United States Patent

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[54] **INCINERATOR SYSTEM**
11 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **110/14**
[51] **Int. Cl.** **F23g 5/06**
[50] **Field of Search** 110/7, 8, 14

[56] **References Cited**
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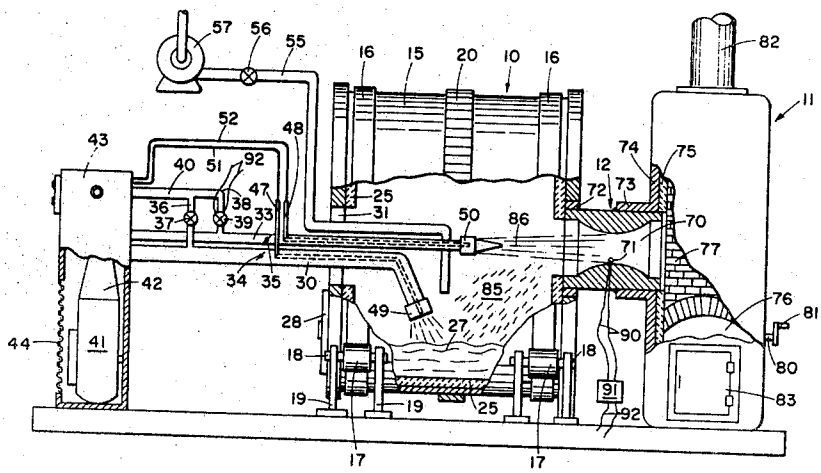
ABSTRACT: An incinerator system having primary and secondary combustion chambers joined by a venturi throat member. The incinerator is grateless, provides agitation to the material being burned and effects a continuous flow of gases and fine particulate material from one chamber to the other with additional burning.



