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3,041,986

INCINERATOR PLANT AND METHOD

Filed Nov. 19, 1958

2 Sheets-Sheet 1

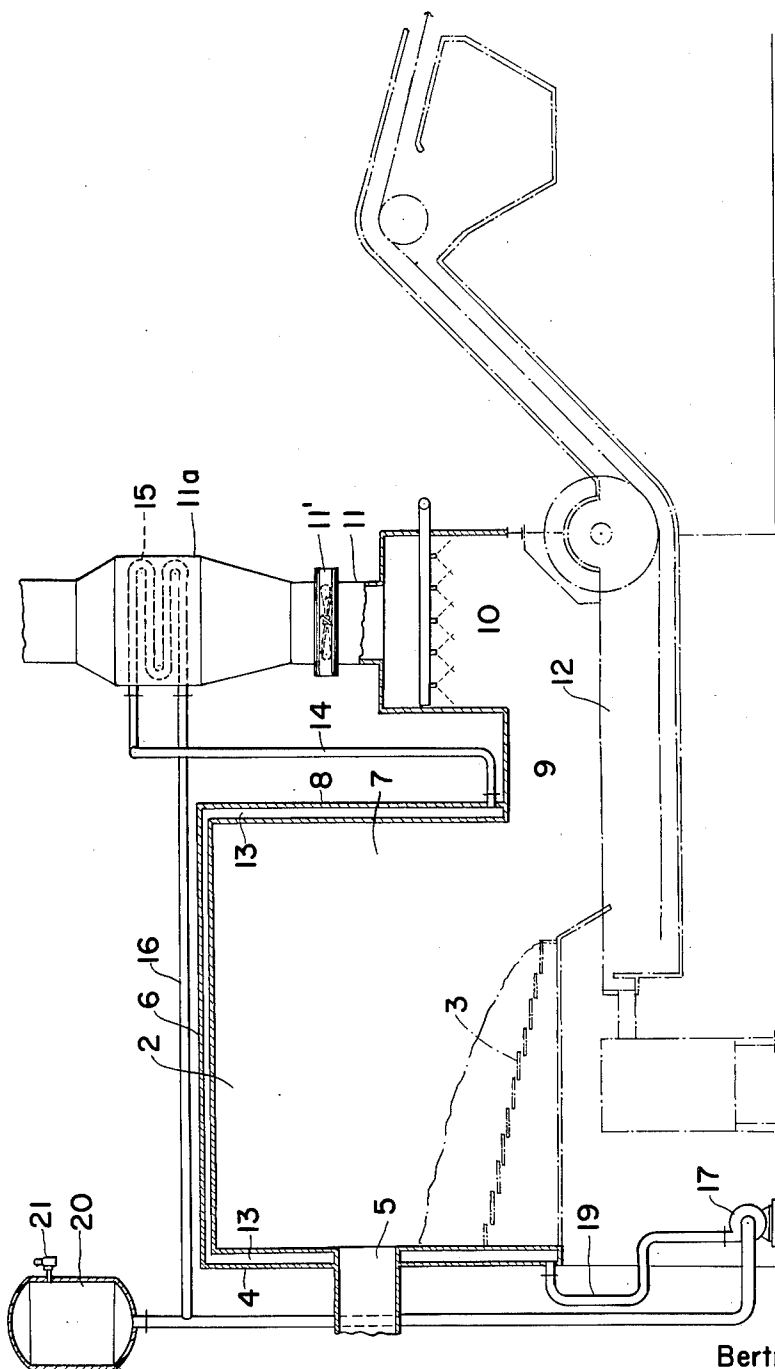


Fig. 1.

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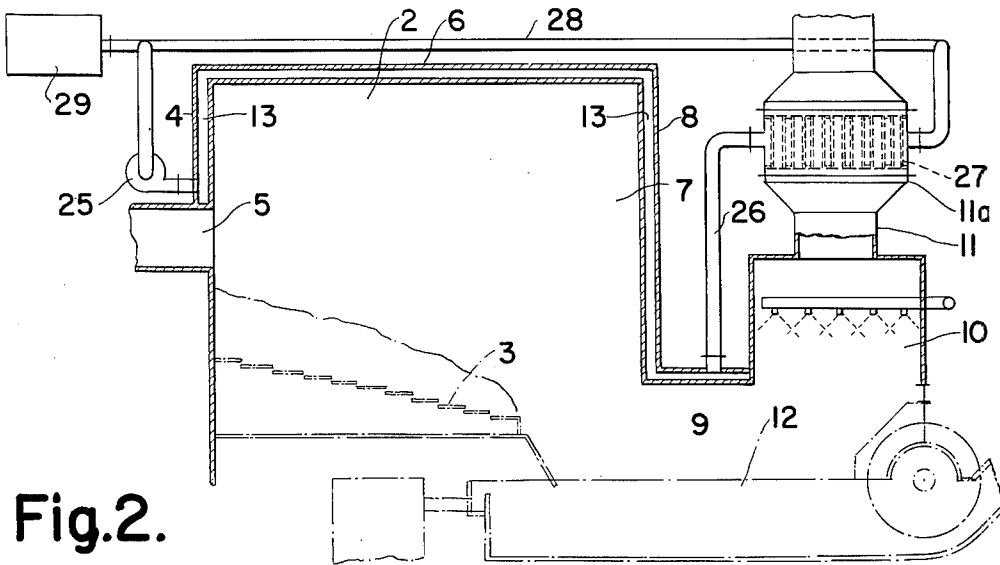


