

May 8, 1956

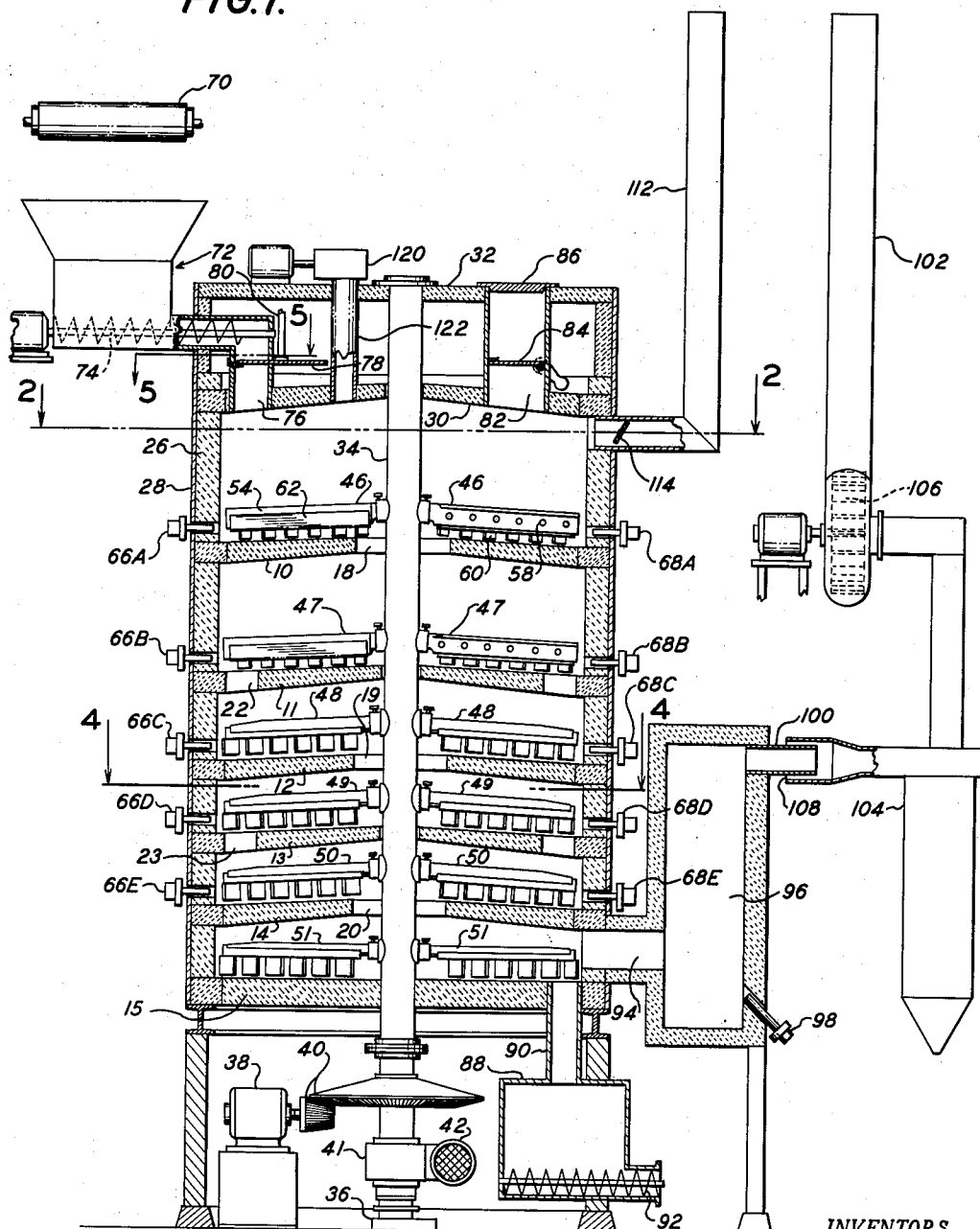
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INCINERATOR

2,744,477

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2 Sheets-Sheet 1

FIG. 1.



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FIG. 2.

