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# (54) COAL PYROLYSIS PROCESS DEVICE

(57) A coal pyrolysis process device, including a primary coal pyrolysis device (1) and a secondary coal pyrolysis device (2), wherein a discharge port (12) of the primary coal pyrolysis device (1) communicates with a feed port (21) of the secondary coal pyrolysis device (2). When coal is in the primary coal pyrolysis device (1), coal tar is extracted to the maximum extent, and then enters the secondary coal pyrolysis device (2). The coal continues to be heated and undergo pyrolysis at an upper portion of the secondary coal pyrolysis device (2), so that volatile matter of upgraded coal having undergone primary pyrolysis and upgrading are further reduced in the secondary coal pyrolysis device (2), and more gas is produced.

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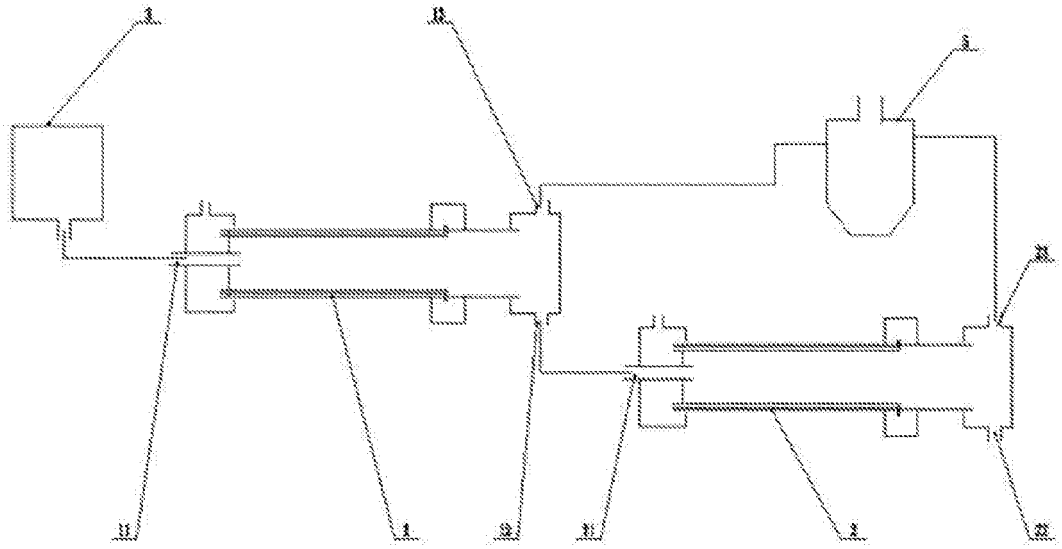

FIG. 1

## Description

### TECHNICAL FIELD

**[0001]** . The present disclosure relates to the technical field of heat exchange, and in particular to a coal pyrolysis process device.

### BACKGROUND ART

**[0002]** . Depending on different requirements of final products, coal pyrolysis apparatuses are greatly different from one another, and also have greatly different coal tar yields, for example, a coke furnace for making coke and a semi-coke furnace for producing semi-coke have a great difference in furnace type. The coke furnace produces coke with a relatively low amount of volatile matter, has low coal tar yield, but produces a large amount of coal gas, whereas the semi-coke furnace produces semi-coke with a higher amount of volatile matter, has relatively high coal tar yield, and produces a slightly lower amount of coal gas. With the demand of petroleum strategy, a rotary kiln for coalite tar with high oil yield has become a new favorite in recent years. A Chinese Patent with application number 201010262786.6 and publication number CN101985558, entitled "Coal Decomposing Equipment", discloses a coal decomposing equipment including an airtight kiln body with an coal inlet and an coal outlet, wherein a flame gas pipeline heating facility is set in the kiln body and a channel for impelling and decomposing coal is formed between the flame gas pipeline heating facility and an inner wall of the kiln body; and a coal decomposition gas collecting pipe is provided on the kiln body to communicate with the channel for impelling and decomposing coal. Since this invention allows a large amount of heat produced by the flame gas pipeline heating facility to be conducted and radiated to the pulverized coal in the channel for impelling and decomposing coal, the pulverized coal fully absorbs the heat so as to be heated and decomposed to the fuel gas, tar gas and coal with a higher heat-value in the channel for impelling and decomposing coal. The fuel gas and tar gas communicate with a gas dedust and liquefaction facility outside of the rotary kiln through the coal decomposition gas collecting pipe, and the decomposed fuel gas and tar gas are dedusted, separated, and pressure liquefied.

