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Hughes, Jr. et al.

[11] **3,855,950**

[45] **Dec. 24, 1974**

[54] **AUTOMATIC LOADING AND ASH REMOVAL SYSTEM FOR INCINERATORS**

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[73] Assignee: **Consumat Systems, Inc.,** Richmond, Va.

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[52] **U.S. Cl.** ..... **110/8 C,** 110/109, 110/165 R, 214/23

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

[58] **Field of Search** ..... 110/8 R, 8 C, 18 R, 109, 110/165 R; 214/23

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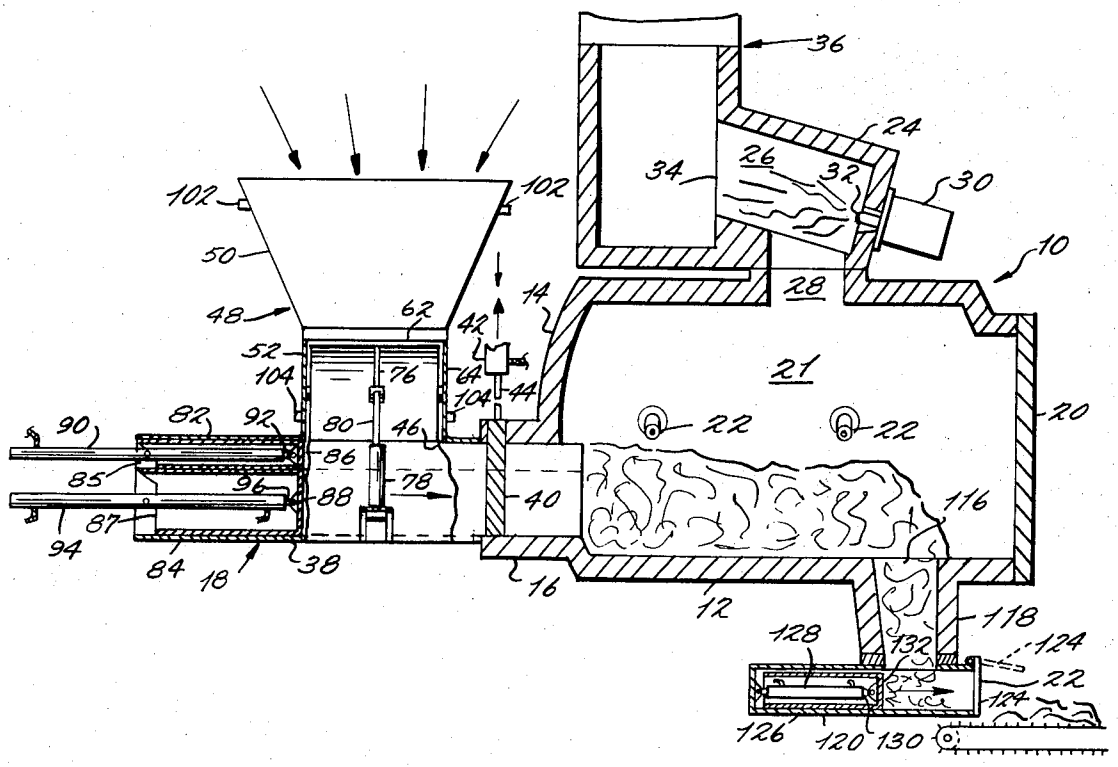
Primary Examiner—Kenneth W. Sprague
Attorney, Agent, or Firm—Cushman, Darby & Cushman

[57] **ABSTRACT**

An incinerator system for loading waste material automatically into a controlled air incinerator and for removing ash from the incinerator, all while the incinerator is in operation. A controlled air incinerator, which is sometimes referred to as a "starved air" incinerator, requires accurate control of burning conditions so as to provide at all times a discharge of clean flue gases free from pollutants. In the present system, waste material is automatically loaded into the combustion chamber without changing the burning conditions for which the incinerator is programmed by loader or charging equipment which, at all times of its operation, is designed to effectively prevent the combustion chamber from being open to atmospheric air which would change the burning conditions in the combustion chamber. Likewise, the ash removal or discharge equipment automatically removes ash from the combustion chamber without disturbing the burning conditions set up for the combustion chamber of the incinerator. No adjustment of the controls for controlling burning within the incinerator is necessary to maintain the preset burning condition for producing clean flue gases while waste material is being fed or ash is being discharged from the incinerator, thus, the system is essentially completely automatic.

24 Claims, 9 Drawing Figures



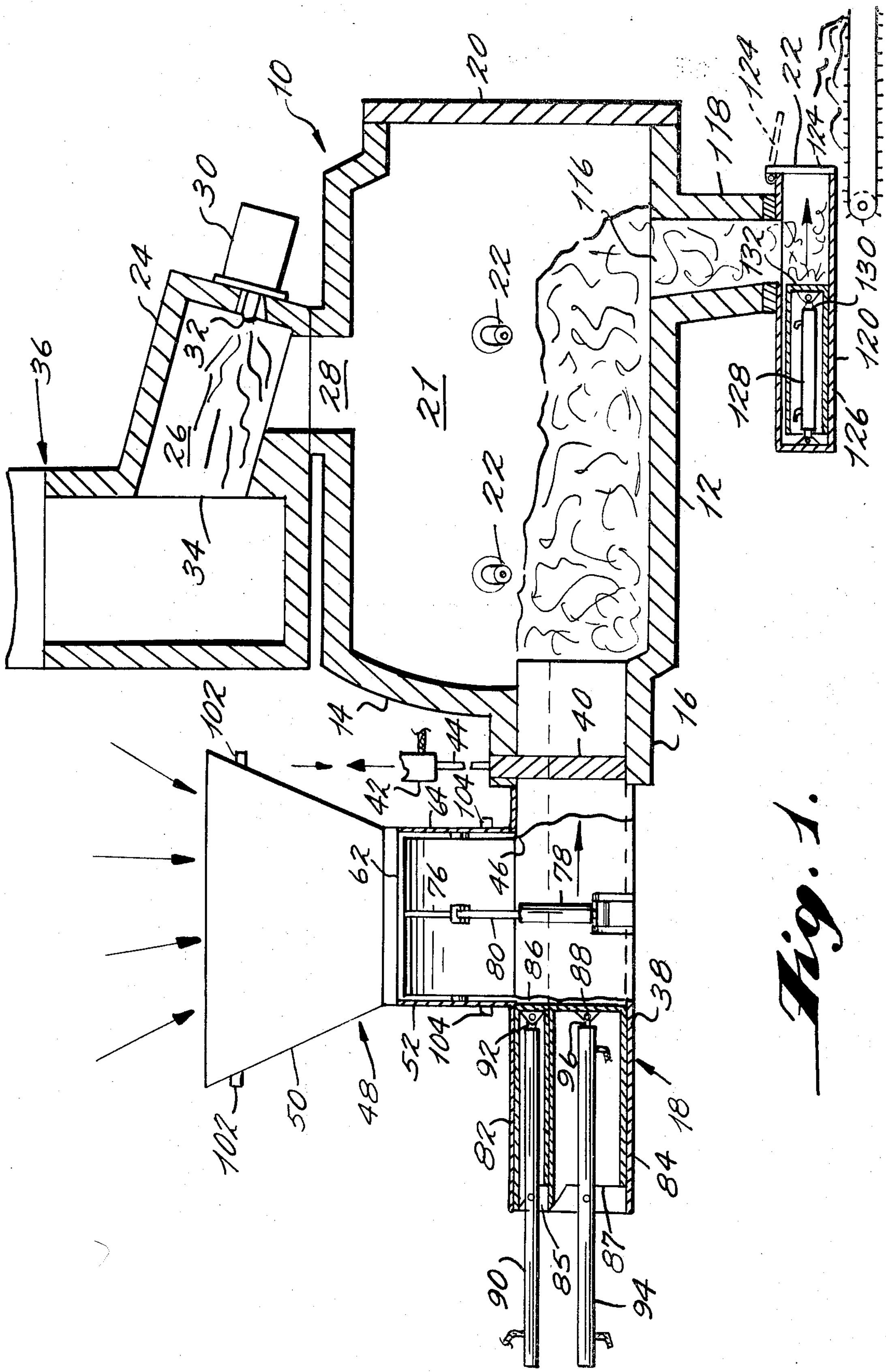


Fig. 1.

