

[54] INCINERATOR

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110/18 R, 18 C

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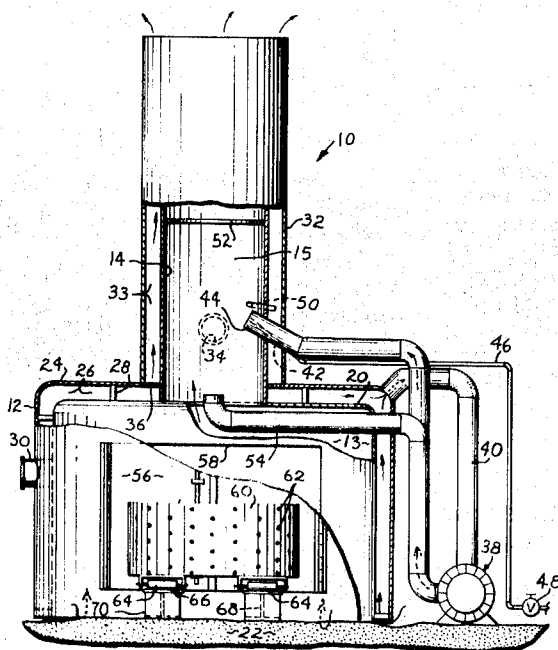
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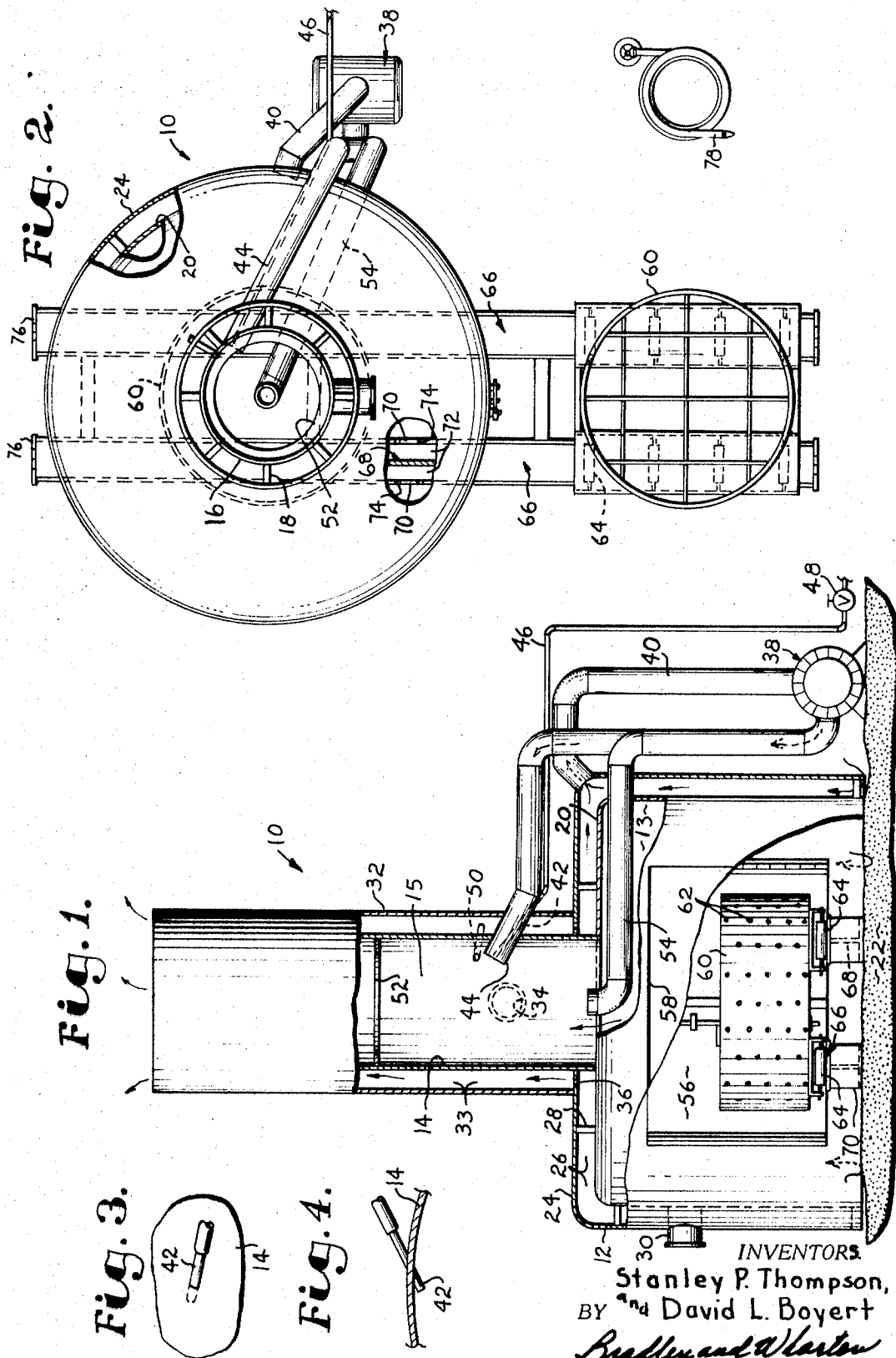
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ABSTRACT