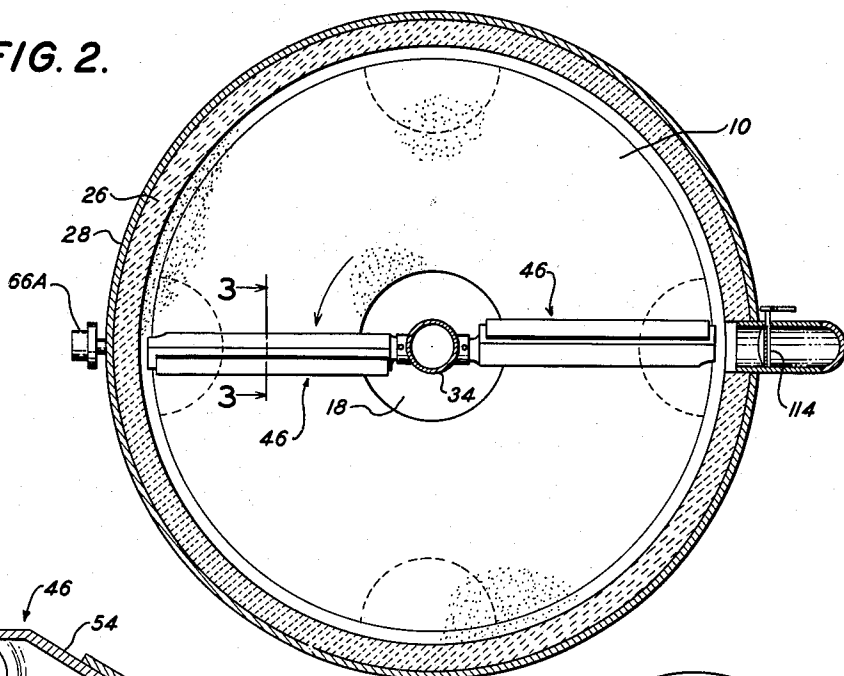


FIG. 3.

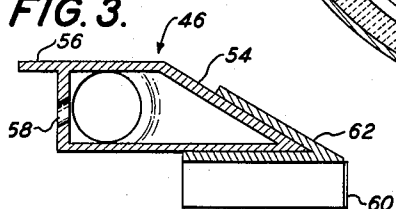


FIG. 4.

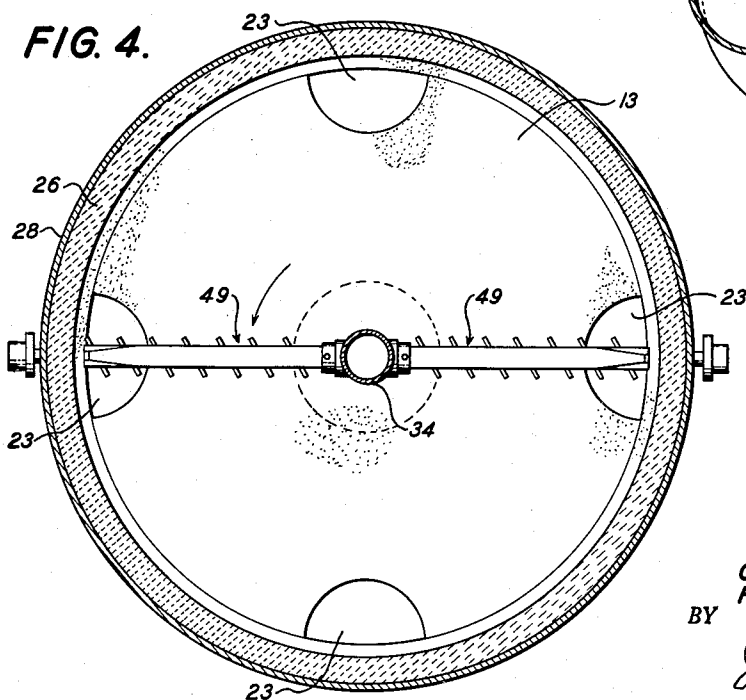
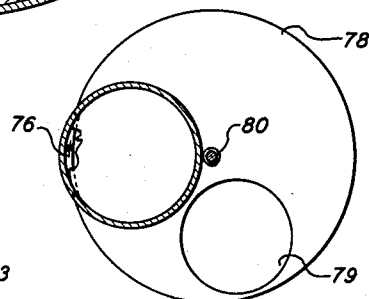


FIG. 5.

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INCINERATOR

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5 Claims. (Cl. 110—8)

This invention relates to an improved incinerator for burning waste materials such as garbage.

The incineration of materials such as garbage which consists of pieces having a great size range and a great variation in moisture content and combustibility imposes a number of serious problems. Multi-hearth furnaces, which have been used heretofore for the drying, roasting, etc., of a great variety of materials, have not been successfully adapted to the incineration of garbage. The rotating rabble arms which move the materials in multi-hearth furnaces across the hearths to the drop holes tend to become jammed by coarse materials such as large pieces of wood, animal carcasses, etc., and the high moisture garbage seriously inhibits combustion.

As a result of our investigations we have developed an improved form of multi-hearth furnace in which garbage incineration is conducted satisfactorily and, as a matter of fact, with greater ease.