**[0003]** . The above-mentioned patent indeed provides relatively high oil yield, and is regarded as an example, but only the maximum tar yield is taken into consideration in this patent, and a relatively large amount of volatile matter in the upgraded coal resulting from such pyrolysis at low temperature and the coal gas amount required by hydrogenation of tar are not taken into consideration. The above-mentioned patent has its limitations in that it either provides a high coal tar yield but low coal gas amount, or provides a high gas yield but low coal tar yield, but cannot satisfy both requirements.

### SUMMARY

**[0004]** . In view of this, an object of the present disclosure is to provide a coal pyrolysis process device in response to the disadvantages of the prior art, which can achieve high-efficient production of both gas and coal tar.

**[0005]** . In order to solve the above technical problem, the following technical solution is adopted in the present disclosure: a coal pyrolysis process device, comprising a primary coal pyrolysis device and a secondary coal pyrolysis device, wherein the primary coal pyrolysis device is a coal decomposition apparatus which is in form of a rotary kiln radiant tube and of heating type, and the primary coal pyrolysis device comprises a primary feed port, a primary discharge port, a primary coal gas outlet, and a heating mechanism in form of a primary radiant tube;

the secondary coal pyrolysis device comprises a secondary feed port, a secondary discharge port, a secondary coal gas outlet, and a secondary heating mechanism;

the primary discharge port communicates with the secondary feed port, coal tar is maximally extracted from coal in the primary coal pyrolysis device and then the coal is introduced into the secondary coal pyrolysis device, and the coal continues to be heated up and pyrolyzed at an upper portion of the secondary coal pyrolysis device, so that volatile matter of the upgraded coal upgraded by the primary pyrolysis is further reduced in the secondary coal pyrolysis device, and more coal gas is produced.

**[0006]** . The secondary coal pyrolysis device is a coal decomposition apparatus which is in form of a rotary kiln radiant tube and of heating type or a coal decomposition apparatus of a shaft kiln heat exchange type.

**[0007]** . The coal pyrolysis process device further comprises a coal drying device disposed upstream of the primary coal pyrolysis device, and the dried coal is introduced into the primary coal pyrolysis device.

**[0008]** . The coal pyrolysis process device further comprises a deduster disposed at the primary coal gas outlet and a deduster disposed at the secondary coal gas outlet, and the deduster is a cyclone deduster or gravity deduster or a high temperature membrane filter having a filter element coated with a membrane at its surface.

**[0009]** . Output of the primary coal gas outlet and output of the secondary coal gas outlet are mixed together and enter the high temperature membrane filter.

**[0010]** . Output of the primary coal gas outlet and Output of the secondary coal gas outlet are mixed together, and firstly pass through the cyclone deduster or gravity deduster and then enter the high temperature membrane filter.

**[0011]** . The primary coal gas outlet leads to a first membrane filter, and the secondary coal gas outlet leads to a second membrane filter.

**[0012]** . Output of the primary coal gas outlet passes through a first cyclone deduster or gravity deduster and then enters a first membrane filter, and output of the sec-

ondary coal gas outlet passes through a second cyclone deduster or gravity deduster and enters a second membrane filter.

**[0013]** . The present disclosure has the advantage that when coal is placed in the primary coal pyrolysis device, the tar yield reaches the maximum value, and the primary upgraded coal which still has a relatively high amount of volatile matter is introduced into the secondary coal pyrolysis device in a hot state and continues to be heated up and pyrolyzed, such that upgraded coal with a lower amount of volatile matter is produced, and at the same time more coal gas is additionally produced. The coal gas produced by secondary pyrolysis contains more amount of CO and H2, and CO can be converted into H2 via coal gas, such that sufficient H2 source can be provided for hydrogenation of coal tar, and the cost of hydrogenation of coal tar is effectively reduced.

**[0014]** . The drying device is added to contribute to reduction of energy consumption in coal pyrolysis; and the filter is added in order to filter out and remove dust from coal gas containing dust and containing tar before separation of oil and gas to ensure the cleanliness of oil and gas so as to establish a good foundation for subsequent treatments of oil and gas.

