0059] The combustion gas flows into the combustion space 30 and is discharged from the discharge tube 11. Heat exchange with the combustion gas (uncombusted gas) G is performed via the tube wall of the inner tube 20 in the preheating region P of the inner tube 20 midway from the combustion space 30 to the discharge tube 11. In this manner, combustion gas G in the supply passage 21 which is preheated to a high temperature is ejected from the hole part 24 in being preheated to a high temperature thereby increase the stability of the flame F. Therefore even when ejected into the confined combustion space 30, uncombusted components are not produced and stable combustion is enabled.

[0060] In the present embodiment as described above, since combustion gas G is ejected from the hole part 24 formed in the tube wall of the inner tube 20 towards the concave curved 50A of the bluff body 50 and retains a flame F at the stagnation point S, cost increases for example caused by provision of a porous tube can be avoided and formation and retention of a stable flame F are facilitated even when varying the flow amount. In addition, in the present embodiment, merely increasing the number of hole parts 24 to increase of the combustion amount. Thus manufacturing costs for the combustion heater 1 can be suppressed by use of fewer components and a simple structure. Further, there is no requirement for considerably increase of the supply pressure of the combustion gas G in contrast to use of a porous tube, and therefore application to low-pressure city gas lines is sufficiently enabled.

Furthermore, since the radiation promotion layer 20B is provided on the outer peripheral surface 20A of each inner tube 20 and the radiation promotion layer 10B is also provided on the inner peripheral surface 10A of the outer tube 10, the heat of the combustion space 30 can be effectively absorbed by the outer tube 10, and heating efficiency is further improved via the outer tube 10.

(Seventh Embodiment)

[0061] Next, a seventh embodiment of the combustion heater 1 will be described making reference to FIG. 7. In the figure, those components which are the same as the components of the sixth embodiment shown in the figure are denoted by the same reference numerals and description thereof will not be repeated.

The different point of difference between the seventh embodiment and the sixth embodiment resides in the fact that a circular tube which is the same as the inner tube 20 is disposed on the central axis of the outer tube 10.

[0062] In other words, as shown by the partial enlarged view in FIG. 7C, in the present embodiment, an inner tube (stagnation point formation member) 120 is axially aligned with central axis of the outer tube 10 and disposed with an interval with respect to the inner tube 20. The inner tube 120 is a round cylinder and is provided with a bottom by closure of a distal end. A premix gas supply mechanism (not shown) for supplying combustion gas G to the supply passage 121 in an inner portion is connected to the base end of the inner tube 20. A radiation promotion layer 120B which is similar to the radiation promotion layer 20B is provided on the outer peripheral surface 120A of the inner tube 120.

[0063] The inner tube 120 includes hole parts 124 for ejecting combustion gas G respectively formed at a position facing each inner tube 20 disposed on a circumference thereof. As shown in FIG 7D, as to the axial orientation, the hole parts 124 are formed at a position facing the outer peripheral surface 20A and do not face the hole parts 24 for each inner tube 20. In other words, the hole parts 24 of the inner tube 20 also face the outer peripheral surface 120A and do not face the hole parts 124 of the inner tube 120.

In other respects, the configuration is the same as the sixth embodiment and includes the provision of the radiation promotion layer 20B on the outer peripheral surface 20A of the inner tube 20 and the provision of the radiation promotion layer 10B on the inner peripheral surface 10A of the outer tube 10 (however in FIG. 7B, the radiation promotion layers 10B, 20B, 120B are omitted).

[0064] In the combustion heater 1 having the above configuration, combustion gas G supplied from the premixed gas supply mechanism to the supply passage 21 of the inner tube 20 is ejected from the respective hole parts 24 towards the outer peripheral surface 120A of the inner tube 120. A stagnation point S for combustion gas G is formed on the outer peripheral surface 120A. Combustion gas G branches at the stagnation point S and flows along the outer peripheral surface 120A.

[0065] On the other hand, combustion gas G supplied to the supply passage 121 of the inner tube 120 is ejected from the respective hole parts 124 towards the outer peripheral surface 20A of the inner tube 20. A stagnation point S for combustion gas G is formed on the outer peripheral surface 20A, and combustion gas G branches at the stagnation point S and flows along the outer peripheral surface 20A. In other words, in the present embodiment, in addition to the inner tube 120, the inner tube 20 also operates as a stagnation point formation member.

[0066] Ignition of the combustion gas G in proximity to the stagnation point S enables formation and retention of a flame at the stagnation point S. Since the flow speed of the gas at the stagnation point S at this time is zero, a resulting flame is stably retained at the stagnation point S.

The combustion gas G branching at the stagnation point S flows into the combustion space 30 on the inner peripheral surface 10A of the outer tube 10 which has a relatively low gas pressure. The combusted gas is discharged from the discharge tube 11.

