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(54) **A BURNER IGNITED BY PLASMA**

(57) This invention relates to a plasma ignition burner. Said plasma ignition burner comprises at least two stages of burner barrels and a plasma generator for igniting the pulverized coal in a first stage burner barrel of said at least two stages of burner barrels, wherein the burning flame of the former stage burner barrel ignites

the pulverized coal in the next stage burner barrel, or further burns with the supplemented air in the next stage burner barrel, **characterized in that** the axial direction of said plasma generator is parallel to the direction along which the pulverized-coal-contained air flow enters into the first stage burner barrel and at the same time, parallel to the axis of the burner barrels.

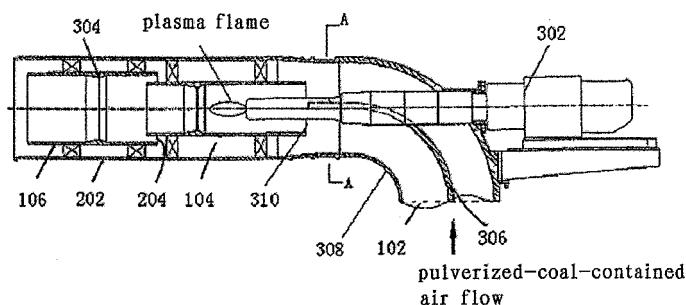


FIG.3

**Description**

## Technical Field

**[0001]** The present invention relates to pulverized coal burning technical field, and particular to a plasma ignition burner.

## Background Art

**[0002]** Coal fired power generation is a main electricity generation manner adopted by different countries at present. Ignition is a main aspect of the burning process of the boiler. With the enlargement of the capacity of the boiler, how to accomplish the starting process of the boiler rapidly and economically becomes an important problem to be imminently solved.

**[0003]** Plasma ignition technology has been developed recently to replace the oil ignition manner which consumes a lot of burning oil.

**[0004]** In order to be able to ignite inferior coal, the conventional plasma igniting system adopts the so-called "precombustion chamber" technology. The precombustion chamber is constructed to keep the temperature of the burner barrel, normally by attaching a layer of fire-resistant material to the internal of the firebox. The chamber wall of the precombustion chamber has very high temperature through initial heating, which aids in (even independently) igniting the fuel. The precombustion chamber is long (about 2 meters) and through the action of the plasma, gasifies the pulverized coal in the pulverized-coal-contained air flow entering into the precombustion chamber, thereby generating a lot of burnable gas, mainly CO et al. And then, the thermal energy released when the burnable gas burns is used to ignite the succeeding pulverized coal. This is also a hierarchical ignition manner, but since the temperature in the precombustion chamber is too high, the pulverized coal easily clinkers inside and therefore can not be used further.

**[0005]** In order to overcome the above problem, a new structure of hierarchical burner barrel has been proposed. As shown in FIG. 1, the plasma ignition burner comprises multi stage burner barrels, such as a first stage burner barrel 104, a second stage burner barrel 106, a third stage burner barrel 108, a fourth stage burner barrel 110, et al (the number of the stages may be either more than four stages or less than four stages depending on the power and the size of the space). The pulverized-coal-contained air flow entering from pulverized-coal-contained air flow inlet 102 (as shown by the broad arrow in FIG. 1) is divided into two ways by spacer 116 and respectively enters into the first stage burner barrel 104 and the second stage burner barrel 106. A plasma generator is inserted into the first stage burner barrel 104 along the axial direction of the multi stage burner barrels and ignites the pulverized-coal-contained air flow entering into the first stage burner barrel 104, thereby generating the first stage pulverized coal flame A. The gener-

ated flame further ignites the pulverized-coal-contained air flow in the second stage burner barrel, thereby forming the second stage pulverized coal flame B. At the same time, the air flow entering from air inlet 114 (as shown by the narrow arrow in FIG. 1) enters into the third stage burner barrel 108 through the third inlet 120 and supplements oxygen for the second stage pulverized coal flame which was not sufficiently burned, thereby forming a third stage pulverized coal flame C. The air may also enter into the fourth stage burner barrel through the fourth inlet 122 to further supplement oxygen. At the same time, the air flow flows in the space between the external wall of the former stage burner barrel and the burner external barrel 118 before entering into the next stage burner barrel, thereby serving for cooling the burner barrels so as to prevent clinkering.

