July 11, 1967 P. W. SPENCER 3,330,231

INCINERATOR AND SMOKE ABATEMENT APPARATUS

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FIG. 1

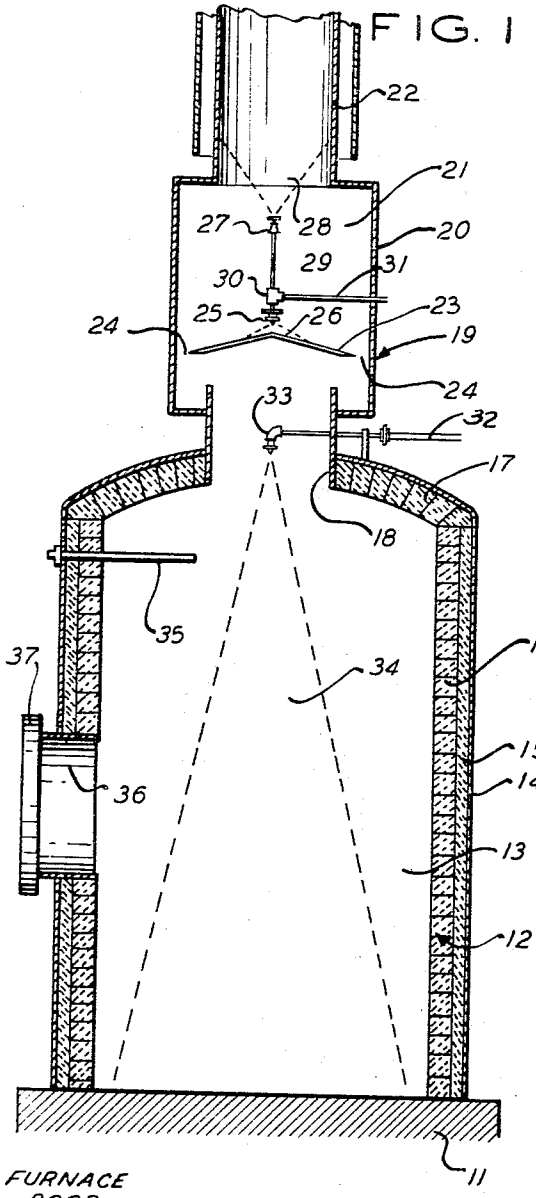
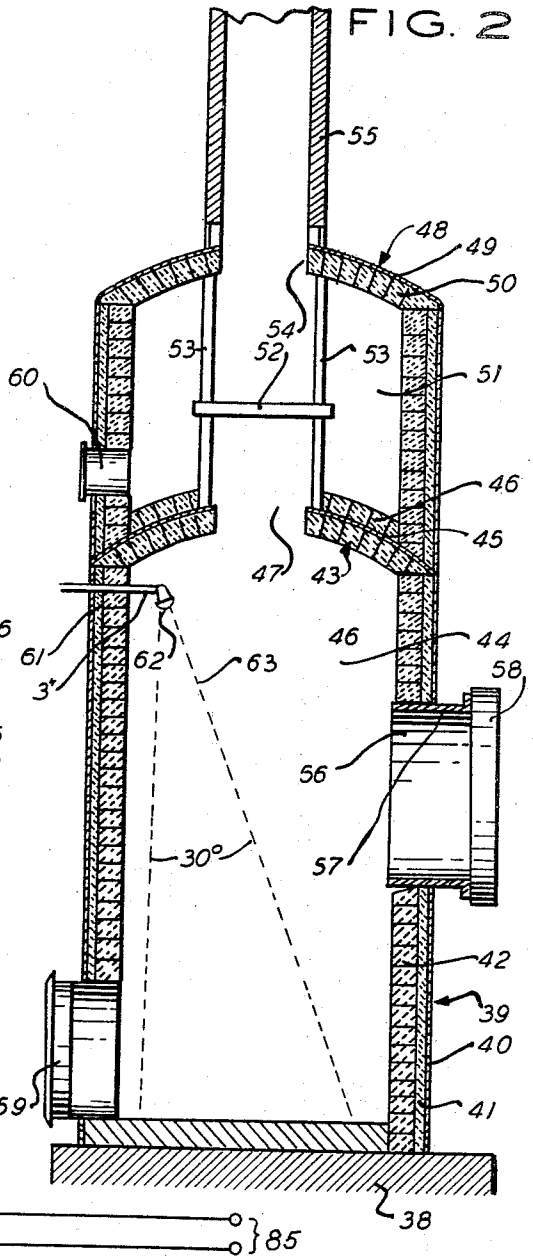



