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Monroe, Jr.

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[54] **CYCLONIC INCINERATOR**

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[52] **U.S. Cl.** ..... **110/8 C**, 110/28 F

[51] **Int. Cl.** **F23g 5/12**

[58] **Field of Search** ..... 110/8 R, 8 C, 18 R, 18 C, 110/28 F

[56] **References Cited**

UNITED STATES PATENTS

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Primary Examiner—Kenneth W. Sprague

[57] **ABSTRACT**

Cyclonic incinerators can be improved in operation by the use of two rows of air injection nozzles of different sizes, one row supplying high velocity air, tangentially and continuously to the combustion zone. To further improve efficiency the flue from the incinerator should have a reduced diameter and provide a sharp cutoff to centrifugally retain small unburned particulates in the combustion zone.

5 Claims, 2 Drawing Figures

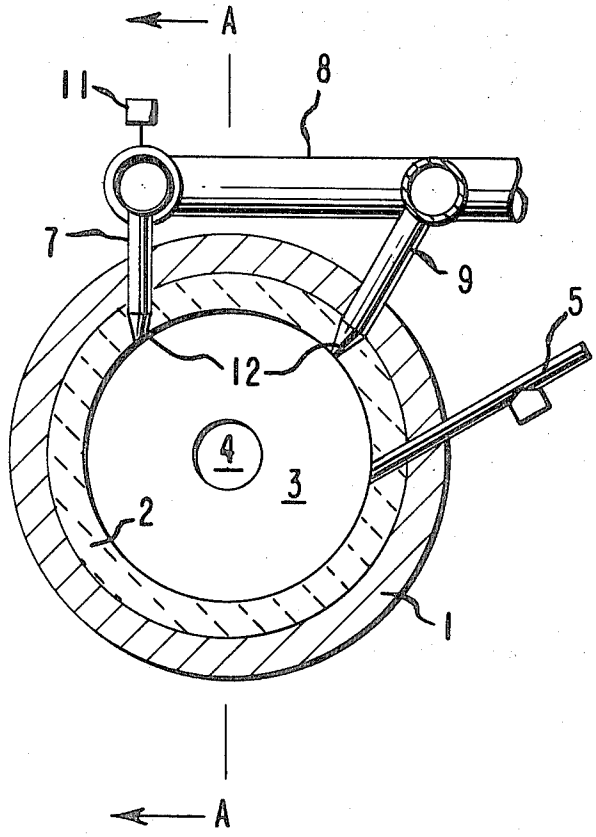


FIG. 2

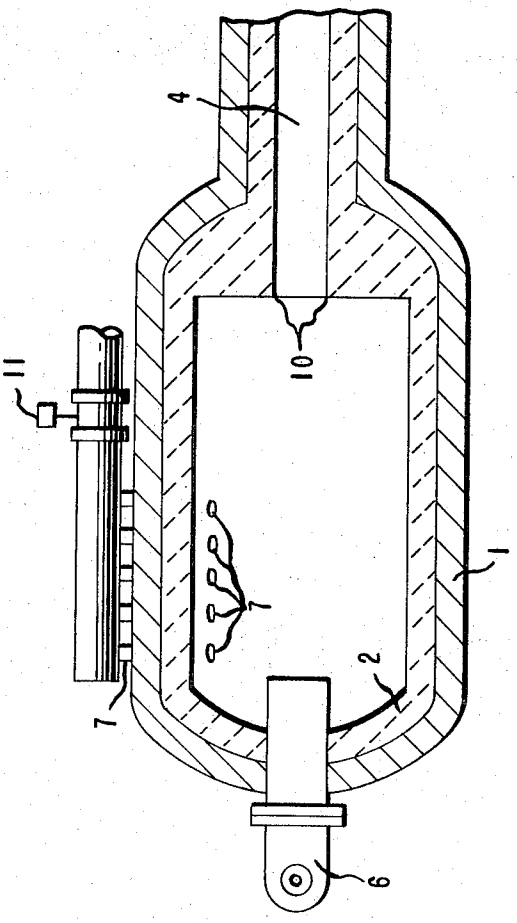
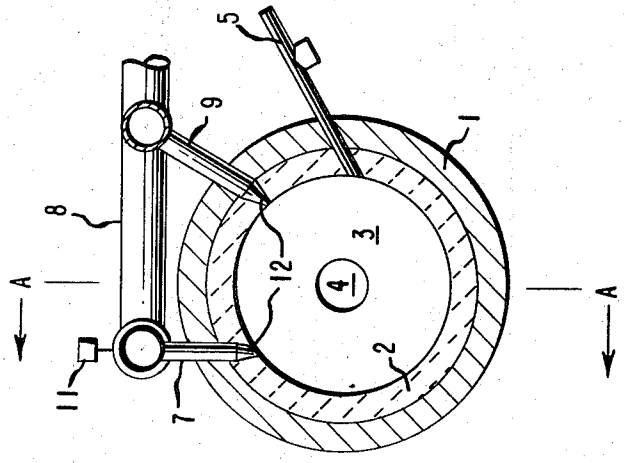


