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(12) # EUROPEAN PATENT APPLICATION

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(54) **A combustor apparatus.**

(57) Apparatus for utilising the energy of waste matte comprises respective gasification and combustion chambers (2, 3) connected by an intermediate chamber (4), an entry (5) for ambient combustion air into at least the intermediate chamber (4), and means (6) to cool an inner and external wall of the apparatus and heat the ambient combustion air for passage to the entry (5).

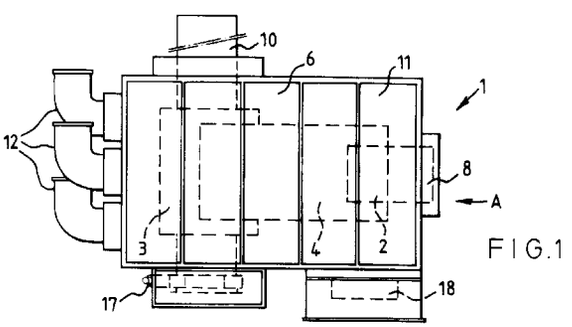

FIG.1

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The invention relates to a combustor apparatus, particularly a combustor for burning waste in order to utilise the heat produced as a source of energy.

Such combustors are of importance for both third world and developed countries alike, in disposing of waste cheaply and efficiently so as to preserve the environment and as a source of power. Unfortunately hitherto proposed combustors have only been able to burn a very limited range of solid fuel. Therefore, only a few end users have been able to use process waste the produce as fuel, or have had to buy in such waste, to provide the fuel required to produce heat.

It is accordingly an object of the invention to seek to mitigate this disadvantage.

According to the invention there is provided apparatus, comprising respective gasification and combustion chambers connected by an intermediate chamber, and means to cool an inner and external wall of the apparatus and heat the ambient combustion air for passage to the entry.

The means may comprise a jacket through which air is passed. This provides a relatively simple yet efficient way of cooling the apparatus and heating the ambient air.

The entry may comprise a louvre. This construction provides a controlled inlet, which may be adjustable depending on the volume of air required. Suitably, the louvre may be situated adjacent a feed inlet for feeding fuel into the apparatus. This provides a compact construction.

The gasification chamber may comprise a well with a grate at the base.

The combustion chamber may comprise a cylindrical chamber for cyclonic combustion. This provides for virtually complete combustion of the fuel supplied.

The gasification and combustion chambers may suitably be adapted for accommodation of thermal expansion or contraction, suitably by arranging that the chamber may be mounted on carriage means. This provides that the apparatus is not damaged if there is different thermal expansions or contractions between the chambers.

The carriage means may comprise a base of a frame of the apparatus supported on a fixed roller, that is the roller is fixed to a substrate so the apparatus can move relative to the substrate when expansion or contraction takes place. This is a relatively simple arrangement which is nevertheless efficient.

The apparatus may include a further air inlet for tertiary combustion air. This arrangement provides the provision of additional air as required.

The major proportion of combustion air may be admitted to the intermediate combustion chamber whereby to maintain the temperature in at least the gasification chamber at a low value. This provides for physical integrity of the apparatus as distortion can be obviated.

The wall temperature of the combustion chamber in use may be maintained relatively cool compared with the temperature at the core. Again, this obviates distortion.

There may be a conduit for air to the gasification chamber upstream of a grating of that chamber. This provides a compact construction.

The conduit may comprise a bifurcated pipe. This provides for ease of construction and installation.

A part of the pipe may be inclined towards a manifold upstream of the grate. This provides for ease of delivery of the air.

There may be a sensor for sensing the colour of a flame above the grate and for controlling the air supply along the conduit. This provides for control of the apparatus. Thus the sensor may, through a control unit of the apparatus, not only control the amount of air supply but also the amount of fuel to be burned as well as the exact location where the fuel is to be dropped on the grate.

A combustor apparatus embodying the invention is hereinafter described, by way of example, with reference to the accompanying drawings.

