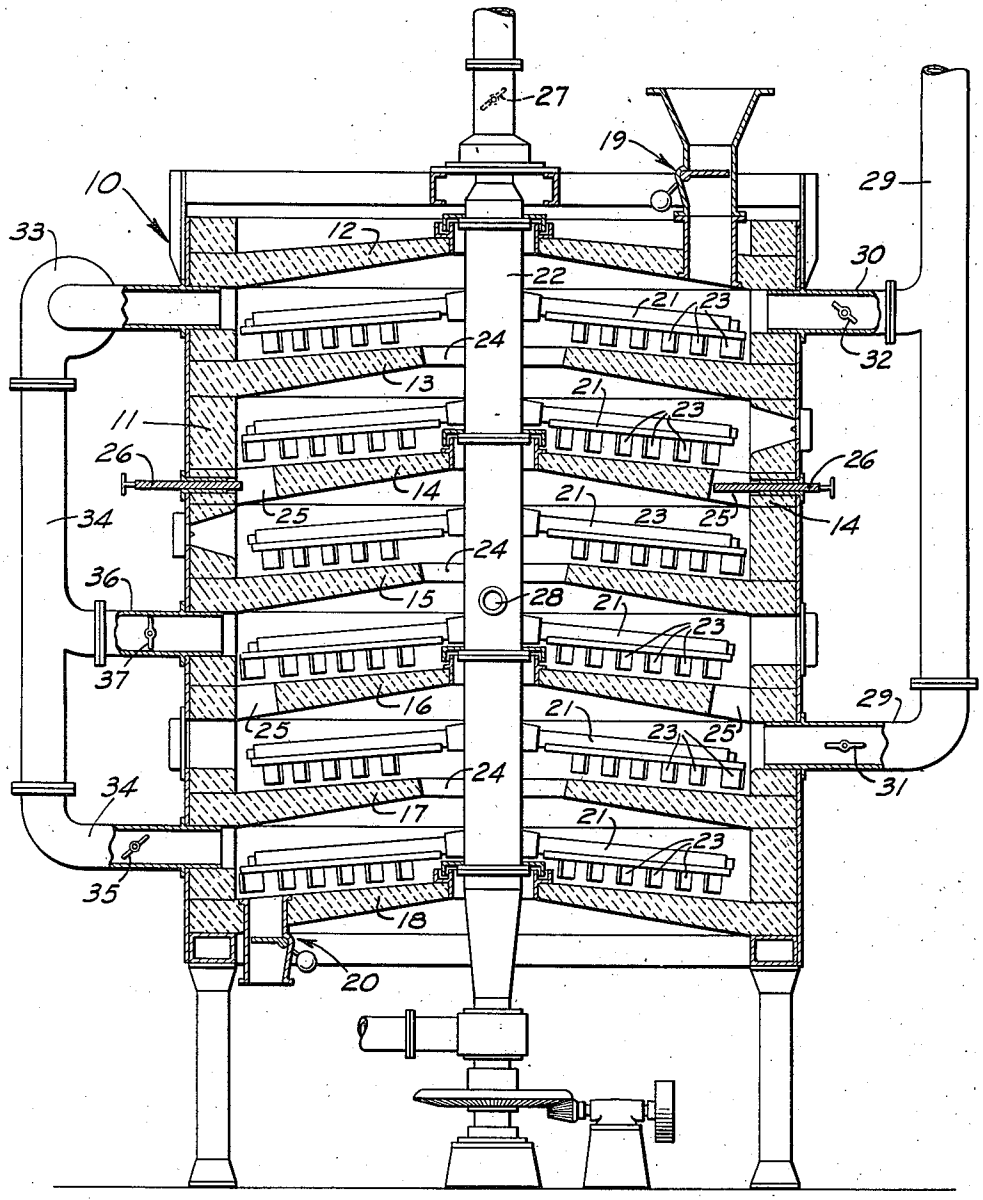
May 19, 1942. W. S. MARTIN ET AL 2,283,641

INCINERATION

Filed May 27, 1939



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Patented May 19, 1942 2,283,641

UNITED STATES PATENT OFFICE

2,283,641

INCINERATION

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Application May 27, 1939, Serial No. 276,068

5 Claims. (Cl. 110—12)

This invention relates to improvements in incineration and more particularly to improvements that may be carried out in a multiple hearth furnace.