Fig. 2.

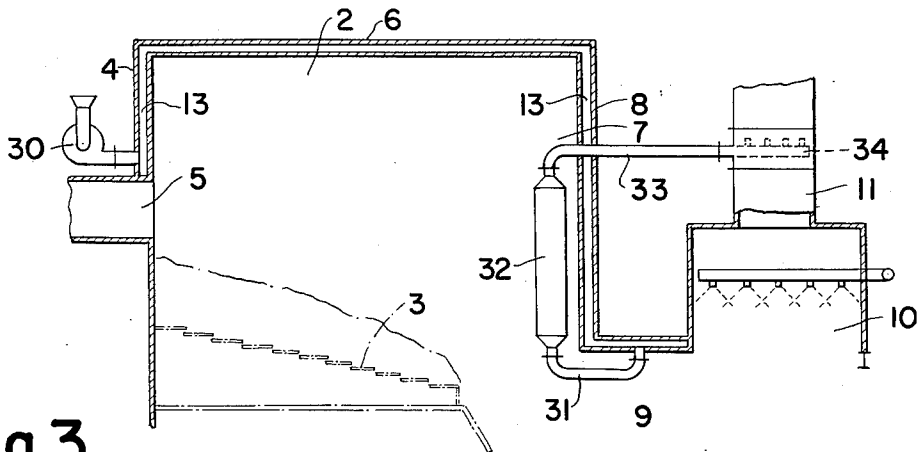


Fig. 3.

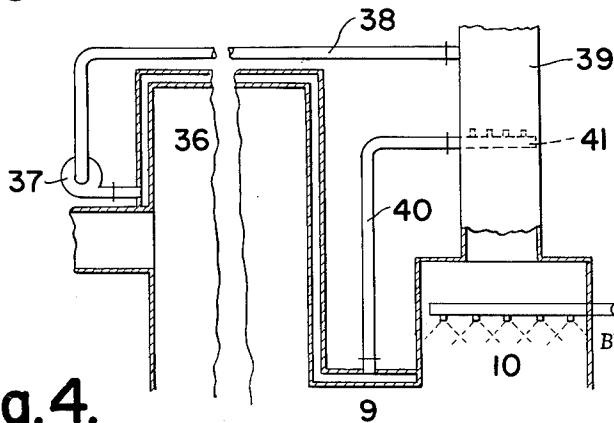


Fig. 4.

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INCINERATOR PLANT AND METHOD

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This invention relates to incinerators, and especially large incinerators of the kind generally identified as municipal incinerators, and more particularly to the processing of the combustion gases and vapors resulting from incineration processes.

Large incinerator plants of the type to which the present invention pertains generally discharge the products of combustion through a stack to the atmosphere. The combustion gases carry a considerable volume of water vapor resulting to some extent from the character of the material being burned and the water vapor formed from combustion processes, and partly from the fact that the hot gases are scrubbed by passing them through a spray type scrubber where the hot gases evaporate moisture from the spray. Upon leaving the chimney stack, the gases, which may be saturated with water vapor, mix with the surrounding cooler atmosphere resulting in a cloud or plume of condensed moisture vapor. This plume is likely to be regarded by the public as objectionable smoke even though negligible solid particulate matter is in it.

The present invention has for its principal object to transfer waste heat from the combustion chamber of the incinerator to the flue gases which have been scrubbed, thereby raising the temperature of the stack gases and reducing the relative humidity. As a result of this the gases leave the stack above the saturation temperature of the gases and the vapor plume is eliminated, or substantially reduced. At the same time the transfer of waste heat in this manner protects the furnace walls from excessive temperatures and prolongs the life of the furnace.

My invention may be more fully understood by reference to the accompanying drawings, in which:

FIG. 1 is a more or less schematic longitudinal vertical section through one form of incinerator plant embodying my invention;

FIG. 2 is a similar view on a smaller scale of a modified construction;

FIG. 3 is a fragmentary view similar to the upper part of FIG. 2, showing a still further modification; and

FIG. 4 is a fragmentary view showing a further modification of FIG. 3.

