United States Patent

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[54] APPARATUS FOR THE DESTRUCTION OF REFUSE

18 Claims, 3 Drawing Figs.

[52] U.S. Cl. 110/8, 13/26
[51] Int. Cl. F23g 5/08
[50] Field of Search 110/7, 8, 18; 13/26, 27

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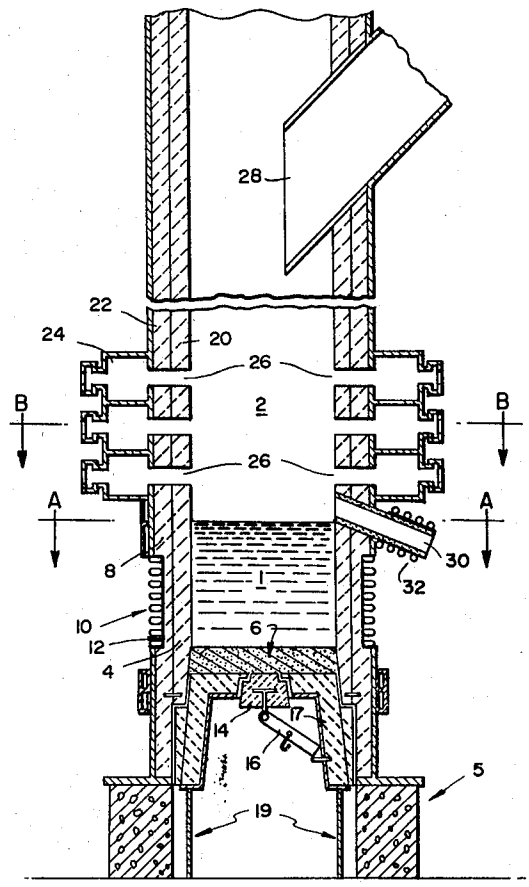
ABSTRACT: A novel apparatus useful for the incineration of refuse material. Essentially, the apparatus involves an integration of structural elements to provide adjacent first and second zones. The first zone is a heat generating zone in which electrical heating means are employed to heat a mass of material disposed therein thereby providing a high temperature environment for a second zone communicating therewith. The second zone is the incineration zone and comprises means to introduce refuse material thereto and means to introduce fluids thereto which promote and/or support the incineration of the refuse material. The products of incineration are continuously discharged from the incinerator by way of either the gases flowing therefrom or by way of removal means located at or near the boundary of the first and second zones.