FIG. 2



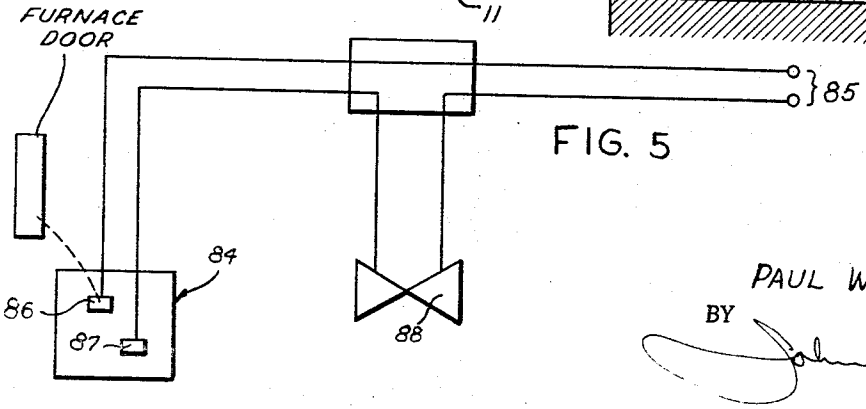




FIG. 5

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FIG. 3

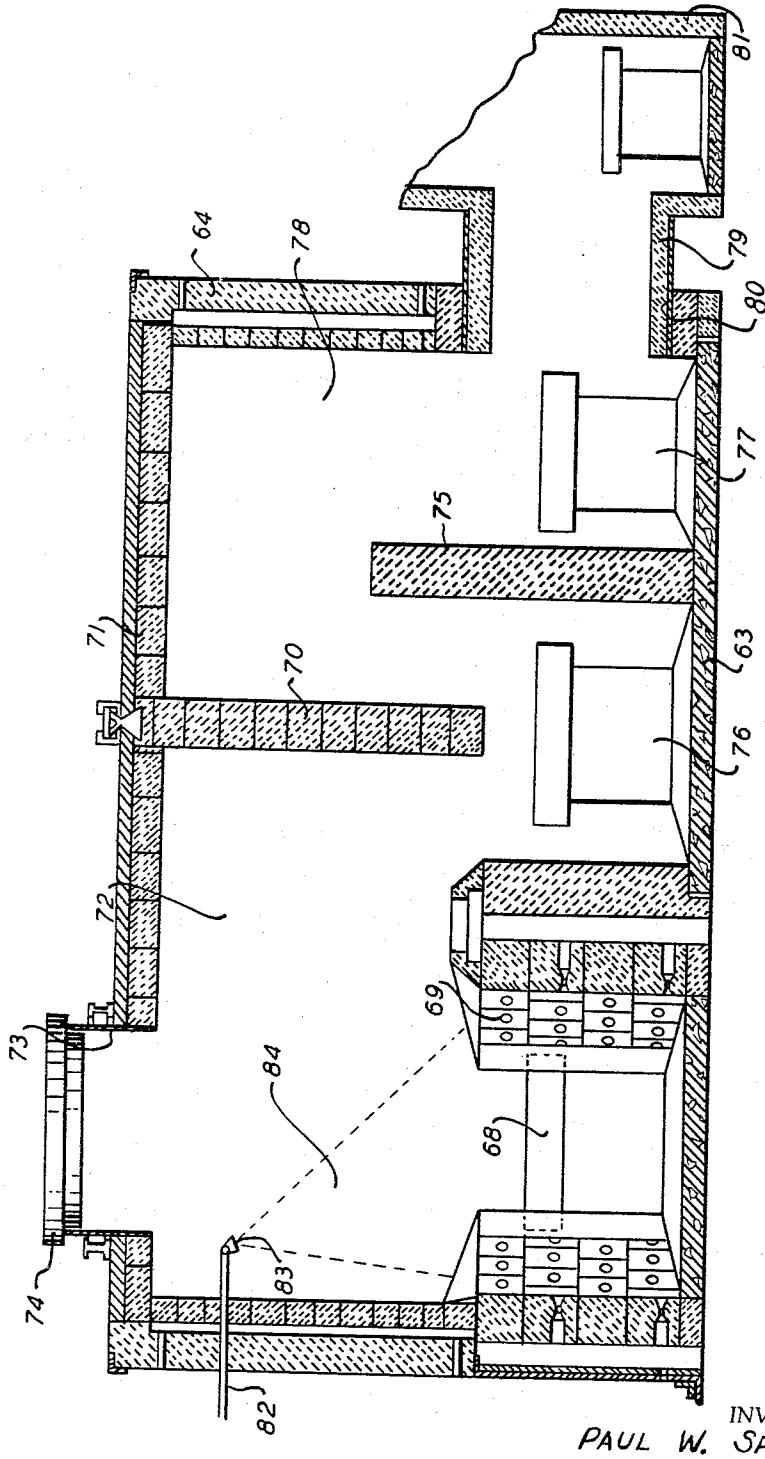


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