[0067] In the above embodiment, in addition to obtaining the same operation and effect as the sixth embodiment, since combustion gas G is also ejected from the inner tube 120, more effective heating is enabled. Furthermore since a stagnation point S is also formed on the outer peripheral surface 20A of the inner tube 20 which is disposed on a circumference thereof and thereby forms and retains a flame, a stable flame can be formed and retained over a wide range.

The hole part 24 of the inner tube 20 and the hole part 124 of the inner tube 120 may be provided at a mutually opposed position. However provision is preferred at a mutually facing position on the outer peripheral surface 120A, 20A in order to form a more stable stagnation point S.

(Eighth Embodiment)

[0068] Next, an eighth embodiment of the combustion heater 1 will be described making reference to FIG 8.

In the figure, those components which are the same as the components of the sixth embodiment shown in FIG. 6 are denoted by the same reference numerals and description thereof will not be repeated.

[0069] As shown in FIG. 8B, in a present embodiment, a plurality of inner tubes 20 is mutually disposed at an interval in a peripheral direction about the central axis (in the figure, six are provided at an interval of 60°) without providing an inner tube on the central axis of the outer tube 10.

As shown by the partial enlarged view in FIG. 8C, each inner tube 20 includes respective hole parts 24 ejecting combustion gas G to a position facing the adjacent inner tube 20.

In the same manner as the seventh embodiment as shown above by the partially enlarged view in FIG. 7D, a position of the axial direction of the hole parts 24 is preferably positioned alternately for adjacent inner tubes 20 so that ejected combustion gas G collides with an outer peripheral surface 20A of the adjacent inner tube 20.

In other respects, the configuration is the same as the sixth embodiment and includes the provision of the radiation promotion layer 20B on the outer peripheral surface 20A of the inner tube 20 and the provision of the radiation promotion layer 10B on the inner peripheral surface 10A of the outer tube 10 (however in FIG. 8B, the radiation promotion layers 10B, 20B are omitted).

[0070] In the combustion heater 1 having the above configuration, in addition to obtaining the same operation and effect as the sixth embodiment, since a stagnation point S and a flame are formed at a more proximate position to the outer tube 10 that acts as a heat radiation tube, heat extraction via the outer tube 10 is facilitated and heating efficiency can be improved.

[0071] Although the preferred embodiments of the present invention have been described above making reference to the attached figures, it is obvious that the present invention is not limited to the examples. The configuration or assembly of each constituent member described in the examples above are merely exemplary and various modifications are possible resulting from design requirements or the like within a scope which does not depart from the spirit of the present invention.

[0072] For example, in the second embodiment, although a configuration was described in which a second hole part 25 was provided in addition to the hole part 24, the invention is not limited in this respect, and a config-

uration of the inner tube 20 is possible with respect to the third to the eighth embodiments in which a second hole part 25 is provided in addition to the hole part 24.
In the same manner, in the third embodiment, although a supporting plate 40 was provided on a distal end of the inner tube 20, the same operation and effect as the third embodiment may be enabled in the fourth to the eighth embodiments by a configuration in which a supporting plate is provided on the distal end.

[0073] In the embodiments above, a configuration was adopted in which a first region 22 having the shortest distance between the outer peripheral surface 20A and the inner peripheral surface 10A of the outer tube 10 was formed by disposing each inner tube 20 in an eccentric orientation to the outer tube 10. However the invention is not limited in this regard and a concentric orientation is also possible.

[0074] In the embodiments above, although a configuration was described in which a radiation promotion layer was provided on both of the inner peripheral surface 10A of the outer tube 10 and the outer peripheral surface 20A of the inner tube 20, the invention is not limited in this regard and the radiation promotion layer may be provided only on the outer peripheral surface 20A of the inner tube 20.
In the embodiments above, a configuration was described in which the radiation promoting surface was formed by the radiation promotion layers 10B, 20B (120B). However in addition, the outer tube 10 and the inner tube 20, 120 may be configured by the material that forms the radiation promotion layers 10B, 20B, 120B and the inner peripheral surface 10A and the outer peripheral surface 20A, 120A may themselves include a radiation promotion characteristic.

[0075] In the embodiments above, a configuration was adopted in which the each inner tube 20 was disposed eccentrically with respect to the outer tube 10. However the invention is not limited in this respect and for example, as shown in FIG. 9, the inner tube 20 that includes a hole part 24 disposed in a radial fashion and includes a radiation promotion layer 20B may be disposed concentrically to the outer tube 10 which has the radiation promotion layer 10B.

[Industrial Applicability]

[0076] As described above, the combustion heater according to the present invention enables suppression of excessive temperature increase in an inner tube and improves heating efficiency.