An incinerator for combustible materials utilizes direct heating distillation to convert the material to a gaseous state after which the gaseous material is directed upwardly past a heat source which functions as an after-burner. A first chamber receives the combustible material while a second chamber disposed above the first chamber houses the heat source. The heat source raises the temperature in the first chamber to achieve conversion of the material to a gaseous state either by partial combustion or vaporization. An aspirator tube located immediately beneath the heat source creates an area of negative pressure which draws the gaseous material upwardly into the second chamber. In the second chamber essentially complete combustion of the gaseous material takes place. The first chamber has an open bottom and is movable vertically upon the pressure within the first chamber exceeding the design maximum. This minimizes any danger of damage from explosion by allowing any excess pressure to be relieved through the open bottom. The combustible material is contained by a basket in the first chamber which basket is mounted on rollers and is movable along a track to and from the interior of the chamber.

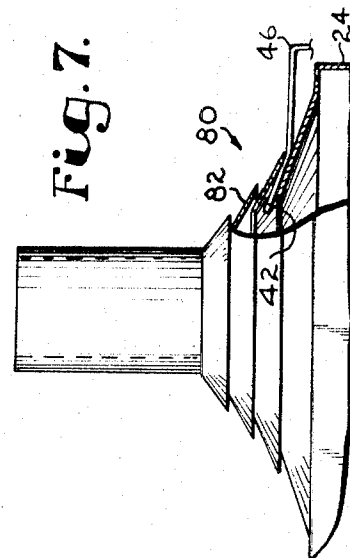
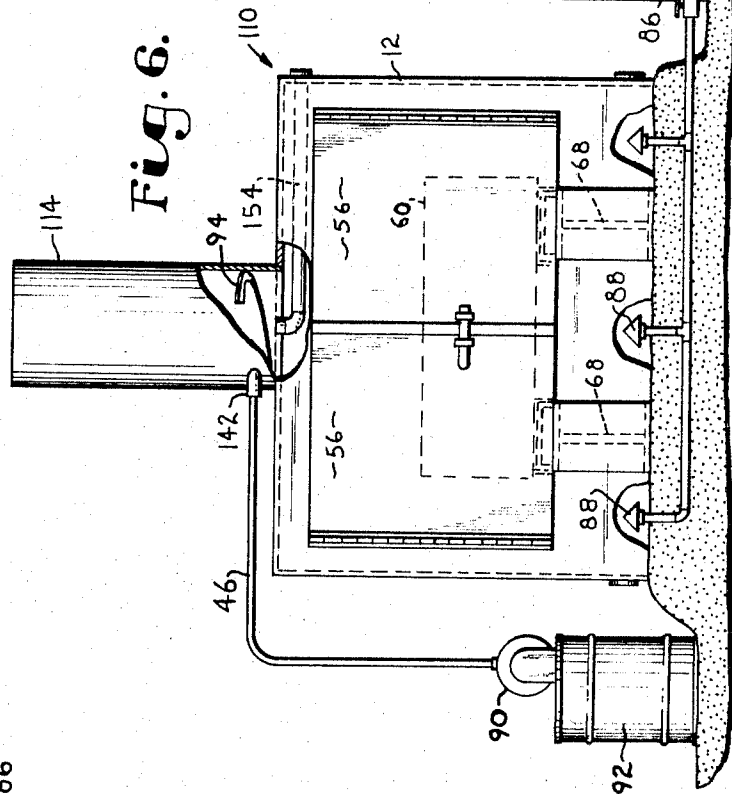
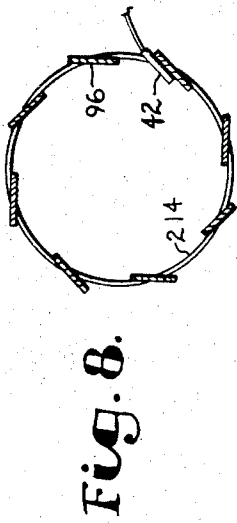
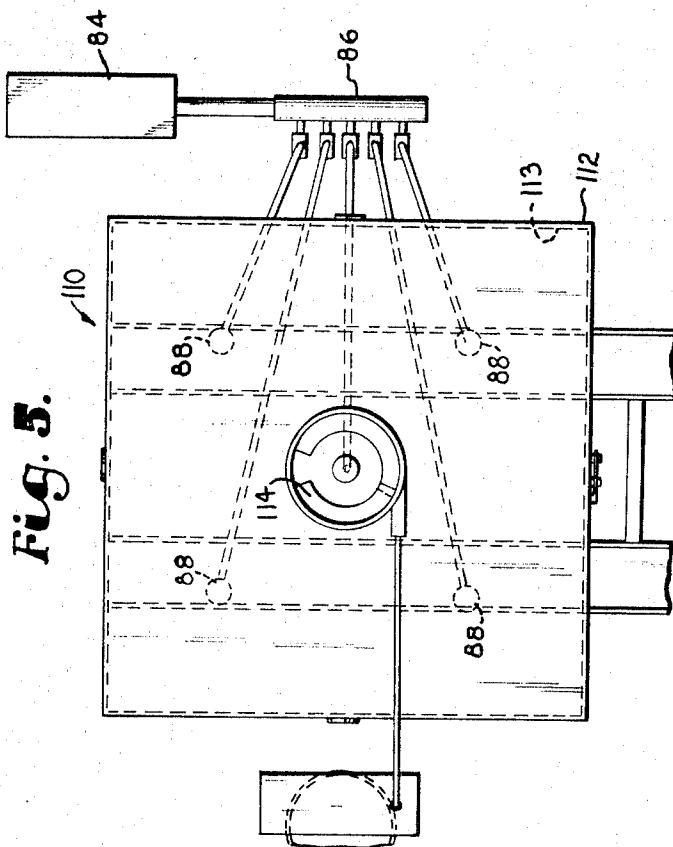
14 Claims, 8 Drawing Figures





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INCINERATOR