In essence, the incinerator of our invention comprises a multi-hearth down-draft furnace, in which the materials being burned and the gases of combustion move concurrently from hearth to hearth. The material to be burned, say garbage, is introduced into an upper hearth across which it is rabbled to a drop hole. The material falls through the drop hole into a lower hearth and is rabbled across it in the opposite direction, this process being continued until the material reaches the bottom hearth. Air for combustion is supplied through a central shaft which drives the rabbles and passes through the hollow rabble arms to be discharged above each hearth. The air for combustion is thus preheated and is supplied at the point where it does the most good. Preferably the leading portion of each rabble arm is wedge-shaped and slopes upwardly so that coarse material which cannot be rabbled in the customary way rides up and over the arm and thus remains in the upper hearth or hearths until it has been sufficiently reduced in size either by combustion or breakage for it to be rabbled to a drop hole and then continue downwardly in the furnace with the finer material.

In accordance with the present invention, a plurality of vertically spaced hearths are provided with alternate hearths having central outlets and peripheral outlets respectively. Preferably, the spacing between the upper hearths is greater than that between the lower hearths. A hollow shaft extends vertically through the hearths, and rabble arms for the hearths are affixed to the shaft. The rabble arms in the upper part of the incinerator are provided with air outlets which communicate with the interior of the hollow vertical shaft, and a blower is provided for forcing air upwardly through the vertical shaft and through the air outlets into the incinerator, so as to cool the vertical shaft and heat the air which is forced into the incinerator.

An outlet is provided at or near the bottom of the incinerator, and a fan is provided for drawing the waste gases which are produced in the incinerator downwardly

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to the outlet and forcing the gases upwardly through a stack.

Thus, a down-draft of air and waste gases is provided in the incinerator so that rapid combustion of the waste materials is achieved. The fly ash content of the waste gases is minimized by effecting most of the combustion of the waste materials in the upper part of the incinerator. The moist waste materials are dried in the upper part of the incinerator, and the foul odors which are produced in drying the materials are largely removed from the waste gases as they pass through the highly heated lower part of the incinerator.

In a preferred embodiment of the invention, an auxiliary combustion chamber is provided adjacent the outlet at the bottom of the incinerator so that the waste gases which are withdrawn from the incinerator are subjected to a flame which consumes substantially all of the remaining noxious gases.

If required, additional means may be provided for admitting air into the upper portion of the incinerator.

The invention is explained with reference to the drawings, in which:

Fig. 1 is an elevation view of the incinerator, partially in section;

Fig. 2 is a sectional view along line 2—2 of Fig. 1;

Fig. 3 is a sectional view of one of the rabble arms taken along line 3—3 of Fig. 2;

Fig. 4 is a sectional view along line 4—4 of Fig. 1; and

Fig. 5 is a sectional view showing the feeder door arrangement taken along line 5—5 of Fig. 1.

The incinerator has six hearths 10 to 15 which are located in vertically spaced relationship, the spacing between the upper hearths being greater than that between the lower hearths. The hearths 10, 12 and 14 are provided with central outlets or drop holes 18, 19 and 20, and the hearths 11 and 13 are provided with peripheral outlets or drop holes 22 and 23 for allowing the waste material to descend through the incinerator.

The hearths are supported by a peripheral wall 26 of the furnace, and the peripheral wall is enclosed by a metallic outer shell 28.

The incinerator has a top 30 which covers the combustion space above the uppermost hearth. An operating platform 32 is placed above the top.

A shaft 34 extends vertically through the center of the hearths. It is supported at the bottom by a bearing 36. The vertical shaft is rotated by a motor 38 and gears 40. A blower 41 having an air inlet 42 is provided at the base of the shaft 34 for forcing air upwardly through the shaft.

Rabble arms 46 to 51 are provided for each of the hearths, and the rabble arms 46, 47 for the two upper hearths are provided with air outlets which communicate with the interior of the vertical shaft 34.

Fig. 2 shows a top view of the rabble arms 46 for the uppermost hearth, and Fig. 3 is a sectional view of one of the rabble arms 46. The interior of the arm is hollow and it communicates with the hollow interior of the shaft 34. The arm has an inclined leading portion or edge 54, an extension 56 on its trailing edge, and air outlets 58 in its trailing edge which are inclined so as to direct the air downwardly. A plurality of rakes 60 are affixed to a V or wedge-shaped rake holder 62 which is secured to the leading edge of the rabble arm. The rakes of the rabble arms 46 are inclined so as to move the waste material toward the central outlet 18 of the hearth 10 when the shaft is rotated.

