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(54) Title: CEMENT KILN TERTIARY AIR DAMPER

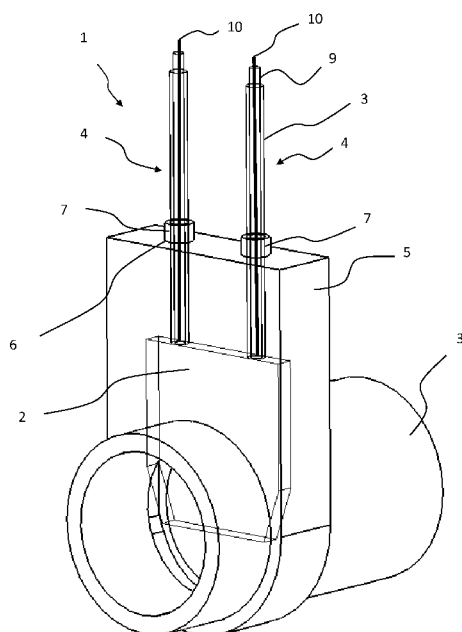


Fig. 1

(57) Abstract: The present invention relates to a cement kiln tertiary air duct damper unit (1) for a tertiary air duct (3) between a clinker cooler and a calciner of a clinker kiln line comprising at least one flow restrictor (2) which can be inserted into the tertiary air duct (3) to at least partially limit the tertiary air flow in the tertiary air duct by reduction of the cross section of the tertiary air duct. The damper unit comprises a control device (4) attached to said flow restrictor (2) for insertion and retraction of said flow restrictor (2) in and from the tertiary air duct (3), a damper unit housing (5) for housing the flow restrictor (2) in a retracted position comprising at least one control device opening (6) through which the control device (4) may be attached to the flow restrictor (2) such that the flow restrictor (2) may be operated from outside the damper unit housing (5), and the at least one control device opening (6) comprises a sealing device (7) for sealing a gap between the control device opening (6) and the control device (4) such that the inside of the tertiary air duct (3) is sealed from the outside surroundings of the tertiary air duct (3) through the damper unit housing (5) and wherein the control device (4) comprises means for internal cooling of the control device.



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CEMENT KILN TERTIARY AIR DAMPER

Field of the invention

5 The present invention relates to a cement kiln tertiary air duct damper unit for a tertiary air duct between a clinker cooler and a calciner of a clinker kiln line comprising at least one flow restrictor which can be inserted into the tertiary air duct to at least partially limit the tertiary air flow in the tertiary air duct by reduction of the cross section of the tertiary air duct.

10

Background art

Cement clinker is usually produced in a rotary kiln. The clinker is discharged from the hot end of the rotary kiln on a cooling grate of a clinker cooler. The clinker
15 resting on top of the cooling grate is cooled by a gas or a mixture of gases, usually air. The air is strongly heated, at least in the area close to the kiln. This strongly heated air has a temperature of approximately 750-1300°C and carries a high amount of dust. The heated air is extracted from the clinker cooler at the kiln hood and/or the cooler roof and fed via a so-called tertiary air duct to some other
20 processing stage. The air is referred to as tertiary air and the duct leading the tertiary air the tertiary air duct accordingly. This tertiary air is normally used for pre-processing of the raw meal and mostly fed to a calciner or an upstream combustion or gasification unit, such as a combustion chamber. The term calciner is used in this application as a synonym for a "raw meal pre-processing unit"
25 being fed with tertiary air as heat and/or oxygen source.

The raw materials which are necessary for the production of cement clinker are at least partly decarbonised in the calciner, using the thermal energy provided by the tertiary air directly, whereas the oxygen contained in the tertiary air is used for
30 the combustion of fuel in the secondary firing. The permanent optimisation of energy efficiency in cement producing plants results in an increase of tertiary air temperature. At the same time, the tertiary air volume per time unit decreases. The increasing use of secondary fuels like coal with high ash content, petrol coke

etc. particularly increases the amount of dust per m³ of tertiary air, i.e. the dust load in the tertiary air. In order to prevent clinker dust from clogging the tertiary air duct in the long term, the flow speed inside the tertiary air duct is increased. The higher temperature and the high dust load, in combination with the higher flow speed, cause higher wear on the refractory lining inside the tertiary air duct.

