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(72) Inventor: **Morandi, Enzo**  
**53031 Siena (IT)**

(74) Representative: **Celestino, Marco**  
**ABM, Agenzia Brevetti & Marchi,**  
**Viale Giovanni Pisano, 31**  
**56123 Pisa (IT)**

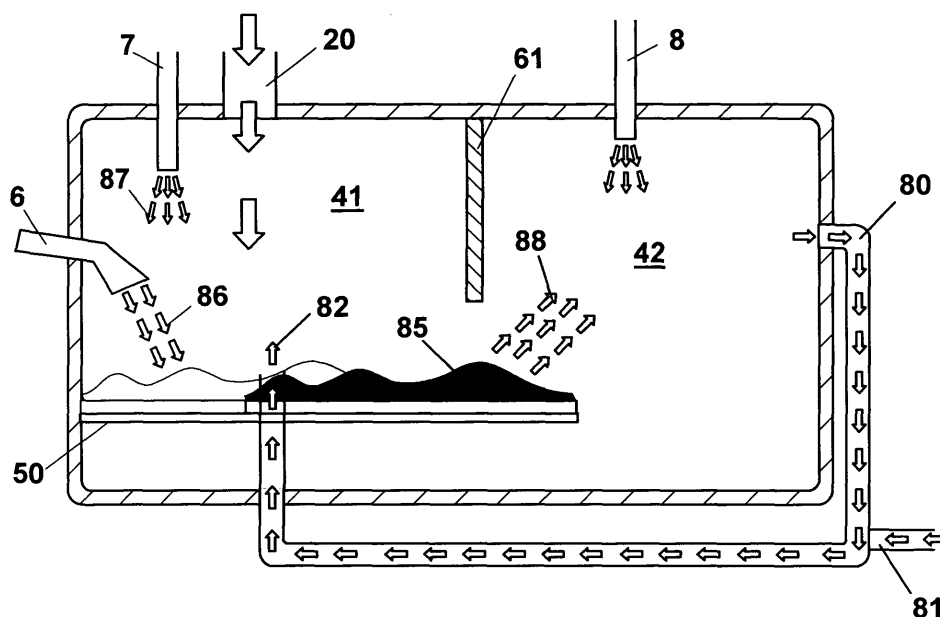
(71) Applicant: **Certo S.r.l.**  
**53036 Poggibonsi SI (IT)**

(54) **Method and apparatus for high temperature heat treatment of combustible material in particular waste**

(57) Apparatus (1) for high temperature heat treatment of combustible material, in particular municipal solid waste (waste products), or waste combustible of a desired nature, provided solid and not explosive, comprising a pyrolysis chamber (41) in which the material to treat is heated in a reducing environment to a temperature suitable for making a first molecular break of the substances in they present and a combustion chamber (42) within which is achieved a full combustion of the combustible material fed by feeding oxygen in amount predetermined. The full combustion of the combustible

material executed in combustion chamber (42) of the apparatus (1) produces, in particular, gas at high temperature that is sent to the pyrolysis chamber in order to raise remarkably the temperature of pyrolysis. This associated to the introducing water vapour, through a duct (6), and of air, through a duct (7), in pyrolysis chamber (41) produce semiwater gas that is then burnt in combustion chamber (42) by feeding a current (8) of a fluid containing oxygen to raise the combustion temperature in order to carry out the process to temperature that assures the molecular break of the totality of the toxic substances.

**Fig. 1**



## Description

### Field of the invention

**[0001]** The present invention relates to an apparatus for high temperature heat treatment of combustible material, in particular industrial and municipal waste of any kind, even toxic or noxious waste, for minimizing the dangerousness of the combustion products. Furthermore, the invention relates to a pyrolytic converter for recovering the energy content of said waste.

### Description of the prior art

**[0002]** It is well known that systems traditionally used for waste disposal, in particular municipal solid waste, provide either burying or burning the waste. Either solution has problems of environmental impact. In case of waste burying the risk is high of polluting for a very long time the underlying ground water table owing to percolates, whereas in case of burning, even if macro-pollutants such as particulates and smoke can be retained, the amount is high of micro-pollutants introduced in the environment.

**[0003]** In the last years attempts have been made for alternative systems. In particular, waste pyrolytic processes have been proposed, i.e. heat treatments for transformation of large molecules into simpler substances. This transformation is made in an environment poor in oxygen and at a high temperature enough to volatilize the organic pollutants. More in detail, without oxygen, i.e. in a reducing environment, pyrolysis causes the thermochemical decomposition of the material. The process, for its endothermic nature, causes the scission of the complex molecules that form rubber, plastics, cellulosic components and other complex chemical components, turning them into structurally simpler molecules.

**[0004]** This way, at the end of the pyrolytic process a gaseous combustible mixture is obtained that can be used, for example, for feeding a gas turbine and producing, then, electric energy. More in detail, the combustion of the waste causes a thermal decomposition and mineralisation of the many organic substances contained in the waste and a transformation of inorganic substances into more easily separable species, which can be recovered or can be safely disposed of, thus allowing a huge reduction of the weight and of the volume of the waste (reaching up to 10% of the starting volume).

