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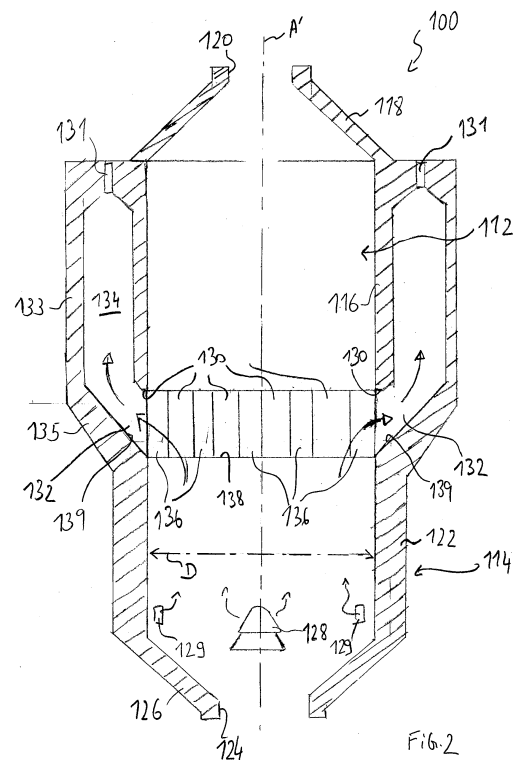
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(54) **COKE DRY QUENCHING DEVICE**

(57) A coke dry quenching device (100) comprises a pre-chamber (112) having a cylindrical wall (116) extending along a vertical axis (A) and comprising a coke inlet aperture (120) through which hot, granular coke is fed into the pre-chamber (112); and a quenching chamber (114), below the pre-chamber (112). The quenching chamber (114) includes a cylindrical wall (122) in axial continuity of the pre-chamber to receive the descending coke; gas supply means (128, 129) for supplying cooling gas inside the quenching chamber; and a coke discharge aperture (124) at the bottom of the quenching chamber. A plurality of gas outlet apertures (130) circumferentially distributed in a transition region at the top of the quenching chamber (114), through which cooling gas is evacuated into gas flues (132) joining into an annular collection channel (134) surrounding the pre-chamber (112) above the gas outlet apertures (130). The cylindrical wall (116) of the pre-chamber (112) is supported at its bottom by a plurality of peripherally distributed, substantially vertical support columns (136) resting on the cylindrical wall (122) of the quenching chamber (114).



Description

FIELD OF THE INVENTION

[0001] The present invention generally relates to coke dry quenching equipment.

BACKGROUND OF THE INVENTION

[0002] As it is known in the art, dry quenching is being adopted for the cooling of the hot coke, generally referred to as "red hot coke", discharged from the coke oven batteries after the carbonization process. In the dry quenching process, the red hot coke is introduced at the top of a shaft-like cooler and travels downward to a bottom outlet, while being cooled by a rising flow of inert gas that circulates in an enclosed system. The coke is cooled down to approximately 200°C while the circulating gas gets heated up to about 800°C.

[0003] Coke dry quenching has several benefits over conventional water quenching. The release of airborne coke dust into the atmosphere is prevented. Furthermore, thermal energy of the red hot coke can be recovered from the cooling gas e.g. for the production of steam, thus contributing to prevent global warming.

[0004] A conventional coke dry quenching device 10 is illustrated in Fig. 1. It comprises a pre-chamber 12 with a coke inlet opening 14 through which hot, granular coke is fed into the pre-chamber, and a quenching chamber 16 located below the pre-chamber 12. The pre-chamber 12 has a cylindrical wall 18 extending along a central, vertical axis A and the quenching chamber 16 comprises a cylindrical wall 20 in axial continuity of the pre-chamber 12 to receive the descending coke. Gas supply means (not shown) are provided in the lower region of the quenching chamber 16 to supply cooling gas (generally inert gas) therein. Such quenching device 10 forms a counter-flow reactor wherein the hot coke introduced at the top gradually descends towards the quenching chamber outlet and is cooled by a rising flow of cooling gas. At the bottom of the quenching chamber, the coke has been cooled down to a temperature of about 200°C and is discharged through a coke discharge aperture (not shown).

