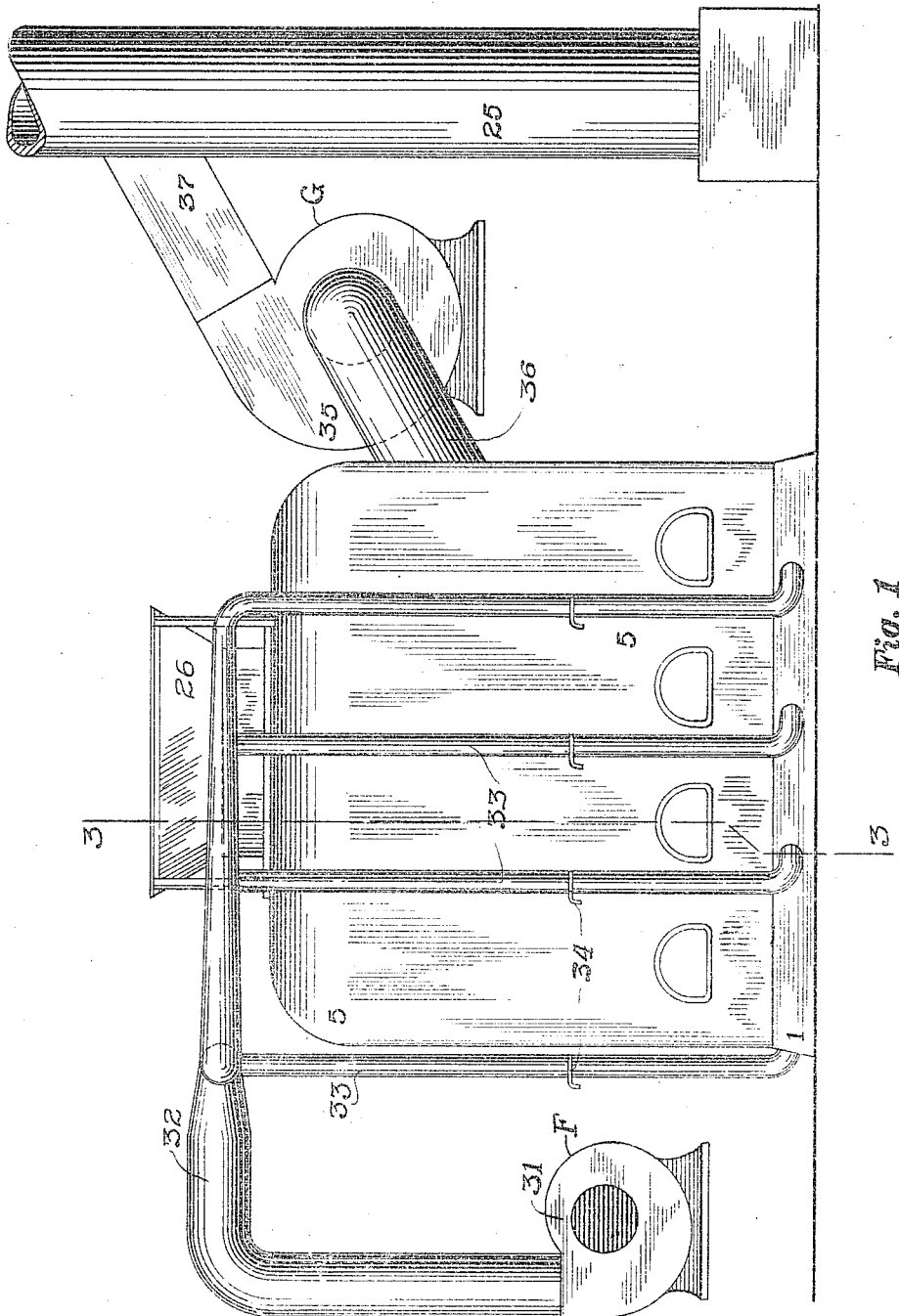


C. A. BYRNE.
GARBAGE INCINERATING AND STEAM GENERATING SYSTEM.
APPLICATION FILED DEC. 27, 1909.

994,636.

Patented June 6, 1911.

8 SHEETS—SHEET 1.



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8 SHEETS—SHEET 2.

