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APPARATUS FOR TREATING MATERIAL

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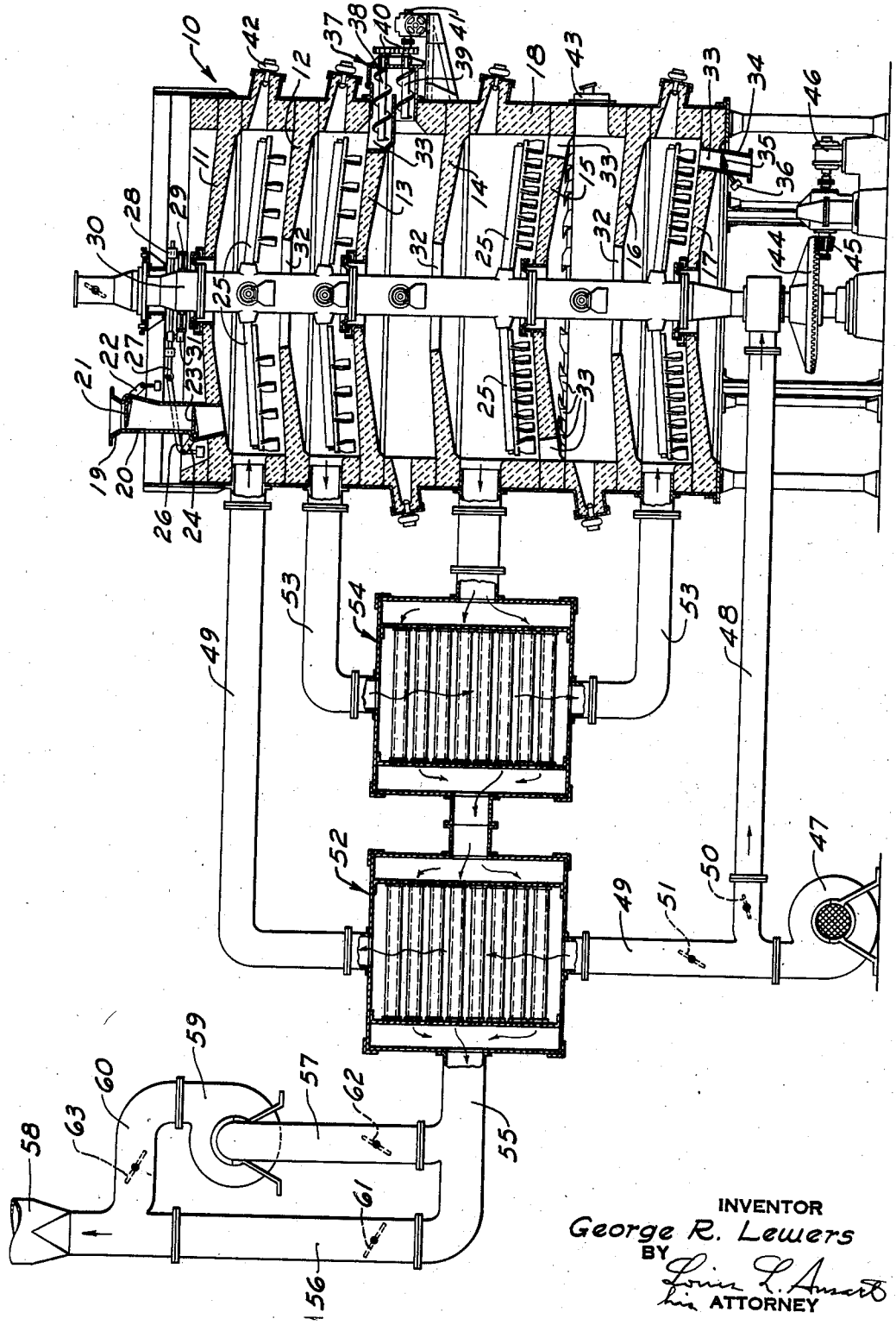

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APPARATUS FOR TREATING MATERIAL

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1 Claim. (Cl. 110—12)

The present invention relates to improvements in a furnace adapted for treatment of material involving a preliminary or drying stage in which moisture and volatile constituents are driven off, as by subjecting material to heating and contact with a stream of air, preferably preheated, and a final stage in which the dried material and the gases and vapors from the drying stage are burned substantially completely, thus eliminating noxious odors.

In the type of multiple hearth furnaces to which the present invention may be applied, the material is introduced at the top of a furnace and falls on a hearth and is then agitated and rabbled to one or more outlets by suitable rabbling means comprising one or more rabbling arms extending over the hearth and supported and driven by a vertical central shaft. Usually the material to be treated is introduced intermittently into the furnace but in course of time it is bound to fall on a rabbling device or devices and interfere with the most advantageous operation of the furnace. For example, some of the material falling on a rabbling device will be retained thereon and will not, in the usual operation, be discharged from the hearth or compartment of which the hearth forms the bottom. Not only would this condition tend to vary the treatment of various parts of the material, but there would be a tendency for the material to cake and harden on the rabbling device or devices, thus interfering with the operation and action and necessitating cleaning from time to time.

