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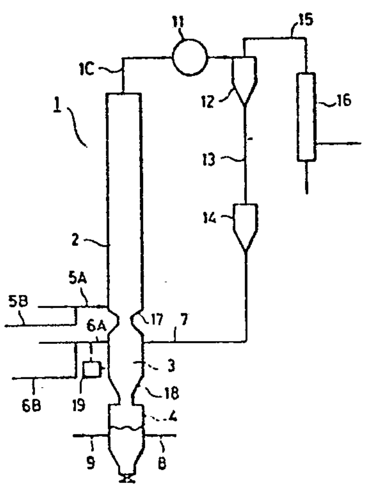
(54) Process of and apparatus for gasifying coals.

(57) A process of, and an apparatus for, gasifying coals through a dry distillation reaction, gasifying reaction and combustion reaction of coal particles within a coal gasifier including a dry distillation gasifying reaction section (2) at the upper side and a combustion gasifying section (3) at the lower side, are disclosed in which systems for supplying coal particles (5A, 6A) are provided at the dry distillation gasifying reaction (2) and combustion gasifying sections (3), respectively, and the amount of the coal particles supplied to the combustion gasifying section (3) is adjusted in response to temperature conditions within the combustion gasifying section (3).

FIG. 1



EP 0 050 863 A1

Croydon Printing Company Ltd.

PROCESS OF AND APPARATUS FOR GASIFYING COALS.

Background of the invention

This invention relates to a process of and an apparatus for gasifying coals, wherein coals are converted and separated into combustible gas, e.g. hydrogen or carbon oxide, and molten ashes (slags).

Coals are one of fossil fuel resources with the maximum estimated amount of deposits and increasing public attention as an alternative energy in place of petrol. However, coals are inconvenient in their treatment because they are solid fuels and require counter measures to prevent environment contamination because they contain ashes, sulphur and nitrogen. Gasification of coals is one prospective method for converting coals into clear fuels, so that coal gas for consumption, fuel gas for industries, raw gas for technical chemistry and hydrogen gas for oil refining or coals gasifying and also the conversion into fuel gas for the power generation by gas turbines may be produced.

Reactions caused in the process of such coal gasification are mainly divided into three reactions; i.e. a combustion reaction between coals and oxidizing agents (air, oxygen), a dry distillation reaction of coals by heat produced during the combustion, and a gasifying reaction between chars (solid substances containing carbon and ashes) as a residual component of the dry distillation and steam or carbon dioxide. The gasifying reaction among those reactions is represented by the following Equations (1) and (2), and combustible gas such as hydrogen or carbon oxide is produced in larger amounts as the temperature is increased up to a higher degree.

$$C + H_2O \rightarrow CO + H_2 \quad \ldots (1)$$

$$C + CO_2 \rightarrow 2CO \quad \ldots (2)$$

However, when the process of gasification is subjected to such higher temperatures, ashes contained in chars are molten and conglomerated to form granular clinkers so that the stable gasification becomes impossible. In order to carry out the coal gasification in a stable state, therefore, such coals as are not molten even at a high termperature should be selected, or the process of gasification should be carried out at a temperature less than the melting temperature of ashes contained in chars and hence the efficiency of gasification has to be restricted to a lower level.

Methods of gasifying coals are basically grouped into a fixed bed system, a fluidized bed system, a jet stream bed system and a molten bath bed system. This grouping is based on the state of the coal particles within furnaces, but also closely related to a diameter of the particles and temperature in the furnaces.

The fixed bed systems has the disadvantage that the reaction velocity is low because of massive coals with a diameter of several tens mm and this leads to limitations in the processing capacity, whereby the system is not suitable for a large scale plant. However, positive achievements have been accumulated for this system up to now, so that gasification furnaces of the fixed bed type are adopted in most plants in the present condition.

In the fluidized bed system, coal particles with a diameter equal to or less than several mm are gasified while being fluidized by the action of gas. Therefore, the furnace temperature becomes uniform in its distribution due to the fact that the coal particles agitate air bubbles, whereby the generation of tars often experienced in the fixed bed system is restricted to a low level, so that a high efficiency of the gasifying reaction can be obtained. On the other hand, since the generation of clinkers due to the solidification of molten ashes has to be restricted, it is difficult to raise the furnace temperature above 950°C and the gasifying reaction is limited in its velocity.

In the jet stream bed (air stream bed) system, coal particles are atomized to a still smaller diameter and gasified by a gasifying agent and ashes are molten at a high temperature above 1300°C, so that discharged ashes include a lower content of parts not yet burnt and the gasification velocity becomes extremely high with little amount of tar byproducts.

There are known at present two gasification methods of the jet stream type as follows:

(1) Fine coals particles are atomized and directed downward together with oxygen and steam from the top of a furnace to be gasified, and the generated gas and slags are made to flow downward within the furnace in parallel.

(2) Fine coal particles are atomized together with oxygen and steam from both sides of a furnace in the horizontal direction and the two streams are allowed to flow in the opposite directions to collide with each other, and the generated gas and slags are made to flow upward and downward, respectively.

The former system (1) has an advantage in that slags can be prevented from adhering to the inner wall of the furnace, but disadvantage in that the recovery of the released gas heat is difficult because the generated gas and slags are introduced into warm water for cooling.

