



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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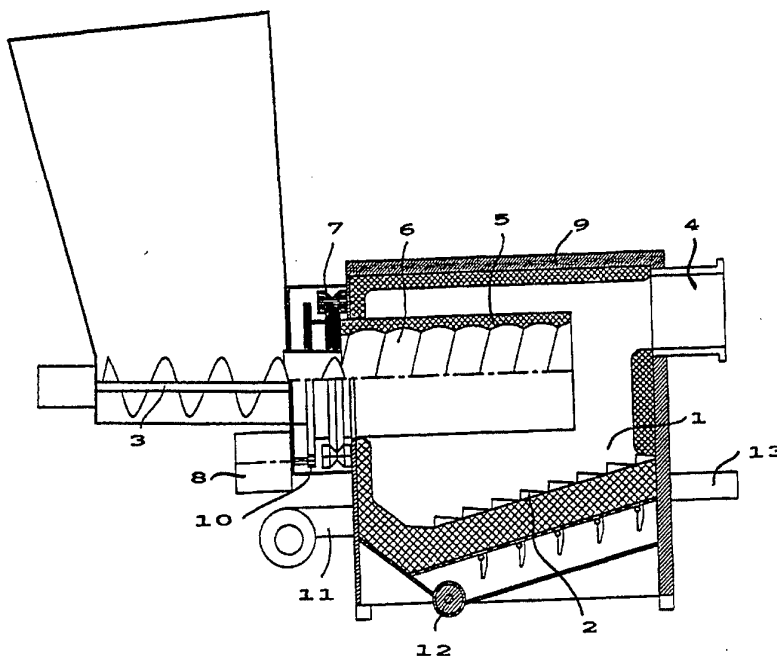
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941818 20 April 1994 (20.04.94) FI(71)(72) Applicant and Inventor: PAPPINEN, Matti [FI/FI]; Par-  
talantie 59, FIN-83780 Horsmanaho (FI).

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(54) Title: A DEVICE FOR COMBUSTION OF MOIST FUEL



## (57) Abstract

The present invention relates to a device for combustion of moist fuel, consisting of a combustion chamber (1), a fire grate (2) on top of which the fuel is burned inside the combustion chamber, feeding apparatus (3) for feeding fuel into the combustion chamber, and a discharge channel (4) for removing flue gas from the combustion chamber. For efficient desiccation of the fuel the device constructed in accordance with the invention is provided with a drum dryer (5) which is mounted inside the combustion chamber (1) and attached to a feeding apparatus (3) and from which the fuel is arranged to drop onto a fire grate (2).

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## A DEVICE FOR COMBUSTION OF MOIST FUEL

The present invention relates to a device for combustion of moist fuel in which a fire grate, on top of which the fuel  
5 burns, is mounted inside a combustion chamber. The mechanical arrangement is also provided with a fuel-feeding apparatus and a discharge channel for removing flue gas from the combustion chamber.

10 The humidity of the organic fuel such as wood chips and turf or the like used in combustion plants is generally too high for direct feeding from the storage into the combustion device. Such fuels are first dried in a separate desiccator and then fed into the combustion device using a  
15 separate feeding apparatus. A separate desiccator is expensive and consumes energy. Desiccation, as well as transfer to and away from the desiccator are all separate stages of the process, and each of them increases the processing expenses of the fuel.

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In addition, the currently available combustion devices share the problem that even though the fuel is desiccated, it is still so damp that a long fire grate is necessary for successful combustion. The fuel is shifted along the grate,  
25 desiccating at the beginning and burning further away on the grate. A long grate requires a long combustion chamber, increasing the costs of the combustion device. The combustion process in large thermal power stations which use moist chip fuel, even upto 65 per cent in humidity, is  
30 based on long fire grates and ceramic masonry, enabling efficient evaporation, desiccation and combustion of the fuel. In order to burn properly, the fuel for currently existing small-sized boilers, front end furnaces and stokers must not exceed 35 per cent in humidity.