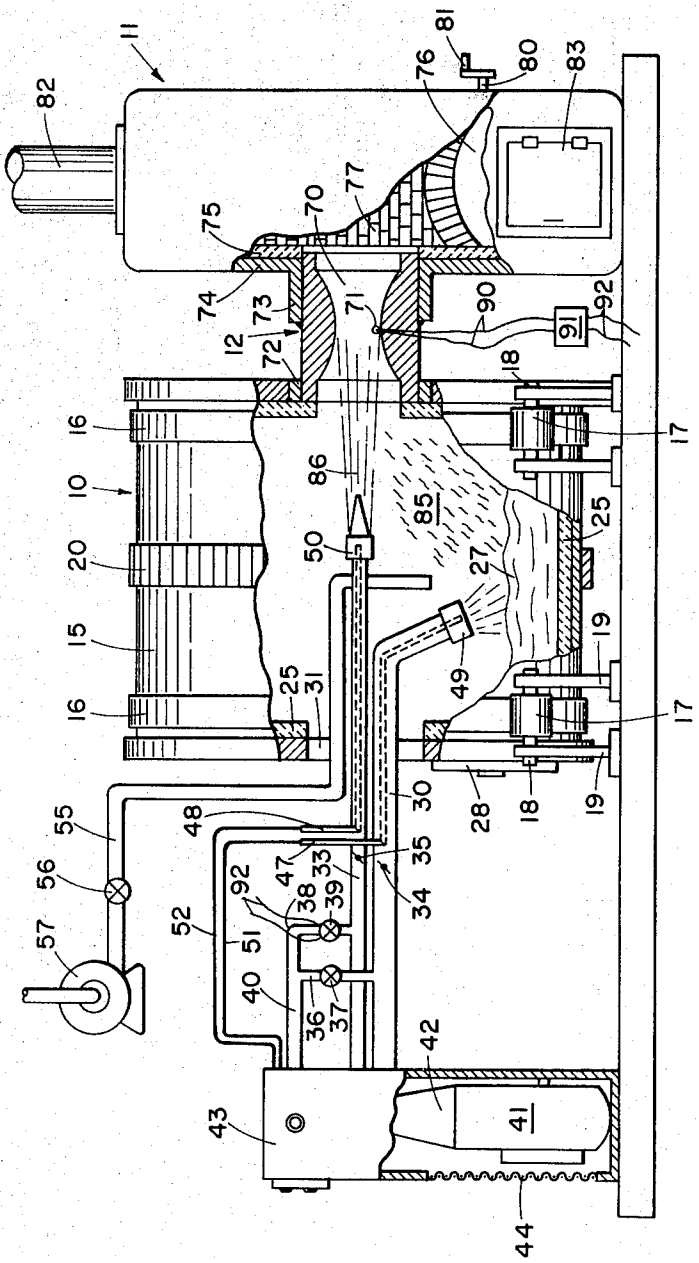


Fig. 1

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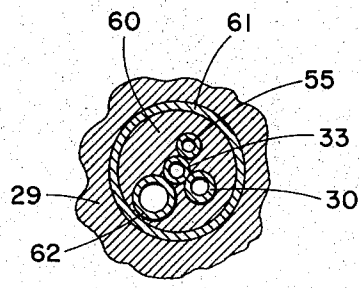