On the other hand, the latter system (2) has an advantage in that the released heat of the generated gas can be recovered with ease, but drawbacks in that the dropping ratio of the slags becomes low because of a tendency to flow upward together with the generated gas, and ashes can be hardly molten due to limitations on the furnace structure when gasifying coals containing ashes with high melting temperature.

Summary of the invention

It is an object of the present invention to provide a method of and an apparatus for gasifying coals, wherein the released heat of generated gas can be recovered and any variety of coals containing ashes with low or high melting temperature can be effectively gasified.

Reactions caused in the process of coal gasification are mainly divided into three reactions; i.e. dry distillation, gasifying and combustion reactions. In the dry distillation reaction, volatile components are formed and combustible gas such as methane, hydrogen, carbon oxide, or others is generated. In the gasifying reaction, chars as a residual component of the dry distillation react with steam or carbon dioxide to generate hydrogen or carbon oxide. These reactions go on in the form of an endothermic reaction and the required heat source is obtained through combustion of the chars. In the process of coal gasification, these three reactions are performed, and effective coal gasification can be obtained only when the three reactions proceed at the optimum ratio therebetween. Depending on the coal varieties, different amounts of gases are generated by dry distillation, and char byproducts have also different amounts. Furthermore, different amounts of silica or aluminum are contained in the generated ashes, so that there is also caused a difference in the melting points of the ashes. More specifically, varieties of coals result in different ratios between the three reactions mentioned above and the optimum ratio depends on the respective coals.

Paying attention on the fact that temperature serves as an operating factor to control the three reactions, i.e. the dry distillation, gasifying and combustion reactions, the invention aims at controlling the amount of the combustion reaction determining the temperature and at adjusting the amount of raw coals supplied to the combustion reaction section with the coal gasification apparatus for that control.

The above mentioned object of the present invention has been achieved by a gasification method comprising a process for gasifying fine coal particles by supplying coals pulverized to particles into a high temperature atmosphere together with a gasifying agent, a process for separating combustible gas and chars generated in the gasifying process, and a process for burning the chars separated in the separating process, wherein the fine coal particles and the gasifying agent are supplied while burning the chars.

The fine coal particles are preferably controlled in their amount in response to the reaction temperature when burning the chars.

A gasifier for realizing the gasification method of the present invention comprises a gasification means including a dry distillation gasifying reaction section at the upper side and a combustion gasifying section, a separation means for separating combustible gas and chars generated in the gasification means, a means for supplying the chars separated in the separation means to the combustion gasifying section in the gasification means, and a means for supplying fine coal particles and gasifying agents to both the dry distillation gasifying reaction section and the combustion gasifying section in the gasification means.

Preferably, there is provided a means for detecting the temperature within the combustion gasifying section in the gasification means and adjusting the amount of the fine coal particles supplied to the combustion gasifying section in response to the detected temperature within the combustion gasifying section.

According to the present invention, an advantage has been achieved in that the chars are burned at a temperature not below the dropping point of the molten ashes contained in the chars irrespective of varieties of coals and thus all varieties of coals can be gasified effectively and stably.

Other objects, features and effects of the present invention will become more apparent from the following description with reference to the accompanying drawings.

Brief Description of the Drawings

Fig.1 is a flow diagram showing a preferred embodiment of a gasifier according to the present invention;

Fig.2 is a view showing a concrete arrangement of a gasification furnace in the embodiment of Fig. 1;

Fig.3 is an illustrative view showing the flow of gas and molten ashes (slags) in the gasification furnace shown in Fig.2; and

Fig.4 is a view showing a more concrete arrangement of a structure of the gasification furnace shown in Fig.2.

Detailed Description of the Preferred Embodiment

A gasifier 1 includes a dry distillation (thermal decomposition) gasifying reaction section 2 at the upper side, a combustion gasifying section 3 at the lower side and a molten ash pot section 4 at the bottom, respectively. Throttled portions 17, 18 are formed between these three sectiones 2 to 4 to increase the combustion efficiency in the combustion gasifying section 3.

To the dry distillation gasifying section 2 connected are ports 5A and 5B for supplying raw coals and a gasifying agent (an oxidizing agent, steam or a gas mixture thereof), to the combustion gasifying section 3 connected are ports 6A and 6B for supplying raw coals and a gasifying agent and ports 7 for resupplying by-producted chars, respectively. Each port 6A formed in the combustion gasifying section 3 for supplying raw coals is opened in the tangential direction of the combustion gasifying section 3 as described hereinafter and radially faces the port 7 for resupplying chars with an angular interval of 180°. Therefore, the raw coals stay in the combustion gasifying section for a loger time, the combustion reaction proceeds effectively, and molten ashes are able to flow downward along the inner surface of the combustion gasifying section. A cooling water supply port 8 and a cooling water exhaust port 9 are connected to the molten ash pot section 4.

A cooler 11 and a cyclone 12 are connected to a outlet tube 10 for leading out the generated gas and chars, the latter tube 10 being connected to the top of the gasifier 1. The leg portion of the cyclone 12 is connected to the port 7 for resupplying the byproducted chars via a transport system comprising a char recycling tube 13 and a char pot 14. An outlet of the cyclone 12 is coupled with a refining system 16 via a gas transport tube 15, so that gas discharged from the cyclone 12 is refined.