**[0006]** In the above technology, the plasma generator is inserted along the axial direction of the burner barrels and the pulverized-coal-contained air flow inlet and the air flow are both arranged to be perpendicular to the axis of the burner barrels. That is, the direction of the plasma flame is perpendicular to the direction of the air flow entering into the first stage burner barrel. Therefore, it is necessary to add guide plate (not shown) to deflect the air flow to be parallel. Similarly, the direction along which the second stage pulverized coal enters into the second stage burner barrel is also perpendicular to the direction of the flame injected from the first stage burner barrel, so it is also necessary to add guide plate to make the directions to be parallel. However, the guide plate can not deflect the air flow completely due to the limitation of the space. Since the two air flows can not be absolutely parallel, the entering air flow will blow the plasma flame (or the former stage flame) deflected, which causes the temperature of the barrel wall increasing and the pulverized coal clinkering.

**[0007]** In addition, in this technology, because the pulverized-coal-contained air flow and the air flow both enters in the direction perpendicular to the burner barrels, on the section plane perpendicular to the burner barrels, the concentration of the pulverized coal and the velocity of the air flow, et al. are not uniform, thereby affecting the burning quality.

**[0008]** Afterward, in order to make it easy to arrange on the spot, a plasma ignition burner constructed as shown in FIG. 2 is used. To be concise, only the pulverized-coal-contained air flow inlet 102, the first stage burner barrel 104 and the second stage burner barrel 106 are shown in the figure and the structures corresponding to the air inlet 114, the burner external barrel 118, the third stage burner barrel and the fourth stage burner barrel in FIG. 1. The pulverized-coal-contained air flow entering from inlet 102 is then divided into two parts by the barrel wall of the first stage burner barrel, in which the central part enters into the first stage burner barrel 104, the peripheral part advances along the space between the first stage burner barrel and the external barrel 202 (the pulverized-coal-contained air flow inlet 102 is provided ther-

eon), and enters into the second stage burner barrel from the second inlet 204 of the second stage burner barrel. As shown in the figure, the plasma generator is inserted along the radial direction of the burner and the pulverized-coal-contained air flow is blown into along the axial direction of the burner barrels, the two directions of which are still perpendicular. Under the action of the pulverized-coal-contained air flow, the plasma flame is blown deflected, causing the temperature of the side to which the plasma flame is deflected extra high so that clinker is formed.

**[0009]** Therefore, a new technology is needed to further prevent the pulverized coal from clinkering on the wall of the burner barrels.

#### SUMMARY OF THE INVENTION

**[0010]** Therefore, an object of the present invention is to provide a plasma generator which can relieve the problem of clinkering. It can be seen from the above description of the prior art, the fact that there exists an angle between the inserting direction of the plasma generator (that is, the direction of the plasma flame) and the direction of the pulverized-coal-contained air flow is a reason of the clinkering problem. Therefore, with respect to the above object, the gist of the present invention is to rearrange the pulverized-coal-contained air flow inlet and the plasma generator, so as to make the direction along which the pulverized-coal-contained air flow enters into the first stage burner barrel consistent with the direction of the plasma flame.

**[0011]** In addition, in order to further solve the problem of clinkering, it is necessary to make the pulverized-coal-contained air flow or air flow of the next stage as consistent with the pulverized coal flame of the former stage as possible.

**[0012]** For this purpose, the present invention provides a plasma ignition burner, comprises at least two stages of burner barrels and a plasma generator for igniting the pulverized coal in a first stage burner barrel of said at least two stages of burner barrels, wherein the burning flame of the former stage burner barrel ignites the pulverized coal in the next stage burner barrel, or further burns with the supplemented air in the next stage burner barrel, **characterized in that** the axial direction of said plasma generator is parallel to the direction along which the pulverized-coal-contained air flow enters into the first stage burner barrel and at the same time, parallel to the axis of the burner barrels.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0013]** The present invention will be described in details with reference to the accompanying drawings. In the drawings, the same reference signs are used for the same or corresponding technical features.

