(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 014 977 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
14.01.2009 Bulletin 2009/03

(21) Application number: **07742866.2**

(22) Date of filing: **26.04.2007**

(51) Int Cl.:
F23D 11/24 *(2006.01)* ***F23D 11/00*** *(2006.01)*
F23D 11/36 *(2006.01)* ***F23D 14/70*** *(2006.01)*

(86) International application number:
PCT/JP2007/059431

(87) International publication number:
WO 2007/126137 (08.11.2007 Gazette 2007/45)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK RS

(30) Priority: **26.04.2006 JP 2006121876**

(71) Applicants:
- **Japan Energy Laboratory Co. Ltd.**
Saga-shi
Saga 840-0842 (JP)
- **Shinka Co. Ltd.**
Beppu-shi
Oita 874-0840 (JP)

(72) Inventor: **Yamamoto, Kazunori**
8400850 (JP)

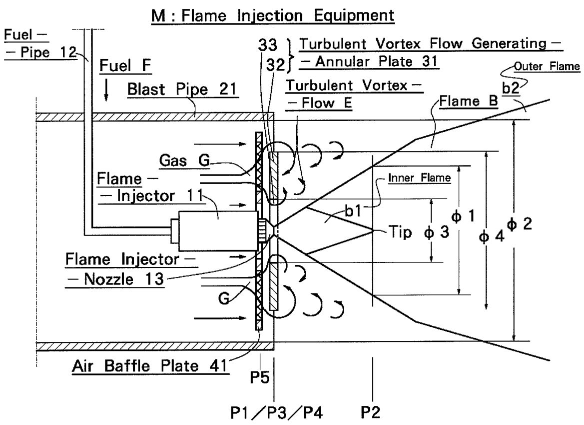
(74) Representative: **Jackson, Richard Eric et al**
Carpmaels & Ransford
43 Bloomsbury Square
London WC1A 2RA (GB)

(54) FLAME INJECTION DEVICE

(57) In flame injection equipment which has a flame injector, a blast pipe surrounding the flame injector and extending forwardly from an air blower for blowing out thereof an oxygen-containing gas, and an air baffle plate, provision is made to increase the combustion efficiency of fuel supplied to the flame injector and the temperature of flame injected from the flame injector.

To this end, at a fourth position between the position corresponding to a flame injection nozzle of the flame injector and the position corresponding to the tip of an inner flame of the flame injected from the flame injector, there is disposed concentrically with the flame a turbulent vortex flow generating annular plate which has an inner diameter larger than the outer diameter of the flame at the fourth position but smaller than the diameter of an extended open end of the blast pipe and an outer diameter smaller than the diameter φ2 of the extended open end of the blast pipe when the fourth position is the position corresponding to the tip of the blast pipe or backward thereof but has an outer diameter smaller than the diameter φ2 or equal to φ2 or larger than φ2 when the fourth position is forward of the position corresponding to the tip of the blast pipe.

FIG. 1



EP 2 014 977 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to flame injection equipment comprises: a flame injector adapted to be supplied with fuel from a fuel source and having a flame injection nozzle attached to its front end; a blast pipe extending forwardly from an air blower for delivering oxygen or oxygen-containing gas, and surrounding said flame injector concentrically with said flame injection nozzle; and an annular disc-shaped air baffle plate having a through hole and disposed at a fifth position near the tip of said flame injection nozzle of said flame injector concentrically with said flame injection nozzle and at right angles to the axis of said flame injection nozzle; wherein said flame injection nozzle is adapted to deliver blasts of flame, the position of an extended open end of said blast pipe is set at a third position between a first position corresponding to the tip of said flame injection nozzle and a second position corresponding to the tip of an inner flame of said flame, and the diameter of the extended open end of said blast pipe is set at φ2 larger than the outer diameter φ1 of the tip of said inner flame of said flame at said second position.

BACKGROUN ART

[0002] Heretofore, there has been proposed flame injection equipment M, such as shown in Figs. 22, 23 and 24, each of which comprises: a flame injector 11 adapted to be supplied with fuel F from a fuel source (not shown) via a fuel pipe 12 and having a flame injection nozzle 13 attached to its front end; a blast pipe 21 extending forwardly from an air blower (not shown) for delivering oxygen or oxygen-containing gas Q surrounding the flame injector 11 concentrically with the flame injection nozzle 13; an annular disc-shaped air baffle plate 41 having a through hole and disposed at a fifth position near the tip of the flame injection nozzle 13 of the flame injector 11 concentrically with the flame injection nozzle 13 and at right angles to the axis of the flame injection nozzle 13; wherein: the oxygen-containing gas G is blown into the blast pipe 21 from the air blower and the oxygen-containing gas G is blown out thereof forwardly through the blast pipe 21 and the air baffle plate 41, while at the same time the fuel F is supplied from the fuel source to the flame injector 11 through the fuel pipe 12 to inject the fuel F in atomized form from the flame injection nozzle 13 of the flame injector, followed by igniting the fuel F in atomized form, thereby injecting forwardly from the flame injection nozzle 13 a flame B composed of an inner flame b1 and an outer flame b2 of higher temperature and spreading wider as it goes forward; and wherein the position of the extended open end of the blast pipe 21 is set at a third position P3 between a first position P1 corresponding to the tip of the flame injection nozzle 13 of the flame injector 11 and a second position P2 corresponding to the tip of the inner flame b1 of the flame B injected from the flame injection nozzle 13, and the diameter of the extended open end of the blast pipe 21 is set at φ2 larger than the outer diameter φ1 of the tip of the inner flame b 1 of the flame B injected from the flame injection nozzle 13 at the second position.

[0003] Incidentally, Fig. 22 illustrates the case where the third position P3 at the extended open end of the blast pipe 21 is set at the first position P1 corresponding to the tip of the flame injection nozzle 13, and a fifth position P5, at which the air baffle plate 41 is placed, is set at a position rearward of the third position P3; Fig. 23 illustrates the case where the third position P3 is se at a position between the first position P1 and the second position P2 corresponding to the tip of the inner flame b 1 of the flame B, and the fifth position p5, at which the air baffle plate 41 is placed, is set at a position forward of the third position P3; and Fig. 24 illustrates the case where the third position P3 is set at the second position P2, and the fifth position P5, at which the air baffle plate 41 is placed, is set at a position forward of the third position P3.

[0004] In the above flame injection equipment M, by presetting the amount and rate of injection of the atomized fuel F from the flame injection nozzle 13 of the flame injector 11, the quantity and velocity of flow of the oxygen-containing gas G from the fuel source into the fuel pipe 12, the third position P3 corresponding to the extended open end of the blast pipe 21 at the first position P1 corresponding to the tip of the flame injection nozzle 13 of the flame injector 11, or at the second position P2 corresponding to the tip of the inner flame b 1 of the flame B, or at a position between the first position P1 and the second position P2, and the diameter φ2 of the extended open end of the blast pipe 21, preadjustment is made to the shape and temperature of the flame B to be injected from the flame injection nozzle 13 of the flame injector 11; and the flame injection equipment M is widely used by itself or in conjunction with a boiler, for instance.

[0005] As described above, the flame injection equipment M is in widespread use in which the shape and temperature of the flame B to be injected from the flame injection nozzle 13 of the flame injector 11 are preadjusted by the above-mentioned presetting, but it cannot be denied that a trace quantity of the fuel F injected in atomized form from the flame injection nozzle 13 does not turn into the flame B and remains mixed as unburned fuel in atomized form not only in the inner flame b1 but also in the outer flame b2 of the flame B injected from the flame injection nozzle 13, and that some of the unburned fuel flies out of the flame B -- this leads to the defects of low combustion efficiency of the fuel F and low temperature of the flame B.

[0006] Therefore, the present invention is intended to propose novel flame injection equipment that effectively overcomes the above-mentioned defects.

DISCLOSURE OF THE INVENTION

[0007] Flame injection equipment according to a first invention of this application comprises: a flame injector adapted to be supplied with fuel from a fuel source and having a flame injection nozzle at its front end; a blast pipe extending forwardly from an air blower for delivering oxygen or oxygen-containing gas, and surrounding said flame injector concentrically with said flame injection nozzle; and an annular disc-shaped air baffle plate having a through hole and disposed at a fifth position near the tip of said flame injection nozzle of said flame injector concentrically with said flame injection nozzle and at right angles to the axis of said flame injection nozzle; wherein said flame injection nozzle is adapted to deliver blasts of flame, the position of an extended open end of said blast pipe is set at a third position between a first position corresponding to the tip of said flame injection nozzle and a second position corresponding to the tip of an inner flame of said flame, and the diameter of the extended open end of said blast pipe is set at φ2 larger than the outer diameter φ1 of said flame at the position corresponding to the second position corresponding to the tip of the inner flame of said flame; and wherein at a fourth position between the first position corresponding to the tip of said flame injection nozzle and the second position corresponding to the tip of the inner flame of said flame, there is disposed at right angles to the axis of said flame and concentrically with said flame a turbulent vortex flow generating annular plate which has an inner diameter φ3 smaller than the diameter φ2 of the extended open end of said blast pipe and has an outer diameter φ4 smaller than the diameter φ2 of the extended open end of said blast pipe when said fourth position is set at said third position or its vicinity or a position rearward of said third position, or an outer diameter φ4 smaller than the diameter φ2 of the extended open end of said blast pipe or equal to said diameter φ2 or larger than said diameter φ2 when said fourth position is set at a position forward of said third position.

[0008] Flame injection equipment according to a second invention of this application comprises: a flame injector adapted to be supplied with fuel from a fuel source and having a flame injection nozzle at its front end; a blast pipe extending forwardly from an air blower for delivering oxygen or oxygen-containing gas, and surrounding said flame injector concentrically with said flame injection nozzle, and an annular disc-shaped air baffle plate having a through hole and disposed at a fifth position near the tip of said flame injection nozzle of said flame injector concentrically with said flame injection nozzle and at right angles to the axis of said flame injection nozzle; wherein said flame injection nozzle is adapted to deliver blasts of flame, the position of an extended open end of said blast pipe is set at a third position between a first position corresponding to the tip of said flame injection nozzle and a second position corresponding to the tip of an inner flame of said flame, and the diameter of the extended open end of said blast pipe is φ2 larger than the outside diameter φ1 of said flame at the second position corresponding to the tip of the inner flame of said flame; and wherein a turbulent vortex flow generating conic-and-cylindrical member or turbulent vortex flow generating dish-like-and-cylindrical member has a first open end which has an inner diameter φ31 larger than the outer diameter of said flame at a fourth position between a sixth position, which is that one of the first position corresponding to the tip of said flame injection nozzle and the fifth position of said air baffle plate which is closer to the tip of said blast pipe than the other, and the second position corresponding to the tip of the inner flame of said flame, but smaller than the diameter φ2 of the extended open end of said blast pipe, and a second open end which has an inner diameter φ32 larger than said inner diameter φ31 and larger than the outer diameter φ1 of said flame at the position corresponding to said second position; and the turbulent vortex flow generating conic-and-cylindrical member or turbulent vortex flow generating dish-like-and-cylindrical member is disposed concentrically with said flame injection nozzle, with said second open end facing forward on the side opposite from said flame injection nozzle and said first open end held at said fourth position.

[0009] Flame injection equipment according to a third invention of this application comprises: a flame injector adapted to be supplied with fuel from a fuel source and having a flame injection nozzle at its front end; a blast pipe extending forwardly from an air blower for delivering oxygen or oxygen-containing gas, and surrounding said flame injector concentrically with said flame injection nozzle, and an annular disc-shaped air baffle plate having a through hole and disposed at a fifth position near the tip of said flame injection nozzle of said flame injector concentrically with said flame injection nozzle and at right angles to the axis of said flame injection nozzle; wherein said flame injection nozzle is adapted to deliver blasts of flame, the position of an extended open end of said blast pipe is set at a third position between a first position corresponding to the tip of said flame injection nozzle and a second position corresponding to the tip of an inner flame of said flame, and the diameter of the extended open end of said blast pipe is φ2 larger than the outside diameter φ1 of said flame at the second position corresponding to the tip of the inner flame of aid flame; and wherein a turbulent vortex flow generating cylindrical member is formed as a one-piece structure by coupling a cylindrical member and a conic-and-cylindrical member or dish-like-and-cylindrical member concentrically with each other, the cylindrical member having an inner diameter φ61 larger than the outer diameter of said flame at a fourth position between a sixth position, which is that one of the first position corresponding to the tip of the flame injection nozzle and the fifth position of said air baffle plate which is closer to the tip of said blast pipe than the other, and the second position corresponding to the tip of the inner flame of said flame, but smaller than the diameter φ2 of the extended open end of said blast pipe, the conic-and-cylindrical member or dish-like-and-cylindrical member having a first open end having the same inner diameter φ71 as said inner diameter φ61 and a second open end having an inner diameter φ72 larger than said inner diameter φ71 and larger than the outer diameter φ1 of said flame at said second position; and said turbulent vortex flow generating cylindrical member is disposed concentrically with said flame injection nozzle, with said conic-and-cylindrical member held forward on the side opposite from said flame injection nozzle and the open end of said cylindrical member on the side opposite from said conic-and-cylindrical member or dish-like-and-cylindrical member held at said fourth position.

[0010] Flame injection equipment according to a fourth invention of this application comprises: a flame injector adapted to be supplied with fuel from a fuel source and having a flame injection nozzle at its front end; a blast pipe extending forwardly from an air blower for delivering oxygen or oxygen-containing gas, and surrounding said flame injector concentrically with said flame injection nozzle, and an annular disc-shaped air baffle plate having a through hole and disposed at a fifth position near the tip of said flame injection nozzle of said flame injector concentrically with said flame injection nozzle and at right angles to the axis of said flame injection nozzle; wherein said flame injection nozzle is adapted to deliver blasts of flame, the position of an extended open end of said blast pipe is set at a third position between a first position corresponding to the tip of said flame injection nozzle and a second position corresponding to the tip of an inner flame of said flame, and the diameter of the extended open end of said blast pipe is φ2 larger than the outside diameter φ1 of said flame at the second position corresponding to the tip of the inner flame of aid flame; and wherein a turbulent vortex flow generating cylindrical member is disposed concentrically with said flame injection nozzle, said turbulent vortex flow generating cylindrical member being formed as a one-piece structure by coupling a first conic-and-cylindrical member or first dish-like-and-cylindrical member and a second conic-and-cylindrical member or second dish-like-and-cylindrical member concentrically with each other, said first conic-and-cylindrical or dish-like-and -cylindrical member having a first open end having an inner diameter φ101 larger than the outer diameter of said flame at a fourth position between a sixth position, which is that one of the first position corresponding to the tip of the flame injection nozzle and the fifth position of said air baffle plate which is closer to the tip of said blast pipe than the other, and the second position corresponding to the tip of the inner flame of said flame, but smaller than the diameter φ2 of the extended open end of said blast pipe, and a second open end having an inner diameter φ102 larger than said inner diameter φ101 and larger than the outer diameter φ1 of said flame at said second position, said second conic-and-cylindrical member or second dish-like-and-cylindrical member having a first open end having an inner diameter φ31' equal to said inner diameter φ102 and a third open end having an inner diameter φ32' larger than said inner diameter φ31' and larger than the outer diameter φ1 of said flame at said second position; and said turbulent vortex flow generating cylindrical member is disposed concentrically with said flame injection nozzle, with said second conic-and-cylindrical member or second dish-like-and-cylindrical member held forward on the side opposite from said flame injection nozzle and the first open end of said first conic-and-cylindrical member or second dish-like-and-cylindrical member held at said fourth position.

[0011] According to the flame injection equipment of the present invention, a turbulent vortex flow develops in an oxygen-containing gas around flame, and the turbulent vortex flow is supplied into the flame to urge burning of unburned fuel remaining in the fuel; further, the turbulent vortex flow prevents the unburned fuel in the flame from flying out thereof

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

Fig. 1 is a schematic diagram showing a first embodiment of the flame injection equipment according to the present invention.

Fig. 2 is a schematic diagram showing a second embodiment of the flame injection equipment according to the present invention.

Fig. 3 is a schematic diagram showing a third embodiment of the flame injection equipment according to the present invention.

Fig. 4 is a schematic diagram showing a fourth embodiment of the flame injection equipment according to the present invention.

Fig. 5 is a schematic diagram showing a fifth embodiment of the flame injection equipment according to the present invention.

