United States Patent [19]

Helke et al.

[11] **3,894,497**

[45] **July 15, 1975**

[54] **ARRANGEMENT FOR REGULATING THE SUPPLY OF COMBUSTION AIR AND THE EXCESS OF OXYGEN IN REFUSE BURNING OVENS**

[75] Inventors: **Risto Helke; Jorma Petajisto; Hakan Romantschuk; Tuomo Ruohola,** all of Tampere; **Antti Salonen,** Forssa, all of Finland

[73] Assignee: **Oy Tampella AB,** Tampere, Finland

[22] Filed: **Mar. 15, 1974**

[21] Appl. No.: **451,710**

[30] **Foreign Application Priority Data**

Mar. 21, 1973 Finland 886/73

[52] **U.S. Cl.** ..... **110/8 R;** 110/72 B; 110/84

[51] **Int. Cl.** **F23g 5/00**

[58] **Field of Search** ..... 110/8 R, 8 C, 15, 18 R, 110/18 C, 84, 72 R, 75 R

[56] **References Cited**

UNITED STATES PATENTS

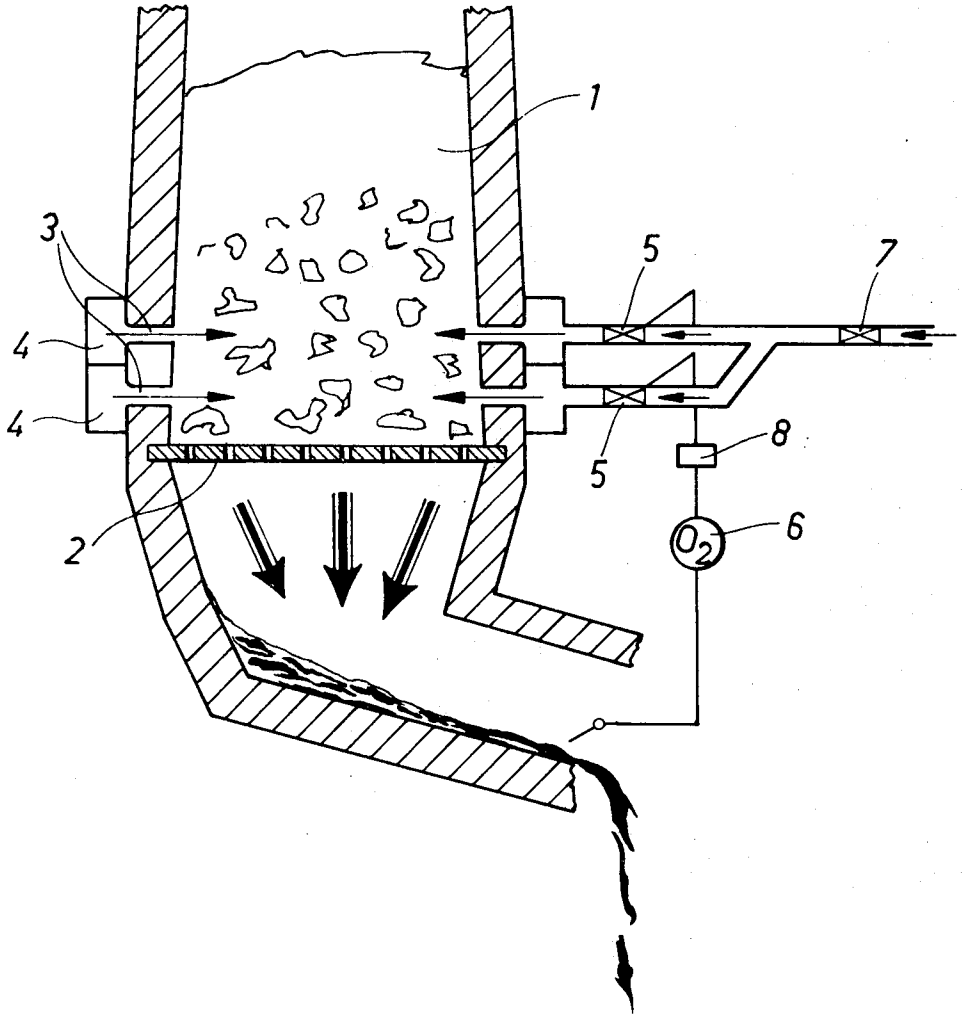
2,160,481	5/1939	Lockwood	110/84 X
2,869,487	1/1959	Sherman	110/84 X
3,697,256	10/1972	Engle	110/8
3,707,129	12/1972	Kawashimo et al.	110/15
3,747,542	7/1973	Ruohola et al.	110/8