**[0014]** FIG. 1 is a sectional view schematically illustrating a plasma ignition burner of the prior art;

**[0015]** Fig. 2 is a partial sectional view schematically illustrating another plasma ignition burner of the prior art;

**[0016]** Fig. 3 is a partial sectional view schematically illustrating the first embodiment of the plasma ignition burner according to the present invention;

**[0017]** FIG. 4 is a sectional view along A-A line in FIG. 3;

**[0018]** FIG. 5 is a partial sectional view schematically illustrating the second embodiment of the plasma ignition burner according to the present invention;

**[0019]** FIG. 6 is a sectional view illustrating the structure of the axial swirl pulverized coal burner of the prior art.

#### 15 DETAILED DESCRIPTION OF THE INVENTION

**[0020]** FIG. 3 illustrates the partial sectional view schematically illustrating the first embodiment of the plasma ignition burner according to the first aspect of the present

20 invention. To be concise, this figure also only illustrates the pulverized-coal-contained air flow inlet 102, the first stage burner barrel 104 and the second stage burner barrel 106 similar to those in FIG. 2. Since the structure of the multi-stage structure of burner barrels has been described as above, it is not repeated here. What should be noted is that, as described in the part "BACK-GRAOUND ART", the stage number of the burner barrels into which the pulverized-coal-contained air flow enters,

25 the stage number of the burner barrel into which the air directly enters and the total stage number of the burner barrels are not limited and can be determined depending on power request and the size of the space. The total number of the stages may be from two stages to three, four or more stages and the air flow as shown in FIG. 1

30 may be also pulverized-coal-contained air flow depending on the application occasions.

**[0021]** The key of the present invention is to make the insertion direction of the plasma generator 302 parallel to the direction along which the pulverized-coal-contained

40 air flow enters into the first stage burner barrel 104 and at the same time, parallel to the axis of the burner barrels. Thus, the pulverized-coal-contained air flow enters into the burner barrels parallel to the axis of the burner barrels, without distribution asymmetry of the pulverized coal on the section plane of the burner barrels due to the inertia of the pulverized-coal-contained air flow.

45 Moreover, since the injection direction of the plasma flame of the plasma generator is consistent with the direction along which the pulverized-coal-contained air flow enters into the burner barrels, the plasma flame will not be blown deflected to the wall of the burner barrels. The above two points effectively alleviate the problem of clinkering on the wall of the burner barrels.

**[0022]** In the first embodiment shown in FIG. 3, the 55 above technical solution is achieved by providing bending tube 308 to guide the pulverized-coal-contained air flow and inserting the plasma generator 302 into the first stage burner barrel 104 through the wall of said bending

tube along the axial direction of the burner barrels. In order to make the distribution on the section plane as uniform as possible without deflection to one side due to centrifugal force when the pulverized-coal-contained air flow enters into the straight burner barrel at the position of A-A section plane, the radian of the bending tube 308 should be as gentle as possible. However, as long as there exists radian, centrifugal force can not be avoided and the pulverized coal will deflect to one side in the burner barrel. In order to avoid this problem, in one preferred embodiment, a guide plate 306 is arranged along the axis of the bending tube 308 and one end of the guide plate on the side of the burner barrel is parallel to the axis of the plasma generator, and even extends to the vicinity of the inlet 310 of the first stage burner barrel 104. At the same time, the plasma generator 302 and the end of the guide plate 306 are both arranged on the axis of the burner barrel (of course, the position of the end of the guide plate 306 may be deflected relative to the axis of the burner barrel to some extent). Thus, the guide plate 306 not only changes the flow direction of the pulverized-coal-contained air flow to make it parallel to the plasma flame, but also concentrates part of the pulverized coal in the vicinity of the central axis of the burner and the plasma flame by the centrifugal separation effect, so as to increase the concentration of the pulverized coal entering into the central barrel, which aids in the ignition. Compared with the structure shown in FIG. 1, only one guide plate is used to simultaneously change the flowing direction of the pulverized-coal-contained air flow entering into the respective stage burner barrels, the structure is simple and the resistance is relatively small. Since the space inside the bending head is large, the shape of the bending plate may be planar and may be various bending surface (an example is shown in FIG. 4) so as to further increase the concentration of the pulverized coal entering into the central barrel.