Claims

1. A combustion heater comprising an inner tube having a supply passage for combustion gas in an inner portion, and an outer tube disposed to provide a separated combustion space in an outer periphery of the inner tube, a hole part for ejecting the combustion gas being formed on a tube wall of the inner tube and a radiation promoting surface is disposed on an outer periphery of the inner tube.

2. The combustion heater according to claim 1, wherein the radiation promoting surface is a coated layer provided on the outer peripheral surface of the inner tube.

3. The combustion heater according to claim 1 further comprising a radiation promoting surface on the inner peripheral surface of the outer tube.

4. The combustion heater according to claim 3, wherein the radiation promoting surface is a coated layer provided on the inner peripheral surface.

5. The combustion heater according to claim 1, wherein the radiation promoting surface is formed using a ceramic binder.

6. The combustion heater according to claim 1, wherein a heat transfer member is provided to connect the inner tube and the outer tube in the combustion space and to transfer heat between the outer tube and the inner tube.

7. The combustion heater according to claim 1, wherein the inner tube and the outer tube are disposed concentrically.

8. The combustion heater according to claim 1, wherein the inner tube is disposed eccentrically to the outer tube.

FIG. 1A

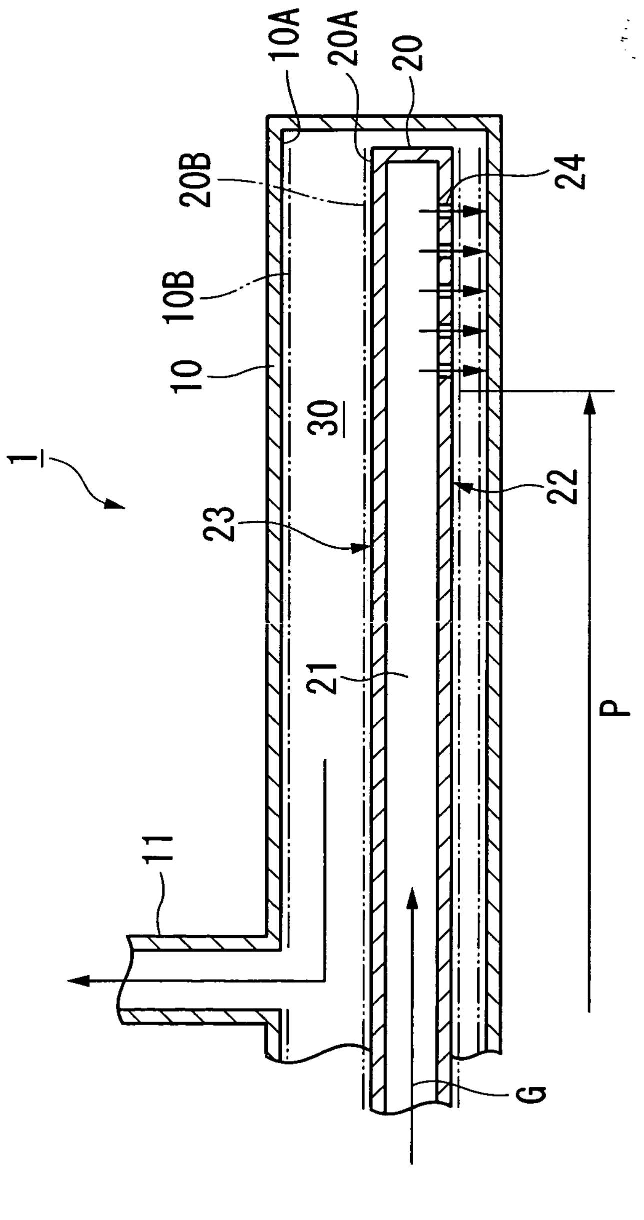

1
10A
20A
20
20B
24
10B
10
30
23
22
21
P
11
G

FIG. 1B

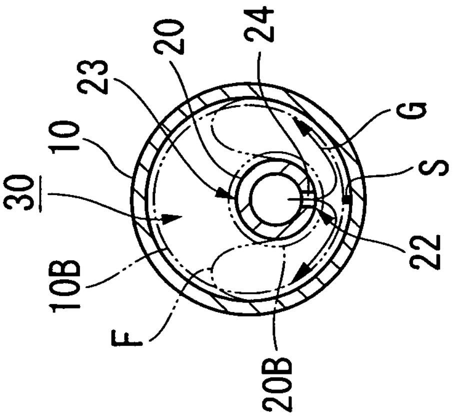

20
24
23
10
30
G
S
10B
22
F
20B

FIG. 2B

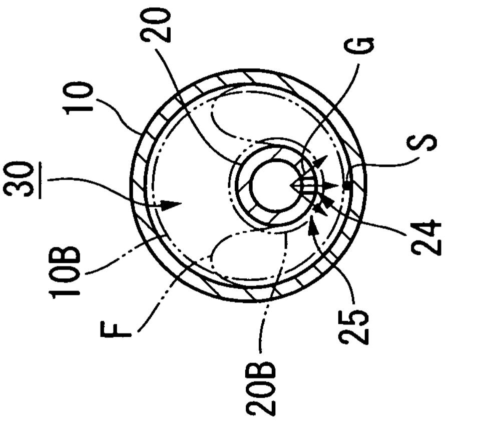
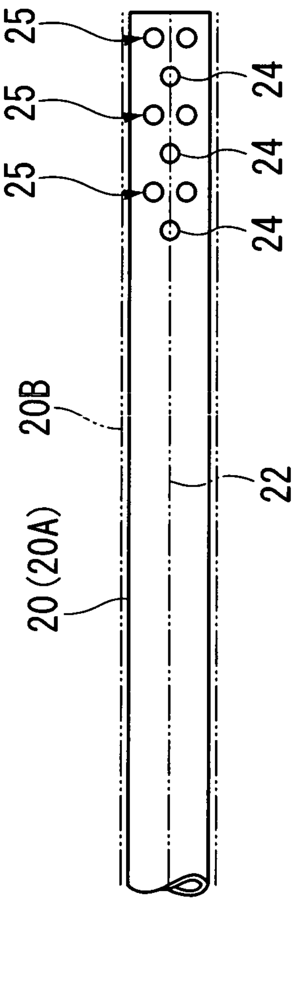