The refined gas serves directly as a fuel for a gas turbine, while the heat thereof is recovered to increase the efficiency of power generation with the aid of a steam turbine.

In the thus arranged apparatus for gasifying coals, fine coal particles are supplied to the dry distillation gasifying reaction section 2 through the supply ports 5A with a gasifying agent by a predetermined amount successively. In the section 2 coals are dry-distilled to generate methane, hydrogen, carbon oxide and other components. Byproducted chars move upward in the gasifier 1 by the action of high temperature gas while being under the gasifying action, whereby the content of carbon contained in the chars is reduced. On the other hand, gas generated from the dry distillation and gas and chars generated from the gasifying reaction are led out through the outlet tube 10 to the cooler 11, where they are cooled and the heat thereof is recovered.

Then, the chars are separated from the gas in the cyclone 12. Separated chars pass down through the char recycling tube 13 and are stored in the char pot 14. The chars stored in the char pot 14 are supplied to the combustion gasifying section 3 with a gasifying agent by a predetermined amount successively.

In the combustion gasifying section 3, the chars are burnt up so as to produce heat. When the chars contains a smaller amount of combustible components, raw coals and a gasifying agent are supplied to the combustion gasifying section 3 through the supply ports 6A,6B, so that the temperature within the combustion gasifying section 3 becomes above the melting temperature of ashes due to the combustion reaction of coals. As a result, ashes contained in the chars are molten, flow down along the inner wall surface of the combustion gasifying section 3 and then drip into the molten ash pot section 4, where the ashes are cooled by cooling water to be solidified. The solidified ahes are discharged out of the system.

For supplying the raw coals to the combustion gasifying section 3, they may be continuously supplied to the section 3, when the used raw coals generate such chars as contain a smaller amount of combustible components. It is pereferable, however, to detect the temperature within the combustion gasifying section 3 and then adjust the amount of the raw coals supplied to the section 3 by a control unit 19 in response to the temperature condition within the combustion gasifying section 3. According to this system, the process of gasification can be effectively operated even when the raw coals are changed in their varieties during the course of coal gasification.

EXAMPLE

The gasifier comprises a pressure-resistant vessel and is lined with fire-resistant material and heat insulating material at the inner surface. The dry distillation (heat decomposition) gasifying reaction section has an inner diameter of 105 mm and a height of 4.2 m, the combustion gasifying section has an inner diameter of 200 mm and a height of 0.4m, and the both sections are coupled with each other via a throttle tube with an inner diameter of 50mm. The molten ash pot section having an inner diameter of 300mm and a height of 0.6 m is connected at the upper end thereof to the combustion gasifying section via an another throttle tube with a diameter of 70mm. A heater of fire-resident material at its periphery is provided within the pressure-resistant vessel to accelerate the radiation of heat. Each supply port connected to the dry distillation gasifying reaction section has an inner diameter of 12.7mm and is opened in the tangential direction of that section. The port for supplying raw coals, connected to the combustion gasifying section, has an inner diameter of 12.7mm and is opened in the downward tangential direction. The port for resupplying chars to the combustion gasifying section has the same diameter as the port supplying raw coals thereto and is opened in the tangential direction at a position radially facing the latter port with an angular interval of 180°.

(CASE-I)

In the apparatus as mentioned above, coals were gasified by supplying Taiheiyo Coal of 14.3 kg/h pulverized to fine particles with diameter not greater than 74 µm, steam of 6.0 kg/h and air of 37 kg/h to the dry distillation gasifying reaction section, and the same coals of 0.7kg/h and air of 9,5kg/h to the combustion gasifying section. Recycled chars of 5.4 kg/h and air of 21.2 kg/h from the char pot are also supplied to the combustion gasifying section. As a result, gas obtained at an outlet of the cyclone was composed of hydrogen 12 vol %, and carbon oxide 20.5 vol %, methane 1.5 vol % and carbon dioxide 8.1vol% and had a calorific power of 4533 kJ/Nm^3 . At this time, the temperature within the combustion gasifying section was 1470°C. Ashes were molten in the combustion gasifying section, adhered to the inner wall surface thereof and also dripped into the molten ash pot section.

(CASE II)

In addition to the above process, coals of 13kg/h, steam of 6.0kg/h and air of 19.2 kg/h were supplied to the dry distillation gasifying reaction section, and the same coals of 2.0kg/h, air of 27.1kg/h, recycled chars of 5.1 kg/h and air of 21 kg/h were supplied to the combustion gasifying section. Coals were gasified in such conditions. As a result, the temperature within the combustion gasifying section raised up to 1630°C, and ashes within the combustion gasifying section dropped down in the molten state and could be collected in the molten ash pot section.

COMPARATIVE EXAMPLE (Case III)

For comparison, the combustion gasifying section was supplided with only recycled char at 5.4 kg/h and air at 21.2kg/h without coals, and the dry distillation (thermal decomposition) gasifying section was supplied with the same coals as above at 15 kg/h, steam at 6 kg/h and air at 46.3 kg/h. In this case, the temperature within the combustion gasifying section was 1280°C, and ashes were hardly adhered to the inner wall surface of the combustion gasification section and not dipped into the molten ash pot section.