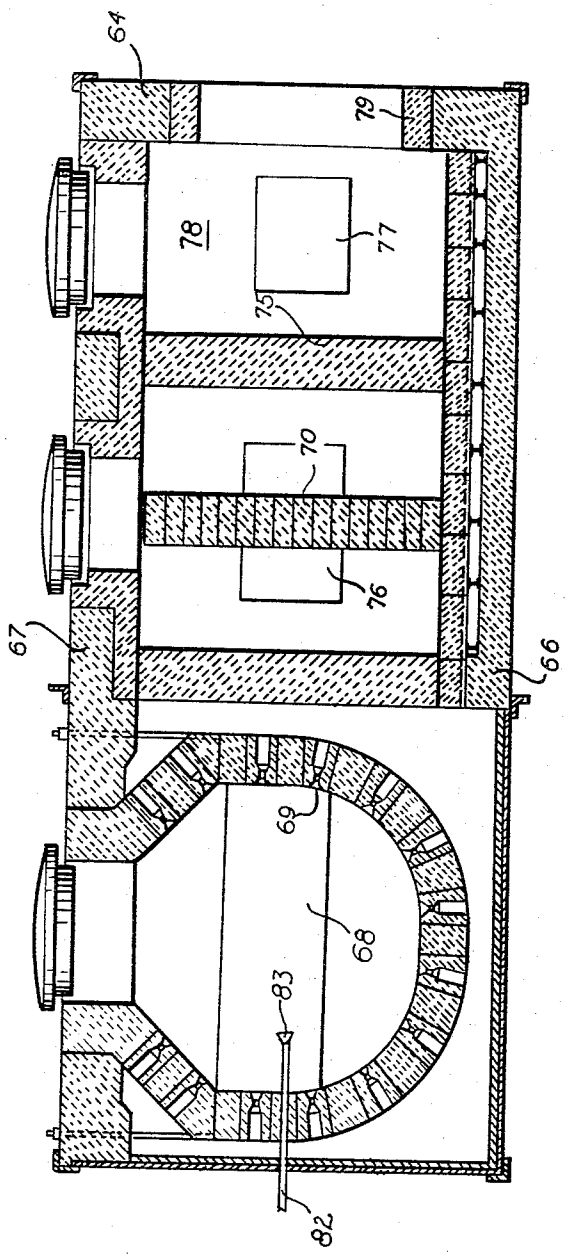
FIG. 4

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Filed Feb. 28, 1964

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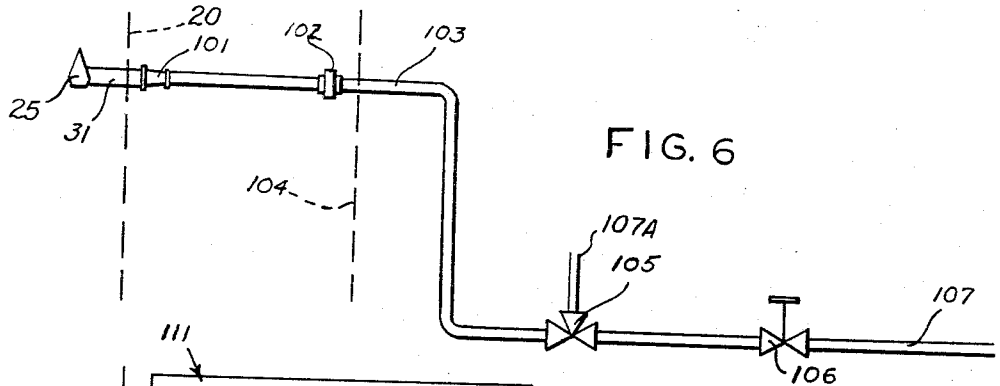