Fig. 6 is a schematic diagram showing a sixth embodiment of the flame injection equipment according to the present invention.

Fig. 7 is a schematic diagram showing a seventh embodiment of the flame injection equipment according to the present invention.

Fig. 8 is a schematic diagram showing an eighth embodiment of the flame injection equipment according to the present invention.

Fig. 9 is a schematic diagram showing a ninth embodiment of the flame injection equipment according to the present invention.

Fig. 10 is a schematic diagram showing a tenth embodiment of the flame injection equipment according to the present invention.

Fig. 11 is a schematic diagram showing an eleventh embodiment of the flame injection equipment according to the present invention.

Fig. 12 is a schematic diagram showing a twelfth embodiment of the flame injection equipment according to the present invention.

Fig. 13 is a schematic diagram showing a thirteenth embodiment of the flame injection equipment according to the present invention.

Fig. 14 is a schematic diagram showing a fourteenth embodiment of the flame injection equipment according to the present invention.

Fig. 15 is a schematic diagram showing a fifteenth embodiment of the flame injection equipment according to the present invention.

Fig.16 is a schematic diagram showing a sixteenth embodiment of the flame injection equipment according to the present invention.

Fig. 17 is a schematic diagram showing a seventeenth embodiment of the flame injection equipment according to the present invention.

Fig. 18 is a schematic diagram showing an eighteenth embodiment of the flame injection equipment according to the present invention.

Fig. 19 is a schematic diagram showing a nineteenth embodiment of the flame injection equipment according to the present invention.

Fig. 20 is a schematic diagram showing a twentieth embodiment of the flame injection equipment according to the present invention.

Fig.21 is a schematic diagram showing a twenty-first embodiment of the flame injection equipment according to the present invention.

Fig. 22 is a schematic diagram showing an example of conventional flame injection equipment.

Fig. 23 is a schematic diagram showing another example of conventional flame injection equipment.

Fig. 24 is a schematic diagram showing still another example of conventional flame injection equipment.

BEST MODE FOR CARRYING OUT THE INVENTION

Embodiment 1

[0013] A description will be given below, with reference to Fig. 1, of a first embodiment of the flame injection equipment according to the present invention.

[0014] In Fig. 1, the parts corresponding to those in Fig. 22 are identified by the same reference numerals.

[0015] As is the case with the afore-mentioned conventional flame injection equipment, the first embodiment of the flame injection equipment M according to the present invention comprises: a flame injector 11 adapted to be supplied with fuel F from a fuel source (not shown) via a fuel pipe 12 and having a flame injection nozzle 13 attached to its front end; a blast pipe 21 extending forwardly from an air blower (not shown) for delivering oxygen or oxygen-containing gas GS surrounding the flame injector 11 concentrically with the flame injection nozzle 13; an annular, disc-shaped air baffle plate 41 having a through hole and disposed at a fifth position near the tip of the flame injection nozzle 13 of the flame injector 11 concentrically with the flame injection nozzle 13 and at right angles to the axis of the flame injection nozzle 13; wherein: the oxygen-containing gas G is blown into the blast pipe 21 from the air blower and the oxygen-containing gas G is blown out forwardly through the blast pipe 21 and the air baffle 41, while at the same time the fuel F is supplied from the fuel source to the flame injector 11 through the fuel pipe 12 to blow out the fuel F in atomized form from the flame injection nozzle 13 of the flame injector 11, followed by igniting the fuel F in atomized form, thereby injecting forwardly from the flame injection nozzle 13 a flame B composed of an inner flame b1 and an outer flame b2 of higher temperature and spreading wider as it goes forward; and wherein the position of the extended open end of the blast pipe 21 is set at the third position P3 between the first position P1 corresponding to the tip of the flame injection nozzle 13 of the flame injector 11 and the second position P2 corresponding to the tip of the inner flame b1 of the flam B to be injected from the flame injection nozzle 13, the third position P3 is set at the first position P1 corresponding to the tip of the flame injection nozzle 13, the diameter of the extended open end of the blast pipe 21 is set at φ2 larger than the outside diameter φ1 of the flame B at the second position P2 corresponding to the tip of the inner flame b1 of the flame injected from the flame injection nozzle 13, and the fifth position P5, at which the air baffle plate 41 is disposed, is se at a position rearward of the first position P1 corresponding to the tip of the flame injection nozzle 13.

[0016] Further, in the first embodiment of the flame injection equipment according to the present invention, which has the configuration described above, at the fourth position P4 between a sixth position (not shown), which is that one of the first position P1 corresponding to the tip of the flame injection nozzle 13 and the fifth position P5 of the air baffle plate 41 which is closer to the extended open end of the blast pipe 21 than the other, and the second position P2 corresponding to the tip of the inner flame b 1 of the flame B, there is disposed at right angles to the axis of the flame B and concentrically with the flame B a turbulent vortex flow generating annular plate 31 which has an inner diameter φ3 larger than the outer diameter (not shown) of the flame B at the fourth position P4 but smaller than the diameter φ2 of the extended open end of the blast pipe 21 and an outer diameter φ4 smaller than the diameter φ2 of the extended open end of the blast pipe 21.

[0017] The above is the configuration of the first embodiment of the flame injection equipment M according to the present invention.

[0018] According to the embodiment of the flame injection equipment M of such a configuration according to the present invention, as is the case with the conventional flame injection equipment M described previously with reference to Fig. 22, the third position P3 at the extended open end of the blast pipe 21 is used as the first position P1 corresponding to the tip of the flame injection nozzle 13 of the flame injector 11, by presetting the amount and rate of injection of the atomized fuel F from the flame injection nozzle 13 of the flame injector 11, the quantity and velocity of flow of the oxygen-containing gas G from the fuel source into the fuel pipe 12, the third position P3 at the extended open end of the blast pipe 21 at the first position P1 corresponding to the tip of the flame injection nozzle 13 of the flame injector 11, or at the second position P2 corresponding to the tip of the inner flame b1 of the flame B, or at a position between the first position P1 and the second position P2, and the diameter φ2 of the extended open end of the blast pipe 21, preadjustment is made to the shape and temperature of the flame B to be injected from the flame injection nozzle 13 of the flame injector 11; and the flame injection equipment M can be widely used by itself or in conjunction with a boiler, for instance.

[0019] Incidentally, in the case of the first embodiment of the flame injection equipment M according to the present invention, since the turbulent vortex flow generating annular plate 31 is disposed at the fourth position P4 set between a sixth position (not shown), which is that one of the first position P1 corresponding to the tip of the flame injection nozzle 13 which is closer to the extended open end of the blast pipe 21 than the other, and the fifth position P5, at which the air baffle plate 41 is disposed, and the second position P2 corresponding to the tip of the inner flame b1 of the flame B, the forward flow of the oxygen-containing gas G from the blast pipe 21 through the air baffle plate 41 is blocked by the plate portion 32 of the turbulent vortex flow generating annular plate 31, and passes through between the inner surface of an opening 33 defining the inner diameter φ3 of the turbulent vortex flow generating annular plate 31 and the outer peripheral surface of the flame injection nozzle 13 of the flame injector 11 and between the outer periphery of the turbulent vortex flow generating annular plate 31 and the inner surface of the blast pipe 21. As a result, a negative pressure develops in the oxygen-containing gas G on the front side of the turbulent vortex flow generating annular plate 31, and consequently the oxygen-containing gas G is delivered as turbulent vortex flow E forwardly of the front side of the turbulent vortex flow generating annular plate 31 placed forward of the first position P1 corresponding to the tip of the flame injection nozzle 13, and the oxygen-containing gas G thus delivered in the form of turbulent vortex flow E gets mixed with the fuel F injected in atomized form from the flame injection nozzle 13 of the flame injector 11.

[0020] Incidentally, in the case of the conventional flame injection equipment M described above with reference to Fig. 22, since the turbulent vortex flow generating annular plate 31 is not used, the oxygen-containing gas G is delivered, as a steady flow, neither a turbulent vortex nor turbulent flow, forwardly of the first position P1 corresponding to the tip of the flame injection nozzle 13, and the oxygen-containing gas G of such a steady flow merely gets mixed with the fuel F injected in atomized form from the flame injection nozzle 13 of the flame injector 11.

[0021] Thus, in the case of the first embodiment of the flame injection equipment according to the present invention, the oxygen-containing gas G more effectively acts on the fuel F injected in atomized form from the flame injection nozzle 13 of the flame injector 11 than in the case of the conventional flame injection equipment M described above with reference to Fig. 22 which does not employ the turbulent vortex generating annular plate 31.

[0022] Therefore, the atomized fuel F from the flame injection nozzle 13 scarcely remains unburned in the flame B injected from the flame injection nozzle 13, and if it remains, its quantity is far smaller than in the case of the conventional flame injection equipment M described above with reference to Fig. 22, and furthermore, the fuel F is scarcely dispersed, as unburned fuel, out of the flame B, and if dispersed, the quantity of such dispersed unburned fuel is far smaller than in the case of the flame injection equipment M described above with reference to Fig. 22; therefore, it is possible to produce the operation/working effects of burning the fuel F with a higher efficiency and injecting the flame B at a higher temperature than in the case of the conventional flame injection equipment M described above with reference to Fig. 22.

Embodiment 2

[0023] Turning next to Fig. 2, a second embodiment of the flame injection equipment according to the present invention will be described below.

[0024] In Fig. 2, the parts corresponding to those in Fig. 1 will be identified by the same reference numerals.

[0025] The second embodiment of the flame injection equipment M according to the present invention is similar in configuration to the first embodiment of the flame injection equipment M according to the present invention shown in Fig. 1, except that the fifth position P5 at the extended open end of the air baffle plate 41 is not rearward of the first position P1 corresponding to the tip of the flame injection nozzle 13 but forward thereof and that the fourth position P4, where the turbulent vortex flow generating annular plate 31 is disposed, is not the first position P1 corresponding to the tip of the flame injection nozzle 13 but between the fifth position P5 at the extended open end of the air baffle plate 41 and the second position P2 corresponding to the tip of the inner flame b 1 of the flame B.

[0026] Since the second embodiment of the flame injection equipment M of such a configuration according to the present invention is similar in configuration to the Fig. 1 embodiment of the flame injection equipment M according to the present invention except the above-mentioned modifications, it is possible to obtain the same operation/working effects as those obtainable with the Fig. 1 embodiment of the flame injection equipment M according to the present invention, though not described in detail.

Embodiment 3

[0027] Turning next to Fig. 3, a third embodiment of the flame injection equipment according to the present invention will be described below.

[0028] In Fig. 3, the parts corresponding to those in Fig. 2 will be identified by the same reference numerals.

[0029] The third embodiment of the flame injection equipment M according to the present invention is similar in configuration to the second embodiment of the flame injection equipment M according to the present invention shown in Fig. 2, except that the outer diameter φ4 of the turbulent vortex flow generating annular plate 31 is not smaller than the diameter φ2 of the extended open end of the blast pipe 21 but is larger than the diameter φ2 of the extended open end of the blast pipe 21.

[0030] The above is the configuration of the third embodiment of the flame injection equipment M according to the present invention.

[0031] Since the third embodiment of the flame injection equipment M of such a configuration according to the present invention is similar in configuration to the Fig. 2 embodiment of the flame injection equipment M according to the present invention except the above-mentioned modification, it is possible to obtain the same operation/working effects as those obtainable with the Fig. 2 embodiment of the flame injection equipment M according to the present invention, by preadjusting the outer diameter φ4 of the turbulent vortex flow generating annular plate 31 to a not-so-large value, though not described in detail.

Embodiment 4

[0032] Turning next to Fig. 4, a fourth embodiment of the flame injection equipment according to the present invention will be described below.

[0033] In Fig. 4, the parts corresponding to those in Fig. 3 will be identified by the same reference numerals.

[0034] The fourth embodiment of the flame injection equipment M according to the present invention is similar in configuration to the first embodiment of the flame injection equipment M according to the present invention shown in Fig. 3, except that the position P4, where the turbulent vortex flow generating annular plate 31 is disposed, is set at the second position P2 corresponding to the tip of the inner flame b1 of the flame B, not at the position between the fifth position P5, where the air baffle plate 41 is disposed, and the second position P2 corresponding to the tip of the inner flame b1 of the flame B.

[0035] The above is the configuration of the fourth embodiment of the flame injection equipment M according to the present invention.

[0036] Since the fourth embodiment of the flame injection equipment M of such a configuration according to the present invention is similar in configuration to the Fig. 3 embodiment of the flame injection equipment M according to the present invention except the above-mentioned modification, it is possible to obtain the same operation/working effects as those obtainable with the Fig. 3 embodiment of the flame injection equipment M according to the present invention, by preadjusting the outer diameter φ4 of the turbulent vortex flow generating annular plate 31 to a not-so-large value, though not described in detail.

Embodiment 5

[0037] Turning next to Fig. 5, a fifth embodiment of the flame injection equipment according to the present invention will be described below.

[0038] In Fig. 5, the parts corresponding to those in Fig. 4 will be identified by the same reference numerals.

[0039] The fifth embodiment of the flame injection equipment M according to the present invention is similar in configuration to the fourth embodiment of the flame injection equipment M according to the present invention shown in Fig. 4, except that the outer diameter φ4 of the turbulent vortex flow generating annular plate 31 is not larger than the diameter φ2 of the extended open end of the blast pipe 21 but is smaller than the diameter φ2 of the extended open end of the blast pipe 21.

[0040] The above is the configuration of the fifth embodiment of the flame injection equipment M according to the present invention.

[0041] Since the fifth embodiment of the flame injection equipment M of such a configuration according to the present invention is similar in configuration to the Fig. 4 embodiment of the flame injection equipment M according to the present invention except the above-mentioned modification, it is possible to obtain the same operation/working effects as those obtainable with the Fig. 4 embodiment of the flame injection equipment M according to the present invention, by preadjusting the outer diameter φ4 of the turbulent vortex flow generating annular plate 31 to value within a range in which the difference between it and the inner diameter φ2 is not so small, though not described in detail.

Embodiment 6

[0042] Turning next to Fig. 6, a sixth embodiment of the flame injection equipment according to the present invention will be described below.

[0043] In Fig. 6, the parts corresponding to those in Fig. 23 will be identified by the same reference numerals.

[0044] The sixth embodiment of the flame injection equipment according to the present invention is similar in configuration to the conventional flame injection equipment described above with reference to Fig. 23, except that the fifth position P5 of the air baffle plate 41 is not forward of the first position P1 corresponding to the tip of the flame injection nozzle 13 but rearward of the first position P1, and as is the case with the first embodiment of the flame injection equipment M according to the present invention shown in Fig. 1, the first position P1 corresponding to the tip of the flame injection nozzle 13 of the flame injector 11 is set at the fourth position P4 between the first position P1 corresponding to the tip of the flame injection nozzle 13 and the second position P2 corresponding to the tip of the inner flame b 1 of the flame B, and the turbulent vortex flow annular plate 31, which has an inner diameter φ3 larger than the outer diameter of the flame B at the fourth position P4 but smaller than the diameter φ2 of the extended open end of the blast pipe 21 and an outer diameter φ4 smaller than the diameter φ2 of the extended open end of the blast pipe 21, is disposed at the fourth position P4 with its plate surface held in a plane crossing at right angles to the axis of the flame B and concentrically with the flame B.

[0045] The above is the configuration of the sixth embodiment of the flame injection equipment M according to the present invention.

[0046] According to the sixth embodiment of the flame injection equipment M of such a configuration according to the present invention in which, as in the case of conventional flame injection equipment M described above with reference to Fig. 23, the third position P3 at the extended open end of the blast pipe 21 is set at the position between the first position P1 corresponding to the tip of the flame injection nozzle 13 of the flame injector 11 and the second position P2 corresponding to the tip of the inner flame b1 of the flame B, and the shape and temperature of the flame B to be injected from the flame injection nozzle 13 of the flame injector 11 are predetermined by presetting the quantity and rate of injection of the atomized fuel F from the flame injection nozzle 13 of the flame injector 11, the quantity and rate of flow of the oxygen-containing gas G from the fuel source to the fuel pipe 12, the diameter φ2 of the extended open end of the blast pipe 21; thus, the flame injection equipment M can be used widely by itself or in conjunction with a boiler, for instance.