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The purpose of the invention is to introduce a device for combustion of moist fuel, at the same time remedying

defects of the currently available devices. Primarily, the purpose is to introduce a device with which no separate desiccator is needed and in which the fuel can be fed into the combustion chamber moister than in the currently available small-sized boilers or similar devices. Further, the purpose is to introduce a device in which the fuel does not need as many transferring stages as compared to the currently available devices, and, in which the combustion chamber and the fire grate are relatively short.

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The purpose of the invention will be achieved with a device which is characterized in what has been stated in the patent claims.

15 The device constructed in accordance with the invention is provided with a drum dryer which is attached to a feeding apparatus and from which fuel is fed directly onto the grate. When the drum dryer is mounted inside the combustion chamber, the temperature inside the dryer is so high that 20 the fuel fed in it dries effectively before it drops onto the grate. Thus, no separate dryer is needed, and the fuel need not be separately fed into nor removed from the dryer. Fuel processing costs will thus reduce and energy will be saved. Furthermore, the fuel dropping onto the fire grate 25 will be so dry that the grate is no longer needed for desiccating the fuel, thus making it possible to use a relatively short grate. The combustion chamber can efficiently use fuel the humidity of which is approximately in the range of 35 to 55 per cent. One advantage is also 30 that the device collects and utilizes the evaporation energy used in desiccating the fuel, increasing the efficiency of the device.

In an inexpensive application of the device the drum dryer 35 is provided with an inner part with an involuted spiral directed towards the combustion chamber. The involuted structure allows unobstructed advancing movement of the fuel. At the same time, the fuel is constantly mixing and

desiccating very efficiently. The transition distance of the fuel is  $\pi$  times the internal diameter of the drum times the number of rising spirals, thus making the transition distance very long even in a relatively short drum dryer.

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In another inexpensive further application the device is provided with external bearers for the drum dryer and with an actuator for running the dryer. When mounted outside the combustion chamber, the apparatuses are easy to service.

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In accordance with the invention, the fire grate is mounted in a diagonal position, and the end of the drum dryer mounted in the combustion chamber reaches a position right above the upper end of the fire grate. In this arrangement  
15 the fuel will shift downwards from the position where it is being fed, thus allowing secure forward movement of the fuel on the grate and as well as constant combustion.

In addition, one application of the invention is provided  
20 with a fire grate consisting of several components in a step-by-step arrangement that are movable in order to shift the fuel from one part to another. Such an application allows easy transition of the fuel in the combustion chamber.

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In the following, the invention will be described in further detail with reference to the accompanying drawing, schematically illustrating one of the applications sideways as a cross section.

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In the illustrated application the device consists of the following parts: machine bed 9 inside which there is a combustion chamber 1, fire grate inside the combustion chamber 2, feeding apparatus 3, discharge channel 4, and  
35 drum dryer 5. The fire grate is situated at the bottom of the combustion chamber, and in this application it is made of components which step by step lead downwards and have been attached onto an endless band or a corresponding

device. The endless band is run using an actuator 13. The feeding apparatus is placed in front of the machine bed and the combustion chamber, and it consists of a feeding bin or similar device and a conveyor placed at the bottom of it, 5 being a feed screw in this application. The feed screw partly reaches both the machine bed and the drum dryer 5, and thus drops the fuel at the beginning of the spiral structure.

10 The drum dryer 5 is provided with an involuted drum 6 placed above the fire grate. The head of the drum dryer inside the combustion chamber reaches the upper end of the fire grate so that the fuel drops from the drum drier right on top of it. The inner surface of the drum dryer is made 15 of metal or coated with some applicable ceramic material. In addition, the drum dryer can be provided with external heat brackets which efficiently store heat.

The device is provided with bearers for the drum dryer 7 20 placed outside the combustion chamber, and with an actuator 8 with which the drum dryer is run. The actuator consists of a motor and a roller 10 which have been arranged so that they can rotate the drum dryer. The device also has a fan for blowing air onto the grate and a discharge screw for 25 removing ashes from the combustion chamber.

When using the device in accordance with the invention, the fuel is automatically transported to a silo or a tank, and from there, using the feed screw, to the beginning of the 30 involuted spiral. The rotational frequency of the motors and fans of the feed screw and the drum dryer is, when necessary, automatically adjusted according to how much heat is needed. Accordingly, ash discharging and moving of the fire grate are automatically adjusted to the amount of 35 burning fuel. The fuel is moved forward in the drum dryer with the help of a spiral, resulting in that the fuel dries and gasifies when inside the rolling drum dryer.