When the clinker kiln line is started up, the tertiary air duct has to be initially closed. So-called tertiary air dampers units are used for this purpose. In the most simple case these are plate-like sliders, which are inserted into the tertiary air duct orthogonally to the flow direction, thus closing it during start-up of the clinker kiln line. Typically, the plate-like sliders are made up from refractory materials suspended on a steel skeleton.

To prevent the steel skeleton inside the refractory material to overheat during operation and thereby due to diminished strength in worst cases collapse, air is typically led from the outside along the damper units to cool the damper unit to protect the steel inside the unit. Due to the very high temperature of the tertiary air passing the damper units, the conventional damper units experience a very high temperature gradient from the upstream side to the downstream side. High temperature gradients are detrimental to refractory materials being very hard and brittle materials.

As a result, it is hard to make the damper units last an entire period of operation or at least it will be abraded and thereby shortened to the extent, that it cannot reliably seal the tertiary air duct. A normal restart of the clinker kiln line after an unscheduled shutdown is therefore typically not possible without exchanging the damper unit.

Another problem is that the damper units deforms due to this temperature gradient induced thermal stress which can result in jamming of the damper blade device and an adjustment of the same becomes impossible.

Therefore, it would be advantageous to be able to construct a damper unit which last a complete period of operation without failure and without increasing the construction costs of such damper units significantly by higher grade materials or even more heavy and costly constructions.

5

Summary of the invention

It is an object of the present invention to wholly or partly overcome the above disadvantages and drawbacks of the prior art. More specifically, it is an object to
10 provide an improved cement kiln tertiary air duct damper unit where the flow restrictor blade of the damper unit will experience a high temperature gradient resulting in premature failure and deterioration of the refractory of the restrictor blade. Furthermore, it is an object of the invention to provide a damper unit that will not experience failure of the unit due to the internal steel constructions of the
15 flow restrictor and control device becoming too hot at elevated temperatures.

The above objects, together with numerous other objects, advantages, and features, which will become evident from the below description, are accomplished by a solution in accordance with the present invention by a cement kiln tertiary air
20 duct damper unit for a tertiary air duct between a clinker cooler and a calciner of a clinker kiln line comprising at least one flow restrictor which can be inserted into the tertiary air duct to at least partially limit the tertiary air flow in the tertiary air duct by reduction of the cross section of the tertiary air duct, wherein the damper unit comprises a control device attached to said flow restrictor for insertion and
25 retraction of said flow restrictor in and from the tertiary air duct, a damper unit housing for housing the flow restrictor in a retracted position comprising at least one control device opening through which the control device may be attached to the flow restrictor such that the flow restrictor may be operated from outside the damper unit housing, and the at least one control device opening comprises a
30 sealing device for sealing a gap between the control device opening and the control device such that the inside of the tertiary air duct is sealed from the outside surroundings of the tertiary air duct through the damper unit housing and

wherein the control device comprises means for internal cooling of the control device.

5 In one embodiment of the invention, the control device comprises an outer tubing having an outer circumference and a sealing device having an inner circumference matching said outer circumference such that air is substantially prevented from passing between the control device and the sealing device while still allowing the control device to move in and out of the damper unit housing.

10 The sealing towards the surroundings of the damper unit ensures that cold air is not entering the damper unit housing and thereby building up a temperature gradient across the flow restrictor between a hot and cold side. Tubes are easily sealed and may also in hollow shapes retain significant strength.

15 In another embodiment of the invention, the at least one control device comprises an inner tubing for dividing an inside compartment of the control device into two compartments; one inflow compartment for accepting an inflow of fluid coolant and an outflow compartment for allowing said fluid coolant to exit the control device through said outflow compartment.

20

In order to cool the steel carrying the most weight of the flow restrictor in the damper unit, a fluid coolant may be led through the interior of an inner tubing carrying most of the weight. The fluid coolant may then be led back out of the damper unit in a compartment between the inner tubing and the outer tubing. In
25 this way the weight-carrying steel experiences the highest cooling power from the coolant, and still isolates the inner tubing from the interior of the tertiary air duct and cools the outer tubing with a somewhat higher temperature of the coolant, but also allows the outer tubing to optimized for heat resistance instead of strength for carrying a lot of weight.

30

In yet another embodiment the weight of the flow restrictor is carried mainly by the inner tubing.

Due to the cooling of the inner tubing the entire or most of the weight of the flow restrictor may be carried by the inner tubing, since the steel of the inner tubing may be kept well below temperatures with significant creep and melting effects.

