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(54) **BURNER**

(75) Inventor: **Ib Ohlsen**, Gentofte (DK)

(73) Assignee: **FL SMITH A/S**, Valby (DK)

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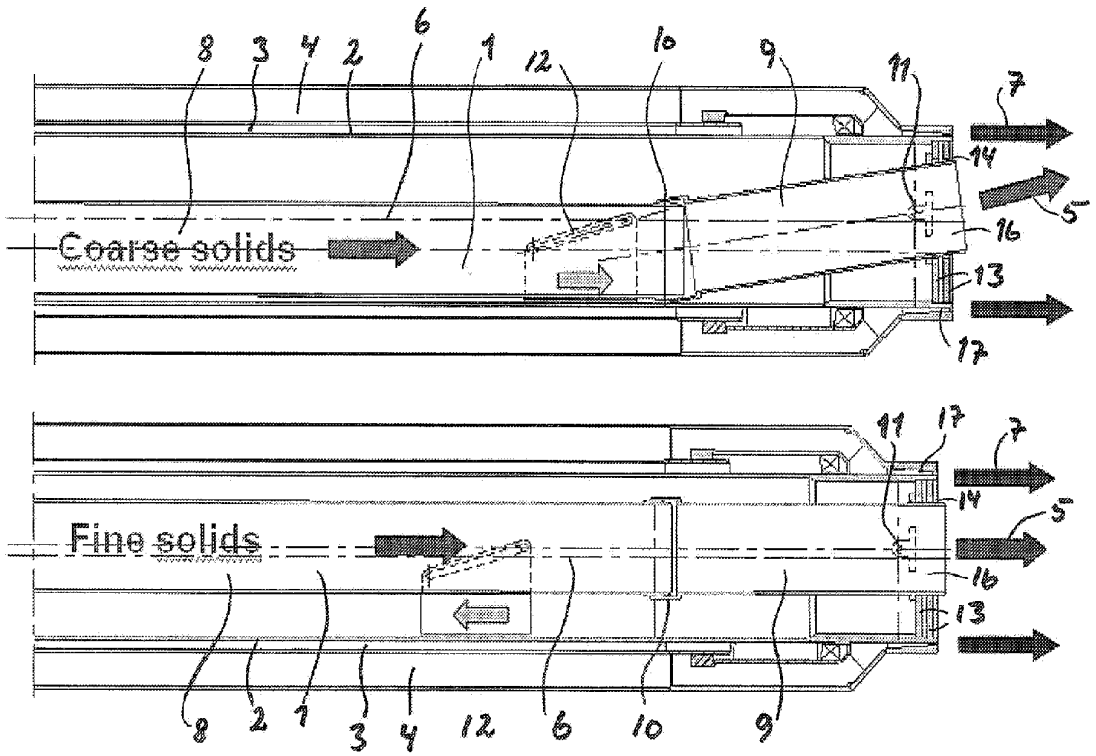
(57) **ABSTRACT**

A burner for introducing solid particulate fuel to a burning zone of a kiln such as a rotary kiln for manufacturing cement clinker or similar material includes a centrally located duct for conducting solid fuel to an inlet opening and at least one duct for conducting primary air to one or more annular nozzles surrounding the inlet opening of the centrally located duct. The centrally located duct for conducting solid fuel is arranged so that the direction of introduction of the fuel relative to the longitudinal axis of the burner and consequently the direction of introduction of the primary air may be adjusted continuously during operation of the burner.