Referring to FIG. 1, 2 designates the combustion chamber of an incinerator having a conveyor grate 3. There is a front wall 4, with a charging opening 5 therein, a top wall 6, side walls 7, and a rear wall 8. At the bottom of the rear wall there is burned gas outlet flue 9 leading into the bottom of a spray type scrubber 10 of a well-known type, in which the gases pass upwardly through fine sprays of water to an outlet duct or stack 11. A shaft induction fan may be used in the duct leading from the scrubber as indicated at 11'. In the particular incinerator shown there is a trough 12 extending from the discharge end of the grate under the flue passage 9 and scrubber 10 so that ash discharged from the grate and the spray water with entrained fly ash enter this trough, as fully explained in a copending application entitled "Incinerator and Ash Removal and Gas Scrubbing Apparatus Therefor," in which the scrubber is also shown in greater detail. There is a conveyor, not here shown, that removes solids from the trough, while the water overflows from the trough to be recirculated through the scrubber, this is not being shown since my present invention is applicable to various incinerator constructions other than the particular form shown.

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According to the present invention the walls of the combustion chamber are made with inner and outer metal walls, as shown, to provide a space 13 therebetween or otherwise provided with internal ducts, particularly in the hottest zones. Refractories may be provided over the inner face of the inner wall to protect the metal, but either the refractory is thin or of good heat-conducting material, such as silicon carbide, or both.

The present invention contemplates that space 13 in the walls is water-tight, and that a heat exchange fluid, either liquid or gas, may be circulated through this space. In connection with FIG. 1, it may be assumed that water fills this space, but it may be a high boiling point liquid. If water is used, the walls will be constructed to hold water at a temperature well above the atmospheric boiling point.

Leading from the rear wall of the combustion chamber is a pipe 14 through which hot fluid or water heated above the atmospheric boiling point may flow from the space 13 through a heat exchanger, such as a coil 15 in the burned gas discharge duct or stack 11, and the stack is shown with an enlargement 11a at this point to reduce the gas velocity in this area. From the heat exchanger the water or other liquid is carried through a pipe system 16 to a motor-driven circulating pump 17. The pump returns the water or other liquid through pipe 19 to the space 13 in the front wall of the furnace, so that with the system full, the injection of water under pressure into the front forces it out at the back into pipe 14. An expansion chamber connected into the pipe system is indicated at 20, and 21 is a pressure relief or safety valve.

In order to be effective, the temperature of the water circulated through the heat exchanger should be higher than the temperature of the flue gases leaving the scrubber, and for this reason superheating of the water to a temperature above its boiling point at atmospheric pressure is reverted to, or high boiling point liquid is used in the system.

In operation of the system, the water is circulated during the operation of the incinerator. The highly humidified flue gases, leaving the scrubber, are close to complete saturation, or carry such a high amount of water vapor that a visible volume or mist would be visible at the top of the stack. By reheating the flue gases above the scrubber, and before discharge from the stack, the relative humidity is substantially reduced, thereby eliminating or substantially reducing the visible plume that generally prevails at the top of the stack of an incinerating plant.

Not only is this primary purpose accomplished by my invention, but the circulation of fluid through the furnace walls lowers the temperature of the inner wall of the furnace, thereby protecting it from the destructive influences of heat and gases, and if the furnace is refractory lined, the refractory will be protected and the life of the furnace or the refractory lining thereby prolonged. After operation has started, a condition of equilibrium is established which precludes either excessive cooling or excessive heating of the furnace walls.

In FIG. 2 I have shown an incinerator and scrubber arrangement similar to that shown in FIG. 1, and have used similar reference numerals to designate corresponding parts. However, in this figure, air instead of water or other liquid is used as a heat transfer medium for utilizing the heat of combustion to reheat the washed combustion gases. In this figure, a blower or pump 25 forces air into the space 13 in the front wall of the furnace. This forces heated air through a duct 26 at the rear of the furnace. This duct leads to a heat exchanger or multipass plenum 27 in the stack enlargement 11a where it transfers its heat to the cooler washed flue gases. In order to conserve heat and prevent excessive cooling of the furnace walls, the air may be recirculated through

duct 28 to the pump or blower 25 for recirculation through the space between the furnace walls. An expansion chamber or other means 29 is provided to prevent excess pressure when the air expands and compensate for the decrease in volume when it is cooled.

Instead of recirculating the heated air, it may be discharged directly into the stack or flue 11 to commingle with the flue gases and thereby not only heat the gases by the sensible heat which it carries, but also dilute the flue gases so as to reduce the burden of moisture in each cubic foot of gases leaving the stack. This is shown in FIG. 3 wherein the furnace structure is similar to that shown in FIG. 1, and similar reference numerals have been used. In this figure, the blower or pump 30 forces air into the space 13 in the front wall of the furnace, forcing it out at the rear through duct 31. I have here shown duct 31 leading to a superheater 32 in the combustion chamber so that the air may be even more intensely heated, should this be desired. The superheater may be of any simple heat-resistant heat exchange construction. There is a duct 33 leading from the superheater to the stack, and to a manifold structure 34 in the stack having a plurality of upwardly-opening air discharge nozzles.