- 5 In a further embodiment the control device further comprises a weight carrying suspension, such as a chain or a cable, arranged within the inside compartment of the control device wherein the weight of the flow restrictor is carried mainly by the weight carrying suspension.
- 10 In order to increase strength of the weight-carrying device carrying the weight of the flow restrictor, a weight-carrying suspension may be placed inside the inner tubing. Since the weight-carrying suspension will be isolated entirely through two stages inside both the outer and the inner tubing the temperature of the steel may be kept even lower. Furthermore, the hoist structure for lowering and elevating
- 15 the flow restrictor by the control device may be simplified since hoist structures using chains or cables are typically easier and cheaper to build.

In one embodiment the damper unit comprises a suspension compartment in a top part of the flow restrictor, said suspension compartment comprising a steel

20 suspension beam for carrying a plurality of suspension rods, characterized in that the suspension compartment in the top part of the flow restrictor furthermore comprises at least one diverter plate for diverting the fluid coolant to the outermost parts of the suspension compartment.

- 25 Using a diverter plate in the suspension compartment ensures cooling of the more outermost parts of the suspension compartment.

In an embodiment of the invention the control device is made from a high temperature-resistant material.

- 30 Using a highly heat resistant material in the control device it may be possible to achieve sufficient strength without internal tubing. By in-letting coolant through one control device and out-letting the coolant through a different internal cooling

may still be achieved. However, this embodiment will typically require highly temperature-resistant materials, since the steel carrying the weight will be in direct contact with the tertiary air. The direct contact may be avoided by coating or shielding the control device by an outer layer of isolating material.

5

In an embodiment of the invention, the outer tubing is cylinder shaped.

Using cylinder shaped tubing for the outer tubing facilitates an easy and efficient sealing by ring-shaped seals which are readily available also for high-temperature applications.

10

In an embodiment of the invention, the outer tubing has a higher heat resistance than the inner tubing.

15

Using both inner and outer tubing allow the fluid coolant to be led back out of the damper unit in a compartment between the inner tubing and the outer tubing. In this way the weight-carrying steel experiences the highest cooling power from the coolant, and still isolates the inner tubing from the interior of the tertiary air duct and cools the outer tubing with a somewhat higher temperature of the coolant, but also allows the outer tubing to optimized for heat resistance instead of strength for carrying a lot of weight. This not only allows for increased strength of the inner parts but also allows for increased heat resistance of the outer parts without the need for high strength, therefore the outer tubing may also be made from non-steel materials with significantly improved heat resistance.

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In an embodiment of the invention, the outer tubing has a higher heat resistance than the weight-carrying suspension.

Brief description of the drawings

30

The invention and its many advantages will be described in more detail below with reference to the accompanying schematic drawings, which for the purpose of illustration show some non-limiting embodiments and in which

Fig. 1 shows a perspective X-ray view a cement kiln tertiary air duct damper unit according to the invention,

Fig. 2 shows a simulated heat map of a cement kiln tertiary air duct damper unit in a tertiary air duct according to the prior art,

Fig. 3 shows a magnified view of a flow restrictor of a damper unit, and

Fig. 4 shows a magnified cut-through view of a damper unit of the invention.

All the figures are highly schematic and not necessarily to scale, and they show only those parts which are necessary in order to elucidate the invention, other parts being omitted or merely suggested.

Detailed description of the invention

Fig. 1 shows a perspective X-ray view a cement kiln tertiary air duct damper unit 1 according to the invention. The damper unit 1 comprises at least one flow restrictor 2 which can be inserted into the tertiary air duct 3 to at least partially limit the tertiary air flow in the tertiary air duct 3 by reduction of the cross section of the tertiary air duct 3. To suspend and control the movement of the flow restrictor 2 a control device 4 is attached to the flow restrictor 2 such that it may be inserted into the tertiary air duct and retracted from and retracted from the tertiary air duct. In order to insert and retract the flow restrictor without exposing the surroundings of the tertiary air duct to the inside of the duct, the damper unit comprises a damper unit housing 5. In order for the control device to be inserted and retracted from an external position, the control device passes through the housing through at least one control device opening 6. Thereby, an operator may handle the flow restrictor from an external position using the control device or control devices. Furthermore the control device openings 6 comprises a sealing device 7 for sealing a gap between the control device opening 6 and the control device 4 such that the inside of the tertiary air duct 3 is sealed from the outside surroundings of the tertiary air duct 3 through the damper unit housing 5. By sealing of the interior of the damper housing both sides of the flow restrictor experience close to the same temperatures and thus no significant temperature