**[0005]** The waste that can be treated in this type of plants may be residues from paper, plastics, rubber converting processes, tyres, as well as combustible material obtained from biomass, such as wood and agriculture residues, and even organic material such as waste of hospitals or toxic/noxious industrial waste.

**[0006]** The substances emitted in the traditional combustion processes are the following: dust, carbon monoxide, sulphur dioxide, nitrogen oxides, hydrochloric or hydrofluoric acid, heavy metals and chloride-organic

substances (dioxins and furans).

**[0007]** In particular, the presence of dioxins and furans in the exhausted flue gas causes a strong environmental impact of the existing processes. The production of dioxins and furans occurs mainly owing to a not full combustion of the waste products. For minimizing the creation of these highly polluting substances, the combustion process must provide: the supply of a sufficient amount of oxygen, a high temperature and long time of contact. Alternatively, the resulting dioxins and the furans can be filtered with the aid of activated carbon (with very high costs of operation) or other filtering systems.

**[0008]** However, the existing apparatus for burning waste, for example of the type described in US 3759036 and US 4732092, is not always capable of avoiding the emission of pollutants so that they fall within the limits provided by the environmental laws. In other cases, instead, it is possible to fall within said limits only with the use of structurally complicated and expensive apparatus, in particular concerning the energy necessary for completing the process.

### Summary of the invention

**[0009]** It is a feature of the present invention to provide a waste heat treatment method that provides a strong reduction of the pollutants present in the flue gas with a considerable energy saving with respect to the solutions of prior art.

**[0010]** It is also a feature of the present invention to provide a waste heat treatment method for conveying the gas products within a burning apparatus even in the presence of very high temperature.

**[0011]** It is also a feature of the present invention to provide such a waste heat treatment method that allows to obtain an optimal recovering of the energy content of said waste.

**[0012]** It is, furthermore, a feature of the present invention to provide a pyrolytic converter that carries out this method.

**[0013]** These and other features are accomplished with one exemplary method for high temperature heat treatment of combustible material, in particular of waste, said heat treatment being carried out between a pyrolysis chamber, where said combustible material is heated in a reducing environment, and a combustion chamber, where said combustible material is completely burnt by introducing a current containing oxygen. The main feature of the method is that in the pyrolysis chamber gas at high temperature and vapour are inserted, said introduction causing the production of semiwater gas. The gas at high temperature is burnt gas drawn downstream of the combustion chamber. The semiwater gas formed in the pyrolysis chamber, once reached the combustion chamber, is burnt causing a considerable rise of the combustion temperature. In other words, in the pyrolysis chamber the combustible material is heated in a

reducing environment up to a determined temperature suitable for causing a preliminary combustion, obtaining partially burnt material and semiwater gas, comprising air gas and water gas. In the combustion chamber, located downstream of the pyrolysis chamber, the partially burnt material and the semiwater gas are then fed and subjected to a further oxygenation/combustion with production of a gaseous mixture at high temperature.

**[0014]** In particular, the production of semiwater gas in the pyrolysis chamber is carried out sending a vapour jet and a gas jet at high temperature on the burning material which is arranged on a grid, and then the burning material reaches the combustion chamber by moving the grid. Advantageously, the semiwater gas reaches a predetermined zone of the combustion chamber according to a path different from that of the combustible material.

**[0015]** In particular, the gas at high temperature produced in the combustion chamber can cross a post-combustion chamber within which a further heating is effected by feeding a further current containing oxygen with completion of the combustion. Then, the burnt gas produced in the post-combustion chamber, having a low oxygen content, is sent to the pyrolysis chamber.

**[0016]** In a preferred aspect of the method according to the invention, the gas produced in one of the chambers is transferred between a starting chamber and an arrival chamber by a system comprising a conveying fluid current that is supplied within a duct that connects the chambers same. The said conveying fluid is fed into the duct direct towards the arrival chamber at a suitable speed to cause a suction of the gas inside. More in detail, both the high speed of the conveying fluid and its expansion, which occurs at the outlet arrival chamber, attract in the duct the same gas to convey, i.e. the semiwater gas or the burnt gas. The attraction, therefore, on one hand occurs by entrainment and on the other hand by pressure difference between the inlet and the outlet of the duct. The above can be exploited both for conveying the semiwater gas from the pyrolysis chamber to the combustion chamber, both for conveying to the pyrolysis chamber the gas at high temperature produced in the combustion chamber, or the burnt gas produced in the post-combustion chamber.

**[0017]** In particular, for conveying the gas at high temperature, or the burnt gas, to the pyrolysis chamber, in the duct conveying water vapour is fed as conveying fluid. This way, the water vapour used as conveying fluid can be also used to obtain water gas in the pyrolysis chamber.

**[0018]** The conveyance of the semiwater gas from the pyrolysis chamber to the combustion chamber is made by sending in the duct variably oxygenated conveying gas as conveying fluid. More in detail, according to the process conditions it is possible to adjust the amount of oxygen supplied.

**[0019]** Advantageously, the burnt gas produced in the post-combustion chamber before being conveyed to the

pyrolysis chamber is separated from possible solid particles giving a vortical movement to the burnt gas, which separate from the solid particles by centrifugal acceleration. This can be made, for example, forcing the burnt gas against the walls of said post-combustion chamber which are suitable for causing said vortical movement.