[0047] Also in the sixth embodiment of the flame injection equipment M according to the present invention, since the first position P1 corresponding to the tip of the flame injection nozzle 13 of the flame injector 11 is set at the fourth position P4 between the first position P1 corresponding to the tip of the flame injection nozzle 13 and the second position P2 corresponding to the tip of the inner flame b 1 of the flame B and the turbulent vortex flow generating annular plate 31 is disposed at the fourth position as in the case of the first embodiment M according to the present invention, the forward flow of the oxygen-containing gas G from the blast pipe 21 through the air baffle plate 41 is blocked by the plate portion 32 of the turbulent vortex flow generating annular plate 31, and passes through between the inner surface of the opening 33 defining the inner diameter φ3 of the turbulent vortex flow generating annular plate 31 and the outer peripheral surface of the flame injection nozzle 13 of the flame injector 11 and between the outer periphery of the turbulent vortex flow generating annular plate 31 and the inner surface of the blast pipe 21 as in the case of the first embodiment of the flame injection equipment M according to the present invention shown in Fig. 1. Thus, as is the case with the first embodiment of the flame injection equipment M according to the present invention shown in Fig. 1, a negative pressure develops in the oxygen-containing gas G on the front side of the turbulent vortex flow generating annular plate 31, and consequently the oxygen-containing gas G is delivered as turbulent vortex flow E forwardly of the front side of the turbulent vortex flow generating annular plate 31 placed forward of the first position P1 corresponding to the tip of the flame injection nozzle 13, and the oxygen-containing gas G thus delivered in the form of turbulent vortex flow E gets mixed with the fuel F injected in atomized form from the flame injection nozzle 13 of the flame injector 11.

[0048] Incidentally, in the case of the conventional flame injection equipment M described above with reference to Fig. 23, too, since the turbulent vortex flow generating annular plate 31 is not used as in the case of the conventional flame injection equipment M described above with reference to Fig. 22, the oxygen-containing gas G is delivered, as a steady flow, neither a turbulent vortex nor turbulent flow, forwardly of the first position P1 at the tip of the flame injection nozzle 13, and the oxygen-containing gas G of such a steady flow merely gets mixed with the fuel F injected in atomized form from the flame injection nozzle 13 of the flame injector 11.

[0049] Thus, in the case of the sixth embodiment of the flame injection equipment according to the present invention, the oxygen-containing gas G more effectively acts on the fuel F injected in atomized form from the flame injection nozzle 13 of the flame injector 11 than in the case of the conventional flame injection equipment M described above with reference to Fig. 23 which does not employ the turbulent vortex generating annular plate 31.

[0050] Therefore, the atomized fuel F from the flame injection nozzle 13 scarcely remains unburned in the flame B injected from the flame injection nozzle 13, and if it remains, its quantity is far smaller than in the case of the conventional flame injection equipment M described above with reference to Fig. 23, and furthermore, the fuel F is scarcely dispersed, as unburned fuel, out of the flame B, and if dispersed, the quantity of such dispersed unburned fuel is far smaller than in the case of the flame injection equipment M described above with reference to Fig. 23; therefore, it is possible to produce the operation/working effects of burning the fuel F with a higher efficiency and injecting the flame B at a higher temperature than in the case of the conventional flame injection equipment M described above with reference to Fig. 23.

Embodiment 7

[0051] Turning next to Fig. 7, a seventh embodiment of the flame injection equipment according to the present invention will be described below.

[0052] In Fig. 7, the parts corresponding to those in

Fig.6 will be identified by the same reference numerals.

[0053] The seventh embodiment of the flame injection equipment M according to the present invention is similar in configuration to the sixth embodiment of the flame injection equipment M according to the present invention shown in Fig. 6, except that the fifth position P5 of the air baffle plate 41 is not rearward of but forward of the first position P1 corresponding to the tip of the flame injection nozzle 13 and that the position P4 of the turbulent vortex flow generating annular plate 31 is not the first position P1 corresponding to the tip of the flame injection nozzle 13 but a position between the fifth position P5 of the air baffle plate 41 and the second position P2 corresponding to the tip of the inner flame b1 of the flame B as in the case of the second embodiment of the flame injection equipment M according to the present invention shown in Fig. 2.

[0054] The above is the configuration of the seventh embodiment of the flame injection equipment M according to the present invention.

[0055] Since the seventh embodiment of the flame injection equipment M of such a configuration according to the present invention is similar in configuration to the sixth embodiment of the flame injection equipment M according to the present invention shown in Fig. 6 except the above-mentioned modifications, it is possible to obtain the same operation/working effects as those obtainable with the flame injection equipment M according to the present invention shown in Fig. 6, though not described in detail.

Embodiment 8

[0056] Turning next to Fig. 8, an eighth embodiment of the flame injection equipment according to the present invention will be described below.

[0057] In Fig. 8, the parts corresponding to those in Fig.7 will be identified by the same reference numerals.

[0058] The eighth embodiment of the flame injection equipment M according to the present invention is similar in configuration to the seventh embodiment of the flame injection equipment M according to the present invention shown in Fig. 7, except that the outer diameter φ4 of the turbulent vortex flow generating annular plate 31 is not smaller than the diameter φ2 of the extended open end of the blast pipe 21 but larger than the diameter φ2 of the extended open end of the blast pipe 21 as in the case of the third embodiment of the flame injection equipment according to the present invention shown in Fig. 3.

[0059] The above is the configuration of the eighth embodiment of the flame injection equipment M according to the present invention.

[0060] Since the eighth embodiment of the flame injection equipment M of such a configuration according to the present invention is similar in configuration to the seventh embodiment of the flame injection equipment M according to the present invention shown in Fig. 7 except the above-mentioned modifications, it is possible to obtain the same operation/working effects as those obtainable with the seventh embodiment of the flame injection equipment according to the present invention shown Fig. 7, by presetting the outer diameter φ4 of the turbulent vortex flow generating annular plate 31 at a not-so-large value, though not described in detail.

Embodiment 9

[0061] Turning next to Fig. 9, a ninth embodiment of the flame injection equipment according to the present invention will be described below.

[0062] In Fig. 9, the parts corresponding to those in Fig.8 will be identified by the same reference numerals.

[0063] The ninth embodiment of the flame injection equipment M according to the present invention is similar in configuration to the eighth embodiment of the flame injection equipment M according to the present invention shown in Fig. 8, except that the fourth position P4 of the turbulent vortex flow generating annular plate 31 is set not at a position between the fifth position P5 of the air baffle plate 41 and the second position P2 corresponding to the tip of the inner flame b 1 of the flame B but at the second position P2 corresponding to the tip of the inner flame b1 of the flame B as in the case of the fourth embodiment of the flame injection equipment M according to the present invention shown in Fig. 4.

[0064] The above is the configuration of the ninth embodiment of the flame injection equipment M according to the present invention.

[0065] Since the ninth embodiment of the flame injection equipment M of such a configuration according to the present invention is similar in configuration to the eighth embodiment of the flame injection equipment M according to the present invention shown in Fig. 8 except the above-mentioned modifications, it is possible to obtain the same operation/working effects as those obtainable with the eighth embodiment of the flame injection equipment according to the present invention shown Fig. 8, by presetting the outer diameter φ4 of the turbulent vortex flow generating annular plate 31 at a not-so-large value, though not described in detail.

Embodiment 10

[0066] Turning next to Fig. 10, a tenth embodiment of the flame injection equipment according to the present invention will be described below.

[0067] In Fig. 10, the parts corresponding to those in Fig.9 will be identified by the same reference numerals.

[0068] The tenth embodiment of the flame injection equipment M according to the present invention is similar in configuration to the ninth embodiment of the flame injection equipment according to the present invention shown in Fig. 9, except that the outer diameter φ4 of the turbulent vortex flow generating annular plate 31 is not larger than the diameter φ2 of the extended open end of the blast pipe 21 but smaller than the diameter φ2 of the extended open end of the blast pipe 21 as in the case of the fifth embodiment of the flame injection equipment M according to the present invention shown in Fig. 5.

[0069] The above is the configuration of the tenth embodiment of the flame injection equipment M according to the present invention.

[0070] Since the tenth embodiment of the flame injection equipment M of such a configuration according to the present invention is similar in configuration to the ninth embodiment of the flame injection equipment M according to the present invention shown in Fig. 9, except the above-mentioned modification, it is possible to obtain the same operation/working effects as those obtainable with the ninth embodiment of the flame injection equipment M according to the present invention shown in Fig. 9, by presetting the outer diameter φ4 of the turbulent vortex flow generating annular plate 31 at a value within a range in which the difference between it and the inner diameter φ2 is not so small, though not described in detail.

Embodiment 11

[0071] Turning next to Fig. 11, an eleventh embodiment of the flame injection equipment according to the present invention will be described below.

[0072] In Fig. 11, the parts corresponding to those in Fig.24 will be identified by the same reference numerals.

[0073] The eleventh embodiment of the flame injection equipment M according to the present invention is similar in configuration to the conventional flame injection equipment M described above with reference to Fig. 24, except that the fifth position P5 of the air baffle plate 41 is not rearward of the first position P1 corresponding to the tip of the flame injection nozzle 13 but forward thereof, and as is the case with the first embodiment of the flame injection equipment M according to the present invention shown in Fig. 1, the first position P1 corresponding to the tip of the flame injection nozzle 13 of the flame injector 11 is set at the fourth position P4 between the first position P1 corresponding to the tip of the flame injection nozzle 13 and the second position P2 corresponding to the tip of the inner flame b 1 of the flame B, and the turbulent vortex flow generating annular plate 31, which has an inner diameter φ3 larger than the outer diameter of the flame B at the fourth position P4 but smaller than the diameter φ2 of the extended open end of the blast pipe 21 and an outer diameter φ4 smaller than the diameter φ2 of the extended open end of the blast pipe 21, is disposed at the fourth position P4 with its plate surface held in a plane crossing the axis of the flame B at right angles thereto and concentrically with the flame B.

[0074] The above is the configuration of the eleventh embodiment of the flame injection equipment M according to the present invention.

[0075] According to the eleventh embodiment of the flame injection equipment M of the present invention in which, as in the case of the conventional flame injection equipment M described above with reference to Fig. 24, the third position P3 at the extended open end of the blast pipe 21 is set at the second position P2 corresponding to the tip of the inner flame b 1 of the flame B, and the shape and temperature of the flame B to be injected from the flame injection nozzle 13 of the flame injector 11 are predetermined by presetting the quantity and rate of injection of the atomized fuel F from the flame injection nozzle 13 of the flame injector 11, the quantity and rate of flow of the oxygen-containing gas G from the fuel source to the fuel pipe, the diameter φ2 of the extended open end of the blast pipe 21; thus, the flame injection equipment M can be used widely by itself or in conjunction with a boiler, for instance.

[0076] Also in the eleventh embodiment of the flame injection equipment M according to the present invention, since the first position P1 at the tip of the flame injection nozzle 13 of the flame injector 11 is set at the fourth position P4 between the first position P1 corresponding to the tip of the flame injection nozzle 13 and the second position P2 corresponding to the tip of the inner flame b1 of the flame B and the turbulent vortex flow generating annular plate 31 is disposed at the fourth position P4 as in the case of the first embodiment M according to the present invention, the forward flow of the oxygen-containing gas G from the blast pipe 21 through the air baffle plate 41 is blocked by the plate portion 32 of the turbulent vortex flow generating annular plate 31, and passes through between the inner surface of the opening 33 defining the inner diameter φ3 of the turbulent vortex flow generating annular plate 31 and the outer peripheral surface of the flame injection nozzle 13 of the flame injector 11 and between the outer periphery of the turbulent vortex flow generating annular plate 31 and the inner surface of the blast pipe 21 as in the case of the first embodiment of the flame injection equipment M according to the present invention shown in Fig. 1. Thus, as is the case with the first embodiment of the flame injection equipment M according to the present invention shown in Fig. 1, a negative pressure develops in the oxygen-containing gas G on the front side of the turbulent vortex flow generating annular plate 31, and consequently the oxygen-containing gas G is delivered as turbulent vortex flow E forwardly of the front side of the turbulent vortex flow generating annular plate 31 placed forward of the first position P1 corresponding to the tip of the flame injection nozzle 13, and the oxygen-containing gas G thus delivered in the form of turbulent vortex flow E gets mixed with the fuel F injected in atomized form from the flame injection nozzle 13 of the flame injector 11.

[0077] Incidentally, in the case of the conventional flame injection equipment M described above with reference to Fig. 24, too, since the turbulent vortex flow generating annular plate 31 is not used as is the case with the conventional flame injection equipment described above with reference to Fig. 22, the oxygen-containing gas G is delivered, as a steady flow, neither a turbulent vortex nor turbulent flow, forwardly of the first position P1 corresponding to the tip of the flame injection nozzle 13, and the oxygen-containing gas G of such a steady flow merely gets mixed with the fuel F injected in atomized form from the flame injection nozzle 13 of the flame injector 11.

[0078] Thus, in the case of the eleventh embodiment of the flame injection equipment according to the present invention, too, the oxygen-containing gas G more effectively acts on the fuel F injected in atomized form from the flame injection nozzle 13 of the flame injector 11 than in the case of the conventional flame injection equipment M described above with reference to Fig. 24 which does not employ the turbulent vortex flow generating annular plate 31.

[0079] Therefore, the atomized fuel F from the flame injection nozzle 13 scarcely remains unburned in the flame B injected from the flame injection nozzle 13, and if it remains, its quantity is far smaller than in the case of the conventional flame injection equipment M described above with reference to Fig. 24, and furthermore, the fuel F is scarcely dispersed, as unburned fuel, out of the flame B, and if dispersed, the quantity of such dispersed unburned fuel is far smaller than in the case of the flame injection equipment M described above with reference to Fig. 24; therefore, it is possible to produce the operation/working effects of burning the fuel F with a higher efficiency and injecting the flame B at a higher temperature than in the case of the conventional flame injection equipment M described above with reference to Fig. 24.

Embodiment 12

[0080] Turning next to Fig. 12, a twelfth embodiment of the flame injection equipment according to the present invention will be described below.

[0081] In Fig. 12, the parts corresponding to those in Fig.11 will be identified by the same reference numerals.

[0082] The twelfth embodiment of the flame injection equipment M according to the present invention is similar in configuration to the eleventh embodiment of the flame injection equipment M described above with reference to Fig. 24, except that the fifth position P5 of the air baffle plate 41 is not rearward of the first position P1 corresponding to the tip of the flame injection nozzle 13 but forward thereof, and as is the case with the second embodiment of the flame injection equipment M according to the present invention shown in Fig. 2, the fourth position P4 of the turbulent vortex flow generating annular plate 31 is set not at the first position P1 corresponding to the tip of the flame injection nozzle 13 but at a position between the first position P1 corresponding to the tip of the flame injection nozzle 13 and the second position P2 corresponding to the tip of the inner flame b1 of the flame B.

[0083] The above is the configuration of the twelfth embodiment of the flame injection equipment M according to the present invention.

[0084] Since the twelfth embodiment of the flame injection equipment M of such a configuration according to the present invention is similar in configuration to the eleventh embodiment of the flame injection equipment M according to the present invention shown in Fig. 11, except the above-mentioned modifications, it is possible to obtain the same operation/working effects as those obtainable with the eleventh embodiment of the flame injection equipment M according to the present invention shown in Fig.11, though not described in detail.

Embodiment 13

[0085] Turning next to Fig. 13, a thirteenth embodiment of the flame injection equipment according to the present invention will be described below.

[0086] In Fig. 13, the parts corresponding to those in Fig.12 will be identified by the same reference numerals.

[0087] The thirteenth embodiment of the flame injection equipment M according to the present invention shown in Fig. 13 is similar in configuration to the twelfth embodiment of the flame injection equipment M described above with reference to Fig. 12, except that the fourth position P4 of the turbulent vortex flow generating annular plate 31 is set not at the position between the fifth position P5 of the air baffle plate 41 and the second position P2 corresponding to the tip of the inner flame b 1 of the flame B but at the second position P2 corresponding to the tip of the inner flame b1 of the flame B.

[0088] The above is the configuration of the thirteenth embodiment of the flame injection equipment M according to the present invention.

[0089] Since the thirteenth embodiment of the flame injection equipment M according to the present invention is similar in configuration to the twelfth embodiment of the flame injection equipment M of such a configuration according to the present invention shown in Fig. 12, except the above-mentioned modification, it is possible to obtain the same operation/working effects as those obtainable with the twelfth embodiment of the flame injection equipment M according to the present invention shown in Fig.12, though not described in detail.

Embodiment 14

[0090] Turning next to Fig. 14, a fourteenth embodiment of the flame injection equipment according to the present invention will be described below.