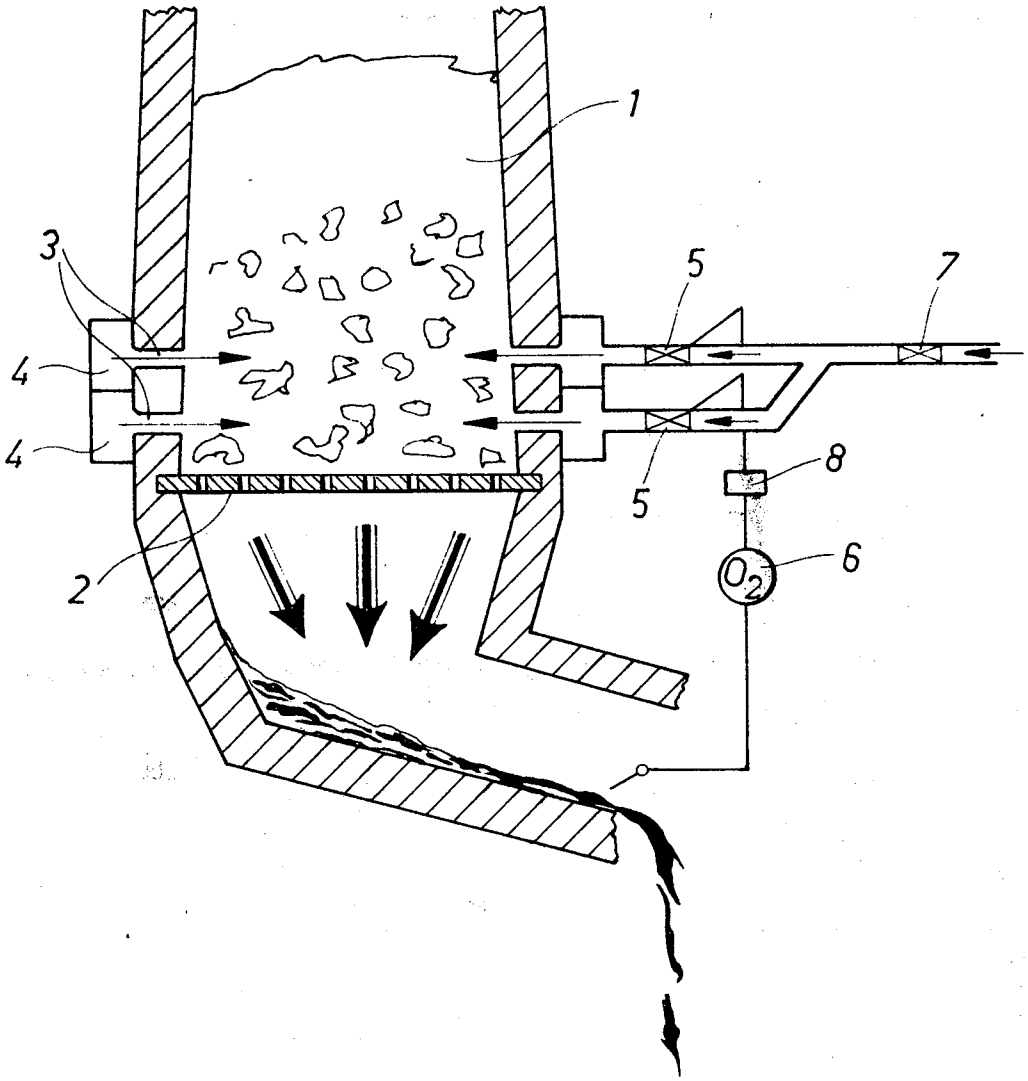
Primary Examiner—Kenneth W. Sprague
Attorney, Agent, or Firm—Burns, Doaner, Swecker & Mathis