**[0020]** Advantageously, a preliminary ignition step is provided suitable for heating the different chambers up to a determined temperature. In particular, the step of heating the pyrolysis chamber provides a preliminary ignition step for bringing the pyrolysis chamber up to a determined temperature necessary so that the reactions take place for the creation of air gas and of water gas. Then, the process is auto-fed. In fact, the production of the gaseous mixture comprising the air gas and the water gas is made sending an air jet and a vapour jet on the burning material in the pyrolysis chamber when it has achieved a measured temperature. When the air jet and the vapour jet are sent on the burning material the semiwater gas, i.e. air gas and water gas, is produced according to known reactions. More in detail, the reaction that causes the production of water gas is an endothermic reaction and the required energy is supplied by the reaction that causes the production of the air gas that is instead an exothermic reaction. Sending then in the pyrolysis chamber a suitable amount of vapour and of air, according to the parameters of process used, in particular responsive to the composition of the combustible material, in particular municipal solid waste, in steady conditions an auto-fed process is obtained.

**[0021]** Like for the pyrolysis chamber, also in the combustion chamber a preliminary heating step is provided suitable for bringing the combustion chamber same to a determined temperature, in particular this step is made before conveying the burnt gas to the pyrolysis chamber. This to avoid conveying in the pyrolysis chamber gas with high content of oxygen that would be potentially dangerous since it could give rise to explosions and backfire.

**[0022]** In particular, conveying in the pyrolysis chamber at least one part of the burnt gas produced in the post-combustion chamber is made only when the temperature in the different chambers has achieved determined values. This because until the temperature in the combustion chamber has not achieved a determined value the amount of oxygen is very high and then it is not possible sending the mixture of gas to the pyrolysis chamber for not to affect its correct operation.

**[0023]** Advantageously, a step is provided of feeding the combustible material in the pyrolysis chamber by forcing it through a tapered duct in order to reduce its volume. This avoids dangerous backfire, provides a semi-combustion of the combustible material and assists a measurement of its composition, in particular on the content of carbon in order to adjust the flows and the temperature in the different chambers of the apparatus.

**[0024]** Advantageously, downstream of the heat treatment of the combustible material treatments are provided

ed of reduction of the waste material. In particular, a treatment of neutralisation is provided, which exploits the produced heat during the heat treatment of the combustible material making inert substances from the ashes deriving from the combustion. More in detail, the ashes coming from the apparatus are superheated by jets of semiwater gas and by air at high temperature for then melting and flowing through a crucible having an opening, an air or vapour jet transforming it into inert grains. Or, the molten material can be fed to special moulds, forming bricks for the building industry.

**[0025]** According to another aspect of the invention, an apparatus for heat treatment of combustible material, in particular waste, comprises a pyrolysis chamber where the combustible material is heated in a reducing environment and a combustion chamber where the combustible material is conveyed for being completely burnt, whose main feature is that said pyrolysis chamber comprises means for feeding a gas at high temperature drawn from the combustion chamber and vapour, in order to make semiwater gas which, once reached the combustion chamber, is burnt for causing a considerable rise of the combustion temperature.

**[0026]** Means can be provided for conveying the semiwater gas from the pyrolysis chamber to the combustion chamber according to a path different from that of the combustible material.

**[0027]** Advantageously, means are provided for connecting a starting chamber to an arrival chamber, in particular for conveying the semiwater gas from the pyrolysis chamber to the combustion chamber or for conveying at least one part of the burnt gas up to the pyrolysis chamber, comprising at least one duct communicating with both the chambers within which a conveying fluid current is fed, the said conveying fluid being supplied to said duct at a suitable speed to cause a suction inside, in particular of the semiwater gas or the burnt gas.

**[0028]** Advantageously, downstream of the combustion chamber a post-combustion chamber can be provided within which the gaseous mixture is further heated at high temperature obtaining burnt gas by feeding a current containing oxygen, said further heating causing a full decomposition of the part of the gaseous mixture not yet dissociated.

**[0029]** Advantageously, means are provided for feeding the combustible material in the pyrolysis chamber comprising means for forcing the passage through a tapered duct in order to reduce its volume.

**[0030]** According to an exemplary embodiment of the invention the means for forcing the motion of the combustible material in the feeding duct comprise a conical track system. In particular, the feeding means are associated to means for measuring at least one parameter of process in the pyrolysis chamber. This adjusts the feeding speed of the combustible material in the pyrolysis chamber according to the variation of the parameters of process, in particular of the temperature in the pyrolysis chamber.

**[0031]** Advantageously, in each chamber ignition means are provided suitable for giving the starting energy necessary for activating the heat treatment of the combustible material.

**[0032]** In particular, in the apparatus directional elements can be arranged of refractory material suitable for deflecting a flow of gas to determined zones of the apparatus, said directional elements being arranged between the different chambers of the apparatus.

**[0033]** Advantageously, in each chamber of the apparatus directional elements are provided of the gas flow obtained during the heat treatment of the combustible material. In particular, the directional elements of the gas flow are diaphragms suitably shaped of refractory material that define the different chambers of the apparatus.