Although the undesirable feature of having material cake on the rabbling devices would occur in the use of any kinds of material, wet and sticky material, such as sewage sludge and the like, would be particularly troublesome. Obviously in a multiple-hearth furnace with vertically spaced hearths and one or more rabbling devices for each hearth, the principal trouble would be at the uppermost hearth where the material would usually be at its stickiest. In passing over the first hearth the material would be freed to a substantial extent of moisture and volatile matter and therefore would not be so sticky. Furthermore the material is fed more regularly from one hearth to another and does not fall in substantial masses as it does on the uppermost hearth.

An important object of the present invention is to provide novel, advantageous and efficient means for preventing material introduced at the top of a furnace of the type specified from falling on a rabbling device.

In installations of the type referred to, burning of sewage wastes is carried out in tiered multiple hearth furnaces, each of which is provided with rotary rabbles extending over the various hearths and driven from a main shaft extending vertically through the hearths. The hearths may be provided, alternately from the top to the bottom, with central outlets and with peripheral outlets and the rotary rabbling devices work the material, which is fed in at the top of the furnace, back and forth over the hearths until it reaches the bottom of the furnace. The material in passing through the furnace would ordinarily be dried and then destroyed by burning. When the material is to be dried only, it is discharged in substantially dry condition from the lowermost hearth. When the material is to be burned or destroyed the ash is discharged from the lowermost hearth. In all cases the gases evolved in the furnace are usually vented from the uppermost hearth or compartment.

The means for controlling admission of the material, such as sewage sludge, to the uppermost hearth may include a door or gate adapted to be swung downwardly by material collected thereon. The opening of this door may also be controlled positively, to prevent the material from dropping on a rabbling device above the uppermost hearth, by a link connected at one end to an arm attached to the door to swing therewith and a slide pivotally connected with the other end of the link. This slide may be guided by suitable guiding means and may be moved into position to close the door or to maintain the door closed by means of a cam mounted on the vertical shaft carrying the rabbling devices, and engaging a cam follower on the slide.

Other objects, features and advantages will appear upon consideration of the following description and of the drawing in which the figure is a sectional elevation illustrating an apparatus embodying a preferred form of invention.

Referring to the drawing, the invention may be embodied in an apparatus including a multiple hearth furnace 10 having a top 11, hearths 12 to 17 inclusive, and a peripheral wall 18 in which the top and the hearths, including the lowermost hearth or bottom 17, are supported. Material may be introduced into the furnace and deposited on the uppermost hearth 12, through a hopper 19 and a chute 20 extending through the top 11 of the furnace and provided with an

upper pivoted door or gate 21 normally held in closed position by means of a weighted arm 22 and a lower pivoted door 23 urged to closing position by a weighted arm 24. As soon as a sufficient amount of material to overcome the effect of the weighted arm 22 collects on the door 21, this door or gate swings downwardly about its pivotal support and the material on the door 21 falls to the next pivoted door 23. Ordinarily the door 23 will open as soon as sufficient material is accumulated thereon and permit the passage of the material to the hearth 12. The lower door 23 may be controlled by other means to prevent the material from the door 23 dropping on a rabbling device 25 in the compartment above the hearth 12.

Control of the door 23 may be effected by means of a link 26 connected at one end to the outer end of the arm 24 and a slide 27 pivotally connected with the other end of the link 26. The slide 27 may be slidably mounted in guides 28 and may be moved into position to close the door 23 or may be held in position to maintain the door closed by means of a cam 29 mounted on a hollow vertical shaft 30 and engaging a cam follower 31 on the slide 27. Rabbling devices 25 may be provided for all of the hearths 12 to 17 inclusive and may be supported and actuated by a hollow shaft 30. The rabble arms or devices are provided with blades which over hearths 12, 14 and 16 are arranged to work the material inwardly to central openings 32 where they pass downwardly adjacent to the shaft 30 to the next lower hearths 13, 15 and 17.

The blades of the rabble arms or devices over the hearths 13, 15 and 17 are arranged to work the materials outwardly to peripheral openings 33. The hearth 17 being the bottom of the furnace, may have only one outlet 33 provided with a chute 34 having a pivoted door or gate 35 normally held in chute-closing position by a weighted arm 36. When the ash or other material accumulates to a sufficient extent on the pivoted door 35, the door will swing downwardly and discharge the material from the furnace.

The hearth 13 may be used to divide the furnace into an upper drying section and a lower burning section and for this reason may have but one outlet 33 controlled by a suitable device 37 which may serve as a zoning valve and pass the material from the top of hearth 13 to the hearth 14. The device 37 may comprise two screw conveyors having conveyor screws 38 and 39 arranged so that one screw 38 draws the material from the outlet 33 in one direction and then transfers it to the control of the other screw 31 which works the material into the compartment above the hearth 14. This action involves rotation of the screws 38 and 39 in opposite directions as by means of intermeshing gears 40 mounted on the shafts of the two screws 38 and 39, one of the shifts being driven by a motor 41. Obviously, as long as the screw conveyors are full of material, there will be practically no direct passage of gases from one section to the other. Each compartment above a hearth may be provided with a burner 42 for use when desired and doors 43 may be provided wherever required.

