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Ali et al.

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[54] **INCINERATOR**

[75] Inventors: **Syed Aejaz Ali; Orval Austin Doherty,** both of Shelbyville, Ind.

[73] Assignee: **General Electric Company,** Indianapolis, Ind.

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[52] **U.S. Cl.** ..... **110/8 R,** 110/18 R, 110/28 F

[51] **Int. Cl.** **F23g 7/00**

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

[56] **References Cited**

UNITED STATES PATENTS

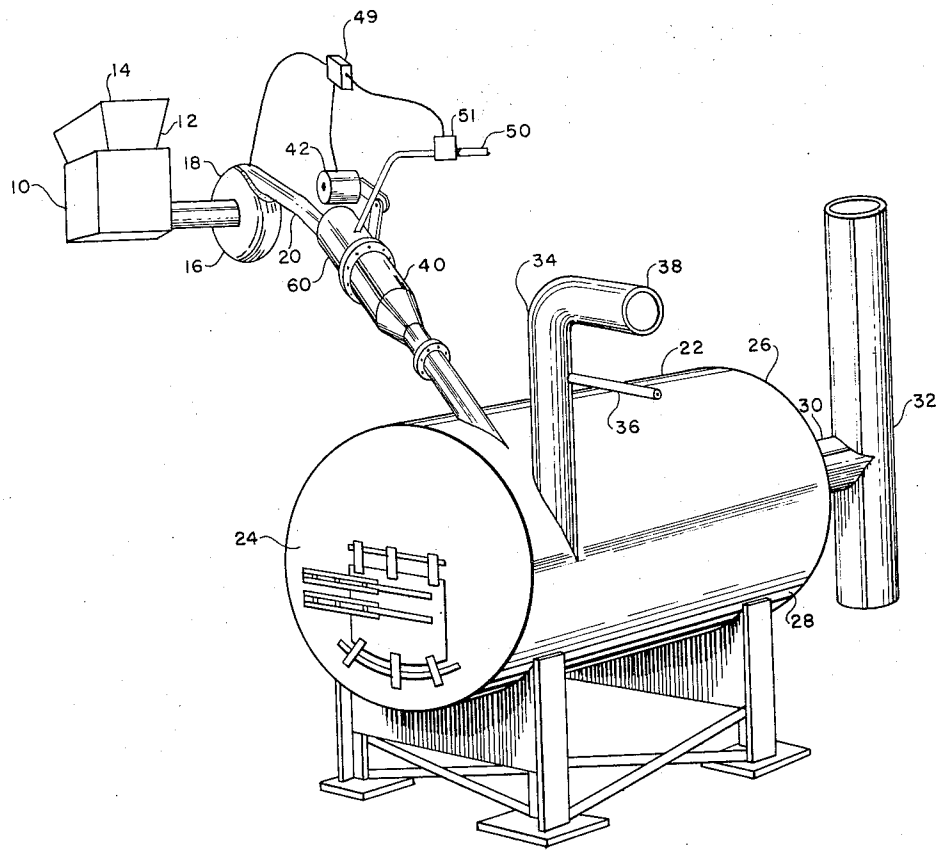
3,727,563	4/1973	Hasselbring et al.	110/8 R
3,658,017	4/1972	Dibelius et al.	110/120
3,601,068	8/1971	Ciaffone et al.	110/8 R
3,645,218	2/1972	Davis	110/8 R

Primary Examiner—Kenneth W. Sprague
Assistant Examiner—Henry C. Yuen
Attorney—Raymond G. Simkins et al.

[57] **ABSTRACT**

An incinerator for burning waste material having a combustion chamber comprising spaced end walls and a side wall through which a mixture of waste material and air is vortically moved and burned. The incinerator combustion chamber includes a tangentially directed inlet conduit means for feeding a mixture of waste material and air under pressure from a blower into the chamber, and an exhaust flue to vent combustion gases from the chamber. The inlet conduit means is provided with a valve means intermediate the combustion chamber and blower for closing off the conduit when the blower is not operational, and means are provided for introducing cooling air to said valve means in the inlet conduit.