**[0034]** In each chamber of the apparatus, furthermore, ducts are provided for introducing hot air.

#### Brief description of the drawings

**[0035]** Further characteristics and the advantages of the method and apparatus for high temperature heat treatment of combustible material, in particular waste, according to the present invention will be made clearer with the following description of an exemplary embodiment thereof exemplifying but not limitative, with reference to the attached drawings wherein:

- figure 1 shows diagrammatically a first exemplary embodiment of an apparatus for high temperature heat treatment of combustible material, in particular waste, according to the present invention;
- figure 2 shows diagrammatically an alternative exemplary embodiment of the apparatus of figure 1;
- figure 3 shows a simplified block diagram of the method for heat treatment of waste operated by the apparatus for figures 1 and 2.

#### Description of a preferred exemplary embodiment

**[0036]** In figure 1 a first exemplary embodiment is diagrammatically shown of an apparatus 1, according to the present invention, for high temperature heat treatment of combustible material, in particular municipal solid waste (waste products), or combustible waste of a desired nature, provided that it is a solid and not explosive waste. It comprises a pyrolysis chamber 41, where the material 85 to treat is heated in a reducing environment, up to a temperature suitable for making a first molecular break of the substances in it present, and a combustion chamber 42 within which a full combustion is achieved of the combustible material by introducing a predetermined flow of oxygen 8. The full combustion of the combustible material is carried out only in combustion chamber 42 of the apparatus 1 and produces, in particular, gas at high temperature that is directed back to pyrolysis chamber 41 in order to remarkably raise the tempera-

ture of pyrolysis. In addition to this water vapour 86, through a duct 6, and air 87, through a duct 7, are added into pyrolysis chamber 41 to produce semiwater gas that is then burnt in combustion chamber 42 by feeding a current 8 of a fluid containing oxygen to raise the combustion temperature in order to carry out the process at a temperature that assures the molecular break of the totality of the toxic substances. According to the invention a part of the burnt gas 88 produced by the combustion of the burning material 85 in combustion chamber 42 is sent to pyrolysis chamber 41 through a duct 80 by introducing a conveying fluid 81. The current of burnt gas 82 that reaches pyrolysis chamber 41 crosses the burning material to cause the production of the semiwater gas.

**[0037]** In figure 2 an alternative exemplary embodiment is diagrammatically shown of the apparatus 1 of figure 1. The substantial difference with the previous exemplary embodiment is the presence of a post-combustion chamber 43 downstream of combustion chamber 42. In both cases a preliminary step is always provided of feeding the waste subject to heat treatment in pyrolysis chamber 41 through a tapered duct 20, block 101 of figure 3. In duct 20 the waste is preheated up to a temperature of about 300°C exploiting the heat produced in pyrolysis chamber 41, and that may be assisted with the use of a electrical resistance, not shown in the figure, arranged along the duct same. The feeding of the waste through duct 20 is effected by a system of toothed tracks 55 that at the same time compress and push forward the waste that in pyrolysis chamber 41 roll on a first hot deflector 61 and then fall on a movable grid 50 arranged inclined in pyrolysis chamber 41.

**[0038]** The feeding system above described causes a considerable reduction of the volume of the waste and reduces the possibility of backfire from pyrolysis chamber 41, making also easier both the steps of semi-combustion of the waste same and a satisfactory measure of the content of carbon in the introduced waste. The content of carbon in the introduced waste is strictly linked to the nature of the waste treated and is a parameter of process of primary importance, on the basis of which the gas flows introduced in the apparatus are then adjusted.

**[0039]** In pyrolysis chamber 41 and behind combustion chamber 42 ignition means are arranged, for example methane gas burners 25, for bringing the temperature in the chamber to a determined temperature beyond which the system practically is auto-fed and does not require other supply of energy from the outside. Once achieved the determined temperature, in fact, the burner 25 can be deactivated, since the material present in the pyrolysis chamber continues burning for the heat transmitted for conductivity from the combustion chamber. In steady conditions the temperature in the pyrolysis chamber is about 800-900°C and allows to gasify a large part of the material deposited on grid 50, block 102 of figure 2.

**[0040]** Once achieved a determined temperature in pyrolysis chamber 41 an compressed air jet 11 and a water vapour jet are directed onto the material at high temperature to create a semiwater gas comprising water gas and air gas, as previously said, according to known reactions. In particular, the reaction that causes the production of the air gas is an exothermic reaction i.e. it occurs with release of a certain amount of energy, which is used for the reaction that produces water gas, which is instead an endothermic reaction, i.e. it occurs with absorption of energy. On this basis the system can be said as completely auto-fed.

**[0041]** The semiwater gas produced as above has a heating power that even if not comparable to that of traditional fuel, is in any case high enough because when burning it an amount can be obtained of energy to cause a further remarkable rise of the temperature. In order to exploit the potentiality of the semiwater gas versus energy, the gas is in part transferred from pyrolysis chamber 41, where it has been just produced, to combustion chamber 42. The semiwater gas can be conveyed, for example, through a duct 21 in which a conveying fluid passes and connecting pyrolysis chamber 41 with combustion chamber 42. More in detail, into duct 21 a conveying fluid current is fed at a suitable speed to cause a suction of the semiwater gas inside, also owing to the expansion of the conveying fluid same that occurs when it reaches combustion chamber 42. In particular, in duct 21 two channels are arranged, a first channel fed with air with a variable oxygen content according to the process needs, and the second channel fed with a current of vapour. This exemplary embodiment avoids the use of fans or other propelling systems to convey the semiwater gas, with a considerable energy saving and reduction of maintenance costs. The vapour is superheated in a way not shown using the heat of the burnt gas.