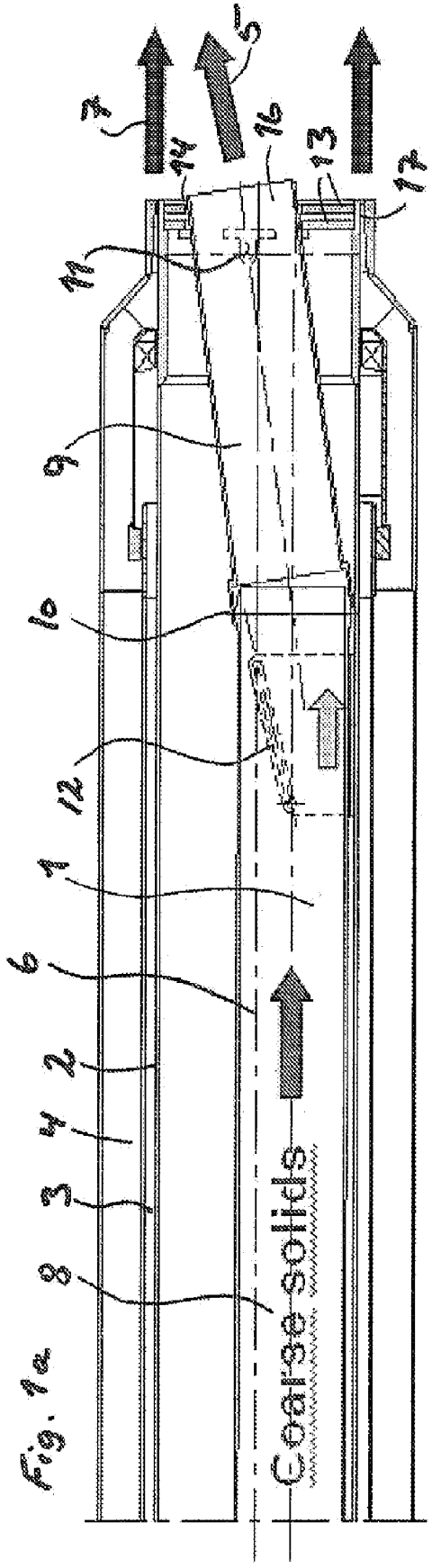
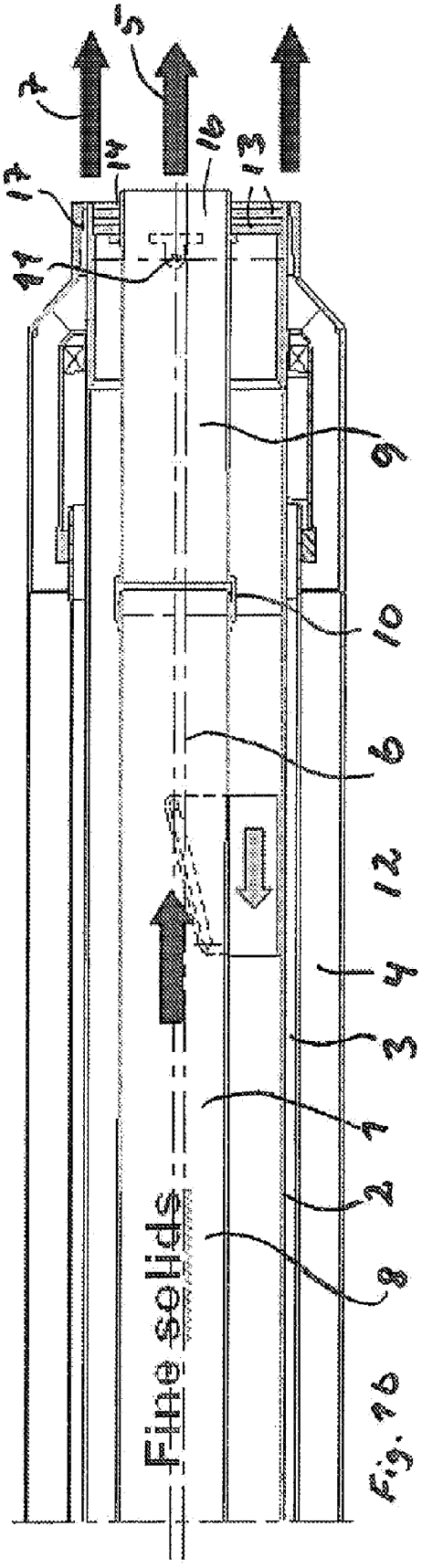

7
5'
14
16
13
17
11
9
10
12
1
6
2
4
3
8
Coarse solids

Fig. 1a


7
5'
14
16
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11
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12
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1
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Fine solids

Fig. 1b

BURNER

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is the United States national stage under 35 U.S.C. §371 of International Application No. PCT/IB2010/051800, filed on Apr. 23, 2010, which claimed priority to Danish Patent Application No. PA 2009 00528, filed on Apr. 24, 2009. The entirety of these applications is incorporated by reference herein.

FIELD OF THE INVENTION

[0002] The present invention relates to a burner for introducing solid particulate fuel to a burning zone of a kiln such as a rotary kiln for manufacturing cement clinker or similar type of material. In some embodiments, the burner may comprise a centrally located duct for conducting solid fuel to an inlet opening and at least one duct for conducting primary air to one or more annular nozzles surrounding the inlet opening of the centrally located duct.