## BRIEF DESCRIPTION OF DRAWINGS

**[0015]** . FIG. 1 is a schematic structural view of a first embodiment of the present disclosure;

FIG. 2 is a schematic structural view of a second embodiment of the present disclosure;
FIG. 3 is a schematic structural view of a third embodiment of the present disclosure; and
FIG. 4 is a schematic structural view of a fourth embodiment of the present disclosure.

## DETAILED DESCRIPTION OF EMBODIMENTS

**[0016]** . In order to make the objects, technical solutions and advantages of the embodiments of the present disclosure clearer, the technical solutions of the embodiments of the present disclosure will be described below clearly and completely with reference to FIGS. 1-4 of the embodiments of the present disclosure. It is apparent that the embodiments to be described are some, but not all of the embodiments of the present disclosure. All the other embodiments obtained by those of ordinary skill in the art in light of the described embodiments of the present disclosure will fall within the scope of the present disclosure as claimed.

**[0017]** . First Embodiment: As shown in FIG. 1, a coal pyrolysis process device comprises a primary coal pyrolysis device 1 and a secondary coal pyrolysis device 2, wherein the primary coal pyrolysis device 1 is a coal decomposition apparatus which is in form of a rotary kiln radiant tube and of heating type, and the primary coal pyrolysis device 1 comprises a primary feed port 11, a primary discharge port 12, a primary coal gas outlet 13, and a heating mechanism in form of a primary radiant tube 14;

the secondary coal pyrolysis device 2 comprises a secondary feed port 21, a secondary discharge port 22, a secondary coal gas outlet 23, and a secondary heating mechanism 24;

the primary discharge port 12 communicates with the secondary feed port 21, coal tar is maximally extracted from coal in the primary coal pyrolysis device 1 and then the coal is introduced into the secondary coal pyrolysis device 2, and the coal continues to be heated up and pyrolyzed at an upper portion of the secondary coal pyrolysis device 2, so that volatile matter of the upgraded coal upgraded by the primary pyrolysis is further reduced in the secondary coal pyrolysis device 2, and more coal gas is produced.

**[0018]** . The secondary coal pyrolysis device 2 is a coal decomposition apparatus which is in form of a rotary kiln radiant tube and of heating type.

**[0019]** . The coal pyrolysis process device further comprises a coal drying device 3 disposed upstream of the primary coal pyrolysis device 1, and the dried coal is introduced into the primary coal pyrolysis device 1.

**[0020]** . The primary coal gas outlet and the secondary coal gas outlet lead to a high temperature membrane filter 5.

**[0021]** . Second Embodiment: As shown in FIG. 2, a coal pyrolysis process device comprises a primary coal pyrolysis device 1 and a secondary coal pyrolysis device 2, wherein the primary coal pyrolysis device 1 is a coal decomposition apparatus which is in form of a rotary kiln radiant tube and of heating type, and the primary coal pyrolysis device 1 comprises a primary feed port 11, a primary discharge port 12, a primary coal gas outlet 13, and a heating mechanism in form of a primary radiant tube 14;

the secondary coal pyrolysis device 2 comprises a secondary feed port 21, a secondary discharge port 22, a secondary coal gas outlet 23, and a secondary heating mechanism 24;

the primary discharge port 12 communicates with the secondary feed port 21, coal tar is maximally extracted from coal in the primary coal pyrolysis device 1 and then the coal is introduced into the secondary coal pyrolysis device 2, and the coal continues to be heated up and pyrolyzed at an upper portion of the secondary coal pyrolysis device 2, so that volatile matter of the upgraded coal upgraded by the primary pyrolysis is further reduced in the secondary coal pyrolysis device 2, and more coal gas is produced.

**[0022]** . The secondary coal pyrolysis device 2 is a coal decomposition apparatus which is in form of a rotary kiln radiant tube and of heating type.

**[0023]** . The coal pyrolysis process device further comprises a coal drying device 3 disposed upstream of the primary coal pyrolysis device 1, and the dried coal is introduced into the primary coal pyrolysis device 1.

**[0024]** . The primary coal gas outlet 13 and the secondary coal gas outlet 23 converge through a cyclone deduster or gravity deduster 4 and then into the high temperature membrane filter 5.