**[0042]** From the pyrolysis chamber the partially burnt material present on grid 50 burns in low oxygenated conditions and forms a "brazier" that is repeatedly transferred to combustion chamber 42, block 103. This is made by grid 50 that is moved in the direction indicated by the arrows in the figure. At the two sides of the waste feeding tapered duct two ducts are provided that end in combustion chamber 42 with two spray nozzles each, one for compressed air and one for oxygen, oriented towards the rear part that carry the gas formed in the high part of pyrolysis chamber 41. In pyrolysis chamber 41 sensors can be arranged for measuring parameters of process such as temperature, pressure and carbon content or the amount of unburnt hydrocarbons on the basis of which are the inlet flows are adjusted.

**[0043]** In the combustion chamber 42 an almost complete combustion of the combustible material is achieved, in part entrained by the gas flow and in part displaced by grid 50. The combustible material under heat treatment is hit by jets of extremely hot air, which burning completes the combustion of the waste, that was already carbonized in pyrolysis chamber 41.

[0044] The gas produced by the combustion of the material arranged on grid 50 in combustion chamber 42 move upwards and in the higher part of chamber 42 mix with the air and the semiwater gas flowing from pyrolysis chamber 41 and that are burning at high temperature (1200-1400°C).

[0045] In combustion chamber 42 a further air flow is supplied at high temperature through a duct 11. The warm air exits at a diaphragm 62 that divides combustion chamber 42 from a third chamber, or post-combustion chamber 43, crossing combustion chamber 42 in the centre and oxygenating the remaining partially burnt waste in addition to lateral semiwater gas flows. This way, the temperature is further raised up to about 1600°C that provides a substantially total dissociation of the molecules present.

The burnt gas comes then to a third chamber, or post-combustion chamber, in which they are further oxygenated by extremely hot air coming from a duct 12. In the last part of this post-combustion chamber, immediately behind another flow-deflecting diaphragm 63, which, as the other two diaphragms, is made of special refractory material, before that the "flue gas" reaches a vapour generating heat exchanger, two opposite and oblique vapour jets slightly cool the gas and create a vertical current for causing the loss of solid particles and for increasing the heat exchange coefficient within the heat exchanger. In this zone of the plant a part of burnt gas is drawn back for being conveyed to the pyrolysis chamber by means of water vapour. This can be made, for example, by a duct 80 in which the vapour is inserted at high pressure and at a high speed through an inlet 81. The high speed of the vapour and the expansion that is achieved at the outlet 83 when entering pyrolysis chamber 41 attracts the burnt gas produced in the post-combustion chamber 43 into duct 80 causing their conveyance through it, using the same system as above described for conveying the semiwater gas from pyrolysis chamber 41 to combustion chamber 42.

[0046] The apparatus 1 for heat treatment of waste can be coupled to systems of reduction of polluting residues. In particular, the burnt gas coming from the post-combustion chamber 43 still hot and containing residue particles, can be "washed" and cooled further in a scrubber, block 107. In the first part of the scrubber any solid or gaseous substances which escaped from dissociation in post-burner 43 are precipitated and captured. In the second part of the scrubber, the same reactions are repeated as in the first part, but with addition of water and basic reactants, in order to eliminate any residue acid substances. In the scrubber sludge is formed that is then put in the heat treatment cycle for being inertized.

[0047] Finally, the gas can be conveyed through a biofilter before being released in the atmosphere, in order to provide to a complete removal of toxic and noxious substances. The action of the biofilter begins with a saturation of the gas, by water vapour, to pass then to the first layer, comprising lignite and organic carbon, in which

colonies of specially selected bacteria live. From here the gas passes through second layer, comprising peat, also this containing colonies of specially selected bacteria, different from the previous and that selectively attack other products; in a third and last layer, formed by chips and saw dust of wood, other bacteria are present that together with a catalyst attack any residue possible molecules of furans or dioxins.

[0048] Similarly, a system of reduction of any solid residues produced by the apparatus 1 is provided, i.e. the ashes, blocks 104 and 106. The high temperature reached in the apparatus 1, allows melting the ashes that are gathered in reservoir 71 located at combustion chamber 42. The ashes already at high temperature, are superheated by jets of water gas and of very hot air, and are conveyed in a crucible with a hole the centre, from which the molten material flows and falls, entrained by a jet of compressed air or vapour, into cold water, creating inert pellets. Alternatively, the molten material is supplied into moulds forming bricks, for example self-locking for pavements or garden pathways. The hardness of the bricks can be adjusted with the addition to the ashes of silica and soda.

