US 20100307391A1

(19) **United States**

(12) **Patent Application Publication**

Tamura et al.

(10) **Pub. No.: US 2010/0307391 A1**

(43) **Pub. Date: Dec. 9, 2010**

(54) **PULVERIZED FUEL BURNER**

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(21) Appl. No.: **12/864,741**

(22) PCT Filed: **Feb. 9, 2009**

(86) PCT No.: **PCT/JP09/00496**

§ 371 (c)(1),
(2), (4) Date: **Jul. 27, 2010**

(30) **Foreign Application Priority Data**

Mar. 10, 2008 (JP) 2008-059309

Publication Classification

(51) **Int. Cl.**
F23C 1/12 (2006.01)

(52) **U.S. Cl.** **110/261**

(57) **ABSTRACT**

The invention provides a pulverized fuel burner including a nozzle body **6** open to a furnace **1** to inject pulverized fuel together with primary combustion air, flow passages for secondary combustion air formed coaxially around the nozzle body and shutters arranged circumferentially along the flow passages and spaced apart from each other at specified intervals. Non-flow portions are formed by the shutters for the flow passages for the secondary combustion air to bring about backflow of hot flue gas. As a result, ignition performance can be improved with pulverized fuel containing less volatile matter and the flame can be continuously kept stably.