This invention relates to combustion apparatus and, more particularly, to an incinerator which utilizes direct distillation and an afterburner to minimize air pollution while also minimizing fuel consumption. In many industrial and business installations, it is necessary to utilize an incinerator to burn combustible waste materials. To meet the requirements of modern-day air pollution control regulations, it is often necessary to install an afterburner in an incinerator to achieve complete combustion and thereby avoid the emission of harmful contaminants into the air. While the use of afterburners is desirable from the standpoint of pollution control, the resulting increase in fuel consumption from an additional burner results in substantial increases in operating expenses.

It is therefore an object of the present invention to achieve complete combustion of a combustible material through the use of a single heating means which functions both as the primary heat source and as the afterburner, thereby substantially reducing fuel consumption.

An aim of this invention is also to provide for a combustion apparatus which utilizes the heat of combustion in what would ordinarily be the afterburner area to convert the combustible material to a gaseous state so that the combustion process will be at least partially self-sustaining thus minimizing fuel consumption by the single heating source.

Another problem with incinerators generally has been the need for either extremely heavy construction or expensive safety equipment to protect the apparatus in the event of an explosion in the combustion chamber. The only alternative to the expensive incinerators heretofore has been to build lighter, less expensive apparatus and restrict its use to materials which are known to be nonexplosive.