gradient will exist across the thickness of the flow restrictor thereby avoiding thermal stresses in the flow restrictor. Since also the control device will now experience higher temperatures compared to solutions of the prior art, where cold air enters the damper housing to cool the flow restrictor and control means, the control device according to the invention comprises means for internal cooling of the control device. Instead of cooling the control device from the outside using cold air along the control device 4 and flow restrictor 2, they are now cooled internally allowing the temperature in the damper housing to be higher, thereby avoiding temperature gradients, while still protecting the internal steel in the control device and flow restrictor.

Fig. 2 shows a simulated heat map of a cement kiln tertiary air duct damper unit in a tertiary air duct according to the prior art to explain in detail the problems of the prior art in conventional solutions. In the left-hand side of the figure the high temperature side of the tertiary air duct 3 is shown by the uniform hatching. As illustrated, cold air is typically led into the damper unit housing 5 to cool the area around the control device and flow restrictor. Since the cold air leaking into the tertiary air duct experiences less mixing with hot air on the downstream side than on the upstream side, the downstream side of the flow restrictor will experience a much colder surface temperature than the upstream side of the flow restrictor, therefore a large temperature gradient will build up in the flow restrictor during operation inducing high thermal stresses in the flow restrictor. It is evident from Fig. 2 that if the damper unit housing 5 is sealed from the surroundings, the damper unit housing 5 is instead gradually heated by the tertiary air and led through the damper unit housing 5 towards the downstream side of the flow restrictor and therefore only be slightly colder than air coming directly from the tertiary air duct reflecting only minor temperature losses in the damper housing instead of a cold stream of air deliberately sent into the damper housing to cool the control devices and flow restrictor.

Fig. 3 shows a magnified view of a flow restrictor of a damper unit comprising a top part 15 comprising the internal cooling and suspension parts of the flow restrictor and a bottom part 18 mainly constituting highly temperature resistant

refractory material. The bottom part 18 is typically the part that is subjected to most wear or brakes due to extensive thermal stresses causing the damper units not to last for a complete operating period in conventional solutions.

5 Fig. 4 shows a magnified cut-through view of an embodiment of the damper unit of the invention, where the control device 4 comprises an inner tubing 9 for dividing an inside compartment 41 of the control device 4 into two compartments; one inflow compartment 12 for accepting an inflow of fluid coolant and an outflow compartment 13 for allowing said fluid coolant to exit the control device 4 through
10 said outflow compartment, wherein the weight of the flow restrictor 2 is carried mainly by the inner tubing 9 and wherein the damper unit 1 furthermore comprises a suspension compartment 14 in a top part 15 of the flow restrictor 2, said suspension compartment 14 comprising a steel suspension beam 16 for carrying a plurality of suspension rods 17, and wherein the suspension
15 compartment 14 in the top part 15 of the flow restrictor 2 furthermore comprises a diverter plate 19 for diverting the fluid coolant towards the outermost parts of the suspension compartment.

The fluid coolant may be in liquid or gas phase. It should be chosen for high
20 temperature applications so water-based liquids are not appropriate. Ambient air is a very appropriate fluid coolant in most applications.

Claims

1. A cement kiln tertiary air duct damper unit (1) for a tertiary air duct between a clinker cooler and a calciner of a clinker kiln line comprising:

- 5 – at least one flow restrictor (2) which can be inserted into the tertiary air duct (3) to at least partially limit the tertiary air flow in the tertiary air duct (3) by reduction of the cross section of the tertiary air duct (3),
- a control device (4) attached to said flow restrictor (2) for insertion and retraction of said flow restrictor in and from the tertiary air duct,
- 10 – a damper unit housing (5) for housing the flow restrictor in a retracted position comprising at least one control device opening (6) through which the control device may be attached to the flow restrictor (2) such that the flow restrictor (2) may be operated from outside the damper unit housing (5),
- 15 – and wherein the at least one control device opening (6) comprises a sealing device (7) for sealing a gap between the control device opening (6) and the control device (4) such that the inside of the tertiary air duct (3) is sealed from the outside surroundings of the tertiary air duct (3) through the damper unit housing (5) and wherein the control device
- 20 comprises means for internal cooling of the control device.