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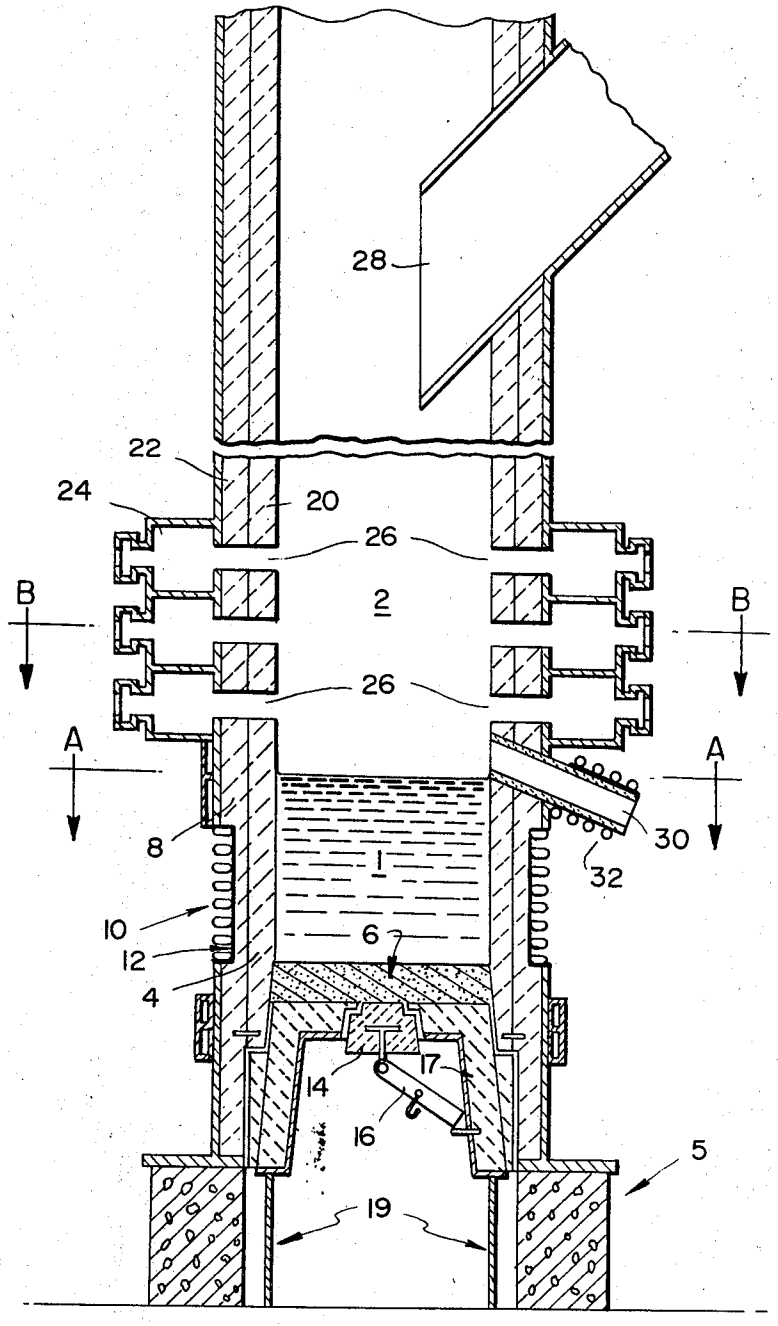

FIG. 1

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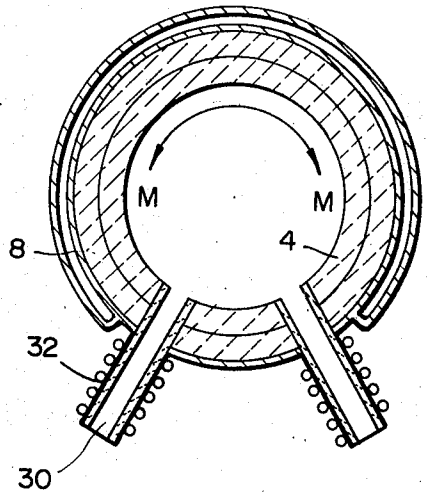

FIG. 2

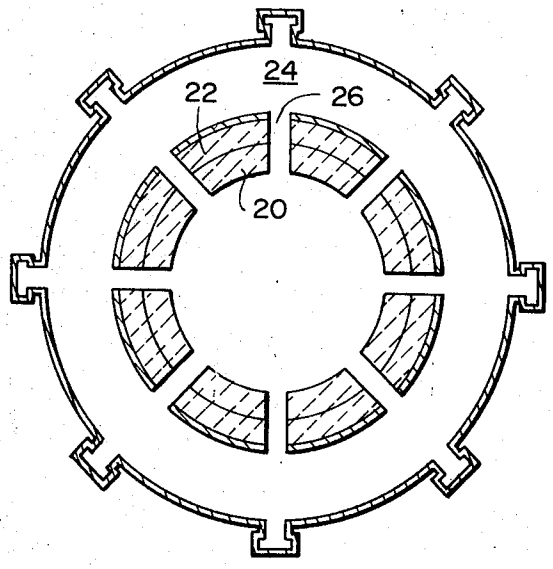

FIG. 3

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APPARATUS FOR THE DESTRUCTION OF REFUSE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the incineration of refuse material. More precisely, the invention disclosed herein relates to a novel incinerator which can efficiently incinerate material such as garbage, paper, cans, bottles and the like.