BACKGROUND OF THE INVENTION

[0003] Burners used to introduce solid particulate fuel to a burning zone of a kiln are well-known. Normally, the central duct for conveying solid fuel in these known burners is configured as one single piece of a long pipe, the extent of which typically runs parallel and concentric to the longitudinal axis of the burner so that the fuel is introduced to the burning zone in a direction parallel to the longitudinal axis of the burner and consequently also to the surrounding primary air. Experiments conducted by the applicant of this patent application with different types of solid fuel with different particle sizes, forms and densities proved that the optimum fuel burnout will not always take place when using parallel introduction. Thus it transpired that fine-grained fuels such as coal meal achieve the best burnout when introduced parallel to the longitudinal axis of the burner, whilst coarse-grained fuels such as various types of alternative fuel, including e.g. plastics, paper, rubber and wood chips, achieve the best burnout when entered at an upward angle to the longitudinal axis of the burner. Attempts have been made to meet the various requirements of the range of solid fuels as regards i.a. the direction of introduction by configuring the burner with more ducts for the introduction of various solid fuel types, see e.g. International Publication No. WO 2008/065554 owned by the assignee of this patent application, the entirety of International Publication No. WO 2008/065554 is incorporated by reference herein. The disadvantage of a burner with several ducts for the introduction of solid fuels is the fact that the quantity of transport air is increased as the number of ducts increase, and the quantity of transport air is therefore relatively large, which is undesirable as it increases both fuel requirements and the cost of the burner as the number of ducts increase. Therefore none of the known burners are configured optimally as regards the operational as well as the financial aspects when they are intended for the introduction of various types of solid particulate fuels.

SUMMARY OF THE INVENTION

[0004] It is the objective of the present invention to provide a burner by means of which the aforementioned disadvantages are reduced.

[0005] According to the invention, this is achieved by a burner of the kind mentioned in the field of invention section and characterized in that the centrally located duct for conducting solid fuel is arranged so that the direction of introduction of the fuel relative to the longitudinal axis of the burner and consequently the direction of introduction of the primary air may be adjusted continuously during operation of the burner.

[0006] Hereby is obtained a burner with which different types of solid particulate fuels and mixtures thereof may be introduced via one and the same duct to the burning zone of a kiln so that the quantity of transport air and the cost of the burner are reduced. This is because the direction of introduction of the solid fuel relative to the longitudinal axis of the burner and consequently the direction of introduction of the primary air may be adjusted to the optimal direction for the solid fuels introduced at any time notwithstanding the type or mixing ratio of these so as to avoid burnout of the burner lining and at the same time achieving a longer introduction path for the fuel.

[0007] In principle, the centrally located duct for conducting solid fuels may be designed in any way which enables the continuous adjustment of the direction of introduction of the fuel relative to the longitudinal axis of the burner during its operation. E.g. the duct may be configured as a long pipe which at a point along its length is pivotally suspended from a hinge, and which is connected to a mechanism for rotating the pipe suspended from the hinge up and down in a vertical plane. Such a mechanism may be considered a solid particulate fuel flow adjustment mechanism. As mentioned in the field of invention section, the solid fuel duct or pipe is surrounded by at least one annular duct, the inner pipe of which defines a pressurised chamber, which by at least one plate is blanked off at the inlet end of the burner, said plate being provided with an opening for the leading through of the solid fuel duct. For the purposes of limiting the size of the opening and thus the gap between the solid fuel duct and the opening as much as possible, it is preferred that the solid fuel duct is pivotally suspended from a hinge, which is placed immediately next to the opening. If necessary, the gap may be sealed using appropriate flexible sealants. In a variation of the burner according to the invention, the pressurised chamber mentioned above is not demarcated from the inner duct for the injection of primary air, but forms a part thereof.

[0008] Burners of the aforementioned type are usually approximately ten meters long, and the achievable change to the direction of introduction of the solid fuel would therefore be limited to a very narrow interval if the solid fuel duct consists of a long, non-flexible pipe. It is therefore preferred that the solid fuel duct is configured of at least two parts being connected to each other by means of a flexible connection, such as a resilient hose made of, for instance, reinforced rubber, a ball joint or similar. The connection between the two parts of the duct does not need to be air-tight as it is preferred to maintain the pressure outside the duct at a higher level than the pressure in the solid fuel duct. The shorter the part of the duct closest to the inlet end of the burner is, the greater is the achievable change to the direction of introduction of the solid fuel, which should be possible to be varied within a range between 0° to 30°, preferably between 0° and 15° and most preferably between 0° and 10° relative to the longitudinal axis of the burner.

[0009] Alternatively, the duct may be formed in full or in part of a flexible hose, such as a reinforced rubber hose, which

may be moved using a suitable mechanism between the two extreme positions as regards adjustment of the direction of fuel introduction.