FIG. 6

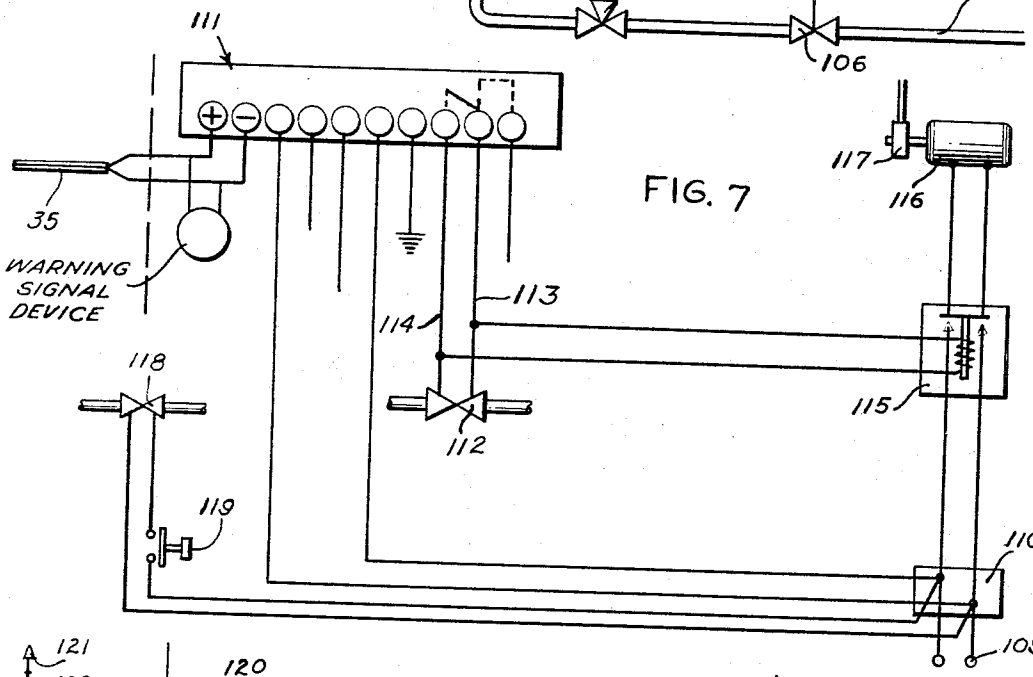


FIG. 7

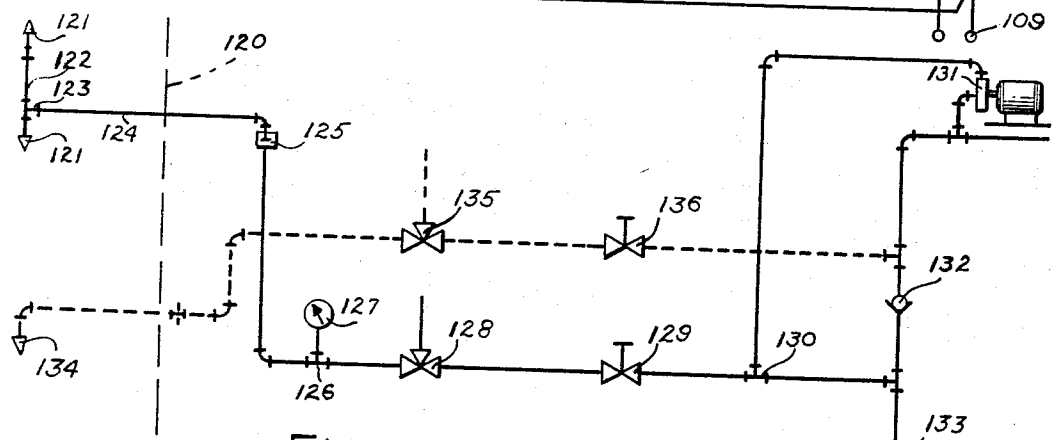


FIG. 8

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3,330,231

# INCINERATOR AND SMOKE ABATEMENT APPARATUS

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6 Claims. (Cl. 110—18)

My invention relates generally to incinerators and methods for firing same and specifically to apparatus methods for preventing the generation of smoke especially during the distillation and ignition periods immediately following charging of the incinerator, while the combustion chamber temperature is high.

Incinerators may be generally classified as either vertical or horizontal and either of the retort or non-retort type. All such incinerators generate smoke during the early stages of combustion after charging the incinerator while the chamber is hot. While it is difficult to give a precise reason for such smoke generation, I have postulated at least one acceptable theory. After a charge of material is placed in the incinerator, the bottom and side portions thereof ignite and begin to burn rapidly. This rapid combustion together with high incinerator wall temperatures generate excessive temperatures near the top of the charge outside of the flame zone. That is, the upper portions of the charge are in a zone of extremely high temperature yet no oxidizing or consuming flame exists. As a result, volatile constituents of the charged material distill in the form of smoke. As the flame zone extends upwardly to include all portions of the charge, these volatile constituents undergo complete combustion and the smoke is no longer experienced. Whether this theoretical explanation is accurate or not, nevertheless, it can be shown that all incinerators generate a large amount of smoke during the initial stages of combustion of a new charge of material. Such a condition is socially unacceptable and unlawful in these days of strict air pollution statutes.