The foregoing three cases were conducted to confirm the presence or absence of slag dropping through experiments utilizing Taiheiyo Coal with the melting point of ashes 1350°C. Then, similar experiments to ensure the presence or absence of slag dropping were conducted under identical condition as above while changing the variety of coals. The result of these experiments is as follows. Besides, Ashibetsu Coal, Daido Coal (China) and Blair Athol (Australia) submitted to the experiments have melting points of the ashes of 1200°C, 1350°C and 1600°C, respectively.

Table 1

Taiheiyo Coal			
	Case I	Case II	Case III
Dry distillation Gasifying Reaction Section			
Amount of supplied coals kg/h	14.3	13	15
Amount of steam kg/h	6.0	6	6
Amount of air kg/h	37.0	19.2	46.3
Combustion Gasifying Section			
Amount of supplied coals kg/h	0.7	2	0
Amount of air kg/h	9.5	27.1	0
Amount of recycled chars kg/h	5.4	5.1	5.4
Amount of air kg/h	21.2	21.0	21.2
Temperature °C	1470	1630	1280
Precence of Slag Dropping	Yes	Yes	No

Table 2

Ashibetsu Coal			
	I	II	III
Temperature °C	1440	1580	1200
Precence of Slag Dropping	Yes	Yes	No

Table 3

Daido Coal		
I	II	III
1400	1600	1240
Yes	Yes	No

Table 4

Blair Athol		
I	II	III
1480	1670	1290
No	Yes	No

In the following, structures of the dry distillation gasifying reaction section 2 and the combustion gasifying section 3 in the gasifier 1 mentioned above and orientations of nozzles provided at those sections for supplying fine coal particles will be described with reference to Figs.2,3 and 4. The following description is to explain the structure of the combustion gasifying section 3 and orientation of nozzles provided at the section 3 referring to Fig.2,3 and 4, but this is also applicable to the structure and nozzle orientation of the dry distillation gasifying reaction section 2.

In Fig.2(a), the combustion gasifying section 3 is shaped into an invert-conical form with a throttled bottom. Raw coals in the pulverized particle form are blown into the combustion gasifying section 3 together with a gasifying agent (oxygen or air and steam) through the nozzles 6A.

As shown in Fig.2(b), the nozzles 6A are disposed in such a manner that the fine coal particles are jetted from the nozzles in the tangential direction of a phantom circle 20 at the furnace wall and the number of nozzles j at each stage i is proportional to the circumferential length of the phantom circle at the same stage. In addition, each nozzle 6A is so oriented that the fine coal particles from the nozzle 6A travel downward obliquely and the fine coal particles reflected at the furnace wall travel downward with respect to the horizontal plane.

More specifically, the angle α of the nozzle 6A against the horizontal plane is set to be not smaller than the vertical angle θ of the invert-conical-shaped furnace, as illustrated in Fig.2(a).

According to such nozzle orientation, as shown in Fig.3, the jet stream of the gasifying agent and fine coal particles from the nozzles 6A, 6'A becomes a whirling stream 21, 21' towarding the bottom of the furnace so that the coal particles collide hard with gas and their staying time at high temperature is prolonged, whereby not only the gasification factor can be increased, but also the generated molten ashes 22, 23 collide with the furnace wall 18 and then drip into water 24 within the molten ash pot section 4.

By adopting the multi-stage jet nozzle system according to this embodiment, low load operation can be faciliated. In other words, it becomes possible to carry out the operation while restricting the influence upon the whirling stream by interrupting jet streams from the nozzles at a certain stage without changing the intensity of the jet streams from nozzles at other stages.

EXAMPLE

As shown in Fig.4, an invert-conical-shaped gasification furnace constituting the combustion gasifying section 3 has a vertical angle of 20°, an inner diameter of 900mm at the upper end and an inner diameter of 300mm at the lower end. Between the upper and lower ends, there are provided a plurality of nozzles at three stages, the upper stage being located at a level A-A' in the upper portion of the conical-shaped furnace, the middle stage being located at a level B-B' lower 600mm than the level A-A', and the lower stage being located at a level C-C' lower 600mm than the level B-B'. Respective nozzles are directed downward at an angle of 30° with respect to the horizontal plane and disposed in such a manner depending on each stage that the nozzles on the level A-A' are oriented in the tangential direction of a phantom circle sectioned at the level B-B', the nozzles on the level B-B' in the tangential direction of a phantom circle sectioned at the level C-C', and the nozzles on the level C-C' in the tangential direction of a phantom circle sectioned at a level D-D' lower 600 mm than the level C-C', respectively. The number (J) of nozzles at respective A,B and C stages (I=1,2,3) are selected as 10, 8 and 6.

The velocity of the gas jet from each nozzle is set not less than 50m/s, preferably not less than 150m/s, and the aperture diameter of and the injection angle from the nozzles are so selected that the running speed at the phantom circles mentioned above becomes not less than 5m/s, preferably not less than 20m/s, thereby producing a satisfactory whirling stream. Besides, the nozzles at the A and B stages are used for supplying coals and the nozzles at the C stage are used for resupplying the chars recovered from the cyclone.