[0010] According to the invention, the burner may include additional ducts for the introduction of other types of fuel, such as oil and gas.

[0011] Other details, objects, and advantages of the invention will become apparent as the following description of certain present preferred embodiments thereof and certain present preferred methods of practicing the same proceeds.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The invention will now be described in further details with reference to the drawing, being diagrammatical, and where

[0013] FIG. **1***a* shows a cross-section of the inlet end of a burner according to the invention, which is set for the introduction of coarse-grained solid fuel, and

[0014] FIG. **1***b* shows the same burner set for the introduction of fine-grained solid fuel.

DETAILED DESCRIPTION OF PRESENT PREFERRED EMBODIMENTS

[0015] FIGS. **1***a* and **1***b* depict a burner meant for the introduction of various types of solid particulate fuels to the burning zone of a kiln. The burner comprises a centrally located duct **1** for conducting solid fuel to an inlet opening **16** and two annular, concentric ducts **3**, **4** for conducting primary air to an annular nozzle **17**, which ducts **3**, **4** and nozzle **17** surround the central fuel duct **1** and the inlet opening **16** respectively. The solid fuel duct **1** is surrounded by the annular duct **3**, the inner pipe **2** of which defines a pressurised chamber **15**, which at the inlet end of the burner is blanked off by two plates **13**, which are provided with an opening **14** for the leading through of the solid fuel duct **1**.

[0016] In order to be able to introduce various types of solid fuels with different particle sizes, forms and densities as well as combinations thereof in an optimum manner via one and the same duct **1** to the burning zone of a kiln so that the quantity of transport air and the cost of the burner may be reduced, the duct **1** for conducting solid fuels is arranged so that the direction **5** of introduction of the fuel relative to the longitudinal axis **6** of the burner and consequently the direction of introduction of the primary air may be adjusted continuously during operation of the burner.

[0017] Thus the burner may be set to take into account the fact that fine-grained fuels, such as coal meal, achieve the best burnout when introduced parallel to the longitudinal axis of the burner, as shown in FIG. **1***b*, whilst coarse-grained fuels, such as various types of alternative fuel, including i.a. plastics, paper, rubber and wood chips, achieve the best burnout when introduced at an upward angle to the longitudinal axis of the burner, as shown in FIG. **1***a*. In other words, the direction **5** of introduction of the solid fuel relative to the longitudinal axis **6** of the burner and consequently the direction **7** of introduction of the primary air may be adjusted to the optimum direction for the solid fuels introduced at any time notwithstanding the type or mixing ratio of these.

[0018] In the illustrated embodiment of the burner, the solid fuel duct **1** comprises two duct parts **8** and **9** which are connected to each other by means of a suitable connection **10**, such as a flexible hose or a ball joint. The duct part **9** is pivotally suspended from a hinge **11** placed immediately next to the opening **14** and may be rotated vertically up and down via a mechanism **12** connected to the duct part **8**, consequently altering the direction **5** of introduction of the fuel. The shorter the duct part **9** closest to the inlet end of the burner is, the greater is the achievable change to the direction **5** of introduction of the solid fuel, which may range between 0° and 30°, and may preferably range between 0° and 10° relative to the longitudinal axis of the burner.

[0019] It should be appreciated that embodiments of the burner permit different types of solid particulate fuels and mixtures thereof to be introduced via one and the same duct to the burning zone of a kiln so that the quantity of transport air and the cost of the burner are reduced. This is because the direction of introduction of the solid fuel relative to the longitudinal axis of the burner and consequently the direction of introduction of the primary air may be adjusted to the optimal direction for the solid fuels introduced at any time notwithstanding the type or mixing ratio of these so as to avoid burnout of the burner lining and at the same time achieving a longer introduction path for the fuel.

[0020] While certain present preferred embodiments of the burner and certain embodiments of methods of practicing the same have been shown and described, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims.

1. A burner for introducing solid particulate fuel to a burning zone of a kiln comprising:
- a centrally located duct for conducting solid fuel to an inlet opening of the kiln;
- at least one duct for conducting primary air to at least one annular nozzle surrounding the inlet opening;
- the centrally located duct being arranged so that a direction of introduction of the solid fuel relative to a longitudinal axis of the burner and a direction of introduction of air is continuously adjustable during operation of the burner.

2. The burner of claim **1** wherein the solid fuel duct is pivotally suspended from a hinge that is placed adjacent to an opening at the inlet end of the burner and wherein the burner further comprises a duct movement mechanism for rotating a portion of the centrally located duct up and down in a vertical plane.