Therefore, it is among the objects and advantages of my invention to provide an incinerator in which the initial stages of combustion can be so as to eliminate the generation of smoke.

Another object of my invention is to provide an incinerator in which temperatures within the incinerator and particularly in the vicinity of the charge not within the flame zone may be carefully controlled at relatively low levels.

Still another object of my invention is to provide an incinerator in which the generation of smoke, particularly during initial stages of combustion of a new charge with high ambient temperatures may be eliminated irrespective of whether the incinerator is of a horizontal or vertical design, or of the retort or non-retort type.

Another object of my invention is to provide an incinerator having means for spraying water on top of the charge therewithin.

Still yet a further object of my invention is to provide an incinerator in which the spraying of water upon a new charge of material may be manually, semi-automatically, or automatically controlled.

Yet a further object of my invention is to provide an incinerator in which the spraying of water upon a charge may be controlled by automatic means operated by temperature sensors within the incinerator.

Yet a further object of my invention is to provide methods for modulating the initial combustion of a new charge in an incinerator thereby eliminating the generation of smoke.

Yet a further object of my invention is to provide methods for controlling the initial combustion of a new charge in an incinerator whereby temperatures in and about portions of the charge not within the flame zone are carefully maintained at relatively low levels.



A further object of my invention is to provide an incinerator in which the manner of initial combustion of a new charge of material as well as the temperatures of the charge outside of the flame zone may be carefully modulated to eliminate the generation of smoke either by manual, semi-automatic, or automatic means.

These objects and advantages as well as other objects and advantages may be achieved by my invention, three embodiments of which are illustrated in the drawings in which:

FIGURE 1 is a schematic side elevational, cross-sectional view of a vertical incinerator embodying my invention and having a fly ash scrubber positioned in the flue;

FIGURE 2 is a schematic side elevational cross-sectional view of a vertical retort type incinerator embodying my invention;

FIGURE 3 is a schematic side elevational, cross-sectional view of a horizontal retort type incinerator embodying my invention;

FIGURE 4 is a top cross-sectional view of the incinerator shown in FIGURE 3.

FIGURE 5 is a schematic electric wiring diagram for the manual system;

FIGURE 6 is a typical schematic piping diagram for the water supply to the fly ash scrubber;

FIGURE 7 is an electrical circuit diagram for automatically controlling the spraying of water and the operation of the fly ash scrubber in the embodiment of my invention shown in FIGURE 1;

FIGURE 8 is a piping diagram of the water supply system for the scrubber and sprayer shown in FIGURE 1.

Referring now to the drawings in detail, my invention and my methods may be employed in any vertical type incinerator, a common structure for which is schematically illustrated in FIGURE 1. This incinerator comprises a base 11 having mounted thereon a generally cylindrical wall 12 defining a generally cylindrical chamber 13. The wall 12 of the incinerator may have a steel outer shell or casing 14, an intermediate insulating layer 15 of some suitable material such as asbestos, and an inner fire resistant brick or castable refractory wall 16 lining the chamber 13. The chamber 13 is closed by a top 17 having a flue 18 therein.

Mounted generally coaxially with the flue 18 is a fly-ash scrubber 19. The fly-ash scrubber 19 comprises a radial enlargement 20 in the flue 18 defining a scrubbing chamber 21. The chamber 21 communicates with a common smoke stack 22. Mounted within the chamber 21 generally coaxial therewith is a generally conical deflector 23. The deflector 23 is mounted above the flue 18 and the peripheral edge thereof extends beyond the edges of the said flue so that fly-ash material passing upwardly through the flue 18 must first engage the deflector 23 and thence pass downwardly and outwardly to escape through the annular opening 24 between the deflector 23 and the radial enlargement 20.

A water spray nozzle 25 is mounted above the deflector 23 and is adapted to emit a conical spray of water 26 downwardly there against. A second water spray nozzle 27 is mounted above the first nozzle 25 and is adapted to emit a conical spray of water 28 upwardly into the throat of the smoke stack 22. A pipe 29 connects spray nozzle 27 with a T 30 the base of which is connected to a water inlet pipe 31, extending horizontally therefrom through the radial enlargement 20. The water inlet pipe 31 is connected to an appropriate source of water as will be more fully described hereafter.