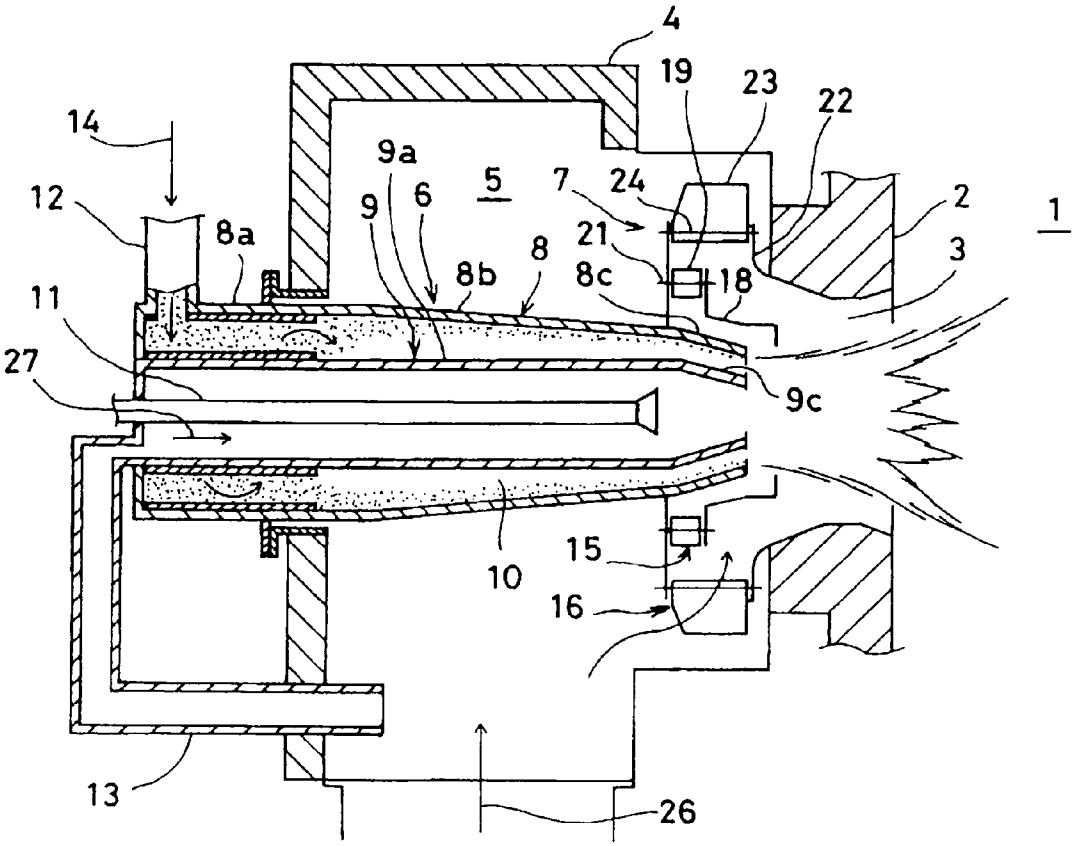

FIG. 1

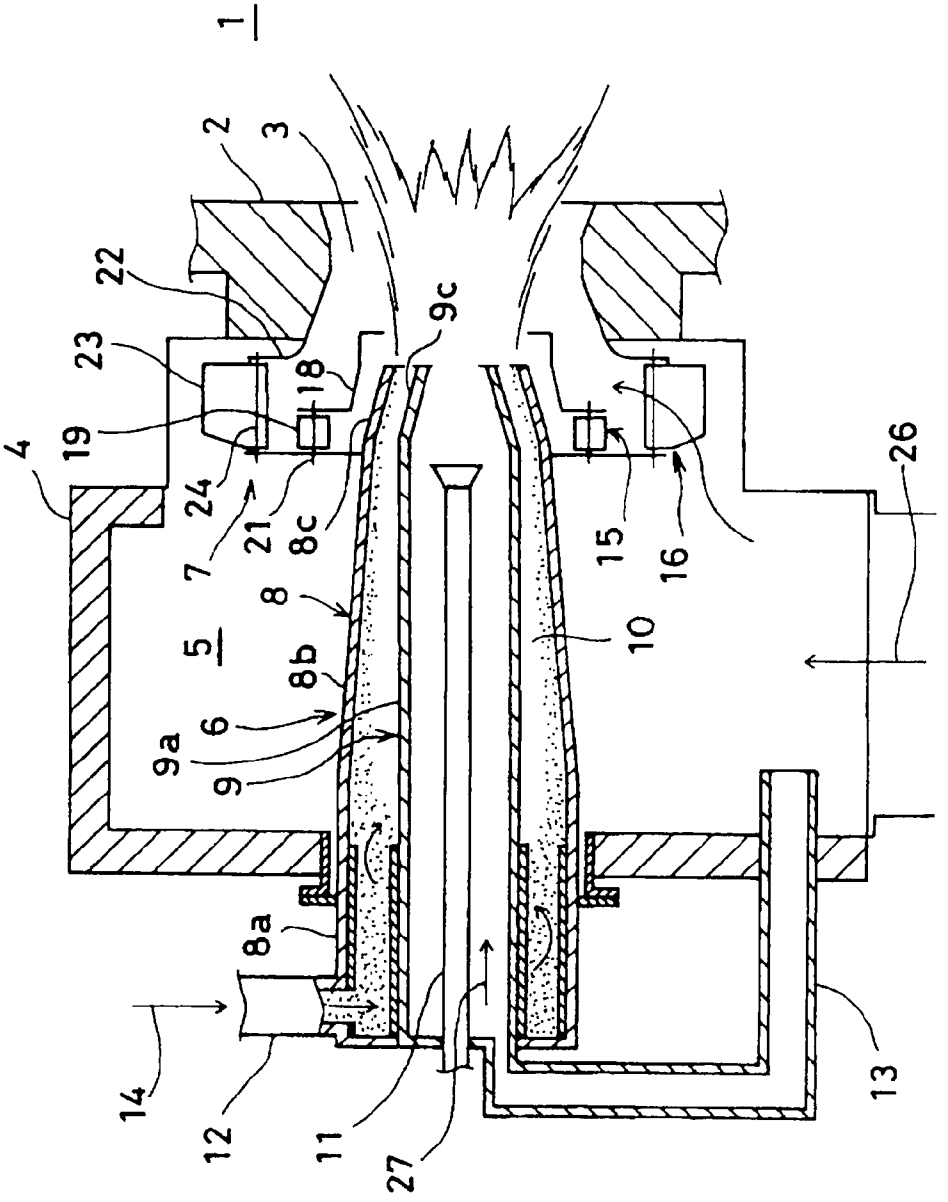

FIG. 2

