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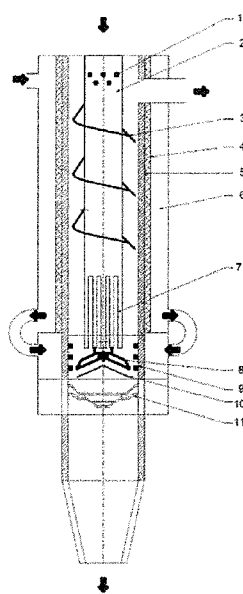


Fig. 1

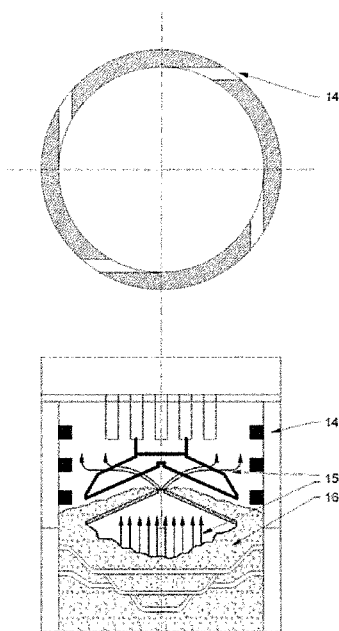


Fig. 3

(57) Abstract: A device for biomass carbonisation designed as a vertical reactor equipped with a column for drying and degassing of biomass and a combustion chamber with a cone-shaped grate and a scraper, and consisting of a tray at the top part of the device hermetically connected with the inside of the device, and inside the device there is a metal vertical retort (2). Inside the retort, there is an inner tube (13), onto which an augered strip is attached (12) inclined at an angle from 30° to 60° relative to the lateral plane of the tube (13). The retort (2) is finished with a cylindrical element. The top part of the retort (2) is equipped with openings. The vortex combustion chamber (9) has a cylinder shape. The side walls of the chamber are equipped with tangent nozzles. Under the retort (2) and the cylindrical part there is a truncated cone (10). Above the surface of the cone (10) there is a mixer (8). The retort (2) is inserted inside a circular flue (5). The retort (2) is equipped on the outer surface with an additional auger (3). The cylindrical part is equipped with at least two levels of tubes (11). In the bottom part of the device there is a system for discharging the product.

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Device for biomass carbonisation

The subject of the invention is a device for biomass carbonisation
5 intended for use in the power industry for the generation of heat and
electricity, and for the production of charcoal.

Polish patent description No. 206503 discloses a device for biomass
carbonisation, which consists of a vertical reactor with a vertical retort
10 and with openings along the perimeter and along the entire length of
a combustion chamber, and facing the combustion chamber that transfers
the gases from the retort to the combustion chamber, with a variable
speed screw conveyor that moves the mixture towards the bottom part of
the reactor, with an air installed tangentially in a wall of the bottom part
15 of the combustion chamber, and with an outlet for process gas or exhaust
gas and a bottom closure of the retort located outside the reactor and
equipped with a piece for outputting carbonised fuel, or with a piece for
feeding carbonised fuel to other devices that utilise the fuel. According to
a variant of the device, a bottom closure of the retort is a device for
20 mechanical fragmentation of carbonised fuel installed at the end of the
screw conveyor inside the reactor and with a piece for outputting
carbonised fuel through a slot along the perimeter of the cone of the
device for mechanical fragmentation of the fuel towards the walls of
the combustion chamber, and subsequently into the top part of the
25 combustion chamber and the outlet.

Polish patent description No. 207596 discloses a device for biomass
carbonisation consisting of a vertical reactor with a cylindrical vertical

drying and heating column, and a combustion chamber. Inside the drying and heating column, a mixer for raising and mixing biomass is installed. Under the bottom part of the drying and heating column, there is a cone-shaped grate, under which a scraper is installed for scraping carbonised biomass from the cone-shaped grate. Under the combustion chamber, a chamber for cooling carbonised biomass and an outlet for the evacuation of the finished product from the device are installed.

The solutions known in the prior art are not suitable for processing biomass with high moisture content, and require its pre-drying in a dryer. This may give rise to significant issues with the interactions between an external dryer and a reactor for biomass carbonisation relating to adequate performance of both devices, and to the control of the temperature of biomass downstream at a dryer outlet and at the inlet of a carbonising reactor. The solutions known in the prior art also do not protect the surface of a reactor from detrimental influence of tar. Moreover, coal obtained from biomass by applying solutions known in the prior art could be used only for combustion, and could not be used in the chemical industry due to insufficient carbon content.