10 Claims, 3 Drawing Figures



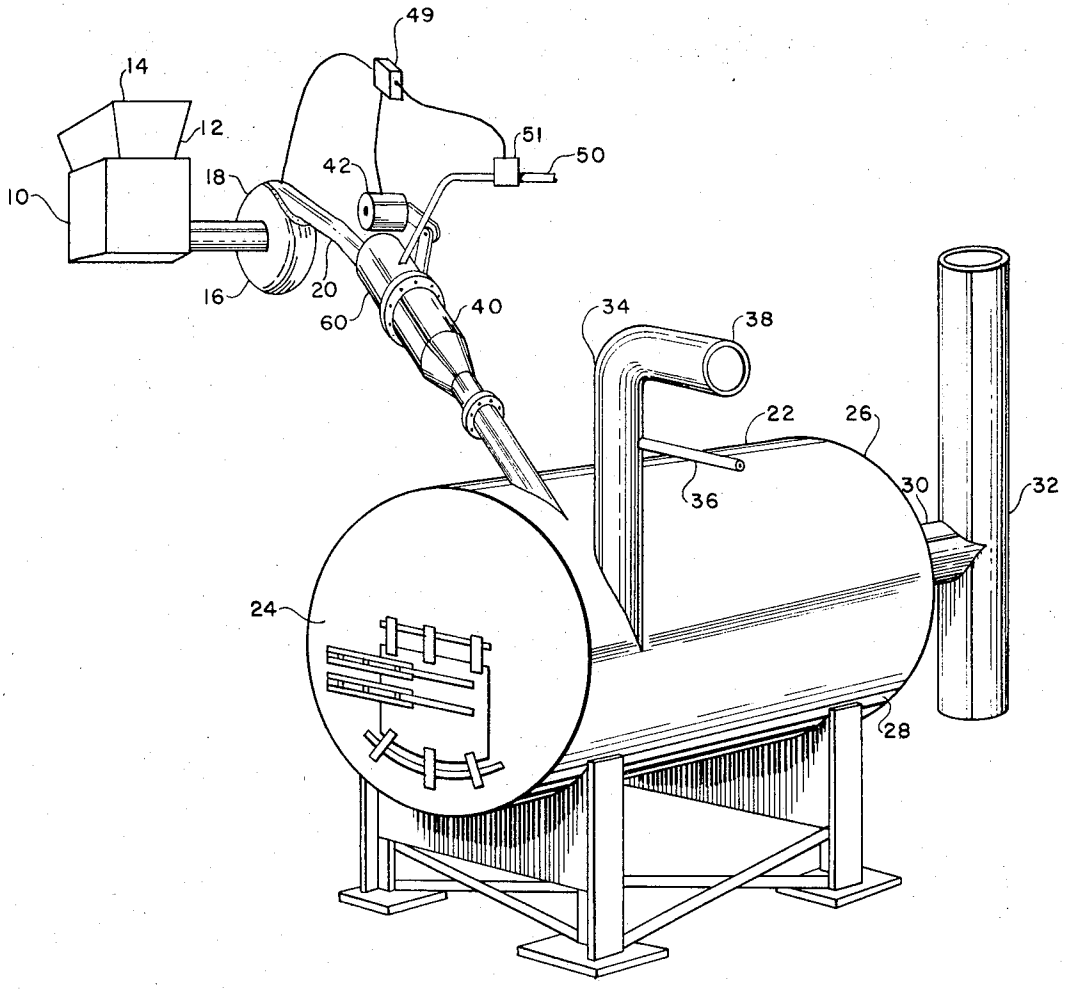


FIG. 1

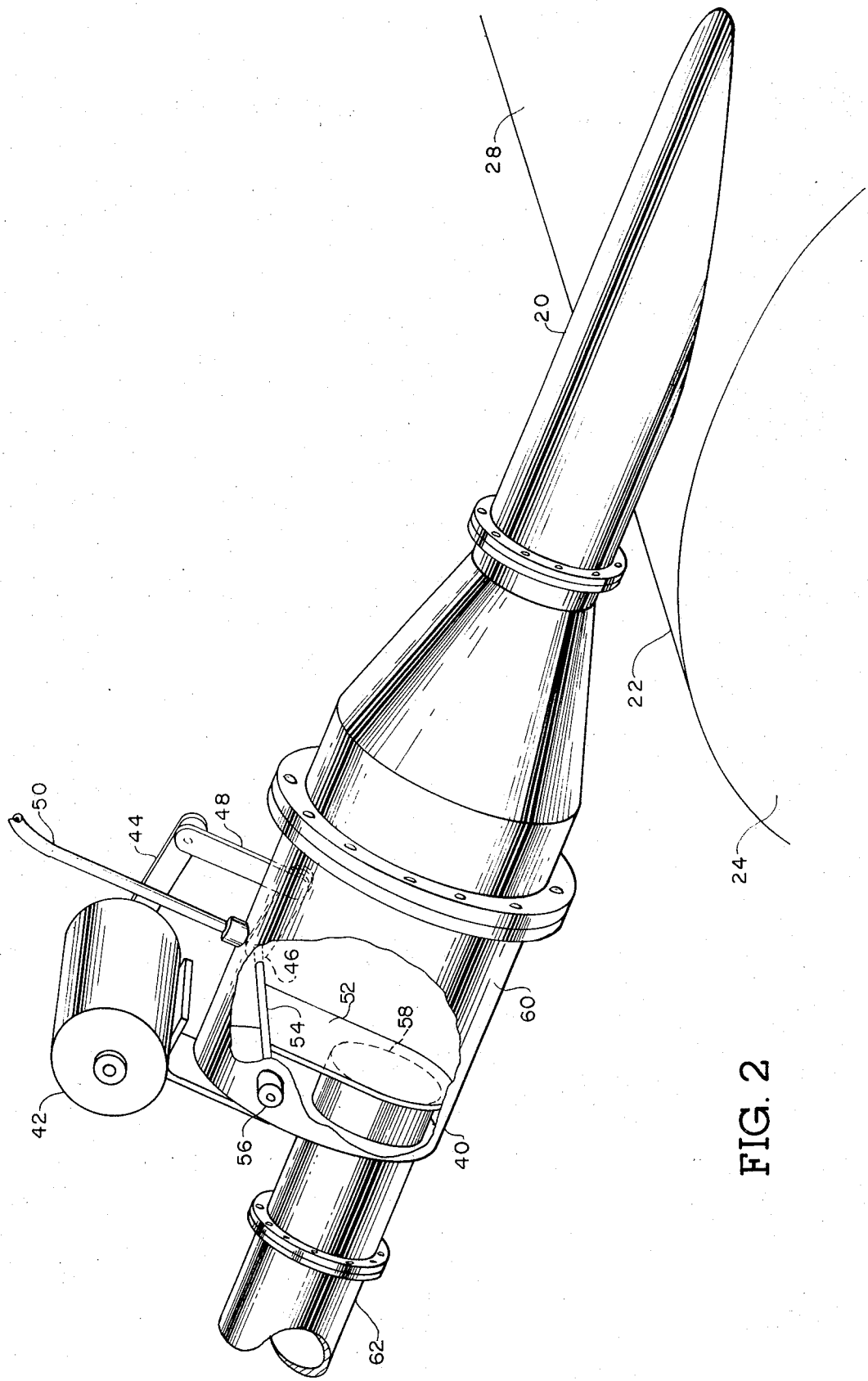


FIG. 2

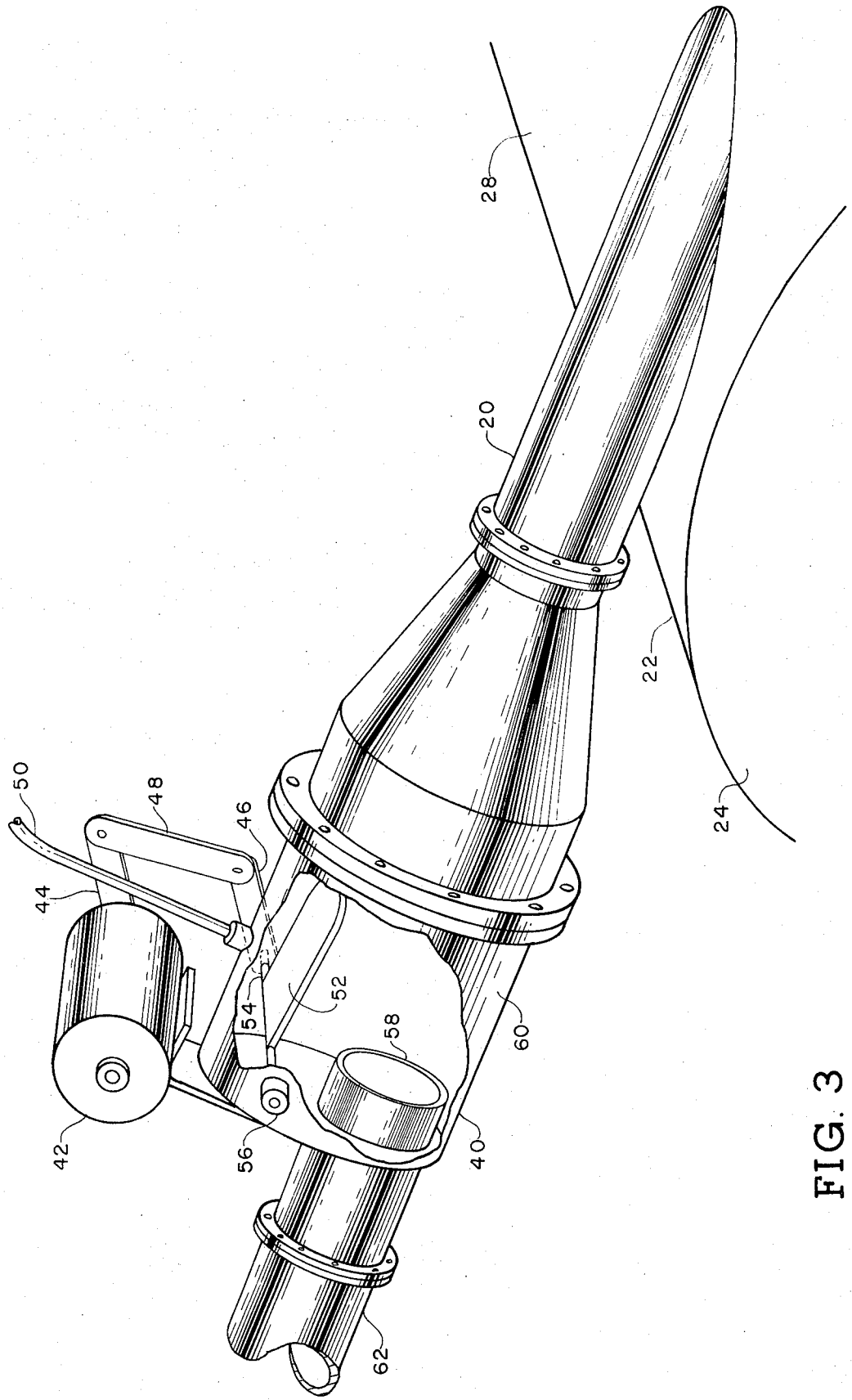


FIG. 3

INCINERATOR

CROSS REFERENCE TO RELATED APPLICATIONS

Certain features disclosed in this application are disclosed and claimed in U.S. Pats. Nos. 3,577,940 issued May 11, 1971 to Robert J. Hasselbring and Robert L. Shields and 3,658,017 issued Apr. 25, 1972 to Norman R. Dibelius and William L Zabriskie, and also in Application Ser. No. 159,251 filed July 2, 1971 by Robert J. Hasselbring and Robert L. Shields, Application Ser. No. 218,926, filed Jan. 19, 1972 by Syed A. Ali and Robert L. Shields, Application Ser. No. 219,041, filed Jan. 19, 1972 by Robert L. Shields, and in Application Ser. No. 279,197, filed Aug. 9, 1972 by Syed A. Ali and Robert L. Shields, all assigned to the same assignee as the present invention.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to incinerators and has particular relation to municipal and industrial type incinerators for burning waste material.

2. Description of the Prior Art