[0005] The hot cooling gas exits the dry quenching device 10 in the top region of the quenching chamber 16 via a plurality of circumferentially distributed gas outlet apertures 22 in communication with gas flues 24 joining into an annular collection channel 26 surrounding the pre-chamber above these openings. Fig.1 shows the conventional design of this transition region of the dry quenching device 10. The wall 18 of the pre-chamber, of smaller diameter than the quenching chamber, is supported by inward cantilevers 30 resting on, and extending from, the top of the quenching chamber wall 20. The annular collection chamber 26 surrounding the pre-chamber 12 is formed between the pre-chamber wall 18 and a surrounding, outer wall 32, supported by an outward

cantilevered wall 34 likewise resting on the top of the quenching chamber wall 20. The gas outlet apertures 22 are located in between the cantilevers and the gas flues 24 are inclined outwardly to fluidly connect the respective apertures 22 with the collection chamber 26. The cantilevers support the entire brickwork and masonry above them. Although this design has been widely employed, one of its weaknesses is that the cantilevers, or parts thereof, can break or crack due to non-uniform pressure arising from the tilting moment resulting from the load of the upper refractory brickwork, the effect being accentuated by the wear out of the cantilevers over time.

[0006] EP2338954 discloses a coke dry quenching device with the same overall configuration, however having a particular design in the region of the gas flues. In fact, the lower edges of the gas flues are located radially closer to the furnace core than is the side wall surface of the cooling chamber and are positioned between the side wall surface and the outer circumferential edge of a blast head. The flow of the coke in the circumferential edge portion of the cooling chamber is improved. However, the lower edge portions represent weak points of the coke dry quenching equipment, since the region of the lower edges shows a break or kink in the structure.

OBJECT OF THE INVENTION

[0007] The object of the present invention is to provide an improved coke dry quenching device, in particular with a more robust design of the top region of the quenching chamber with the gas outlet apertures.

[0008] This object is achieved by a coke dry quenching device as claimed in claim 1.

SUMMARY OF THE INVENTION

[0009] The present invention relates to a coke dry quenching device in which hot coke is introduced from a top region and moves downward while being cooled by a counter flow of cooling gas introduced in a bottom region. The coke dry quenching device comprises a pre-chamber having a cylindrical wall extending along a vertical axis and includes a coke inlet aperture through which hot, granular coke is fed into the pre-chamber.

[0010] A quenching chamber is located below the pre-chamber and comprises: a cylindrical wall in axial continuity of the pre-chamber to receive the descending coke; gas supply means for supplying cooling gas inside the quenching chamber; and a coke discharge aperture at the bottom of the quenching chamber.

[0011] A plurality of gas outlet apertures are circumferentially distributed in a transition region at the top of the quenching chamber, through which cooling gas is evacuated into gas flues joining into an annular collection channel surrounding the pre-chamber above the gas outlet apertures.

[0012] According to the present invention, the cylindrical wall of the pre-chamber is supported at its bottom by

a plurality of circumferentially (peripherally) distributed, substantially vertical support columns resting on the cylindrical wall of the quenching chamber. A corollary of this feature is that the walls of the pre-chamber and of the quenching chamber are substantially aligned along the furnace axis and have a similar or (substantially) identical inner diameter (although their wall thickness may differ).

[0013] Hence, in the coke dry quenching device according to the present invention, the brickwork / masonry of the pre-chamber is no longer supported by cantilevers but by vertical columns. This change of design has numerous practical benefits. The removal of the cantilever supports for the pre-chamber avoids the creation of weakness points leading to cracks in the support structure at the transition zone.

[0014] Furthermore, the use of vertical support columns permits increasing the supporting capacity per volume of structural support (i.e. the columns can be narrower than the usual cantilevers), and thus to noticeably enlarge the cross-section of the gas outlet apertures and gas flues. As a consequence, a larger cooling gas flow rate can be obtained with the same gas speed, which has a direct result of a proportionally larger cooled coke production for the same quenching chamber dimensions (i.e. the specific production, expressed in quenching chamber volume per ton of coke hourly quenched, increase). This is an important benefit because, as it will appear to those skilled in the art, augmenting the flow rate by increasing the gas speed is problematic in practice, as a too large gas speed would fluidize and carry the coke pieces until the flues and/or annular collection channel get clogged. Alternatively, the increased section of the gas outlet apertures permits, when necessary, reducing the gas speed, and hence the transport effect.