Fig. 1 is a schematic side view of a first embodiment of apparatus according to the invention;

Fig. 2 is a plan view of the apparatus of Fig. 1;

Fig. 3 is a view in the direction of arrow 'A' of Fig. 1

Figs. 4 and 5 are respective side elevational and plan views of part of a second embodiment of apparatus according to the invention.

Referring to the drawings, in which like parts are indicated by like reference numerals, there is shown in Figs. 1 - 3, a combustor apparatus 1, comprising respective gasification and combustion chambers 2, 3 connected by an intermediate chamber 4, and means 6 to cool an external wall of the apparatus 1 and heat the ambient combustion air for passage to the entry 5.

The gasification or first chamber 2 is a deep well shaped chamber having a grate 7 at the base which is adapted to receive solid fuel of different shapes and sizes. The grate 7 is a two part flat bar grate with single or dual air delivery tubes for primary air. The amount of primary air is regulated in such a way that the first combustion stage temperature is controlled and will be kept as low as possible to prevent sintering of the ash produced during combustion particularly of agricultural matter being used as fuel, and so that gasification of the fuel ensues.

There is a permanently open inlet 8 to the apparatus 1 through which the fuel is fed to the grate 7 and under the grate 7 there is a conveyor 9 for conveying ash away from the apparatus 1. The intermediate chamber 4 is a transition chamber between the first and second chambers 2 and 3 and is horizontal and feeds tangentially into the second combustion chamber 3 which is substantially cylindrical. The intermediate chamber 4 gives into the second chamber 3 over

substantially the whole length of the second chamber.

The inlet 5 for combustion air into the intermediate chamber 4 is a louvre inlet adjacent the fuel inlet 8. There is an outlet 10 for heat and flame from the second chamber 3, coaxial with the axis thereof. The combustion chambers 2, 3, 4 are encased in a jacket 11 through which cooling ambient air is passed from cooling fans 12. The apparatus 1 is also mounted on a frame 13 which is able to move on thermal expansion and contraction effects by a carriage means 14 which comprises a foot 15 of the frame 13 which is able to move on thermal expansion and contraction effects by a carriage means 14 which comprises a foot 15 of the frame 13 mounted on a roller 16 over which the foot can pass, the roller being fixed in the sense that it is secured to a substrate such as the ground in a bracket. Adjacent the exit there is an inlet 17 for tertiary air comprising an automatic damper which is set for a particular type of fuel.

The outlet 10 can be connected up with further apparatus in order to utilise the heat produced. Thus the outlet 10 itself can be connected to a power plant including a steam raising boiler, or a crop drying system, both of which have induction fans for drawing the combustion gases through the system, and for providing secondary combustion air for fuel combustion and secondary combustion in the apparatus 1. Thus the combustor apparatus itself does not require a stack or an I.D. fan, though such a fan can be provided where the apparatus is merely used to burn waste.

In operation, fuel is added to the grate 7 through the fuel inlet 8, and primary air is passed therethrough partially to fluidise the fuel bed on the grate 7. The fuel is ignited by insertion of a lance and when a flame front is seen, the lance may be removed. The fans 12 are on as the I.D. fan. When the flame front is established, the hot products of gasification pass vertically upwards to the transition chamber 4. The flame heats the wall thereof which is cooled by the cooling air in the jacket 6, which air is itself therefore heated. The heated air is sucked in through the louvres 5 where because it is cooler than the flame, it tends to form a cloak or shield round the flame between the flame and the wall, thereby protecting the wall from exposure to excessive heat. At the same time, the air promotes combustion and keeps particulate matter in the flame, so that it does not scour the wall, and thereby again protects the apparatus.

