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Sargent et al.

[11] **3,842,762**

[45] **Oct. 22, 1974**

[54] **APPARATUS FOR DISPOSING OF SOLID WASTES**

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[73] Assignee: **Grumman Ecosystems Corporation**, Bethpage, N.Y.

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[21] Appl. No.: **379,190**

[52] **U.S. Cl.** ..... **110/14**, 110/119, 110/165 R

[51] **Int. Cl.** **F23g 5/06**

[58] **Field of Search** ..... 110/8 R, 8 A, 14, 119, 110/165 R

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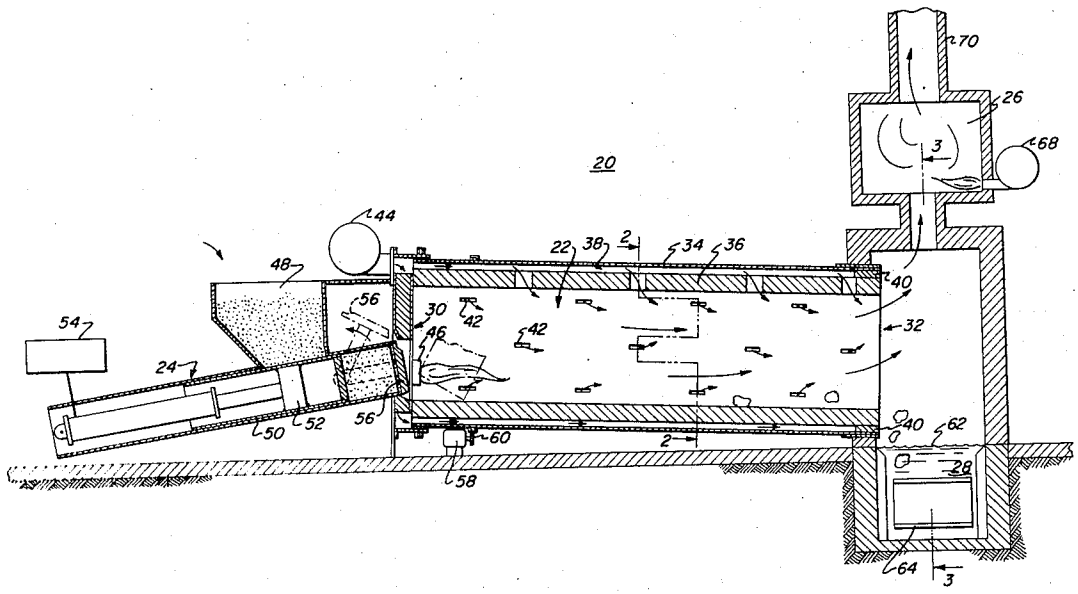
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Primary Examiner—Kenneth W. Sprague
Attorney, Agent, or Firm—Samuelson & Jacob

[57] **ABSTRACT**

Apparatus for disposing of solid wastes having a kiln sealed at its feed and discharge ends. A compacted slug of waste material is collected at the feed end and when the slug is of sufficient size and density, it is pushed into the kiln combustion chamber where it is burned. The combustion gases enter a secondary combustion chamber which is provided with an afterburner. After complete combustion, the gases exhaust through a stack. The kiln is provided with a unique air distribution system and is formed of a steel outer jacket and a spaced inner refractory jacket which has a plurality of openings to permit the feeding of oxygen or other combustion supporting gas from outside the kiln to the inside of the kiln. The kiln rotates about its axis to improve the combustion of the waste material. The burning is in a controlled atmosphere since the discharge end of the kiln is water sealed. The ash from the combustion chamber drops onto a water submerged conveyor for automatic removal from the system while maintaining the seal of the controlled combustion furnace.