Fig. 2.

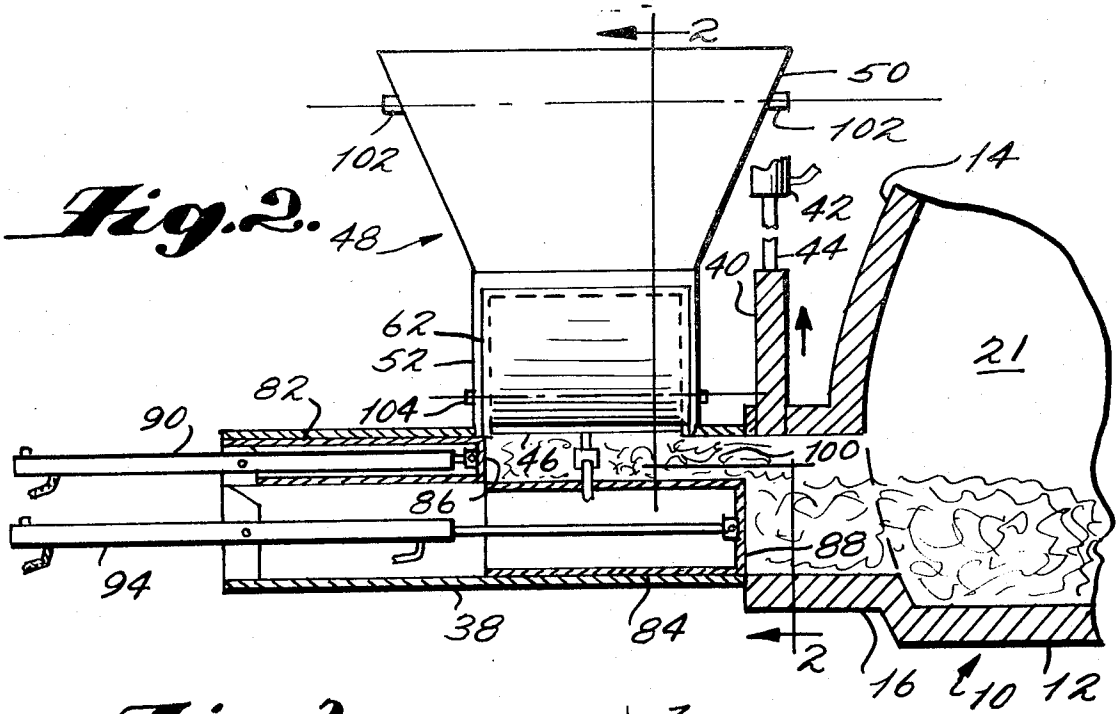


Fig. 3.

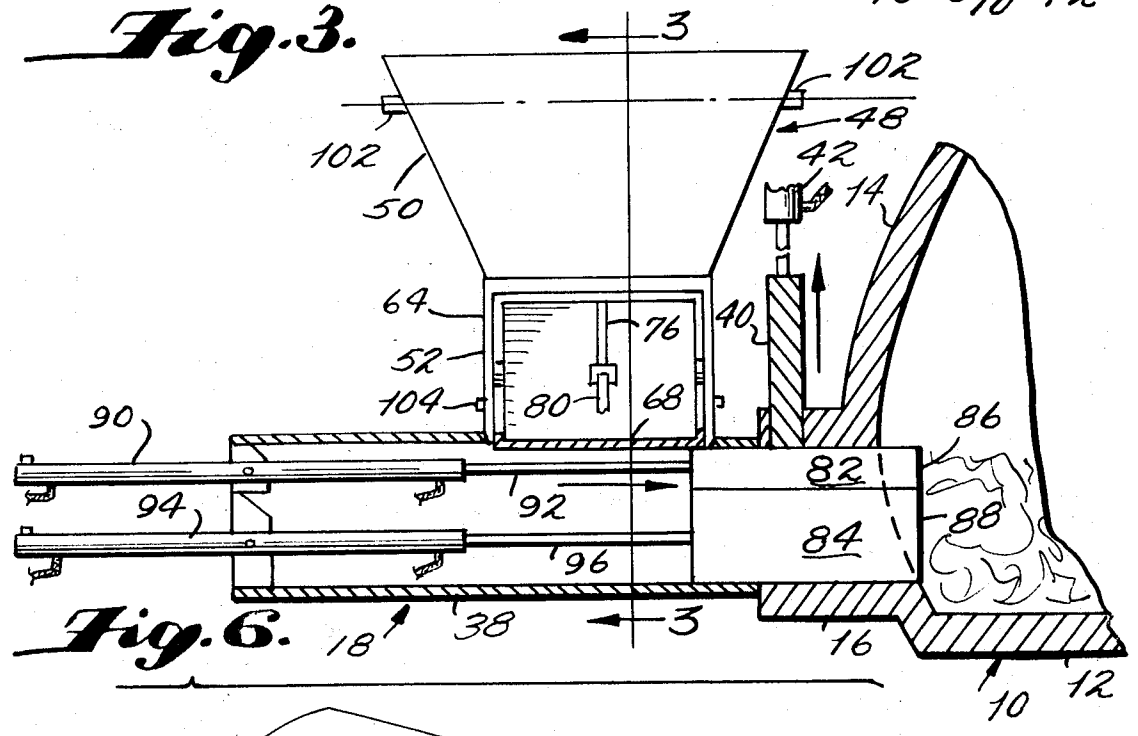


Fig. 6.

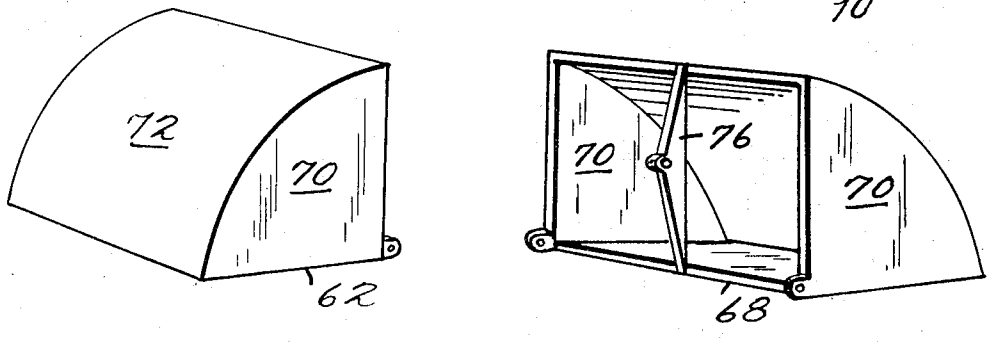


Fig. 4.