Partial combustion accordingly takes place in the intermediate chamber, prior to the gas and flame passing into the second combustion chamber 3, where further hot air enters via the tertiary air inlet 17 to promote full combustion. The combustion in the second chamber is cyclonic, this has a long flame path and generates a very high temperature (about 2000°C) at the core. This ensures that particulate matter is virtually all burnt, that remaining being retained in the chamber by spiralling to the bottom within the cyclonic flame, so that that matter does not pass out of the exit 10 and so cannot damage downstream plant. When used to fire into a boiler (not shown) as downstream plant, the second combustion chamber 3 is provided with a downstream open flame nozzle which is directed into, or enters a furnace tube of the boiler. Flame then passes through the nozzle and rotates down the length of the furnace tube, thereby providing a similar effect to an oil or gas burner.

The chambers 2, 3, 4 are manufactured from high quality stainless steel, and the jacket is an insulated mild steel jacket 6 through which the cooling ambient air is passed prior to entry through the louvres. There is no requirement for refractory lining of the chambers 2, 3, 4 because of the efficient combustion achieved and because of the shielding effect of the heated admitted cooling air.

Most of the combustion air is supplied through the louvre 5 the remainder being supplied through the inlet, the grate 7 and the tertiary air inlet 17 which last is balanced to provide a full completion of the combustion process, leaving a negligible volume of carbon monoxide and unburnt material in the exit flame and/or flu gases.

The apparatus 1 includes a control panel 18.

Referring now to the modified apparatus 100 shown in Figs. 4 and 5, in which like parts are identified by like numerals to those in Figs. 1 - 3, those Figs. show an air feed to the gasification chamber 2 which air feed is provided by a conduit or primary gasification air feed pipe 10 which bifurcates from an inlet 102 to by-pass structural foundation work 103 of the apparatus 100, the bifurcations 104, 105 being reunited to enter a manifold 106 which extends substantially over the width of the grate 7 of the gasification chamber 2. It will be noted from Fig.4 particularly that the bifurcated pipe has a substantially horizontal run 107 from the inlet 102, leading into an inclined run 108 which in turn leads to the manifold 106, the angle of inclination of the run 108 being about 17° to the horizontal in the embodiment.

The inlet pipe 101 is insulated by external insulation 109 such as glass wool, refractory or the like. The inlet 102, pipe 101 and manifold 106 are connected together in any suitable manner as by nuts, bolts and flanges 110.

In operation, primary gasification air is fed in under the grate 7 from the inlet 102, through the bifurcated pipe 101 onto the manifold 106 and upwardly (as viewed, Fig. 4) through the grate 7 of the gasification chamber 2. The rate of gasification is controlled by the volume air passed up through the grate 7 by determining the colour of the flame in the gasification chamber 2. The colour is determined by the amount of fuel on the grate 7, the fuel being added through the fuel inlet 8. The colour of the flame is

measured, electronically by a colour sensor, and this sensor in turn controls the volume of air admitted by controlling a supply such as a fan therefor. If the colour of flame is yellow/blue, there is too much oxygen for gasification, so the controller acts to reduce the air flow. If the colour of the flame is red there is too little oxygen and the volume is increased. In this way the temperature is controlled within a 700°C - 800°C temperature range which is desirable for gasification (combustion generally taking place at about 1100°C).

Thus using cool air as a feed, actual combustion is avoided but gasification is achieved, burning it will be understood producing too high a temperature for the initial stages of the process.

Thus in all the embodiment, combustion of the feed material, which can for example be wooden pallets, takes place in three phases. In the first, gasification phase in the chamber 2, gaseous compounds are emitted from the solid fuel on the (steel) grid 7. In the second phase the gases are mixed with preheated ambient air and burned above the bed, and/or in the intermediate chamber 4. A complete burning out of the fuel and solids particles takes place in the third phase in the chamber 3 in a cyclonic fashion, and in effect as a fuidized bed. The primary air flow is adjusted continuously as described with reference to Figs. 4 and 5, for example; secondary airflow is defined through the fuel inlet in combination with the ambient cooling air flow round the firing chamber 4. In the third phase, it will be understood that it is possible to supply tertiary air through an ambient air valve 17. Thus by utilising a three stage process for combustion, of which the final stage is cyclonic, combustion efficiency is enhanced to near 100% which provides the advantage of extremely clean discharges. This is achieved by high temperature secondary combustion and extended residence time in the cyclone chamber, ensuring the destruction of PCBs when plastic and PVC is used as the feedstock. As combustion is controlled as described, this means that any downstream apparatus such as a boiler heated thereby is also controlled in a commensurate way.