A second water inlet pipe 32 extends in a generally horizontal plane through the flue 18 and into the passage de-

fined thereby. The end of the water inlet pipe 32 is provided with a quenching spray nozzle 33. The quenching nozzle 33 is adapted to emit a conical spray of water 34 downwardly toward the base 11 of the incinerator. The nozzle 33 is shown in FIGURE 1 to be generally coaxial with the flue 18 which is in turn generally coaxial with the chamber 13 of the incinerator. The angle of divergence of the spray 34 is controlled so that the spray does not contact the inner fire brick or castable refractory wall 16. If water contacts this wall when it is at high temperatures, spaulling occurs. In addition, a temperature detector is provided. In FIGURE 1, it is shown to be a tube 35 extending through the wall 12 into the incinerator chamber 13. The tube 35 contains a thermocouple which is electrically connected to a control system which will be more fully described hereafter.

FIGURE 2 shows a vertical, retort type incinerator embodying my invention. This type of incinerator comprises a base 38 having mounted thereon a generally cylindrical incinerator wall 39. The incinerator wall 39 comprises a generally cylindrical steel outer shell or casing 40. An intermediate insulating layer 41 of asbestos or some other suitable material is provided on the internal surface of the casing 40. The interior wall 42 of the incinerator is comprised of fire brick or a castable refractory. A generally dome-shaped partition or baffle 43 extends across the incinerator wall 39 intermediate its end defining a combustion chamber 44. The partition 43 may comprise a generally dome-shaped steel base 45 having fire brick 46 covering the top and bottom thereof. The partition 43 is provided with a flue 47 which is generally coaxial with the cylindrical combustion chamber 44. A generally dome-shaped top 48 extends across the top of the incinerator wall 39. The top 48 comprises an outer shell 49 of steel and an inner fire brick wall 50. The top 48 defines with the partition 43 a secondary chamber 51.

A baffle 52 is mounted on supporting rods 53, 53 above the flue 47 to deflect fly-ash passing upwardly there through into chamber 51. The top 48 of the incinerator is provided with a flue 54 communicating with the stack 55.

A charging port 56 is provided in the wall 39. An annular conduit 57 is mounted in the port 56 extending externally to the wall 39. The end of the conduit 57 is closed by a movable charging door 58. The bottom of the wall 39 is provided with an appropriate ash removal port 59. In addition, the secondary chamber 51 is provided with an appropriate inspection and cleanout port 60.

A water inlet pipe 61 extends through the wall 39 into the combustion chamber 44 immediately beneath the partition 43. The water inlet pipe 61 is provided at its internal end with a spray nozzle 62. The spray nozzle 62 is shown in FIGURE 2 to be positioned near the wall 39 and displaced away from the central axis of the primary chamber 44. The nozzle 62 is adapted to emit a generally conical spray 63 of water downwardly towards the base 38. As in the case of the incinerator shown in FIGURE 1, the spray 63 is adapted to avoid contact with the fire brick or refractory interior 42 of the incinerator wall 39 to prevent spaulling.

The external end of the water inlet pipe 61 is connected to an appropriate supply of water which will be described in greater detail hereafter.

FIGURE 3 shows a third embodiment of my invention comprising a well known horizontal, retort-type incinerator. The incinerator shown in FIGURE 3 comprises a base 63 supporting a pair of opposed, generally parallel side walls 66 and 67. A precase lintel 68 is mounted centrally with respect to a cell tile support 69. A curtain wall 70 extends downwardly from a roof 71 and defines with the end wall 65 a primary or combustion chamber 72. An appropriate feed throat 73 is located in the top 71 above the cell tile support 69. The feed throat 73 may be closed by a movable charging door 74.

A bridge wall 75 extends upwardly from the base 63 intermediate the curtain wall 70 and one end wall 64. A pair of precast lintels 76 and 77 are mounted on the base 63 on opposite sides of the bridge wall 75. The curtain wall 70 and the end wall 64 define a secondary chamber 78.



A generally horizontal, annular conduit 79 extends through an opening 80 in the bottom of the end wall 64 and communicates with a generally vertical stack 81.

A water inlet pipe 82 extends through the end wall 65 into the primary chamber 72. The end of the water inlet pipe 82 within the chamber 72 is provided with a spray nozzle 83. The spray nozzle 83 is adapted to direct a conical spray of water 84 downwardly toward the cell tile support 69. As in the case of the embodiments of my invention illustrated in FIGURES 1 and 2, the conical spray 84 is adapted to avoid contact with the internal walls of the primary chamber 72.