FIG. 2A



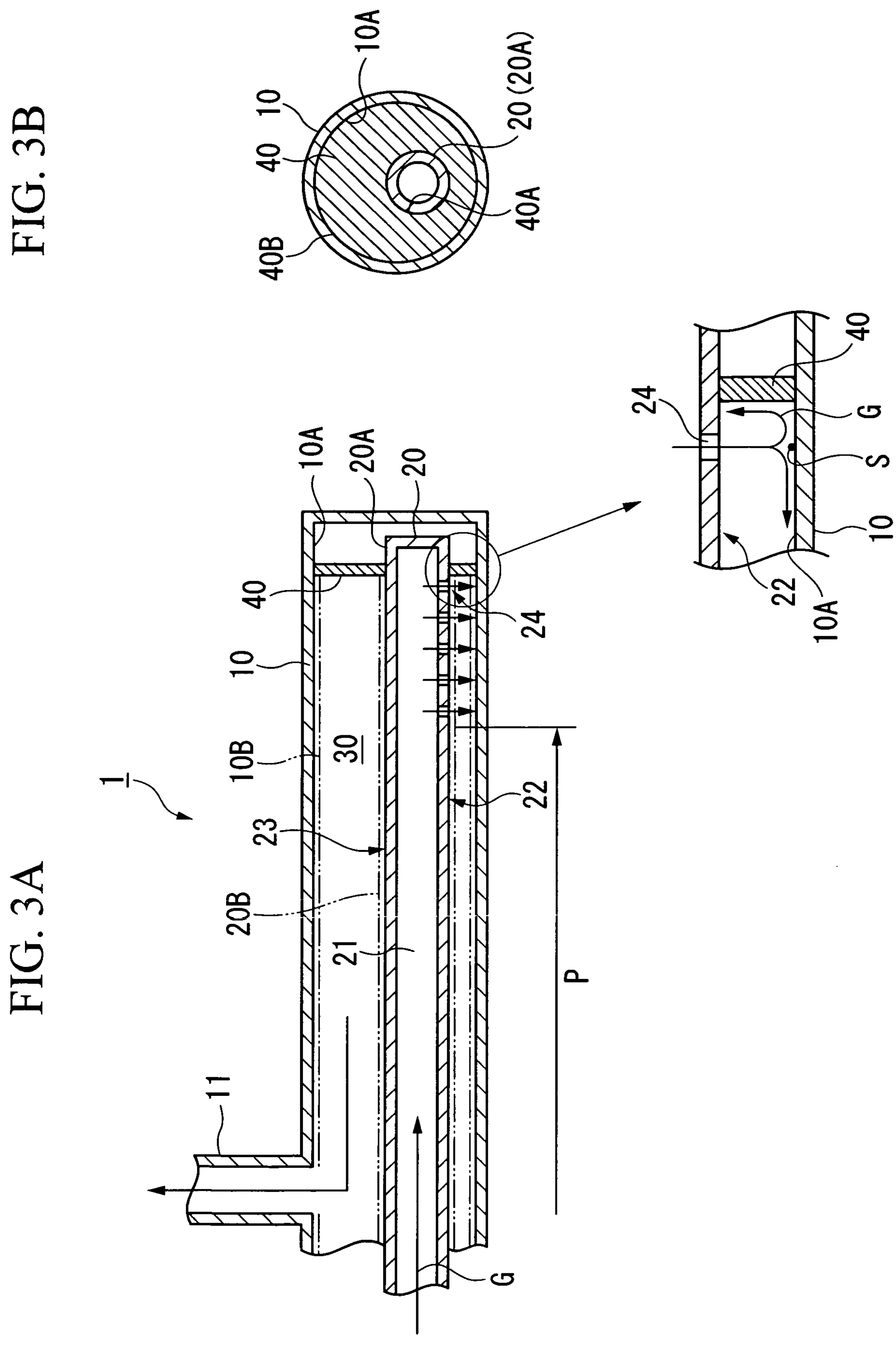


FIG. 3B
10A
10
40
40B
20(20A)
40A
FIG. 3A
1
11
10A
20A
20
40
10
10B
30
23
20B
21
22
24
P
G
24
40
G
S
22
10
10A

FIG. 4