FIG. 1



CYCLONIC INCINERATOR

BACKGROUND OF THE INVENTION

Incinerators are often the lowest cost method of waste disposal. They can convert large quantities of noxious, toxic, or bulky waste to harmless gases with minimum residue for landfill. Fuels may be gases, liquids, or solids. Traditionally, incinerators have been custom designed for specific applications and have had high investment cost and limited use.

One type of incinerator which has been used is the open pit, e.g., see U.S. Pat. No. 3,483,832. However, as air pollution codes have developed in many areas of the world, the open pit has become impractical because of the difficulties in controlling the feed to it and the carryover of fly ash when burning paper type material.

Cylindrical cyclonic incinerators are also known, for example see U.S. Pat. No. 3,654,881; 3,628,473; 3,519,397; 3,548,759; 3,563,187 and 3,565,021. In these incinerators the air is admitted tangentially to produce a circle of flame which may also leave the unit in a spiral path.

SUMMARY OF THE INVENTION

I have discovered a cylindrical cyclonic incinerator of improved performance composed of

a. a cylindrically shaped combustion chamber,

b. feeding means for introducing waste to be burned into one area of said chamber, said area being near one end of the chamber,

c. a first row of nozzles parallel to the axis of the combustion chamber, said nozzles capable of directing air into said area of the chamber in a direction tangentially with respect to the circumference of the chamber,

d. means for adjusting the rate of air flow from said first row of nozzles in relation to the amount of waste introduced into the chamber,

e. a second row of nozzles parallel to the axis of the combustion chamber and spaced apart from the first row, said nozzles being smaller in diameter than the nozzles in the first row and capable of directing a fixed amount of air tangentially into said area of the combustion chamber at such a velocity to maintain turbulence in said chamber, and

f. in the opposite end of the chamber from said area wherein the waste and air are introduced, an exit means for exhausting the gases created by combustion in an axial direction, said exit being smaller in diameter than the chamber, centered on the axial center line of the chamber, and forming a sharp angle with the end of the chamber.

The incinerator of the invention is particularly useful for the combustion of industrial wastes, e.g., chemical wastes. It can handle solid, liquid or gaseous wastes such as aqueous wastes, plastics, soaps, sludge from sewage treatment plants, or halogenated compounds.

The incinerators of the invention have several advantages, low investment cost, require only minimum operator attention or maintenance, are safe in operation and they are reliable. They can operate continuously at temperatures up to 3,000°F and can handle multiple waste streams simultaneously.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross sectional view of an embodiment of the incinerator of the invention.

FIG. 2 is a horizontal sectional view of the embodiment of FIG. 1, taken along line A—A.

DESCRIPTION OF THE INVENTION

The cyclonic incinerator of the invention is composed of a cylindrical metal shell **1**, the interior of the shell being lined with a suitable refractory material **2**. The interior of the shell forms the combustion chamber **3**. This cylindrical shell can be located such that its axis is in any direction, e.g., vertical; but preferably, the shell axis is in a horizontal direction as illustrated in FIG. **2**.