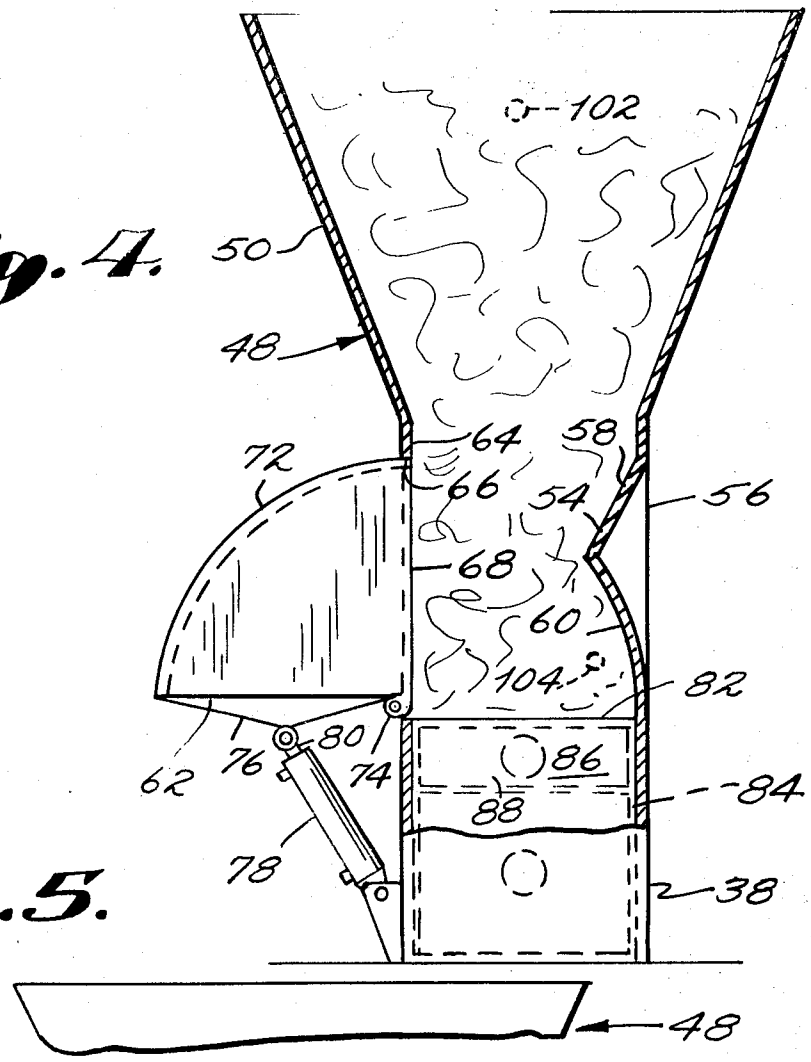

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Fig. 5.

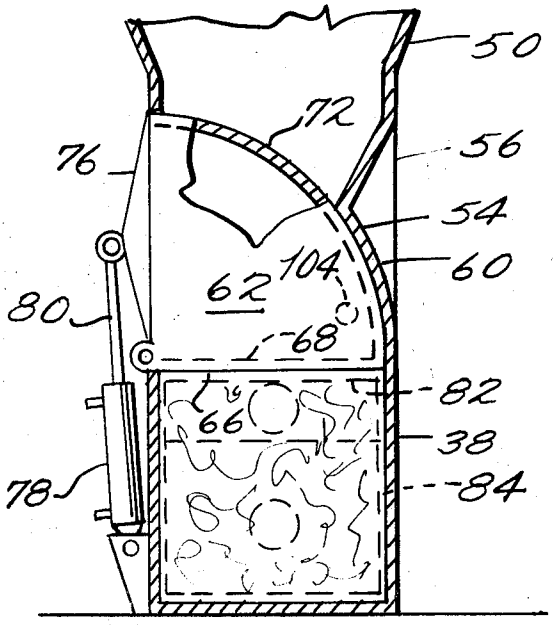
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Fig. 7.

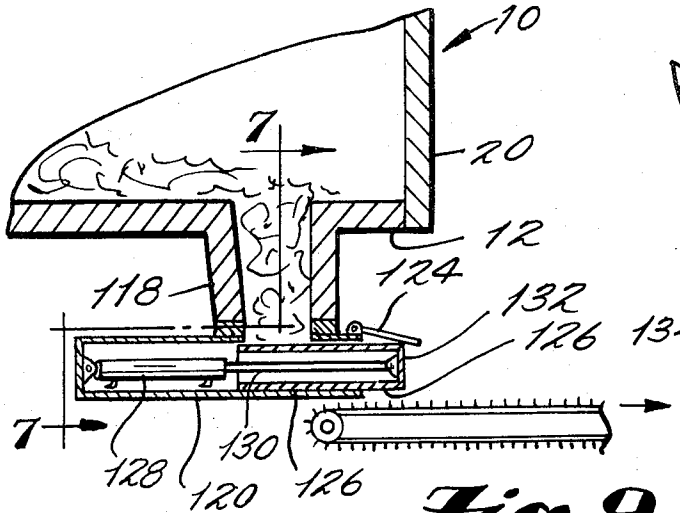


Fig. 8.

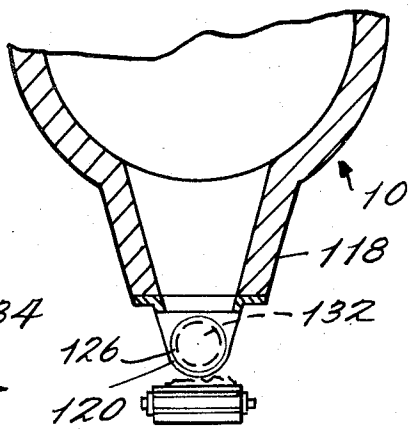
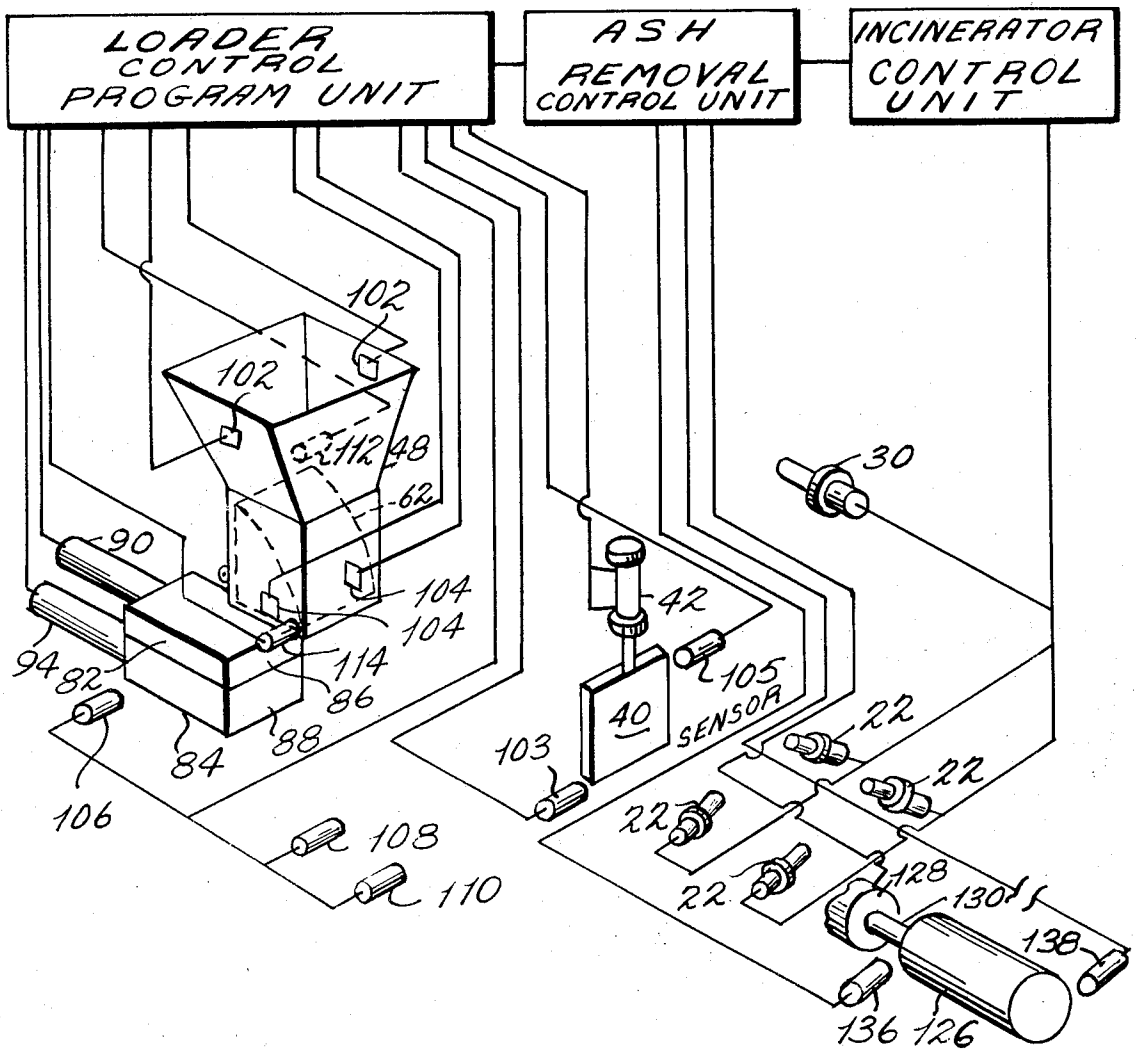