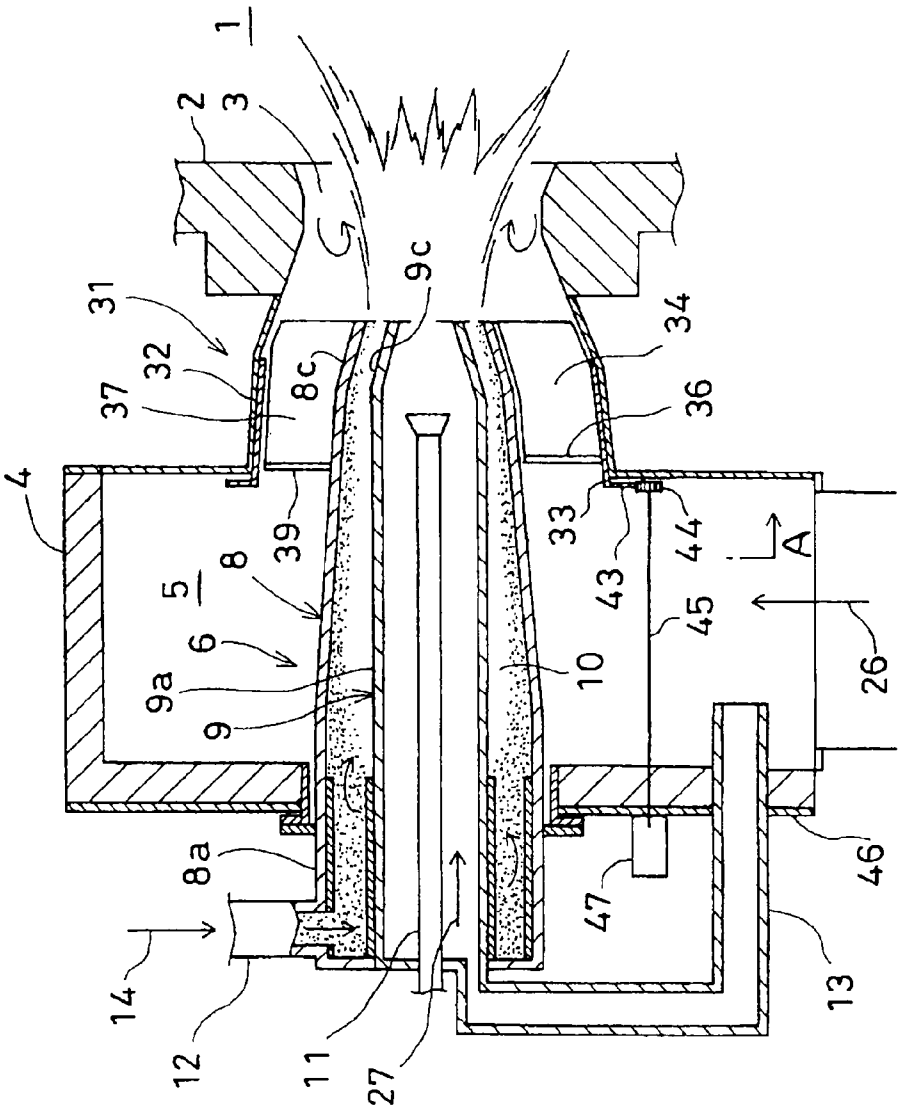
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FIG. 3