When coals of 6.4 kN/h (128 kN/h in total), air of 21.6 kN/h and steam of 0.59 kN/h were supplied from each nozzle at the A and B stages at a pressure of 20 bar, the amount of chars recovered from the cyclone was 22.6 kN/h and each nozzle at the C stage was set to supply the recycled chars at about 3.9 kN/h, air at 11.3 kN/h and steam at 0.29 kN/h. Non-caking betuminous coal containing ashes 14 wt% and carbon 67.4 wt% was used as the supplied coals.

The generated gas had a temperature of 960^{o}C at the outlet of the gasification furnace and was composed of H_2 13.8 vol%, CO 24.2 vol%, CO_2 5.5 vol%, H_2S 0.2 vol% and N_2 56.3 vol%. The calorific power, carbon gasified rate and energy yield (cooling gas efficiency) of the generated gas were 4856 kJ/Nm^3, 992% and 75%, respectively.

Even if the amount of supplied coals and the gasifying agent from the nozzles at the A and B stages were reduced to 60% of the above rated value, operation could be continued in the stable state. However, that amount reduced to below 60% has resulted in a drawback such that effect of the whirling stream is reduced and hence a stream of molten ashes (slags) is hard to generate.

Then, the total amount of supplied coals was lowered to 60% of the above rated value by interrupting the supply of coals from the nozzles at the B stage while maintaining the supply from the nozzles at the A stage at the rated value (100%, 49 kN/h). In this case, a stable stream of slags was formed, because the whirling stream from the nozzles at the A stage was kept at nearly the same one as generated under the rated state. Furthermore, in case of using the nozzles at the A stage only, the supply amount from those nozzles reduced to 60% of the rated value has also resulted in the phenomenon that a stable formation of a slag stream is prevented. Therefore, it becomes possible to maintain the stable operation in a range from 60 to 36% of the total processing amount corresponding to the rated state by using the nozzles at the A stage only.

Next, the amount of supplied coals was lowered to 40% of the rated value by interrupting the supply of coals from the nozzles at the A stage while keepting the supply amount from the nozzles at the B stage at its raged value (49 kN/h for each nozzle). In this case, operation was performed at the sufficiently stable state. When the processing amount by the nozzles at the B stage is reduced to below 60% of the rated value, the slag stream may be also brought into an unstable state. But practical processing can be continued in a range up to 50% of the rated value.

In such a manner, when varying the processing amount, each nozzle has a lower limitation at about 60% of the rated value in its allowable fluctuation. However, it became possible to change the load factor from 20% to 100% through the combined using of the nozzles at the A and B stages. Furthermore, the gas composition and gas conversion rate which are variable due to the load fluctuation could be maintained at nearly constant level.

In addition, the lowered load factor leads to a reduction in the flowing speed of the gas within the furnace and the amount of chars recovered from the cyclone is reducted, so that the char supply amount from the nozzle at the C stage is also significantly lowered, whereby the formation of slags may become not easy. But solidification of the slag stream is relatively hard to occur, because gasification of the char jet from the nozzles at the C stage is accelerated by slag streams from the nozzles at the A and B stages.

As described above, for supplying raw coals, chars recycled from the cyclone and a gasifying agent, multi-stage nozzles are provided at the gasifying section in the form of an inverted cone, the number of nozzles at each stage is made proportional to the circumferencial length of a circle sectioned at the level of each stage, and each nozzle is so directed and oriented downward obliquely that the angle of the nozzles with respect to the horizontal plane becomes greater than the vertical angle of the conical-shaped gasifying section, and the nozzles are directed in the tangential direction of a phantom circle in the furnace sectioned horizontally, thereby permitting to maintain dripping of molten ashes, increase the gasification efficiency and achieve stable gas composition, even when the supply amount of materials is remarkably changed.

The foregoing arrangement as shown in Fig.4 is one embodiment and the present invention is not limited to this embodiment. It is a matter of course that the vertical angle of the conical-shaped gasifying section can be changed, and the number of nozzles and orientation thereof can be also varied. Furthermore, raw coals can be supplied not only dry but also in the form of water slurry, and oxgen or steam can be used as a gasifying agent in place of air.

Claims:

1. A coal gasification process comprising the steps of gasifying fine coal particles by supplying coals pulverized to particles into a high temperature atmosphere together with a gasifying agent, separating the gas and solid substances generated from said gasifying process, and burning said solid substances separated in said separating process, characterized in that said fine coal particles and gasifying agent are supplied while burning said solid substances.

2. The process of claim 1, characterized in that the amount of said fine coal particles to be supplied is controlled in response to the reaction temperature when burning said solid substances.

3. A process of gasifying coals by dry distillation reaction, gasifying reaction and combustion reaction of fine coal particles within a coal gasifier including a dry distillation gasifying reaction section at the upper side and a combustion gasifying section at the lower side, characterized in that said fine coal particles are supplied to said dry distillation gasifying reaction and combustion gasifying sections, respectively.