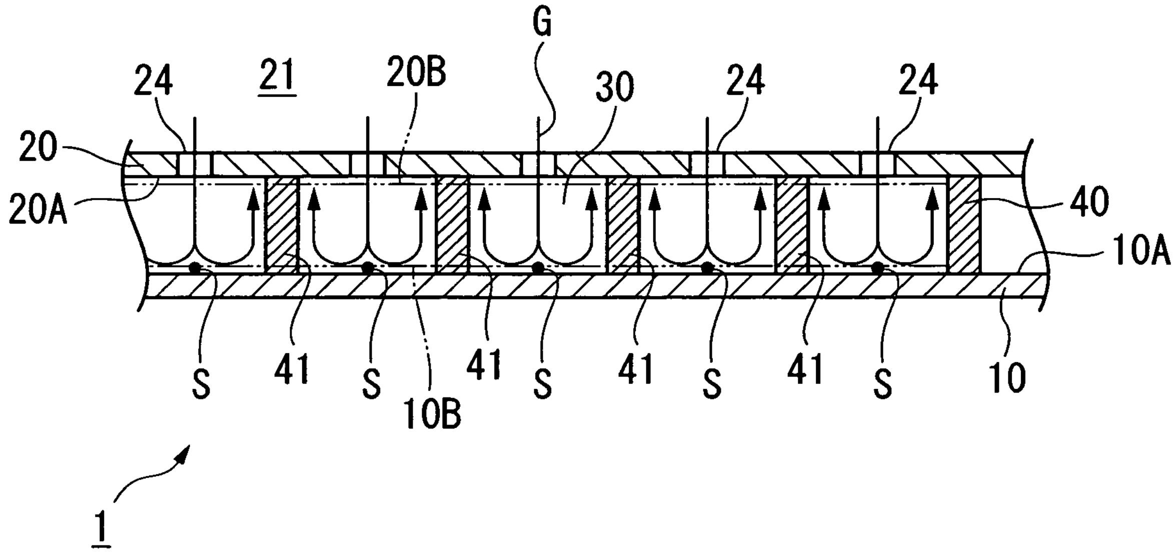

G
24
21
20B
30
24
24
20
20A
40
10A
S
41
S
10B
41
S
41
S
41
S
10
1

FIG. 5

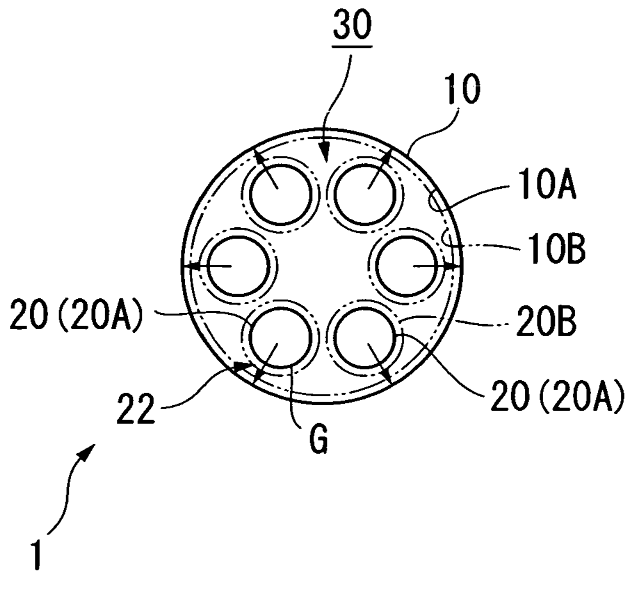

30
10
10A
10B