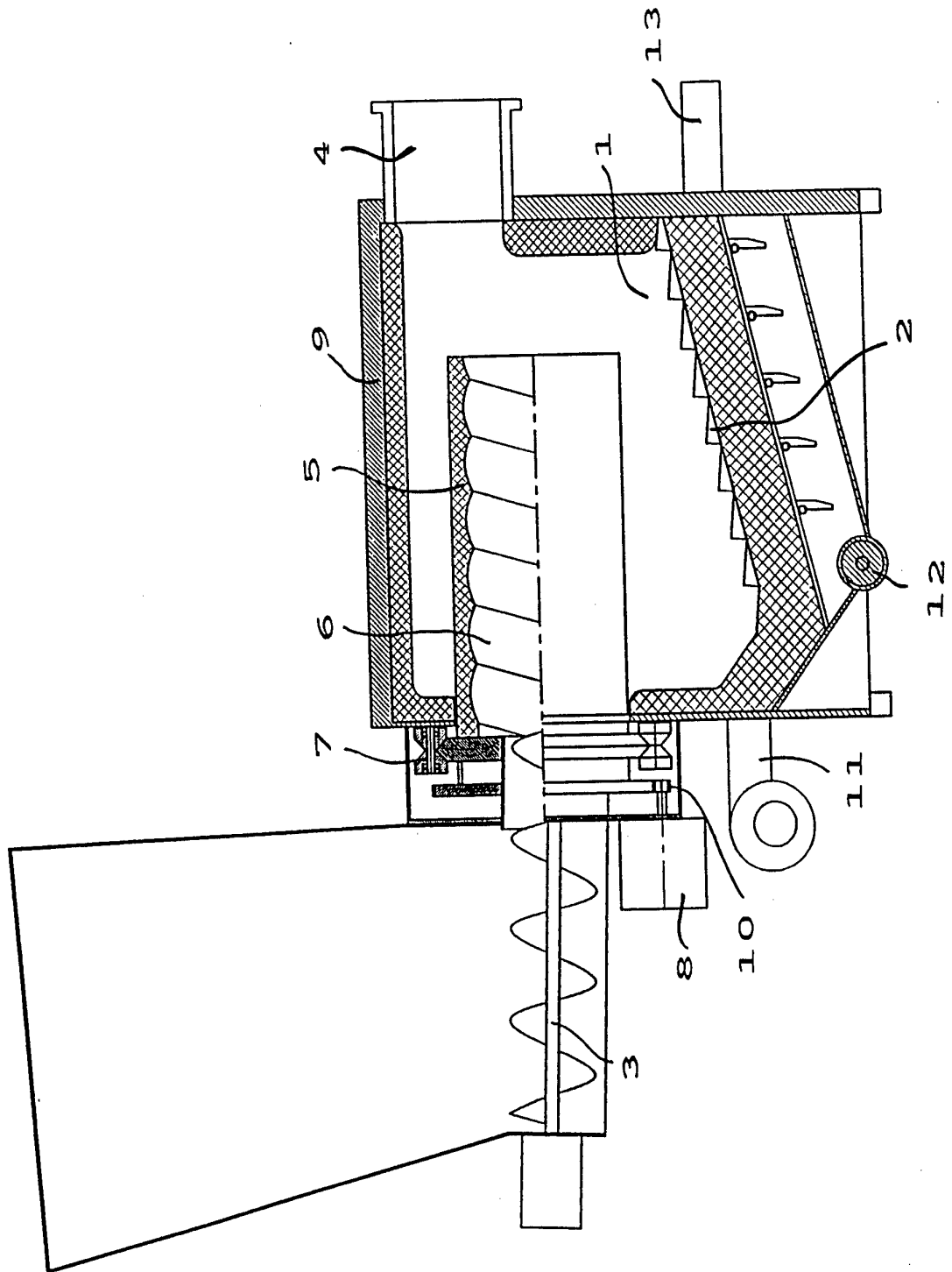
From the drum dryer the fuel drops down to the upper end of the fire grate which then shifts the combusting, partly charred fuel further downwards. The fan blows primary air through the grate into the fuel bed. The fire in the grate  
5 heats the drum dryer above it, heating and partly gasifying the contents in it. Primary air can also be blown into the drum dryer.