Conventional municipal and industrial type incinerators ordinarily include one or more combusiton chambers having drying grates with a flue for discharging to atmosphere the gaseous products of combustion of waste material in the chamber. Depending upon the efficiency of a particular incinerator design, varying amounts of noxious gases and ash are discharged through the flue to atmosphere. The above-mentioned earlier incinerator designs in general have been incapable of effecting efficient combustion of waste material with the consequence that the products of the resulting imcomplete combustion consist of large quantities of noxious gases and ash which are discharged to the surrounding atmosphere in the form of dense acrid smoke and falling ash.

In an effort to comply with regulatory air pollution codes, more recent incinerator designs have provided for cleaning the gaseous products of combustion prior to their discharge to atmosphere. Such flue gas cleaning apparatus in usually of costly and bulky construction and in some cases has operated to clean the flue gases sufficiently to comply with regulatory codes. One known flue gas cleaning apparatus includes means for conducting the gaseous products of combustion through water sprays so that the suspended ashes and other particulate matter are entrained in the water which is then collected and conveyed to a suitable clarification system. This type of flue gas cleaning apparatus is expensive and complex and contributes not only to the high costs and massive structure of prior art incinerators, but also to water pollution. Further, the very high temperatures within the chamber necessary to effect good combustion result in very hot flue gases which may result in inefficient operation of the flue gas cleaning apparatus and resulting undesirable pollution of the surrounding atmosphere. The provision of flue gas cleaning apparatus thus imposes a limitation upon the temperature within the combustion chamber which contributes to the poor combustion realized by certain prior art designs.

OBJECTS OF THE INVENTION

It is therefore a primary object of this invention to provide a novel and improved incinerator capable of effecting substantially complete combustion of waste material and having improved means for maintaining prolonged operation and apparatus service life which minimizes replacement of components and down time for repair.

It is another object of this invention to provide a novel and improved incinerator having improved safety features.

It is a further object of this invention to provide a novel and improved vortex incinerator wherein protective means are provided to prevent the blow back of flame and/or hot combustion gases out through the waste material inlet.