7 Claims, 13 Drawing Figures



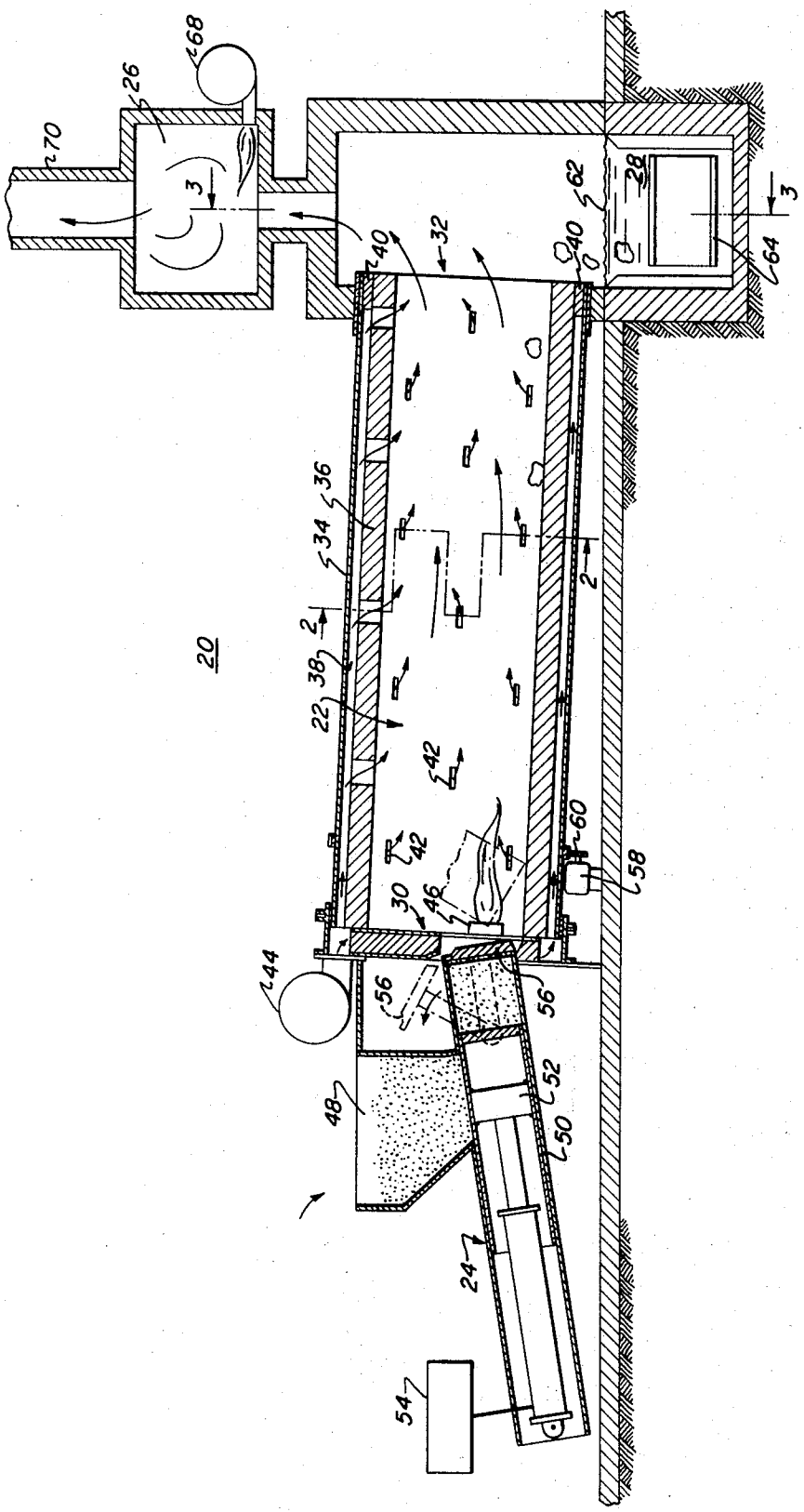

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FIG. 1

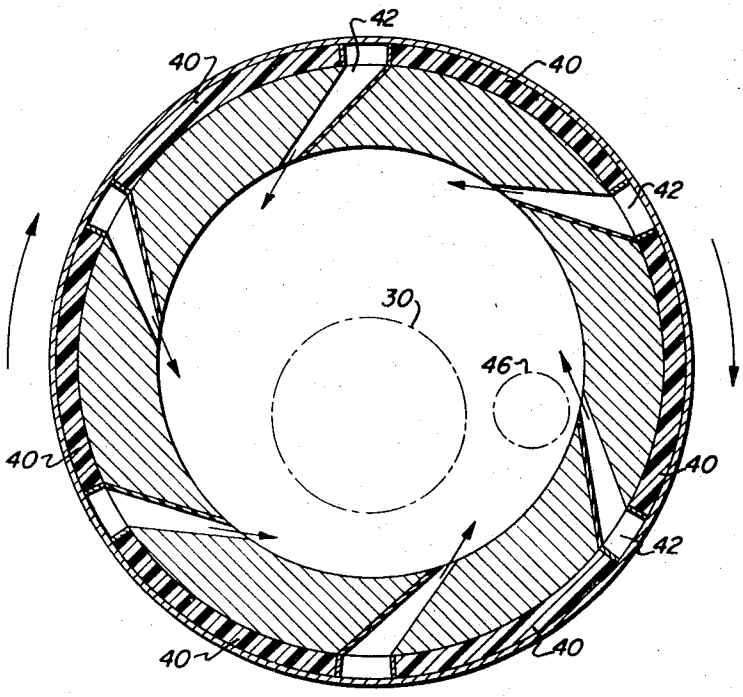


FIG. 2

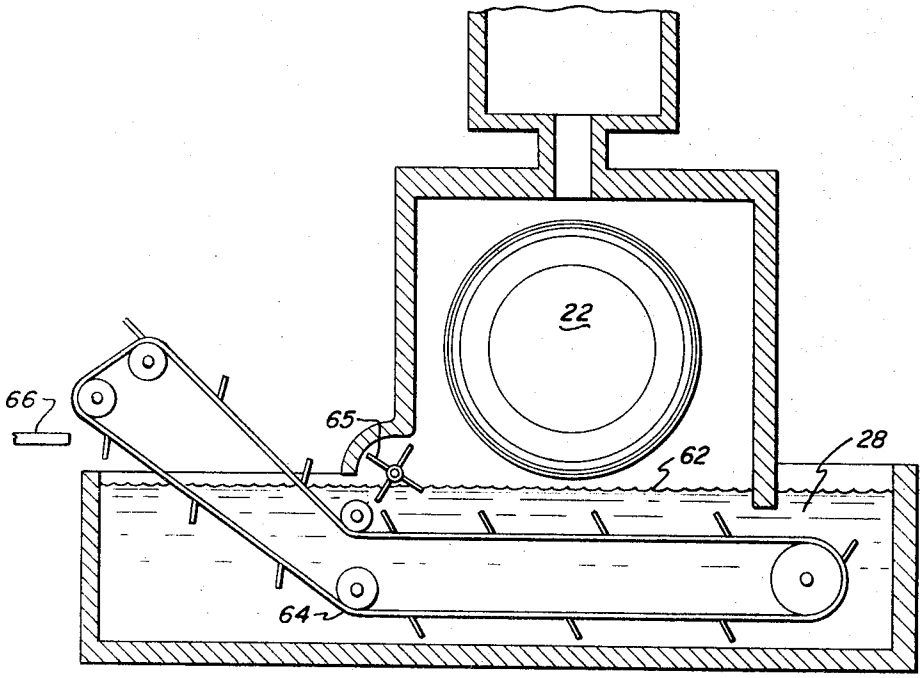


FIG. 3

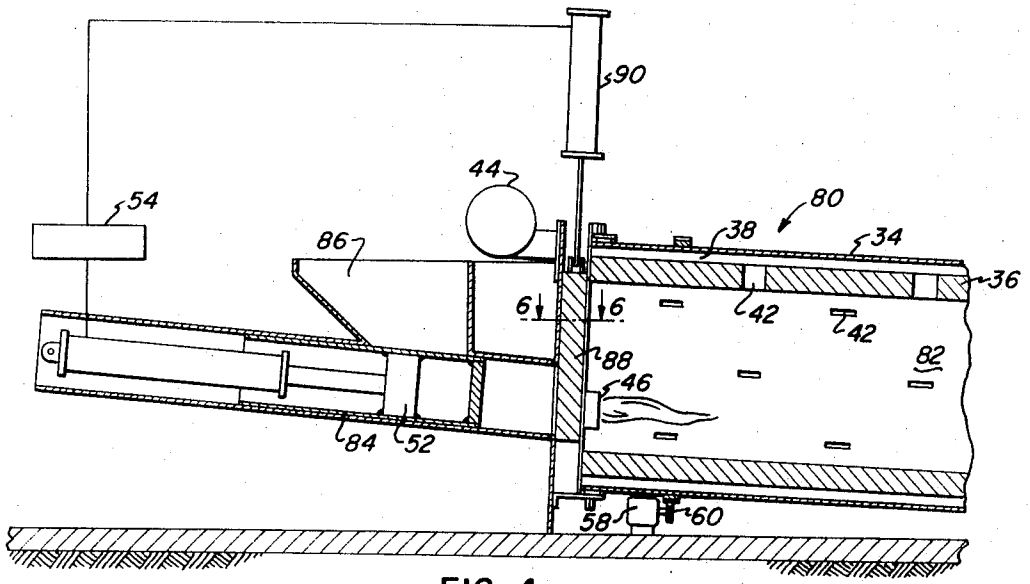


FIG. 4

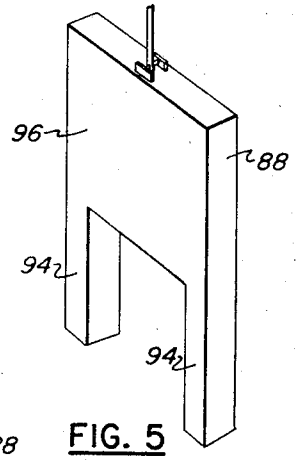


FIG. 5

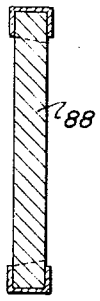


FIG. 6

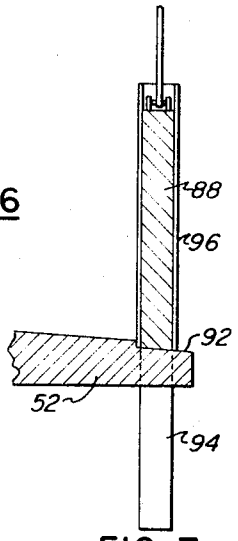


FIG. 7

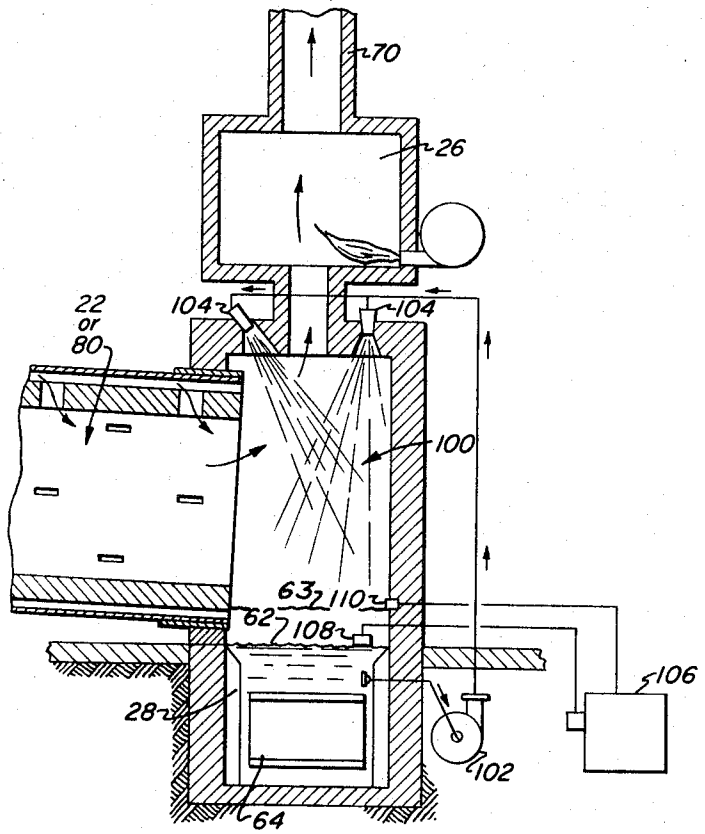


FIG. 8

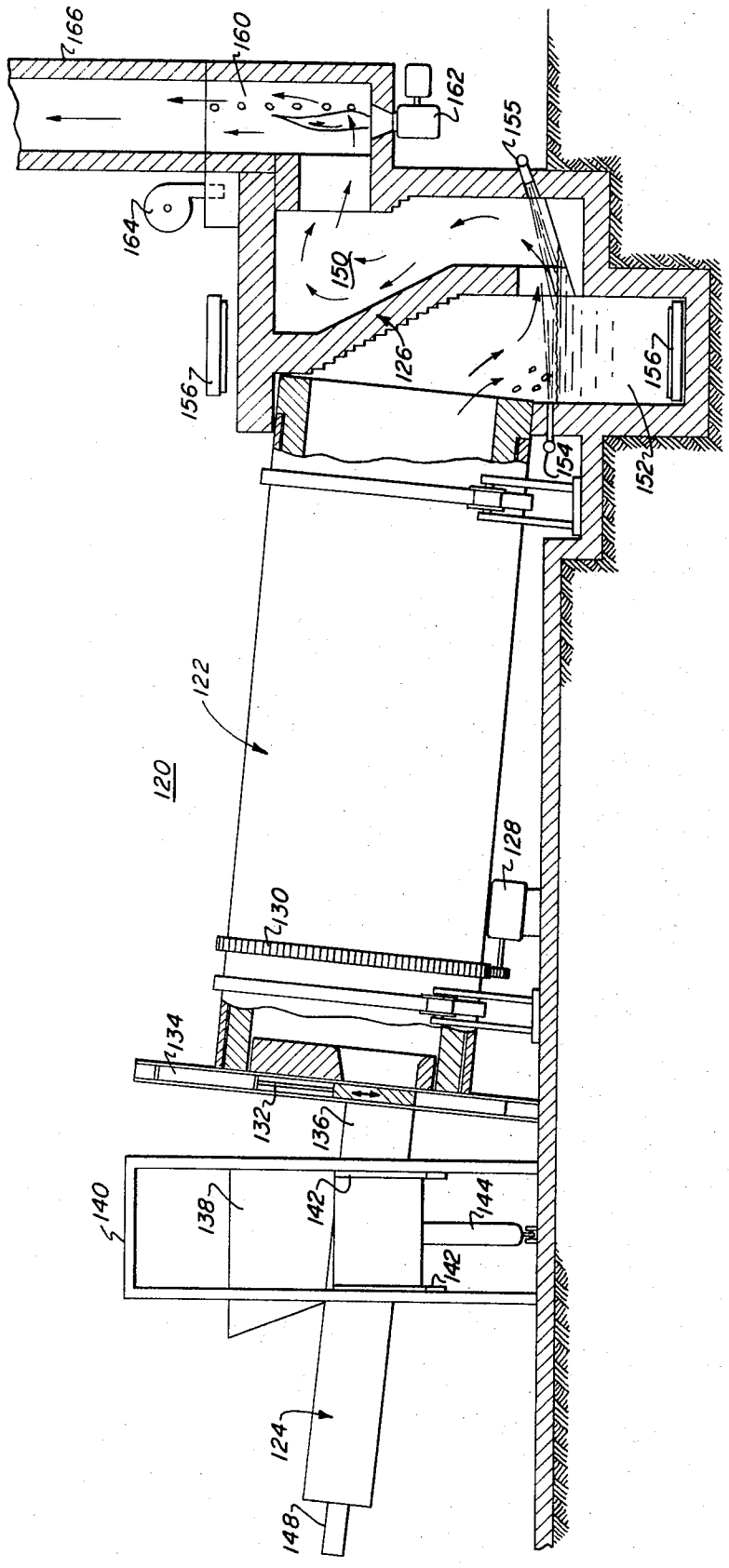

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FIG. 9

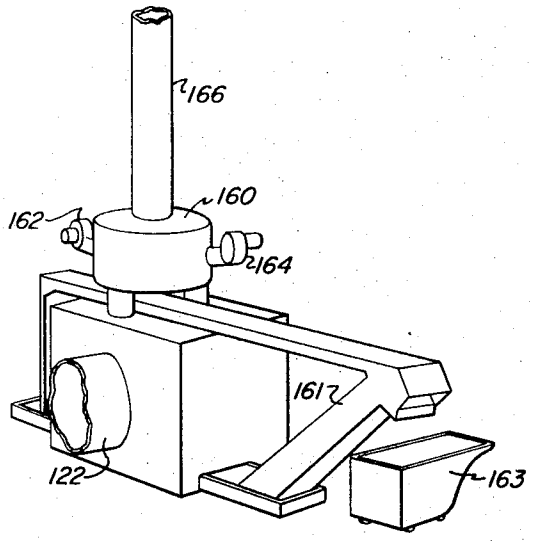


FIG. 10

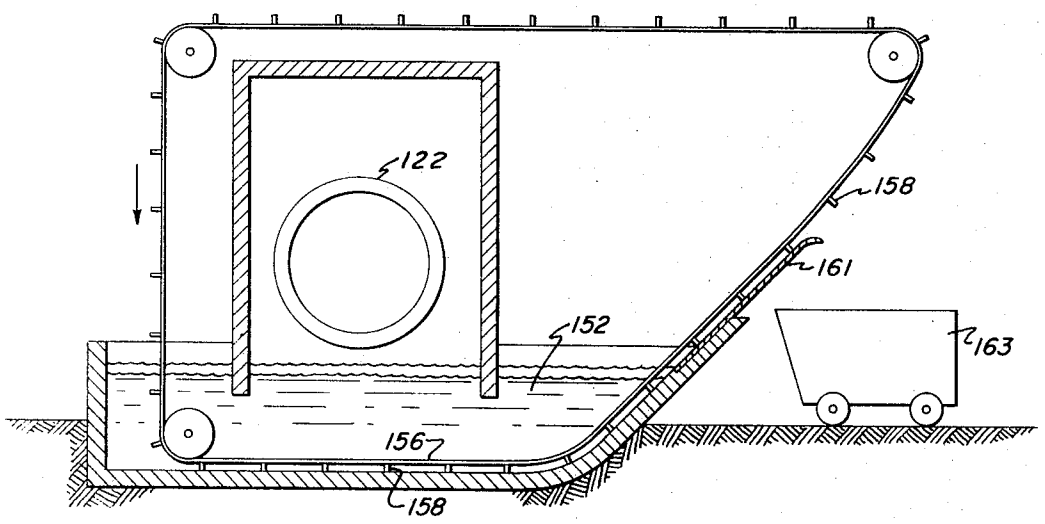


FIG. 11

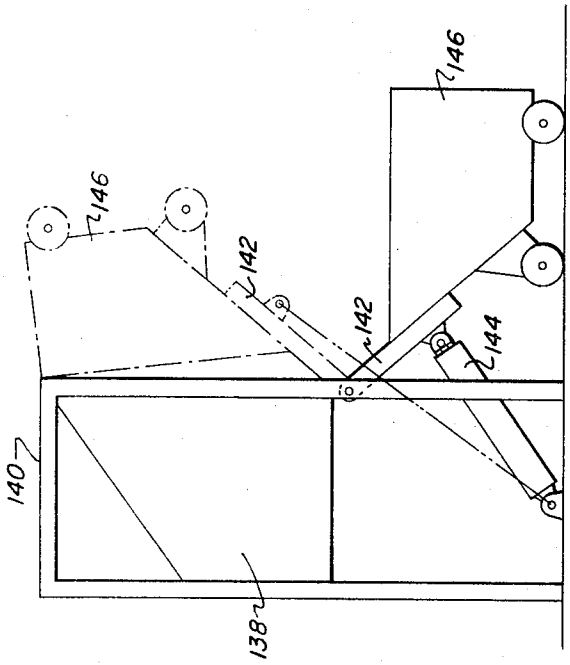

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FIG. 12

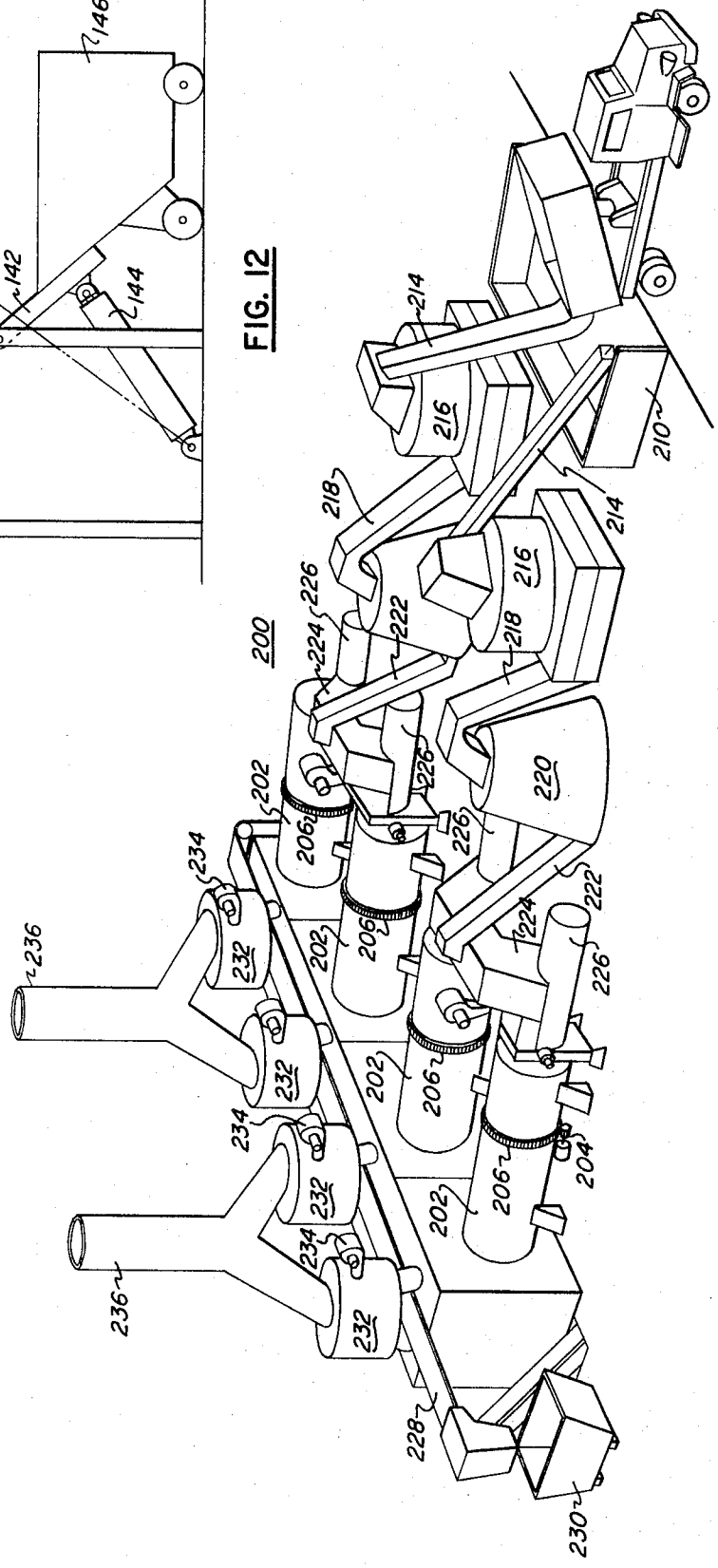

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FIG. 13

APPARATUS FOR DISPOSING OF SOLID WASTES