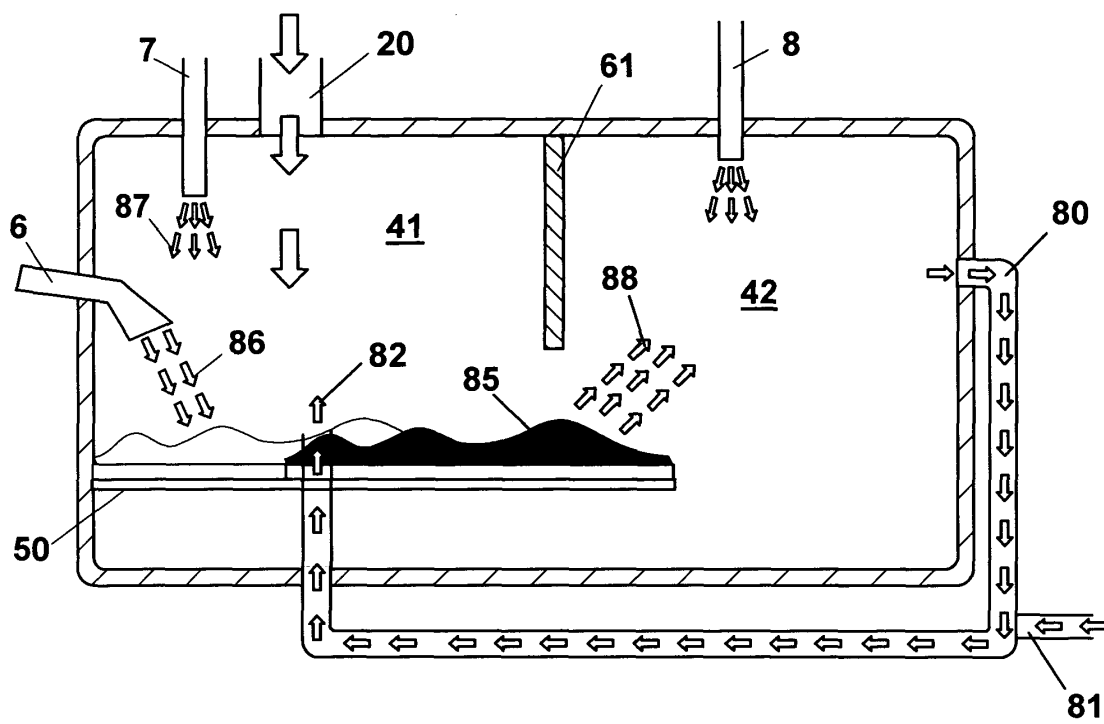
[0049] The foregoing description of a specific embodiment will so fully reveal the invention according to the conceptual point of view, so that others, by applying current knowledge, will be able to modify and/or adapt for various applications such an embodiment without further research and without parting from the invention, and it is therefore to be understood that such adaptations and modifications will have to be considered as equivalent to the specific embodiment. The means and the materials to realise the different functions described herein could have a different nature without, for this reason, departing from the field of the invention. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

## Claims

1. Method for high temperature heat treatment of combustible material, in particular of waste, said heat treatment being carried out between a pyrolysis chamber wherein said combustible material is heated in a reducing environment and a combustion chamber wherein said combustible material is completely burnt **characterised in that** in said pyrolysis chamber gas and vapour are inserted at high temperature, said introduction causing the production of semiwater gas, wherein said gas at high temperature is burnt gas drawn downstream said combustion chamber, said semiwater gas formed in said pyrolysis chamber being burnt once reached said combustion chamber, thus causing a considerable rise of the combustion temperature.