2. Description of the Prior Art

The elimination or destruction of refuse is an outstanding problem of critical proportions. Incinerators are known and routinely employed in the destruction of such refuse. However, known incinerators leave much to be desired in both their operation and overall efficiency. For example, small scale incinerators such as those employed in the home can dispose of such refuse as paper or the like but cannot conveniently dispose of such refuse material as bottles and cans or the like. Moreover, large scale incinerators such as those employed to destroy refuse collected from municipalities leave much to be desired. For example, incinerators employed in such applications require supplemental fuels which limit the heat available for incineration of the refuse material and also contribute to the increased pollution of the air. Moreover, many present incinerators are not truly capable of continuous operation over extended times. Instead, their operation time is somewhat limited by the accumulation of the incinerated residue which must periodically be discharged therefrom by way of grates or the like thereby interrupting continuous operation. It is to these and related problems outstanding in the art of incineration in general to which the present invention is addressed to provide a novel solution therefor.

SUMMARY OF THE INVENTION

In accordance with the present invention, novel apparatus for incineration is presented. Essentially, the apparatus is an integration of structural elements combined in a fashion to provide two adjacent zones. In the first zone which functions as a heat generating zone, a mass of material is heated by electrical means to provide heat for the incineration of refuse material charged to the second zone. The mass of material heated in the first zone can be, for example, a pure metal, metal alloy, metal refuse or other electrically conducting material, if desired. The electrical heating means heats the mass to at least about the melting temperature and maintains the mass in a semi-molten or preferably molten state. The level of the melted mass approximately defines the boundary between the zones. The heat generating zone provides a high temperature environment in the second zone wherein the major portion of incineration occurs. The second zone is provided with means to charge refuse material thereto and means to introduce a fluid thereto. The fluid which can be air or like fluids provides support for and/or promotes incineration of the material charged into the zone. The products of incineration are continually removed from the incinerator during the operation. The manner by which the product is removed depends primarily on the nature of the material incinerated and the nature of the product resulting from substantially complete incineration thereof. For example, easily combustible material such as paper or the like can be rapidly incinerated and converted to relatively light products upon incineration. These products are easily discharged from the incinerator by entrainment with gaseous products emerging therefrom. The products of less readily combustible materials such as glass or metal which are produced in the present apparatus are collected at the boundary between the first and second zones which is approximately defined by the level of the melted material in the first zone. At this boundary, the products are heated to a molten state or semi-molten state and means are provided to remove the products. For example, overflow spouts or the like are positioned at or near the boundary to remove excess melted material accumulated there to thereby maintain the material at a substantially constant level throughout the operation.

Many advantages can be derived from the practice of the present invention. Chief among these is the reduced pollution of the atmosphere. Unlike present incinerators, the apparatus of the present invention does not require the use of secondary fuels such as coal, coke, gas or the like. Instead, the refuse material is employed as the primary fuel and thus the amount of pollution is limited to that created by the incineration of the refuse material alone. Also in present incinerators employing secondary fuels, the heat available is primarily limited by the fuel employed. Accordingly, the operating temperatures cannot be conveniently varied. In contrast thereto, the present apparatus permits variations in temperatures. For example, if the only refuse material involved should be easily combustible such as paper or the like, a low melting metal or alloy can be employed in the first zone and can be heated by electrical induction heating means of a preselected frequency. Accordingly, the incineration temperature can be varied by selecting the appropriate combination of metal and power input in the first zone thereby permitting close adjustment and control between the energy and/or heat required to incinerate the particular refuse material involved. Another advantage in the present invention is that incineration can be conducted in a substantially continuous fashion over extended periods of time since the incineration products are continuously removed therefrom during operation. Other advantages and benefits involved in the practice of the present invention will be set forth in detail hereinafter or will be apparent to those skilled in the art from the following detailed description.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The invention will be better understood by reference to the attached figures in which FIG. 1 is a cut-away view in elevation of an arrangement of apparatus suitable for practicing the present invention. FIG. 2 is a cross sectional view along line AA of FIG. 1 which approximately defines the boundary between zones 1 and 2. FIG. 3 is a cross sectional view along line BB of FIG. 1.