Fig. 9.



AUTOMATIC LOADING AND ASH REMOVAL SYSTEM FOR INCINERATORS

The present invention relates to an improved incinerator system to load with waste material and/or discharge ash from a controlled air incinerator during operation of the incinerator without affecting the burning conditions within the incinerator, which conditions produce pollutant-free clean flue gases. More specifically, the waste material loader means for the controlled air incinerator is designed so that during its entire operation, waste material can be fed continuously or intermittently into the combustion chamber without subjecting the combustion chamber to the free passage of atmospheric air at any time. Likewise, the invention includes an ash removal means which can continuously or intermittently remove ash and unburnable residue of waste material while the incinerator is in operation without the combustion chamber being open to the free passage of atmospheric air through the ash removal means.

BACKGROUND OF THE INVENTION

In recent years, there has been deep concern by the general public over the pollution of the environment from the discharge of pollution containing gases into the atmosphere by incinerators and the like. Consequently, the technology of incinerators has increased, as has the technology for scrubbing or cleaning flue gases from any flue gas discharging system, including incinerators, furnaces, gas heaters, and the like.

The technology for incinerators has resulted in the development of the controlled air or "starved air" incinerator which can burn many types of waste material, including solids as well as some liquids, the incinerator being designed to accurately control the burning process so that pollutants are eliminated from flue gases being discharged. The controlled air incinerator is disclosed in U.S. Pat. No. 3,403,645 issued Oct. 1, 1968 to George H. Flowers, Jr. and U.S. Pat. No. 3,489,109 issued Jan. 13, 1970 to George H. Flowers, Jr., both patents being assigned to the common Assignee of this Application. These patents disclose incinerators which utilize a two-stage combustion process for producing clean flue gases. In the first stage, burning of the bulk of the waste material is accomplished by a controlled burning condition in a first combustion chamber. The hot gases discharged from this chamber, before they have had a chance to cool, enter a second combustion chamber where a controlled amount of additional air is supplied to further support burning of any combustionable products in the exhaust gases so as to produce a clean flue gas which is substantially pollution free and which will pass government, state, and municipal regulations on this subject. The subject matter of these patents is incorporated herein by reference.

One difficulty with the controlled air incinerator has been in the charging of the incinerator and the removal of ash from the incinerator while the incinerator is in operation. With regard to initially charging a controlled air incinerator, waste material for a particular load was placed into the main combustion chamber and the incinerator was then started and its controls so set to establish a particular desired burning condition for producing clean flue gases. Once this burning condition had been set up, the incinerator functioned perfectly until all of the charge had been burned. However, it

was desirable to add waste material to the main combustion chamber periodically to prevent the accumulation of waste material and to increase the capacity of the incinerator by continuous operation over a longer period of time. The reloading or charging was done either manually or by some type of loader means, but each time waste material was added, the desired burning conditions within the main combustion chamber were by free passage of atmospheric air into the chamber which sometimes resulted in a change in character of the flue gases being discharged and, consequently, the burning condition had to be quickly re-established to again provide efficient burning. Oftentimes, personnel recharging the incinerator were not skilled in the overall operation and this led to an ineffectiveness in obtaining efficiency for which the incinerator was designed.

Stokers for furnaces and incinerators have been known for many years. The usual stoker design provided a rotating screw in an enclosed duct or chute for feeding material of uniform size and general shape to the combustion chamber of an apparatus. Oftentimes, these screw type stokers became clogged, even with uniform size and shape material such as coal, and this resulted in shearing of the drive shaft or sheering of a shear pin provided between the drive shaft and the screw conveyor. In any event, little or no concern was given to the fact that atmospheric air was fed through the stoker duct or chute when the stoker was empty, or even when the stoker was in operation. Such arrangements as screw type stokers have proved unsatisfactory for use in loading waste material into incinerators because the waste material comes in various sizes and shapes and, thus, would not be particularly suitable for feeding by a screw in a confined duct.

Rams operated pusher members, operable in enclosed ducts or chutes, have been tried as means for feeding loose waste material to incinerators. One such recent development is disclosed in U.S. Pat. No. 3,570,421 issued Mar. 16, 1971 to George H. Flowers, Jr. and assigned to the same Assignee as the present Application. In this arrangement, a hydraulic ram assembly with a pusher member was utilized to compact and transfer the waste material into a controlled air incinerator, and the purpose of the compacting feature was primarily to eliminate flashback of fire from the combustion chamber through the duct or chute during the loading operation. The arrangement did not necessarily provide for complete isolation of the combustion chamber from the free passage of atmospheric air during all conditions of operation of the loader apparatus. The most serious drawback to the arrangement disclosed in the patent was the provision of a single pusher member in a confined duct or chute operating on the waste material to compact and transfer the same. Many times, the pusher member, in performing its operation of compacting and/or transferring waste material, would cause the waste material to wedge in the duct or chute and this would result in jamming of the hydraulic operated ram pusher mechanism. Other than this, the arrangement disclosed in the aforementioned U.S. Pat. No. 3,570,421 has proved satisfactory, especially for small installations, and especially when the type of waste material fed into the loader mechanism was carefully controlled to avoid feeding of tough material or material having extra large pieces of waste therein which would encourage jamming.