The device according to the invention comprises a tray at the top part of the device hermetically connected with the inside of the device. Inside the device there is a vertical retort i.e. a metal tube with a length preferably from 1 to 15 metres, most preferably 6 metres, with inner diameter preferably from 400 to 1000 mm, most preferably 600 mm, through which biomass is conveyed vertically in the downward direction. Inside the retort there is an inner tube with an outer diameter preferably from 200 to 800 mm, most preferably 400 mm, onto which an augered strip is

attached. The inner tube preferably is attached to the top part of the device in a swivelling manner. The augered strip is inclined at an angle from 30° to 60° relative to the lateral plane of the inner tube, preferably at an angle of 45° . The inclination of the augered strip improves the contact

5 surface of biomass with the inner surface of the retort. The inclination of the augered strip between 30° and 60° is preferable due to the flow of the gases generated during the drying and degassing of biomass. The pitch of the auger ensures that the biomass on the surface of the auger biomass does not move spontaneously. The ratio of the outer diameter of the

10 inner tube with the auger to the inner diameter of the retort should be between 0.5 and 0.8, preferably 0.667. The biomass conveyed by the auger inside the vertical retort with a length between 1 and 15 metres, preferably 6 metres is heated, dried, degassed, and undergoes partial carbonisation. The retort is finished with a cylindrical element comprising

15 a set of connected parallel bars forming a palisade-like shape. This element positively affects the heating of the biomass leaving the vertical retort and the outflow of gases from inside the retort into a vortex combustion chamber located beneath the inner tube. Some biomass may move through gaps between the bars into the vortex combustion

20 chamber. At the top of the retort there are openings through which water vapour escapes into the combustion chamber. The vortex combustion chamber has a cylinder shape, and its side walls are equipped with tangent nozzles that supply air for the combustion of the gases generated during biomass degassing. It is preferable that the air supply nozzles are

25 placed at four locations distributed evenly along the perimeter of the vortex combustion chamber, and it is preferable that the nozzles are placed on several levels, preferably on 4 levels. The diameter of the vortex

combustion chamber is larger than the outside diameter of the retort, preferably 1.2 to 4 times larger, preferably 2 times larger. The height of the vortex combustion chamber preferably is from 0.5 to 3 diameters of the vortex combustion chamber, preferably 1.5. Under the retort and
5 the cylindrical element, there is a cone for redirecting the flow of biomass from vertical to horizontal. The diameter of the base of the cone preferably is from 0.6 to 0.9 of the inner diameter of vortex combustion chamber, most preferably 0.85. The angle between the base of the cone and the slant height that determines the side surface of the cone is
10 between 10 and 45°, preferably 20°. Above the surface of the cone, there is a mixer for raking and flipping the biomass on the cone. The mixer should preferably be equipped with 2 to 8 arms arranged so as to ensure proper mixing and raking of biomass, preferably 4 arms. Some or all gases generated during biomass of degassing are combusted in the vortex
15 combustion chamber, above the layer of biomass. The generated exhaust gases flow through a circular flue, in which a retort is installed. The retort is equipped on its outer surface with an additional auger that extends the duration of the exhaust gas stay in the vicinity of the retort. The auger strip outside the retort is inclined at an angle from 30° to 60° relative to
20 the lateral plane of the outer tube, preferably at an angle of 45°. The diameter of the flue is between 1.3 and 2.2 times the outer diameter of the retort, most preferably 1.7. The length of the flue corresponds to the length of the retort. The exhaust gases that leave the flue are directed into a cyclone and subsequently into an afterburn chamber for afterburning.

25 The carbonised biomass in the vortex combustion chamber, as a result of the combustion of a part of volatile components and the mixing, moves along the surface of the cone and flows into the bottom part of the

reactor, which is cylindrical and its cross-section preferably changes to square along the way. Any remaining gases and tars are removed from the carbonised biomass, which stays and moves downwards in a ceramic chamber intended to be located under the cone. The obtained gases flow
5 in the vertical direction and escape through an opening in the cone, whereas the tars may be carbonised on the biocoal grains located above. The cylindrical part is equipped with at least two levels of tubes with openings facing down and the sides intended for adding water vapour or other additives to the hot biocoal to activate it, and to control the
10 carbonisation ratio and temperature. These tubes are spaced horizontally preferably by 100 to 200 mm, most preferably 150 mm, and the distance between the levels is preferably between 100 and 200 mm, most preferably 150 mm. The tubes located at the respective levels can be arranged perpendicular to each other or in parallel and moved by half the
15 distance between the tubes at a level. The openings in the tubes located along their length can be spaced by 50 to 200 mm, preferably by 100 mm. The diameter of the openings should be sufficient to enable the flow of water vapour at a speed from 0.5 to 5 m/s, preferably 2 m/s.