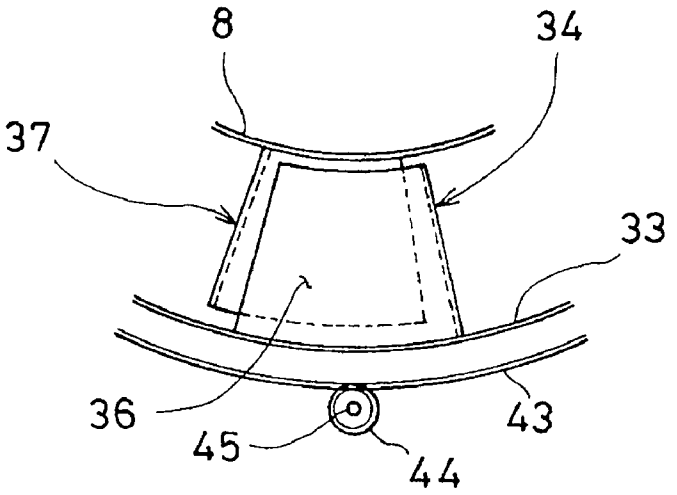


FIG. 4A

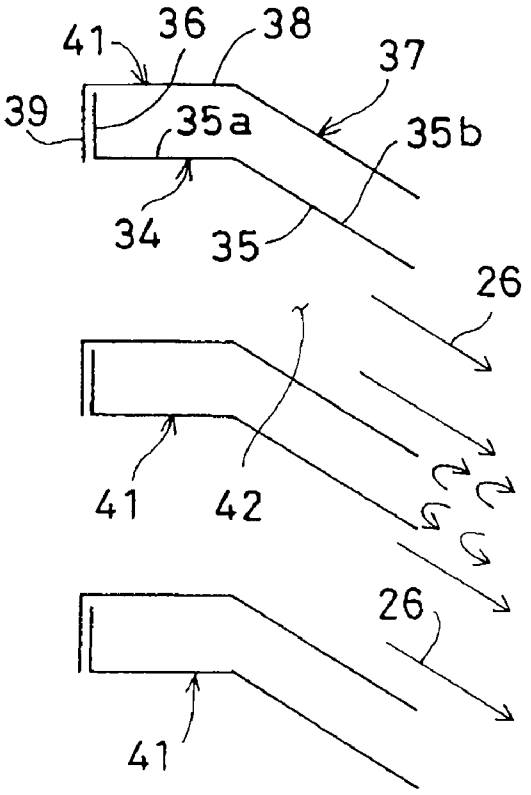


FIG. 4B

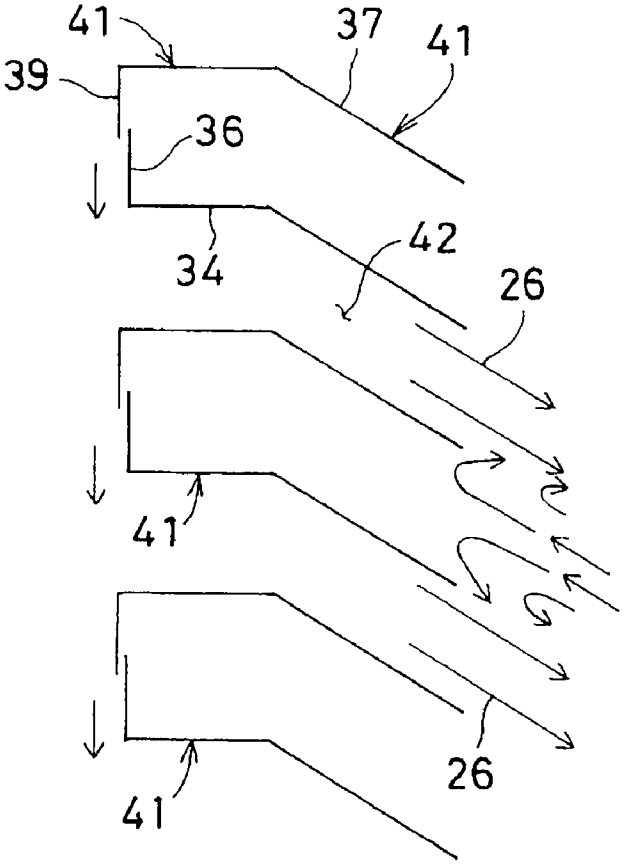


FIG. 5A

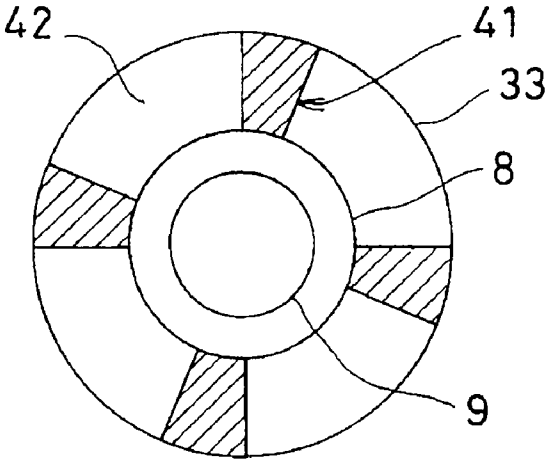
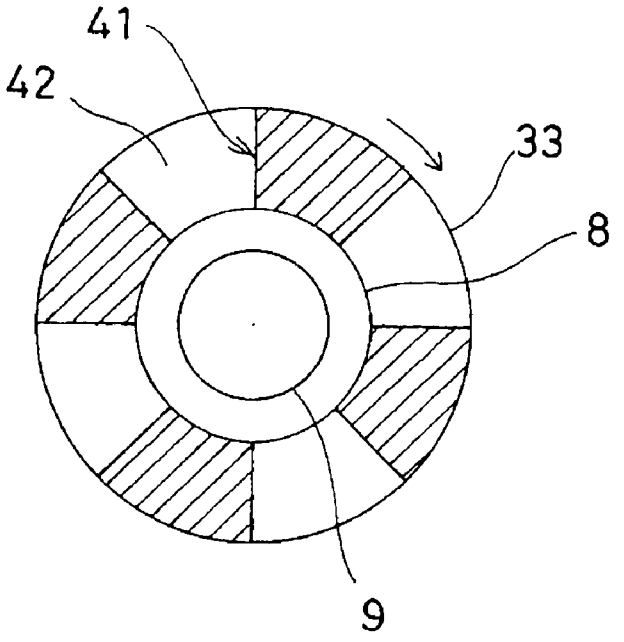


FIG. 5B



PULVERIZED FUEL BURNER

TECHNICAL FIELD

[0001] The present invention relates to a pulverized fuel burner for a furnace such as coal-fired boiler which uses pulverized material as fuel.

BACKGROUND ART

[0002] In some of furnaces using pulverized material, e.g., in a furnace using coal as fuel, lump coal is pulverized by a coal pulverizer into pulverized coal which in turn is mixed and fed with primary air into a pulverized coal burner where the pulverized coal is injected into the furnace and is suspension-fired.

[0003] Further fed to the flow of the primary air mixed with the pulverized coal is secondary combustion air which has been heated to a required temperature (for example, 250° C.-300° C.). The pulverized coal in the mixed flow is heated by the secondary air and by radiation heat from the furnace to discharge and ignite volatile matter to thereby establish flames.

[0004] A conventional pulverized coal burner will be described in FIG. **1**.

[0005] In FIG. **1**, reference numeral **1** denotes a furnace; and **2**, a furnace wall of the furnace **1**.

[0006] A throat **3** is set on the furnace wall **2**, which has a wind box **4** on a side away from the furnace **1**. A pulverized coal burner **5** is arranged in the wind box **4** and coaxially of the throat **3**.

[0007] The pulverized coal burner **5** comprises a nozzle body **6** and a secondary air adjusting device **7** surrounding a front end of the nozzle body **6**.

[0008] The nozzle body **6** comprises an outer tube nozzle **8**, an inner tube nozzle **9** coaxial of the nozzle **8** and an oil burner **11** arranged on an axis of the nozzle **9**.