[0015] Another benefit of the present design is linked to the increase in diameter of the pre-chamber (compared to conventional cantilevered design) that is aligned with that of the quenching chamber, which allows reducing the height of the pre-chamber for a same volume. The overall plant height can be reduced, leading, amongst others, to savings in the steel structure and reducing the cycle time of the charging crane.

[0016] Depending on the embodiments, the present coke dry quenching device may include one or more of the following features:

- the vertical support columns have a substantially constant horizontal cross-section over their height;
- the annular collection channel is formed as inner horizontal channel between the cylindrical wall of the pre-chamber and a surrounding, outer cylindrical wall;
- the outer cylindrical wall is supported by an outward cantilevered wall resting on the top edge of the quenching chamber wall and surrounding the tran-

sition region, whereby the cantilevered wall with its inner side defines sloped bottom surfaces of said gas flues;

- 5 - the pre-chamber comprises, above the cylindrical wall, a truncated conical section defining the coke inlet aperture;
- 10 - the quenching chamber comprises, below the cylindrical wall, a truncated conical section with the coke discharge aperture;
- 15 - the gas supply means comprise at least one blast head located inside the quenching chamber and/or at least one gas inlet orifice in the quenching chamber cylindrical wall;
- 20 - the cylindrical wall of the quenching chamber and of the pre-chamber is made from fire-resistant material, in particular from refractory bricks or blocs.
- 25 - said pre-chamber (112), quenching chamber (114) and vertical support columns (136) are formed as one single masonry piece, preferably with the outer cylindrical wall and outward cantilevered wall, and possibly with the truncated conical section with the coke discharge aperture.

[0017] These and other embodiments of the present invention are described in the appended dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The present invention will now be described, by way of example, with reference to the accompanying drawing, in which:

FIG. 1 is a schematic diagram illustrating a conventional coke dry quenching device as known from the prior art; and

FIG. 2 is a schematic diagram illustrating a section view through an embodiment of the present coke dry quenching device.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0019] As explained above, in the conventional design of coke dry quenching devices shown in Fig.1, the pre-chamber 12 is supported by the quenching chamber 16 via cantilevers 30. Such cantilevers 30 are the weak points of the entire brickwork and will, with time, break or crack.

[0020] Fig.2 shows a principle drawing of an embodiment of the present coke dry quenching device 100. The device 100 comprises a pre-chamber 112 and a quench-

ing chamber 114 (or cooling chamber) that are vertically connected to receive the flow of gradually descending coke, and thus forms a shaft-like cooling device.

[0021] The pre-chamber 112 comprises mainly a cylindrical wall 116 extending along a vertical axis A'. The wall 116 is generally made from refractory bricks or blocks. The pre-chamber 112 is formed to have, above the cylindrical wall portion 116, a truncated conical section 118, the narrower end of which defines a coke inlet aperture 120 through which hot, granular coke is fed into the pre-chamber 112. A conventional charging device (not shown) - comprising a hopper and removable lid with hydraulic seal - is associated with this inlet aperture 120 to operate the selective charging of the device.

[0022] The pre-chamber 112 is supported by the quenching chamber 114, which comprises a cylindrical wall 122 in axial continuity of the pre-chamber 112 to receive the descending coke. The wall 122 is generally made from refractory bricks or blocks. The coke, gradually moving down (under the effect of gravity) in the pre-chamber 112 and quenching chamber 114, is evacuated at the bottom of the quenching chamber via a discharge orifice 124 located at the bottom of a funnel section 126 adjacent the lower end of cylindrical wall 122. Although not shown, a gas tight vibro extractor and rotary vane valve may be installed below the coke discharge orifice 124. Alternatively, a double flap valve may be used.

[0023] Gas supply means are provided for supplying cooling gas inside said quenching chamber. Any appropriate type of gas supply means may be used and no limitation on their shape and amount is imposed herein. In this variant, for example, reference sign 128 designates a blast head with one or more gas ports (not shown) that is centrally arranged in the quenching chamber, towards the bottom of the cylindrical portion. Additionally, a plurality of gas inlet orifices 129 are provided in cylindrical wall 122 to allow introduction of gas from the periphery of the coke charge. The cooling gas may generally be an inert gas, e.g. mixture of mainly N₂ with some other gases, e.g. CO, CO₂ and/or H₂ (coming from residual coke distillation in very low percentage). The injected cooling gas flows upward (as indicated by the arrows in Fig.2) through the gaps between the coke pieces. As the cooling gas flows upward, it takes up the heat from the coke, which is cooled down.