In the bottom part of the device there is a system for discharging the
20 product and cooling it at the same time. Preferably, the system has a "V" shape so as to enable the discharge of the product from the device. This shape is preferable due to minimum risk of product jamming. The heat exchange surface is increased, which is necessary for the purposes of cooling. This element may be designed as a banded structure with water.

25 The process of biomass carbonisation in the device according to the invention involves feeding fragmented biomass from the tray to the inside of the reactor, where the biomass is heat-dried, degassed and carbonised.

The device is equipped with systems for the control of the flow of the biomass fed to the inside of the reactor. The fed biomass is conveyed vertically with an auger in the downward direction inside a metal retort. The biomass conveyed by the auger inside the vertical retort is heated, 5 dried, degassed, and undergoes partial carbonisation. Some biomass may move through gaps in the cylindrical element, between the bars, into the vortex combustion chamber. Some or all gases generated during biomass of degassing are combusted in the vortex combustion chamber, above the layer of biomass. The generated exhaust gases flow through a circular flue 10 in which the retort is located, whose outer surface is equipped with auger coils that extend the duration of the exhaust gas stay in the vicinity of the retort. The exhaust gases that leave the flue are directed into a cyclone and subsequently into an afterburn chamber for afterburning. The carbonised biomass in the vortex combustion chamber, as a result of 15 the combustion of a part of volatile components and the mixing, moves along the surface of the cone and flows into the bottom part of the reactor. The product is collected in the bottom part of the device.

The device for biomass carbonisation solves the following issues:

- 20 • The device for biomass carbonisation can be used for the carbonisation of biomass with high moisture content, as it is installed inside a reactor of a vertical retort, which dries the biomass. The design solutions known in the prior art use dryers as additional elements of the installation. This may give rise to 25 significant issues with the interactions between an external dryer and a reactor for biomass carbonisation relating to adequate performance of both devices, and to the control of the temperature

of biomass downstream at a dryer outlet and at the inlet of a carbonising reactor. In specific circumstances the biomass therein may ignite. The proposed solution obviates the hazard of biomass ignition in the case of integration of drying and carbonisation within one device, and, in the case of low moisture content of biomass, the inner dryer (i.e. the vertical retort) may also serve as a zone for initial pyrolysis and carbonisation of biomass so as to substantially increase in the biomass carbonisation performance of the entire device.

- Under the vertical retort, which also acts as a dryer or the zone of initial carbonisation, there is a cone for redirecting the flow of carbonised biomass to extend the duration of its stay in the high temperature zone to enable rapid carbonisation. The use of a mixer above the cone allows the carbonised biomass to be mixed so that the obtained product, i.e. biocoal is characterised by high carbon content and high uniformity. The use of a cone and a mixer intensifies the carbonisation process, which directly improves the performance of the device for biomass carbonisation. The carbonised biomass flowing under the cone may undergo further degassing due to the high temperature (if large lumps of biocoal are present) so as to obtain a product with higher quality. For this purpose the cone described above was truncated, and the opening thus obtained enables free escape of gases from the biomass carbonisation process to the vortex chamber of the reactor.
- Any remaining gases and tars are removed from the carbonised biomass, which stays and moves downwards in a ceramic chamber

intended to be located under the cone. The obtained gases flow in the vertical direction and escape through an opening in the cone, whereas the tars may be carbonised on the biocoal grains located above. This protects the inside of the reactor against the harmful effects of tar and simultaneously increases the efficiency of biocoal production.

- At the bottom of the ceramic chamber, there is a set of ducts for adding water vapour or other additives to the hot biocoal to activate it. This enables the production of biocoal with a high carbon content and with predetermined physical characteristics, e.g. with the ability to adsorb selected gases. Products made by using this solution can be used not only for burning but also in the chemical industry.

The device according to the invention is presented in figures, where fig. 1 presents the diagram of the design of the device for biomass combustion, fig. 2 – the design of the inner tube, and fig. 3 – the design of the vortex combustion chamber.