2. A damper unit according to claim 1, wherein the control device (4) comprises an outer tubing (3) having an outer circumference and a sealing device (7) having an inner circumference matching said outer circumference such that air is

25 substantially prevented from passing between the control device (4) and the sealing device (7) while still allowing the control device to move in and out of the damper unit housing (5).

3. A damper unit according to claim 1 or 2, wherein the at least one control device

30 (4) comprises an inner tubing (9) for dividing an inside compartment (41) of the control device (4) into two compartments; one inflow compartment (12) for accepting an inflow of fluid coolant and an outflow compartment (13) for allowing said fluid coolant to exit the control device (4) through said outflow compartment,

wherein the weight of the flow restrictor (2) is carried mainly by the inner tubing (9).

4. A damper unit according to claim 1 or 2, wherein the weight of the flow
5 restrictor (2) is carried mainly by the inner tubing (9).

5. A damper unit according to any of claims 1-3, wherein the control device (4)
further comprises a weight-carrying suspension (10), such as a chain or a cable,
arranged within the inside compartment (41) of the control device (4), wherein the
10 weight of the flow restrictor (2) is carried mainly by the weight-carrying
suspension (10).

6. A damper unit according to any of claims 1-5, wherein the damper unit (1)
comprises a suspension compartment (14) in a top part (15) of the flow restrictor
15 (2), said suspension compartment (14) comprising a steel suspension beam (16)
for carrying a plurality of suspension rods (17), **characterized in** that the
suspension compartment (14) in the top part (15) of the flow restrictor (2)
furthermore comprises at least one diverter plate (18) for diverting the fluid
coolant to the outermost parts of the suspension compartment.

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7. A damper unit according to any of claims 1-6, wherein the control device (4) is
made from a high temperature-resistant material.

8. A damper unit according to any of claims 2-7, wherein the outer tubing (3) is
25 cylindrically shaped.

9. A damper unit according to any of claims 3-8, wherein the outer tubing (3) has
a higher heat resistance than the inner tubing (9).

30 10. A damper unit according to any of claims 5-9, wherein the outer tubing (3) has
a higher heat resistance than the weight-carrying suspension (10).

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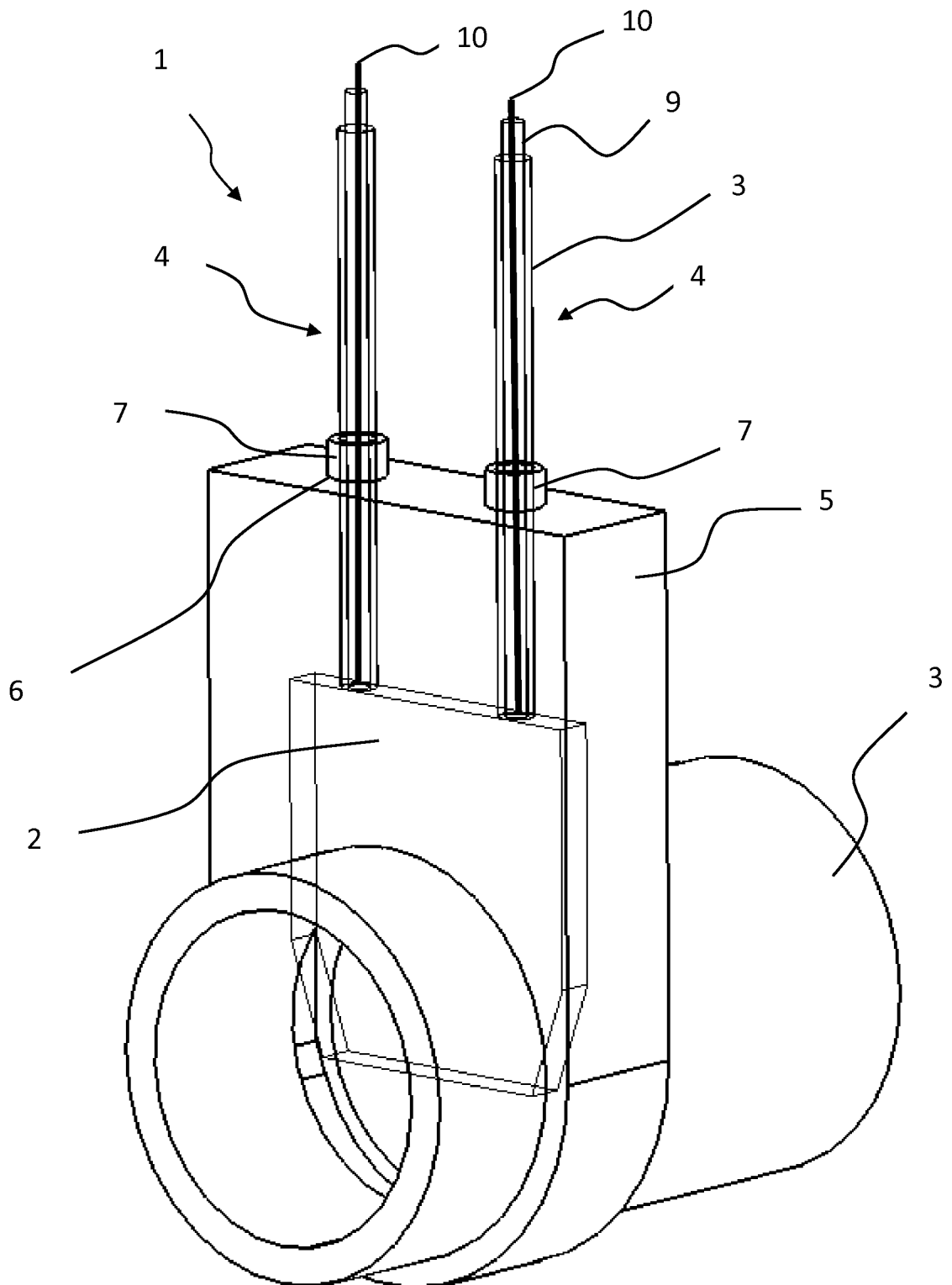