The main object of the invention is to provide novel and advantageous improvements in incineration. Another object is to provide novel and advantageous improvements in multiple hearth furnaces. A further object is to provide a novel and advantageous furnace, the operation of which may be controlled to a considerable extent by regulating drafts. A further object is to provide an improved multiple-hearth furnace which is particularly adapted for drying and burning material of high moisture content such as sewage sludge and is not only simple in construction but is economical to build and operate.

According to one embodiment of the invention use is made of a furnace structure having a top and a plurality of vertically spaced hearths arranged beneath said top so as to provide a plurality of compartments. The top of the furnace is provided with a gas seal through which material to be treated is introduced into the furnace and the bottom hearth is provided with a gas seal through which ash or ashes from the lowermost compartment may be discharged from the furnace. Certain hearths between the top of the furnace and the lowermost hearth have outlets or drop holes arranged at their centers and others have such outlets or drop holes at their peripheries, a hearth with either arrangement of outlets being alternated with hearths having the other arrangement of outlets.

The material falling on the various hearths is fed across the same in layers to the outlets therein, by suitable rabbling means which may include a central hollow shaft, arms projecting therefrom over the hearths and blades depending from the arms, the blades on the various arms being inclined to work the material inwardly or outwardly in accordance with the location of the outlets of the hearths.

The material is dried in the upper hearths of a furnace and burned in the lower hearths thereof. Air is admitted to one or more of the hearths in which burning is effected and may easily be supplied through the hollow central shaft and one or more suitably located ports or openings in the wall of the shaft. The air is supplied to the lower part of the hollow shaft and is preheated in the part of the shaft extending through one or more lower or burning compartments.

According to the present invention hot gases from the burning section which comprises the burning compartments or zones are drawn upwardly into the drying compartments of a drying section and out of the same, and exit gases are drawn from a burning compartment. By suitable regulation of the drafts which cause withdrawal of gases from the drying section and the burning section there may be selected a hearth which may be considered as a dividing hearth between the upper or driving section and the lower or burning section. Preferably the dividing hearth has outlets at its periphery and these outlets may be provided with means to close the same to prevent the fire from working up therethrough particularly when the furnace is shut down, as well as to assist in controlling the operation of the furnace.

The exit gases may be withdrawn from the burning section either by natural or induced draft through a suitable flue and the withdrawal of gases and vapor from the upper or drying section of the furnace may be effected through a duct connected with the exit gas flue, the regulation of drafts being effected by any suitable means such as a damper in the duct leading from the drying section to the exit gas flue and suitable means such as a damper in the exit gas flue between its connection with the burning section and its connection with the duct connected with the drying section, and also by controlling the outlets in the dividing hearth.

The balancing of the drafts may also be produced by means including a fan for drawing gases and vapor from the drying section of the furnace and a duct through which the fan forces the gases and vapor from the drying section to the burning section. This duct may have a connection with the lowermost hearth of the burning section so that the gases and vapor supplied to the burning section in this way will cool the ashes and at the same time be heated before passing upwardly into the next compartment of the burning section. This duct through which the gases and vapor are passed to the burning section may also serve as a manifold and have another connection with a higher portion of the burning section which may be above the level of the exit flue connection. Gases and vapor introduced into the burning section through the upper connection from the manifold may serve to cool the upper part of the burning section and keep temperatures from becoming excessive therein. For suitable regulation of the proportions of gases and vapor passing through the two connections into the burning section of the furnace, each of these connections may be furnished

with suitable means such as a damper. Although the operations of different features have been described separately, it should be understood that the apparatus can be operated in additional ways and is capable of a high degree of flexibility of operation.