The device according to the invention comprises a tray at the top part of the device hermetically connected with the inside of the device. Inside the device, there is a vertical retort 2 i.e. a metal tube with a length of 6 metres, with inner diameter preferably of 600 mm, through which biomass is conveyed vertically in the downward direction. Inside the retort 2 there is an inner tube 13 with an outer diameter of 400 mm, onto which an augered strip 12 is attached. The inner tube 13 is attached to the top part of the device in a swivelling manner. The augered strip 12 is inclined

at an angle of 45° relative to the lateral plane of the inner tube. The inclination of the augered strip 12 improves the contact surface of biomass with the inner surface of the retort 2. The inclination of the augered strip 12 of 45° is preferable due to the flow of the gases generated during the drying and degassing of biomass. The pitch of the auger 12 ensures that the biomass on the surface of the auger biomass does not move spontaneously. The ratio of the outer diameter of the inner tube 13 with the auger 12 to the inner diameter of the retort is 0.667. The biomass conveyed by the auger inside the vertical retort 2 with a length of 6 metres is heated, dried, degassed, and undergoes partial carbonisation. The retort 2 is finished with a cylindrical element comprising a set of connected parallel bars 7 forming a palisade-like shape. This element positively affects the heating of the biomass leaving the vertical retort and the outflow of gases from inside the retort 2 into a vortex combustion chamber 9 located beneath the inner tube 12. Some biomass may move through gaps between the bars into the vortex combustion chamber 9. At the top of the retort 2, there are openings 1 through which water vapour escapes into the vortex combustion chamber 9. The vortex combustion chamber 9 has a cylinder shape, and its side walls are equipped with tangent nozzles 14 that supply air fed from the outside via the duct 6 for the combustion of the gases generated during biomass degassing. It is preferable that the air supply nozzles 14 are placed at four locations distributed evenly along the perimeter of the vortex combustion chamber 9 on 4 levels. The diameter of the vortex combustion chamber 9 is two times larger than the outside diameter of the retort 2. The height of the vortex combustion chamber 9 is 1.5 of the diameter of the vortex combustion chamber 9. Under the retort 2 and

the cylindrical element there is a truncated cone 10 for redirecting the flow of biomass from vertical to horizontal. The diameter of the base of the cone 10 is 0.85 of the inner diameter of vortex combustion chamber 9. The angle between the base of the cone 10 and the slant height that
5 determines the side surface of the cone 10 is 20° . Above the surface of the cone 10 there is a mixer for raking and flipping the biomass on the cone 10. The mixer 8 is equipped with 4 arms. Some or all gases generated during biomass of degassing are combusted in the vortex combustion chamber 9, above the layer of biomass. The generated exhaust gases flow
10 through a circular flue 5, in which a retort is installed. The flue 5 consists of a brickwork clad on the outside with an insulation layer 4. The retort 2 is equipped on its outer surface with an additional auger that extends the duration of the exhaust gas stay in the vicinity of the retort 2. The auger strip outside the retort 2 is inclined at an angle of 45° relative to the
15 lateral plane of the outer tube. The diameter of the flue is 1.7 times the outer diameter of the retort 2. The length of the flue corresponds to the length of the retort 2. The exhaust gases that leave the flue are directed into a cyclone and subsequently into an afterburn chamber for afterburning. The carbonised biomass 16 in the vortex combustion
20 chamber 9, as a result of the combustion of some volatile components and the mixing, moves along the surface of the cone 10 and flows into the bottom part of the reactor, which is cylindrical and its cross-section changes to square along the way. Any remaining gases 15 and tars are removed from the carbonised biomass 16 which stays and moves
25 downwards. The obtained gases 15 flow in the vertical direction and escape through an opening in the cone 10, whereas the tars may be carbonised on the biocoal grains located above. This protects the inside of

the reactor against the harmful effects of tar and simultaneously increases the efficiency of biocoal production. The cylindrical part is equipped with two levels of tubes 11 with openings facing down and the sides intended for adding water vapour or other additives to the hot biocoal to activate it, and to control the carbonisation ratio and temperature. The tubes 11 are spaced horizontally by 150 mm, and the distance between the levels is 150 mm. The tubes 11 located at the respective levels can be arranged perpendicular to each other or in parallel and moved by half the distance between the tubes at a level. The openings in the tubes 11 located along their length are spaced by 100 mm. The diameter of the openings should be sufficient to enable the flow of water vapour at a speed from 0.5 to 5 m/s. In the bottom part of the device there is a system for discharging the product and cooling it at the same time. The system has a "V" shape so as to enable the discharge of the product from the device. This shape is preferable due to minimum risk of product jamming. The heat exchange surface is increased, which is necessary for the purposes of cooling. This element is designed as a bundled structure with water.