Claims

1. Apparatus for utilising energy of waste matter, characterised by respective gasification and combustion chambers (2, 3) connected by an intermediate chamber (4), by an entry (5) for ambient combustion air into at least the intermediate chamber (4), and by means (6) to cool an inner and external wall of the apparatus (1, 100) and heat the ambient combustion air for passage to the entry (5).

2. Apparatus according to Claim 1, characterised by the means (6) comprising a jacket through which air is passed.

3. Apparatus according to Claim 1 or Claim 2, the entry (5) comprising a louvre.

4. Apparatus according to Claim 3, characterised by the louvre (5) being adjacent an inlet (8) for feeding fuel into the apparatus.

5. Apparatus according to Claim 4, characterised by the gasification chamber (2) comprising a well with a grate (4) at the base.

6. Apparatus according to Claim 4 or Claim 5, characterised by the combustion chamber (3) comprising a cylindrical chamber for cyclonic combustion.

7. Apparatus according to any preceding claim, characterised by the gasification and combustion chambers (2, 3) being adapted for accommodation of thermal expansion or contraction.

8. Apparatus according to Claim 7, characterised by the gasification and combustion chambers (2, 3) being mounted on carriage means (13) for accommodation of thermal expansion or contraction.

9. Apparatus according to Claim 8, characterised by the carriage means (13) comprising a base (15) of a frame of the apparatus (1, 100) supported on a fixed roller (16).

10. Apparatus according to any preceding claim, characterised by a further air inlet (17) for tertiary combustion air.

11. Apparatus according to any preceding claim, characterised by the major proportion of combustion air being admitted to the intermediate combustion chamber (4) whereby to maintain the temperature in at least the gasification chamber at a low value.

12. Apparatus according to Claim 11, characterised by the wall temperature of the combustion chamber (3) in use being maintained relatively cool compared with the temperature at the core.

13. Apparatus according to any preceding claim, characterised by a conduit (101) for air to the gasification chamber (2) upstream of a grate (7) of that chamber.

14. Apparatus according to Claim 13, characterised by the conduit (101) comprising a bifurcated pipe (104, 105).

15. Apparatus according to Claim 14, characterised by a part (108) of the pipe (101) being inclined towards a manifold (106) upstream of the grate (7).

16. Apparatus according to Claim 15, characterised by a sensor for sensing the colour of a flame above the grate and for controlling the air supply along the conduit.