[0009] The outer tube nozzle **8** comprises a base (an end away from the furnace **1**) **8***a*, an intermediate portion **8***b* contiguous with the base **8***a* and a front end **8***c* contiguous with the intermediate portion **8***b*. The base **8***a* is a cylinder with a constant radius of cross section; the intermediate portion **8***b* and the front end **8***c* are tapered cylinders with radii of cross section reduced toward the furnace **1**, respectively. The front end **8***c* has a tapered angle greater than that of the intermediate portion **8***b* and therefore has radii reduced more greatly than those of the intermediate portion **8***b*.

[0010] The inner tube nozzle **9** comprises a cylindrical portion **9***a* and a front end **9***c* contiguous with the cylindrical portion **9***a*. The cylindrical portion **9***a* is a cylinder with a constant radius of cross section and extending adjacent to a front side of the outer tube intermediate portion **8***b*, and the front end **9***c* is tapered with a tapered angle similar to that of the outer tube front end **8***c*. Formed between the inner and outer tube nozzles **8** and **9** is a hollow, cylindrical fuel conduction space **10** with an end open to the furnace **1**.

[0011] The base (the end away from the furnace **1**) of the outer tube nozzle **8** communicates with a primary air feed pipe **12** through which primary air **14** and the pulverized coal carried by the air **14** tangentially flow into and swirl in the space **10** and are injected through the front end of the space. Open to the base of the inner tube nozzle **9** is one end of a tertiary air feed pipe **13** the other end of which is open to the wind box **4**, so that combustion air fed to the wind box **4** is taken in and is guided to the inner tube nozzle **9** as auxiliary combustion air, i.e., tertiary combustion air.

[0012] The secondary air adjusting device **7** comprises an auxiliary air adjusting mechanism **15** accommodating the front end of the nozzle body **6** and a main air adjusting mechanism **16** arranged coaxially and outward of the mechanism **15**.

[0013] The auxiliary air adjusting mechanism **15** comprises a first air guide duct **18** with diameters reduced toward a front end of the duct and air swirl adjusting vanes **19** circumferentially equidistantly arranged in a base of the duct **18**, the vanes **19** being rotatable about rotary axes **21** in sync.

[0014] The main air adjusting mechanism **16** comprises a second air guide duct **22** with diameters reduced toward its front end and air swirl adjusting vanes **23** circumferentially equidistantly arranged in a base of the duct **22**, the vanes **23** being rotatable about rotary axes **24** in sync.

[0015] The front end of the second air guide duct **22** is contiguous with the throat **3**. The front end of the first air guide duct **18** is set back from an inner wall surface of the furnace wall **2**. The front ends of the nozzles **8** and **9** are set back further from the front end of the guide duct **18**.

[0016] Combustion at the above-mentioned pulverized coal burner **5** will be briefly described. The pulverized coal is fed together with the primary air **14** through the primary air feed pipe **12** into the base of the fuel conduction space **10**. The primary air **14** swirls in the space **10** toward the furnace **1**, is reduced in flow during its passing through the space **10** and is injected through the front end of the outer tube nozzle **8**. The wind box **4** is fed with the secondary air **26** as auxiliary combustion air elevated to a required temperature. The secondary air **26** is adjusted in air swirl by the vanes **23** and is injected together with the primary air **14** and the pulverized coal into the furnace **1** via the second air guide duct **22**.

[0017] The pulverized coal is heated by the secondary air **26** through its injection into the furnace **1**, and is heated by the radiation heat from the furnace **1**. By the heating, the pulverized coal releases the volatile matter which is ignited to continuously keep the flames.

[0018] Part of the secondary air **26** taken in the second air guide duct **22** is taken via the air swirl adjusting vanes **19** into the first air guide duct **18** and is injected as secondary auxiliary air. Air volume adjustments by the vanes **23** and **19** change feed flow condition of the secondary air **26** to adjust the combustion condition of the pulverized coal.

[0019] Part of the secondary air **26** is guided as the tertiary air **27** via the tertiary air feed pipe **13** into and is injected from the inner tube nozzle **9**. Injection of the tertiary air **27** adjusts the combustion condition of the pulverized coal. Thus, by adjustment of, for example, the secondary and tertiary airs **26** and **27**, combustion condition of the pulverized coal is adjusted to optimum.

[0020] The oil burner **11** is used to ignite the pulverized coal.

[0021] For the above-mentioned conventional pulverized coal burner **5**, the pulverized coal is used such as bituminous coal with a predetermined amount of, say about 20% of volatile matter.

[0022] However, use of lower-graded fuel has been demanded recently; for example, used is oil coke which is a residue in petroleum refinery and which has volatile matter as low as about 10%. Use of the oil coke in the above-mentioned conventional pulverized coal burner **5** may bring about problems that the pulverized fuel injected via the pulverized coal

burner **5** is low in temperature and that volatile matter released is not enough for keeping the flames. When the flames are not kept, NO_x produced is remarkably increased.

[0023] State-of-art technology for the above-mentioned pulverized coal burner is disclosed, for example, in Patent Literature 1.