Table 1 summarises the results of the technical and elemental analysis and the obtained product averaged over 6 hours of steady operation of the device according to the invention. 12 samples of raw biomass and biocoal were collected during this period.

Table 1

Parameter	Biomass	Biocarbon
The total moisture in the operational condition [%]	37,3	4,5
Ash [%]	1,2	7,2
Volatile components [%]	81,3	13,1
Fixed Carbon [%]	17,5	79,7

Bulk density [kg/m ³]	169	128
Heat of combustion [kJ/kg]	20159	29732
Calorific value [kJ/kg]	18091	28974
C [%]	46,24	82,43
H [%]	5,15	2,87
N [%]	0,42	0,79
S [%]	0,019	0,002
O [%]	46,97	6,71

The average values summarised in table 1 demonstrate that the product obtained during the tests in optimum process conditions constitutes biocarbon with a content of carbon above 80%, fixed carbon near 80%, and with a low moisture content of less than 5%. The product obtained by carbonisation has high calorific value.

The tests also demonstrated that

1. The total moisture of the raw biomass samples generally falls within the range of 33-43%, however, in adverse weather conditions (e.g. rain) and without adequate protection, it can substantially increase and reach as much as above 60%, which corresponds to a moisture level of fresh biomass. Since implementation of autothermal carbonisation of biomass with a moisture content above approximately 30-35% poses difficulties, in this case an upstream dryer of raw material must be installed so that woodchips that are fed into the reactor have a moisture content of approximately 20-30%. The moisture content in the product of carbonisation was low (<10%, cf. table 2), which can be most likely attributed to the absorption of ambient humidity by dry biocoal (biocarbon) during cooling;

2. The ash content in biomass was very low and amounted to approximately 1-2.5%. The ash content in biocoal amounted to approximately 7-12%;
3. The sample woodchips and biocarbon differed substantially in terms
5 of the estimated content of fixed carbon, with approximately 10-20% for biomass, and 50-80% for biocoal. These substantial differences in the fixed carbon content in the product also point to broad possibilities of controlling and modifying the parameters of a carbonisation process (duration of stay and temperature) with the
10 use of the described device, which enables the adjustment of operational conditions to the fuel;
4. A comparison of the summarised values of bulk density of the woodchips and the biocoal (approximately 146-171 kg/m³ and 95-165 kg/m³ respectively) shows that the product is up to 50%
15 lighter than the fed biomass. The improved carbonisation of the raw material (as evidenced e.g., by lower content of volatile components and higher carbon and fixed carbon content) results in decreased bulk density of the product;
5. The heat of combustion and calorific values of the biocarbon
20 samples were very high amounting to – in the case of calorific value – in the range between 22 and 29.5 MJ/kg. These values were substantially (by a factor of 2) higher than the calorific values estimated for woodchips in their operational condition, and at the level of black coal of very good quality;
- 25 6. The results of the elemental analysis (C, H, N, S, O content) of the samples of woodchips and biocarbon. For carbon, the comparative analysis of the results points to an almost twofold increase of its

content in the carbonisation products compared to the fed woodchips – the respective values are in the range of 48-50% (woodchips) and 65-86% (biocarbon). The content of hydrogen and oxygen in the products also decreased due to heat treatment and carbonisation – these elements were most often discharged along with volatile components. An analysis of the N (nitrogen) and S (sulphur) content reveals their low percentages both in the carbonisation products and in raw biomass; the content of nitrogen is below 1%, and there is almost no sulphur;

5

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Patent Claims

- 5 1. A device for biomass carbonisation designed as a vertical reactor equipped with a column for drying and degassing of biomass and a combustion chamber with a cone-shaped grate and a scraper, and **characterised in that** it consists of a tray at the top part of the device hermetically connected with the inside of the device, and inside the device
- 10 there is a metal vertical retort (2), inside which there is an inner tube (13), onto which an augered strip is attached (12) inclined at an angle from 30° to 60° relative to the lateral plane of the tube (13), whereas the retort (2) is finished with a cylindrical element comprising a set of connected parallel bars, and the top part of the retort (2) is equipped with openings,
- 15 whereas a vortex combustion chamber (9) has a cylinder shape, and its side walls are equipped with tangent nozzles, and under the retort (2) and the cylindrical element there is a truncated cone (10), and above the surface of the cone (10) there is a mixer (8), and the retort (2) is inserted inside a circular flue (5) with a length corresponding to the length of the
- 20 retort (2), and the retort (2) is equipped on the outer surface with an additional auger (3), whose strip is inclined at an angle from 30° to 60° relative to the lateral plane of the outer tube, and the cylindrical part is equipped with at least two levels of tubes (11) with openings facing down and the sides, and in the bottom part of the device there is a system for
- 25 discharging the product.
2. The device according to claim 1, characterised in that the metal vertical retort (2) has a length between 1 and 15 metres.