The invention relates to apparatus for disposing of solid wastes efficiently and economically. In particular, the invention is directed toward providing such an apparatus which will produce little or no ecological damage.

Prior art devices for incinerating solid waste material are either of the open type or of the sealed batch feed type. The open type incinerator is open to the ambient atmosphere or environment and, as a consequence, it is difficult to control combustion precisely or to prevent fly ash and other atmospheric contaminants from entering the air. The closed type incinerator is free of the disadvantages of the open type but, up to now, has only been available for batch operation. Batch operation requires that a fixed amount of material be fed to the incinerator, burned and removed. Then a new batch is fed to the incinerator.

Broadly, the present invention overcomes the disadvantages of both of these systems. It permits almost continuous processing of solid wastes in a closed system and, for all practical purposes, the process is continuous. A cylindrical kiln is sealed from ambient atmosphere and is tilted downward a slight amount toward its discharge end. Material is fed from a hopper to a cylinder in which a ram is mounted. The ram compresses the material and when a slug of predetermined size and density is collected in the cylinder, the feed end door opens and the slug is pushed into the kiln. While the feed end door is open to receive the slug, the slug serves to seal the kiln from the ambient atmosphere. The kiln is formed of a pair of spaced shells and means are provided for feeding combustion supporting gas into the interior of the kiln.

The discharge end of the kiln is sealed against a chimney. The combustion gases and fly ash rise in the chimney and enter an afterburner where additional burning takes place. The heavier, solid products of combustion drop onto a conveyor which is submerged in water which serves to seal the discharge end from the ambient atmosphere.

Alternatively, the discharge end of the kiln may be adjacent a large, closed pit into which the ash drops. In such a case, processing must be stopped in the event that it is necessary to remove the ash from the pit.