Unloading or removal of ash and the residue of unburnable product of waste material from the combustion chamber has also presented a problem to the industry and has resulted in decreased efficiency of controlled air incinerators. Of course, ash removal could be accomplished upon completion of a full burning cycle by manually moving the ash from the combustion chamber through an access door after all waste material has been burned, but this required complete shutting down of the incinerator unit. However, it is more highly desirable to be able to remove the ash and any residue of unburnable material at any time during the operation of the controlled air incinerator so that, in effect, the incinerator could be continuously used over long periods of time with shutdown being only for lack of waste products or routine maintenance inspections. In this respect, it is desirable that there may be continuous charging or at least intermittent charging of the combustion chamber of the incinerator while excess ash therein can be continuously or intermittently removed. With regard to automatic removal of ash, the same problem exists with regard to use with a controlled air incinerator as exists in loading the waste material therein, namely providing an arrangement which can remove the ash without the passage of atmospheric air to the interior of the combustion chamber, which would unbalance the controlled burning condition. Another problem exists in ash removal systems, namely how to cool the ash sufficiently prior to removal so as to eliminate trouble with the removal equipment. The cooling of the ash must not be such as to affect the temperature within the combustion chamber.

PRIOR ART

The following patents represent some of the prior art arrangements relating to charging of incinerators or furnaces, as well as removal of ash therefrom:

U.S. Pat. Nos. 454,379 Proctor June 16, 1891; 900,390 Kingsley Oct. 6, 1908; 3,323,475 Melgaard June 6, 1967; 3,556,025 Holley Jan. 19, 1971; 3,685,437 Panning Aug. 22, 1972.

BRIEF DESCRIPTION OF THE PRESENT INVENTION

The present invention provides an improved incinerator system, particularly for a controlled air incinerator, the system including means for automatically loading waste material into the combustion chamber of an operating incinerator without changing the burning conditions in the combustion chamber by subjecting the combustion chamber to the free passage of atmospheric air through the loader means. Additionally, the invention envisions providing ash removal means for automatically removing ash and any non-combustible products of waste material while the incinerator is operating, the ash removal means likewise being designed to prevent free passage of atmospheric air into the combustion chamber of the incinerator without changing the burning conditions therein. By providing automatic loader means and automatic ash removal means, the incinerator system is made safer for operation as it eliminates dangers of loading waste material into an operating incinerator and dangers resulting from attempts to remove hot ashes from an operating incinerator. Additionally, the incinerator system of the present invention permits substantially continuous operation of a controlled air incinerator without affecting the incinerator's normal discharge of pollution free flue gases.

More specifically, the incinerator system of the present invention includes the controlled air incinerator having a waste material loader means connected thereto, the loader means comprising a duct or chute extending outwardly from the lower portion of the combustion chamber through the casing, a guillotine type fire door arranged to reciprocate across and out of the duct or chute, a pair of individual pusher members mounted in the chute forward of the fire door, and a hopper operatively connected to the duct or chute for supplying waste material to an area in the chute forward of the pusher members. The hopper is provided with a loader door which functions in the closed position as a support for waste material and a seal to the interior of the duct or chute prior to operation of the loader mechanism and it further functions as part of a wall of the hopper when open for the transfer of waste material into the loader duct or chute.

The lowermost pusher member in the chute is arranged to reciprocate back and forth in the chute to progressively push waste material into the combustion chamber, the lower pusher member blocking entry of waste material into the chute rearwardly of the same on its forward stroke. Since the lower pusher member has a space above the same in the chute when it is operating to advance waste material into the combustion chamber, this eliminates any jamming within the chute as the lower pusher member can crush or shear any material lodged in the space at the top of the chute.

The upper pusher member is operated simultaneously with the lower pusher member only when the hopper is empty of waste material and the forward simultaneous strokes of both pusher members are long enough for both pusher members to extend at least to the interior wall of the casing for the combustion chamber so that the chute may be entirely clear of any waste material that may have previously stuck in the upper portion of the chute during the actual loading by the lower pusher member individually of the upper pusher member.

Control means are provided to coordinate the operation of the door in the hopper, fire door, the loading operation of the lower pusher member, and the clearing operation by both pusher members so that at no time free passage of atmospheric air can enter the combustion chamber through the automatic means. A more detailed description of this operation will appear later in the specification.

The ash removal includes a downwardly depending annular ash pit member connected to an opening in the lower portion of the combustion chamber casing at a point remote from the point of charging of the combustion chamber. The ash pit member has connected to its lower end an automatically operable ash removal means including an annular elongated duct or chute member with a pusher member therein. The discharge member or elongated dust has an open end which is normally closed by a gravity operated weighted door and the pusher member is moved toward the door to push ash against the door to open the same and discharge the ashes into a suitable takeoff conveyor or ash cart. The pusher member, in its forward stroke for pushing ashes out of the open end of the duct, is so designed as to block off the entrance of the ash pit member to the duct to prevent free passage of atmospheric

air into the combustion chamber and prevent ash from falling behind the pusher member. Also, by having a downwardly depending annular ash pit member, there are always ashes in the same which help to prevent flow of atmospheric air up into the combustion chamber, but which also functions as an insulating means to give the ashes time to cool down prior to their being discharged by the pusher member. The annular ash pit member is preferably refractory lined so as to make the exterior surface of the same relatively cool. Control means are provided for actuating the pusher member in the ash discharge duct and these control means may be coordinated with the control means for the loader means.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagrammatic view, partly in side elevation and partly in cross-section, and illustrates the incinerator system of the present invention.

FIG. **2** is a fragmentary view of the loader means of the present invention and is similar to FIG. **1,** except that it illustrates the hopper door and fire door in their open positions and the lower pusher member in the forward position of its stroke for pushing waste material into the combustion chamber.

FIG. **3** is a view similar to FIG. **2,** but illustrating a portion of the cycle of operation when the hopper door is closed after emptying of the hopper and both upper and lower pusher members have moved simultaneously to clear the loader duct or chute.

FIG. **4** is an enlarged sectional view taken substantially on the line **2—2** of FIG. **2.**

FIG. **5** is a sectional view taken substantially on the line **3—3** of FIG. **3,** but with the upper and lower pusher members shown in their retracted positions.

FIG. **6** is a perspective view disclosing the contour shaped door for the hopper of the loader means, the view showing the door from both sides of the same.

FIG. **7** is a fragmentary sectional view of the ash removal means and illustrates the pusher member in the forward position of its stroke.

FIG. **8** is a sectional view taken substantially on the line **7—7** of FIG. **7.**

FIG. **9** is a schematic view illustrating the various control units which may be programmed for a desired operation of the incinerator system.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings wherein like characters or reference numerals represent like or similar parts, a controlled air incinerator for the present invention is generally designated by the reference numeral **10.** The incinerator **10** includes an annular casing **12** provided with a suitable refractory lining, the annular casing **12** having a substantially horizontal axis. One end **14** of the annular casing **12** is made integral therewith and includes a rectangular annular extension **16** to which automatic loading means generally designated at **18** is connected. The other end **20** is an access door so as to provide access to the interior of the casing **12** for periodic maintenance and inspection.

Casing **12,** which may be of the type shown in the aforementioned U.S. Pat. No. 3,489,109 and which defines a main combustion zone or chamber **21,** is provided with one or more of the usual pressure burners **22** having nozzles within the chamber for starting the burning process of the waste material. The burners **22** are normally turned off once the combustion has started and controlled temperatures are reached. As will be appreciated by those skilled in the art, air is supplied in controlled amounts to the main combustion chamber **21,** for example, as shown in the aforementioned U.S. Pat. No. 3,489,109, to assist in supporting combustion during starting and once the waste material is burning.