[0024] The hot cooling gas is evacuated via a plurality of gas outlet apertures 130 circumferentially distributed in a transition region at the top of the quenching chamber 114. Via these apertures that surround the top wall 122 of the quenching chamber 114, the cooling gas flows into gas flues 132 joining into an annular collection channel 134 surrounding the pre-chamber 112 above these openings 130. This annular collection chamber 134 may generally be formed between the pre-chamber wall 116 and a surrounding, outer cylindrical wall 133, supported by an outward cantilevered wall 135 resting on the top edge 138 of the quenching chamber wall 122 and surrounding the transition region. This cantilevered wall 135 with its

inner side defines the sloped bottom surfaces 139 of gas flues 132.

[0025] The annular collection channel 134 has one or more outlet orifices 131 that communicate with a gas purification and heat recovery system (not shown). For example, the hot cooling gas may firstly be lead through a primary dust catcher and then to a boiler to recover its energy via the production of steam that can be used as process steam or for power generation. From the boiler, the cooled gas may be lead to a secondary dust catcher and then recirculated towards the dry quenching device 10. By virtue of this recycling process of the cooling gas, the latter is also often referred to as "circulating gas".

[0026] It shall be appreciated that the pre-chamber is supported by the quenching chamber by means of a plurality of substantially vertical columns 136 installed in the transition region. These columns 136 are circumferentially/peripherally distributed on the top edge of the quenching chamber wall 122, and thus surround the quenching chamber 114. Generally, in the transition region, the gas outlet apertures 130 and columns 136 may be arranged in an alternate fashion. The columns 136 may have any appropriate shape (e.g. round, square or rectangular cross-section) with a generally constant horizontal cross-section and are designed to support the above brickwork.

[0027] Hence, compared to the prior art design with cantilevered supports as shown in Fig.1, in the present dry quenching device 100 the pre-chamber 112, and in particular its cylindrical wall 116, is supported by vertical columns 136 resting on the top of the cylindrical wall 122 of the quenching chamber 114.

[0028] A practical consequence of this design is that the pre-chamber cylindrical wall 116 and quenching chamber wall 122 have a substantially identical inner diameter D.

[0029] As discussed above, this design of the transition region with vertical support columns 136 that bear the cylindrical wall 116 of the pre-chamber 112 has numerous benefits:

- more robust construction without inner cantilever supports, leading to a enhanced brickwork life-time;
- increased flow section for the gas through the gas outlet apertures and gas flues, leading to lesser transport effect and reducing clogging;
- Reduced plant height and weight.

[0030] The cylindrical walls of the pre-chamber and quenching chamber are made from fire proof materials, e.g. refractory bricks or blocks. In fact all of the wallings in contact with the coke charge or hot air are advantageously manufactured from refractory materiel. This includes the columns 136 of the transition region and the outer wall 135 and 133 and may also include the inlet

cone 118 and lower funnel 126. Any appropriate refractory materials can be used. For example, the bricks and masonry for the above cited parts of the device 100 can include reinforced concrete, bricks produced from natural and synthetic materials, including for example: mullite and fireclay bricks, basalt tiles, insulating bricks, various castable types, ceramic boards and fibers, blankets and others. In particular, High quality alumina refractory material such as mullite bricks, having a compression stress around 60-70 MPa can support the compression loads coming from the upper construction without any further reinforcement.

[0031] From the construction point of view, the shaft structure comprising the quenching chamber 114, pre-chamber 112, transition region with columns 136 and walls 133, 135 are generally designed as one single masonry piece. The brickwork is realized with circular rings of bricks; to achieve the desired wall thickness, shaped bricks (with tongue and grooves) are preferably used to erect several contiguous circular rings of different radii. Sliding joints may be foreseen at appropriate locations to compensate for small differential expansions. Advantageously, the masonry is designed to avoid points of stress concentration, which allows using refractory bricks for the whole shaft structure without the need for specific reinforcement.