**[0025]** . Third Embodiment: As shown in FIG. 3, a coal pyrolysis process device comprises a primary coal pyrolysis device 1 and a secondary coal pyrolysis device 2, wherein the primary coal pyrolysis device 1 is a coal decomposition apparatus which is in form of a rotary kiln radiant tube and of heating type, and the primary coal pyrolysis device 1 comprises a primary feed port 11, a primary discharge port 12, a primary coal gas outlet 13, and a heating mechanism in form of a primary radiant tube 14;

the secondary coal pyrolysis device 2 comprises a secondary feed port 21, a secondary discharge port 22, a secondary coal gas outlet 23, and a secondary heating mechanism 24;

the primary discharge port 12 communicates with the secondary feed port 21, coal tar is maximally extracted from coal in the primary coal pyrolysis device 1 and then the coal is introduced into the secondary coal pyrolysis device 2, and the coal continues to be heated up and pyrolyzed at an upper portion of the secondary coal pyrolysis device 2, so that volatile matter of the upgraded coal upgraded by the primary pyrolysis is further reduced in the secondary coal pyrolysis device 2, and more coal gas is produced.

**[0026]** . The secondary coal pyrolysis device 2 is a coal decomposition apparatus of a shaft kiln heat exchange type.

**[0027]** . The coal pyrolysis process device further comprises a coal drying device 3 disposed upstream of the primary coal pyrolysis device 1, and the dried coal is introduced into the primary coal pyrolysis device 1.

**[0028]** . The primary coal gas outlet 13 leads to a first membrane filter 51, and the secondary coal gas outlet 23 leads to a second membrane filter 52.

**[0029]** . Fourth Embodiment: As shown in FIG. 4, a coal pyrolysis process device comprises a primary coal pyrolysis device 1 and a secondary coal pyrolysis device 2, wherein the primary coal pyrolysis device 1 is a coal decomposition apparatus which is in form of a rotary kiln radiant tube and of heating type, and the primary coal pyrolysis device 1 comprises a primary feed port 11, a primary discharge port 12, a primary coal gas outlet 13, and a heating mechanism in form of a primary radiant tube 14;

the secondary coal pyrolysis device 2 comprises a secondary feed port 21, a secondary discharge port 22, a secondary coal gas outlet 23, and a secondary heating mechanism 24;

the primary discharge port 12 communicates with the secondary feed port 21, coal tar is maximally extracted from coal in the primary coal pyrolysis device 1 and then the coal is introduced into the secondary coal pyrolysis device 2, and the coal continues to be heated up and pyrolyzed at an upper portion of the secondary coal pyrolysis device 2, so that volatile matter of the upgraded coal upgraded by the primary pyrolysis is further reduced in the secondary coal pyrolysis device 2, and more coal gas is produced.

**[0030]** . The secondary coal pyrolysis device 2 is a coal decomposition apparatus of a shaft kiln heat exchange type.

**[0031]** . The coal pyrolysis process device further comprises a coal drying device 3 disposed upstream of the primary coal pyrolysis device 1, and the dried coal is introduced into the primary coal pyrolysis device 1.

**[0032]** . The primary coal gas outlet 13 leads to a first membrane filter 51, and the secondary coal gas outlet 23 leads to a second membrane filter 52.

**[0033]** . Output of the primary coal gas outlet 13 passes through a first cyclone deduster or gravity deduster 41 and then enters a first membrane filter 51, and output of the secondary coal gas outlet 23 passes through a second cyclone deduster or gravity deduster 42 and enters a second membrane filter 52..

**[0034]** . The above description is illustrative of preferred embodiments of the present disclosure, and it should be noted that several improvements and modifications can be made by those of ordinary skill in the art without departing from the principles described in the present disclosure, and these improvements and modifications should also be considered to fall within the scope of protection of the present disclosure.