Incinerator **10** further includes a transition conduit **24** defining a second combustion chamber or zone **26,** the transition conduit **24** being in communication with passageway **28** in the upper portion of the casing **12.** As described in the aforementioned U.S. Pat. Nos. 3,403,645 and 3,489,109, hot exhaust gases from the main combustion chamber **21** pass through the passageway **28** into the second combustion chamber **26** where a secondary stage of burning is accomplished. The exhaust gases leaving the main combustion chamber **21** carry with them burnable pollution particles or products which must be removed so that the resulting flue gases are substantially pollution free. In order to assist in the burning of the waste particles or products in the exhaust gases, a pressure burner **30,** having a nozzle **32** in the chamber **26,** is provided and as shown in the aforementioned U.S. Pat. Nos. 3,403,645 and 3,489,109, an air blower discharges air into the secondary combustion chamber **26** to assist in supporting the combustion process. Once burning begins in the secondary combustion chamber **26** and the temperature therein has risen a sufficient amount, the pressure burner **30** may be cut off when the air to the combustion chamber **26,** plus the heat of the exhaust gases, is sufficient to support complete burning of waste products so as to produce substantially pollution free flue gases.

The secondary combustion chamber **26** is provided with a discharge opening **34** to which is attached a main stack assembly generally designated at **36.** The stack assembly may be of the type which discharges the clean flue gases directed to atmosphere, or it may be of the type as shown in the co-pending U.S. Application Ser. No. 386,878 filed Aug. 9, 1973 of James K. Fishback, which includes heat exchanger means for recovering heat from the flue gases for auxiliary uses.

Referring now specifically to FIGS. **1** through **6,** inclusive, there is disclosed the automatic loading means **18** for loading waste material into the incinerator **10** while the incinerator is operating, the loading means **18** at all times preventing the free passage of atmospheric air to the main combustion chamber **21** so that the burning conditions in this chamber, as well as in the secondary combustion chamber **26,** are not disturbed. The loading means **18** includes an elongated annular loader chute or duct **38** operatively connected to and in axial alignment with the annular extension **16,** the loader chute or duct being rectangular in cross-section and complementary to the opening provided by the annular extension **16.** While it is preferable to have the annular loader chute **38** and the annular extension **16** rectangular in cross-section, it will be appreciated by those skilled in the art that the cross-sectional shape could be oval or round if so desired. The annular extension **16** is provided with a guillotine type of fire door **40** which is reciprocated by means of a hydraulic cylinder **42** having a piston rod **44.** A more detailed description of the operation of the fire door **40** will follow in the specification and, of course, it will be understood that

the fire door could be provided in the loader chute **38** if desired. For the purpose of this specification, it will also be understood that the annular extension **16** is part of the loader chute, but is made from refractory lined material when making the casing **12,** whereas the loader chute itself is made from steel.

The loader chute **38,** forward of the fire door **40,** is provided with an opening **46** in its upper wall and a waste receiving hopper **48** is mounted on the upper wall of the loader chute **38** and has its lower end surrounding the opening **46** of the loader chute **38.** Hopper **48,** which is generally rectangular in cross-section, has an upper portion **50** which diverges inwardly and is connected to a lower portion **52** which has a uniform cross-sectional area except for a contoured wall **54** on one side of the same, the contoured wall being reinforced by a plurality of vertically extending web shaped members **56** (FIGS. **4** and **5**). In more detail, the contoured wall includes an inwardly diverging portion **58** and an outwardly curved portion **60,** the curved portion **60** cooperating with a hopper door **62.** The opposite wall **64,** from the contoured shaped wall **54,** is provided with an opening **66** through which the hopper door **62** swings between the open and closed positions.

Referring to FIG. **6,** the contoured hopper door **62** is scooped shaped forming a sector of a cylinder and includes a flat wall **68,** end walls **70,** and a contoured shaped curved wall **72.** As shown in FIGS. **2** through **5,** the hopper door is pivoted to the hopper at **74** adjacent the lower edge of the opening **66** and is capable of pivoting from an open position, as shown in FIGS. **2** and **4,** with its flat wall **68** forming part of the wall of the hopper in the opening **66** to a closed position, as shown in FIGS. **3** and **5** where the flat wall **68** closes the opening **46** in the loader chute **38.** A web member **76** extends across the open back of the hopper door and provides a means for connecting a hydraulic cylinder assembly **78** and the piston rod **80** to the door and to the loader chute **38.** As will be appreciated, operation of the hydraulic cylinder assembly will cause the door **62** to swing between the opened and closed positions during the proper portion of the cycle of operation.

An upper pusher member **82** and a lower pusher member **84** are mounted in the loader chute **38** for reciprocation therein, separately and simultaneously, as will be described later in the specification. Both the upper and the lower pusher members **82** and **84** are elongated box shaped structures having open ends **85** and **87,** respectively, and pusher faces **86** and **88,** respectively, which have a combined pushing area substantially equal to the cross-sectional area of the loader chute **38.** The upper pusher member **82** is reciprocated by means of a hydraulic cylinder assembly **90** and a piston rod **92,** whereas the lower pusher member **84** is reciprocated by a hydraulic cylinder assembly **94** having a piston rod **96.** In the retracted position, as shown in FIG. **1,** the pusher members **82** and **84** have their faces **86** and **88,** respectively, aligned with the rearward edge of the opening **46** in the loader chute **38.** As shown in FIG. **2,** the pusher member **84** reciprocates forward to an intermediate position when the hopper door is open and it pushes waste material in front of the same into the combustion chamber **21.** It will be noted that because of its elongated shape, its upper portion prevents waste material from the hopper falling behind the pusher face **88.** When the hopper door **62** is open, the pusher member **84** will continue to reciprocate between the retracted position, shown in FIG. **1,** and the intermediate position, shown in FIG. **2,** until all waste material is emptied from the hopper. Because of the space **100** above the lower pusher member **84,** waste material cannot clog in the chute **38** and interfere with the operation of the pusher member **84** as the pusher member can shear such material in this upper space. Once the hopper **48** is empty, the hopper door **62** moves to the closed position, as shown in FIG. **3,** and then both the upper pusher member **82** and the lower pusher member **84** move simultaneously forward to a position in advance of the intermediate position of FIG. **2** to an advance position as shown in FIG. **3,** wherein the entire loader chute **38** is cleared of all waste material. It should be noted that the advanced position of both the upper pusher member **82** and the lower pusher member **84** is just past the opening into the main combustion chamber **21** and, thus, the chute is entirely clear.