It is a still further object of this invention to provide air cooled means for closing off the waste material inlet conduit to prevent the transmission of hot combustion gases back through the waste material inlet to the waste material feed means when said feed means are not operational.

SUMMARY OF THE INVENTION

In carrying out the invention in one preferred form, an incinerator is provided which includes a combustion chamber having spaced end walls and a side wall with its central longitudinal axis extending between the end walls. The combustion chamber is generally cylindrical in configuration and is preferably disposed in operative position with the central longitudinal axis extending horizontally or substantially horizontally. Inlet means are provided for introducing waste material and primary air for combustion into the combustion chamber for establishing a vortical movement of the waste material toward one of the end walls, and exhaust flue means are provided for expelling gaseous combustion products from the chamber. Means are provided for igniting the waste material during its vortical movement along the combustion chamber.

The inlet conduit means extending from the blower to the combustion chamber for the entrainment of waste material in air and its conveyance under pressure into the combustion chamber in a manner to establish the vortical movement, is provided with a fluid cooled valve means to prohibit the passage of flame and/or hot combustion gases back through the inlet conduit towards the blower or other units for the feeding, preparation, handling or storage of the waste material for incineration. The valve means in the inlet conduit of this invention is preferably provided with actuating means to open and close the valve in response to the operation of the blower or other feed or handling means whereby the valve is in open position when the blower or other means is conveying waste material through the inlet conduit to the combustion chamber and conversely the valve is closed blocking off the inlet conduit when the blower or other feed or handling means is not operational. Also a cooling means such as a stream of cool air is applied to flow over the valve mechanism during said period of inoperativeness of the blower, etc. when the valve is closed to minimize the degrading effects of high temperatures emanating from the combustion chamber and the back flow of flame and hot combustion gases.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of the incinerator system;

FIG. 2 is an enlarged perspective view of the valve means in the inlet conduit with portions broken away to illustrate details of the mechanism; and

FIG. 3 is also an enlarged perspective view of the valve means in the inlet conduit with portions broken away to illustrate details of the same mechanism as in FIG. 2 in a different position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawing, there is illustrated in FIG. 1 an incinerator unit embodying the invention and comprising in general, a size-reducing unit for chopping up or shredding the waste material; a blower for entraining the waste material in air and pneumatically conveying the fine waste material to a combustion chamber; inlet conduit means for conducting the waste material and air into the combustion chamber for establishing a vortical movement of the waste material; a generally cylindrical combustion chamber; means for igniting the waste material during its vortical movement along the combustion chamber; and exhaust means for venting gaseous products of combustion.

Preferably the incinerator unit also includes means for adding secondary air to the combustion chamber and discharge means for discharging non-combustible material or ashes from the combustion chamber having a separator for separating the gases and solid materials discharged by the discharge means, as shown in the above identified related applications and issued patents.

The incinerator of the present invention is particularly suited for disposing of solid industrial and municipal waste material such as, for example, paper, peanut hulls, cardboard cartons, wood scraps, garbage, foliage, bottles, cans, and combustible floow sweepings. However, the incinerator is also capable of disposing of liquid waste material such as oils, paint sludges, and plating tank residue.

The incinerator unit or system of this invention includes a size reducing device **10** designed to shred and chop the waste material into particles small enough to be effectively conveyed to and burned in a combustion chamber. If the waste material to be disposed of is already of an acceptable size such as sawdust, the size reduction device **10** is not required. The size-reducing device **10** may be of any suitable construction and include a hopper **12** having an open end **14** which the waste material is fed for size-reduction by a shredding and chopping mechanism (not shown) operated by a motor (not shown). After being reduced in size, the waste material is drawn into a pneumatic conveying device including a blower **16** comprising a fan **18** operated by a motor (not shown) which entrains the size-reduced waste material in a primary stream of air and thus conveys it through an inlet conduit **20** which communicates with the combustion chamber **22.**

The combustion chamber **22** may be of any suitable configuration and preferably is cylindrical including a pair of spaced end walls **24** and **26** connected by annular side wall **28.** Combustion chamber **22** is preferably disposed when in operative position so that its central longitudinal axis which extends between the end walls **24** and **26** is horizontally or substantially horizontal. If desired, the end wall **24** of the chamber **22** may include an access door to permit access to the interior of the combustion chamber **22.**

Continuous feeding of a mixture of waste material and air under pressure into the combustion chamber **22** from the inlet conduit **20** tangentially to the side wall **28** of the combustion chamber establishes a vortical movement of the waste material which travels from adjacent the end wall **24** toward the end wall **26** in a clockwise, swirling direction as viewed from the end wall **24** in FIG. **1.** It is understood, of course, that the inlet conduit **20** may be disposed to enter the combustion chamber **22** at the upper right hand side thereof instead of at the upper left hand side, in which event the direction of the vortex would be reversed from clockwise swirling direction illustrated in a counter-clockwise swirling direction.