Other objects, features and advantages will appear upon consideration of the following description and of the drawing in which:

The figure is a view in vertical section of apparatus constituting an approved embodiment of the apparatus of the present invention.

Referring to the drawing, the apparatus is illustrated as including a multiple hearth furnace 10 having a peripheral wall 11, a top 12 and hearths 13, 14, 15, 16, 17 and 18, the hearth 18 constituting the bottom of the furnace. Material may be introduced into the uppermost compartment, that is above the hearth 13, through a suitable feeding device 19 that acts substantially as a gas seal, and the ash or ashes may be discharged from the lowermost hearth through a suitable device 20 which also serves substantially as a gas seal. The material is passed downwardly from hearth to hearth through suitable ports or outlets which are arranged alternately at the centers or peripheries of successive hearths, the material being fed either to the center or to the periphery by suitable rabbling means which may include arms 21 projecting from a usual rotatable hollow central shaft 22 and having downwardly extending inclined blades 23 which tend to move the material to the outlets of the corresponding hearths. The hollow shaft 22 may be rotated by any suitable means.

As illustrated, the material introduced into the furnace is dropped on the hearth 13 at its periphery and accordingly said hearth 13 is provided with a central outlet 24 so that the material on this hearth can gradually be moved in a layer to this outlet by a series of rabbling impulses produced by inclined rabbling blades 23 above this hearth. In view of the central outlet in hearth 13 the odd-numbered hearths 15 and 17 will have central ports or outlets 24, and hearths 14 and 16 will have peripherally located ports 25.

Preferably, the hearth 14 may be considered as dividing the furnace into an upper drying section containing two compartments, over the hearths 13 and 14, and a lower burning section containing four compartments, over the hearths 15, 16, 17 and 18. There are, however, no usual gas seals for the outlets 25 in hearth 14 and there is no attempt to prevent the passage of gases through these outlets during the regular operation of the furnace. Consequently there is no necessity for providing additional means, such as one or more flues, for passing gases from the burning section to the drying section. At times when the furnace is put out of use the ports 25 in the dividing hearth may be closed by suitable means including sliding gates 26, thus avoiding working of the fire upwardly into the drying section. These gates 26 may be opened and closed to control the drafts, and are very effective in controlling the operation of the furnace.

Preferably air to aid combustion is supplied to the furnace by means of the hollow shaft 22 to which air is supplied at its lower end, the passage of air from the upper end of the hollow shaft being controlled by suitable means including a damper 27. The air passing through the shaft 22 is preheated by transfer of heat from the lower compartments of the burning section and preferably is discharged from the shaft through one or more ports or openings 28 into an intermediate compartment of the burning section, only one such port 28 being shown on the drawing.

Hot exit gases are discharged from a compartment of the burning section, which may be below the level at which air is admitted, through a discharge duct or draft flue 29, under a draft which may be either natural or induced and a portion of the gases in the burning section is drawn up into the drying section and after acting on the material on the hearths to dry the same is drawn out of the drying section. As illustrated, the draft flue 29 is connected with the compartment over hearth 17 which in turn constitutes the top of the compartment over hearth or bottom 18.

One arrangement of parts to obtain the desired operation is shown at the right on the drawing. As illustrated, gases and vapor may be withdrawn from the uppermost drying section through a duct 30 connected to the flue 29, the relative proportions of flow from the burning section and the drying section being determined by dampers 31 and 32 in the ducts 29 and 30 respectively. Obviously the furnace of the present invention may be regulated to reduce the flow through the upper compartments of the furnace and therefore reduce the temperature and vary the flow of gases through the various parts of the furnace. The gates or valves 26 may also be used for such regulation. Furthermore there will be a tendency to deodorize the gases and vapor from the drying section by introducing them into the high temperature gases from the burning section.