Fig. 1

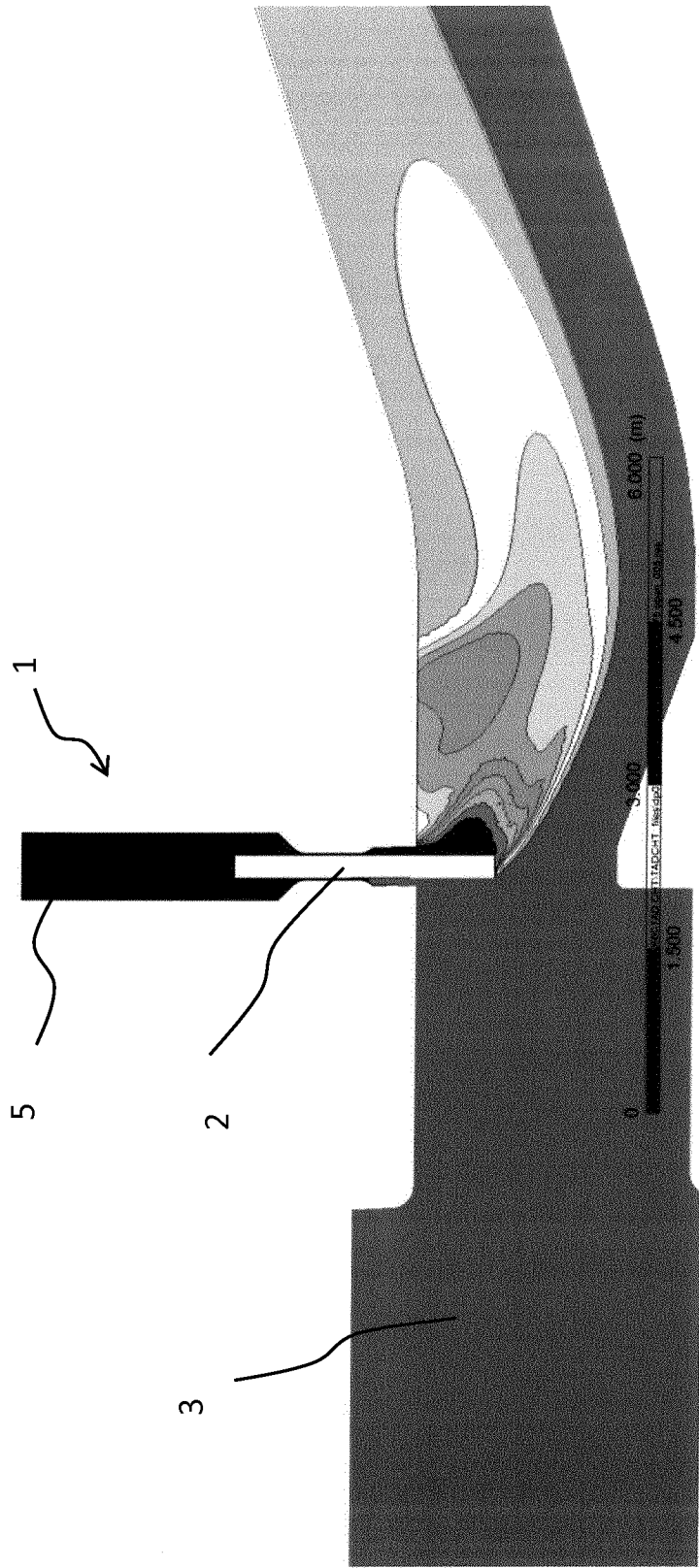


Fig. 2

