



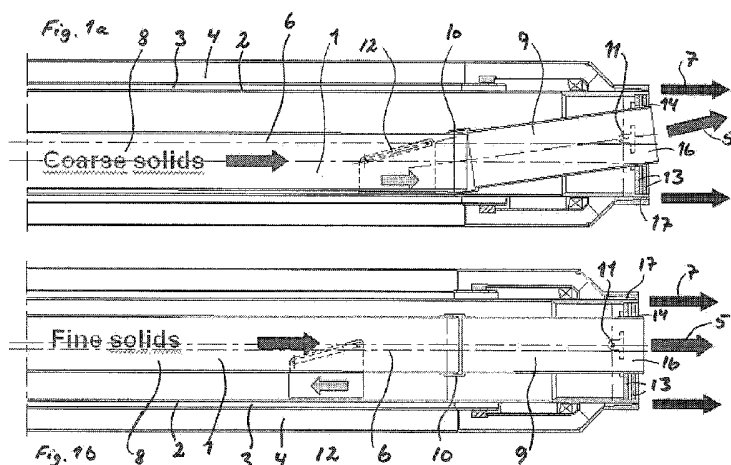
- (51) International Patent Classification:  
F23D 1/04 (2006.01)
- (21) International Application Number:  
PCT/IB2010/051800
- (22) International Filing Date:  
23 April 2010 (23.04.2010)
- (25) Filing Language:  
English
- (26) Publication Language:  
English
- (30) Priority Data:  
PA200900528 24 April 2009 (24.04.2009) DK
- (71) Applicant (for all designated States except US):  
FLSMIDTH A/S [DK/DK]; 77 Vigerslev Alle, DK-2500 Valby (DK).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): OHLSEN, Ib [DK/DK]; Liljevej 15, DK-2820 Gentofte (DK).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published: — with international search report (Art. 21(3))

(54) Title: A BURNER



(57) Abstract: This is a description of 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, said burner comprising a centrally located duct (1) for conducting solid fuel to an inlet opening (16) and at least one duct (3, 4) for conducting primary air to one or more annular nozzles (17) surrounding the inlet opening (16) of the centrally located duct (1). The particular aspect of the burner is the fact that the centrally located duct (1) for conducting solid fuel 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. 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.

## Description

### Title of Invention: A BURNER

- [1] 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, said burner comprising 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.
- [2] Burners of the aforementioned kind 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. WO 2008-065554 owned by the applicant of this patent application, the content of which patent is hereby claimed to be included 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.
- [3] It is the objective of the present invention to provide a burner by means of which the aforementioned disadvantages are reduced.
- [4] According to the invention, this is achieved by a burner of the kind mentioned in the introduction 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.

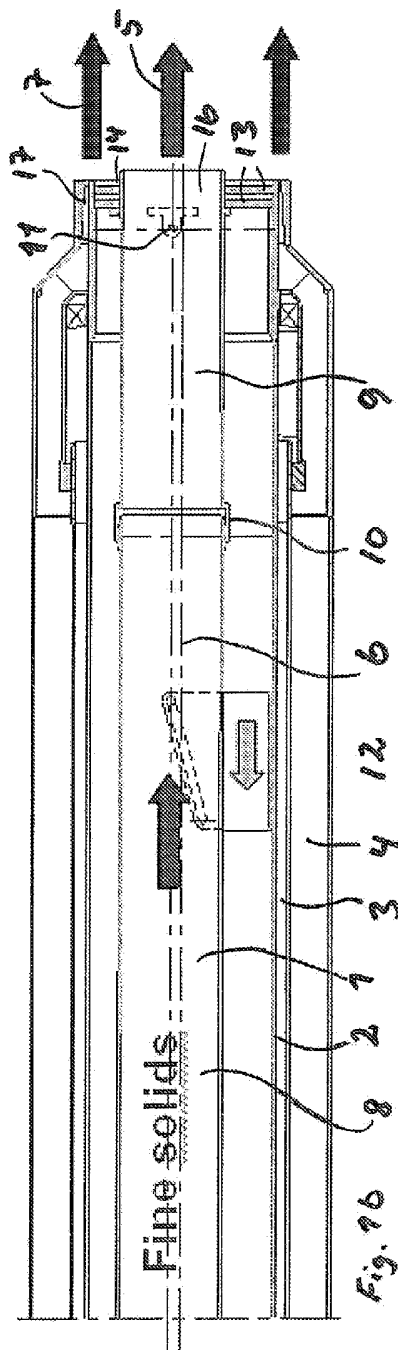
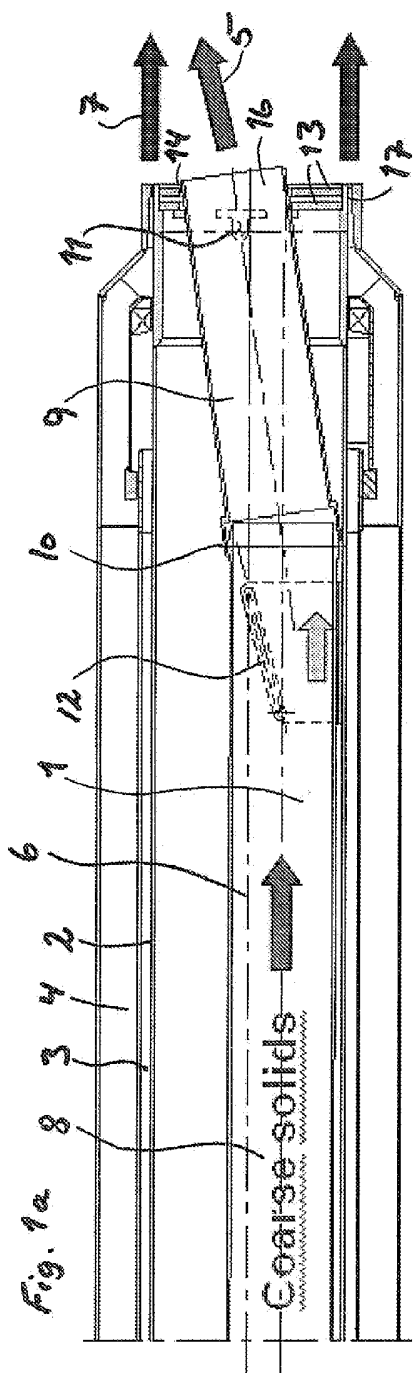
- [5] Hereby is obtained a burner with which different types of solid particulate fuels and mixtures thereof may be introduced via one and the same duct to the burning zone of a kiln so that the quantity of transport air and the cost of the burner are reduced. This is because the direction of introduction 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.
- [6] 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. As mentioned in the introduction, 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.
- [7] Burners of the aforementioned type are usually approximately ten metres 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.