[57] **ABSTRACT**

Refuse containing combustible components of variable caloric content is completely burned in a furnace having a vertical shaft for a combustion zone and a grate through which molten incombustibles and gaseous products of combustion are discharged downward into a pit. Annular streams of preheated air are injected inwardly and downwardly into the mass of refuse on the grate. Gaseous combustion products in the pit are continuously analyzed for the presence of free oxygen or incompletely burned combustibles. Combustion air is caused to travel through a thinner layer of refuse by injecting it at a lower point if combustion is not complete, or through a thicker layer of refuse by injection at a higher level if excess free oxygen is present. Regulation of the level of injection is achieved by control means connected to the analyzer and to valves in the air inlet lines.

3 Claims, 1 Drawing Figure




1
3
4
4
5
5
7
8
6
2
O_2

ARRANGEMENT FOR REGULATING THE SUPPLY OF COMBUSTION AIR AND THE EXCESS OF OXYGEN IN REFUSE BURNING OVENS

The present invention concerns an arrangement for controlling the supply of combustion air and of the excess of oxygen in a refuse burning oven, where the combustion of downwardly falling refuse takes place with the aid of preheated combustion air introduced into the burning shaft and at a temperature of such height that the ashes melt.

The maintenance of a high enough temperature in the combustion zone requires on one hand that enough combustion air is supplied in order to achieve an adequate intensity of combustion and on the other hand that not too much air is supplied, which would consume heat to warm the excessive air quantity. From the viewpoint of the combustion process the control of primary air quantity is a highly important factor, but it is one that is very difficult to keep under control. This is due to the fact, among others, that the caloric value of the refuse fluctuates momentarily within a fairly wide range.

The object of the invention is to find a solution to the primary air quantity control problem such that an optimum combustion process is obtained in spite of the transient variations of the caloric value of the refuse.

The solution of this problem constitutes the invention, the main characteristics of which are described below.

In the following, the invention is more closely described with reference to the attached drawing, which schematically presents a refuse burning system according to the invention, in vertical section.

The mixed refuse to be burned is dropped through an entry port onto the grating **2** in the vertical combustion shaft **1.** The primary combustion air preheated to a high temperature is supplied through openings **3** above the grate **2.** The air openings **3** have been disposed over the grate **2** in two or more circles one above the other. The combustion air can be fed through the feed boxes **4** either into the upper or the lower circle of feeding openings, or simultaneously to both, by the aid of valves **5.**

The hot air ignites the refuse, which burns upon the grate **2** in a zone having a combustion temperature of such height that the inorganig ashes melt and flow through the grate into the melt pit under it. The hot melt is drained from the pit through an opening in its bottom. The temperature in the melt pit is appr. 1,300°–1,500°C. The flue gases continue from the melt pit into an after-burning chamber (not depicted), into which secondary air in excess is supplied. In this manner the completeness of combustion is ensured. The temperature in the after-burning chamber is appr. 900°–1,100°C. From the after-burning chamber the flue gases are conducted to a combustion air preheater, where the temperature of the primary air is raised to 500°–600°C. The cooled flue gases continue through a boiler and through a flue gas washing device into the smoke stack. The refuse burning system described is completely self-sufficient as regards fuel, provided that the caloric value of the fuel does not substantially differ from the average caloric value of household refuse.

This burning method is superior to other refuse burning methods in that owing to the high combustion temperature the combustion products are very pure. The solid residue is solidified, water-insoluble slag, which

may used as ground filling without endangering the ground water. The flue gases contain no unburned gases. In conventional refuse burning methods attempts are made to avoid excessively high burning temperatures expressly owing to the formation of molten residue. However, the combustion temperature should be high enough so that the combustion is complete. This necessitates an operation within a comparatively narrow temperature range. The ash from conventional refuse burning plants contains also salts which are soluble in water, whereby the disposal of the ash may cause difficulties. The melt pit oven is also well appropriate for the destroying of various poisons. The temperature in the combustion zone of the oven is high enough and the delay time long enough e.g. for chlorinated bisphenols (PCB) to be completely decomposed. The

The content of the flue gases in the melt pit is continuously monitored and analyzed with an oxygen analyzer **6.** The total input of primary air is set to be nearly constant by keeping the valve **7** at a constant setting. It is observed however, that if the oven is supplied with a constant air flow rate, at times unconsumed air enters the melt pit, whereby the oxygen content is high, while at other times the air is burned completely and unburned gases enter the melt pit in addition. Both occurrences have the consequence that the high combustion temperature cannot be maintained. It has also been found that the combustion process cannot be controlled by controlling the primary air quantity in accordance with the oxygen content. This is primarily due to the variable caloric value of the refuse.