The rabble arms 47 are of the same construction as the arms 46 with the exception that the rakes of the rabble arms 47 are inclined so as to move the waste material in the opposite direction, i. e. toward the peripheral outlets 22 of the hearth 11.

The rabble arms 48 to 51 on the lower hearths may be any suitable type with rakes inclined to move the waste material toward the outlets of the respective hearths. Fig. 4 shows the rabble arms 49 with the rakes of the arms inclined so as to move the waste material toward the peripheral outlets 23 of the hearth 13.

Burners 66A to 66E and 68A to 68E are provided for each of the hearths except the bottom hearth.

A belt conveyor 70 serves to transmit the waste materials to a feeder 72 which is provided with a screw or pug mill type of discharge 74. An inlet 76 for admitting the waste material to the incinerator is provided with a closure member 78 which is operated by means of a shaft 80. As shown in Fig. 5, the closure member 78 has an opening 79 in it which may be moved into the inlet 76 so as to permit waste materials to be introduced into the incinerator through the inlet 76.

An auxiliary inlet 82 is provided for admitting large articles, such as wooden boxes. This inlet is provided with a hinged door 84 and a lid 86 which may be removed by hand.

The closure member 78, the door 84, and the lid 86 serve to seal the upper portion of the incinerator so that the inlets 76 and 82 do not have an appreciable effect upon the flow of air within the incinerator.

An ash pit 88 is connected to the lower hearth by means of a drop pipe 90, and a screw conveyor 92 is provided for removing ashes from the pit.

A flue 94 is provided at the bottom of the incinerator adjacent the hearth 15 for removing the waste gases. The flue communicates with an auxiliary combustion chamber 96 which has a burner 98 located so as to direct a flame toward the flue 94.

An outlet 100 for the combustion chamber communicates with a stack 102 through a dust collector 104 and a fan 106. An air inlet 108 is provided around the outlet 100 so that cooling air is drawn into the stack system when the fan 106 is in operation.

An auxiliary stack 112 connected to the space above the uppermost hearth is provided for venting the furnace when it is not operating, and a vane 114 serves to open and close the passageway between the stack 112 and the interior of the incinerator.

If additional air is required for the incinerator, it may be introduced by a blower 120 and a conduit 122, or through an opening in the shaft 34 located intermediate the top 30 and the first hearth 10.

In operation, the waste materials are admitted to the incinerator by rotating the shutter member 78 so that periodically the aperture 79 in the member is within the conduit 76.

If the waste materials have a small moisture content it is necessary to ignite only the two upper burners 66A and 68A which communicate with the space above the hearth 10. If the waste materials have a large moisture content, it may be desirable to ignite some or all of the lower burners 66B to 66E and 68B to 68E.

As the rabble arms rotate, the teeth 60 on the arms 46 cause the smaller pieces of the waste material to move toward the opening 18 in the hearth 10, and the larger pieces of the waste material are caused to ride over the inclined faces of the rabble arms 46 and drop down behind the rabble arms.

This results in a tumbling action which aids the combustion and breaking up of bulk materials, such as boxes, animal carcasses, etc. When the coarse materials are sufficiently reduced in size by combustion or breaking, they too move to the next hearth through the drop holes.

The preheated air which is forced into the incinerator through the outlets in the rabble arms serves to dry the waste materials and to cause the materials which are sufficiently dry to burn rapidly.

On the hearth 11 the waste materials are subjected to further drying and burning and any larger pieces of

the materials are again caused to tumble over the rabble arms 47 with further combustion and comminution. The materials are caused to move outwardly to the peripheral outlets 22 where they drop to the hearth 12.

The large spacing between the upper hearths permits rapid drying and burning of the waste materials and thereby causes more rapid destruction of the materials.

Since the waste materials are dried and partially burned on the hearths 10 and 11 as well as comminuted by tumbling and combustion, and since a down-draft is provided in the incinerator, it is ordinarily unnecessary to provide air outlets or inclined leading edges for the lower rabble arms because the material will continue to burn as it moves downwardly through the incinerator. When the material reaches the bottom hearth 15 it is completely reduced to ashes, and the rakes on the arms 51 cause these to move outwardly to the conduit 90 where they drop into the ash pit 88.

The heat of the burning waste material heats the vertical shaft 34 and also the air which is forced through the shaft; hence the air which is ejected through the outlets 58 is heated before it enters the interior of the incinerator. Thus the air which is forced upwardly through the shaft 34 serves to cool the shaft 34, and it is also employed to dry the waste materials when it is ejected through the outlets in the rabble arms.

If desired, the temperature of the air in the upper portion of the incinerator may be controlled by controlling the amount of air admitted through the conduit 122.