[0024] [Patent Literature 1] JP 8-145320A

SUMMARY OF INVENTION

Technical Problems

[0025] The invention was made in view of the above and has its object to provide a pulverized fuel burner wherein pulverized fuel with less volatile matter is used to improve ignition performance and continuously keep flames stably.

Solution to Problems

[0026] The invention is directed to a pulverized fuel burner comprising a nozzle body open to a furnace to inject pulverized fuel together with primary combustion air, flow passages for secondary combustion air formed coaxially around said nozzle body and shutters arranged circumferentially along said flow passages and spaced apart from each other at specified intervals, non-flow portions being formed by said shutters for said flow passages to bring about backflow of hot flue gas.

[0027] The invention is further directed to a pulverized fuel burner wherein occupied areas of said shutters for said flow passages are variable.

[0028] The invention is further directed to a pulverized fuel burner wherein a movable ring is rotatably arranged coaxially of a front end of said nozzle body, said movable ring having movable guide vanes, fixed guide vanes being arranged on the front end of said nozzle body, each of said movable and fixed guide vanes having a shutter perpendicular to an axis of the nozzle, overlapped state of said two shutters being varied by turning said movable ring.

[0029] The invention is further directed to a pulverized fuel burner wherein said nozzle body is accommodated in a wind box, an air guide duct being arranged in said wind box coaxially of a front end of said nozzle body, a movable ring being rotatably arranged at the front end of said nozzle body, said movable ring having movable guide vanes, said air guide duct having fixed guide vanes, each of said movable and fixed guide vanes having a shutter perpendicular to an axis of the nozzle, overlapped state of said two shutters being varied by turning said movable ring.

ADVANTAGEOUS EFFECTS OF INVENTION

[0030] According to the invention comprising a nozzle body open to a furnace to inject pulverized fuel together with primary combustion air, flow passages for secondary combustion air arranged coaxially around said nozzle body and shutters arranged circumferentially along said flow passages and spaced apart from each other at specified intervals, non-flow portions being formed by said shutters for said flow passages to bring about backflow of hot flue gas, so that hot flue gas is brought in to heat the pulverized fuel; ignition performance is improved even with pulverized fuel having less volatile matter; and ignition is made stably and certainly and the flames are kept.

[0031] According to the invention, occupied areas of said shutters for said flow passages are variable, so that a degree of backflow of the hot flue gas can be adjusted; and pulverized fuels with different volatile matter can be burned in proper conditions.

[0032] According to the invention, a movable ring is rotatably arranged coaxially of a front end of said nozzle body, said movable ring having movable guide vanes, fixed guide vanes being arranged on the front end of said nozzle body, each of said movable and fixed guide vanes having a shutter perpendicular to an axis of the nozzle, overlapped state of said two shutters being varied by turning said movable ring, so that occupied area of said shutters for the flow passages may vary to adjust a degree of backflow of hot flue gas; and pulverized fuels with different volatile matter can be burned in proper conditions.

[0033] According to the invention, said nozzle body is accommodated in a wind box, an air guide duct being arranged in said wind box coaxially of a front end of said nozzle body, a movable ring being rotatably arranged at the front end of said nozzle body, said movable ring having movable guide vanes, said air guide duct having fixed guide vanes, each of said movable and fixed guide vanes having a shutter perpendicular to an axis of the nozzle, overlapped state of said two shutters being varied by turning said movable ring, so that occupied area of said shutters for the flow passages may vary to adjust a degree of backflow of hot flue gas; and pulverized fuels with different volatile matter can be burned in proper conditions.

BRIEF DESCRIPTION OF DRAWINGS

[0034] FIG. **1** is a sectional view showing a conventional pulverized coal burner;

[0035] FIG. **2** is a sectional view showing an embodiment of a pulverized coal burner according to the invention;

[0036] FIG. **3** is a view looking in the direction of arrow A in FIG. **2**;

[0037] FIG. **4**A is a view for explanation of an operation of variable shutters used in a pulverized coal burner according to the invention, movable and fixed guide vanes being in a condition closest to each other;

[0038] FIG. **4**B is a view for explanation of the operation of the variable shutters used in a pulverized coal burner according to the invention, the movable and fixed guide vanes being in a condition most away from each other;

[0039] FIG. **5**A is a view for explanation of the operation of the variable shutters used in a pulverized coal burner according to the invention, the movable and fixed guide vanes being in a condition closest to each other; and

[0040] FIG. **5**B is a view for explanation of the operation of the variable shutters used in a pulverized coal burner according to the invention, the movable and fixed guide vanes being in a condition most away from each other.

REFERENCE SIGNS LIST

[0041] **1** furnace
[0042] **4** wind box
[0043] **5** pulverized coal burner
[0044] **6** nozzle body
[0045] **8** outer tube nozzle
[0046] **14** primary air
[0047] **26** secondary air
[0048] **32** air guide duct
[0049] **33** movable ring
[0050] **34** movable guide vane

[0051] **36** flow shutter
[0052] **37** fixed guide vane
[0053] **39** flow shutter
[0054] **43** ring gear
[0055] **44** drive gear
[0056] **47** motor

DESCRIPTION OF EMBODIMENT

[0057] An embodiment of the invention will be described in conjunction with the drawings.