To exhaust gaseous products of combustion from the combustion chamber **22** to the atmosphere, a flue **30** having an open end opening into the combustion chamber **22** in the region of the end wall **26** and substantially concentric with the central longitudinal axis of the combustion chamber **22** is provided to connect the combustion chamber to an exhaust stack **32** opening to the atmosphere.

As indicated hereinbefore, it is preferred that the combustion chamber **22** also be provided with both outlet means for discharging non-combustible solid materials from the combustion chamber **22** during the burning process, and with means for introducing controlled quantities of high-velocity secondary air into the combustion chamber **22** during the burning process to enhance combustion of the waste material and to maintain the energy of the vortical flow in a predetermined and controlled manner through the entire length of the combustion chamber. These preferred features and others are all shown in detail in the related applications and patents identified hereinabove.

To ignite the waste material entering the combustion chamber **22,** a fluid fueled combustion burner **34,** such as one operated with gas or oil fuel, is disposed near end wall **24** of the combustion chamber **22,** directed to fire its flame jet into the combustion chamber tangentially to its annular side wall **28** and preferably directly into the path of waste material and air entering the chamber through the inlet conduit **20.** Combustion burner **34** may be of any suitable design comprising a fuel supply pipe **36** from a source (not shown) and having a source of combustion oxygen such as an air supply pipe **38** which may be supplied by any convenient means such as air supply fans preferably associated with the incinerator unit to provide primary or secondary air to the system, or by independent means. The combustion burner **34** may comprise a pilot light, spark plug, or the like conventional means to activate the flame.

Under normal operating conditions wherein a mixture of shredded waste material and primary air is continuously fed into the combustion chamber, but dependent somewhat upon the nature and moisture content of the waste material to be incinerated, the burner can be turned off upon heating the chamber to effective ignition and burning temperatures whereupon the waste material and primary air thereafter sustain combustion. Apt operating temperatures for the combustion chamber comprise about 1,200° F to 2,200° F. Thus, a typical operating procedure would be to initially fire the

burner **34** alone for a period sufficient to preheat the combustion chamber up to its intended operating temperature of, for example, about 1600° F whereupon the feeding of the size reduced waste material and primary air under pressure into the combustion chamber is initiated and combustion thereof incited by the thus attained high temperatures within the combustion chamber. Thereafter combustion may be self-sustaining without the need for added impetus provided by a separate source of fuel, but again depending upon the nature and heat content of the waste material "fuel" and its moisture content. However, if or when needed or maintain or regain combustion conditions because of the nature of the waste material, or for whatever reason, the burner can simply be continuously fired to maintain combustion or reactivated to return to effective combustion temperatures. In some cases, such as burning sewage sludge which normally contains a relatively high moisture content, it may be feasible or even necessary to continuously fire the burner to maintain effective combustion. Automatic means such as a temperature sensor within the combustion chamber can be provided to govern the firing of the ignition burner in response to the chamber temperature.

The combustion burner **34** may be a commerically available unit, such as a MAXON burner, for example, an EB-3, EB-4, or EB-5, depending upon the size and capacity desired.

In accordance with this invention a valve means **40** is provided in the inlet conduit **20** which feeds the waste material and air into the combustion chamber **22** for alternatively closing off and opening passage through the inlet conduit at a location between the blower **18** and combustion chamber **22.** When in its closed position blocking off passage through the inlet conduit to the combustion chamber, the valve protects the blower and/or size reducing device structures from the deteriorating effects of flame and/or hot combustion gases and prevents fires or the spread of fires due to the ignition of residual waste material retained within the system comprising the inlet conduit, blower, size-reducing device or other handling apparatus and even the stock of waste awaiting incineration. The valve **40** is also provided with cooling means described in detail hereinafter to protect the mechanism and moderate the destructive temperature conditions about the location of the valve and within the inlet conduit.