Referring now to FIG. 1, there is shown an incinerator solidly supported on supports 5. The incinerator has two adjacent zones; zones 1 and 2. Zone 1 is defined by a periphery wall 4 which is preferably fabricated of an electrically non-conductive refractory material but can be fabricated of an electrically conductive material depending on the type of electrical heating means involved. In turn, wall 4 is often times bounded by another reinforcing wall 8 also preferably fabricated of suitable refractory material. The lower boundary of zone 1 is defined by a layer 6 of a non-conductive heat resistant material preferably in particulate form such as foundry sand. In the operation of the incinerator, a material such as a relatively pure metal and/or metal alloy is charged to zone 1. The charged material is then heated preferably to above its melting point by electrical heating means 10 which as shown is a water cooled, high frequency induction heating coil wrapped about a substantial portion of zone 1. The level of the heated mass of material approximately defines the boundary between zones 1 and 2 and is indicated by AA of FIG. 1. Electrical insulation means 12 are employed to isolate electrical heating means 10 from any metal components of the incinerator which may be located near induction heating means 10. Grounding means (not shown) can also be employed in manners known to the art.

The direct high frequency induction heating means illustrated in FIG. 1 is definitely preferred in heating the mass of material disposed in zone 1. However, it is to be understood that other electrical induction heating means such as indirect and semi-direct electrical induction heating means as well as dielectric heating means can be employed. The manners, methods and arrangements by which such means can be employed to heat the mass of material in zone 1 are known to those skilled in the art and they need not be discussed in detail. Also the frequencies employed will depend upon such factors as the nature of the material to be incinerated, the size of the incinerator and the particular metal heated in zone 1.

The frequencies normally employed are those between about 60—960 cps which can be obtained by rotating generators or converters or the like. If higher frequencies are employed, *e.g.* from about 960—10,000 cps or even higher, motor generator sets and converters can be employed as suitable sources of power. Often times, two separate frequencies with separate induction coils can be employed to obtain maximum efficiency at minimum cost.

Often times means to purge or discharge the heated material from zone **1** are desirable in incinerators of the present invention. One arrangement of such means is shown in FIG. **1** in which bottom plate **17** having plug **14** in the central regions thereof is supported by supports **19**. Plug **14** can be removed from plate **17** by actuating lever **16**. Layer **6** which is normally a heat resistant and electrically non-conducting particulate material such as foundry sand can be drained from zone **1** together with the heated material. Alternately, supports **19** can be withdrawn thereby permitting the removal of plate **17** and discharge of the mass in zone **1**. It is to be understood that the means to purge or discharge the heated mass from zone **1** normally need not be employed except in an extreme emergency or for replacing refractory material in zone **1**. During normal operation the mass need not be removed. For example, if the operation is terminated for any particular interval of time, the operation can be resumed by merely reheating the mass in zone **1** to provide sufficient heat for the incineration of material charged to zone **2**.

Zone **2** defines the incinerator chamber and comprises a periphery of preferably electrically non-conducting refractory material **20** which is normally bounded by an insulating or reinforcing wall **22** also preferably fabricated of non-conducting refractory. At the lower portion of zone **2**, a series of tuyeres **26** are provided to introduce a fluid to zone **2** to promote and/or maintain the incineration of refuse material. The fluid is introduced to zone **2** such as from wind box **24** by way of tuyers **26**. As illustrated in FIG. **1**, three series of tuyers **26** are arranged concentrically one above the other about zone **2**. The number of series and the concentric arrangement and the shape of the individual tuyeres can vary and is dependant primarily upon such factors as the nature of the material incinerated and the particular fluid employed. Accordingly, modifications of these features can be employed to introduce sufficient fluid to promote and/or maintain incineration of the refuse material delivered to zone **2**. For example, as illustrated in FIG. **3**, tuyeres **26** are positioned approximately equidistant about zone **2** and arranged to direct fluid to the center of zone **2** along a line approximately parallel to the horizontal axis of zone **2**. The positioning and arrangement shown can be varied. For example, tuyeres **26** can be arranged so as to introduce the fluid in a tangential fashion to zone **2** or to direct some or all of the fluid downward toward zone **1** or substantially upward through zone **2**.