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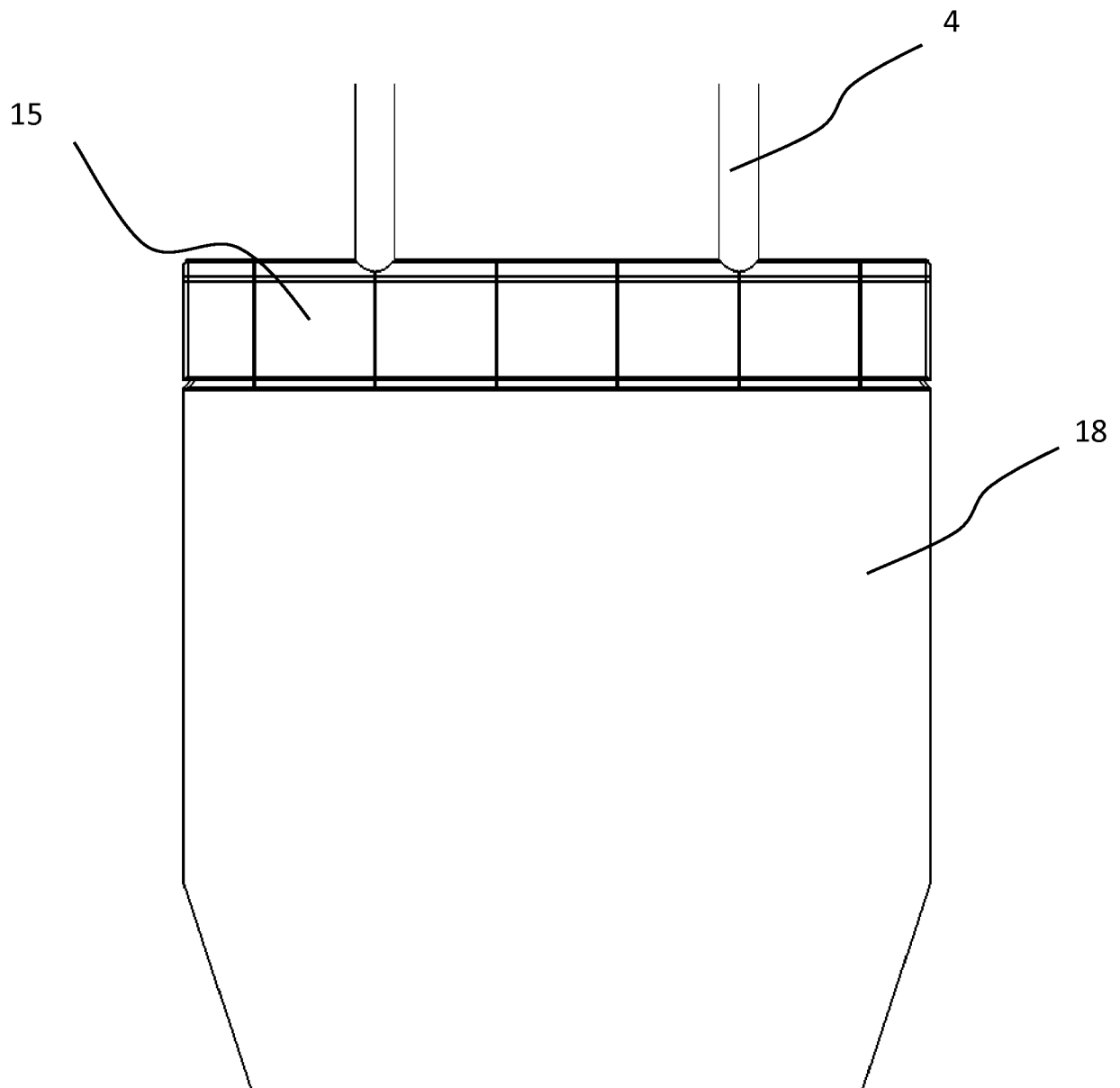