## Claims

1. A coal pyrolysis process device, comprising a primary coal pyrolysis device and a secondary coal pyrolysis device, **characterized in that** the primary coal pyrolysis device is a coal decomposition apparatus which is in form of a rotary kiln radiant tube and of heating type;

   the primary coal pyrolysis device comprises a primary feed port, a primary discharge port, a primary coal gas outlet, and a heating mechanism in form of a primary radiant tube;

   the secondary coal pyrolysis device comprises a secondary feed port, a secondary discharge port, a secondary coal gas outlet, and a secondary heating mechanism;

   the primary discharge port communicates with the secondary feed port, coal tar is maximally extracted from coal in the primary coal pyrolysis device and then the coal is introduced into the secondary coal pyrolysis device, and the coal continues to be heated up and pyrolyzed at an upper portion of the secondary coal pyrolysis device, so that volatile matter of upgraded coal upgraded by a primary pyrolysis is further reduced in the secondary coal pyrolysis device, and more coal gas is produced.

2. The coal pyrolysis process device according to claim 1, wherein the secondary coal pyrolysis device is a coal decomposition apparatus which is in form of a rotary kiln radiant tube and of heating type or a coal decomposition apparatus of a shaft kiln heat exchange type.

3. The coal pyrolysis process device according to claim 1, wherein the coal pyrolysis process device further comprises a coal drying device disposed upstream of the primary coal pyrolysis device, and dried coal is introduced into the primary coal pyrolysis device.

4. The coal pyrolysis process device according to claim 1, wherein the coal pyrolysis process device further comprises a deduster disposed at the primary coal gas outlet and a deduster disposed at the secondary coal gas outlet, and the deduster is a cyclone deduster or gravity deduster or a high temperature membrane filter having a filter element coated with a membrane at its surface.

5. The coal pyrolysis process device according to claim 4, wherein output of the primary coal gas outlet and output of the secondary coal gas outlet are mixed together and enter the high temperature membrane filter.

6. The coal pyrolysis process device according to claim 4, wherein output of the primary coal gas outlet and output of the secondary coal gas outlet are mixed together, and firstly pass through the cyclone deduster or the gravity deduster and then enter the high temperature membrane filter.

7. The coal pyrolysis process device according to claim 4, wherein the primary coal gas outlet leads to a first membrane filter, and the secondary coal gas outlet leads to a second membrane filter.

8. The coal pyrolysis process device according to claim 4, wherein output of the primary coal gas outlet passes through a first cyclone deduster or gravity deduster and then enters a first membrane filter, and output of the secondary coal gas outlet passes through a second cyclone deduster or gravity deduster and enters a second membrane filter.