3. The device according to claim 2, characterised in that the metal vertical retort (2) has a length of 6 metres.
4. The device according to claim 1, characterised in that the metal vertical retort (2) has an inner diameter between 400 and 1000 mm.
- 5 5. The device according to claim 4, characterised in that the metal vertical retort (2) has an inner diameter of 600 mm.
6. The device according to claim 1, characterised in the inner tube (13) has an inner diameter between 200 and 800 mm.
7. The device according to claim 4, characterised in the inner tube (13) has
10 an inner diameter of 400 mm.
8. The device according to claim 1, characterised in that the inner tube (13) is attached to the top part of the device in a swivelling manner.
9. The device according to claim 1, characterised in that the augered strip (12) of the inner tube (13) is inclined at an angle of 45°.
- 15 10. The device according to claim 1, characterised in that the ratio of the outer diameter of the inner tube (13) with the auger (12) to the inner diameter of the retort (2) is between 0.5 and 0.8.
11. The device according to claim 1, characterised in that the ratio of the outer diameter of the inner tube (13) with the auger (12) to the inner
20 diameter of the retort (2) is 0.667.
12. The device according to claim 1, characterised in that the air supply nozzles (14) are placed at four locations distributed evenly along the perimeter of the vortex combustion chamber (9).
13. The device according to claim 1, characterised in that the nozzles (14)
25 are located on several levels.
14. The device according to claim 13, characterised in that the nozzles (14) are located on 4 levels.

15. The device according to claim 1, characterised in that the diameter of the vortex combustion chamber (9) is 1.2 to 4 times larger than the outside diameter of the retort (2).

16. The device according to claim 15, characterised in that the diameter of
5 the vortex combustion chamber (9) is two times larger than the outside diameter of the retort (2).

17. The device according to claim 1, characterised in that the height of the vortex combustion chamber (9) is between 0.5 to 3 times the diameter of the vortex combustion chamber (9).

10 18. The device according to claim 17, characterised in that the height of the vortex combustion chamber (9) 1.5 times the diameter of the vortex combustion chamber (9).

19. The device according to claim 1, characterised in that the diameter of the base of the cone (10) is from 0.6 to 0.9 of the inner diameter of vortex
15 combustion chamber (9).

20. The device according to claim 19, characterised in that the diameter of the base of the cone (10) is 0.85 of the inner diameter of vortex combustion chamber (9).

21. The device according to claim 1, characterised in that the angle
20 between the base of the cone (10) and the slant height that determines the side surface of the cone (10) is between 10 and 45°.

22. The device according to claim 21, characterised in that the angle between the base of the cone (10) and the slant height that determines the side surface of the cone (10) is 20°.

23. The device according to claim 1, characterised in that the mixer (8) is
25 equipped with 2 to 8 arms.

24. The device according to claim 23, characterised in that the mixer (8) is equipped with 4 arms.

25. The device according to claim 1, characterised in that the additional augered strip (3) is inclined at an angle of 45° relative to the lateral plane
5 of the outer tube.

26. The device according to claim 1, characterised in that the diameter of the flue (5) is 1.3 to 2.2 times larger than the outer diameter of the retort (2).

27. The device according to claim 26, characterised in that the diameter of
10 the flue (5) is 1.7 times larger than the outer diameter of the retort (2).

28. The device according to claim 1, characterised in that the bottom part of the reactor, which is cylindrical and its cross-section changes to square along the way.

29. The device according to claim 1, characterised in the tubes (11) are
15 spaced horizontally by 100 to 200 mm.

30. The device according to claim 29, characterised in the tubes (11) are spaced horizontally by 150 mm.

31. The device according to claim 29, characterised in that the distance between the levels is from 100 to 200 mm.

20 32. The device according to claim 31, characterised in that the distance between the levels is 150 mm.

33. The device according to claim 29, characterised in that the tubes (11) located at the respective levels are arranged perpendicular to each other or in parallel and moved by half the distance between the tubes (11) at
25 a level.

34. The device according to claim 1, characterised in that the openings in the tubes (11) located along their length are spaced by 50 to 200 mm.