[0091] In Fig. 14, the parts corresponding to those in Fig.7 will be identified by the same reference numerals.

[0092] The fourteenth embodiment of the flame injection equipment M according to the present invention shown in Fig. 14 is similar in configuration to the seventh embodiment of the flame injection equipment M described above with reference to Fig. 7, except that the turbulent vortex flow generating annular plate 31 is substituted with a turbulent vortex flow generating conic-and-cylindrical member 51 which has a first open end of an inner diameter φ31 larger than the outer diameter of the flame B at the fourth position P4 between a sixth position, which is that one of the first position P1 corresponding to the tip of the flame injection nozzle 13 and the fifth position P5 of the air baffle plate 41 which is closer to the tip of the blast pipe 21 than the other, and the second position corresponding to the tip of the inner flame b 1 of the flame B, but smaller than the diameter φ2 of the extended open end of the blast pipe 21 and a second open end of an inner diameter φ32 larger than the inner diameter φ31 and larger than the outer diameter φ1 of the flame B at the second position P2, and that the turbulent vortex flow generating conic-and-cylindrical member 51 is disposed concentrically with the flame injection nozzle 13, with the second open end positioned forward on the side opposite to the flame injection nozzle 13 and with the first open end at the fourth position P4, the second open end having an outer diameter φ42 equal to the outer diameter φ4 of the turbulent vortex flow generating annular plate 31 and the first open end having an outer diameter φ41 smaller than the outer diameter φ41 of the second open end.

[0093] The above is the configuration of the fourteenth embodiment of the flame injection equipment M according to the present invention.

[0094] Since the fourteenth embodiment of the flame injection equipment of such a configuration according to the present invention is similar in configuration to the seventh embodiment of the flame injection equipment M according to the present invention shown in Fig. 7, except the above-mentioned modifications, and since the plate portion between the first open end and the second open end of the turbulent vortex flow generating conic-and-cylindrical member 51 corresponds to the plate portion 32 of the turbulent vortex flow generating annular plate 31 in the seventh embodiment of the present invention shown in Fig. 7, it is possible to obtain the same operation/working effects as those obtainable with the seventh embodiment of the flame injection equipment M according to the present invention shown in Fig.7, though not described in detail.

Embodiment 15

[0095] Turning next to Fig. 15, a fifteenth embodiment of the flame injection equipment according to the present invention will be described below.

[0096] In Fig. 15, the parts corresponding to those in Fig.14 will be identified by the same reference numerals.

[0097] The fifteenth embodiment of the flame injection equipment M according to the present invention shown in Fig. 15 is similar in configuration to the fourteenth embodiment of the flame injection equipment M shown in Fig. 14, except that the turbulent vortex flow generating conic-and-cylindrical member 51 is substituted with a turbulent vortex flow generating dish-like-and-cylindrical member 52 having a first open end of the same inner and outer diameters as those φ31 and φ41 of the first open end of the conic-and-cylindrical member and a second open end of the same inner and outer diameters as those φ32 and φ42 of the second open end of the turbulent vortex flow generating conic-and-cylindrical member 51.

[0098] The above is the configuration of the fifteenth embodiment of the flame injection equipment according to the present invention.

[0099] Since the fifteenth embodiment of the flame injection equipment of such a configuration according to the present invention is similar in configuration to the fourteenth embodiment of the flame injection equipment according to the present invention shown in Fig. 14, except the above-mentioned modification, it is possible to obtain the same operation/working effects as those obtainable with the fourteenth embodiment of the flame injection equipment according to the present invention shown in Fig.14, though not described in detail.

Embodiment 16

[0100] Turning next to Fig. 16, a sixteenth embodiment of the flame injection equipment according to the present invention will be described below.

[0101] In Fig. 16, the parts corresponding to those in Fig.14 will be identified by the same reference numerals.

[0102] The sixteenth embodiment of the flame injection equipment according to the present invention shown in Fig. 16 is similar in configuration to the fourteenth embodiment of the flame injection embodiment shown in Fig. 14 except that: the turbulent vortex flow generating conic-and-cylindrical member 51 is substituted with a turbulent vortex flow generating cylindrical member 90 composed of a cylindrical member 60 of the same inner diameter φ61 as that φ31 of the first open end of the turbulent vortex flow generating conic-and-cylindrical member 51 and a conic-and-cylindrical member 70 having a first open end of the same inner diameter φ71 as that φ61 and a second open end of the same inner diameter φ72 as that φ32 of the second open end of the turbulent vortex flow generating conic-and-cylindrical member 51, the cylindrical member 60 and the conic-and-cylindrical member 70 being concentrically coupled as a one-piece structure with the first open end of the latter connected to the former; and the turbulent vortex flow generating cylindrical member 90 is disposed concentrically with the flame injection nozzle 13 with the open end of the cylindrical member 60 at the fourth position P4 on the side opposite from the conic-and-cylindrical member 70, the second open end of the conic-and-cylindrical member 70 having the same outer diameter φ82 as that φ42 of the turbulent vortex generating conic-and-cylindrical member 51, the first open end of the conic-and- cylindrical member 70 having an outer diameter φ81 smaller than that φ82, and the cylindrical member 60 having the same outer diameter as that φ81.

[0103] The above is the configuration of the sixteenth embodiment of the flame injection equipment according to the present invention.

[0104] Since the sixteenth embodiment of the flame injection equipment of such a configuration according to the present invention is similar in configuration to the seventh embodiment of the flame injection equipment according to the present invention shown in Fig. 14, except the above-mentioned modifications, it is possible to obtain the same operation/working effects as those obtainable with the fourteenth embodiment of the flame injection equipment according to the present invention shown in Fig.14, though not described in detail.

Embodiment 17

[0105] Turning next to Fig. 17 a seventeenth embodiment of the flame injection equipment according to the present invention will be described below.

[0106] In Fig. 17, the parts corresponding to those in Fig.16 will be identified by the same reference numerals.

[0107] The seventeenth embodiment of the flame injection equipment according to the present invention shown in Fig. 17 is similar in configuration to the sixteenth embodiment of the flame injection embodiment shown in Fig. 16 except that the conic-and-cylindrical member 70 of the turbulent vortex flow generating conic-and cylindrical member 90 is substituted with a dish-like-and-cylindrical member 80 having a first open end of the same inner and outer diameters as those φ71 and φ81 of the first open end of the conic-and-cylindrical member and a second open end of the same inner and outer diameters as those φ72 and φ82 of the second open end of the conic-and-cylindrical member 70.

[0108] The above is the configuration of the seventeenth embodiment of the flame injection equipment according to the present invention.

[0109] Since the seventeenth embodiment of the flame injection equipment of such a configuration according to the present invention is similar in configuration to the sixteenth embodiment of the flame injection equipment according to the present invention shown in Fig. 16, except the above-mentioned modification, it is possible to obtain the same operation/working effects as those obtainable with the sixteenth embodiment of the flame injection equipment according to the present invention shown in Fig.16, though not described in detail.

Embodiment 18

[0110] Turning next to Fig. 18 an eighteenth embodiment of the flame injection equipment according to the present invention will be described below.

[0111] In Fig. 18, the parts corresponding to those in Fig.16 will be identified by the same reference numerals.

[0112] The eighteenth embodiment of the flame injection equipment according to the present invention shown in Fig. 18 is similar in configuration to the sixteenth embodiment of the flame injection embodiment shown in Fig. 16 except that: the cylindrical member 60 of the turbulent vortex flow generating cylindrical member 90 is substituted with a conic-and-cylindrical member 110 having a first open end of the same inner diameter φ101 as that φ61 of the cylindrical member 60 and a second open end of an inner diameter larger than the inner diameter φ101 but smaller than the inner diameter φ72 of the second open end of the conic-and-cylindrical member 70; and the inner diameter φ71 of the first open end of the conic-and-cylindrical member 70 of the turbulent vortex flow generating cylindrical member 90 is changed to the same diameter as that φ102 of the second open end of the conic-and-cylindrical member 110, the first open end of the conic-and-cylindrical member has an outer diameter smaller than that φ72 of the second open end, the second open end of the conic-and-cylindrical member 110 has the same outer diameter as that of the first open end of the conic-and-cylindrical member 70, and the first open end of the conic-and-cylindrical member 110 has an outer diameter smaller than that of the second open end.

[0113] The above is the configuration of the eighteenth embodiment of the flame injection equipment according to the present invention.

[0114] Since the eighteenth embodiment of the flame injection equipment of such a configuration according to the present invention is similar in configuration to the sixteenth embodiment of the flame injection equipment according to the present invention shown in Fig. 16, except the above-mentioned modifications, it is possible to obtain the same operation/working effects as those obtainable with the sixteenth embodiment of the flame injection equipment according to the present invention shown in Fig.16, though not described in detail.

Embodiment 19

[0115] Turning next to Fig. 19 a nineteenth embodiment of the flame injection equipment according to the present invention will be described below.

[0116] In Fig. 19, the parts corresponding to those in Fig. 18 will be identified by the same reference numerals.

[0117] The nineteenth embodiment of the flame injection equipment according to the present invention shown in Fig. 19 is similar in configuration to the eighteenth embodiment of the flame injection embodiment shown in Fig. 18 except that the conic-and-cylindrical member 70 of the turbulent vortex flow generating cylindrical member 90 is substituted with a dish-like-and-cylindrical member 80 having a first open end of the same inner and outer diameters as those φ71 and φ81 of the first open end of the conic-and-cylindrical member and a second open end of the same inner and outer diameters as those φ72 and φ82 of the second open end of the conic-and-cylindrical member 70.

[0118] The above is the configuration of the nineteenth embodiment of the flame injection equipment according to the present invention.

[0119] Since the nineteenth embodiment of the flame injection equipment of such a configuration according to the present invention is similar in configuration to the eighteenth embodiment of the flame injection equipment according to the present invention shown in Fig. 18, except the above-mentioned modification, it is possible to obtain the same operation/working effects as those obtainable with the eighteenth embodiment of the flame injection equipment according to the present invention shown in Fig.18, though not described in detail.

Embodiment 20

[0120] Turning next to Fig. 20 a twentieth embodiment of the flame injection equipment according to the present invention will be described below.

[0121] In Fig. 20, the parts corresponding to those in Fig. 18 will be identified by the same reference numerals.

[0122] The twentieth embodiment of the flame injection equipment according to the present invention shown in Fig. 20 is similar in configuration to the eighteenth embodiment of the flame injection embodiment shown in Fig. 18 except that the conic-and-cylindrical member 110 of the turbulent vortex flow generating cylindrical member 90 is substituted with a dish-like-and-cylindrical member 120 having a first open end of the same inner and outer diameters as the inner diameter φ101 and the outer diameter of the first open end of the conic-and-cylindrical member and a second open end of the same inner and outer diameters as the inner diameter φ102 and the outer diameter of the second open end of the conic-and-cylindrical member 110.

[0123] The above is the configuration of the twentieth embodiment of the flame injection equipment according to the present invention.

[0124] Since the twentieth embodiment of the flame injection equipment of such a configuration according to the present invention is similar in configuration to the eighteenth embodiment of the flame injection equipment according to the present invention shown in Fig. 18, except the above-mentioned modification, it is possible to obtain the same operation/working effects as those obtainable with the eighteenth embodiment of the flame injection equipment according to the present invention shown in Fig.18, though not described in detail.

Embodiment 21

[0125] Turning next to Fig. 21 a twenty-first embodiment of the flame injection equipment according to the present invention will be described below.

[0126] In Fig. 21, the parts corresponding to those in Fig. 19 will be identified by the same reference numerals.

[0127] The twenty-first embodiment of the flame injection equipment according to the present invention shown in Fig. 21 is similar in configuration to the nineteenth embodiment of the flame injection embodiment shown in Fig. 19 except that the conic-and-cylindrical member 110 of the turbulent vortex flow generating cylindrical member 90 is substituted with a dish-like-and-cylindrical member 120 having a first open end of the same inner and outer diameters as the inner diameter φ 101 and the outer diameter of the first open end of the conic-and-cylindrical member and a second open end of the same inner and outer diameters as the inner diameter φ102 and the outer diameter of the second open end of the conic-and-cylindrical member 110.

[0128] The above is the configuration of the twenty-first embodiment of the flame injection equipment according to the present invention.

[0129] Since the twenty-first embodiment of the flame injection equipment of such a configuration according to the present invention is similar in configuration to the nineteenth embodiment of the flame injection equipment according to the present invention shown in Fig. 19, except the above-mentioned modification, it is possible to obtain the same operation/working effects as those obtainable with the nineteenth embodiment of the flame injection equipment according to the present invention shown in Fig.19, though not described in detail.

Modifications and Variations of the Mode of Working of the Invention

[0130] The above description has been given of no more than a miniscule number of embodiments of the flame injection equipment according to the present invention; however, in the Fig. 7 embodiment of the flame injection equipment according to the present invention, the fourth position P4 where the turbulent vortex flow generating annular plate 31 is disposed may be changed to the third position P3 at the extended open end of the air baffle pipe 21 or to a position rearward of the third position P3; in the above-described embodiments using the turbulent vortex flow generating annular plate 31, the outer diameter φ4 of the turbulent vortex flow generating annular plate 31 may be made smaller than the diameter φ2 of the open end of the blast pipe 21 1 when the fourth position P4, at which the turbulent vortex flow generating annular plate 31 is disposed, is the third position P3 at the extended open end of the blast pipe 41 or a position rearward of the third position P3, and the above-said outer diameter may be made smaller, equal to or larger than the diameter φ2 of the open end of the blast pipe 21 when the fourth position P4, at which the turbulent vortex flow generating annular plate 31 is disposed, is forward of the third position P3 at the extended open end of the blast pipe 21; thus, various modifications may be made in the above-described embodiments using the turbulent vortex flow generating annular plate 31.

[0131] Further, in the above-described embodiments in which the turbulent vortex flow generating annular plate 31 is provided, the plate portion 32 of the turbulent vortex flow generating annular plate 31 may have a ventilation opening bored therethrough, or ventilation notch extending inwardly from the marginal edge of the plate.

[0132] Moreover, the turbulent vortex flow generating conic-and-cylindrical member 51 in the fourteenth embodiment of the flame injection equipment according to the present invention, the turbulent vortex flow generating dish-like-and cylindrical member 52 in the fifteenth embodiment of the flame injection equipment according to the present invention, the conic-and-cylindrical member 70 of the turbulent vortex flow generating cylindrical member 90 in the sixteenth, eighteenth and twentieth embodiments of the flame injection equipment according to the present invention, and the conic-and-cylindrical member 80 of the turbulent vortex flow generating cylindrical member 90 in the seventeenth, nineteenth and twenty-first embodiments of the flame injection equipment according to the present invention may each have a plurality of spaced-apart ventilation openings and/or a plurality of equiangularly spaced ventilation notches extending inwardly from its marginal edge, and it will be apparent that various other modifications and variations may be effected without departing from the spirit of the present invention.

INDUSTRIAL APPLICABILITY

[0133] The flame injection equipment according to the present invention can be widely used by itself or in conjunction with a boiler, for instance.

Claims

1. Flame injection equipment comprises: a flame injector adapted to be supplied with fuel from a fuel source and having a flame injection nozzle at its front end; a blast pipe extending forwardly from an air blower for delivering oxygen or oxygen-containing gas, and surrounding said flame injector concentrically with said flame injection nozzle; and an annular disc-shaped air baffle plate having a through hole and disposed at a fifth position near the tip of said flame injection nozzle of said flame injector concentrically with said flame injection nozzle and at right angles to the axis of said flame injection nozzle; wherein said flame injection nozzle is adapted to deliver blasts of flame, the position of an extended open end of said blast pipe is set at a third position between a first position corresponding to the tip of said flame injection nozzle and a second position corresponding to the tip of an inner flame of said flame, and the diameter of the extended open end of said blast pipe is φ2 larger than the outer diameter φ1 of said flame at the second position corresponding to the tip of the inner flame of said flame; **characterized in that:**

   at a fourth position between a sixth position, which is that one of the first position corresponding to the tip of said flame injection nozzle and a fifth position of said air baffle plate which is closer to the extended open end of said blast pipe, and the second position corresponding to the tip of the inner flame of said flame, a turbulent vortex flow generating annular plate is disposed with its plate portion held at right angles to the axis of said flame and concentrically with said flame, said turbulent vortex flow generating annular plate having an inner diameter φ3 smaller than the diameter φ2 of the extended open end of said blast pipe and an outer diameter φ4 smaller than the diameter φ2 of the extended open end of said blast pipe when said fourth position is set at said third position or its vicinity or a position rearward of said third position, or an outer diameter φ4 smaller than the diameter φ2 of the extended open end of said blast pipe or equal to said diameter φ2 or larger than said diameter φ2 when said fourth position is set at a position forward of said third position.