3. The burner of claim **1** wherein the centrally located duct has at least two parts connected to each other via a connection mechanism.

4. The burner of claim **1** wherein one duct part of the centrally located duct is pivotally suspended from a hinge placed adjacent to an opening at the inlet end of the burner and wherein the burner also comprises a mechanism for rotating the one duct part up and down in a vertical plane.

5. The burner of claim **1** wherein the direction of introduction of the solid fuel via the centrally located duct can be varied within an interval of between one of: 0° and 30°, 0° and 15° and 0° and 10° relative to the longitudinal axis of the burner.

6. The burner of claim **1** wherein the centrally located duct fully or partly consists of a flexible hose or a reinforced rubber hose.

7. A burner for feeding solid particulate fuel to a burning zone of a kiln, the burner having a length defining a longitudinal axis of the burner, the burner comprising:
- a feed duct for feeding the solid particulate fuel to an inlet opening of the kiln;

at least one annular nozzle surrounding the inlet opening of the kiln;

at least one duct for conducting at least one gas to the at least one annular nozzle; and

a solid particulate fuel flow adjustment mechanism connected to the central duct, the solid particulate fuel flow adjustment mechanism being moveable to adjust a direction of flow along which the solid particulate fuel moves through the inlet opening.

8. The burner of claim **7** wherein the direction of flow is adjustable from a first direction that is parallel to the longitudinal axis of the burner to a second direction that is angled 10°, 15°, or 30° relative to the longitudinal axis of the burner.

9. The burner of claim **7** wherein the feed duct is a flexible hose.

10. The burner of claim **7** wherein the feed duct is comprised of a first duct part connected to a second duct part, the second duct part being between the inlet opening and the first duct part.

11. The burner of claim **10** further comprising a moveable connection connecting the second duct part to the first duct part such that the second duct part is moveable relative to the first duct part.

12. The burner of claim **11** wherein the moveable connection is a ball joint or a flexible hose.

13. The burner of claim **11** wherein the solid particulate fuel flow adjustment mechanism comprises:

a hinge attached to the second duct part adjacent to the inlet opening and an opening of the central duct through which the solid particulate fuel passes to be fed to the burning zone of the kiln via the inlet opening; and

a duct movement mechanism connected to the first duct part, the duct movement mechanism driving movement of the second duct part about the hinge to adjust the direction of flow along which the solid particulate fuel moves through the inlet opening.

14. The burner of claim **11** wherein the solid particulate fuel flow adjustment mechanism comprises:

a connector attached to the second duct part adjacent to the inlet opening and an opening of the central duct through which the solid particulate fuel passes to be fed to the burning zone of the kiln via the inlet opening; and

a duct movement mechanism connected to the first duct part, the duct movement mechanism driving movement of the second duct part about the connector to adjust an angle at which the second duct part extends from the first duct part to adjust the direction of flow along which the solid particulate fuel moves through the inlet opening.

15. The burner of claim **14** wherein the connector is a hinge and the moveable connection is a ball joint or a flexible hose.

16. The burner of claim **14** wherein the angle at which the second duct part extends from the first duct part is adjustable from 0° relative to the longitudinal axis of the burner to an angle of between 10° and 30° relative to the longitudinal axis of the burner.

17. The burner of claim **16** wherein the second duct part extends from the first duct part at the 0° angle when the solid particulate fuel is fine and wherein the second duct part extends from the first duct part at the angle of between 10° and 30° relative to the longitudinal axis of the burner when the solid particulate fuel is coarse.

18. The burner of claim **13** wherein the direction of flow along which the solid particulate fuel moves through the inlet opening is adjustable from a flow direction along which the solid particulate fuel moves through the inlet opening at an angle of 0° relative to the longitudinal axis of the burner to a flow direction along which the solid particulate fuel moves through the inlet opening at an angle of between 10° and 30° relative to the longitudinal axis of the burner.

19. The burner of claim **18** wherein the wherein the solid particulate fuel moves at the angle of 0° relative to the longitudinal axis of the burner when the solid particulate fuel is fine and the solid particulate fuel moves in a direction of flow at the angle of between 10° and 30° relative to the longitudinal axis of the burner when the solid particulate fuel is coarse.

20. The burner of claim **7** wherein the solid particulate fuel flow adjustment mechanism is moveable to adjust a direction of flow along which the solid particulate fuel moves through the inlet opening to provide a continuous adjustability of the direction of flow during operation of the burner.

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