The waste gases are removed through the flue 94, and they are subjected to a flame from the burner 98 in the auxiliary combustion chamber 96 before being drawn through the outlet 100. When the gases pass through the outlet 100, air is sucked in through the inlet 108 so as to reduce the temperature of the gases in the stack. Then the gases are drawn through the dust collector 104 by the fan 106 and forced upwardly through the stack 102 to the atmosphere.

The noxious or foul-smelling gases created by drying the waste materials are reduced by the combustion process in the lower part of the incinerator because most of these gases are created in the upper part of the incinerator and are then caused to move downwardly through the highly heated lower part of the incinerator where they are consumed.

The flame produced by the burner 98 in the auxiliary combustion chamber 96 serves to remove substantially all of the remaining noxious gases, and the dust collector 104 serves to remove most of the dust from the waste gases so that the gases which are ejected from the stack 102 are substantially free from odor and dust.

The auxiliary combustion chamber 96 may be omitted if the waste materials which are to be consumed in the incinerator produce only small quantities of noxious or evil-smelling gases.

The fly ash content of the waste gases is reduced if most of the burning of the waste materials is achieved in the upper hearths. If the waste materials have a very large moisture content, it is preferably to employ rabble arms of the type shown in Figs. 2 and 3 for the lower arms 48 to 51 so that additional hot air for drying the waste materials is applied as the materials descend through the incinerator.

Since there is a down-draft inside the incinerator, it is particularly effective in consuming moist waste materials because the materials are first subjected to a drying action due to the preheated air admitted through the rabble arms and then subjected to intense heat due to the down-draft in the incinerator which causes the materials to burn as they descend through the incinerator.

If desired, pipes may be placed in the lower hearth 15 and water circulated through them in order to keep the lower hearth from becoming excessively hot. Such an

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arrangement also serves as a source of hot water which may be employed in any manner desired.

The number of hearths which are required in the incinerator is determined by the general type of waste materials to be consumed. If the waste materials are easy to ignite and burn rapidly, four hearths are sufficient.

We claim:

1. An incinerator comprising a closure defining a chamber, at least three spaced superposed hearths within the chamber and cut away so that solids can fall from one hearth to the next lower hearth, the enclosed space above a hearth in an upper portion of the chamber being substantially higher and greater than the enclosed space above each of the hearths in the lower portion of the chamber, a rotatable hollow shaft extending vertically through the hearths, at least one rabble arm for each hearth affixed to the vertical shaft, a rabble arm located above said upper hearth, said rabble arm being hollow and communicating with the hollow interior of the shaft and having a plurality of air outlets spaced along it in the chamber, said arm above said upper hearth being wedge-shaped in cross section with the narrow portion of the wedge at the leading edge of the arm so as to provide an inclined plane on the top of the arm that coarse solid pieces can ride up and over, means for forcing air through the shaft and out the air outlets in said arm located above the upper hearth into the chamber, means for feeding material to be incinerated to an upper hearth, means for firing the space above the hearth above which said arm of wedge-shaped cross section is disposed, an outlet in the closure adjacent a lower hearth for conveying combustion gases from the incinerator, and means for sucking gas through the last named outlet to provide a down draft inside the chamber.

2. An incinerator comprising a closure defining a chamber, at least four spaced superposed hearths within the chamber and cut away so that solids can fall from one hearth to the next lower hearth, the enclosed space above at least two of the hearths in an upper portion of the chamber being substantially higher and greater than the enclosed space above a hearth in the lower portion of the chamber, a rotatable hollow shaft extending vertically through the hearths, at least one rabble arm for each hearth affixed to the vertical shaft, a rabble arm located

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above at least one of said upper hearths, said rabble arm being hollow and communicating with the hollow interior of the shaft and having a plurality of air outlets spaced along it in the chamber on the trailing portion of the arm, said arm above said upper hearth being wedge-shaped in cross section with the narrow portion of the wedge at the leading edge of the arm so as to provide an inclined plane on the top of the arm that coarse solid pieces can ride up and over, means for forcing air through the shaft and out the air outlets in said arm located above the upper hearth into the chamber, means for feeding material to be incinerated to an upper hearth, an outlet in the closure adjacent a lower hearth for conveying combustion gases from the incinerator, and means for sucking gas through the last named outlet to provide a down draft inside the chamber.

3. Apparatus according to claim 2 in which the hollow arm located above the upper hearth has a flange extending along its upper trailing portion above the air outlets in the arm.

4. Apparatus according to claim 2 in which the air outlets in the hollow arm located above the upper hearth are downwardly directed.

5. Apparatus according to claim 2 provided with a burner for throwing a flame across the space in the closure above at least one of the upper hearths.

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