Fig. 2

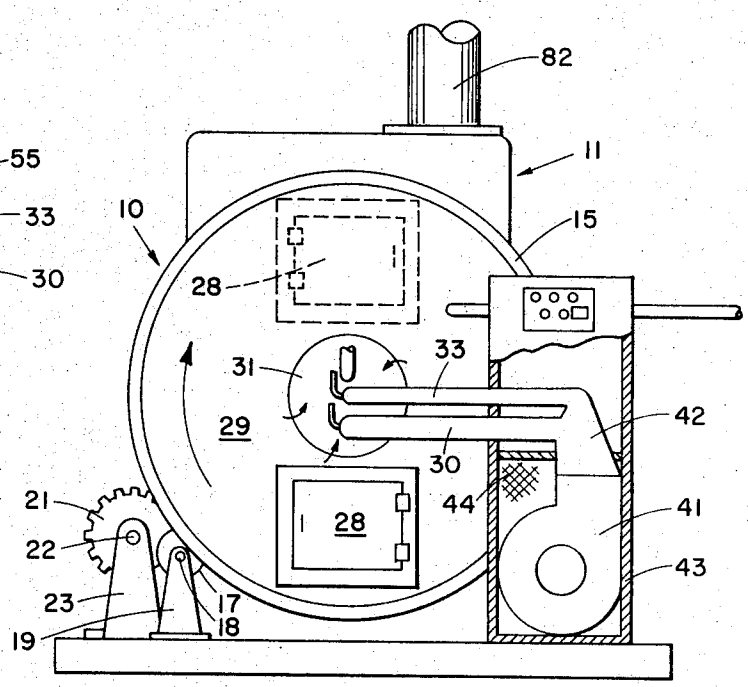

Fig. 3

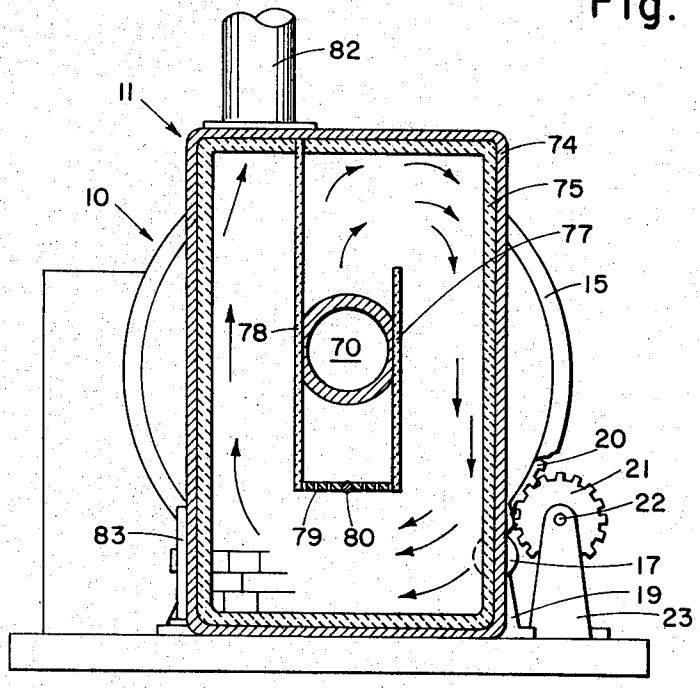

Fig. 4

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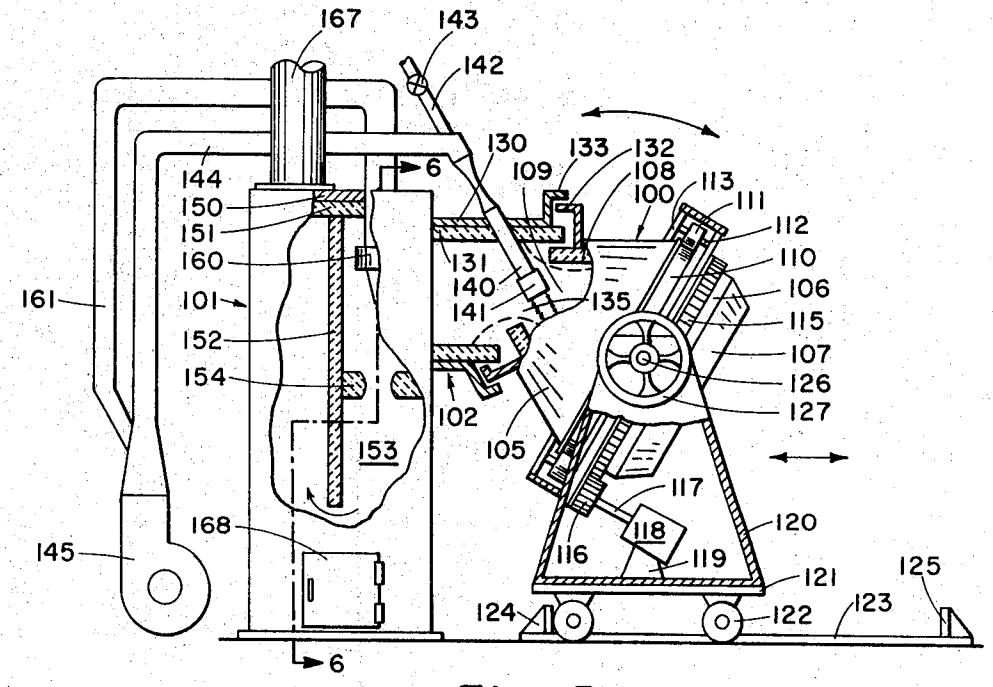

Fig. 5

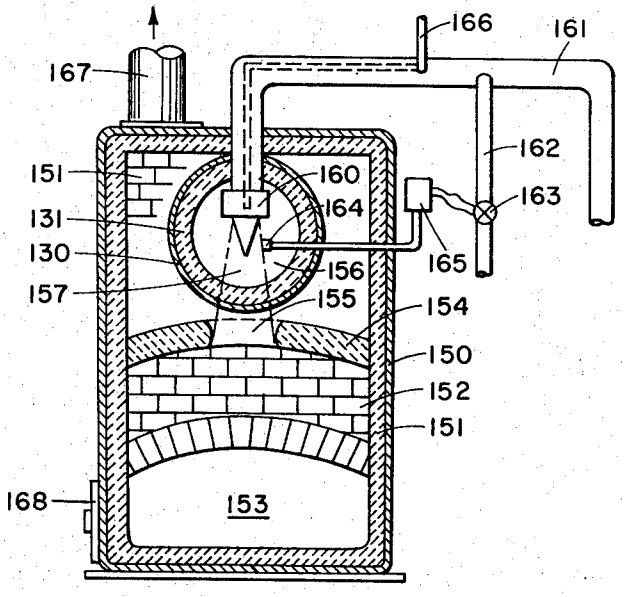

Fig. 6

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INCINERATOR SYSTEM

This invention relates to incinerators and more particularly to relatively small incinerators designed to burn difficultly combustible or fusible materials which may be toxic.

There is a growing need for incinerators capable of burning such materials as waste organic matter, plastics or liquids which tend to clog or deteriorate grates, and materials which may give off combustible toxic or malodorous fumes in burning and decomposition. Examples of such materials include pathological matter, pesticides, toxic organic solids, liquid sludges and ordinary refuse.

Generally, incinerators to burn such materials need not be of the continuously operating type; nor are large quantities involved at any one time. This means that a relatively small capacity incinerator is adequate provided it can handle the material in an efficient and effective manner. The incinerator system of this invention which meets such needs can be characterized as combining agitation of the charge without the use of any grates and means for assuring good mixing of the products of combustion with suitable quantities of air with or without the addition of heat energy from an external source.