20 (20A)
20B
20 (20A)
22
G
1

FIG. 6A

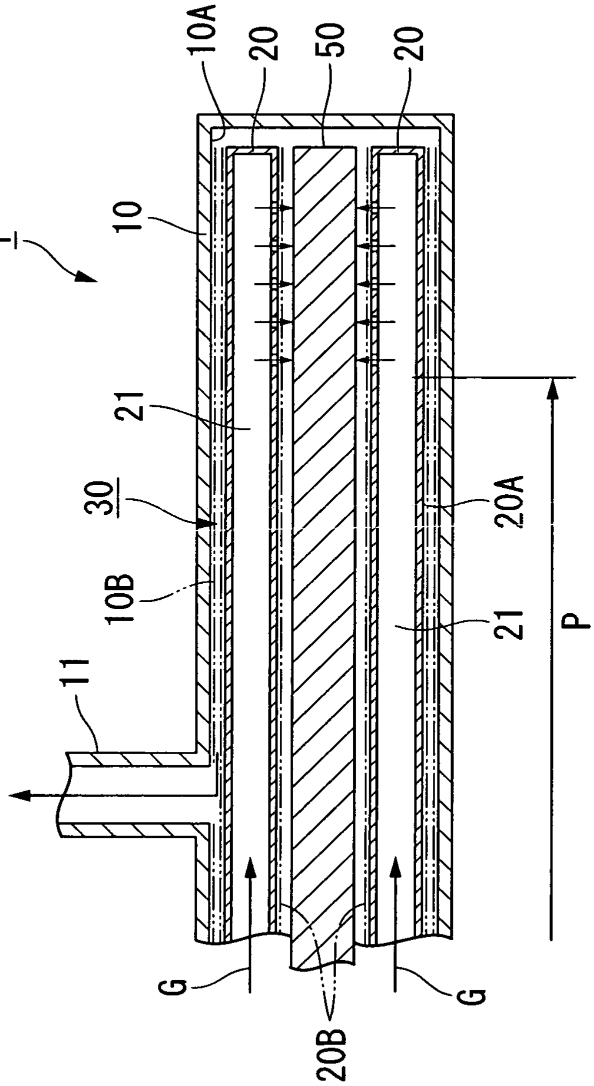


FIG. 6B

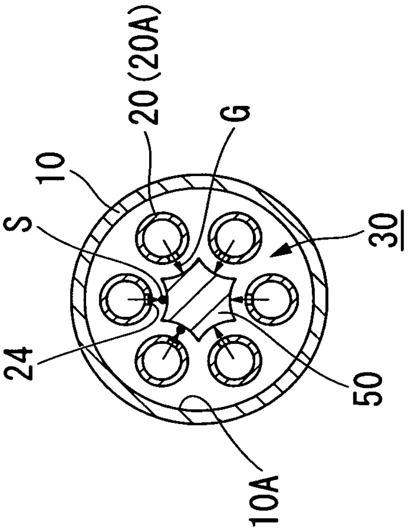
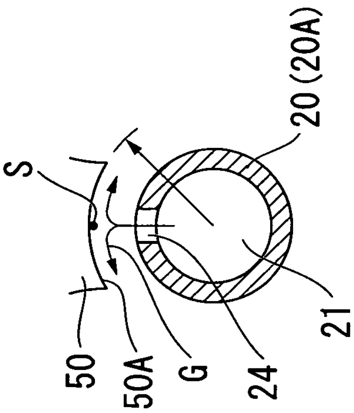