It is therefore an important object of this invention to provide for an incinerator which is constructed with an open bottom and the incinerator is movable vertically when the internal pressure exceeds the design maximum to thereby relieve the pressure through the bottom thus minimizing the danger of damage from an explosion without restricting use of the incinerator and without the need for expensive safety equipment.

In certain types of incinerator installations where recovery of one material is to be achieved simultaneously with destruction of another material, it is necessary to employ accurate control means to insure nondestruction of the one material. This has heretofore been achieved only by an indirect distillation process where indirect heat is applied to the aggregate material to convert the destructible material to a gaseous state after which combustion of the gaseous material is accomplished through use of an afterburner. This is a costly process in both the equipment required and the operating expense.

A further important objective of this invention is, therefore, to provide an incinerator where direct distillation takes place without damage to the material which is to be recovered and the destructible material is burned by the same heat source which is used to achieve distillation.

As a corollary to the above object, an aim of this invention is to provide an incinerator which, because of the variable capacity of the heat source, can be adapted to incinerate materials which are from 90 percent re-

coverable and 10 percent destructible to materials which are as much as 50 percent destructible.

This invention also has as one of its objectives the provision of an incinerator wherein a single blower fan achieves cooling of the incinerator, provides for an up-draft through the incinerator, and supplies the fuel burner with a source of air thus minimizing the moving parts required in the incinerator construction.

Other objects of the invention will be made clear or become apparent from the following description and claims.

In the drawings:

FIG. 1 is a side elevational view, with portions broken away, of the incinerator of the present invention, the incinerator basket being shown on the outside of the lower chamber;

FIG. 2 is a top plan view of the incinerator shown in FIG. 1, again with portions broken away;

FIG. 3 is a fragmentary detailed view of the fuel burner taken from the outside of the uppermost chamber of the incinerator;

FIG. 4 is a fragmentary horizontal cross-sectional view looking down on the fuel burner which is shown in FIG. 3;

FIG. 5 is a top plan view of an alternative form of the invention wherein air is introduced into the lower incinerator chamber;

FIG. 6 is a side elevational view with portions broken away, of the incinerator shown in FIG. 5;

FIG. 7 is a side elevational view with portions broken away of an alternative form of the upper chamber of the incinerator; and

FIG. 8 is a top plan view of another alternative form of the invention wherein the upper chamber of the incinerator includes a baffle arrangement which can be employed to facilitate movement of air.

Referring initially to FIGS. 1 and 2 wherein the combustion apparatus of the present invention is designated generally by the numeral 10 it is seen that the apparatus comprises a first preferably cylindrical member 12 which presents a lower chamber 13 and a second preferably cylindrical member 14, rigid with and disposed immediately above the first member, which presents an upper chamber 15. In addition to being rigid with the first member, member 14 is secured to first member 12 by a retaining ring 16 (FIG. 2) and a plurality of gusset braces 18 which have been omitted in FIG. 1 for clarity. The first member 12 has a top 20 which is provided with a central opening for communicating lower chamber 13 with upper chamber 15. It is desirable to have all areas of the apparatus 10 which are subject to heat deterioration lined with a protective layer such as stainless steel. Thus, top 20 and the inner wall of member 14 are normally so lined. The first member 12 has an open bottom and is preferably disposed on an irregular surface 22 of an energy absorbing material such as sand with a sufficient clearance between the bottom edge of the walls of the member and the surface 22 to permit the passage of air into the lower chamber.

A shroud 24 is disposed in spaced relationship to and completely surrounds the member 12 to define an air passage 26 between the member and the shroud. The shroud is held in place by a plurality of spacers 28 which are positioned around the outside of member 12. At the left side of member 12 as viewed in FIG. 1, a tubular structure 30 extends through the shroud 24 and provides an observation port into lower chamber 13. A

cylindrical jacket 32 surrounds the member 14 in equispaced relationship and defines an air passage 33 on the outside of the member. An observation port 34 also extends through member 14 and jacket 32 to allow visual observation of the upper chamber 15 from the outside of the apparatus. Air passage 33 is in communication with air passage 26 by virtue of a plurality of openings 36 in the shroud 24. During operation of the apparatus, heat from the upper chamber 15 will produce convection currents causing an upward flow of air in passage 33 as indicated by the arrows in FIG. 1. Air is drawn through passage 26 to cool shroud 24 by a blower fan 38, the intake of which is coupled with the passage by a conduit 40.