It is, therefore, a primary object of this invention to provide a unique type of incinerator system particularly suitable for burning such materials as pathological and organic wastes, plastics or liquid wastes which are normally difficult to burn. It is another object of this invention to provide an apparatus of the character described which can handle materials which become molten when heated and which may give off combustible toxic or malodorous fumes in their burning. It is another object of this invention to provide an incinerator system of the character described which is a relatively small, highly efficient apparatus having a number of applications including the burning of various forms of organic material, plastics, liquid wastes and the like. It is yet another object of this invention to provide a relatively small size incinerator system which combines agitation with the absence of any grates. It is still another object of this invention to provide such an incinerator system which is simple to construct and easy to operate. Other objects of the invention will in part be obvious and will in part be apparent hereinafter.

The invention accordingly comprises the features of construction, combinations of elements and arrangement of parts which will be exemplified in the constructions hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention reference should be had to the following detailed description taken in connection with the accompanying drawings in which:

FIG. 1 is a side elevational view, partly cut away, of one embodiment of an incinerator system constructed in accordance with this invention;

FIG. 2 is a fragmentary cross section of the end of the primary combustion chamber illustrating a modification in the air inlet system;

FIG. 3 is an end view of the incinerator system of FIG. 1 showing the auxiliary equipment housing partially cut away;

FIG. 4 is an end view of the incinerator system of FIG. 1 showing the secondary combustion chamber in cross section;

FIG. 5 is a side elevational view, partly cut away, of a second embodiment of the incinerator system of this invention; and

FIG. 6 is a cross section taken along line 6–6 of FIG. 5.

The incinerator system of this invention comprises a primary combustion chamber and a secondary combustion chamber joined by means which define a venturi throat. Any particulate matter which is not completely combusted in the primary chamber, along with any fumes arising from combustion, are swept by the gas flow in the system into the venturi throat and either at the entrance or exit of the venturi throat additional mixing, combustion and/or heating takes place so that as the materials are circulated in the secondary combustion chamber combustion is essentially completed and the finely divided material may be separated from the gas before it is withdrawn and processed in any desired manner.

One embodiment of an incinerator system constructed in accordance with this invention is illustrated in FIGS. 1—4, and reference should be had to all four of these drawings in the following description of this embodiment. The primary combustion chamber **10** is connected to a secondary combustion chamber **11** by joining member **12**. The primary combustion chamber comprises a rotatable drum **15** which is mounted in any manner known and suitable for rotating kilns. In the embodiment shown in FIG. **1** two tires **16** are mounted on the exterior wall of the drum **15** to be supported by four rollers **17** which rotate on shafts **18** supported by shaft supports **19**. The actual rotation of the drum is accomplished through the use of a driven gear **20** which is affixed to the external wall of the drum **15** and a driving gear **21** which is rotated on shaft **22** supported by shaft support **23** (FIG. **3**). This gear shaft may be rotated by any suitable means (not shown) such as an electric motor. Alternative drive systems, including friction drive, belts and chains, may of course also be employed. Under some conditions it may be desirable to provide means to drive the drum at two different speeds. The more rapid drive is then available for the rapidly turning over of the refuse to stir it up periodically; while the slower drive is available for reducing abrasion of the refractory lining and avoiding or limiting unnecessary raising of the particulate material. A number of ways for providing a two-speed drive are available.

The drum is lined throughout with a suitable refractory lining **25**. The refuse **27** will generally remain within the bottom section of the drum **15**, although in any rapid rotation of the drum the refuse will be carried partly up along the drum sidewalls and dropped by gravity thus achieving the necessary agitation during burning. As pointed out previously, no grates are supplied and, therefore, if the refuse is a material such as plastic which becomes molten upon heating, there is no damage or clogging of grates. Refuse is introduced into the drum **15** through a door **28**, in drum end **29**, which may be brought through rotation of the drum to any suitable position during loading. Hence, as shown in FIG. **2** by the dotted lines, it may be convenient to have the door at the uppermost position for loading and at its lowermost position for withdrawal of burned residue.