The sequence of operation of the loader apparatus **18** will be best understood by referring to the diagrammatic view shown in FIG. **9,** as well as the views shown in FIGS. **1** through **5,** inclusive. It will be noted that the hopper **48** is provided with a sensor **102** for indicating when the hopper is filled with waste material and a second sensor **104** for indicating when the hopper is empty. These sensors **102** and **104** may be conventional sonic sensors which feed signals back to a loader control program unit for programming the cycle of operation. Assuming that the hopper door **62** is in the closed position, as will be the fire door **40,** the hopper **48** is then filled with waste material to be burned until the sonic sensor **102** indicates that the hopper is completely filled. Upon this condition occurring, the hopper door **62,** which up to this time has been closed and which has its curved surface **72** supporting the waste material and its flat wall **68** closing the opening **46** in the chute **38,** moves from the position shown in FIG. **1** to the position shown in FIGS. **2** and **4,** thus, permitting material to fall downwardly through the lower portion **52** through the opening **46** into the area of the loader chute **38** forward of both of the pusher faces **86** and **88** of the pushers **82** and **84.** Additionally, the signal indicating that the hopper **48** has been filled will also initiate opening of the fire door **40** which is provided with closed and open sensors **103** and **105** that may be limit switches and reciprocation of the lower pusher member **84** only. The pusher member **84** will continue to reciprocate between the position shown in FIG. **1** and the position shown in FIG. **3.** Sensors such as limit switches **106** and **108** feed signals back to the loader control program unit to cause the hydraulic cylinder **94** to actuate the pusher member back and forth between the aforementioned positions, and this will cause the lower pusher member **84** to continuously advance waste material into the combustion chamber **21** until such time as all waste material is exhausted from the hopper **48.** When all waste material has been exhausted from the hopper, the sonic sensor **104** will sense this condition and will cause the hopper door **62** to close to the position shown in FIGS. **3** and **5** when the pusher member **84** has returned to its rear position, this being sensed by limit switch **106** and a signal is furnished to the loader control program unit which, in turn, will actuate both hydraulic cylinder assemblies **90** and **94** simultaneously to cause both pushers to make a forward stroke to clear

the loader chute **38.** An extreme forward limit switch **110** will cause both pusher members **84** and **82** to be retracted to the intermediate position just rearward of the fire door which is sensed by sensor **108** and then the fire door **40,** being sensed as open by limit switch **105,** is moved to its closed position. When the fire door closes and is sensed by sensor **103,** both pusher members will fully retract.

The hopper door **62** is sensed as either open or closed by means of the sensors **112** and **114,** which may also be in the form of limit switches. These sensors **112** and **114** send signals into the loader control program unit and it will be appreciated that they, too, are programmed into the cycle of operation of the automatic loading means to control the operation of the various elements.

From the above-described cycle of operation, it will be noted that at no time can there be passage of free air from the atmosphere into the main combustion chamber **21.** In this respect, the fire door **40** and the hopper door **62,** when in their initial closed positions, block flow of free air to the combustion chamber **21.** When the hopper **48** is filled with waste material, the waste material in and of itself provides a blockage of free air from the atmosphere into the main combustion chamber **21** and this even occurs when the hopper is sensed as empty by the sensors **104** as in the interval between the closing of the hopper door **62** and the retraction of the pusher member **84,** there will still be waste material in the loader chute **38** above and in front of the pusher member **84.**

As the waste material drops in the hopper **48,** additional waste material can be added at any time without changing the cycle of operation so long as the sonic sensor **104** indicates waste material in the hopper. Thus, the operation of continuously loading the combustion chamber **21** can be realized and as new waste material is pushed into the combustion chamber **21** by the reciprocating lower pusher member **84,** it will move the burning mass within the chamber toward the end of the chamber closed by the access door **20.**

At the end of the casing **12,** remote from the annular extension **16,** there is provided an opening **116** in the lower portion of the casing. Surrounding this opening **116,** there is provided an annular ash pit member **118** depending downwardly therefrom, the member **118** being refractory lined or made from a refractory material and having an enlarged entrance tapering slightly inwardly. At the lower end of the ash pit member **118,** there is provided an elongated annular ash discharge member or duct **120** having an opening therein cooperating with the annular ash pit member **118** and having a generally horizontal axis. The annular ash discharge member **120** is opened at one end as indicated at **122,** and this end is normally closed by a weighted gravity operated pivoted door **124.** Carried within the annular ash discharge member **120** is an elongated pusher member **126** which is connected to a hydraulic cylinder assembly **128** by means of a piston rod **103.** The pusher member **126,** in its retracted position, has a pusher face **132** which is adjacent the rearward position or edge of the opening of the ash pit member **118** to the ash discharge member **120** (FIG. **1**). As shown in FIGS. **7** and **8,** the pusher member **126** is pushed forward by the hydraulic cylinder assembly **128** and ashes which fall through and fill up the ash pit member **118** and are in front of the pusher face **132** of the pusher member **126,** are pushed against the door **124,** opening the same, and are discharged therefrom onto an endless conveyor **134** or into an ash truck (not shown) where they may be conveyed away. By having an elongated ash pit member or duct **118,** burnt ashes and any unburnable waste products can fall therethrough and they have a time in which to cool and to insulate the ash discharge member or duct **120** from the heat of the main combustion chamber **21.** It will be noted by reference to FIG. **7** that when the pusher member **126** is in the forward position, its rear end portion blocks the opening of the ash pit member **118** so that ashes cannot fall behind the member **126** and interfere with its operation.

Referring to FIG. **9,** sensors **136** and **138,** which may be limit switches, are provided for sensing the retracted and forward positions of the pusher member **126,** these sensors sending signals to the ash removal control unit for properly operating the hydraulic cylinder assembly **128.** If desired, the ash removal control unit can be coupled into the loader control program unit and programmed to operate the ash removal means in accordance with any desired program set up for the automatic loader control.

The incinerator assembly includes an incinerator control unit (FIG. **9**) operable to initially start the burners **22** in the main combustion chamber **21,** as well as the burner **30** in the secondary combustion chamber **26.** This incinerator control unit can automatically operate the burners to turn the same off when proper temperatures have been reached in the various combustion chambers and it also can include control means for controlling the amount of air supplied both to the main combustion chamber **21** and the secondary combustion chamber **26.** Additionally, the incinerator control unit can be coupled into the automatic loader control program unit and to the ash removal control unit so that it can be programmed into the overall system.

The terminology used throughout this specification is for the purpose of description and not limitation, the scope of the invention being defined in the appended claims.

What is claimed is:

1. A controlled air incinerator comprising:

a casing defining at least a main combustion chamber;

loader means for automatically loading said combustion chamber with waste material without materially affecting burning conditions within said main combustion chamber, said loader means including an elongated chute having one end opening to a lower portion of the combustion chamber and having an opening in its upper portion thereof remote from its opening to the combustion chamber for receiving waste material, a fire door positioned in a portion of said chute intermediate the waste receiving opening of said chute and the opening of said chute to said combustion chamber, said fire door being moved between a closed position across said chute and an opened position out of said chute, an upper elongated pusher member and a lower elongated pusher member in said chute and having a combined pushing area substantially equal to the cross-sectional area of said chute, at least said lower pusher member having a longitudinal length at least as great as the length of the waste receiving opening in said chute;

a hopper mounted on said loader chute over the waste receiving opening therein for feeding waste material by gravity to said chute in front of said pusher members;

a first means to reciprocate said lower pusher member between a retracted position adjacent the waste receiving opening's rearward edge and an intermediate position where said lower pusher member is beneath the waste receiving opening in said chute when said upper pusher member is retracted while said door is open;

and means to simultaneously reciprocate said upper and lower pusher members when said hopper is empty between a retracted position adjacent the waste receiving opening's rearward edge and an extended position at least into the opening of the chute into the combustion chamber to entirely clear said chute.

2. An incinerator as claimed in claim **1** including door means to close the waste receiving opening in said chute and to form a portion of said chute when said upper and lower pusher members are simultaneously extended.

3. An incinerator as claimed in claim **1** in which said hopper has an opening in its side wall adjacent the waste receiving opening in the upper portion of said chute and including a door pivoted to said hopper and movable between a position across said hopper whereby waste material can be loaded into said hopper thereon to a position wherein said door closes the opening in said hopper to permit waste material to fall by gravity in front of said pusher members.