**[0023]** As shown in FIG.3, a large part of the plasma generator 302 exposes to the pulverized-coal-contained air flow. In order to prevent the plasma generator from being abraded by the pulverized-coal-contained air flow, anti-abrasion protecting sleeve (such as ceramics sleeve) can be used to protect the plasma generator. Moreover, in order to reduce the resistance, the windward surface of the sleeve may be made V-shaped.

**[0024]** Compared with the burner inserted along the radial direction in FIG.2, in addition to solving the problem of clinkering, this burner also has stronger ignition capacity. Specifically, the reason is as follows. The plasma flame is positioned on the central line of the burner and since the central barrel is circle, the ignition capacity of the plasma flame for respective directions is the same, the flame is uniform and the transmission capacity is strong. On the other hand, if the plasma flame is arranged on one side of the central barrel of the burner, the temperature of the flame on one side of the plasma flame will be high and that on the other side is low. In this case, if inferior coal is burned, ignition will even fail.

**[0025]** In the first embodiment as described above, the concentrating of the pulverized coal in the central barrel of the burner depends on the concentrating action of the guide plate 306 in the bending tube 308. However, due to the limitation of the space, the concentration in the central barrel can not be increased without limitation, which affects the effect of ignition. For this purpose, the second embodiment according to the present invention as shown in FIG. 5 is provided as the second aspect of the present invention.

**[0026]** To be concise, FIG.5 only illustrates the components corresponding to those in FIG. s 2 and 3, that is, the first stage burner barrel 104 and the burner internal barrel 202. As described in the above embodiment, inside the burner internal barrel 202, more stages of burner barrels can be arranged after the first stage burner barrel 104. And outside the burner internal barrel 202, there may be components corresponding to the burner external barrel 118 and multi stages of burner barrels after the burner internal barrel and inside the burner external barrel 118.

**[0027]** In this embodiment, the pipe for supplying the pulverized-coal-contained air flow branches into two pipes, that is, primary pipe 508 and branch pipe 502. The primary pipe 508 may be connected to the burner internal barrel 202 in a conventional way or by adopting the bending tube 308 in the first embodiment. At the same time, the central barrel 510 is guided from the first stage burner barrel 104 to be connected to the branch pipe 502. Similarly, the connection between the branch pipe 502 and the central barrel 510 may adopt the conventional way or a second bending tube 512 similar to the bending tube 308 in the first embodiment and wherein, the guide plate 306 (not shown in Fig.5) in the first embodiment can also be used. The arrangement manner of the plasma generator 302 may also be similar to the first embodiment.

**[0028]** In this way, the concentration of the pulverized coal entering into the central barrel and further entering into the first stage burner barrel may be made relatively high by directly guiding the pulverized-coal-contained air flow into the central barrel using the branch tube, so as to aid in the ignition. As a preferred embodiment, it is necessary to adjust the amount of the entering pulverized-coal-contained air flow, and/or increase the concentration of the pulverized coal in the pulverized-coal-contained air flow entering into the plasma ignition burner as high as possible. For this purpose, an adjuster may be arranged on the branching point of the primary pipe and the branch pipe for flexibly adjusting the amount of the pulverized coal entering into the branch tube.

**[0029]** As a variation of the above-described solution, if there are three or more stages of burner barrels guiding the pulverized-coal-contained air flow in the burner, the respective stages of burner barrels may be distributed between the central barrel and the burner internal barrel. For example, if there are three stages of burner barrels, the pulverized coal in the first stage burner barrel and the second stage burner barrel of the plasma ignition

burner may be guided in simultaneously through the central barrel and the branch pipe (in this case, the central barrel and the internal structure thereof is similar to that shown in FIG.2, with only the burner internal barrel in FIG.2 changing to the central barrel in FIG.5) and the pulverized coal in the third stage burner barrel enters from the primary pipe. Inversely, the pulverized coal in the first stage burner barrel of the plasma ignition burner may be guided in through the central barrel and the branch pipe and the pulverized coal in the second and the third stage burner barrels may enter from the primary pipe.