The single heat source for the apparatus 10 is a burner 42 which may be of the jet type disposed in the upper chamber 15. Burner 42 extends through jacket 32 and member 14 at an angle so that the burner is inclined upwardly relative to the lower chamber. It is desirable to position burner 42 at an angle of between 0° and 45° relative to a horizontal plane passing through the uppermost point of the burner as best illustrated in FIG. 3. An angle of approximately 21° is preferable in most instances. It is also desirable that the burner jet extend into the interior of chamber 15 so that the end of the burner is in spaced relationship to member 14 as best illustrated in FIG. 4. Immediately adjacent the burner 42 is an air tube 44 which is disposed at a similar angle relative to the horizontal and communicates with the output of the fan 38 to supply burner 42 with an adequate amount of air for combustion purposes. Burner 42 is coupled with a fuel line 46 having a shutoff valve 48 located adjacent the apparatus 10. Various types of fuel can be utilized with the apparatus 10 including fuel oil, natural gas, and liquid petroleum gases. A suitable ignitor 50 which can take various forms depending upon the fuel and readily apparent to those skilled in the art is disposed immediately above burner 42. Spaced above the burner is an annular frame retaining ring 52 which is contiguous with the member 14. This ring facilitates deflection of the combustion flame downwardly toward lower chamber 13 to facilitate heating of the latter. In certain instances it may be desirable to replace ring 52 with a plurality of baffles or fingers disposed in spaced relationship around the interior of member 14.

An upward draft from lower chamber 13 to upper chamber 15 is created by an aspirator tube 54 positioned below burner 42 at the juncture between the upper and lower chambers. Aspirator tube 54 is also coupled with the output of fan 38 to receive a positive flow of air which results in a negative pressure at the top of the lower chamber immediately beneath the outlet of the aspirator tube. This upward draft moves gaseous materials from the lower chamber upwardly past the burner in the second chamber where relatively complete combustion of the gases takes place.

Access to lower chamber 13 is obtained through a pair of hinged doors 56 in the side of shroud 24 and an access opening 58 immediately behind the doors in member 12. A basket 60 for containing a combustible material is shown in FIG. 1 immediately in front of doors 56. Basket 60 is provided with a plurality of openings 62 therein to allow the passage of air up through the combustible material. The basket is mounted on a plurality of rollers 64 which can be moved along a pair of rails 66 that define a track ex-

tending into chamber 13. The track is located immediately beneath doors 56 and opening 58. Each of the rails 66 may be presented by an I-beam 68 having a plate 70 welded or otherwise rigidly secured to each side thereof to define a pair of air passages 72 (FIG. 2) on either side of the central web of the I-beam. A plurality of openings 74 in plates 70 permit the passage of air into lower chamber 13. The flow of air through passages 72 is controlled by a pair of dampers 76 positioned in the ends of each of the rails 66.

As illustrated in FIG. 2, it is desirable to have a source of water and a fire hose 78 located adjacent the apparatus 10 to terminate operation of the incinerator when this is desired.

Although the second member 14 may be constructed as indicated in FIGS. 1 and 2, in the preferred form of the invention the second member also includes a frustoconical section designated generally by the numeral 80 (FIG. 7) intermediate jacket 32 and shroud 24. The frustoconical section is comprised of a plurality of non-aligned, annular, frustoconical elements 82 which are disposed in spaced relationship to allow for the passage of air between the respective elements. It is to be noted that each of the elements 82 is disposed at a slightly different angle relative to the horizontal to achieve optimum movement of air upwardly while deflecting heat from the second chamber downwardly into the first chamber. In this preferred form of the invention, it is also to be noted that burner 42 is disposed in the frustoconical section 80 between two adjacent elements 82.