4. The process of claim 3, c h a r a c t e r i z e d i n t h a t the amount of said fine coal particles supplied to said combustion gasifying section is adjusted in response to temperature conditions within said combustion gasifying section.

5. The process of claim 3 or 4, c h a r a c t e r i z e d i n t h a t said fine coal particles are so supplied to said combustion gasifying section that the temperature within said combustion gasifying section becomes above the melting temperature of ashes contained in the supplied coals.

6. An apparatus for gasifying coals, c h a r a c t e - r i z e d by a gasification means including a dry distillation gasifying reaction section (2) at the upper side and a combustion gasifying section (3) at the lower side; a means (12) for separating combustible gas and chars generated from said gasification means; a means (7) for supplying said chars separated in said separation means to said combustion gasifying section in the gasification means; and a means (5A, 5B, 6A, 6B) for supplying fine coal particles and a gasifying agent to both said dry distillation gasifying reaction and combustion gasifying sections (43).

7. The apparatus of claim 6, c h a r a c t e r i z e d b y a means (19) for detecting the temperature within said combustion gasifying section (3) of the gasification

means and for adjusting the amount of fine coal particles supplied to said combustion gasifying section (3) in response to the detected temperature within said combustion gasifying section.

8. The apparatus of claim 6 or 7, characterized in that said combustion gasifying section (3) is shaped into the form of a cone with a smaller diameter at the lower part toward the bottom, a plurality of nozzles (6A) being provided at the periphery of said combustion gasifying section (3).

9. The apparatus of claim 8, wherein the number of said nozzles (6A) at each stage is set proportional to the circumferential length of said combustion gasifying section (3) at the respective level where said nozzles (6A) are located, each nozzle being so directed downward obliquely that the angle (α) of the nozzle (6A) with respect to the horizontal plane is greater than the vertical ange (θ) of said conical-shaped combustion gasifying section (3), all nozzles (6A) being oriented in the tangential direction of a horizontal phantom circle (20) in said combustion gasifying section (3).