**[0030]** In a preferred embodiment, a valve 504 may be provided in the branch pipe, which is turned on in the starting ignition stage and the low-load stable combustion stage of the burner and turned off after the ignition is completed and the combustion of the burner becomes stable. This valve 504 may also be designed to be incorporated with the adjuster 506, so that the adjuster serves as an adjuster and a branch tube valve simultaneously.

**[0031]** It can be seen from the above description of the second embodiment, the gist of this embodiment is to increase the concentration of the pulverized coal in the first stage burner barrel by using the branch tube. It is neither limited to ignite using the plasma generator, nor limited to provide the plasma generator along the axial direction of the burner barrels. Therefore, the detail of various aspects of the second embodiment can be either combined or not combined with those of the first embodiment. Specifically, the ignition device may be oil gun besides the plasma generator and the arrangement manner thereof can be insertion along any direction besides axial insertion, including radial insertion and slanting insertion.

**[0032]** In the above-described solutions, since the branch tube is arranged and the adjuster is attached, the flowing velocity of the pulverized-coal-contained air flow and the concentration of the pulverized coal in the central barrel of the burner can be independently adjusted, so that the optimum ignition working condition can be achieved.

**[0033]** In addition, for those old type burners which have been amounted on the spot, a convenient and low-cost reconstructing means can be provided by using the above-described second embodiment, so that the present invention can be applied.

**[0034]** For example, the whirling type pulverized coal burner adopted by many burning coal fire-power electricity generator has a central barrel and the mixture of the pulverized coal and the air is sent into the hearth from the external of the central barrel. For example, LNASB axial swirl pulverized coal burner (refer to FIG.6) developed by Mitsui Babcock Energy Ltd in the eighties of 20th century adopts this kind of structure. In this structure, the oil gun is inserted into the central barrel 602 and the pulverized coal sent into the hearth from the external of the central barrel is ignited by the flame of the oil gun. For this kind of burner, if the reconstruction of the plasma

ignition technology is to be directly performed, it is necessary to remove the structure of the central barrel 602, which will cause the concentration distribution of the pulverized coal and the air velocity inside the burner to be changed greatly and will affect the original performance of the burner. However, this problem can be solved by adopting the second embodiment of the present invention. At the time of reconstructing the plasma technology, it is simply necessary to reconstruct the central barrel 602 to the first stage burner barrel 104, the central barrel 510, the ignition device (such as the plasma generator 302) and the branch tube 502 connected thereto as shown in Fig.5. And it is unnecessary to make any reconstruction for the original mechanism of the pulverized-coal-contained air flow of the burner (that is, the structure from the primary air to the tertiary air tube shown in FIG. 6), thereby making the performance as consistent with the original burner as possible.

**[0035]** The above-described reconstruction manner forms a third-stage burner (that is, the first stage burner barrel, the central barrel and the external barrel). In fact, if possible, a two-stage burner may be formed only by the central barrel and the external barrel, without the first stage burner barrel added. In addition, more stages of burner barrel may be added in the central barrel, or more stages of burner barrel may be added in the external barrel.

**[0036]** In addition, the ignition device may be any kind of ignition device either in the original burner, or in the reconstructed burner, including oil gun and plasma ignition device, et al.

**[0037]** The preferred embodiments of the present invention are described with reference to the accompanying drawings in the above. Apparently, the present invention is not limited to the specific details as described above and various changes or substitutions can be made, which also falls within the protection scope of the present invention.