[0058] FIGS. **2** and **3** show the embodiment of a pulverized coal burner according to the invention. In FIG. **2**, the parts similar to those in FIG. **1** are represented by the same reference numerals and explanations thereon are omitted.

[0059] A pulverized coal burner **5** comprises a nozzle body **6** and a secondary air adjusting device **31**. The burner **5** is arranged coaxially of a throat **3** open to the furnace wall **2**. The burner **5** is accommodated in a wind box **4**.

[0060] Secondary air **26** is fed to the wind box **4** by a forced draft fan (not shown). Air volume of the secondary air **26** is controlled by the forced draft fan to control air pressure for the air volume required for combustion.

[0061] The nozzle body **6** comprises an outer tube nozzle **8** and an inner tube nozzle **9** coaxially of the nozzle **8**. Formed between the nozzles **8** and **9** is a hollow, cylindrical fuel conduction space **10**.

[0062] The nozzle body **6** has a base extending out of the wind box **4**. An outer tube base **8***a* communicates with a primary air feed pipe **12**. An end of the inner tube nozzle **9** communicates with a downstream end of a tertiary air feed pipe **13** and an upstream end of the pipe **13** communicates with the wind box **4**. The primary air feed pipe **12** is connected through a coal pulverizer (not shown) to the forced draft fan (not shown). By the feed pipe **12**, primary air **14** carrying the pulverized coal is introduced into the fuel conduction space **10**. The tertiary air feed pipe **13** takes in and feeds part of the secondary air **26** into the inner tube nozzle **9**.

[0063] The wind box **4** is provided, on its side adjacent to the furnace **1**, with a secondary air adjusting device **31** coaxially of the front end of the pulverized coal burner **5**.

[0064] The secondary air adjusting device **31** will be described.

[0065] Arranged on a surface of the wind box **4** facing the furnace **1** is an air guide duct **32** coaxially of the outer tube nozzle **8**. The air guide duct **32** is substantially tapered with radii reduced toward the furnace **1** and is connected at its front end to the throat **3**.

[0066] Rotatably arranged in and coaxially of the air guide duct **32** is a movable ring **33** which is formed, at its inner surface, with a required number of movable guide vanes **34** arranged equidistantly of say 90°.

[0067] Each of the movable guide vanes **34** comprises a flow guide **35** (see FIG. **4**A) extending toward an axis of the pulverized coal burner **5** and arranged along a direction of flow of the secondary air **26** and a flow shutter **36** on an upstream end of and perpendicular to the flow guide **35** (perpendicular to the axis of the pulverized coal burner **5**), the movable guide vanes being rotatable integrally with the movable ring **33**.

[0068] The flow guide **35** comprises a first flow straightener **35***a* (see FIG. **4**A) in parallel with the axis of the pulverized coal burner **5** and a second flow straightener **35***b* (see FIG. **4**A) slant to the axis to cause the secondary air **26** to swirl.

[0069] The outer tube nozzle **8** is provided, at its front end, with fixed guide vanes **37** of the same number as the movable guide vanes **34** and arranged equidistantly of say 90°.

[0070] The fixed guide vanes **37** are substantially similar in shape with movable guide vane **34** and extend radially from the axis of the pulverized coal burner **5**. Each of the fixed guide vanes **37** comprises a flow guide **38** (see FIG. **4**A) along the direction of flow of the secondary air **26** and a flow shutter **39** on an upstream end of the flow guide **38** perpendicular to the flow guide **38** (perpendicular to the axis of the pulverized coal burner **5**). In order not to interfere with rotation of the movable ring **33**, outer peripheral ends of the fixed guide vanes **37** are spaced apart from the inner surface of the movable ring **33**, and the flow shutters **39** are axially shifted to the flow shutters **36**.

[0071] Like the movable guide vane **34**, the flow guide **38** comprises the first and second flow straighteners **35***a* and **35***b*.

[0072] The movable guide vanes **34** are paired with the fixed guide vanes **37** to provide variable shutters **41** (see FIGS. **4**A, **4**B, **5**A and **5**B); each of the movable guide vanes **34** and the fixed guide vane **37** of the adjacent variable shutter **41** provide a flow passage **42** (see FIGS. **4**A, **4**B, **5**A and **5**B).

[0073] Arranged at an upstream end of the movable ring **33** is a ring gear **43** which engages with a drive gear **44**. The drive gear **44** is connected with a drive shaft **45** which in turn is connected to a motor **47** on a front plate **46** of the drive gear **44**.

[0074] Rotation of the motor **47** causes the ring gear **43** to turn through the drive shaft **45** and the drive gear **44**, so that the movable ring **33** is turned integrally with the ring gear **43**.

[0075] Thus, the movable and fixed guide vanes **34** and **37** are relatively turned normally/reversely to move toward/away from each other.