35. The device according to claim 34, characterised in that the openings in the tubes (11) located along their length are spaced by 100 mm.
36. The device according to claim 1, characterised in that the product discharge system has a "V" shape.
- 5 37. The device according to claim 37, characterised in that product discharge system is designed as a bundled structure with water.

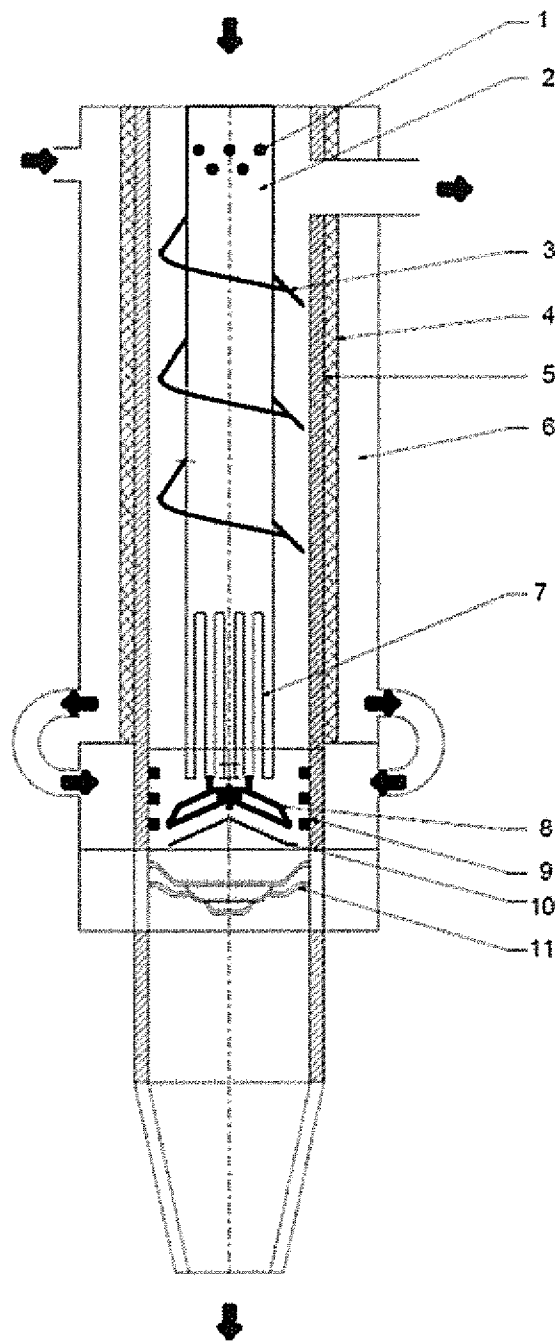


Fig. 1

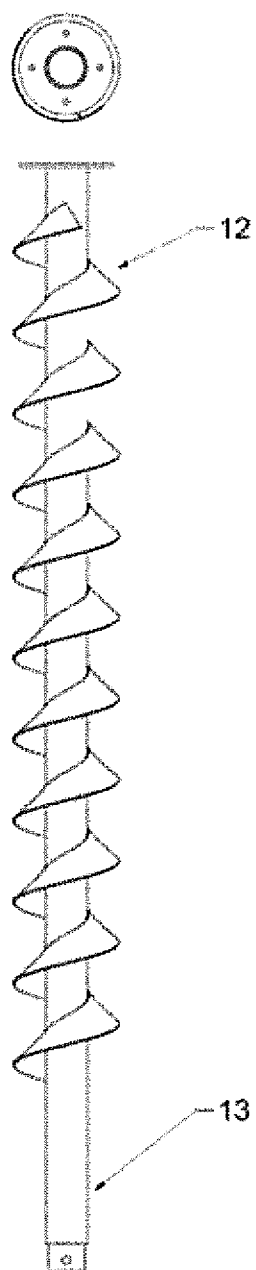


Fig. 2

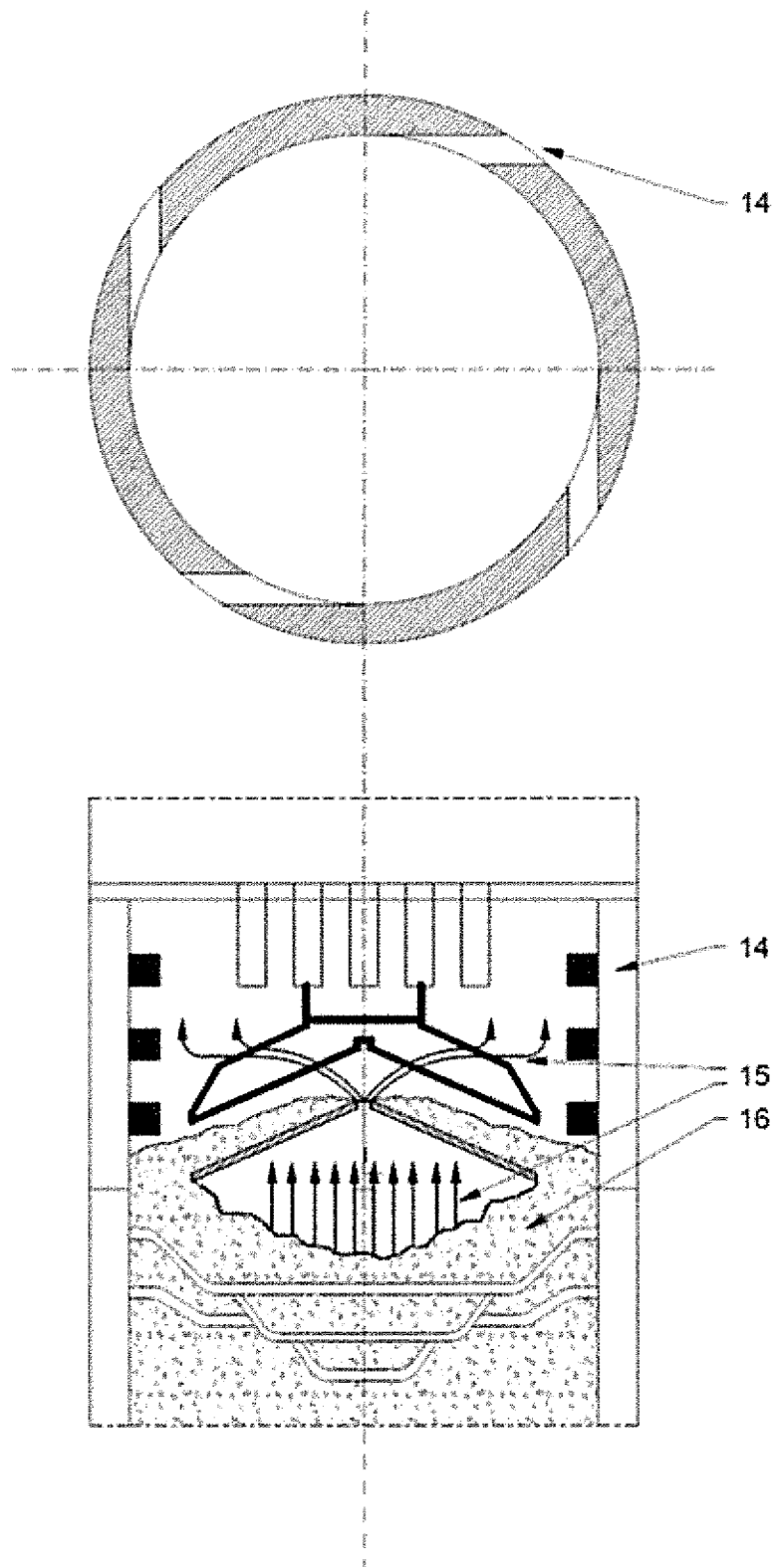


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/PL2017/000057

A. CLASSIFICATION OF SUBJECT MATTER		
INV. C10B1/04	C10B7/02	C10B7/10 C10B53/02 C10B57/10
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) C10B		
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		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PL 114 365 B2 (AKAD ROLNICZO TECH) 31 January 1981 (1981-01-31) cited in the application abstract; figures 1-3 -----	1-37
A	PL 118 613 B1 (KONIECPOLSKIE ZAKLADY PLYT PIL [PL]; OS BAD ROZWOJOWY PRZEM POLIGR [PL] 30 October 1981 (1981-10-30) cited in the application abstract; figures 1,2 -----	1-37
A	US 2010/258429 A1 (UGOLIN NICOLAS [FR]) 14 October 2010 (2010-10-14) paragraphs [0067] - [0069], [0084] - [0092]; figures 2-6 ----- -/-	1-37
☒ 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 application or patent 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 1 November 2017		Date of mailing of the international search report 09/11/2017
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 Bertin, Séverine

INTERNATIONAL SEARCH REPORT

International application No

PCT/PL2017/000057

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 2 343 349 A1 (BREITER MARK [CH]) 13 July 2011 (2011-07-13) claims 1-15; figure 1 paragraphs [0004], [0005] -----	1-37

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Information on patent family members

International application No

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