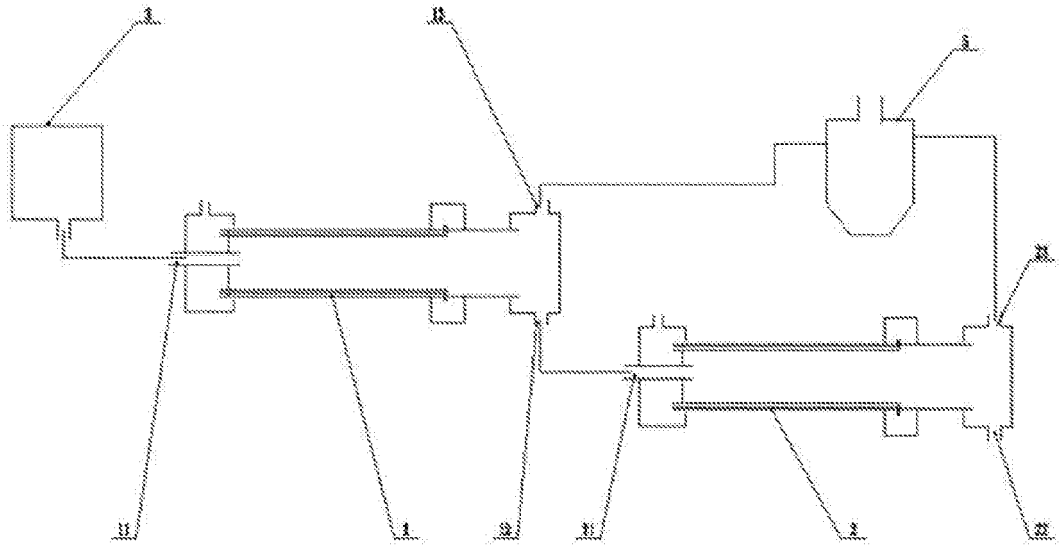

FIG. 1

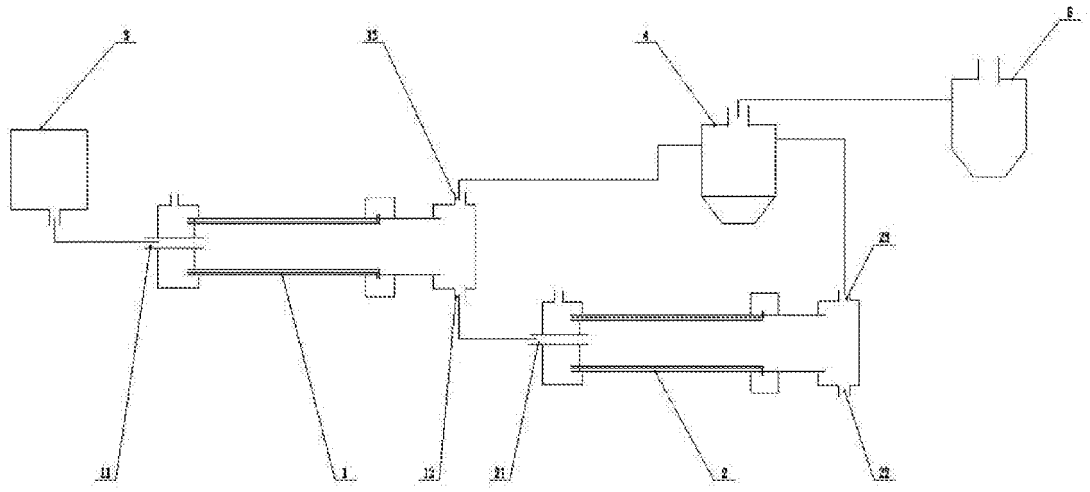

FIG. 2

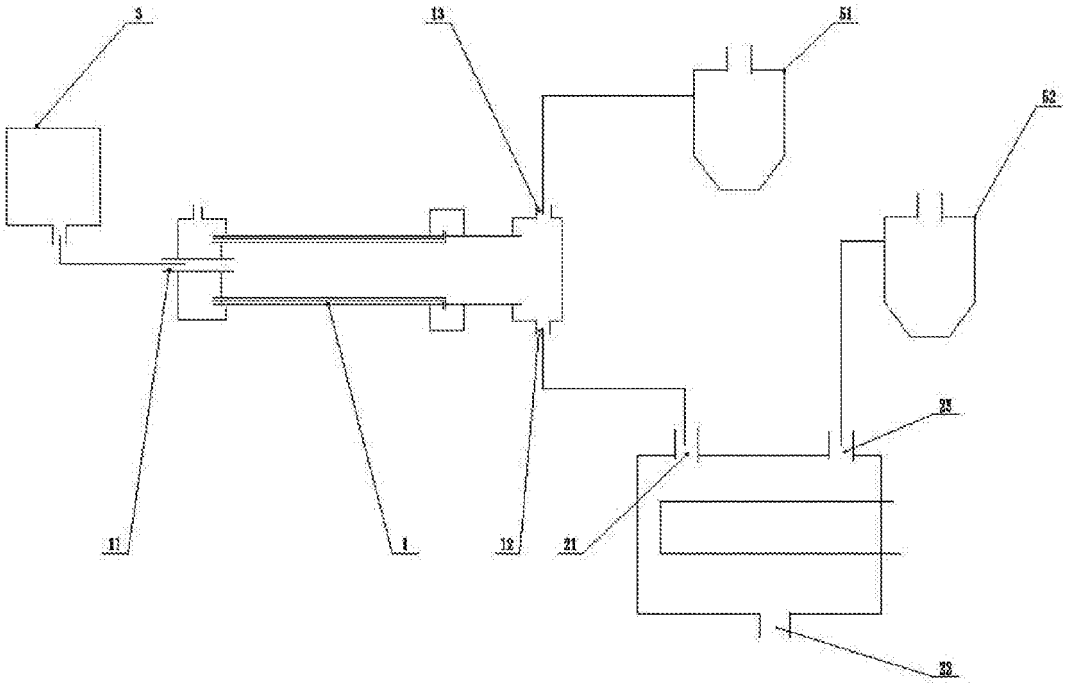


FIG. 3

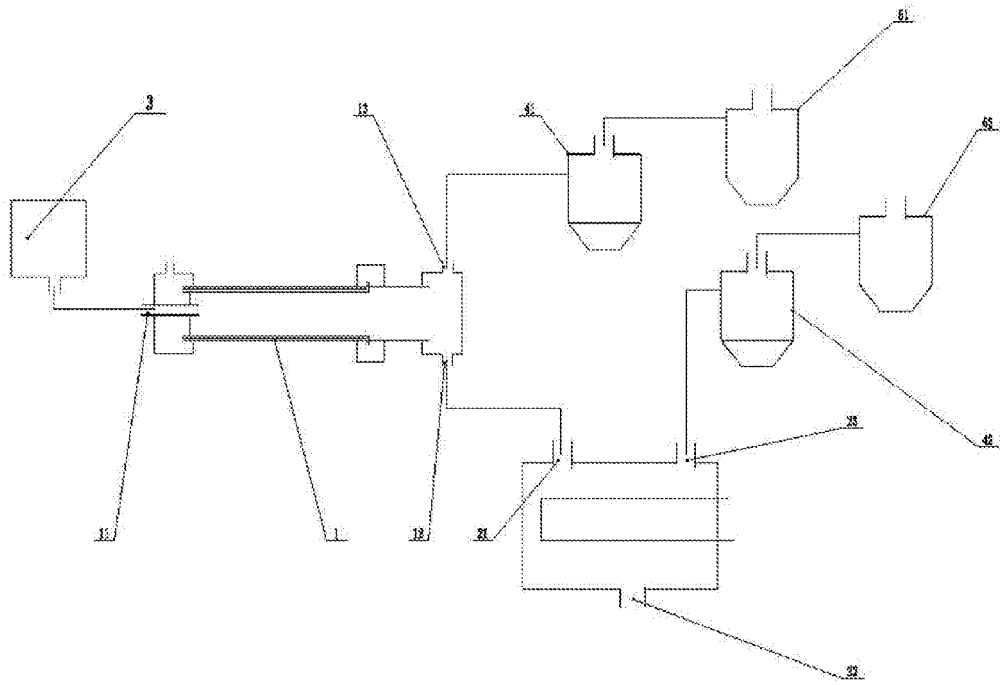


FIG. 4

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/114976

**A. CLASSIFICATION OF SUBJECT MATTER**

C10J 3/00 (2006.01) i; C10J 3/84 (2006.01) i; C10G 1/00 (2006.01) i
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C10J 3/-, C10G 1/-

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)

CNABS, CNKI, VEN, ISI Web of Knowledge: 煤, 热解, 热交换, 回转窑, 辐射管, 多级, 一级, 二级, coal, pyrolysis, heat exchang+, volatile, ratiant tube, first, second+, grade

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| PX | CN 107033963 A (HENAN LONGCHENG COAL EFFICIENT TECHNOLOGY APPLICATION CO., LTD. et al.), 11 August 2017 (11.08.2017), description, paragraphs 17-24 | 1-8 |
| X | CN 104610989 A (SHENHUA GROUP CORPORATION LIMITED et al.), 13 May 2015 (13.05.2015), description, paragraphs 16, 32 and 36, and figure 2 | 1-8 |
| A | CN 106833753 A (WANG, Shukuan), 13 June 2017 (13.06.2017), entire description | 1-8 |
| A | US 2012066974 A1 (JORGENSON, R. et al.), 22 March 2012 (22.03.2012), entire description | 1-8 |

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

* Special categories of cited documents:

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 01 March 2018 | 14 March 2018 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| State Intellectual Property Office of the P. R. China<br>No. 6, Xitucheng Road, Jimenqiao<br>Haidian District, Beijing 100088, China<br>Facsimile No. (86-10) 62019451 | WANG, Zuyuan<br>Telephone No. (86-10) 62084691 |

Form PCT/ISA/210 (second sheet) (July 2009)

# INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2017/114976

| Patent Documents referred in the Report | Publication Date | Patent Family | Publication Date |
|---|---|---|---|
| CN 107033963 A | 11 August 2017 | None | |
| CN 104610989 A | 13 May 2015 | CN 104610989 B | 31 May 2017 |
| CN 106833753 A | 13 June 2017 | None | |
| US 2012066974 A1 | 22 March 2012 | None | |

Form PCT/ISA/210 (patent family annex) (July 2009)

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


- CN 201010262786 **[0002]**
- CN 101985558 **[0002]**