The preferred system of operation and means therefor of this invention, includes an actuator mechanism **42,** suitably secured or mounted adjacent to or on inlet conduit **20** to move valve means **40** from its open position to its closed position and back to open, such as through a simple mechanical linkage of pivoting arms **44** and **46** and linkage **48** or other suitable means such as rotating screws. Actuator mechanism **42** can be operatively connected with blower **18** through a suitable means such as for example, control unit **49,** whereby the actuator mechanism can be programmed to move valve **40** to close off inlet conduit **20** when blower **18** is not operative, during such periods as the preheating or warm-up when the ignition burner is being fired and waste material and air are not being fed into the combustion chamber through the inlet conduit pursuant to normal incinerating procedure. Moreover the actuating mechanism can be activated to effect the valve closing and thus obviate damage or fires if the blower or other components of the system are not operating due to a malfunction such as power failure or equipment breakdown, as well as during preparatory or waiting periods wherein the incinerator unit is operating without the addition of waste material.

Cooling means comprising an air or fluid coolant duct **50,** connected with a source therefor such as an air supply fan (not shown), which is in fluid communication with the inlet conduit **20** intermediate the valve means **40** and combustion chamber **22** and preferably is located so as to discharge its stream of fluid coolant adjacent to the surface of the valve member, such as in a transverse direction flowing past the valve face as illustrated. The flow of coolant through duct **50** into the valve's hot face can be regulated by valve **51** which may comprise an actuating mechanism such as a solenoid which in turn can be operatively connected with the blower **18** through the control unit **49,** or independently in cooperation with any other apt component, whereby cooling air can be administered to valve **40** and/or inlet conduit **20** whenever blower **18** is not operating for whatever reason, or whenever valve **40** is moved to its closed position.

A preferred construction for the valve unit **40** in the incinerator system of this invention, as illustrated in the enlarged detailed view of FIGS. **2** and **3,** comprises a pivoting valve member **52** which is secured in fixed relation to a rotatable shaft **54** mounted in a pair of bearings **56,** or otherwise appropriately hinged whereby member **52** will at least pivot through an arc of at least about 90° extending from a closed position to a fully open position. In its closed pivotal position shown in FIG. **2,** valve member **52** seats transversely across and abutting against a terminal end **58** of a section of inlet conduit **20,** thereby obstructing passage through the said inlet conduit. From the aforesaid and illustrated closed position, valve member **52** pivots upon actuation away from its seat across section end **58** through a radius of about 90° or more to a fully open position as seen in FIG. **3** to permit unobstructed passage of material through the inlet conduit.

A further feature of the incinerator system and inlet valve means of this invention comprises housing the valve member within an enlarged housing section **60** of the inlet conduit as shown whereby the valve mechanism can be offset out of the way of the path of waste material moving therethrough when the valve member **52** is in open position. This can be achieved as illustrated by having the inlet conduit section **62** join and enter into enlarged housing section **60** of the inlet conduit **20,** in an offset or eccentric axial relationship and locating the valve member pivotal mounting or hinge means within the enlarged housing section offset opposite the entry position of the section **62** and its terminal end **58** forming the valve seat. This design allows the smooth, uninterrupted flow of waste material entrained in air in a stream past the valve structure and through the length of the inlet conduit into the combustion chamber.

The preferred pivotal valve and its arrangement described has the advantage of performing as a check valve in that in its closed position there is a positive blockage of any flow in the direction from the combustion chamber towards the blower or other external units of the system, which will resist substantial pressure applied outward from the combustion chamber with the sealing effect of the valve member upon its seat increasing as the pressure rises. Moreover the

valve member 52 can easily be arranged to be self-closing upon a power failure or other malfunction to protect the apparatus and minimize fire hazards.

The self-closing or check valve features of the inlet shutoff valve of this invention can be implemented with the preferred pivotal valve member construction by providing the pivoting valve member with positive closing means such as a spring or other biasing devices, or by so positioning and arranging the pivotal member of the valve so that it is maintained by gravity in its closed position, and conversely the pivoting member is moved to and held in its open position with appropriate actuating means only during the feeding of waste material through the inlet conduit or at other appropriate times.

The unique valve arrangement and construction of the incinerator system of this invention prevents damage or accelerated deterioration of the blower fan, shredder device or other components of the waste material preparation and/or handling units of the system due to exposure to the hot and corrosive combustion gases from the combustion chamber and ignition burner. Moreover, the invention provides a positive safety means which eliminates the possibility of fires or spread of fires resulting from exposure of waste material remaining within the feed system comprising the inlet conduit, blower, shredder or other handling apparatus due to the heat emitting from the combustion chamber or blow back of hot gases therefrom.

Also the enlarged housing for the valve mechanism formed in the inlet conduit and its smooth contour permits the uninterrupted laminar flow of the waste material and air therethrough without the material becoming obstructed and retained, which condition can add to the fire hazard and increases maintenance. Moreover, the arrangement of providing a valve seat for the pivoting valve member by terminating the section of the inlet conduit connected to and leading from the blower or other feed means within the enlarged section of the inlet conduit connected and leading to the combustion chamber and which forms the valve housing, produces a check valve effect providing positive closing engagement preventing blow back of combustion gases or flame from the combustion chamber. As indicated before, this valve construction can be implemented by positive closing means which can be provided to seal off the inlet conduit upon any occurrence other than normal operation comprising the routine feeding of waste material to the combustion chamber.