At one end of the incinerator is located the exit **4** for exhausting the gases created by the combustion within the chamber. This exit is centered on the axial center line of the chamber as illustrated. The waste to be burned is introduced into the opposite end of the chamber through suitable feeding means **5**. The waste can be propelled into the chamber by air or fuel. This feeding means will be of different design depending upon whether the waste to be burned is liquid, solid or gas. If desired, a row of similar feeding means can be used so as to feed different wastes simultaneously into the combustion chamber.

Thus if a liquid waste is involved, the feeding means can be an atomizer or simply and open pipe with an air supply to eject the liquid. If the waste is a gas, the means can be an open pipe, or if the waste is a solid, a screw conveyor, pneumatic injector, ramfeed or the like, can be employed.

The feeding means can also be used to introduce fuel into the combustion chamber if this is desirable.

In the end of the chamber opposite the exit can be located an auxiliary burner **6**. This burner will use natural gas or fuel oil and can be used at start-up to heat the combustion chamber to the desired temperatures. Once the unit is started, this burner can be turned off. The burner can be located at other locations within the combustion chamber; however, it is preferable to have it in the chamber close to the area wherein waste and air are introduced.

Air is introduced into the combustion chamber by two rows of nozzles. The first row of nozzles **7** is located in the end of the chamber wherein the waste is introduced. The row of nozzles is parallel to the axis of the cumbustion chamber and directs the air tangentially into the combustion chamber. The row of nozzles is connected to a manifold **8** which communicates with a blower (not illustrated). The air is normally not preheated; however, if desired it can be heated prior to introduction into the chamber.

The second row of nozzles **9** is also parallel to the axis of the combustion chamber and also directs the air tangentially into the combustion chamber. In some embodiments it may be desirable to stagger the nozzles with a row such that they are not parallel to the axis of the chamber.

The nozzles in the second row are smaller than the nozzles in the first row. The number of nozzles in each row is a function of the size of the unit and the type of waste to be treated. Embodiments have been made employing from **2** to **14** nozzles in each row.

The nozzles in both rows are preferably convergent nozzles as illustrated **12**; however, in some embodiments straight pipe nozzles can be employed.

The exit **4** from the combustion chamber is smaller in diameter than the chamber and forms a sharp corner

10 with the chamber. In this respect a 90° corner is preferred; however, the corner could be conical in shape.

In operation the waste is introduced into one end of the combustion chamber through the feeding means 5. This waste feed is caught up in the rapid cyclonic flow of hot gases in the chamber and is rapidly combusted. If desired, a fuel, e.g., natural gas, can be introduced along with the waste. Into the same end of the chamber air is introduced through the two rows of nozzles. The first row of nozzles supplies most of the air into the chamber, i.e., 65 percent by volume or more, during operation. The amount of air introduced in the first row is adjusted in relationship to the amount of waste introduced into the chamber or to the temperature within the chamber by an adjusting valve, throttle or damper 11.

The air introduced by the second row 8 is at a fixed velocity, the velocity being such as to maintain turbulence in the chamber. The velocities can normally range from 200 to 400 ft/sec. Thus by sweeping the lower half of the chamber with high velocity air continuously, carbon and coking of impinging liquids are prevented and solids are burned at a high rate.

In operation the cyclonic incinerator will have an operating temperature of 1,600°F to 3,000°F. At start-up this temperature can be obtained through use of an auxiliary burner. However, once this temperature has been obtained, the auxiliary burner can be turned off and the temperature maintained by adjustment of the air and/or waste feed into the chamber. One method of controlling the temperautre is by use of radiation pyrometers to directly observe the flame pattern.

Temperature control is best exercised by first reducing air flow in the first row of nozzles to a minimum level which retains good turbulence and then by adding auxiliary fuel or use of the auxiliary burner. This permits good start-ups without smoking and control of rapidly changing firing rates under optimum conditions.

The flow of combustion gases is cylindrical in the combustion chamber but the exiting gases leave in an axial fashion. This means that the combustion of fuels introduced at or near the front of the chamber will initially be of a rich fuel nature and gradually progress to complete combustion towards the end of the chamber. This multi-staging results in very stable ignition even when the overall fuel-air ratio is very lean and might normally burn poorly.

One advantage of the stable flame produced in the incinerator of the invention is that the operation is quiet, i.e., significantly quieter than a Vortex type incinerator for example. Another advantage of multistaging is that NO_x abatement can be obtained in short residence times within the chamber.