It is an important object of the invention to provide apparatus for disposing of solid waste in a sealed system on an essentially continuous basis.

It is a further object of the invention to provide a cylindrical kiln for use in such a system which will be efficient in operation.

It is a still further object of the invention to provide such a kiln wherein the injection of combustion supporting gas is accomplished easily and efficiently.

These and other objects, features, advantages and uses will be apparent during the course of the following description when taken together with the accompanying drawings wherein:

FIG. 1 is a longitudinal section of a first form of apparatus of the invention;

FIG. 2 is a sectional view taken on lines 2—2 of FIG. 1, viewed in the direction of the arrows;

FIG. 3 is a sectional view taken on lines 3—3 of FIG. 1, viewed in the direction of the arrows;

FIG. 4 is a view similar to that of FIG. 1 of the feed end of a kiln of the invention showing an alternative construction for sealing the feed end of the kiln;

FIG. 5 is a perspective view of the door used with the embodiment of FIG. 4;

FIG. 6 is a sectional view taken on lines 6—6 of FIG. 4, viewed in the direction of the arrows;

FIG. 7 is a side view of the door of FIG. 4 in the closed position;

FIG. 8 is a view similar to that of FIG. 1 of the discharge end of a kiln of the invention showing a spray chamber located below the secondary combustion chamber;

FIG. 9 is a veiw similar to that of FIG. 1 of a further embodiment of the apparatus of the invention for handling large quantities of waste material;

FIG. 10 is a perspective view of the elements associated with the discharge end of the apparatus of FIG. 9;

FIG. 11 is an enlarged side elevation, partly in section, of the ash conveyor used in the embodiment of FIG. 9;

FIG. 12 is a view of an alternative construction for feeding a system of the invention used for handling high volumes of material; and

FIG. 13 is a perspective view of a battery of incinerators of the invention used for handling large volumes of solid waste.