It should be noted from FIGURES 1 through 4, that in all embodiments of my invention the conical water spray is adapted to contact the top of the charge of waste material, the fire initiating at the bottom thereof and spreading upwardly. I have found that by spraying water on top of the charge of waste material as combustion proceeds rapidly therebelow, the temperature within the primary or combustion chamber is vastly reduced. By reducing the temperature within the chamber in and about the charge of material above the flame zone, smoke is substantially eliminated.

As earlier recited, my water quenching system may be operated manually, semi-automatically or fully automatically. In manual operation an electrical, momentary push button switch is connected to an electrically operated solenoid valve admitting water to the spray nozzle. As long as the push button is depressed, water passed through the valve and is sprayed upon the charge of waste material. In this type of operation, water may be made available at all times merely by actuating the push button switch or may be available only after the charging door has been opened to trip a limit switch connected to the push button.

In the semi-automatic system, a temperature sensing device within the primary or combustion chamber senses excessive heat and energizes a warning device such as a light. Simultaneously, a push-button actuated, electrically operated solenoid valve permits a metered amount of water to pass through the spray nozzle as long as the push button is depressed. In the semi-automatic operation, water becomes available only after the charging door to the incinerator has been opened. This feature prevents water from being sprayed into the combustion chamber after the flame zone has extended throughout the charge thereby causing the warning device to operate. It is not merely high temperature within the primary chamber which generates smoke but rather high temperature in combination with a substantially unburned charge of material in the chamber outside of the flame zone. This occurs only after initial charging and not after the flame zone has surrounded almost all of the charge material.

In the fully automatic system, a temperature sensing device detects excessive temperatures after charging and automatically opens a solenoid operated water valve emitting a spray from the nozzle until the temperature drops to a predetermined level. Here again the water does not become available for spraying unless the charging door has been opened. Once the spray has emitted and has ceased, water will not become available until the charging door is opened again.

FIGURE 5 shows a schematic wiring diagram for manual control of the quenching operation. A combination control switch 84 is connected to a power source 85. The combination control switch 84 comprises a limit switch 86 which is manually engaged and set by movement of the charging door to the incinerator. Limit switch 86 permits operating switch 87 to pass a current signal to a well known three-way solenoid valve 88. Closing operating switch 87 after the limit switch 86 has been set opens

solenoid valve 88 permitting water to pass to the quenching nozzle in the incinerator.

FIGURE 6 shows a typical water pipe installation schematically for supply of water to the quenching nozzle. The scrubber nozzle 25 is adapted to emit a generally conical fog type spray downwardly. An iron pipe 31 connects the scrubber nozzle 25 to a source of water supply and extends through the wall 20 of either the incinerator or the flue of the incinerator. A reducing bushing 101 is connected to the external end of the iron pipe 31 and joins with an iron to copper fitting 102. Soft copper piping 103 extends through the outside wall 104 enclosing the incinerator location. The copper piping is connected to a three way solenoid valve 105 which in turn is connected to a common gate valve 106. The gate valve 106 is connected to an appropriate water supply 107. The third side of the three way solenoid valve 105 connects to a waste pipeline 107A.

FIGURE 7 schematically illustrates a wiring diagram for a semi-automatic system. A thermocouple detector 35 extends through the wall of the incinerator and is adapted to sense temperatures therein. The leads from the thermocouple are connected to a solid state, null balance potentiometer controller that provides time-proportioning or on-off control action utilizing a thermocouple or DC input millivoltage. Such a potentiometer is presently manufactured by Minneapolis-Honeywell Regulator Co., of Minneapolis, Minnesota. A source of power supply 109 is connected through a junction box 110 to the potentiometer 111. The potentiometer is provided with a plurality of connections adapted to receive a power supply of different voltages.

The output control circuit from the potentiometer 111 is connected to a three way solenoid valve 112 which will provide water for the scrubber if the same is employed. The leads 113 and 114 from the potentiometer 111 to the solenoid 112 are connected also to a magnetic contactor 115. The magnetic contactor is connected through the junction box 110 to the source of power 109. The opposite side of the contactor 115 is connected to a motor 116 which drives a water pump 117. The water pump 117 supplies water pressure for the entire system.

The power supply 109 is also connected through the junction box 110 to another three way solenoid valve 118 which supplies water to the quenching nozzle 33. A single pole momentary push button switch 119 is connected in series to the power supply to the solenoid valve 118.

In operation, a rise in temperature is detected by the thermocouple 35. The signal is input to the potentiometer 111 and the output circuit will close after the temperature has arisen to a predetermined level. Thus, power is supplied both to the solenoid valve 112 and to the motor 116. The pump 117 is energized to supply water pressure which passes through the now opened solenoid valve 112 to the scrubber. Simultaneously, an alarm in the form of a buzzer, light, bell or any other appropriate device may be connected in series or in parallel to the magnetic contactor 115 output circuit to warn that the temperature has risen to a predetermined level.