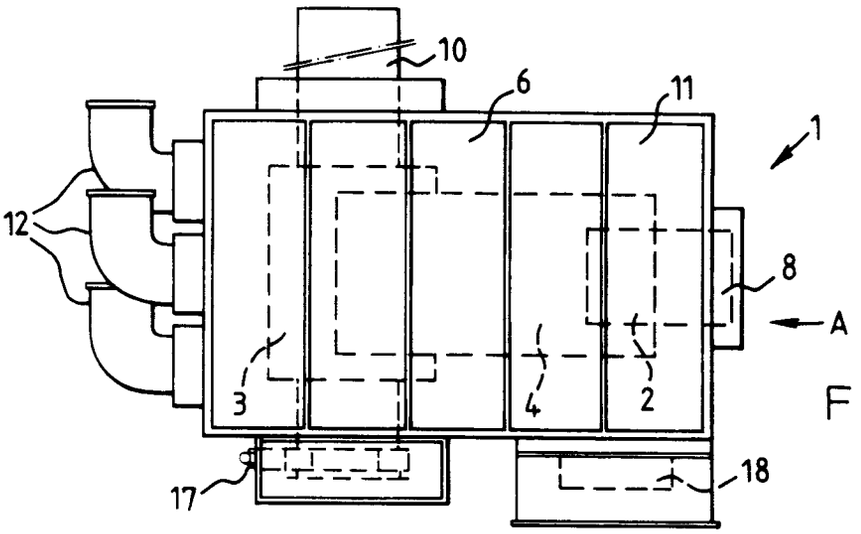

FIG.1

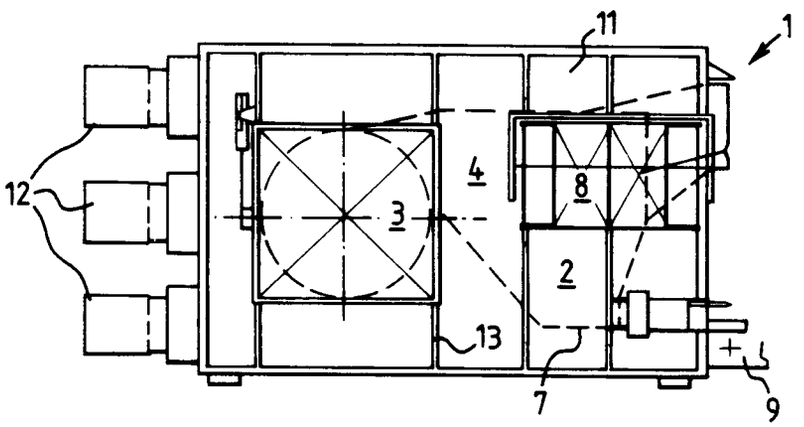

FIG.2

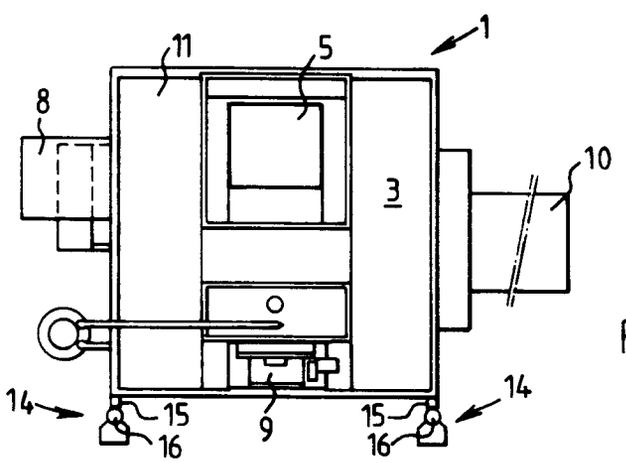

FIG.3

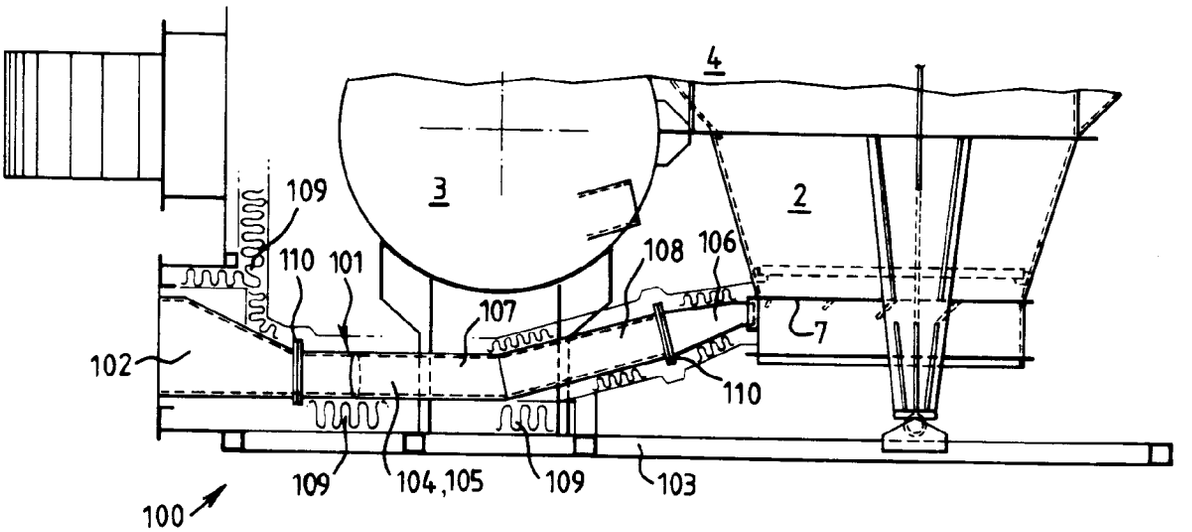
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FIG.4