In the drawings, wherein, for the purpose of illustration, there are shown various embodiments of the apparatus of the invention, the numeral **20** designates an embodiment of the apparatus of the invention, generally. Apparatus **20** which may be used to process of the order of about 2000 lbs. of solid waste per hour, is seen to comprise a rotary kiln **22**, a feeder **24** for feeding the kiln, a secondary combustion chamber **26** and an ash pit **28** (FIG. 1).

Kiln **22** is cylindrical and is tipped downward from its feed end **30** toward its discharge end **32.** It is formed of an outer steel shell **34** and an inner refractory shell **36** of brick or similar material spaced from the outer shell **34** as shown at **38** and affixed thereto with heat insulating material as shown at **40.** A plurality of openings **42** connect between the space **38** and the interior of the kiln as shown in FIG. **2.** A blower **44** feeds combustion supporting gas such as air into the space between the shells, through the openings **42** and into the interior of kiln **22.** A burner **46** is utilized to ignite the solid waste material in the kiln.

Feeder **24** comprises a hopper **48** into which the solid waste is deposited by any suitable means. The material from the hopper **48** drops into the compactor cylinder **50** where it is compressed into a slug by means of a hydraulic ram **52** which is actuated by the usual control and supply means **54** (details not shown). As ram **52** moves toward the right of FIG. **1,** it compacts the material which dropped into compactor **50** from hopper **48** into a slug. When the slug exerts a minimum predetermined pressure as measured on a sensor (not shown) a door **56** moves from the first position wherein the feed end **30** is sealed closed to the dotted position (second position) shown in FIG. **1.**

In this second position of door **56,** the compacted slug seals feed end **30** and ram **52** pushes the slug into kiln **22.** As soon as ram **52** starts to retract, door **56** moves back to its first position. Thus, it can be seen that the feed end of the kiln is kept sealed while contin-

uous operation is maintained. In order to obtain more even incineration within the kiln, it is rotated by means of a motor **58** and a drive ring **60** which is affixed to the steel shell **34.**

The ash, unburned solids and exhaust gases leave the discharge end **32** of the kiln **22.** The heavier material drops into the pit **28** which is preferably shown as a water filled pit with the water at the level shown at **62.** A conveyor **64** is mounted below the level of the water. The water seals the discharge end of the kiln from the ambient atmosphere.

FIG. **3** illustrates one construction of ash conveyor **64** which is used to remove the ash from pit **28.** The conveyor is under the level **62** of the water until it is clear of the kiln so that the kiln is sealed. The ash drops onto a table **66** or into a dump truck or similar unit used for its removal. A paddle wheel **65** is used to wet the lighter floating ash particles by agitating the water near the surface. The wetted particles then drop onto the conveyor **64.**

The exhaust gases and some unburned solids carried by the gases rise into secondary combustion chamber **26** which is provided with a burner which burns the unburned solids. Most of the ash burned in the secondary combustion chamber **26** drops into pit **28** and the balance is exhausted with the gases through a chimney **70.**

Incinerator **80** (FIG. **4**), which will process of the order of about 2,000 lbs. of solid waste per hour, is provided with a kiln **82** which is similar to kiln **22** except for the configuration at its feed end. A hopper **86** drops the solid waste into a compactor **84** which is provided with a ram **52** and a control and supply **54.** It is noted that the difference between compactor **84** and compactor **50** resides in the direction of the vertical component of the feed into the kiln. The downward feed of compactor **84** makes it less likely that any material will "hang up" on the sill and thereby keep the door from closing.

A door **88** is controlled by means of a cylinder **90.** Door **88** is raised when the slug is sufficiently compacted to thereby permit ram **52** to push the waste material into the kiln. It closes to the down position after the feed is completed.

Door **88** is bifurcated at its lower end where it is provided with a pair of depending legs **94.** The space between the legs **94** serves as the opening through which the kiln is fed when the door **88** is up. The bottom edge of the solid portion **96** of door **88** rests on sill **92** when the door is in its closed position (FIG. **7**). The stepped shape of the sill limits the possibility that solid waste will remain on the sill rather than dropping into the kiln.

FIG. **8** illustrates a scrubber **100** located at the discharge end of kiln **22** or kiln **80.** Water from pit **28** is pumped by a pump **102** to one or more sprays **104** to wash the exhaust gases. This washing soaks the solid particles carried by the gases and causes them to drop into pit **28.** Since this procedure uses up a certain amount of water, make up is added from a supply **106** when the water drops below the level **62** as measured by a sensor **108.** Make up is stopped when the level reaches that of a sensor **110,** namely, level **63.**

In FIGS. **9–12** there is illustrated a system of the invention for incinerating solid wastes which will process solid wastes at a rate of the order of 4,000 lbs. per hour. Apparatus **120** comprises a kiln **122** which is similar in concept and operation to those already described, a compaction section **124** and a discharge section **126.** The kiln **122** is rotated by means of a motor **128** and a drive **130.** It is sealed from ambient atmosphere at its feed end by a door **132** which is moved up and down by a hydraulic cylinder **134.** Door **132** is similar in construction to door **88** and its operation is controlled by cylinder **134** which is similar to cylinder **90.**

Compaction section **124** is seen to comprise a compaction chamber **136,** a hopper **138** and a feed frame **140.** Feed frame **140** (FIG. **12**) supports hopper **138** and is provided with a pair of dump arms **142** which are operated by a hydrualic cylinder **144.** The arms **142** grasp a mobile container **146** and raise it from the lower position shown in FIG. **12** to the upper position. In the upper position, its contents are deposited in hopper **138** from which it is delivered to the compaction chamber **136.**

The compaction chamber **136** is similar to those previously described. Its ram (not shown) is controlled by a hydraulic cylinder **148.** When the slug reaches a predetermined degree of compaction, door **132** is raised to permit the slug to enter kiln **122** where the initial incineration process is carried out.