Some wastes such as sludge from biological oxidation ponds, spent sulphuric acid, etc., tend to form carbon particles that require long residence times in furnaces to complete combustion. By introducing the air tangentially with a high velocity and by arranging the exit so that a sharp and smaller diameter flue leads from the furnace in an axial direction, the small particles of carbon or organic materials can be centrifugally retained in the furnace for a residence time greater than that of the combustion product gases. In a test in a furnace with a heat release of 100,000 BTU/cu-ft-hr and a calculated residence time of less than 0.5 seconds, all carbon was retained in the furnace and consumed.

I claim:

1. A cyclonic incinerator capable of burning chemical wastes comprising:
   a. a cylindrically shaped combustion chamber,
   b. feeding means for introducing waste to be burned into one area of said chamber, said area being near one end of the chamber,
   c. a first row of convergent nozzles parallel to the axis of the combustion chamber, said nozzles capable of directing air into said area of the chamber in a direction tangentially with respect to the circumference of the chamber,
   d. means for adjusting the rate of air flow from said first row of nozzles in relation to the amount of waste introduced into the chamber or the temperature within the chamber,
   e. a second row of convergent nozzles parallel to the axis of the combustion chamber and spaced apart from the first row, said nozzles being smaller in diameter than the nozzles in the first row and capable of directing a fixed amount of air tangentially into said area of the combustion chamber at such a velocity to maintain turbulence in said chamber, and
   f. in the opposite end of the chamber from said area wherein the waste and air are introduced, an exit means for exhausting the gases created by combustion in an axial direction, said exit being smaller in diameter than the chamber, being centered on the axial center line of the chamber, and forming an angle with the end of the chamber.

2. The cyclonic incinerator of claim 1 with a burner means in the end of the chamber nearest said area wherein the waste and air are introduced.

3. In a cyclonic incinerator having a cylindrically shaped combustion chamber, means for introducing waste into one area of said chamber, and exit means for exhausting the combustion gases, the improvement comprising a first row of convergent nozzles parallel to the axis of the combustion chamber, said nozzles capable of directing air into said area of the chamber in a direction tangentially with respect to the circumference of the chamber; means for adjusting the rate of air flow from said first row of nozzles in relation to the amount of waste introduced into the chamber or the temperature within the chamber; and second row of convergent nozzles parallel to the axis of the combustion chamber and spaced apart from the first row, said nozzles being smaller in diameter than the nozzles in the first row and capable of directing a fixed amount of air tangentially into said area of the combustion chamber at such a velocity to maintain turbulence in said chamber.

4. A cyclonic incinerator capable of burning chemical wastes comprising:
   a. a cylindrically shaped combustion chamber,
   b. feeding means for introducing waste into one area of said chamber, said area being near one end of the chamber.
   c. a first row of nozzles parallel to the axis of the combustion chamber, said nozzles capable of directing air into said area of the chamber in a direction tangentially with respect to the circumference of the chamber,
   d. means for adjusting the rate of air flow from said first row of nozzles,
   e. a second row of nozzles parallel to the axis of the combustion chamber and spaced apart from the first row, said nozzles being smaller in diameter

than the nozzles in the first row and capable of directing a fixed amount of air tangentially into said area of the combustion chamber, and

f. in the opposite end of the chamber from said area wherein the waste and air are introduced, an exit means for exhausting the gases created by combustion in an axial direction, said exit being smaller in diameter than the chamber, being centered on the axial center line of the chamber, and forming an angle with the end of the chamber.

5. In a cyclonic incinerator having a cylindrically shaped combustion chamber, means for introducing waste into one area of said chamber, and exit means for exhausting the combustion gases, the improvement comprising a first row of convergent nozzles parallel to the axis of the combustion chamber, said nozzles capable of directing air into said area of the chamber in a direction tangentially with respect to the circumference of the chamber; means for adjusting the rate of air flow from said first row of nozzles; and a second row of convergent nozzles parallel to the axis of the combustion chamber and spaced apart from the first row, said nozzles being smaller in diameter than the nozzles in the first row and capable of directing a fixed amount of air tangentially into said area of the combustion chamber.

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