The fluid, which can be preheated, is introduced to zone **2** to promote and/or maintain the incineration of refuse material delivered thereto. Normally air or oxygen-enriched air is the fluid employed. However, other fluids can be employed sometimes alone or in combination with others. These can be combustible in nature such as the various lower boiling hydrocarbons or diverse other hydrocarbons normally employed as fuels. Also normally non-combustible fluids such as water vapor can be employed especially when high temperatures are generated within the incinerator chamber. Under such conditions the water vapor or like fluid can be broken down into its elemental components providing additional heat for incineration. Inert gases such as nitrogen and argon or the like which can ionize under conditions of high temperatures to generate heat can oftentimes be advantageously employed. Normally the fluid is introduced to zone **2** under somewhat higher than atmospheric pressure to promote agitation of the refuse material delivered to zone **2** thereby promoting rapid and efficient incineration. Also by employing high pressures which can be alternately or selectively regulated, removal of the products of incineration is enhanced. One arrangement of providing high agitation and efficient incineration involves a series of tuyeres arranged one above the other concentrically about the periphery of zone **2** with each series of tuyeres being connected to fluid sources under different pressures.

Shute **28** provides means to introduce the refuse material into the incineration zone **2**. As illustrated in FIG. **1**, shute **28** is arranged to direct the refuse material to that portion of zone **2** opposite slag spouts **30**, *e.g.* to that portion of wall **4** bounded by MM of FIG. **2**. This arrangement of shute **28** is preferable but as will be apparent from the further description, other arrangements of shute **28** can be employed. The refuse material delivered into zone **2** can include easily combustible material such as paper, leaves and garbage or the like as well as materials which are not normally readily combustible such as materials of metal (cans) or of glass (bottles). Accordingly, the nature of the refuse material will normally determine the area in zone **2** where the major incineration of the material occurs. For example, when temperatures above 2000°F are generated in zone **2** of FIG. **1**, easily combustible material will undergo substantially complete incineration oftentimes almost immediately after being introduced to zone **2**, *e.g.* well above the junction of zones **1** and **2** as indicated by line AA of FIG. **1**. Moreover, the major portion of the products of the incineration of such materials are readily removed from zone **2** by the fluid flow therethrough.

The incineration of materials which are not readily combustible or which form incineration products of high density will normally occur closer to the junction of zones **1** and **2**. Indeed in some instances, complete incineration of materials such as cans and bottles or the like will occur after the material has contacted the molten mass in zone **1**. The products of materials which undergo incineration at or near the boundary of zones **1** and **2** are removed from the incineration apparatus by way of means to maintain the boundary substantially constant which are shown as slag spouts **30**. As illustrated, slag spout(s) **30** are located below tuyeres **26** and arranged so as to maintain the level of the melted mass of material heated in zone **1** substantially constant. The removal of the products of incineration by way of slag spout(s) **30** can be enhanced by assuring a difference in the density of the products and the material heated in zone **1**. Also convection currents can be created in the mass of melted material in zone **1** to enhance removal of the products. For example, when high temperatures are employed, the heated material in zone **1** can resemble a boiling mass of molten lava. Since products removed by way of slag spout(s) **30** are normally in a molten or semi-molten state, heating means are usually provided for slag spout(s) **30** to assure efficient discharge of products therethrough. For example, induction heating means **32** is shown in FIG. **1** as a suitable heating means. Obviously, slag spout(s) **30** must be fabricated of a suitable heat resistant material.

Many advantages of the apparatus discussed above will be apparent to those skilled in the art. For example, the temperatures obtained in the incineration zone can be varied over a wide range by controlling the power input. Although high temperatures are preferred, *e.g.* temperatures above about 2000° F, low temperatures can be realized by employing low melting metals in the heat generating zone (zone **1**). Accordingly, incinerators of the present invention present features which permit close adjustment and control over such operating parameters as energy input and heat produced. These features permit design of large scale incinerators as well as small scale units which can be employed efficiently in remote areas for incineration of specific refuse. Still another advantage of the present apparatus is the reduced volume of the products of incineration. Even the less readily combustible refuse material undergoes substantially complete incineration and is removed or extruded from the apparatus in a substantially molten state. The molten material can be molded into convenient shapes and disposed of in this form. Alternatively the molten material can be quenched, pelletized or ground up and employed as an inert filler useful in the construction of roads and like structures. Perhaps the most outstanding ad-

vantage of the apparatus is the continuous manner in which it can operate. This is in marked contrast to present incinerators which must be periodically shut down at frequent intervals to remove products of incineration therefrom.