In operation, a combustible material is loaded into basket 60 when the latter is positioned on the outside of member 12 as illustrated in FIG. 1. The apparatus 10 is particularly adapted for combustion with recoverable metals. For example, discarded wiring may comprise from 10% to 50% (by weight) of a phenolic resin insulative covering and from 90% to 50% recoverable metal. It is important in the recovery of any metal that care be taken not to damage the metal by the application of intense heat and direct flame. Thus, when apparatus 10 is utilized to recover such metals as copper and aluminum, it is desirable to maintain the temperature in lower chamber 13 below approximately 1000° F. to avoid damage to the metal. When basket 60 is properly loaded it is rolled along rails 66 into lower chamber 13 and doors 56 are secured. Ignitor 50 is utilized to start burner 42 and the heat from burner 42 raises the temperature in the first chamber to achieve conversion of the combustible material to a gaseous state. It is to be understood that the phrase "gaseous state" as used in this application is intended to refer to both the products of vaporization and partial combustion of the material in the first chamber. Depending upon the material, in some instances it will be vaporized by the heat from the burner 42 and in other cases there will be an initial relatively incomplete combustion in lower chamber 13. With still other materials it may be found that both vaporization and partial combustion occur in lower chamber 13. Generally, a thin film of flame can be observed where the gases from the lower chamber meet the air introduced into the upper chamber. In any event, the negative pressure created by aerator 54 will carry the gaseous material upwardly for relatively complete combustion in the second chamber by burner 42. Particularly when frusto-conical section 80 is employed a substantial amount of the heat of combustion from

upper chamber 15 is deflected down to increase the temperature in lower chamber 13. This reduces the quantity of heat which must be produced by burner 42, thereby minimizing fuel consumption. In fact, with certain materials it may be found that the heat of combustion in the upper chamber is sufficient to maintain the process without continued operation of burner 42.

In certain instances, it may also be desirable to place a sheet of a nondestructible metal such as stainless steel over basket 60 to further distribute the heat and increase the degree of control over the combustion process. Care should generally be taken to accurately control the negative pressure created by aeration tube 54 so as not to overload burner 42. It has been found that air passing through the tube 54 under a pressure sufficient to support a column of water 40 inches high is adequate to create the desired negative pressure. While members 12 and 14 can assume different forms it is preferred that they be generally cylindrical to facilitate air movement within chambers 13 and 15. Optimum results are obtained when the cross-sectional area of the upper chamber is from one-seventh to one-twelfth the cross-sectional area of the lower chamber.

As previously mentioned, in the event that the pressure within chamber 13 exceeds the design maximum, the entire apparatus 10 is movable vertically to allow the excess pressure to be relieved through the open bottom of member 12. Thus any danger of explosion damage is substantially minimized without the need for expensive safety equipment.

An alternative form of the invention is illustrated in FIGS. 5 and 6 wherein the apparatus is designated generally by the numeral 110. A lower chamber 113 is presented by a generally rectangular member 112 and an upper chamber 115 is presented by a cylindrical member 114. Although there is no showing in FIGS. 5 and 6 of structure corresponding to shroud 24 and jacket 32 of the preferred form of the invention, it is to be understood that such structure could be included in the apparatus 110 if desired. Apparatus 110 employs an air compressor coupled with a surge tank 86 to provide a source of air which enters lower chamber 113 through a plurality of outlets 88. The outlets 88 are disposed in the lower chamber below basket 60 containing the combustible material. An aspirator tube 154 is disposed at the bottom of upper chamber 115 for facilitating upward movement of gaseous materials from the lower chamber, although it may be found that a sufficient draft is created by air from outlets 88 so that operation of aspirator 154 is not required.

Apparatus 110 is provided with a burner 142 of the type which uses a low grade of fuel oil for heating the apparatus. To this end, burner 142 is coupled with a reservoir 90 and a fuel tank 92 disposed adjacent member 112. At the base of upper chamber 115 a length of spiral flighting 94 directs the flame from burner 142 downward toward the lower chamber.