[0032] In the transition region, the columns 136 in fact result from the interruption in the brickwork to provide the openings 130 toward the flues 132. Seen from the interior of the device, there is one cylindrical wall of substantially constant diameter between the two inlet and outlet cone section, with gas openings 130 towards the center.

[0033] The shaft structure of the device 100 is generally held in place by a surrounding metallic structure (not shown). It may e.g. comprise a metallic external shell anchored in the ground at the outer periphery of wall 133 to support the shaft structure laterally, in combination with a supporting structure such as reinforced concrete or structural steel tetrapode.

Claims

1. A coke dry quenching device (100) in which hot coke is introduced from a top region and moves downward while being cooled by a counter flow of cooling gas introduced in a bottom region, said device comprising:

a pre-chamber (112) having a cylindrical wall (116) extending along a vertical axis (A) and comprising a coke inlet aperture (120) through which hot, granular coke is fed into the pre-chamber (112);

a quenching chamber (114), below said pre-chamber (112), comprising:

a cylindrical wall (122) in axial continuity of

said pre-chamber to receive the descending coke;

gas supply means (128, 129) for supplying cooling gas inside said quenching chamber; and

a coke discharge aperture (124) at the bottom of said quenching chamber;

a plurality of gas outlet apertures (130) circumferentially distributed in a transition region at the top of said quenching chamber (114), through which cooling gas is evacuated into gas flues (132) joining into an annular collection channel (134) surrounding said pre-chamber (112) above said gas outlet apertures (130);

characterized in that said cylindrical wall (116) of said pre-chamber (112) is supported at its bottom by a plurality of peripherally distributed, substantially vertical support columns (136) resting on said cylindrical wall (122) of said quenching chamber (114).

2. The coke dry quenching device according to claim 1, **characterized in that** said cylindrical wall (116) of said pre-chamber and said cylindrical wall (122) of said quenching chamber have a similar or substantially identical inner diameter.
3. The coke dry quenching device according to claim 1 or 2, **characterized in that** said vertical support columns (136) have a substantially constant horizontal cross-section.
4. The coke dry quenching device according to claim 1, 2 or 3, **characterized in that** said annular collection channel (134) is formed as inner horizontal channel between said cylindrical wall (116) of said pre-chamber and a surrounding, outer cylindrical wall (133).
5. The coke dry quenching device according to any one of the preceding claims, **characterized in that** said pre-chamber (112), quenching chamber (114) and vertical support columns (136) are formed as one single masonry piece.
6. The coke dry quenching device according to any one of the preceding claims, **characterized in that** said outer cylindrical wall (133) is supported by an outward cantilevered wall (135) resting on the top edge (138) of said quenching chamber wall (122) and surrounding said transition region, whereby said cantilevered wall (135) with its inner side defines sloped bottom surfaces (139) of said gas flues (132).
7. The coke dry quenching device according to claims 5 and 6, wherein said truncated conical section (126) with said outer cylindrical wall (133) and outward

cantilevered wall (135) are included in said single masonry piece.

8. The coke dry quenching device according to any one of the preceding claims, **characterized in that** said pre-chamber (112) comprises, above said cylindrical wall, a truncated conical section (118) defining said coke inlet aperture (120). 5
9. The coke dry quenching device according to any one of the preceding claims, **characterized in that** said quenching chamber (114) comprises, below said cylindrical wall, a truncated conical section (126) with said coke discharge aperture (124). 10
10. The coke dry quenching device according to claims 5 and 9, wherein said truncated conical section (126) with said coke discharge aperture (124) is included in said single masonry piece. 15
11. The coke dry quenching device according to any one of the preceding claims, **characterized in that** said gas supply means comprise at least one blast head (128) located inside said quenching chamber and/or at least one gas inlet orifice (129) in said quenching chamber cylindrical wall. 20
12. The coke dry quenching device according to claim 1, **characterized in that** said cylindrical walls (122, 116) of said quenching chamber and pre-chamber, as well as said vertical columns (136) are made from fire-resistant material, in particular from refractory bricks or blocks. 25