FIG. 6C



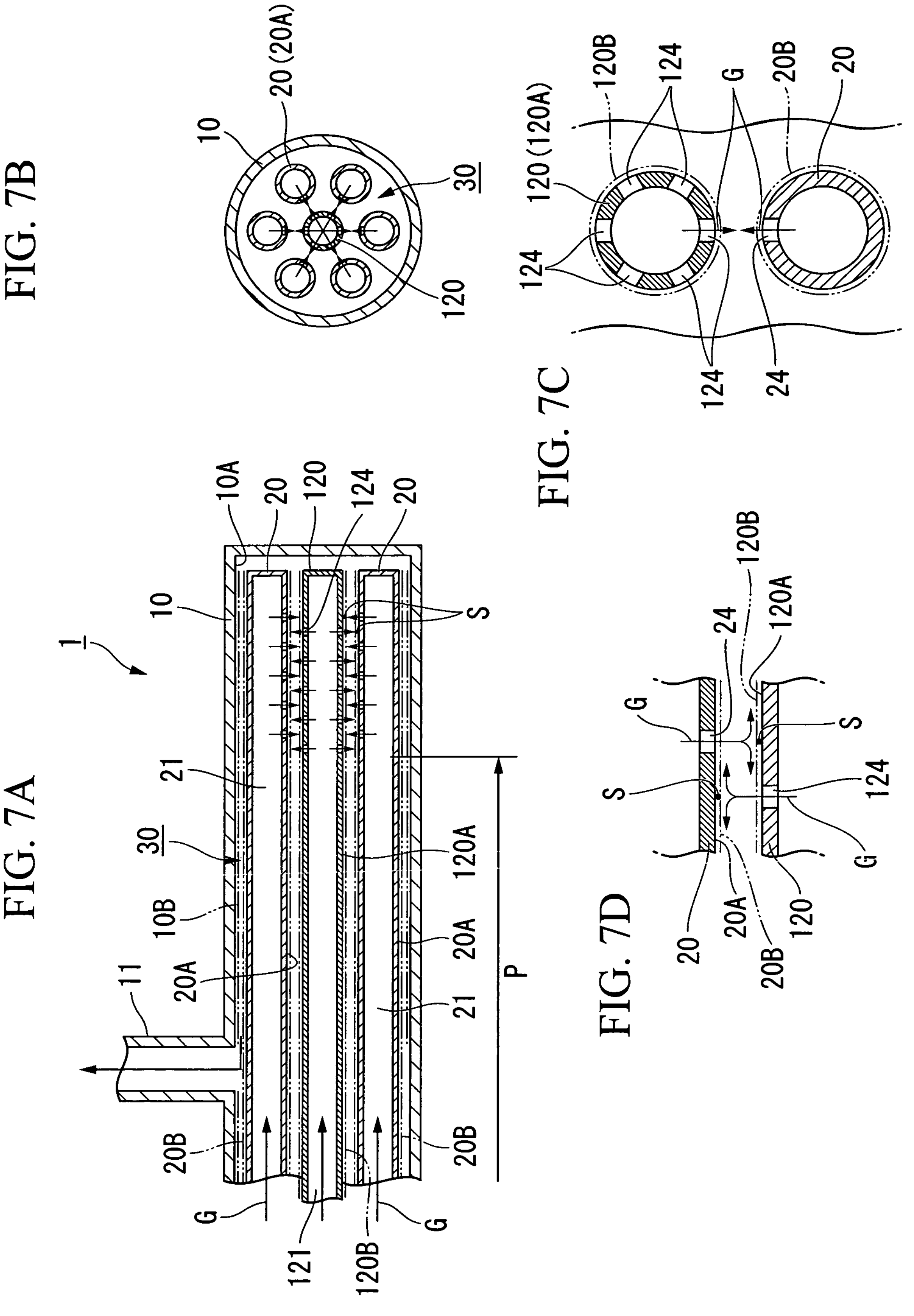


FIG. 7A

FIG. 7B

FIG. 7C

FIG. 7D

FIG. 8B

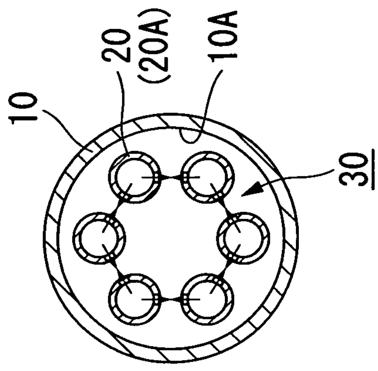


FIG. 8C

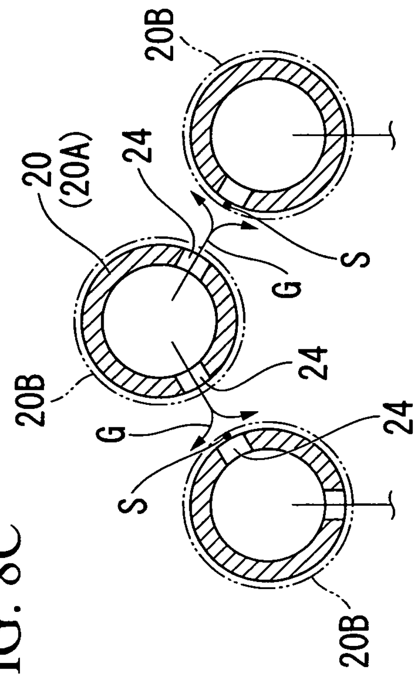


FIG. 8A

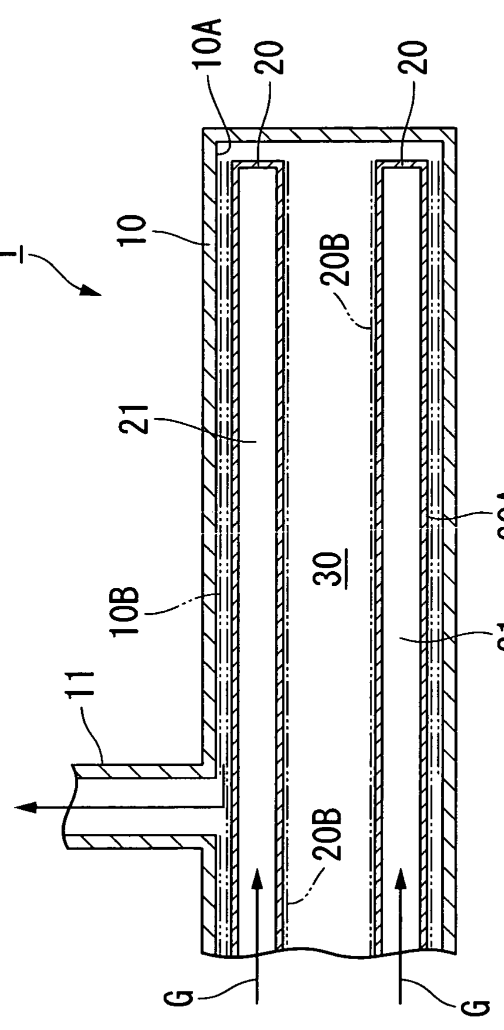
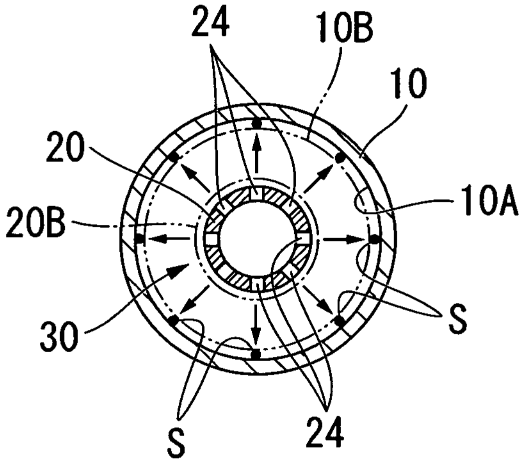


FIG. 9



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/051642

A. CLASSIFICATION OF SUBJECT MATTER
F23C3/00(2006.01)i, *F23D14/12*(2006.01)i

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)
F23C3/00, F23D14/12

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	1996-2009
Kokai Jitsuyo Shinan Koho	1971-2009	Toroku Jitsuyo Shinan Koho	1994-2009

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.
X Y	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 32067/1992(Laid-open No. 90119/1993) (Toho Gas Co., Ltd.), 07 December, 1993 (07.12.93), Par. Nos. [0007] to [0014]; Fig. 1 (Family: none)	1 2
Y	JP 2-150608 A (Toho Gas Co., Ltd.), 08 June, 1990 (08.06.90), Page 2, upper right column, line 7 to lower right column, line 15; Fig. 1 (Family: none)	2

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

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

Date of the actual completion of the international search	Date of mailing of the international search report
10 April, 2009 (10.04.09)	21 April, 2009 (21.04.09)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2009/051642

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 6-213408 A (Nippon Steel Corp.), 02 August, 1994 (02.08.94), Par. No. [0013] (Family: none)	2

Form PCT/ISA/210 (continuation of second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/051642

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See extra sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1, 2

Remark on Protest the

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/051642