Apparatus 110 is particularly adapted for use where a relatively large amount of combustion can be tolerated in lower chamber 115. For example, when waste products having a natural plant or animal derivation are being burned apparatus 110 could be employed. Burner 142 when ignited will cause the temperature in the first chamber to be raised sufficiently to institute combustion therein. The gaseous products of this relatively incomplete combustion will rise upwardly under the influence of a draft created by air emanating from

outlets 88, and these gaseous products will undergo further combustion in the second chamber.

Still another alternative form of the invention is illustrated in FIG. 8 of the drawings. A plurality of spaced apart baffles 96 are located in circumscribing relationship around a cylindrical member 214 so as to allow the passage of air therebetween. Member 214 defines the upper chamber 15 of the apparatus, as previously described for the preferred embodiment. Baffles 96 are positioned in the area of burner 42 and its associated air tube 44 (not shown). Baffles 96 serve to increase the swirling motion of the air in the upper chamber thereby increasing the upward draft of gaseous products.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. Apparatus for the combustion of a material capable of conversion to a gaseous state upon the application of heat, said apparatus comprising:

a first lower chamber for receiving the combustible material,

said first lower chamber being free of any source of fuel which would support combustion of the material in the lower chamber;

a second upper chamber disposed above and in communication with said lower chamber and having a horizontal cross-sectional area of between one-seventh and one-twelfth of the corresponding area of the lower chamber;

burner means disposed in said second chamber at an angle of between 0° and 45° relative to the horizontal for raising the temperature in said first lower chamber to achieve conversion of said material to a gaseous state;

deflection structure disposed in said upper chamber for deflecting heat currents from the burner means down into said first chamber; and

means for creating an upward draft in said first chamber to move the gases upwardly into said second chamber and past said burner means whereby complete combustion of the material occurs when the material is in a gaseous state in said second chamber.

2. Apparatus as set forth in claim 1, wherein said first chamber is provided with an open bottom and is movable vertically upon the pressure within the first chamber exceeding the design maximum whereby the excess pressure is relieved through said open bottom.

3. Apparatus as set forth in claim 1, wherein said draft creating means comprises an aspirator tube disposed beneath said burner means and having its outlet directed toward the heating means for creating an area of negative pressure immediately beneath said heating means.

4. Apparatus as set forth in claim 3, wherein is included means for delivering an auxiliary supply of air to the burner means.

5. Apparatus as set forth in claim 1, wherein said second chamber extends above said heating means to provide a stack for delivery of the products of combustion of the gaseous materials to the atmosphere.

6. Apparatus as set forth in claim 1, wherein is included blower means for providing said auxiliary air supply; a shroud in spaced relationship to and surrounding said first chamber; and means for coupling the area between the shroud and the first chamber to the intake of said blower means whereby air is circu-

lated around said first chamber to cool the latter when the blower means is in operation.

7. Apparatus as set forth in claim 6, wherein said aspirator tube is coupled with the output of said blower means for creating said area of negative pressure.

8. Apparatus as set forth in claim 7, wherein is included a basket movable to and from said first chamber for holding said combustible material in the first chamber.

9. Apparatus as set forth in claim 8, wherein said shroud and said first chamber are provided with an access door to the inside of said first chamber, said basket is provided with a plurality of rollers disposed in supporting relationship thereto; and including a track extending into said first chamber from the outside whereby said basket can be rolled in and out of said first chamber along the track and through said door.

10. Apparatus as set forth in claim 1, wherein said draft creating means comprises means for introducing a flow of air into said first chamber beneath said mate-

rial.

11. Apparatus as set forth in claim 1, wherein said second chamber includes a frustoconical section adjacent said first chamber, and said heating means is disposed in said section.

12. Apparatus as set forth in claim 11, wherein said section provides for the introduction of air into the second chamber in parallel relationship to the sidewalls of said section.

13. Apparatus as set forth in claim 12, wherein said section comprises a plurality of nonaligned frustoconical elements disposed in spaced relationship to allow the passage of air therebetween.

14. Apparatus as set forth in claim 1, wherein said second chamber includes a plurality of baffles disposed therein in spaced relationship to allow the passage of air therebetween, said baffles extending into the interior of said second chamber to promote distribution of air therein.

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