According to the invention the combustion is controlled as follows.

The oxygen analyzer **6** is connected to an action means **8,** which by means of the valves **5** supplies either more combustion air into the upper feed box **4,** if the oxygen content of the flue gases is too high, or more combustion air into the lower feed box **4,** if the oxygen content of the flue gases is too low. The combustion air fed through the upper openings **3** has to traverse a thicker layer of refuse before reaching the grate, whereby the oxygen introduced in this air is completely used up. In contrast, the combustion air fed through the lower openings **3** has only a short way to go to the grate **2.** If the greater part of the combustion air is introduced by the lower openings **3,** the oxygen content of the flue gases in the melt pit increases. The situation may also imagined to be that when the air quantities blown in through the upper and lower ring of feed openings are varied, this means at the same time that one varies the height of the combustion zone, that is the quantity of refuse subject to the combustion process. In this manner, by changing the extent of the area involved in the combustion process, one may sensitively compensate the transient tendency of the combustion temperature to change with changing caloric value of the refuse.

The total air flow into the oven, consistent with the burning capacity of the oven, is manually adjusted by the valve **7.**

We claim:

1. In a furnace for burning refuse, at least a portion of said refuse comprising combustible components of variable caloric content, said furnace having a vertical combustion shaft, a grate at the bottom of said combustion shaft for retaining said refuse while being burned, and a pit beneath said grate for receiving combustion products,

a. means for supplying primary combustion air to said vertical shaft to burn refuse in said shaft, said means comprising a plurality of successive, vertically stacked, circumferential, annular air inlets in the wall of said combustion shaft for admitting air into a mass of refuse, separate feed boxes surrounding said annular air inlets for supplying combustion air to said inlets, separate conduit means connecting each of said feed boxes to a source of combustion air, and valve means in each of said conduit means for independently controlling the flow of air therein, and

b. means for varying the amount of oxygen supplied to the burning refuse in accordance with the caloric content of said refuse to completely burn the combustible components of said refuse without supplying substantial excess of oxygen, said means comprising oxygen-analyzing means connected to the pit for determining the amount of free oxygen or unburned combustible material in gaseous combustion products flowing through said pit, a valve operating means connected to each of the valves in said conduit means, and control means connecting said oxygen-analyzing means to each of said valve operating means for directing air through a thicker layer of refuse if unused oxygen appears in the gaseous products of combustion in the pit and for directing air through a thinner layer of refuse if unburned combustible material appears in the gaseous products of combustion in the pit.

2. In a furnace as in claim **1**, means for regulating the capacity of the oven comprising a common duct connected to said separate conduit means and valve means in said common duct for regulating the total air supplied to said separate conduit means.

3. A method for completely burning refuse, at least a portion of which comprises combustible components of variable caloric content, whereby the discharge into the atmosphere of malodorous and noxious gaseous products is avoided, said process comprising:

a. providing a mass of refuse in a vertical combustion zone, at least a portion of said refuse comprising combustible components of variable caloric content;

b. injecting annular streams of preheated combustion air from at least two levels inwardly and downwardly into said mass of combustible refuse at a temperature sufficient to ignite the combustible components of said mass and to melt the incombustible components;

c. withdrawing gaseous products of combustion and melted ash downwardly into a receiving zone;

d. continuously analyzing said gaseous products of combustion for the presence of excess free oxygen and incompletely burned combustible components; and

e. increasing the amount of air injected at a lower level to cause said air to pass through a thinner layer of refuse if incompletely burned combustible components are present and increasing the amount of air injected at a higher level to cause said air to pass through a thicker layer of refuse if excess oxygen is present, the total amount of air injected being sufficient to completely burn all combustible components while maintaining a ratio of excess air of no more than about **1** after combustion.

* * * * *