The structural integrity of the inlet shut off valve is also maintained and heat distortion which might impair its function prevented by means of the fluid cooling system which can be programmed to bathe the valve member in a cooling stream of fluid when needed such as whenever it is in its closed position in response to the same means which actuates the inlet shut off valve or by independent means.

Although the invention has been described with reference to certain specific embodiments thereof, numerous modifications are possible and it is desirable to cover all modifications falling within the spirit and scope of this invention.

What we claim as new and desire to secure by letters Patent of the United States is:

1. An incinerator for burning waste material comprising in combination:

a) a combustion chamber having spaced end walls and a side wall with its central longitudinal axis extending between said end walls;

b) inlet conduit for introducing waste material and air into said combustion chamber in a manner effective for providing a vortical movement of said waste material toward one of said end walls, said inlet conduit having valve means therein for closing off and opening passage through the inlet conduit and means for introducing cooling air into said inlet conduit in the region of the said valve means; and

c) means for igniting said waste material during its vortical movement.

2. The incinerator as defined in claim **1**, wherein said means for introducing cooling air into said inlet conduit comprises an air duct supplied from a source of air and which is located to direct its discharging stream of cooling air into said inlet conduit adjacent to the surface of the valve means facing the combustion chamber to cool said valve surface and protect it from heat distortion.

3. The incinerator as defined in claim **1**, having means to open and close the said valve means within the inlet conduit, and to regulate the introduction of cooling air into said inlet conduit.

4. The incinerator as defined in claim **1**, having size-reducing means for reducing the size of the waste material and a blower means communicating with said inlet conduit for entraining the size-reduced waste material in air and thus conveying it through the inlet conduit into the combustion chamber, and said valve means for closing off and opening the inlet conduit being located within the inlet conduit between the blower means and the combustion chamber.

5. The incinerator as defined in claim **4**, having an actuator means connected to said valve means within the inlet conduit to open and close said valve, said actuator means being in operative contact with the said blower means communicating with the inlet conduit whereby said acutator means closes the valve means to terminate passage through the inlet conduit when the blower means is not operating and opens the valve means to permit passage through the inlet conduit when the blower means is operating.

6. The incinerator as defined in claim **5**, having means for introducing cooling air into said inlet conduit comprising an air duct supplied from a source of cooling air and which is located to direct a discharge stream of cooling air into said inlet conduit adjecent to the surface of the valve means in the inlet conduit facing the combustion chamber, and said air duct being provided with a valve to regulate the introduction of cooling air into said inlet conduit and actuating means for said valve in operative communication with the blower means whereby said actuator means operates the valve in the cooling air duct to permit cooling air to be introduced into the inlet conduit adjacent the said surface of the valve means therein when the blower means is not operating and the said valve means is closing off the inlet conduit.

7. The incinerator as defined in claim **6**, wherein said valve means in the inlet conduit comprises a pivotal valve member which seats transversely abutting against a terminal end in a section of the inlet conduit when in closed position thereby obstructing passage through said inlet conduit, and which pivots away from its seat on said terminal end of the inlet conduit section in open

position to permit passage through the inlet conduit to the combustion chamber.

8. The incinerator as defined in claim **7**, wherein said valve means is contained within a housing comprising an enlarged section of the inlet conduit which is in communication with said terminal end in the section of the inlet conduit when the valve means is in open position, and the said cooling air duct is connected with the enlarged section of the inlet conduit adjacent to the pivotal valve member whereby the stream of cooling air from the duct is directed over the surface of the said valve member.

9. The incinerator as defined in claim **8**, wherein said valve member pivots in an arc of at least about 90° between its closed and fully open position on a rotatable shaft which is mounted on said enlarged section of the inlet conduit comprising the valve housing.

10. The incinerator as defined in claim **9**, wherein the valve member is secured in fixed relation to the said rotatable shaft and said shaft is rotatably connected to an actuating means which is controlled by the operation of the blower means whereby the said actuator means rotates the shaft to pivot the valve member to open position when the blower is in operation and rotates the shaft to pivot the valve member to closed position seated transversely abutting over the terminal end of the section of inlet conduit connected to the said blower means when the blower is not operating whereby the pivoted valve functions as a check valve and in its closed position provides positive blockage preventing blow back from the combustion chamber to the blower.

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