FIG. 1

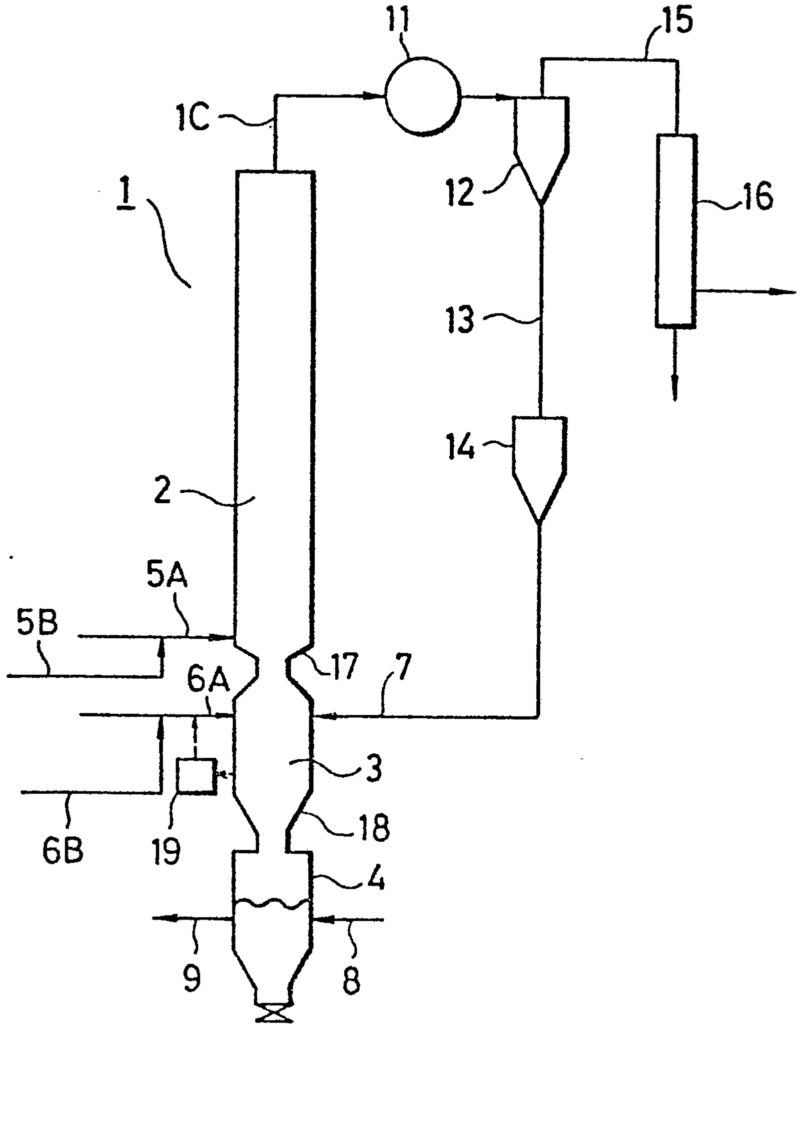


FIG. 2

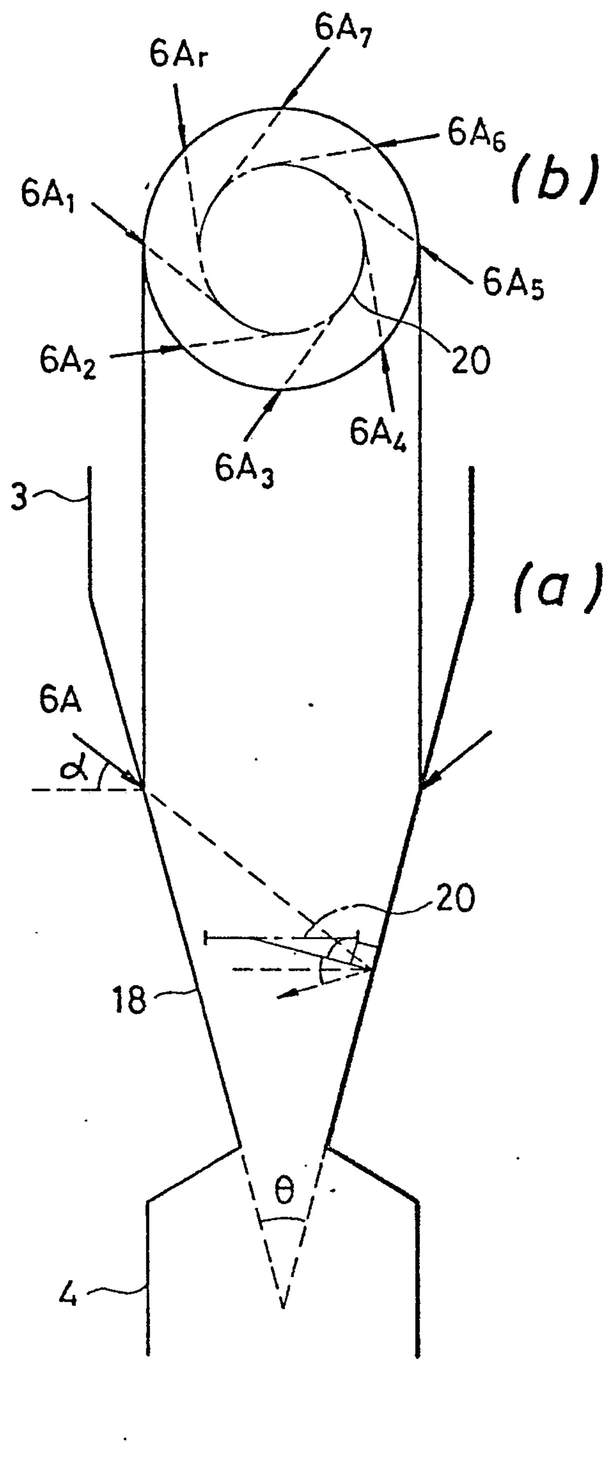


FIG. 3

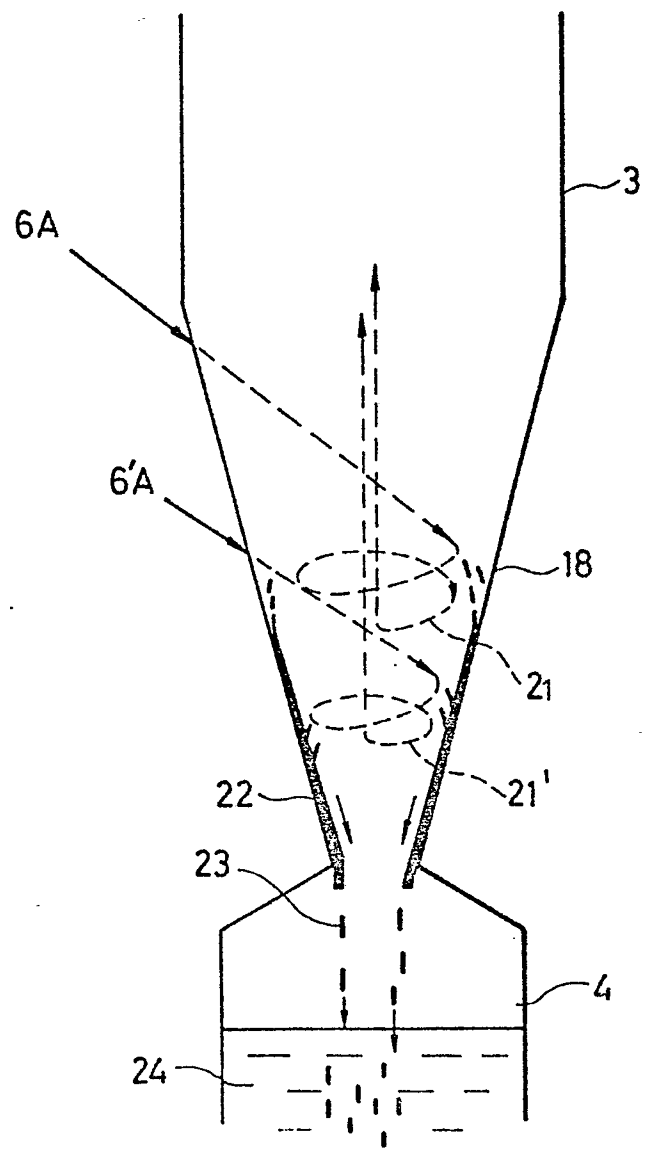
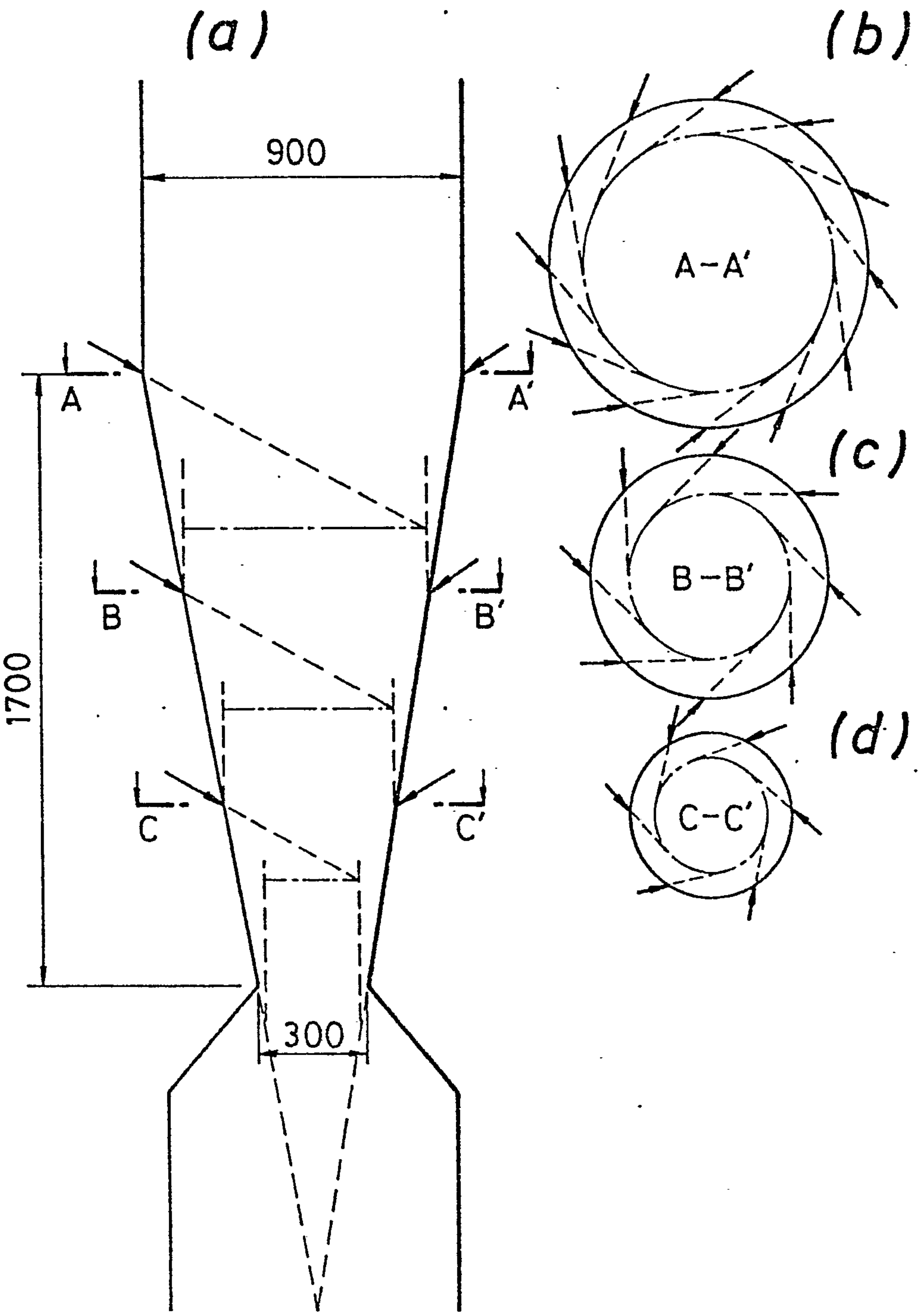


FIG. 4



European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 81 10 8825

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
	FR - A - 2 400 550 (COMBUSTION ENGINEERING)	
	* the whole document *	1,3,5, 6,8
	& US - A - 4 168 956	

	FR - A - 2 401 982 (COMBUSTION ENGINEERING)	
	* the whole document *	1-8
	& US - A - 4 158 552	

	DE - B - 1 017 314 (BASF)	
	* column 1, lines 35-55; column 2; column 3; column 4, lines 1-22 *	1,3,5

	FR - A - 2 177 089 (BITUMINOUS COAL RES.)	
	* pages 10-13; claims *	1,3
	& US - A - 3 782 913	

	US - A - 2 644 745 (HENNINGER)	
	* column 4, lines 53-73 *	1,8,9

A	US - A - 2 801 158 (GROSSMAN)	
	* column 5, lines 1-25 *	1,8

A	US - A - 2 971 830 (KAWAI)	
	* columns 7 and 8; claims *	1,8

CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)

C 10 J 3/46
C 10 J 3/48

TECHNICAL FIELDS SEARCHED (Int.Cl. 3)

C 10 J 3/46
C 10 J 3/48

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
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D: document cited in the application
L: document cited for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	13.01.1982	WENDLING