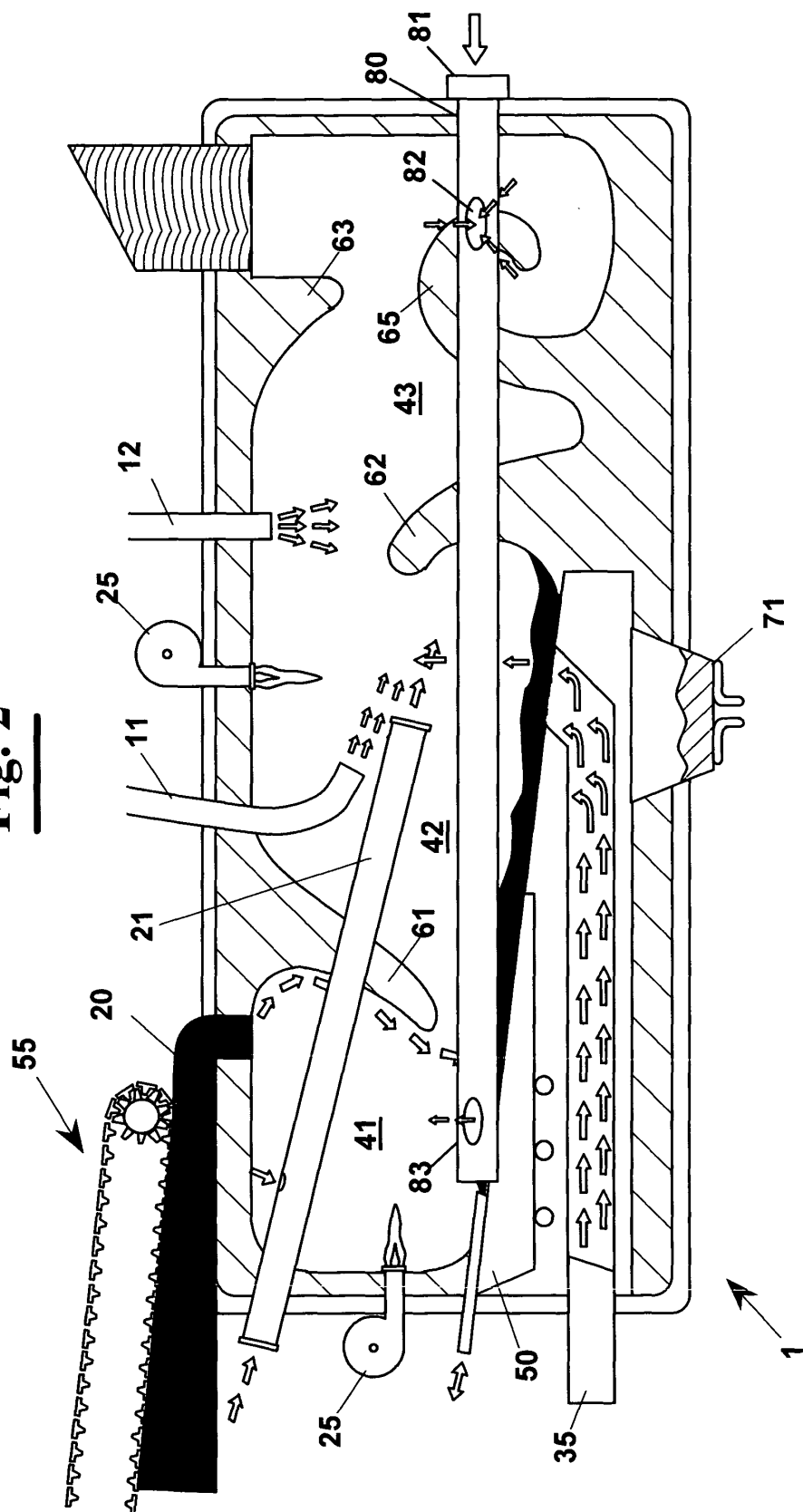
2. Method, according to claim 1, wherein said semi-water gas is produced in said pyrolysis chamber sending a vapour jet and a gas jet at high temperature on the burning material which is arranged on a grid, and then said burning material achieves said combustion chamber by moving said grid. 5
3. Method, according to claim 1, wherein said semi-water gas reaches a predetermined zone of said combustion chamber according to a path different from that of said combustible material. 10
4. Method, according to claim 1, wherein said gas at high temperature produced in said combustion chamber crosses a post-combustion chamber within which a further heating is effected by feeding a current containing oxygen with completion of said combustion, said burnt gas produced in said post-combustion chamber having a low oxygen content and being in part sent to said pyrolysis chamber. 15 20
5. Method, according to claim 1, wherein a gas produced in one of said chambers is conveyed between a starting chamber and an arrival chamber by a system comprising a conveying fluid current that is supplied within a duct that connects said chambers, said conveying fluid being supplied to said duct direct towards said arrival chamber at a speed suitable to cause a suction of said gas inside said duct. 25 30
6. Method, according to claim 6, wherein conveying said burnt gas to said pyrolysis chamber is made sending in said duct water vapour as conveying fluid, said water vapour being used to obtain water gas in said pyrolysis chamber. 35
7. Method, according to claim 6, wherein conveying said semiwater gas from said pyrolysis chamber to said combustion chamber is made sending in said duct variably oxygenated gas as conveying fluid, said amount of oxygen supplied being adjustable according to the process conditions. 40
8. Method, according to claim 1, wherein said burnt gas before being conveyed to said pyrolysis chamber are separated from possible solid particles suspended giving a vortical movement of said burnt gas separates from said solid particles by centrifugal acceleration. 45 50
9. Method, according to claim 1, wherein a step is provided of feeding said combustible material in said pyrolysis chamber that is made forcing the passage through a tapered duct in order to reduce its volume. 55
10. Apparatus for heat treatment of combustible material, in particular waste, comprising a pyrolysis chamber wherein said combustible material is heated in a reducing environment and a combustion chamber to which said combustible material moves for being completely burnt, **characterised in that** said pyrolysis chamber comprises means for feeding a gas at high temperature drawn from said combustion chamber and vapour, in order to make semiwater gas which, once reached said combustion chamber, is burnt for causing a considerable rise of the combustion temperature.
11. Apparatus, according to claim 14, wherein means are provided for conveying said semiwater gas from said pyrolysis chamber to said combustion chamber according to a path different from that of said combustible material.
12. Apparatus, according to claim 14, wherein downstream said combustion chamber a post-combustion chamber is provided within which a further said gas is further heated at high temperature obtaining burnt gas by feeding a current containing oxygen, said further heating causing a full decomposition of the part of said gas not yet dissociated.
13. Apparatus, according to claim 14, wherein means are provided for connecting a starting chamber to an arrival chamber, in particular for conveying said semiwater gas from said pyrolysis chamber to said combustion chamber or for conveying at least one part of said burnt gas up to said pyrolysis chamber, comprising at least one duct communicating with both said chambers among which said conveyance has to be executed, within which a conveying fluid current is fed, said conveying fluid being supplied to said duct at a speed suitable to cause a suction inside, in particular of said semiwater gas or of said burnt gas.
14. Apparatus, according to claim 14, wherein means are provided for feeding said combustible material in said pyrolysis chamber comprising means for forcing the passage through a tapered duct in order to reduce its volume.
15. Apparatus, according to claim 14, where in each chamber of the apparatus directional elements are provided of the gas flow obtained during the heat treatment of the combustible material.