A portion of the air for combustion is introduced into the primary combustion chamber through line **30** which extends through central opening **31** in the end wall of the drum and which may be so configured as to cause the air to impinge upon the refuse **27**. A second portion of the air for combustion of the gases and fine particulate material which are "pumped," by virtue of the configuration, into the secondary combustion chamber is delivered through line **33**, which in this embodiment is positioned along the drum axis. Both air lines **30** and **33** have dampers, schematically shown at **34** and **35**, respectively. They both also have means to mix gaseous fuels with the incoming air. Thus fuel line **36** (with valve **37**) and fuel line **38** (with valve **39**) connect air lines **30** and **33** with a main fuel supply line **40**. Air is supplied to inlet lines **30** and **33** by a blower **41** through duct **42**, the blower if desired being located within an auxiliary housing **43** having a screen **44** as part of its walls.

Ignition means **47** and **48** (such as suitable sources of electric sparks) are positioned along the length of inlet lines **30** and **33** to terminate within burner nozzles **49** and **50**. Ignition may be controlled by any suitable means, connections to such control means being represented as connecting wires **51** and **52**.

If at least a portion of the refuse to be burned is in the form of a liquid or slurry waste, additional quantities of the refuse may be continuously or periodically introduced into the rotating drum of the primary combustion chamber through liquid inlet conduit **55**, having valve **56**, which passes through opening **31** and which may be connected to a pump **57**.

Finally, a third portion of air is introduced through opening **31** or by means of an alternative arrangement illustrated in the fragmentary cross section through drum end **29** of FIG. **2** in which like numbers refer to like components of FIG. **1**. In FIG.

2, the opening 31 is replaced by packing 60 and an air seal ring 61 which permits rotation of the drum. The lines 30, 33 and 55 extend through this packing as does a fourth air line 62 adapted to bring in additional air.

In either arrangement it is possible to burn all types of refuse. For example in the case of burning wet sludge, a material impregnated with a flame retardant or a nonsustaining combustible refuse such as a halogenated hydrocarbon plastic it will be necessary continuously to supply external fuel to sustain combustion. This external fuel is supplied in line 30 from fuel line 36 along with air. However, such an arrangement will generally require additional air which is introduced through opening 31 or through air inlet 62 (FIG. 2). In cases where the refuse burns easily and is self-sustaining, then it may be possible to use line 30 (along with line 62 or air passage in opening 31 if desired) to supply only air. However, in either case, it may be necessary to supply auxiliary fuel in line 33 to assure complete burnout of odors and combustibles in the flue gases being carried into the secondary combustion chamber.

It will be seen from FIG. 1 that the joining member 12 connecting the primary combustion chamber 10 and the secondary combustion chamber 11 is so shaped as to define within it a venturi throat 70, which may have a shielded thermocouple 71 affixed to its wall for monitoring or controlling the temperature within the venturi throat. Since it is preferable that the venturi throat and connecting member remain stationary, there is provided a bushing or air seal 72 to permit rotation of the primary combustion chamber around this connecting member 12. The connecting member 12 is affixed to the secondary combustion chamber through an annular ring 73 which is integral with or welded to an opening in the secondary combustion chamber-housing wall 74. The secondary combustion chamber is lined with a refractory lining 75. Within volume 76 defined by the secondary combustion chamber housing 74 there is positioned a baffle system formed, as shown in FIG. 4, of two parallel vertical refractory walls 77 and 78 supported by arches in accordance with known practice. Between these walls 77 and 78 is a tiltable grate 79 rotating about a shaft 80. As will be seen in FIG. 1, the shaft 80 is externally connected to a handle 81 which makes it possible to tilt the grate and dump the ashes into the bottom of the secondary combustion chamber. The flue gases, including any finely divided particulate matter, are discharged from the end of the venturi throat into the secondary combustion chamber, and, as will be seen by the arrows in FIG. 4, the gas follows a tortuous path around the baffle system causing the ashes to separate from the gas before the gas is discharged through exhaust 82. Such a flow path within the secondary combustion chamber also ensures good mixing of air with any residual combustible fumes. It is, of course, within the scope of this invention to connect the exhaust 82 to any further separating means, such as one or more cyclone separators or any other suitable filtering system for removing the finest sized particulate material if this is necessary. Finally, door 83 provides access to the secondary combustion chamber for removing ashes.