As seen at the left on the drawing, hot gases from the upper part of the burning section may be drawn through the outlets or ports 25 in the dividing hearth 14 and through the drying section, over the layers of material on the hearths thereof, by a fan 33 which may supply the gases and vapor from the drying section to a compartment, preferably the lowermost, of the burning section through a duct 34, connected to the uppermost compartment of the drying section and provided with regulating means such as a damper 35. Some of the gases and vapor received in the lowermost compartment of the furnace may be recirculated but to a great extent may be drawn with exit gases from the compartment of the burning section above hearth 17 and discharged through the duct 29 under the action of induced or natural draft. In passing through the lowermost compartment of the burning section, the relatively cool gases and vapor from the drying section act to cool the ashes while taking up heat therefrom and in the high temperatures of the burning section are deodorized. Greater flexibility in operation may be obtained by using duct 34 as a manifold and connecting it with a higher portion of the burning section by a short duct 36 controlled by suitable means such as a damper 37.

The apparatus described may be operated in various ways. For example, substantially as follows:

Material, such as sewage sludge which has been dewatered to as great an extent as is practicable, may be supplied through the feeding device 19 to the uppermost compartment of the furnace and falls on the hearth 13. Then by means of the rabbling mechanism the material is fed inwardly by successive rabbling impulses to

the central outlet 24 through which it drops to the central part of the hearth 14 over which it is gradually fed outwardly to the peripheral outlets 25. This feeding of the material is carried on in a similar manner for the lower hearths until finally the ash or ashes are discharged from the furnace through the device 20.

According to one effective mode of operation, the connections at the left of the drawing may be thrown out of operation, as by closing the dampers 35 and 36. Then the material to be treated, after introduction into the top of the furnace, is fed downwardly from hearth to hearth and is first dried and then burned, the residue being discharged from the bottom of the furnace. Preferably, as illustrated, the preheated air is discharged from the hollow shaft 22 through an opening 28 in the wall of the shaft, said opening or port 28 being preferably in a compartment above the entrance of duct 29 and being at least the height of a compartment beneath the top of the burning section. It should be understood that the highest temperatures may be developed in the compartment over the hearth 16 and that the compartment above the hearth 15 assists in preventing the development of excessive temperatures in the zone above hearth 15. Furthermore the compartment below the hearth 17 enables cooling of the ash before discharge from the furnace.

The draft through the discharge duct 29 may then draw some of the combustion gases from the upper part of the burning section and also some from the lower part of the burning section. Also due to the connection through duct 30 from the drying section to the draft duct 29, gases will be drawn upwardly from the burning section through the ports or openings 25 of the hearth 14 into the drying section and then, at lower temperatures and laden with vapor taken up in the drying section, through the duct 30 to the draft duct 29 containing high temperature gases from the burning section. In the resulting mixing of gases and vapor the gases and vapor from the drying section may be deodorized. By use of the dampers 31 and 32 and the gates 26 the temperatures in the drying section and the temperatures of the mixture of gases and vapor from the drying section and from the burning section may be varied substantially as desired.

According to another mode of operation, the damper 32 may be closed and use may be made of the connections shown at the left of the drawing. The fan 33 draws hot gases from the upper part of the burning section over the layers of material on the hearths 14 and 13 and out of the uppermost compartment. From the fan 33 the gases, now at lower temperatures and accompanied by vapors picked up in the drying section, may be passed to the lowermost compartment of the furnace where the ashes are cooled thereby prior to discharge from the furnace and the gases and vapor are correspondingly raised in temperature, to a higher compartment through the duct 36, or, in desired proportions to both of such compartments, depending upon the adjustments of the dampers 35 and 37. These dampers may also be used to control the volume of flow through the drying section, and consequently the temperatures therein. The relatively cool gases and vapor introduced through the duct 36 into the upper part of the burning section tends to avoid excessive temperatures in and above the corresponding compartment.

In the event that it be desired to pass only part of the gases and vapor from the drying section through the fan 33 to the burning section, a portion of the gases and vapor may be withdrawn from the drying section through the duct 30 and discharged into the draft flue 29, the various dampers being adjusted as required.

It will be evident that the present invention provides a very simple and efficient apparatus for producing substantially the same results as obtained heretofore by much more elaborate and expensive apparatus.

It should be understood that various features may be changed and that certain features may be used without others, without departing from the true spirit and scope of the invention.