Fig. 3

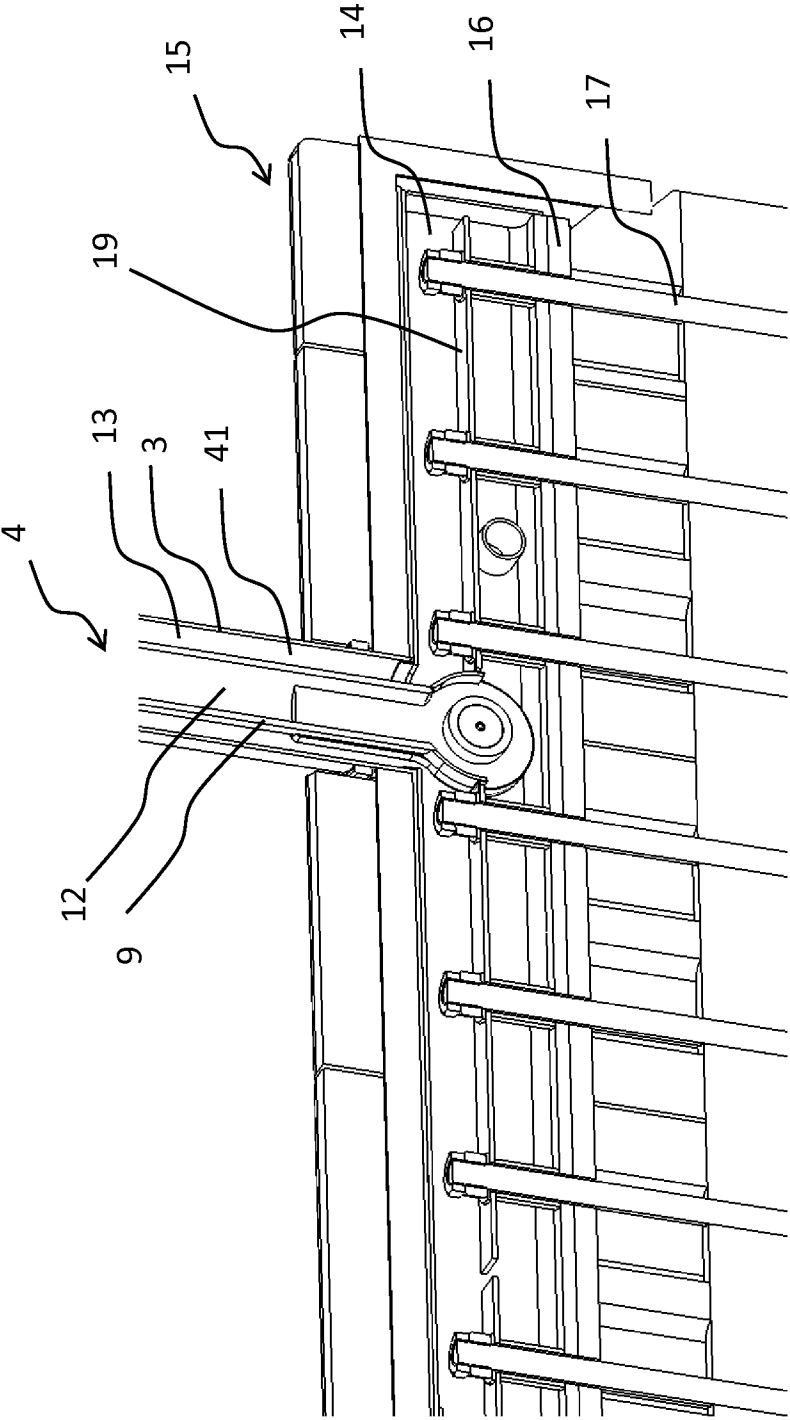


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/056213

A. CLASSIFICATION OF SUBJECT MATTER
INV. F27B7/20 F27D17/00 F27D99/00
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)
F27B F27D C21B

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Date of the actual completion of the international search

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Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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