Rotation of the hollow shaft 30 carrying the rabble arms may be effected through a bevel gear 44 on the lower end of the shaft, a bevel gear 45 meshing with the bevel gear 44 and a motor 46.

In operation air, preferably preheated, is introduced into the drying section above the hearth 13 and passes through this section either concurrently with the material to be treated or countercurrently thereto and the air with the resulting vapor may be transferred to the burning section and pass therethrough either concurrently with the flow of material or countercurrently thereto. Preferably as disclosed, the preheated air is introduced into the upper part of the drying section and withdrawn from the lower part of this section and then is introduced into the lower part of the burning section and pass upwardly therethrough to the discharge outlet from which it passes to the stack.

The waste gases from the burning section may be utilized both to preheat the air introduced into the drying zone and to heat the air and gases, discharged from the drying zone at a lower temperature than that of the air introduced, so as to render the burning section more efficient. As illustrated, air is forced by suitable means such as a fan 47 into a duct 48 supplying air to the hollow shaft 30 for cooling purposes and a duct 49 to supply air through the drying section. For control of the proportions of air passed through the pipes or ducts 48 and 49 the duct 48 may be provided with a damper 50 and the duct 49 may be provided with a damper 51.

The air supplied through the duct 49 may be heated in any suitable manner before introduction into the drying section. Preferably, however, such heating or preheating is obtained by passing it through a heat interchanger 52 utilizing the hot gases of combustion from the burning section of the furnace tank. The air and gases from the lower part of the drying section may be passed through a duct 53 into the lower part of the burning section of the furnace. In passing through the drying section, the temperature of the preheated air is reduced substantially. To obtain efficient burning in the burning section of the furnace, it is desirable to heat the air and gases passing from the drying section to the burning section and this result may be attained by interposing in the duct 53 a heat interchanger 54 also heated by the exhaust gases from the burning section of the furnace.

The hot gases from the burning section may be passed through the heat interchanger 54 and then through the heat interchanger 52 to a duct 55 having two branches 56 and 57 one of which, 56, leads directly to a stack 58 and the other of which, 57, leads to a fan 59 which forces the air through a duct 60 into a branch 56 leading to the stack 58. In order to control the flow of gases in the different pipes, branches 56 and 57 may be provided with dampers 61 and 62 respectively, and the duct 60 may be provided with a damper 63.

Although the air and vapors discharged from the drying section through the pipe 53 may be introduced into the burning section at any desired point and the gases of combustion may be discharged from the burning section at any desired point, it has been found desirable to connect the inflow pipe 53 with the lowermost compartment or zone of the burning section and the outflow pipe 55 with the compartment above the hearth 15 leaving the compartment above the hearth 14 without any gas inlet or outlet other than the large central output in the hearth 14. With this arrangement the flow of gases is countercurrent to the flow of material in all zones of the burning section except the uppermost zone or compart-

ment in which the flow is both concurrent with and countercurrent to the flow of solid material. With this arrangement, the device **37** is not subjected to as high temperatures as exist just below the hearth **14** and the zone immediately above the hearth **14** serves to some extent as a heat insulating zone between the drying and burning sections and also may serve to reduce the suction pull on the device **37** resulting from the draft to the stack through the pipe **55**.

In operation, material introduced into the hopper **20** falls on the hearth **12** when permitted by cam **29** on shaft **30** and due to the action of the rabbling devices is carried inwardly and outwardly on successive hearths to central or peripheral outlets and passes downwardly through the furnace until in its final form it passes out through the discharge chute **34**. At the same time the air from the fan **47** not only passes upwardly through the hollow shaft **30** to cool the same, but passes through the duct **49** under control of the damper **51** and through the heat interchanger **52** through the compartment above the hearth **12**. Preheated air then passes over the surface of material on the hearth **12** and downwardly through the central opening **32** to the next compartment above the hearth **13** and is discharged from the last mentioned compartment to the duct **53**.

In passing through the drying section, the air takes up moisture and vapors and is cooled to a very considerable extent. In order to raise the temperature to promote burning in the burning section, the gases from the drying section are passed through the heat interchanger **54** and temperature is raised by heat transfer from the hot exhaust gases discharged from the burning section. It is evident that the zoning valve **37** renders it possible to regulate the drying and burning action of the furnace and that the flow of gases through the different parts of the apparatus may be controlled effectively by means of the dampers **50**, **51**, **61**, **62** and **63**.

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

Having thus described my invention, I claim:

In an apparatus of the character described, the combination with a furnace top having a charging chute, a hearth to receive material from said chute, a door pivoted in said chute, yielding means for holding the door closed until the weight of material on the door overcomes said yielding means, and a radial rabbling device above said hearth and rotating so as to pass beneath said charging opening, of means positively holding said door closed during the passage of the rabbling device, such positive holding means including an arm connected with said door to move it about its pivot, a link connected at one end to said door, a slide connected to the other end of said link, a cam follower rigidly connected to said slide, and a cam engaging said follower and acting to hold said door closed during the passage of the rabbling device beneath said chute.

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