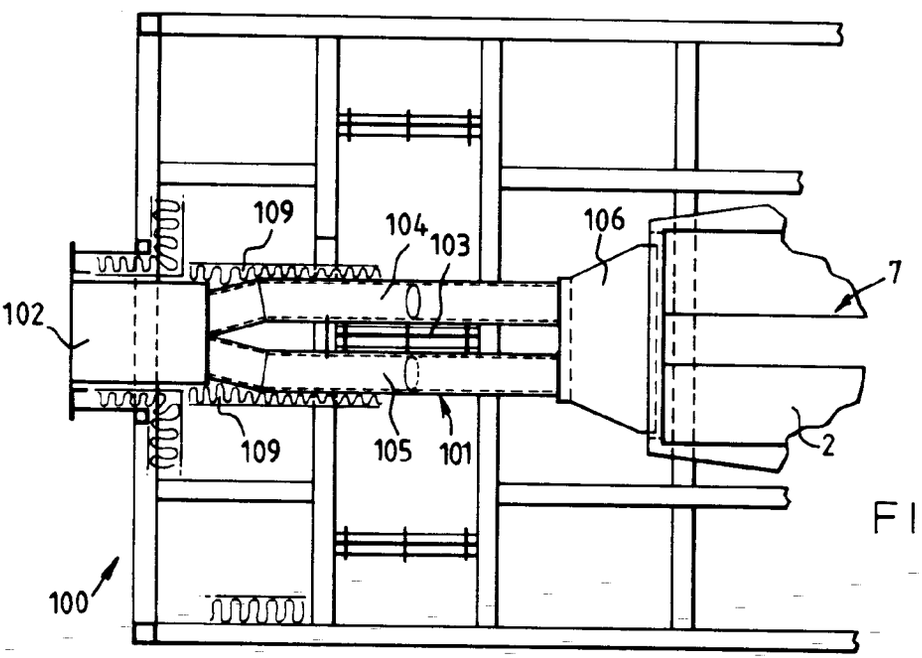
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FIG.5

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EUROPEAN SEARCH REPORT

Application Number
EP 92 30 9245

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	EP-A-0 188 073 (WILLIAMS) * page 4, line 4 - page 4, line 12 * * page 5, line 10 - page 7, line 12 * * page 8, line 11 - page 9, line 16 * * page 10, line 16 - page 11, line 7 * * page 11, line 15 - page 11, line 24 * * figures 1,2 *	1,2,6,10	F23G5/027 F23M5/08 F23G5/50
A	EP-A-0 289 355 (WILLIS) * column 5, line 56 - column 6, line 38 * * column 7, line 40 - column 8, line 12 * * column 8, line 24 - column 8, line 48 * * column 9, line 16 - column 10, line 54 * * figures 1,2 *	1,6,12, 13	
A	WO-A-8 909 364 (HARLANDER) * page 2, paragraph 1 * * page 4, last paragraph - page 5, paragraph 2; figures 1-4 *	1,5	
A	DE-C-3 918 508 (DEILMANN) * column 4, line 65 - column 5, line 66 * * column 6, line 7 - column 6, line 17; figure *	1,10	TECHNICAL FIELDS SEARCHED (Int. Cl.5) F23G F23M F23B
A	EP-A-0 242 232 (HENRY) * abstract; figures 1-3 *	2	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	08 JANUARY 1993	PHOA Y.E.

CATEGORY OF CITED DOCUMENTS

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