In the operation of the incinerator system of FIG. 1, a first portion of the combustion air, with or without gaseous fuel, is introduced and caused to impinge against the surface of the refuse 27 which may either be constantly changed because of the agitation induced by the rotation of the drum or which may be stirred periodically if a two-speed drive is provided for the drum. With the burning of this refuse the fumes and finely divided particulate material 85 are caused to be swept into the venturi throat by the air fuel jet 86 delivered from line 33 through nozzle 50. The nozzle 50 associated with the air fuel line 33 is preferably so positioned in this embodiment that the periphery of the air fuel jet 86 essentially corresponds to the venturi throat diameter. The net result of this configuration in conjunction with the air fuel jet forward velocity is to "pump" the gases and particulate material 85 arising from the burning refuse surface through the connecting member and into the secondary combustion chamber 11. Additional burning of the combustible gases and particulate material will occur during their passage through the venturi throat. The venturi throat configuration is especially valuable in assuring good mixing of air with any combustible material. If desired the burning in the venturi throat may be sensed and automatically controlled through the use of thermocouple 71. Thus if this thermocouple 71 senses a temperature below a predetermined level a suitable signal by way of leads 90, a signal-generating means 91 and lead 92 will be transmitted to valve 39 to inject additional fuel into the line 33 and nozzle 50. Such a control mechanism is well known in the art and it may also, of course, be used to decrease or cut off fuel to line 33 if the temperature in the venturi throat exceeds a predetermined level.

FIGS. 5 and 6 illustrate another embodiment of an incinerator system constructed in accordance with this invention, the primary combustion chamber being indicated by the numeral 100, the secondary combustion chamber by 101 and the joining member by 102. In this modification the burner for completing the combustion of the gases and fine particulate material is located within the secondary combustion chamber and is therefore associated with the exit end of the venturi throat. In the embodiment of FIGS. 5 and 6 the primary combustion chamber may be considered to be formed in three sections: a truncated conical section 105 forming a major part of its structure, a central drum section 106, and a closed short-truncated conical section 107. This particular configuration defines an internal volume in which the refuse is readily agitated by rotation alone.

The entire chamber 100 is lined with a refractory 108 which extends beyond a constricted opening 109 at the discharge (and loading)end. The primary combustion chamber is mounted through the tire 110, which is affixed to the exterior wall of the drum section 106, and rollers 111 which rotate on pins 112 maintained in a pin support frame 113. It will be appreciated that FIG. 5 illustrates but one-type of support system. Other suitable support mechanisms may of course be used.

Rotation of the primary combustion chamber is by means of the driven gear 115 affixed to the external wall of the drum section of the chamber, the driving gear 116, gear shaft 117, and a motor 118 mounted on a support 119. The support in turn is mounted within a primary combustion chamber support frame 120 which may be set on a movable support 121 mounted on wheels 122, designed to move along a track 123 between a forward stop 124 and a back stop 125. The primary combustion chamber is also supported by shafts 126 which are so mounted that the primary combustion chamber may be tilted back and forth through the turning of a wheel 127 as indicated by the arrows. Thus there is provided the opportunity of disengaging the primary combustion chamber from the secondary combustion chamber rolling it backwards and tipping it to remove any ashes and to reload another charge.

The connecting member comprises a cylindrical housing 130 with a refractory lining 131. A seal which need not be airtight is provided between the rotating primary combustion chamber 100 and the connecting member 102 in the form of a labyrinth arrangement comprising a seal member 132 affixed to the rotating chamber and the other seal member 133 affixed to or integral with the joining member housing. This arrangement forms in effect a portion of a venturi throat means 135, the confines of which are indicated by the dotted lines.

air inlet line 140 is so positioned as to direct the air (with or without fuel mixed in) downwardly to impinge on the refuse contained within the primary combustion chamber. In this position it may also help to burn some of the fine particulate matter and gases being withdrawn through the venturi throat into the secondary combustion chamber. The air supply line 140 may be equipped with a nozzle 141 which permits the control of the amount of air injected into the system and effects final mixing of any fuel with the air. Fuel line 142, having valve 143, is provided to communicate with air supply line 140 to bring in any fuel desired. Air is supplied to the air inlet line 140 through line 144 which is connected by suitable ducting

to a fan **145**. Suitable ignition means (not shown) are provided as in the apparatus of FIG. **1**.