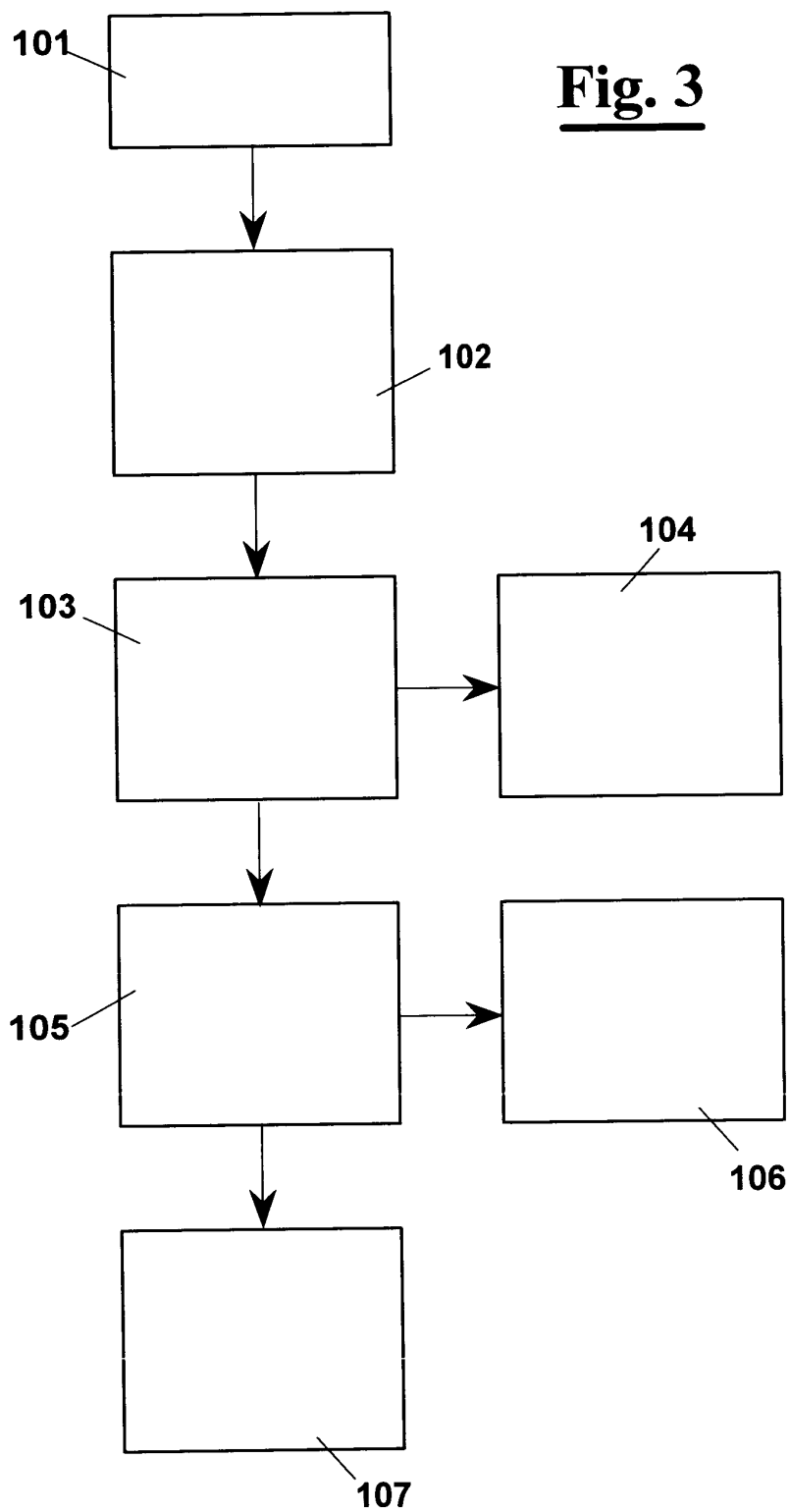
**Fig. 1**





**Fig. 2**







European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 04 42 5425

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                               |                                                            |                                                     |
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| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Citation of document with indication, where appropriate, of relevant passages                                                                                                                 | Relevant to claim                                          | CLASSIFICATION OF THE APPLICATION (Int.Cl.7)        |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | US 5 553 554 A (URICH JR ALBERT E)<br>10 September 1996 (1996-09-10)                                                                                                                          | 10                                                         | F23G5/027                                           |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | * column 2, line 41 - line 49 *<br>* column 3, line 12 - line 15 *<br>* column 3, line 35 - column 6, line 52;<br>figures 1-4 *                                                               | 1                                                          |                                                     |
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