- [8] 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.
- [9] According to the invention, the burner may include additional ducts for the introduction of other types of fuel, such as oil and gas.
- [10] The invention will now be described in further details with reference to the drawing, being diagrammatical, and where
- [11] Figure 1a 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
- [12] Figure 1b shows the same burner set for the introduction of fine-grained solid fuel.
- [13] Figures 1a and 1b 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.
- [14] 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.
- [15] 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 Figure 1b, 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 Figure 1a. 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.
- [16] In the illustrated 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 im-

mediately next to the opening 14 and may be rotated vertically up and down via a mechanism 12 connected to the duct part 8 in the current version, 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 should preferably range between 0° and 10° relative to the longitudinal axis of the burner.

## Claims

- [Claim 1] 1. Burner for introducing solid particulate fuel to a burning zone of a kiln, such as a rotary kiln for manufacturing cement clinker or similar, said burner comprising a centrally located duct (1) for conducting solid fuel to an inlet opening (16) and at least one duct (3, 4) for conducting primary air to one or more annular nozzles (17) surrounding the inlet opening (16) of the centrally located duct (1) **characterised in** that the centrally located duct (1) for conducting solid fuel 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.
- [Claim 2] 2. Burner according to claim 1 **characterised in** that the solid fuel duct (1) is pivotally suspended from a hinge (11) which is placed immediately next to an opening (14) at the inlet end of the burner and being connected to a mechanism (12) for rotating the duct (1) up and down in a vertical plane.
- [Claim 3] 3. Burner according to claims 1 or 2 **characterised in** that the solid fuel duct (1) is configured of at least two parts (8, 9) being connected to each other by means of a suitable connection (10).
- [Claim 4] 4. Burner according to claim 3 **characterised in** that the duct part (9) is pivotally suspended from a hinge (11) placed immediately next to an opening (14) at the inlet end of the burner and comprises a mechanism (12) for rotating the duct part (9) up and down in a vertical plane.
- [Claim 5] 5. Burner according to any of the aforementioned claims **characterised in** that the direction of introduction of the solid fuel can be varied within an interval of 0° and 30°, preferably between 0° and 15° and most preferably between 0° and 10° relative to the longitudinal axis (6) of the burner.
- [Claim 6] 6. Burner according to claim 1 **characterised in** that the solid fuel duct (1) fully or partly consists of a flexible hose, such as a reinforced rubber hose.



**INTERNATIONAL SEARCH REPORT**

International application No  
PCT/IB2010/051800

**A. CLASSIFICATION OF SUBJECT MATTER**  
INV. F23D1/04  
ADD.

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)  
F23D

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 practical, search terms used)

EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 439 136 B1 (MANN JEFFREY S [US] ET AL) 27 August 2002 (2002-08-27) column 11, line 49 - column 17, line 15; figures 2-4	1
A	US 5 464 344 A (HUFTON PETER F [GB]) 7 November 1995 (1995-11-07) column 2, line 1 - line 25 column 2, line 49 - line 61; figures 1,2	1
A	WO 2008/065554 A1 (SMIDTH AS F L [DK]; OHLSEN IB [DK]; SKAARUP JENSEN LARS [DK]; HANSEN J) 5 June 2008 (2008-06-05) cited in the application the whole document	1

Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

23 June 2010

Date of mailing of the international search report

01/07/2010

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040,  
Fax: (+31-70) 340-3016

Authorized officer

Theis, Gilbert



# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/IB2010/051800
---

Patent document cited in search report	Publication date	Patent family member(s)	Publication date	
US 6439136	B1	27-08-2002	CA 2451088 A1	16-01-2003
			CN 1551964 A	01-12-2004
			EP 1402215 A1	31-03-2004
			IL 159419 A	03-11-2008
			WO 03004935 A1	16-01-2003
US 5464344	A	07-11-1995	AU 671027 B2	08-08-1996
			AU 6732794 A	19-01-1995
			CA 2126812 A1	09-01-1995
			CN 1100791 A	29-03-1995
			DE 69407676 D1	12-02-1998
			DE 69407676 T2	16-04-1998
			DK 633428 T3	02-03-1998
			EP 0633428 A1	11-01-1995
			ES 2111249 T3	01-03-1998
			IN 189493 A1	08-03-2003
			ZA 9404972 A	11-05-1995
WO 2008065554	A1	05-06-2008	AU 2007326900 A1	05-06-2008
			CA 2667921 A1	05-06-2008
			CN 101542204 A	23-09-2009
			EP 2087285 A1	12-08-2009
			JP 2010511140 T	08-04-2010
			US 2010003625 A1	07-01-2010