## Claims

1. a plasma ignition burner, comprising at least two stages of burner barrels and a plasma generator for igniting the pulverized coal in a first stage burner barrel of said at least two stages of burner barrels, wherein the burning flame of the former stage burner barrel ignites the pulverized coal in the next stage burner barrel, or further burns with the supplemented air in the next stage burner barrel, **characterized in that** the axial direction of said plasma generator is parallel to the direction along which the pulverized-coal-contained air flow enters into the first stage burner barrel and at the same time, parallel to the axis of the burner barrels.
2. The plasma ignition burner according to claim 1, further comprising a bending tube for guiding the pul-

verized-coal-contained air flow into said at least two stages of burner barrels, wherein one end of the bending tube on the side of the burner barrels is parallel to the axis of the burner barrels, and said plasma generator is inserted into the first stage burner barrel through the wall of said bending tube along the axial direction of the burner barrels. 5

3. The plasma ignition burner according to claim 2, further comprising a guide plate arranged along the axis of the bending tube, wherein one end of the guide plate on the side of the burner barrels is parallel to the axis of the plasma generator. 10
4. The plasma ignition burner according to claim 3, wherein said guide plate extends to the vicinity of the inlet of the first stage burner barrel. 15
5. The plasma ignition burner according to claim 4, wherein the ends of said plasma generator and said guide plate are arranged on the axis of the burner barrels, or deflected from the axis of the burner barrels for a predetermined distance. 20
6. The plasma ignition burner according to any one of claims 3~5, wherein the shape of the section plane of said guide plate is planar. 25
7. The plasma ignition burner according to any one of claims 3~5, wherein the shape of the section plane of said guide plate is bending surface. 30
8. The plasma ignition burner according to any one of claims 2~7, wherein an anti-abrasion protecting sleeve is provided to protect said plasma generator. 35
9. The plasma ignition burner according to claim 8, wherein the windward surface of said anti-abrasion protecting sleeve is V-shaped. 40

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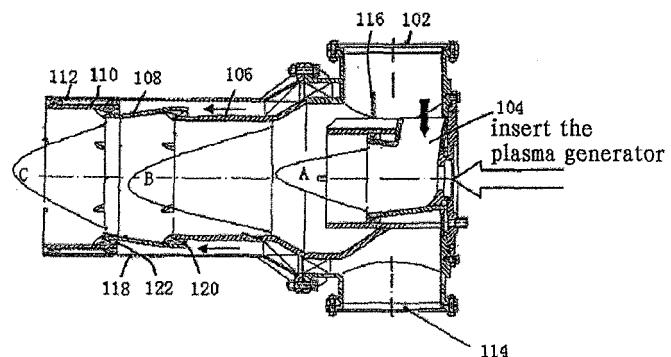