2. The flame injection equipment of claim 1, **characterized in that** said turbulent vortex flow generating annular plate has a ventilation opening bored therethrough.

3. The flame injection equipment of claim 1, **characterized in that** said turbulent vortex flow generating annular plate has a ventilation notches extending inwardly from its marginal edge.

4. Flame injection equipment comprises: a flame injector adapted to be supplied with fuel from a fuel source and having a flame injection nozzle at its front end; a blast pipe extending forwardly from an air blower for delivering oxygen or oxygen-containing gas, and surrounding said flame injector concentrically with said flame injection nozzle, and an annular disc-shaped air baffle plate having a through hole and disposed at a fifth position near the tip of said flame injection nozzle of said flame injector concentrically with said flame injection nozzle and at right angles to the axis of said flame injection nozzle; wherein said flame injection nozzle is adapted to deliver blasts of flame, the position of an extended open end of said blast pipe is set at a third position between a first position corresponding to the tip of said flame injection nozzle and a second position corresponding to the tip of an inner flame of said flame, and the diameter of the extended open end of said blast pipe is φ2 larger than the outside diameter φ1 of said flame at the second position corresponding to the tip of the inner flame of aid flame; **characterized in that:**

   a turbulent vortex flow generating conic-and-cylindrical member or turbulent vortex flow generating dish-like-and-cylindrical member is disposed concentrically with said flame injection nozzle, said turbulent vortex flow generating conic-and-cylindrical member or turbulent vortex flow generating dish-like-and-cylindrical member having a first open end of an inner diameter φ31 larger than the outer diameter of said flame at a fourth position between a sixth position, which is that one of the first position corresponding to the tip of the flame injection nozzle and the fifth position of said air baffle plate which is closer to the tip of said blast pipe than the other, and the second position corresponding to the tip of the inner flame of said flame, but smaller than the diameter φ2 of the extended open end of said blast pipe, and a second open end which has an inner diameter 32 larger than the inner diameter 31 and larger than outer diameter φ1 of said flame at the position corresponding to the said second position, and said turbulent vortex flow generating conic-and-cylindrical member or turbulent vortex flow generating dish-like-and-cylindrical member having said second open end facing forward on the side opposite from said flame injection nozzle and said first open end held at said fourth position.

5. The flame injection equipment of claim 4, **characterized in that** said turbulent vortex flow generating conic-and-cylindrical member or turbulent vortex flow generating dish-like-and-cylindrical member has a ventilation opening bored therethrough.

6. The flame injection equipment of claim 4, **characterized in that** said turbulent vortex flow generating conic-and-cylindrical member or turbulent vortex flow generating dish-like-and-cylindrical member has a ventilation notch extending from said second open end toward said first open end.

7. Flame injection equipment comprises: a flame injector adapted to be supplied with fuel from a fuel source and having a flame injection nozzle at its front end; a blast pipe extending forwardly from an air blower for delivering oxygen or oxygen-containing gas, and surrounding said flame injector concentrically with said flame injection nozzle, and an annular disc-shaped air baffle plate having a through hole and disposed at a fifth position near the tip of said flame injection nozzle of said flame injector concentrically with said flame injection nozzle and at right angles to the axis of said flame injection nozzle; wherein said flame injection nozzle is adapted to deliver blasts of flame, the position of an extended open end of said blast pipe is set at a third position between a first position corresponding to the tip of said flame injection nozzle and a second position corresponding to the tip of an inner flame of said flame, and the diameter of the extended open end of said blast pipe is φ2 larger than the outside diameter φ1 of said flame at the second position corresponding to the tip of the inner flame of aid flame; **characterized in that:**

a turbulent vortex flow generating cylindrical member is disposed concentrically with said flame injection nozzle, said a turbulent vortex flow generating cylindrical member being formed as a one-piece structure by coupling a cylindrical member and a conic-and-cylindrical member or dish-like-and-cylindrical member concentrically with each other, the cylindrical member having an inner diameter φ61 larger than the outer diameter of said flame at a fourth position between a sixth position, which is that one of the first position corresponding to the tip of the flame injection nozzle and the fifth position of said air baffle plate which is closer to the tip of said blast pipe than the other, and the second position corresponding to the tip of the inner flame of said flame, but smaller than the diameter φ2 of the extended open end of said blast pipe, the conic-and-cylindrical member or dish-like-and-cylindrical member having a first open end having the same inner diameter φ71 as said inner diameter φ61 and a second open end having an inner diameter φ72 larger than said inner diameter φ71 and larger than the outer diameter φ1 of said flame at said second position, said turbulent vortex flow generating cylindrical member having said conic-and-cylindrical member held forward on the side opposite from said flame injection nozzle and the open end of said cylindrical member on the side opposite from said conic-and-cylindrical member or dish-like-and cylindrical member held at said fourth position.

8. The flame injection equipment of claim 7, **characterized in that** said conic-and-cylindrical member or dish-like-and-cylindrical member has a ventilation opening bored therethrough.

9. The flame injection equipment of claim 7, **characterized in that** said conic-and-cylindrical member or dish-like-and-cylindrical member has a ventilation notch extending inwardly from its marginal edge.

10. Flame injection equipment comprises: a flame injector adapted to be supplied with fuel from a fuel source and having a flame injection nozzle at its front end; a blast pipe extending forwardly from an air blower for delivering oxygen or oxygen-containing gas, and surrounding said flame injector concentrically with said flame injection nozzle, and an annular disc-shaped air baffle plate having a through hole and disposed at a fifth position near the tip of said flame injection nozzle of said flame injector concentrically with said flame injection nozzle and at right angles to the axis of said flame injection nozzle; wherein said flame injection nozzle is adapted to deliver blasts of flame, the position of an extended open end of said blast pipe is set at a third position between a

first position corresponding to the tip of said flame injection nozzle and a second position corresponding to the tip of an inner flame of said flame, and the diameter of the extended open end of said blast pipe is φ2 larger than the outside diameter φ1 of said flame at the second position corresponding to the tip of the inner flame of aid flame; **characterized in that:**

a turbulent vortex flow generating cylindrical member is disposed concentrically with said flame injection nozzle, said turbulent vortex flow generating cylindrical member being formed as a one-piece structure by coupling a first conic-and-cylindrical member or first dish-like-and-cylindrical member and a second conic-and-cylindrical member or second dish-like-and-cylindrical member concentrically with each other, said first conic-and-cylindrical or first dish-like-and -cylindrical member having a first open end having an inner diameter φ101 lager than the outer diameter of said flame at a fourth position between a sixth position, which is that one of the first position corresponding to the tip of the flame injection nozzle and the fifth position of said air baffle plate which is closer to the tip of said blast pipe than the other, and the second position corresponding to the tip of the inner flame of said flame, but smaller than the diameter φ2 of the extended open end of said blast pipe, and a second open end having an inner diameter φ102 larger than said inner diameter φ101 and larger than the outer diameter φ1 of said flame at said second position, said second conic-and-cylindrical member or second dish-like-and-cylindrical member having a first open end having an inner diameter φ31' equal to said inner diameter φ102 and a third open end having an inner diameter φ32' larger than said inner diameter φ31' and larger than the outer diameter φ1 of said flame at said second position, and said turbulent vortex flow generating cylindrical member having said second conic-and-cylindrical member or second dish-like-and-cylindrical member held forward on the side opposite from said flame injection nozzle and the first open end of said first conic-and-cylindrical member or second dish-like-and-cylindrical member held at said fourth position.

11. The flame injection equipment of claim 10, **characterized in that** the first conic-and-cylindrical member or first dish-like-and cylindrical member of said turbulent vortex flow generating cylindrical member and/or the second conic-and cylindrical member or second dish-like-and-cylindrical member of said turbulent vortex forming cylindrical member has a ventilation opening bored therethrough.

12. The flame injection equipment of claim 10, **characterized in that** the first conic-and-cylindrical member or second dish-like-and-cylindrical member of said turbulent vortex flow generating cylindrical member has a ventilation notch extending from said fourth open end toward said third open end.

FIG. 1

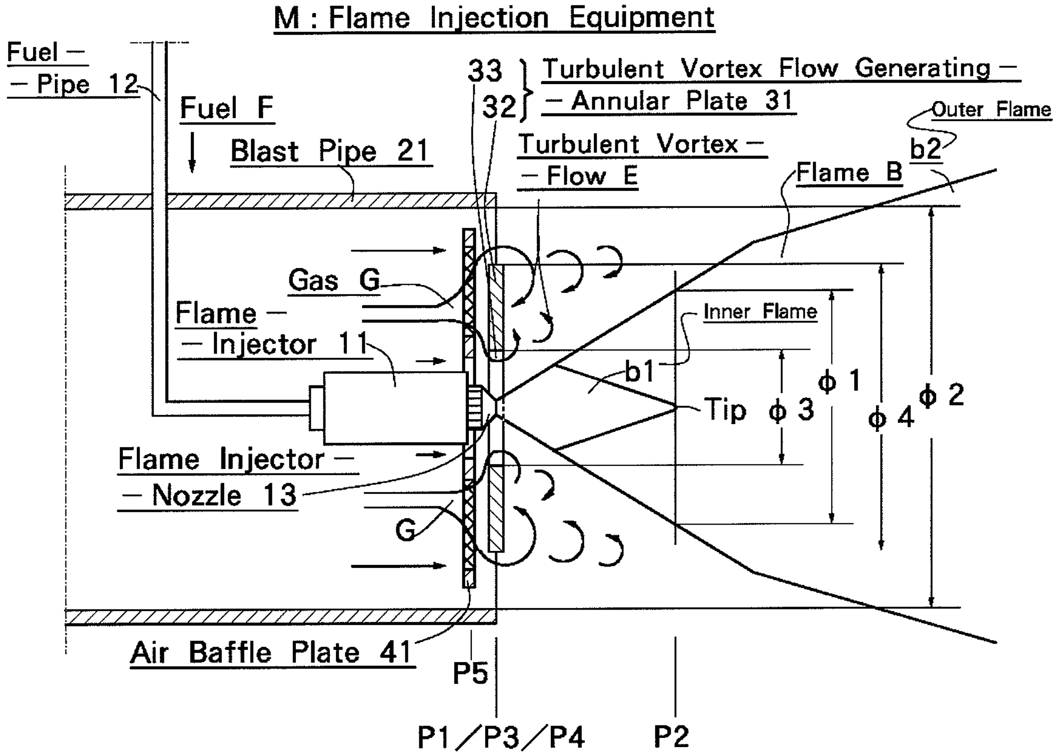

M : Flame Injection Equipment
Fuel – – Pipe 12
Fuel F
Blast Pipe 21
33
32
Turbulent Vortex Flow Generating – – Annular Plate 31
Outer Flame
b2
Turbulent Vortex – – Flow E
Flame B
Gas G
Flame – – Injector 11
Inner Flame
b1
Tip
φ 1
φ 2
φ 3
φ 4
Flame Injector – – Nozzle 13
G
Air Baffle Plate 41
P5
P1／P3／P4
P2

FIG. 2

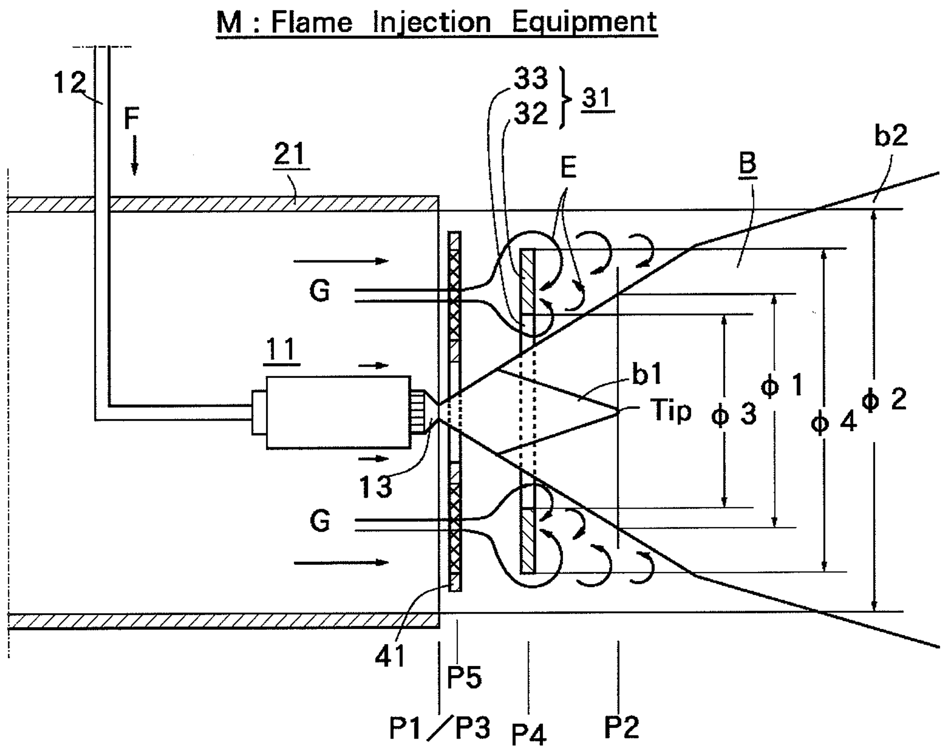

M : Flame Injection Equipment
12
F
21
33
32
31
E
B
b2
G
11
b1
Tip
φ 1
φ 2
φ 3
φ 4
13
G
41
P5
P1／P3
P4
P2

FIG. 3

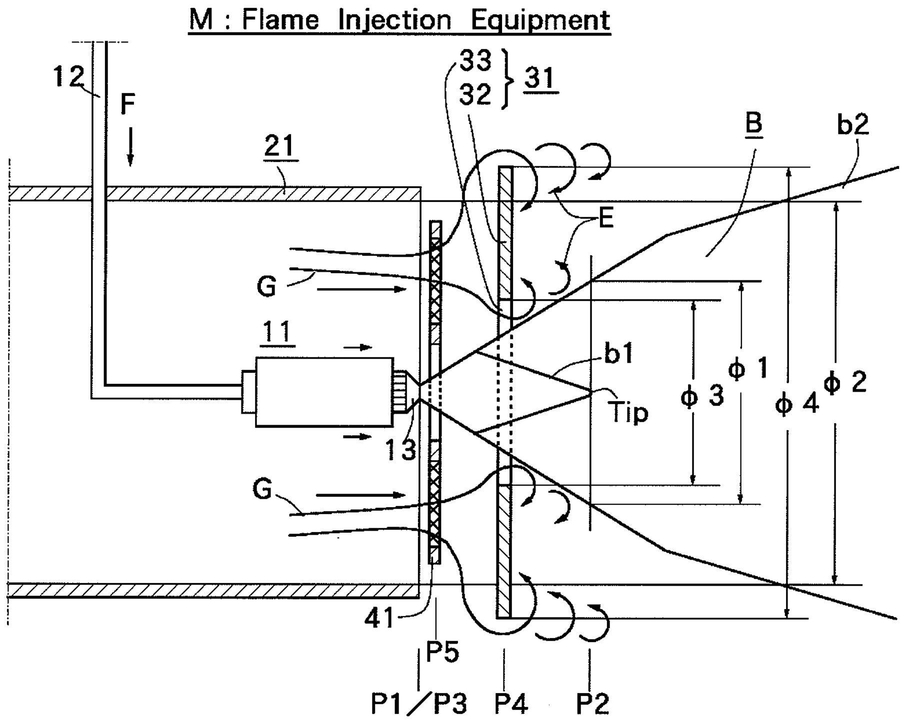

M : Flame Injection Equipment
33
32
31
12
F
21
B
b2
E
G
11
b1
Tip
φ 1
φ 3
φ 4
φ 2
13
G
41
P5
P1／P3
P4
P2