What we claim is:

1. A multiple hearth furnace comprising a plurality of hearths dividing the interior of the furnace into a plurality of compartments, alternate hearths of said plurality having central outlets and peripheral outlets respectively to enable material to be fed downwardly from hearth to hearth; means for utilizing an intermediate hearth to divide the furnace into an upper multiple-hearth drying section and a lower multiple-hearth burning section, comprising means for supplying air to the interior of an intermediate compartment of the burning section, means for drawing from the furnace a stream of hot gases from a lower compartment of said burning section, means for drawing a stream of gases from the upper part of the burning section through the dividing hearth into the drying section and out of the upper part of said drying section together with gases and vapors taken up from the material in said drying section, and means for varying the effect of the two drawing means to maintain said intermediate hearth as the dividing hearth.

2. A multiple hearth furnace comprising a plurality of hearths dividing the interior of the furnace into a plurality of compartments, alternate hearths of said plurality having central outlets and peripheral outlets respectively; means for utilizing an intermediate hearth to divide the furnace into an upper multiple-hearth drying section and a lower multiple-hearth burning section comprising means for supplying air to the interior of an intermediate compartment of the burning section, means for drawing hot gases from said burning section through the dividing hearth into the drying section and gases and vapor from an upper compartment of the drying section to the outside of the furnace, means for drawing from the furnace hot gases and vapor in a compartment of the burning section below the compartment into which air is supplied, and means for varying the effect of the two drawing means to maintain said intermediate hearth as the dividing hearth; and means for mixing said gases and vapor from the drying section with said hot gases withdrawn from the burning section.

3. A multiple hearth furnace comprising a plurality of hearths dividing the interior of the furnace into a plurality of compartments, alternate hearths of said plurality having central outlets and peripheral outlets respectively, and means for utilizing an intermediate hearth to divide the furnace into an upper multiple-hearth drying section and a lower multiple hearth burning section, comprising means for supplying air to the burning section, means for drawing gases from said burning section through the dividing hearth into the drying section and gases and vapor out of the drying section and delivering said gases

and vapor to the burning section, draft means for drawing gases and vapors from the burning section at a level below that at which air is supplied to the burning section, means for drawing gases and vapors from the drying section to the outside of the furnace, and means for varying such drawing actions to maintain said intermediate hearth as the dividing hearth.

4. A multiple hearth furnace comprising a plurality of hearths dividing the interior of the furnace into a plurality of compartments, alternate hearths of said plurality having central outlets and peripheral outlets respectively, and means for utilizing an intermediate hearth to divide the furnace into an upper multiple-hearth drying section and a lower multiple-hearth burning section comprising means for supplying air to the burning section, a draft flue leading to the outside of the furnace from the burning section at a level lower than the level at which air is supplied, a draft flue leading from the drying section to the outside of the furnace, a duct leading from the upper part of the drying section to the burning section, means for passing gases from said burning section through the dividing hearth into the drying section and gases and vapor from the upper part of the drying section through said duct to the burning section, and means for controlling the flow through said draft flues and said duct to maintain said intermediate hearth as a division between the burning section and the drying section.

5. A multiple hearth furnace comprising a plurality of hearths dividing the interior of the furnace into a plurality of compartments, alternate hearths of said plurality having central outlets and peripheral outlets respectively, and means for utilizing an intermediate hearth with peripheral outlets to divide the furnace into an upper multiple hearth drying section and a lower multiple-hearth burning section, comprising means for drawing gases from said burning section through said outlets of the dividing hearth into the drying section and gases and vapor out of the upper part of the drying section and delivering the gases and vapor to the lower part of the burning section, means for supplying air to an intermediate part of the burning section, draft means for drawing gases and vapor from the burning section at a level below the part of the burning section where air is supplied and above the part where gases and vapors from the drying section are introduced, draft means for drawing gases and vapors from the drying section to the outside of the furnace, and means for controlling said draft means and said means for passing gases from the drying section to the burning section to maintain such intermediate hearth as the dividing hearth.

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