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PRIOR ART

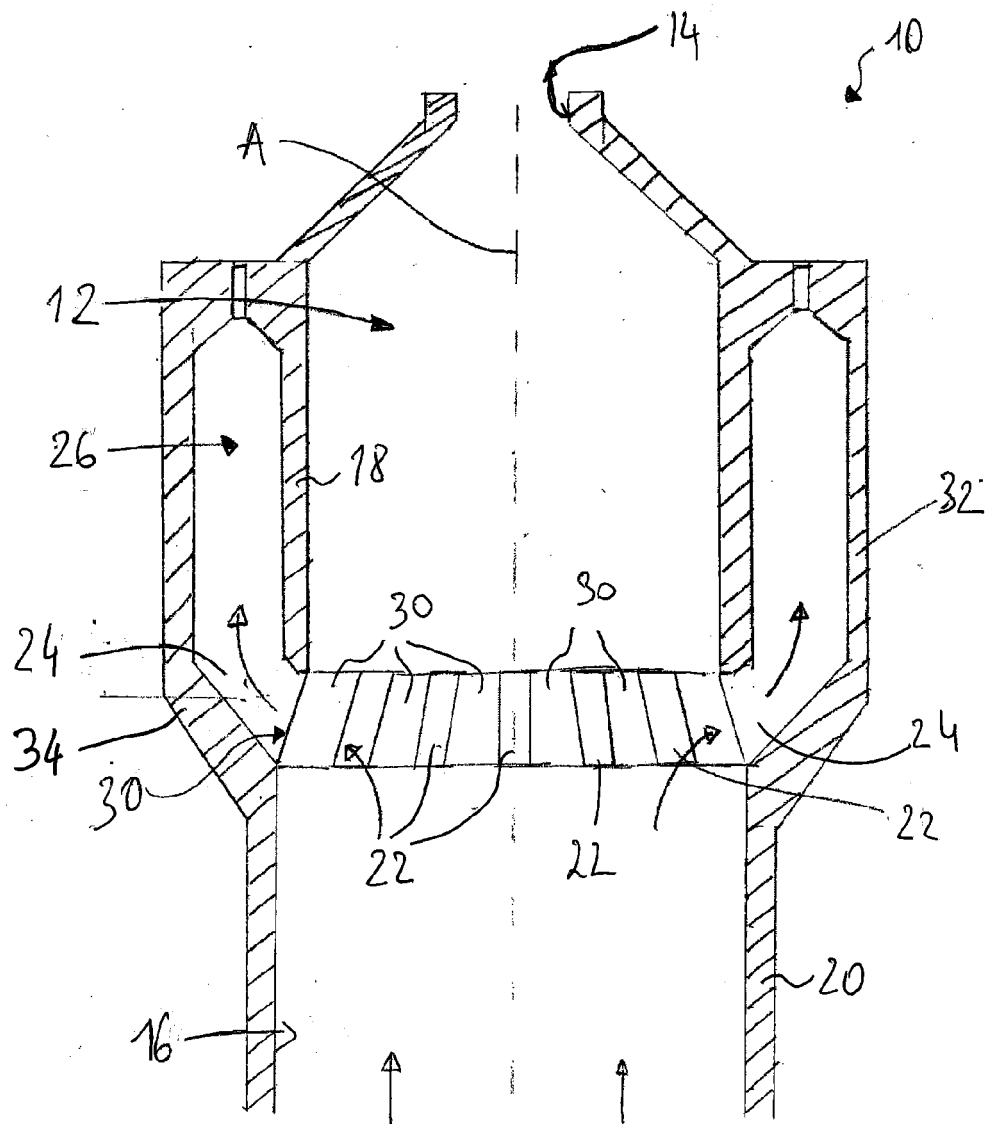
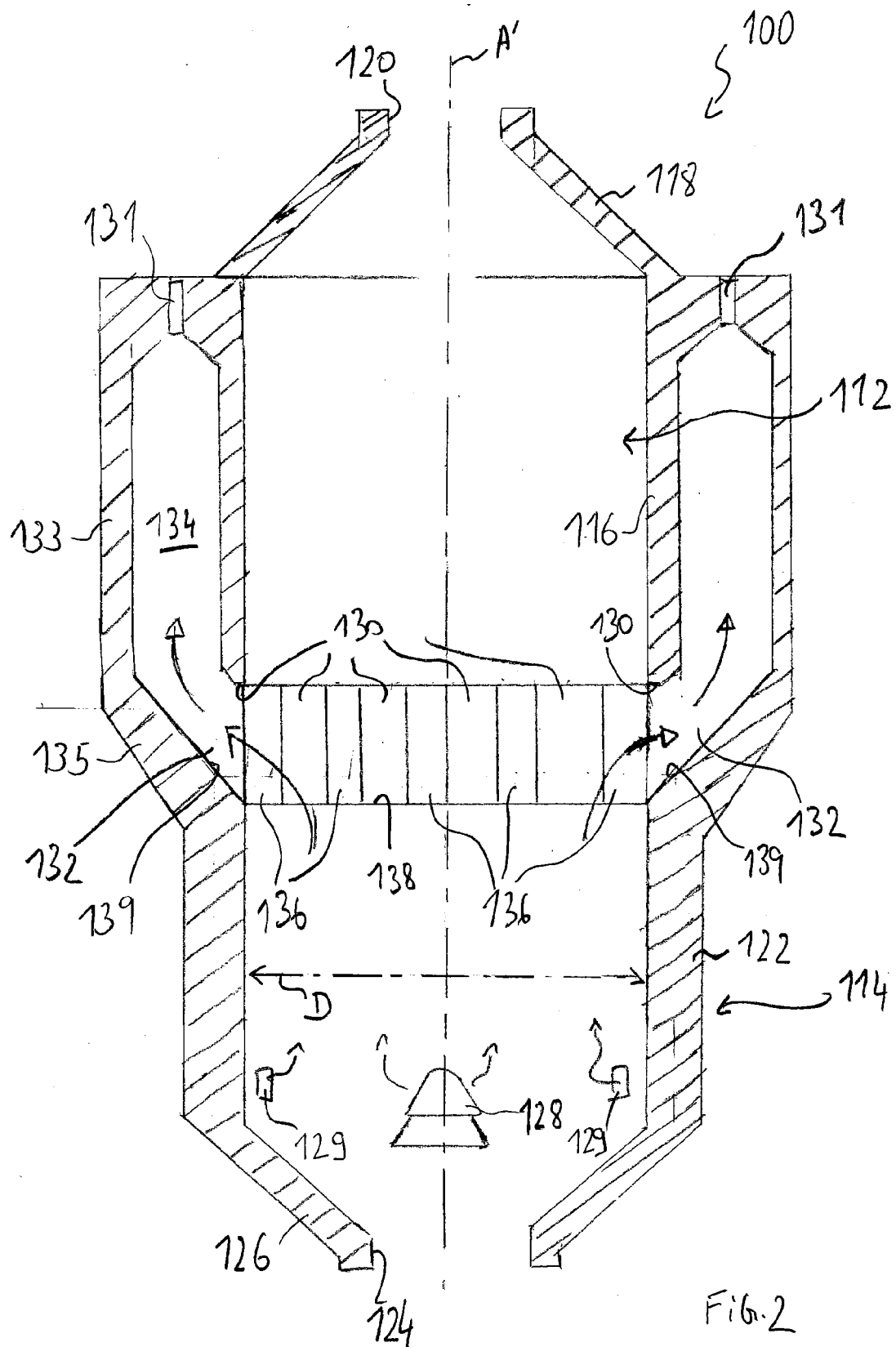


FIG. 1





EUROPEAN SEARCH REPORT

Application Number
EP 15 17 0151

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	CN 101 705 102 A (ACRE COKING & REFRACTORY DALIA; ACRE COKING & REFRACTORY ENG) 12 May 2010 (2010-05-12) * figures 1,2 * * claims 1-3 * * paragraphs [0009] - [0016] * -----	1-12	INV. C10B39/02
X	JP H03 66795 A (SHINAGAWA REFRACTORIES CO) 22 March 1991 (1991-03-22) * figures 1,2 * -----	1-12	
A	JP S56 39446 U (N.N.) 13 April 1981 (1981-04-13) * figure 1 * -----	1-12	
			TECHNICAL FIELDS SEARCHED (IPC)
			C10B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 2 November 2015	Examiner Zuurdeeg, Boudewijn
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 15 17 0151

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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02-11-2015

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Patent document cited in search report		Publication date	Patent family member(s)	Publication date
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EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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