FIG. 4

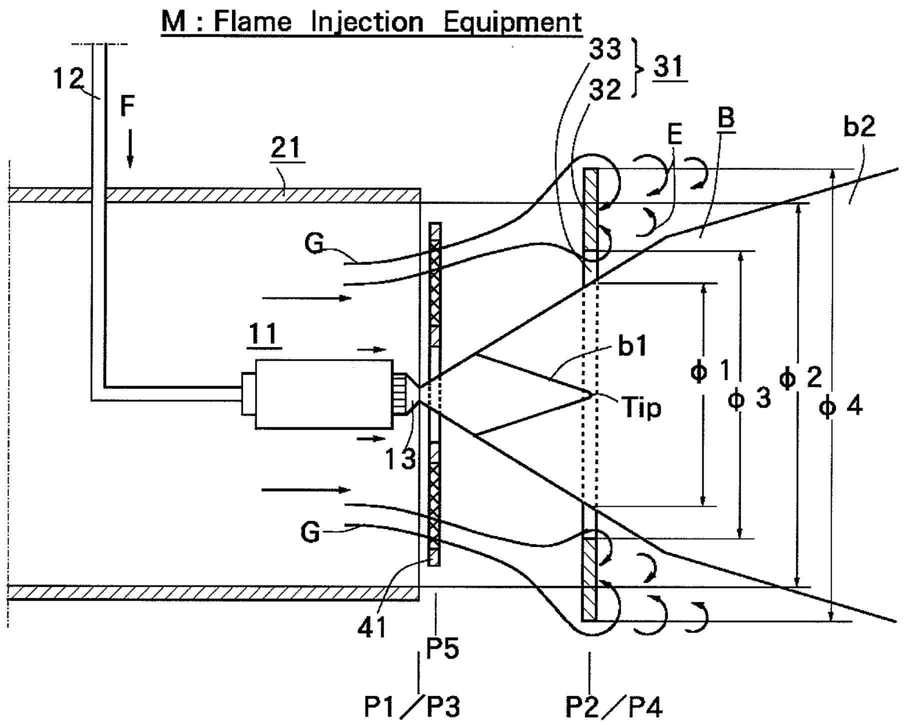

M : Flame Injection Equipment
33
32
31
12
F
E
B
b2
21
G
11
b1
φ 1
Tip
φ 3
φ 2
φ 4
13
G
41
P5
P1／P3
P2／P4

FIG. 5

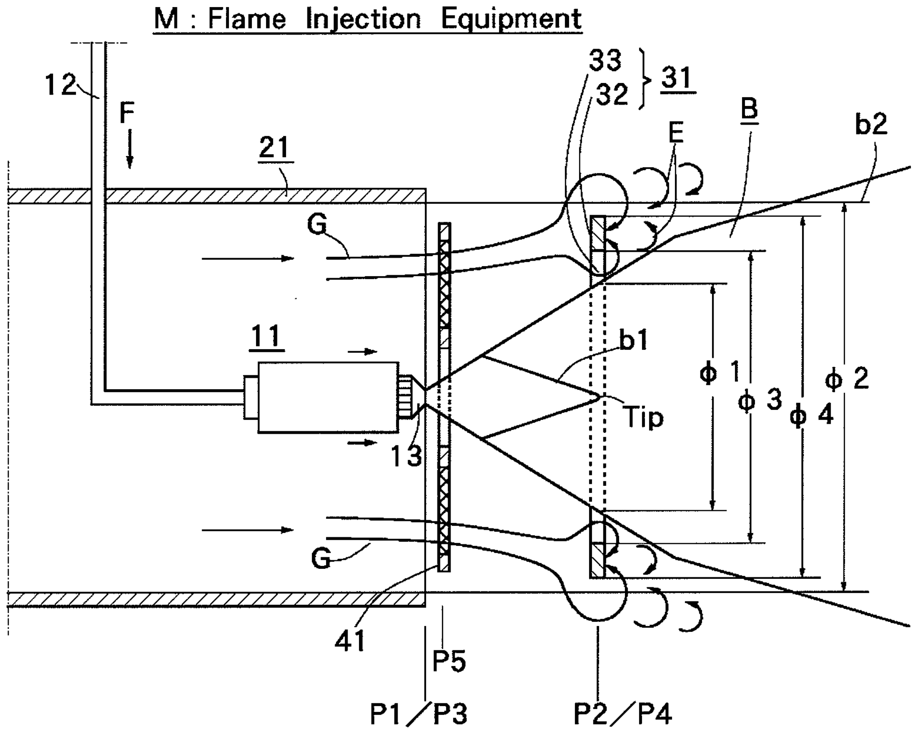

M : Flame Injection Equipment
12
F
21
33
32
31
E
B
b2
G
11
b1
Tip
φ 1
φ 3
φ 4
φ 2
13
41
P5
P1／P3
P2／P4

FIG. 6

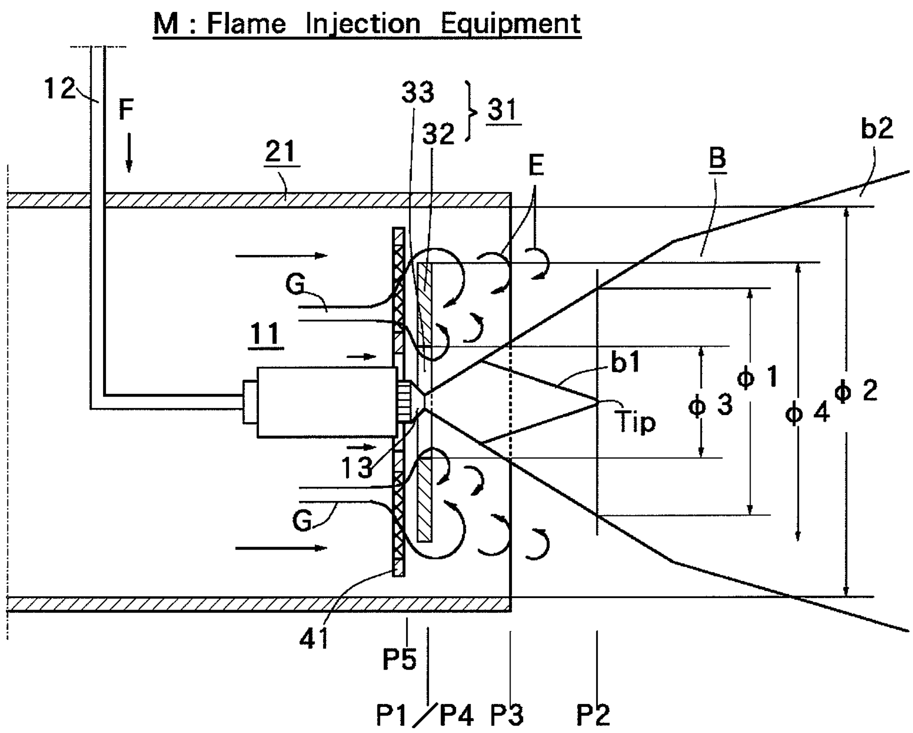

M : Flame Injection Equipment
12
F
21
33
32
31
E
B
b2
G
11
b1
Tip
φ 3
φ 1
φ 4
φ 2
13
41
P5
P1／P4
P3
P2

FIG. 7

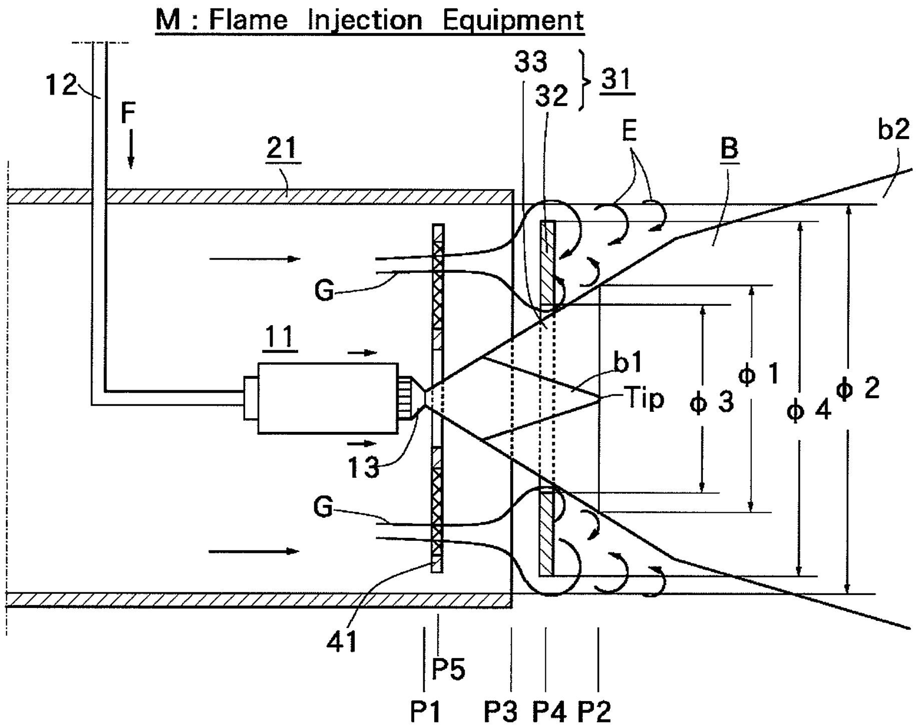

M : Flame Injection Equipment
12
F
21
33
32
31
E
B
b2
G
11
b1
Tip
ϕ 3
ϕ 1
ϕ 4
ϕ 2
13
G
41
P5
P1
P3
P4
P2

FIG. 8

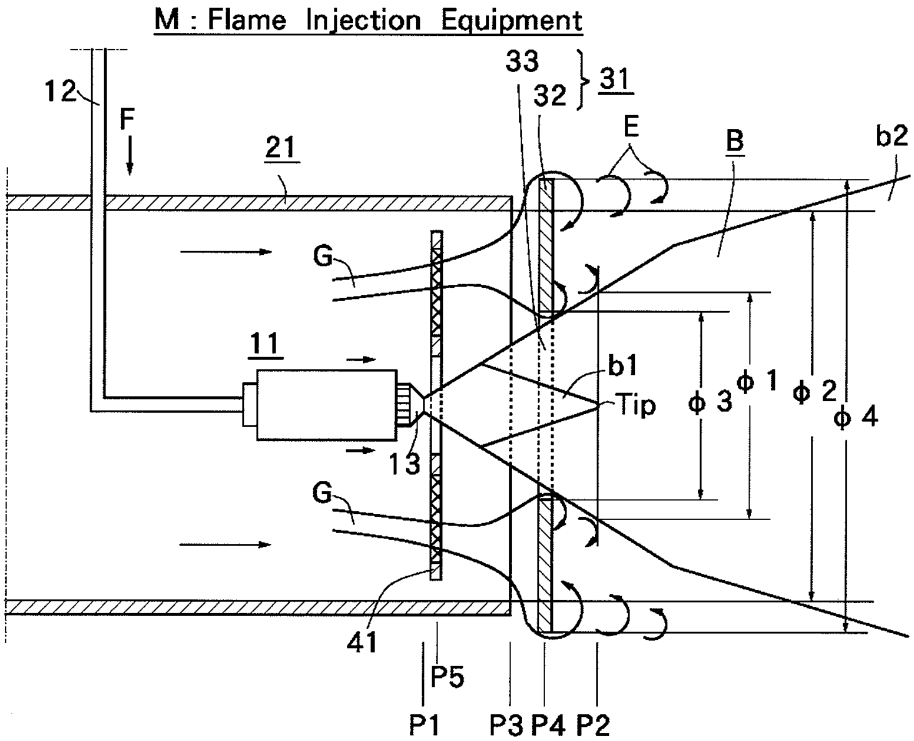

M : Flame Injection Equipment
12
F
21
33
32
31
E
B
b2
G
11
b1
Tip
ϕ 3
ϕ 1
ϕ 2
ϕ 4
13
G
41
P5
P1
P3
P4
P2

FIG. 9

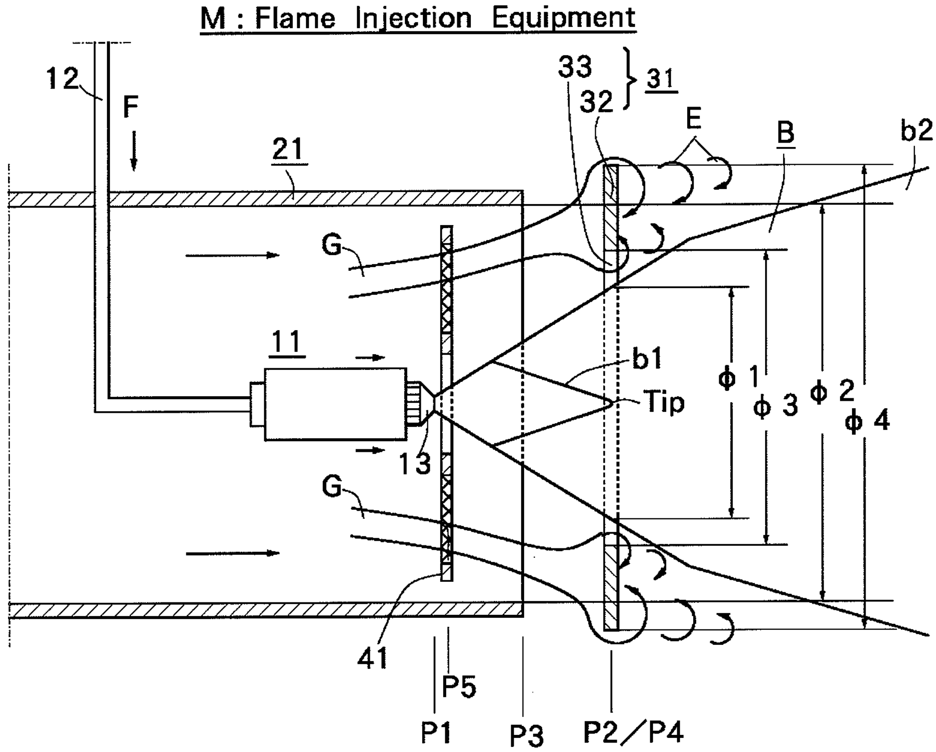

M : Flame Injection Equipment
12
F
21
33
32
31
E
B
b2
G
11
b1
Tip
13
φ 1
φ 3
φ 2
φ 4
G
41
P5
P1
P3
P2／P4

FIG. 10

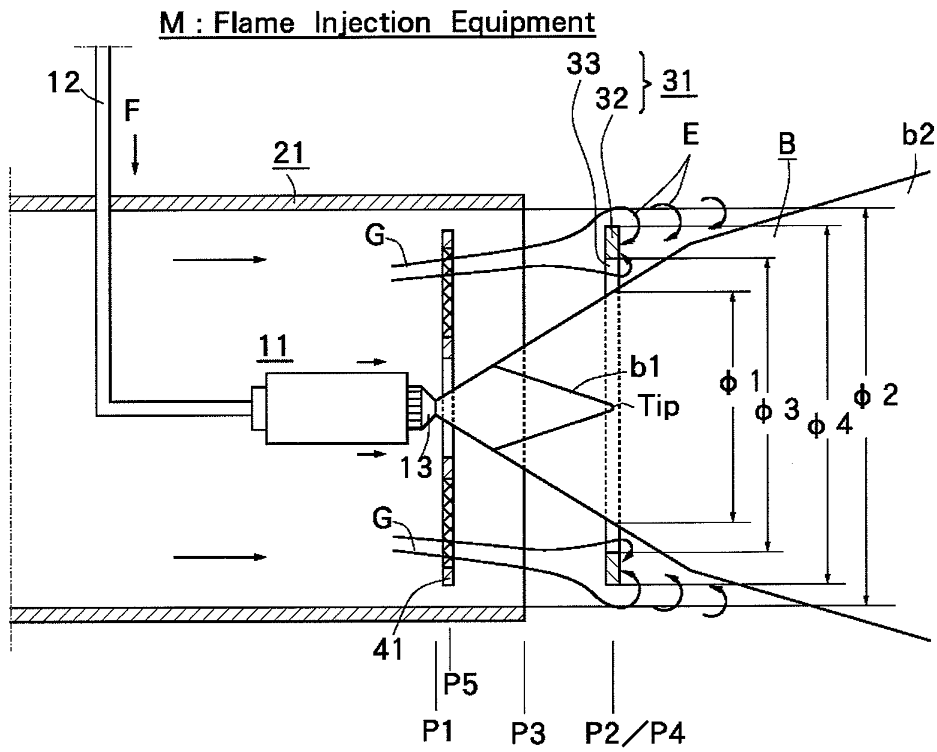

M : Flame Injection Equipment
12
F
21
33
32
31
E
B
b2
G
11
b1
Tip
13
φ 1
φ 3
φ 4
φ 2
G
41
P5
P1
P3
P2／P4