The secondary combustion chamber **101** comprises a stationary housing **150** having a refractory lining **151** and a refractory wall **152** forming within the chamber an extended gas passage **153**. Affixed to refractory wall **152** is a refractory arch dividing member **154** and opening **155** are positioned below and in an axial alignment with the center of the exit **156** of the venturi **135**.

The final burning of any combustible gases and of any fine particulate material suspended therein is accomplished at the exit end **156** of the venturi throat where they enter the secondary combustion chamber. This necessitates the placing of a burner **160** near the venturi throat exit **156** (FIG. **6**) to in effect provide another portion of venturi throat means **157** within the secondary combustion chamber to "pump" and mix the gases entering the secondary combustion chamber. Air is brought in through conduit **161** which may be connected to fan **145**. Gaseous fuel is introduced through line **162** having valve **163** which may be automatically controlled through signals generated by thermocouple **164** and signal generating means **165** in the same manner as described for the apparatus of FIG. **1**. Ignition means **166** are also provided. Gas is withdrawn from the secondary combustion chamber through stack **167** and residual ashes through door **168**.

The operation of the incinerator assembly of FIGS. **5** and **6** is essentially the same as that of the apparatus of FIGS. **1—4**, except that the gases and suspended fine material are pulled through the connecting member **102** by virtue of the location of the burner **166** with relation to the venturi throat **157**. The results are, however, the same.

The incinerator systems of this invention are particularly suitable for burning relatively small lots of material or liquid wastes fed at a moderate rate. As an example, the incinerator system of FIGS. **1** through **4** is particularly adaptable to handling about 100 to 250 pounds an hour; while the incinerator system of FIGS. **5** and **6** is capable of handling from about 50 to 150 pounds per hour.

It will thus be seen that the objects set forth above among those made apparent from the preceding description are efficiently attained and, since certain changes may be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. An incinerator system, comprising in combination:
   a. a rotatable primary combustion chamber;
   b. means to rotate said primary combustion chamber;
   c. means to introduce air into said primary combustion chamber during its rotation;
   d. a stationary secondary combustion chamber adapted to effect separation of at least a portion of any fine particulate material from the gas carrying it prior to discharge of said gas from said secondary combustion chamber, and to assure complete burnout of combustible materials in the flue gas stream;
   e. connecting means joining said primary and secondary combustion chambers;
   f. venturi throat means associated with said connecting means and adapted to effect transfer of gas and said particulate material from said primary combustion chamber to said secondary combustion chamber; and
   g. burner means associated with said venturi throat means and having controllable air and fuel supply means.

2. An incinerator system in accordance with claim **1** wherein said primary combustion chamber is a drum and said connecting means and said venturi throat means are one component.

3. An incinerator system in accordance with claim **1** wherein said primary combustion chamber has a truncated conical section of a configuration such that in conjunction with said connecting means it serves as one part of said venturi throat means and wherein said burner means is located within said secondary combustion chamber in such relationship with the exit of said connecting member as to provide the other part of said venturi throat means.

4. An incinerator system in accordance with claim **1** wherein said means to rotate said primary combustion chamber provides at least two different speeds of rotation.

5. An incinerator system in accordance with claim **1** wherein said means to introduce air into said primary combustion chamber is adapted to direct said air against the waste being burned in said primary combustion chamber.

6. An incinerator system in accordance with claim **1** wherein means are provided to introduce fuel into and mix it with said air introduced into said primary combustion chamber.

7. An incinerator system in accordance with claim **1** including means to introduce auxiliary air into said primary combustion chamber.

8. An incinerator system in accordance with claim **1** including means adapted for introducing additional wastes into said primary combustion chamber during rotation.

9. An incinerator system in accordance with claim **1** wherein said secondary combustion chamber has baffle means positioned internally.

10. An incinerator system in accordance with claim **1** including temperature-measuring means located within said venturi throat means.

11. An incinerator system in accordance with claim **10** wherein said temperature-measuring means are adapted to generate a signal which is a function of the temperature obtaining within said venturi throat means and wherein means are provided to transmit said signal to said controllable air and fuel supply means.