4. An incinerator as claimed in claim **3** in which said door in said hopper, when in said position across said hopper, closes the waste receiving opening in said chute and defines a portion of said chute when said upper and lower pusher members are simultaneously extended.

5. An incinerator as claimed in claim **1** in which said hopper has an opening in its side wall adjacent the waste receiving opening in the upper portion of said chute and including a door pivoted to said hopper, said door having a shape like a sector of a cylinder and including a curved wall and a flat wall, said door being movable between a first position where said curved wall is across said hopper and provides a support for waste material being loaded into said hopper and said flat wall is across the waste receiving opening in said chute and defines a portion of said chute to a second position where said curved wall is out of said hopper to permit waste material to fall by gravity in front of said pusher members and said flat wall closes the opening in said hopper.

6. An incinerator as claimed in claim **5** including a first sensor means in said hopper for sensing when said hopper is filled with waste material and for initiating said movement of said hopper door from said first position to said second position and for initiating said means for reciprocating said lower pusher member.

7. An incinerator as claimed in claim **6** including a second sensor means in said hopper for sensing when said hopper is empty so as to initiate movement of said hopper door from said second position to said first position and to initiate said means to simultaneously reciprocate said upper and lower pusher members to extend the same.

8. An incinerator as claimed in claim **7** including sensor means for sensing the extended position of said upper and lower pusher members to cause retraction of said upper and lower pusher members and closing of said fire door.

9. An incinerator as claimed in claim **8** including a first hopper door sensor means for sensing when said door is in said first position and a second hopper door sensor means for sensing when said hopper door is in said second position, and a first sensor means for sensing the retracted position of said lower pusher member for initiating reciprocation of said lower pusher member when said hopper door is sensed in said second position, and a second sensor means for sensing when said second pusher member is extended to an intermediate position to thereby cause retraction of said second pusher member.

10. An incinerator as claimed in claim **9** including a first fire door sensor means for sensing the closed position of said fire door and initiating the opening of said fire door when said hopper door is sensed in said second position, and a second fire door sensor means to sense the opened position of said door when said upper and lower rams have moved simultaneously to their retracted positions, and thereby cause said fire door to close.

11. An incinerator as claimed in claim **1** in which said chute and its opening into the lower portion of the combustion chamber are rectangular in cross-section, said chute having a substantially horizontal axis.

12. An incinerator as claimed in claim **11** in which said elongated upper and lower pusher members are each rectangular in cross-section and in which said lower pusher member has a larger cross-section pushing area than the pushing area of said upper chute.

13. An incinerator as claimed in claim **12** in which each of said upper and lower pusher members is box-shaped open at one end and having a pusher wall at the opposite end connected to top, bottom, and side walls.

14. An incinerator as claimed in claim **1** in which said casing is annular and has a generally horizontal axis, said casing having end walls and said chute opening to said casing in one of its end walls.

15. An incinerator as claimed in claim **14** in which said casing has an opening in its bottom portion at a point remote from the opening for waste material to said combustion chamber, and including an ash pit member extending downwardly from said opening, and automatic ash removal means connected to the lower end of said ash pit member.

16. An incinerator as claimed in claim **15** in which said automatic ash removal means includes an annular elongated casing member having a generally horizontal axis and open at least at one end, a gravity operated door pivoted to said annular casing member and normally closing the open end of the same and a reciprocating elongated pusher member movable between a retracted position away from said ash door and clear of the opening of the ash pit to said annular casing member to an extended position where it blocks off the opening between the ash pit and the annular casing member with ashes in front of said pusher member being forced against said ash door to open the same and being discharged from the open end of the annular casing member.

17. An incinerator as claimed in claim 16 including conveyer means positioned below said ash door for receiving and further removing ashes.

18. An incinerator as claimed in claim 17 in which said annular casing member of said ash removal means is cylindrical and in which said pusher member is cylindrically shaped.

19. An incinerator as claimed in claim 18 in which the other of said end walls of said casing for said combustion chamber is an access door to permit access to the interior of said casing when the incinerator is inoperative.

20. A controlled air incinerator comprising:

a casing defining at least a main combustion chamber, said casing being annular and having end walls and a generally horizontal axis;

means for loading waste material into the combustion chamber of said casing adjacent one end wall thereof, said means also causing the moving of burning waste material within said main combustion chamber away from the said one end wall of said casing toward the other end wall where it is burned primarily into ash, said means for loading waste material comprising a chute connected to the said end wall around and opening into the combustion chamber, said chute having a horizontal axis and an opening at a remote point from the end wall for receiving waste material, said chute further having an upper pusher member which is reciprocated and a lower pusher member which is reciprocated, said lower and upper pusher members having pusher face areas which, when combined, substantially equal the overall cross-sectional area of the chute, said lower pusher member being reciprocated back and forth between a retracted position adjacent the rearward edge of the waste receiving opening of the chute to a second position short of the opening of the chute through the said end wall so long as waste material is being fed through the opening into the chute, said upper pusher member being reciprocated simultaneously with said lower pusher member when no waste material is fed through the opening in the chute, said upper and lower pusher members being reciprocated from a position adjacent from the waste receiving opening's rearward edge to an extended position at least into the interior of the combustion chamber so as to entirely clear said chute;

an opening in a bottom portion of said casing adjacent the other end wall of said casing which is remote from said loading means;

an annular member connected to said casing and surrounding said opening and defining an ash pit, said annular member extending downwardly beneath said casing; and

means connected to the lower end of said annular member for discharging ash falling therein, said discharging means including an annular elongated ash discharge member having an opening therein cooperating with the lower end of the annular ash pit member and having a generally horizontal axis, said annular ash discharge member having at least one open end, a gravity operated door pivoted to said annular ash discharge member and normally closing the open end thereof, a reciprocating elongated pusher member movable between a retracted position away from said ash door and clear of the opening of the annular ash pit member to an extended position where it blocks off the opening between the annular ash pit member and the annular ash discharge member with ashes in front of said pusher member being forced against said ash door to open the same and being discharged therefrom.

21. An incinerator as claimed in claim 20 including endless conveyor means positioned beneath said ash door for receiving the discharged ashes therefrom and further removing the same.

22. An incinerator as claimed in claim 20 in which said annular ash discharge member is cylindrical and in which said pusher member is cylindrically shaped.

23. An incinerator as claimed in claim 1 in which said fire door reciprocates between the closed position across said chute and the open position out of said chute.

24. A controlled air incinerator comprising:

a casing defining a combustion chamber; and

loader means for automatically loading said combustion chamber with waste material, said loader means including an elongated chute having one end opening to a lower portion of the combustion chamber and having an opening in its upper portion thereof remote from its opening to the combustion chamber for receiving waste material, said chute further having therein an upper pusher member which is reciprocated and a lower pusher member which is reciprocated, said upper and lower pusher members having pusher face areas which, when combined, substantially equal the overall cross-sectional area of the chute and the opening of the chute to the lower portion of the combustion chamber, said lower pusher member being reciprocated back and forth between a retracted position adjacent the rearward edge of waste receiving opening of the chute to a second position short of the opening of the chute to the combustion chamber so long as waste material is being fed through waste receiving opening into the chute, and said upper pusher member being reciprocated simultaneously with said lower pusher member when no waste material is fed through the waste receiving opening into the chute, said upper and lower pusher members being reciprocated from a position adjacent the waste receiving opening's rearward edge to an extended position at least into the interior of the combustion chamber so as to entirely clear said chute.

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