FIG. 11

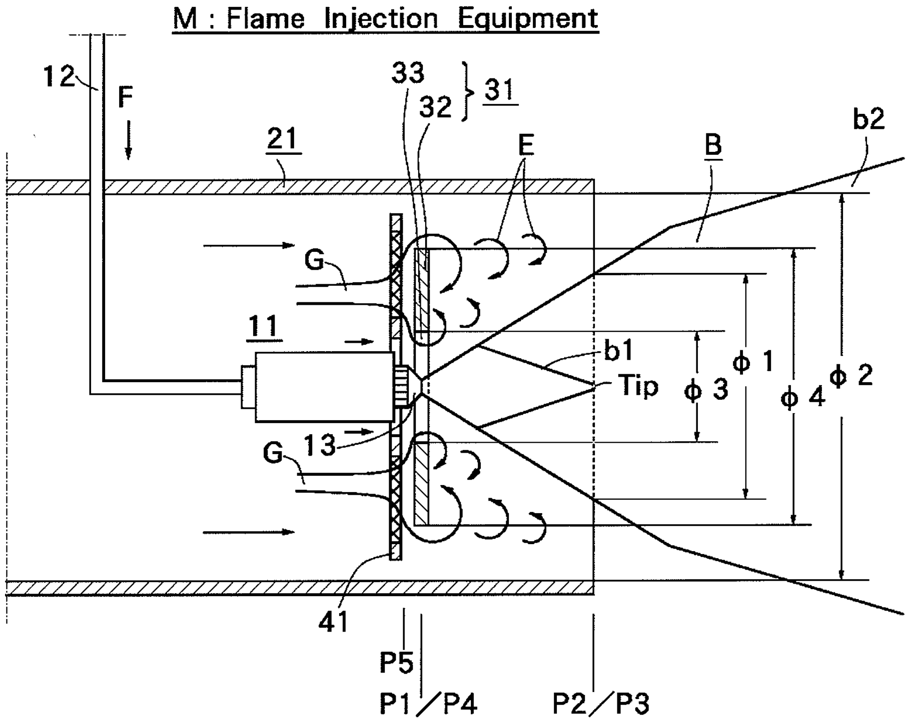

M : Flame Injection Equipment
12
F
33
32
31
21
E
B
b2
G
11
b1
Tip
φ 1
φ 3
φ 4
φ 2
13
G
41
P5
P1／P4
P2／P3

FIG. 12

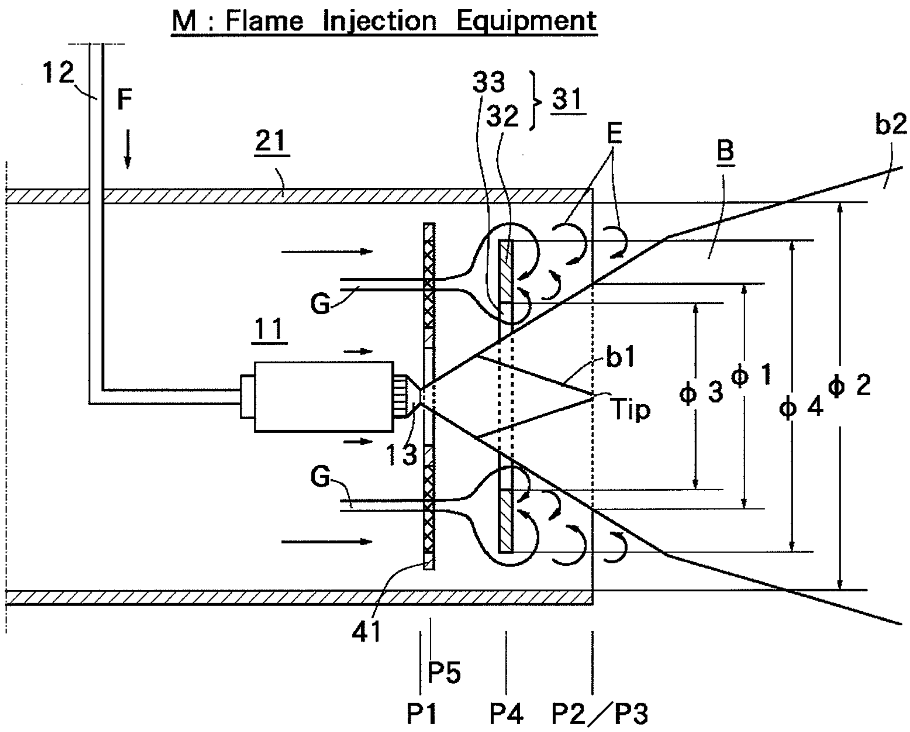

M : Flame Injection Equipment
12
F
33
32
31
21
E
B
b2
G
11
b1
Tip
φ 3
φ 1
φ 4
φ 2
13
G
41
P5
P1
P4
P2／P3

FIG. 13

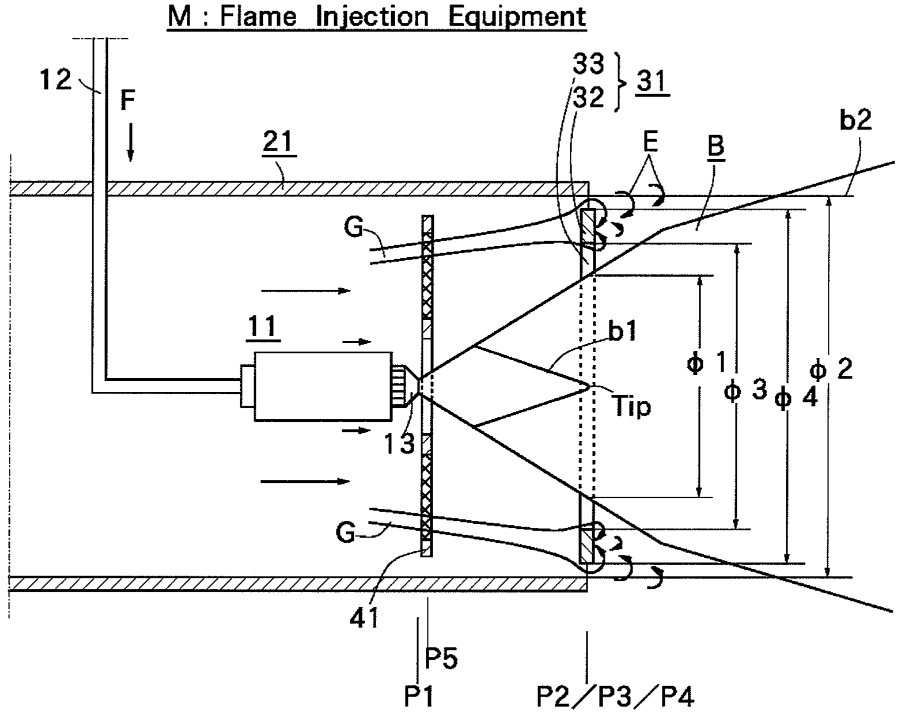

M : Flame Injection Equipment
12
F
21
33
32
31
E
B
b2
G
11
b1
Tip
13
ϕ 1
ϕ 3
ϕ 4
ϕ 2
G
41
P5
P1
P2／P3／P4

FIG. 14

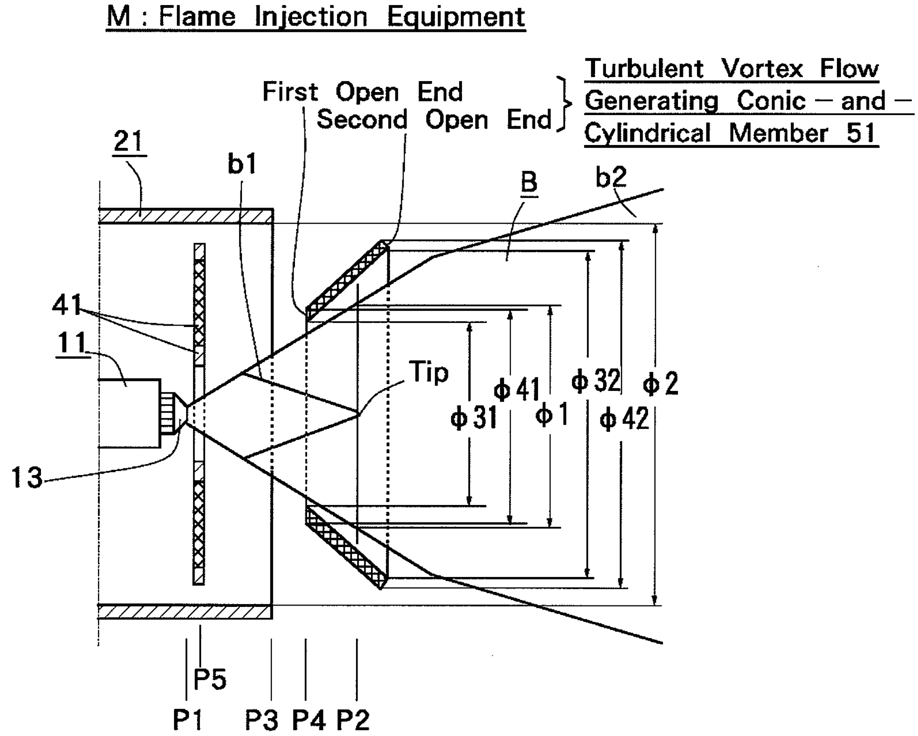

M : Flame Injection Equipment
First Open End
Second Open End
Turbulent Vortex Flow
Generating Conic – and –
Cylindrical Member 51
21
b1
B
b2
41
11
13
Tip
ϕ31
ϕ41
ϕ1
ϕ32
ϕ42
ϕ2
P5
P1
P3
P4
P2

FIG. 15

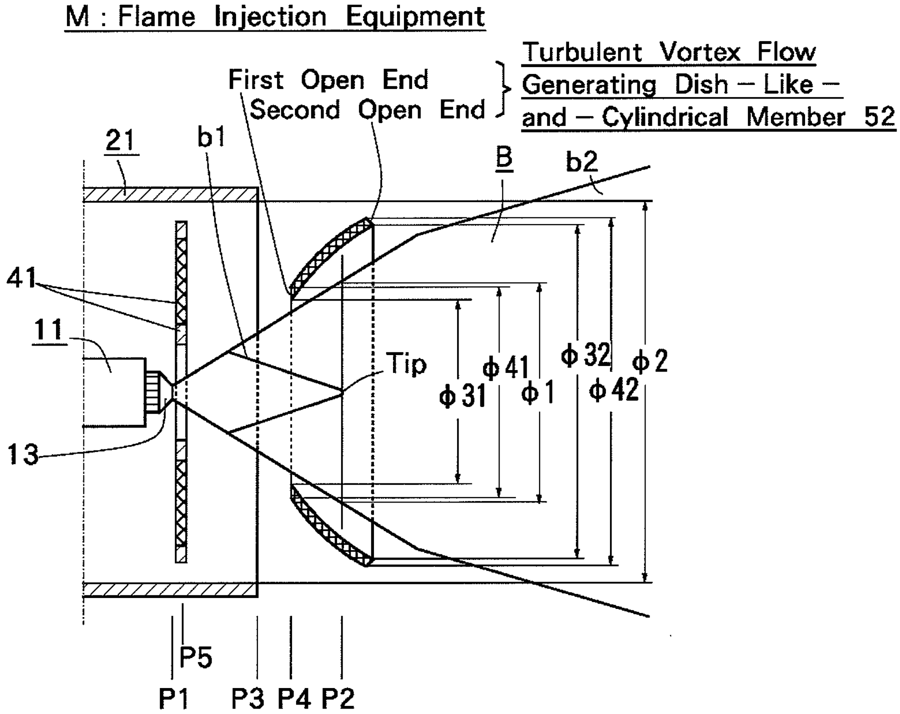

M : Flame Injection Equipment
First Open End
Second Open End
Turbulent Vortex Flow
Generating Dish – Like –
and – Cylindrical Member 52
21
b1
B
b2
41
11
13
Tip
φ41
φ31
φ1
φ32
φ42
φ2
P5
P1
P3
P4
P2

FIG. 16

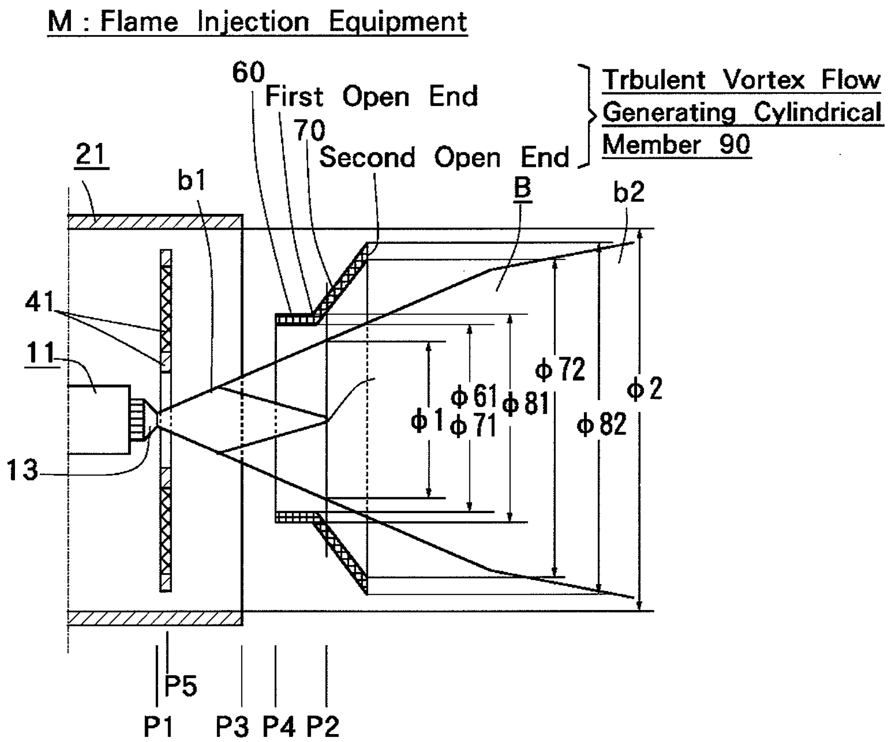

M : Flame Injection Equipment
60
First Open End
70
Second Open End
Trbulent Vortex Flow
Generating Cylindrical
Member 90
21
b1
B
b2
41
11
13
φ1
φ61
φ71
φ81
φ72
φ82
φ2
P5
P1
P3
P4
P2

FIG. 17

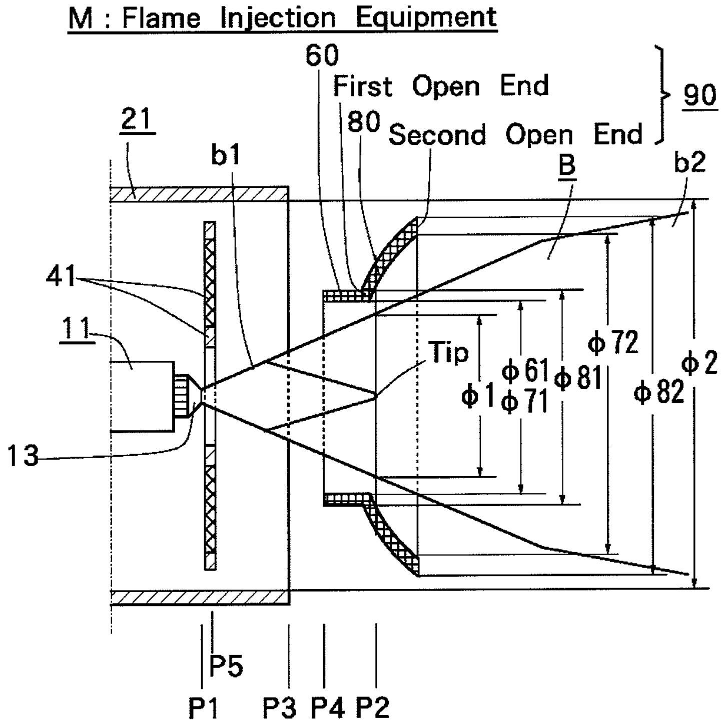

M : Flame Injection Equipment
60
First Open End
80
Second Open End
90
21
b1
B
b2
41
11
Tip
φ1
φ61
φ71
φ81
φ72
φ82
φ2
13
P5
P1
P3
P4
P2