[0076] FIGS. **4**A, **4**B, **5**A and **5**B show a relationship between the movable and fixed guide vanes **34** and **37**; FIGS. **4**A and **5**A show the movable and fixed guide vanes **34** and **37** in their closest state to each other and FIGS. **4**B and **5**B show the movable and fixed guide vanes **34** and **37** in their state most away from each other.

[0077] In the closest state of the vanes, each of the flow passages **42** has a maximum cross section and is shut out minimumly by the variable shutters **41**. In the state of the vanes most away from each other, each of the flow passages **42** has a minimum cross section and is shut out maximumly by the variable shutters **41**.

[0078] If a supplied amount of secondary air is the same, flow velocity of the secondary air **26** is low and high in the state of the vanes closest to each other and in the state of the vanes most away from each other, respectively.

[0079] Next, a mode of operation of the secondary air adjusting device **31** will be described.

[0080] When pulverized fuel such as pulverized coal with relatively less volatile matter, the motor **47** rotates the movable ring **33** to make the movable and fixed guide vanes **34** and **37** close to each other.

[0081] This increases the cross sections of the flow passages **42**, reduces the flow velocity of the secondary air **26** passing through the flow passages **42** and reduces shut-out areas of the flow passages by the variable shutters **41**. A downstream portion of the variable shutter **41** provides a non-flow portion for the secondary air **26** on opposite sides of which the secondary air **26** flows to generate eddies which in turn bring about backflow of hot flue gas so that the furnace gas is brought in from the furnace **1**.

[0082] The furnace gas, which is hot, heats the pulverized coal injected together with the primary air **14**, so that even fuel with less volatile matter is ignited certainly. Thus, even with the pulverized fuel having less volatile matter, ignition is certainly ensured to keep the flames stably. The shut-out areas by the variable shutters **41** are small, so that the eddies are small and an amount of the furnace gas brought in from the furnace **1** is also a little.

[0083] When the pulverized fuel with extremely less volatile matter is supplied, the movable ring **33** is turned by the motor **47** through the ring gear **43**, so that the movable guide vanes **34** are maximumly separated from the fixed guide vanes **37**.

[0084] Thus, the flow passages **42** are narrowed and the shut-out areas of the flow passages by the variable shutters **41** are increased. The flow velocity of the secondary air **26** passing through the flow passages **42** is increased to enhance the eddies generating in the secondary air **26** passing on the opposite sides of the variable shutters **41** and the backflow phenomenon of the hot flue gas becomes remarkable. As a result, an amount of the furnace gas brought in from the furnace **1** is increased, so that the pulverized fuel is heated to further high temperature by the furnace gas, which enables ignition of the pulverized fuel with less volatile matter and keeping of the flames after the ignition.

[0085] Thus, by adjusting the separated amount between the movable and fixed guide vanes **34** and **37** in the variable shutters **41**, optimal combustion state can be obtained with respect to various pulverized fuels with less volatile matter.

[0086] In a case where the pulverized fuels supplied have no variations in volatile matter, flow-shutting plates (corresponding to the flow shutters **36** and **39**) each with a required area may be arranged circumferentially between the outer tube nozzle **8** and the air guide duct **32** at required intervals.

[0087] Means for turning the movable ring **33** or the movable guide vane **34** may be through out variously. For example, a cylinder may be used or position change may be conducted manually.

[0088] The movable ring **33** has been described to be rotatably arranged in the air guide duct **32**; alternatively, it may rotatably arranged at the front end of the outer tube nozzle **8**, the fixed guide vanes **37** being mounted on the air guide duct **32**.

1. A pulverized fuel burner comprising a nozzle body open to a furnace to inject pulverized fuel together with primary combustion air, flow passages for secondary combustion air formed coaxially around said nozzle body and shutters arranged circumferentially along said flow passages and spaced apart from each other at specified intervals, non-flow portions being formed by said shutters for said flow passages to bring about backflow of hot furnace gas.

2. A pulverized fuel burner as claimed in claim **1**, wherein occupied areas of said shutters for said flow passages are variable.

3. A pulverized fuel burner as claimed in claim **1**, wherein a movable ring is rotatably arranged coaxially of a front end of said nozzle body, said movable ring having movable guide vanes, fixed guide vanes being arranged on the front end of said nozzle body, each of said movable and fixed guide vanes having a shutter perpendicular to an axis of the nozzle, overlapped state of said two shutters being varied by turning said movable ring.

4. A pulverized fuel burner as claimed in claim **1**, wherein said nozzle body is accommodated in a wind box, an air guide duct being arranged in said wind box coaxially of a front end of said nozzle body, a movable ring being rotatably arranged at the front end of said nozzle body, said movable ring having movable guide vanes, said air guide duct having fixed guide vanes, each of said movable and fixed guide vanes having a shutter perpendicular to an axis of the nozzle, overlapped state of said two shutters being varied by turning said movable ring.

* * * * *