The device can be attached as a sequel to a convection  
10 device in which the gases can be burned completely using secondary air and then cooled down using an economizer. The device is also applicable as a front end furnace, for example, for an oil vessel. Water-cooling can be mounted around the device, thus making it a part of the entire  
15 vessel.

The invention is not only limited to the inexpensive applications presented herein, but may be varied within the framework of the inventive idea as presented in the patent  
20 claims.

## PATENT CLAIMS

- 1.A device for combustion of moist fuel, consisting of a combustion chamber (1), a fire grate on top of which the  
5 fuel is burned inside the combustion chamber (2), a feeding apparatus for feeding fuel into the combustion chamber (3), a discharge channel for removing flue gas from the combustion chamber (4), and a drum dryer (5), characterized in that inside the combustion chamber  
10 (1) there is a drum dryer (5) which is attached to a feeding apparatus (3) and from which the fuel is arranged to drop onto the fire grate (2).
- 2.A device as claimed in claim 1, characterized in that the drum dryer (5) is provided with an inner part  
15 which has an involuted spiral (6) directed towards the combustion chamber (1).
- 3.A device as claimed in claims 1 or 2, characterized in that the device is provided with bearers for the drum dryer (7) mounted outside the combustion chamber and with  
20 an actuator (8) for running the drum dryer.
- 4.A device as claimed in any of claims 1 to 3, characterized in that the fire grate (2) is mounted in a diagonal position and that the head of the drum dryer (5) in the combustion chamber reaches a position  
25 where it is right above the upper end of the fire grate, thus making the fuel shift downwards from where it is being fed.
- 5.A device as claimed in any of claims 1 to 4, characterized in that the fire grate (2) consists of  
30 several components in a step-by-step arrangement which are movable for shifting the fuel from one component to another.



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 95/00192

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| <b>A. CLASSIFICATION OF SUBJECT MATTER</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                |                                                                          |
| IPC6: F23K 1/04, F23G 5/04 // F23K 3/00<br>According to International Patent Classification (IPC) or to both national classification and IPC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                |                                                                          |
| <b>B. FIELDS SEARCHED</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                |                                                                          |
| Minimum documentation searched (classification system followed by classification symbols)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                |                                                                          |
| IPC6: F23K, F23G                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                |                                                                          |
| Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                |                                                                          |
| SE,DK,FI,NO classes as above                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                |                                                                          |
| Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                |                                                                          |
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| <b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                |                                                                          |
| Category*                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Citation of document, with indication, where appropriate, of the relevant passages                             | Relevant to claim No.                                                    |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | US 562845 A (I.S. MCGIEHAN), 30 June 1896<br>(30.06.96)<br><br>--                                              | 1-3                                                                      |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | DE 564236 C (DEUTSCHE BEBCK & WILCOX<br>DAMPFKESSEL-WERKE ATK.-GES.), 15 November 1932<br>(15.11.32)<br><br>-- | 1-5                                                                      |
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| <input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                |                                                                          |
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| Date of the actual completion of the international search                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                | Date of mailing of the international search report                       |
| 10 August 1995                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                | 11 -08- 1995                                                             |
| Name and mailing address of the ISA/<br>Swedish Patent Office<br>Box 5055, S-102 42 STOCKHOLM<br>Facsimile No. +46 8 666 02 86                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                | Authorized officer<br><br>Herman Phalén<br>Telephone No. +46 8 782 25 00 |

## INTERNATIONAL SEARCH REPORT

Information on patent family members

10/07/95

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| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|---------------------|----------------------------|---------------------|
| US-A- 562845                              | 1896                | NONE                       |                     |
| DE-C- 564236                              | 15/11/32            | NONE                       |                     |
| DE-A1- 4122157                            | 23/01/92            | NONE                       |                     |