FIG. 18

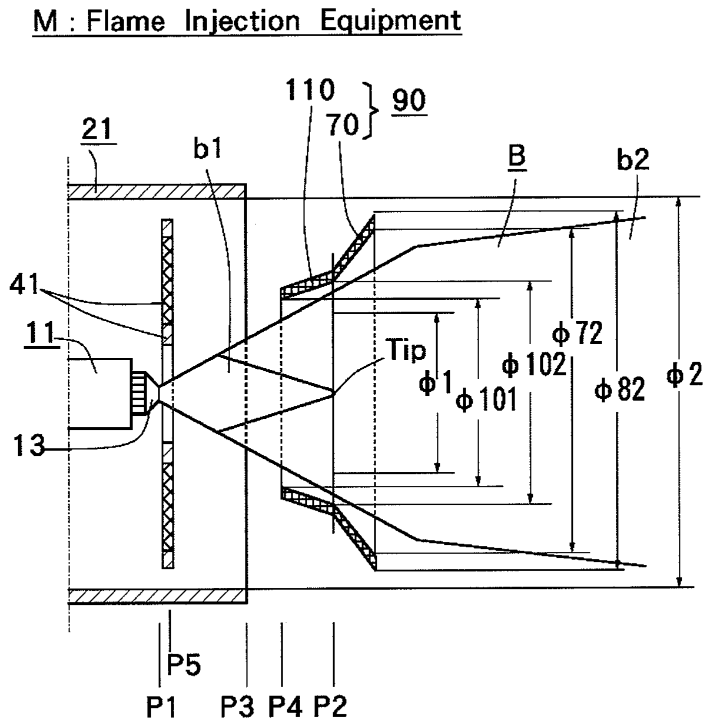

M : Flame Injection Equipment
110
70
90
21
b1
B
b2
41
11
Tip
φ1
φ101
φ102
φ72
φ82
φ2
13
P5
P1
P3
P4
P2

FIG. 19

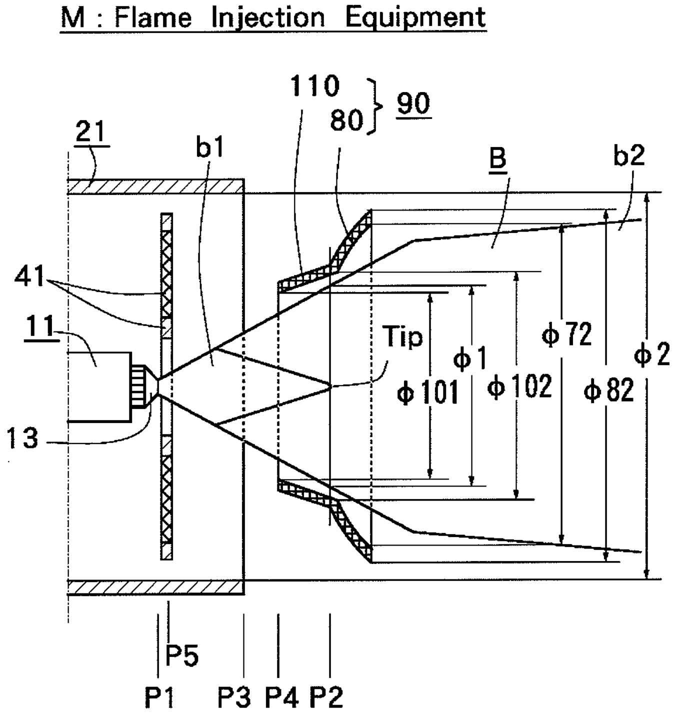

M : Flame Injection Equipment
110
80
90
21
b1
B
b2
41
11
Tip
φ1
φ72
φ2
φ101
φ102
φ82
13
P5
P1
P3
P4
P2

FIG. 20

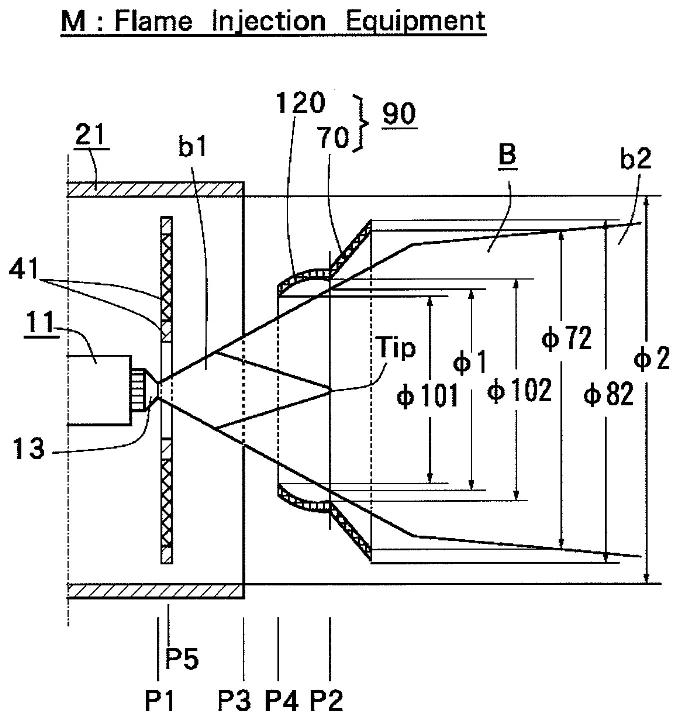

M : Flame Injection Equipment
120
70
90
21
b1
B
b2
41
11
Tip
φ1
φ72
φ2
φ101
φ102
φ82
13
P5
P1
P3
P4
P2

FIG. 21

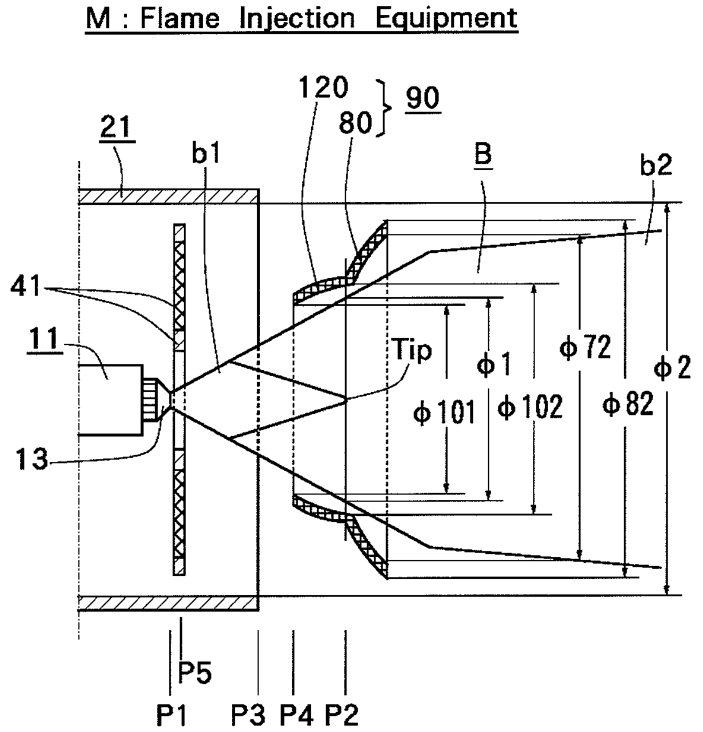

M : Flame Injection Equipment
120
80
90
21
b1
B
b2
41
11
13
Tip
φ1
φ72
φ2
φ101
φ102
φ82
P5
P1
P3
P4
P2

FIG. 22

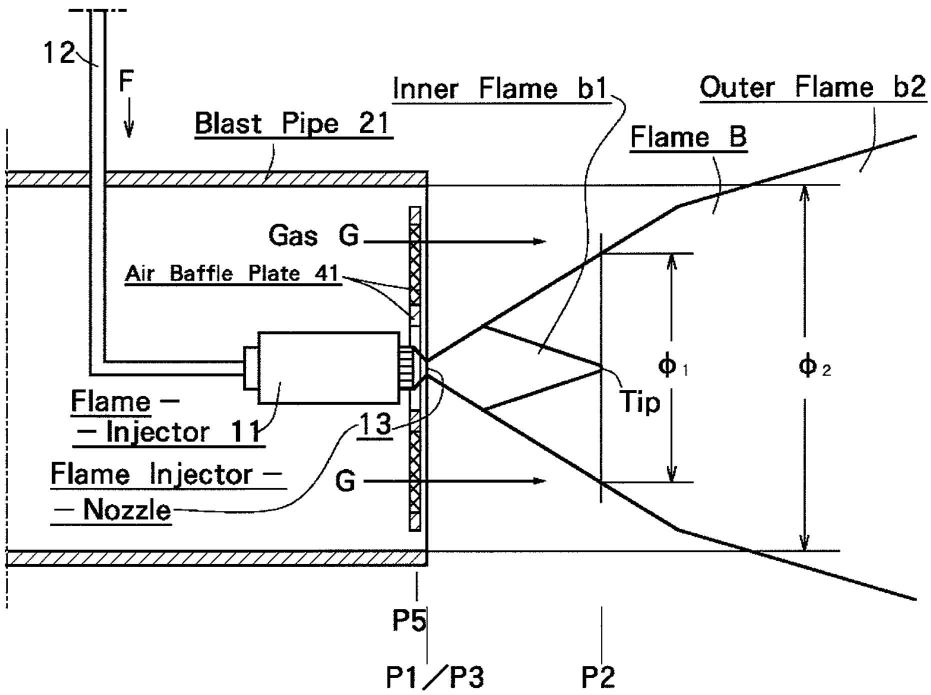

12
F
Inner Flame b1
Outer Flame b2
Blast Pipe 21
Flame B
Gas G
Air Baffle Plate 41
Flame –
– Injector 11
13
Tip
Flame Injector –
– Nozzle
G
P5
P1／P3
P2

FIG. 23

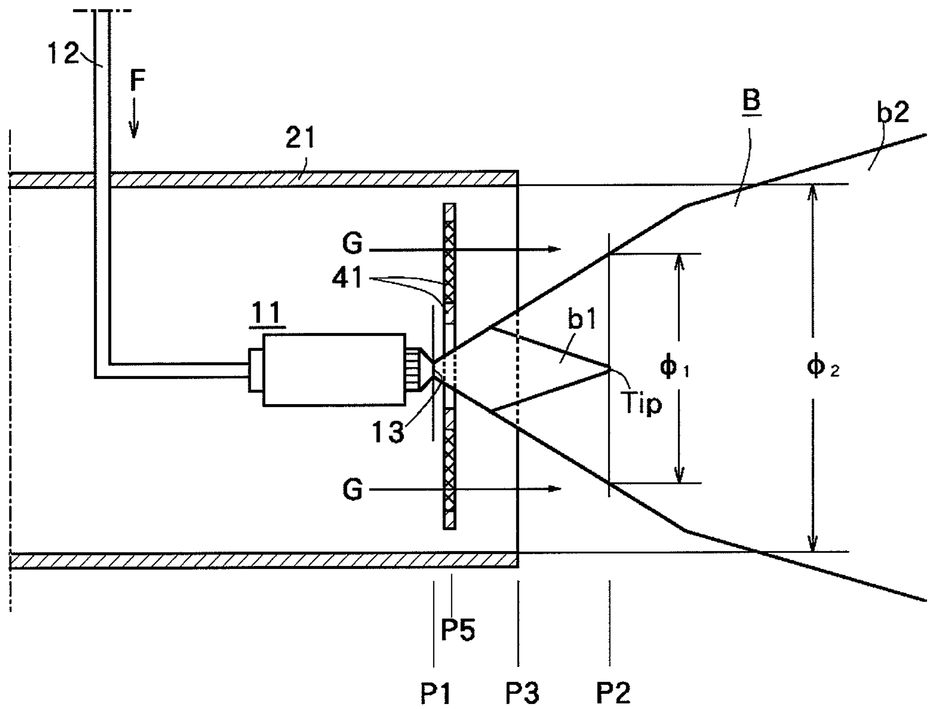
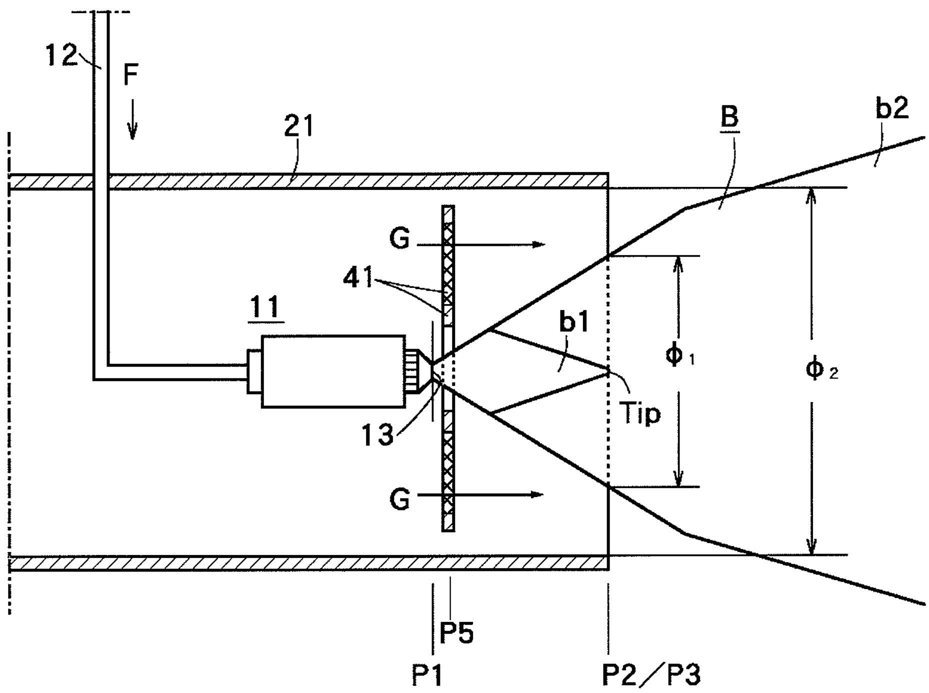

12
F
21
B
b2
G
41
11
b1
ϕ1
ϕ2
Tip
13
G
P5
P1
P3
P2

FIG. 24


12
F
21
B
b2
G
41
11
b1
ϕ1
ϕ2
Tip
13
G
P5
P1
P2／P3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/059431

A. CLASSIFICATION OF SUBJECT MATTER
F23D11/24(2006.01)i, *F23D11/00*(2006.01)i, *F23D11/36*(2006.01)i, *F23D14/70* (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)
F23D11/24, F23D11/00, F23D11/36, F23D14/70

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	1996-2007
Kokai Jitsuyo Shinan Koho	1971-2007	Toroku Jitsuyo Shinan Koho	1994-2007

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 09-196315 A (Hodaka Co., Ltd.), 29 July, 1997 (29.07.97), Column 1, lines 23 to 47; Fig. 14 (Family: none)	1-12
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 079397/1988(Laid-open No. 007423/1990) (Nepon Kabushiki Kaisha), 18 January, 1990 (18.01.90), Page 5, lines 4 to 9; Figs. 1, 3 (Family: none)	1-12

☒ 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
27 July, 2007 (27.07.07)

Date of mailing of the international search report
07 August, 2007 (07.08.07)

Name and mailing address of the ISA/
Japanese Patent Office

Facsimile No.

Authorized officer

Telephone No.

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/059431

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 035446/1987(Laid-open No. 142522/1988) (Kaneko Agricultural Machinery Co., Ltd.), 20 September, 1988 (20.09.88), Page 2, line 17 to page 3, line 12; Figs. 4 to 5 (Family: none)	3,6,9,12
Y	JP 63-271008 A (Kabushiki Kaisha Yamamoto Seisakusho), 08 November, 1988 (08.11.88), Page 2, upper left column, line 16 to lower right column, line 17; Fig. 1 (Family: none)	4-6
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 182555/1984(Laid-open No. 101213/1986) (Toto Ltd.), 27 June, 1986 (27.06.86), Fig. 4 (Family: none)	7-12
A	JP 2001-349509 A (Japanese Marine Equipment Association), 21 December, 2001 (21.12.01), Column 4, line 43 to column 5, line 30; Fig. 1 (Family: none)	1-12

Form PCT/ISA/210 (continuation of second sheet) (April 2005)