The discharge section **126** is divided into several separate elements. The solid material leaving the kiln drops into a water filled pit **152.** A pair of sprays **154** and **155** have their nozzles directed so that their streams are directed across the top of the water in the pit **152** and thereby wash the solid ash particles thereby causing them to drop into pit **152** for removal by a water submerged conveyor **156.** Spray **155** also serves as a sluice to wash down the solids which collect.

The ash which drops into pit **152** is scraped from the pit by flight bars **158** which are affixed to conveyor **156.** The material is carried up the incline **161** and is deposited, for example, in a dump truck **163.** Since the drive of the conveyor is well known in the art, no details of the drive means are shown.

The exhaust gases carrying some unburned solid particles next enter a mixing chamber **150** where a change in gas velocities causes settling of the solid particles and they eventually drop into the pit **152.** The gases leave the mixing chamber **150** and enter a secondary combustion chamber **160** which is provided with a burner **162** and a blower **164.** Here, the unburned gases, smoke and odors are incinerated and are disposed of by controlled high temperatures of the order of 1750°–1800°F with proper air distribution from blower **164.** The gases are exhausted through a stack **166.**

FIG. **13** is a perspective view of a system **200** utilizing the teachings of the invention for processing volumes of the order of about 8,000 lbs. of solid waste per hour. It is seen to comprise a plurality of kilns **202** which are rotated by motors **204** (one shown) and drives **206.** Solid waste to be processed is delivered by, for example, a dump truck **208** to a refuse pit **210.** The refuse from refuse pit **210** is moved by conveyors **214** to at least one shredder **216** where the large pieces are reduced in size. Next, the material is moved by a shredded waste conveyor **218** to a surge bin **220.**

The output of the surge bin is a metered discharge through a conveyor **222** to a hopper **224.** The waste is delivered from the hopper **224** to one or more compactors **226.** The kiln is charged by the compactor in the same manner as has been described heretofore. The solid ash waste is removed by a conveyor **228** to, for ex-

ample a dump truck **230.** Secondary incineration occurs in a chamber **232** which is provided with a burner **234** and the gases are exhausted through a stack **236.**

While particular embodiments of the invention have been shown and described, it is apparent to those skilled in the art that modifications are possible without departing from the spirit of the invention or the scope of the subjoined claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Apparatus for disposing of solid waste material comprising:

a cylindrical kiln having a feed end and a discharge end and rotatable about its axis, mounted such that the feed end is somewhat higher than the discharge end;

means for feeding compacted solid waste material into the kiln through the feed end thereof;

first sealing means for sealing the feed end of the kiln from the ambient environment such that a compacted slug of solid waste material may be fed to the kiln without breaking the seal;

second sealing means for sealing the discharge end of the kiln from the ambient environment;

means for rotating the kiln;

means for burning the solid waste material in the kiln;

means for introducing combustion supporting gas such as air into the kiln to thereby promote the burning of the solid waste material in the kiln;

a secondary combustion chamber mounted at the discharge end of the cylindrical kiln for incinerating those combustibles which pass through the kiln;

a stack connected to the secondary combustion chamber for removing the exhaust gases; and

collecting means for collecting solid ash which is ejected from the discharge end of the cylindrical kiln.

2. The invention of claim **1** including:

removing means for removing such solid ash without breaking the seal at the said discharge end of the cylindrical kiln.

3. The invention of claim **2** wherein:

the second sealing means comprises a pool of liquid just below the said discharge end of the cylindrical kiln; and

the removing means comprises a conveyor moving through the liquid pool to the ambient environment such that the liuqid serves to seal the discharge end of the cylindrical kiln while removal of the solid ash takes place on a continuous basis.

4. The invention of claim **1** wherein the first sealing means comprises:

a door movable between a first position in which the feed end of the cylindrical kiln is closed to the ambient environment and a second position in which a compacted slug of waste material of predetermined size being fed to the kiln seals the said feed end as the door is opened to receive the said slug.

5. The invention of claim **1** wherein the cylindrical kiln comprises:

an outer steel shell;

an inner refractory shell spaced from the outer steel shell;

the inner refractory shell having a plurality of openings therein leading from the space between the outer steel shell and the inner refractory shell to the interior of the cylindrical kiln forming the means for introducing combustion supporting gas or air into the cylindrical kiln.

6. The invention of claim **1** wherein:

the secondary combustion chamber is provided with an afterburner mounted above the discharge end of the cylindrical kiln for burning any unburned solid particles carried by the exhaust gases.

7. The invention of claim **6** including:

a spray chamber mounted above the discharge end of the cylindrical kiln and below the secondary combustion chamber;

at least one spray nozzle mounted in the spray chamber for wetting the solid ash particles carried in the exhaust gases and causing said particles to drop below the discharge end of the cylindrical kiln.

* * * * *