Many modifications of features of the apparatus described for the purpose of illustrating the invention can be employed without departing from the spirit and scope of the invention defined in the appended claims. For example, direct induction heating means, indirect induction and semi-direct induction heating means or dielectric heating means can be employed for heating slag spout(s) **30**. Also, various equipment normally employed with present incinerators can be associated with the apparatus of the present invention. Such equipment includes precipitators and filters or like equipment normally employed to reduce pollution. Afterburners can also be employed as well as energy recovery and energy conversions means such as to generate electricity which can be utilized in the operations involved. The manners and methods of integrating such elements with the present invention need not be discussed in detail since such manners and methods are well known to those skilled in the art to which the present invention pertains.

I claim:

1. An incinerator comprising adjacent first and second zones:

said first zone defining a heat generating zone and comprising a periphery wall of refractory material, electrical heating means operationally communicating with said zone and means to retain a mass of material in said zone to be heated by said electric heating means whereupon the upper level of said heated mass approximately defines the boundary between said first and second zone; and

said second zone defining primarily an incineration zone and comprising a periphery wall of refractory material, means to introduce an incineratable material to said zone, means to introduce a fluid to said zone which in combination with heat generated in said first zone can cause incineration of material delivered to said second zone and means to remove molten products produced in said incinerator, said removal means being located approximately at the boundary of said first and second zone and arranged so as to maintain said boundary substantially constant.

2. The incinerator of claim **1** wherein said electrical heating means is a direct electrical induction heating means.

3. The incinerator of claim **1** wherein said electrical heating means is an indirect electrical induction heating means.

4. The incinerator of claim **1** wherein said electrical heating means is a semi-direct electrical induction heating means.

5. The incinerator of claim **1** wherein said electrical heating means is a dielectric heating means.

6. The incinerator of claim **1** wherein said means to introduce said fluid comprises a plurality of ports arranged about the periphery of said second zone near said boundary with said ports being operationally connected to a fluid source.

7. The incinerator of claim **1** wherein said means to maintain said boundary substantially constant comprises at least one spout arranged approximately at said boundary.

8. An incinerator comprising two substantially cylindrical adjacent first and second zones:

said first zone defining a heat generating zone and comprising a periphery wall of refractory material, high frequency electrical induction heating means operationally communicating with said zone and means to retain a mass of material in said zone to be heated by said induction heating means whereupon the upper level of said heated mass approximately defines the boundary between said zone; and

said second zone defining primarily an incineration zone and comprising a periphery wall of refractory material, means to introduce an incineratable material to said zone, a plurality of ports arranged about said periphery near said boundary and connected to a fluid source to introduce fluid to said zone which in combination with heat generated in said first zone can cause incineration of material delivered to said second zone, and at least one spout located at approximately the boundary of said first and second zone and arranged to remove molten products from said boundary and to maintain said boundary substantially constant.

9. The incinerator of claim **8** further including electrical heating means for heating said spout.

10. The incinerator of claim **8** wherein said electrical heating means is a direct electrical induction heating means.

11. The incinerator of claim **8** wherein said electrical heating means is an indirect electrical induction heating means.

12. The incinerator of claim **8** wherein said electrical heating means is a semi-direct electrical induction heating means.

13. The incinerator of claim **8** wherein said electrical heating means is a dielectric heating means.

14. The incinerator of claim **8** wherein a plurality of spouts are located and arranged about said boundary.

15. The incinerator of claim **14** further including electrical heating means for heating said spouts.

16. The incinerator of claim **8** wherein said series of said ports are arranged one above the other concentrically about said periphery with each series connected to a separate source of fluid under different pressures.

17. The incinerator of claim **1** further including means to discharge substantially all of said heated mass of material from said first zone.

18. The incinerator of claim **8** further including means to discharge substantially all of said heated mass of material from said first zone.