Continuation of Box No.III of continuation of first sheet(2)

The matter common to the inventions in claims 1-8 is "a combustion heater comprising an inner tube having a combustion gas supply passage therein and an outer tube disposed around the outer periphery of the inner tube with a combustion space interposed therebetween, having a hole part for jetting the combustion gas in the wall of the inner tube, and having a radiation promoting surface on the outer periphery of the inner tube".

However, the search has revealed that the common matter is not novel since it is disclosed in CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 4-32067 (Laid-open No. 5-90119) (Toho Gas Co., Ltd.), 7 December, 1993 (07.12.93), paragraphs [0007]-[0014], Fig. 1, JP 2-150608 A (Toho Gas Co., Ltd.), 8 June, 1990 (08.06.90), line 7, right upper column, -line 15, right lower column, page 2, Fig. 1.

Since the common matter makes no contribution over the prior art, it is not a special technical feature in the meaning of the second sentence of PCT rule 13.2.

Therefore, there is no matter common to all the inventions in claims 1-8.

Since there is no other common matter considered to be a special technical feature in the meaning of the second sentence of PCT rule 13.2, any technical relation in the meaning of PCT rule 13 cannot be found among these different inventions.

As a result, it is obvious that the inventions in claims 1-8 do not satisfy the requirement of unity of invention.

First invention: inventions in claims 1, 2
Second invention: invention in claim 3
Third invention: invention in claim 4
Fourth invention: invention in claim 5
Fifth invention: invention in claim 6
Sixth invention: invention in claim 7
Seventh invention: invention in claim 8

Form PCT/ISA/210 (extra sheet) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2008022976 A **[0001]**
- JP 6241419 A **[0003]**