When the operator has been warned of this temperature rise, he operates the push button switch 119 which opens solenoid valve 118 supplying water to the quenching nozzles as long as the switch 119 is depressed.

It should be noted that this is but one possible circuit. Many other arrangements are also contemplated within the scope of my invention. For instance, appropriate circuitry can be provided to make water available only after the charging door has been opened. In other circuits, the water can be available to the scrubber on a more or less continuous basis but available to the quenching nozzles only after the charging door has been opened. This arrangement is particularly useful when the material being burned in the incinerator is of such a nature that fly ash appears at very much lower temperatures than that at which smoke is generated. In addition, circuitry may be provided to permit quenching nozzles to emit water for either a fixed period of time, or a fixed volume of water, or until the temperature detected by the thermocouple has fallen to a predetermined level.



FIGURE 8 is a schematic piping diagram for supplying water to both a scrubber and the quenching nozzles. Vertical dotted lines 120 represent the incinerator wall. Fog nozzles 121, 121 are connected together by means of a pipe 122. A T 123 is connected to the pipe 122 and leads to a water supply line 124. The water supply line 124 passes through a vacuum breaker 125 and from thence extends to a fitting 126 connecting a pressure gauge 127 to the line. The water supply line thence extends to a three way solenoid valve 128 and from thence to a gate valve 129. The gate valve 129 is connected through a fitting 130 to a well known water pump 131. The opposite side of water pump 131 is connected through a check valve 132 to a supply of water 133.

The quenching nozzle 134 is connected to stainless steel pipe which extends through the wall of the incinerator. The piping to the nozzle 134 is shown in dotted lines in FIGURE 8. A three way solenoid valve 135 is positioned in the water supply line. The opposite end of the three way solenoid operated water valve 135 is connected to a gate valve 136 which is in turn connected to the low pressure side of the water supply line to water pump 131.

The foregoing description is merely intended to illustrate an embodiment of this invention. The component parts have been shown and described. They each may have substitutes which may perform a substantially similar function; each substitutes may be known as proper substitutes for the said components and may have actually been known or invented before the present invention; these substitutes are contemplated as being within the scope of the appended claims, although they are not specifically catalogued herein.

I claim:

1. An incinerator for effecting the smokeless combustion of waste combustibles charged thereinto comprising:

means defining a combustion chamber adapted to receive a charge of waste combustibles whereby burning of said charge of combustibles initiates at the bottom and spreads upwardly therethrough,

a charging door defining an access means to said combustion chambers disposed so as to position a new charge of waste combustibles onto pile of waste combustibles burning therein,

means operatively connected to said combustion chamber to exhaust the waste gases,

means for controlling the temperature of the charge extending beyond the flame zone of said pile of burning combustibles to prevent the smoking distillation thereof prior to ignition when the temperature in said chamber exceeds a predetermined limit,

said control means including a water spray nozzle extending into said chamber and above said burning charge of waste materials for modulating initial combustion of a new charge of waste combustible, and said nozzle having an angle of divergence to assure that the fluid sprayed therethrough does not contact the fire walls of said combustion chamber,

means responsive to the opening of the door for activating said spray nozzle to spray to top of said pile of combustibles to reduce the temperature thereof below the distillation temperature thereof after the charging door has been opened,

and means for indicating when the temperatures in said combustion chamber exceeds the distillation temperature of said combustibles.

2. The invention as defined in claim 1 wherein the means for activating said spray nozzle includes:

a solenoid valve operatively connected with said nozzle to control the flow of fluid thereto,

and a manually actuated actuator operatively connected

in circuit with said solenoid valve to effect the operation thereof.

3. The invention as defined in claim 1 wherein means for operating said spray nozzle is rendered semi-automatic.

4. The invention as defined in claim 3 wherein said semi-automatic means includes:

a warning device operatively connected to said means for detecting the temperature in said combustion chamber, whereby said warning device is actuated to indication when activating means for said spray nozzle is to be energized.

5. The invention as defined in claim 4, and including means which render water available to the spray nozzle only after the charging door to the combustion chamber has been opened.

6. The invention as defined in claim 1 including a solenoid valve for controlling the flow to said spray nozzle, and said temperature detecting means being operatively connected to said spray nozzle and its controlling valve to automatically control fluid flow therethrough when said temperature detecting means detects temperatures exceeding said distillation temperatures.




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