FIG.1

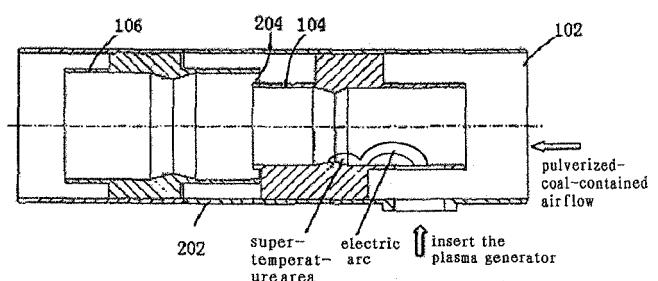


FIG.2

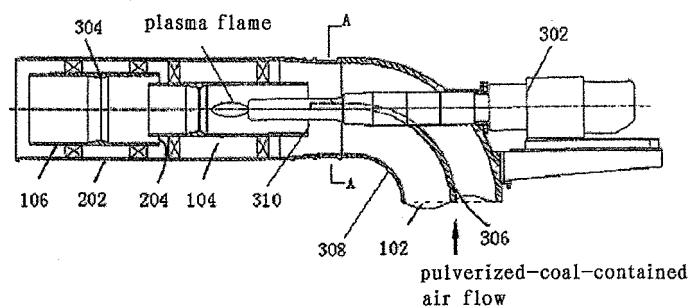


FIG.3

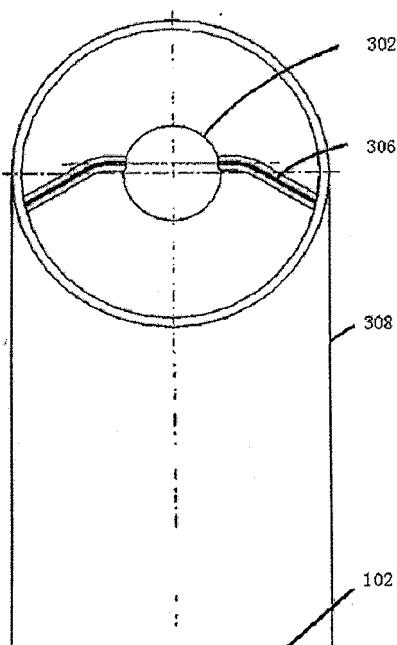


FIG.4

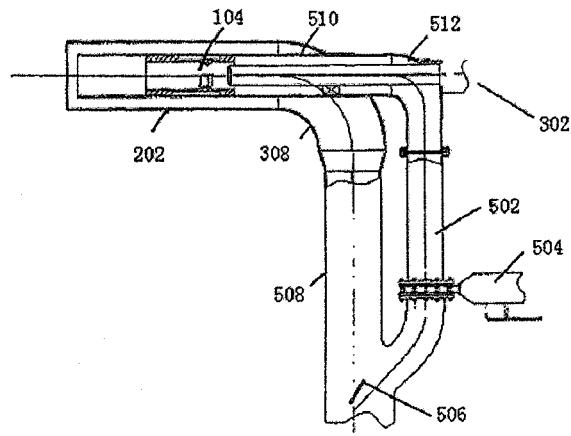


FIG.5

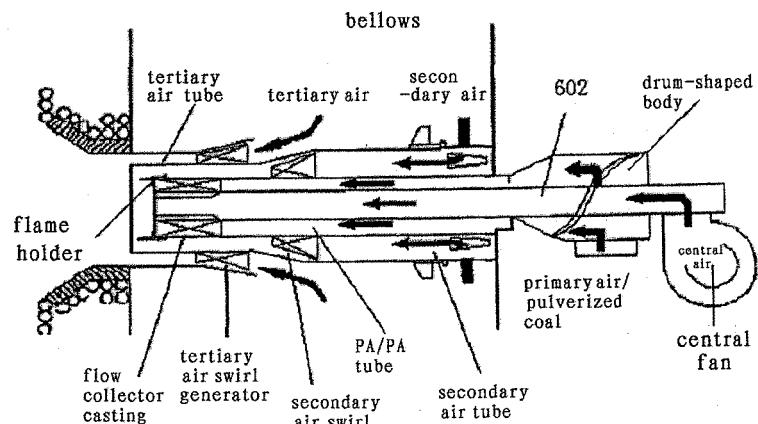


FIG.6

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2008/000521

## A. CLASSIFICATION OF SUBJECT MATTER

See the extra sheet

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)

IPC: F23Q7, F23Q2, F23D1, H05H1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

WPI; EPODOC; PAJ; CNKI; CPRS; plasma, parallel, coal, pulverize, igniter, burner, combustion, torch

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                       | Relevant to claim No. |
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| Y         |  | 2,8,9                 |
| Y         | CN2526693Y (FANHUA POWER ENGINEERING TECHN) 18 Dec. 2002 (18.12.2002) Description page 2 line 11- page 7 line 14, fig. 1 | 2,8,9                 |
| A         | CN1105874C (KAZAK NII IM SH CH CHOKINA et al.) 16 Apr. 2003 (16.04.2003)<br>The whole document                           | 1-9                   |
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| A         | US4862814A (ELEC COMMISS NEW S WALES et al.) 05 Sep. 1989 (05.09.1989)<br>The whole document                             | 1-9                   |

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

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|--|--|
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| “A” document defining the general state of the art which is not considered to be of particular relevance   | “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  |
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| Date of the actual completion of the international search<br>02 Jun. 2008 (02.06.2008)   | Date of mailing of the international search report<br>26 Jun. 2008 (26.06.2008) |
| Name and mailing address of the ISA/CN<br>The State Intellectual Property Office, the P.R.China<br>6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China<br>100088<br>Facsimile No. 86-10-62019451 | Authorized officer<br>YANG, Yi<br>Telephone No. (86-10)62084859                 |

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

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.

PCT/CN2008/000521

| Patent Documents referred in the Report | Publication Date | Patent Family  | Publication Date   |
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