In this modification no stack enlargement is shown, as in the previous figures, but this may be used. However, since the effect of discharging hot air into the stack gases will not only heat these gases, but will desirably increase the draft or stack effect, no enlargement at this point appears to be advantageous.

In FIG. 4, the apparatus is much the same as that shown in FIG. 3, except that in this form, hot gases are withdrawn from the stack and recirculated through the furnace, thereby preventing excessive cooling of the furnace or any part of it. In this view, only a portion of the furnace is indicated at 36, and it may be similar to the one shown in the other figures. A blower 37 has its intake duct 38 leading to the interior of the stack 39, so that flue gases are led from the stack through the blower and forced into the air space in the furnace walls, thereby supplying heated air and/or gases for circulation between the furnace walls instead of ambient air. The air is forced into duct 40 leading to a manifold 41 in the stack with a plurality of upwardly-opening discharge nozzles.

The superheater shown in FIG. 3 may be used, if desired, in any of the other forms of the invention here shown, including FIG. 1, and it will be understood that while certain specific constructions have been shown for reheating the flue gases after they have been cooled in the scrubber by the transfer of heat from the combustion chamber to the flue gases, various other modifications and constructions may be used, and that both heated gases and liquids may be used together or separately to accomplish this purpose. I have indicated a forced draft induction fan only in FIG. 1, but this may be used in the other modifications. Also, it will be understood that I have described circulation of fluid in the furnace from the front to the rear walls, but this is only by way of illustration, as the air or water may enter and leave at spaced points other than this as conditions may require.

I claim:

1. An incinerating plant comprising a furnace with a combustion chamber having walls with a passageway provided therein through which fluid may be circulated for cooling the walls and heating the fluid, said passageway having spaced inlet and outlet connections, a spray-type scrubber connected with the furnace into which spent combustion gases pass upon leaving the furnace, a stack leading from the scrubber and open at its top to atmosphere, means including ducts for conducting fluid from

the outlet connection of said passageway to the stack below the top, means in the stack for transferring heat of the fluid to the gases in the stack beyond the scrubber and thereby decrease the relative humidity of the stack gases, and means for effecting circulation of fluid through said passageway in the combustion chamber wall and said ducts to and from said means in the stack.

2. An incinerator plant as defined in claim 1 in which the furnace combustion chamber has spaced inner and outer walls to provide the passageway.

3. An incinerator plant as defined in claim 1 in which the means in the stack for transferring heat comprises a heat exchanger through which the fluid circulates and about which the spent combustion gases flow after being scrubbed, a second duct for conducting fluid from the heat exchanger to the inlet of the passageway in the furnace walls, the said means for effecting the circulation of fluid comprising the passageway in the furnace, the heat exchanger and the connecting ducts.

4. An incinerator plant as defined in claim 1 in which the fluid is a gas, and the means in the stack comprises a discharge nozzle for discharging the gas into the stack.

5. An incinerator plant as defined in claim 4 wherein a duct is provided for conducting gases which have been scrubbed from the stack to the passageway in the furnace.

6. The method of operating an incinerator plant having a combustion chamber, a spray-type scrubber for spent gases leaving the combustion chamber and a stack through which scrubbed spent combustion gases are discharged to atmosphere to reduce the visible vapor plume at the top of the stack which comprises reheating the spent combustion gases after scrubbing by transfer of heat thereto from a heat-transfer medium by bringing said medium into heat transfer relation with said combustion chamber and by carrying said heat transfer medium from the combustion chamber to the stack gases.

7. The method of operating an incinerator plant as defined in claim 6 in which the transfer medium is a fluid which is first circulated in the combustion chamber walls to cool said walls.

8. The method of operating an incinerator plant as defined in claim 6 in which the transfer medium is a fluid which is first circulated in the combustion chamber walls to cool said walls, and superheating the fluid in the combustion chamber after the fluid is first used to cool the combustion chamber walls and before it is carried to the stack.

9. The method of incineration which comprises burning refuse in a combustion chamber, heating a fluid in a closed environment surrounding the chamber by the heat of combustion within the chamber, exhausting the products of combustion from the chamber through a conduit to the atmosphere, scrubbing the products of combustion with a liquid at a station in the conduit as they pass to the atmosphere, and circulating the heated fluid from the closed environment to a location within the conduit intermediate the scrubbing station and the atmosphere whereby the scrubbed gases are heated by the fluid and the moisture content thereof is lowered.

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