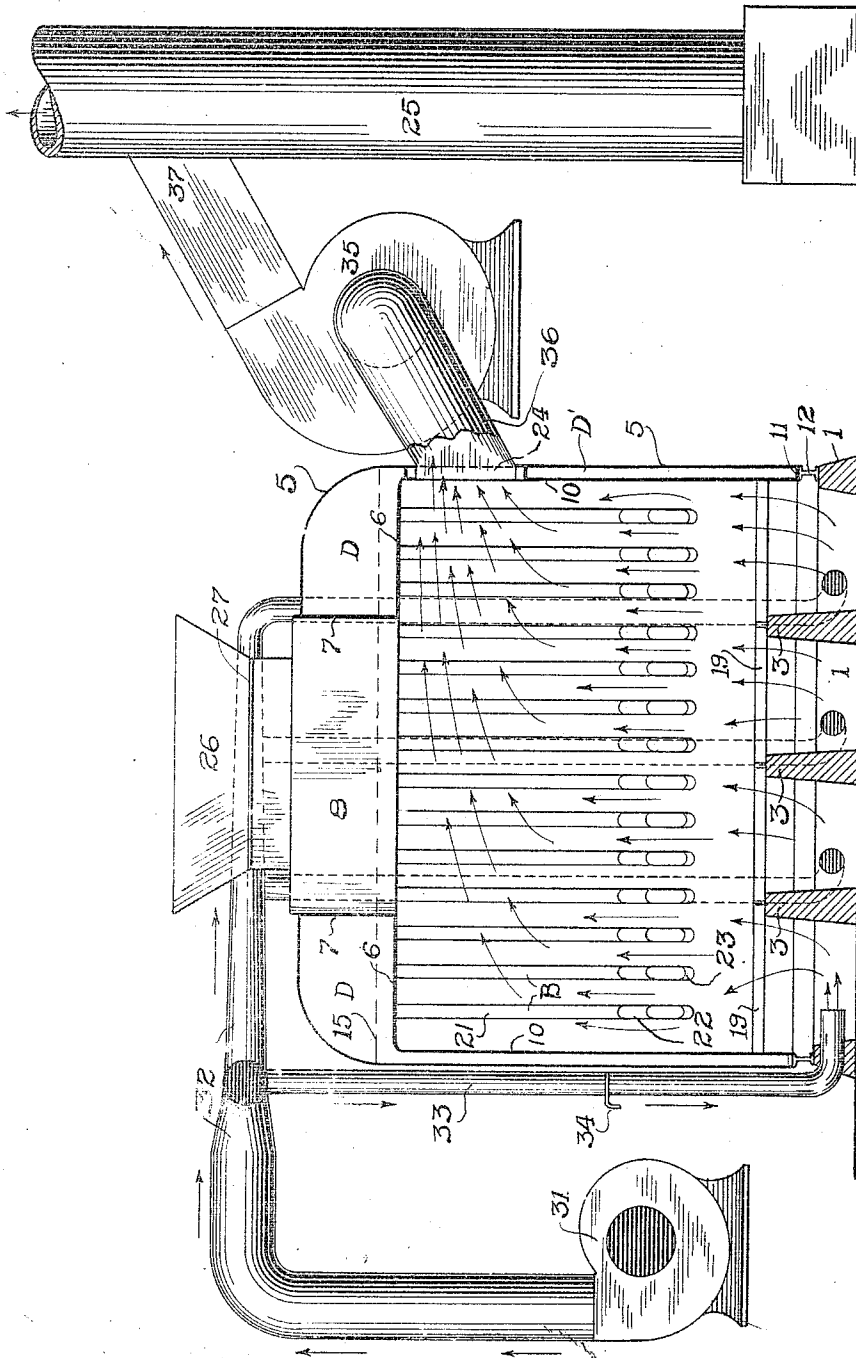


Fig. 2

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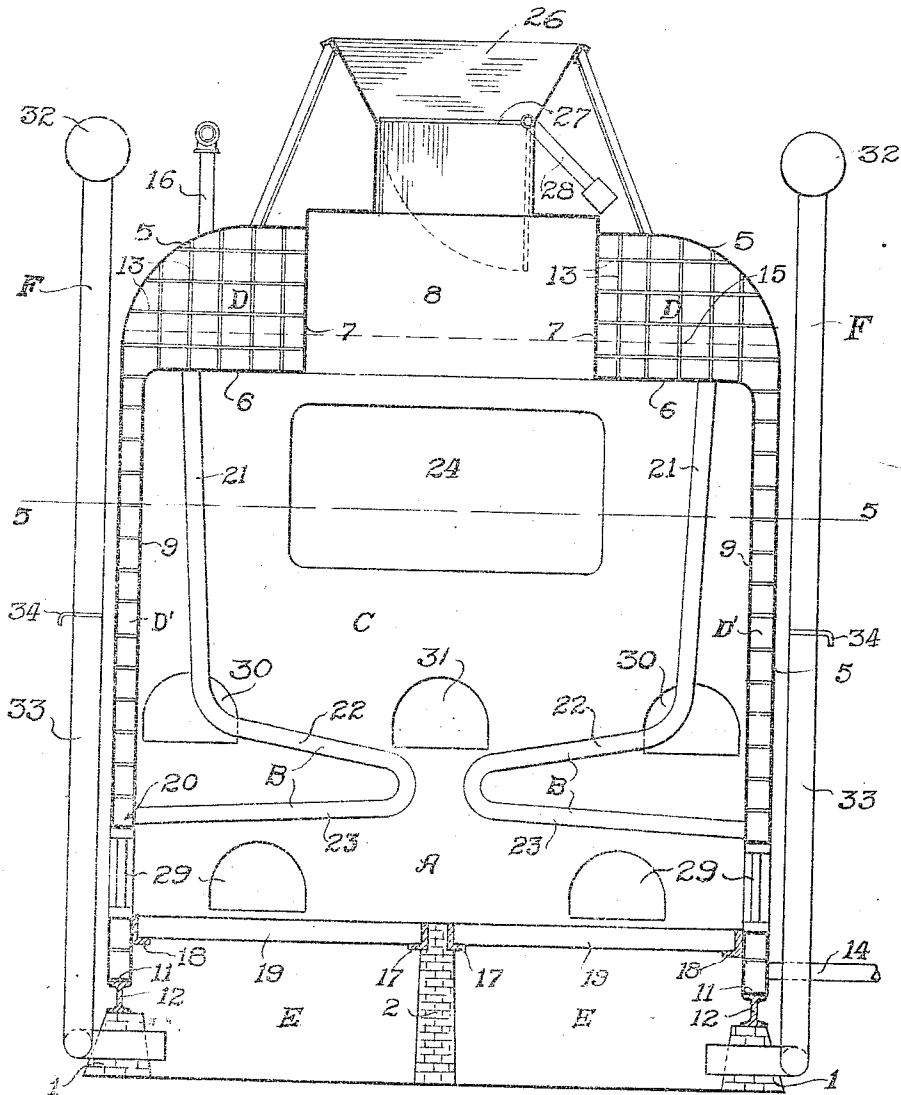
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8 SHEETS—SHEET 3.



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Fig. 3

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8 SHEETS—SHEET 4.

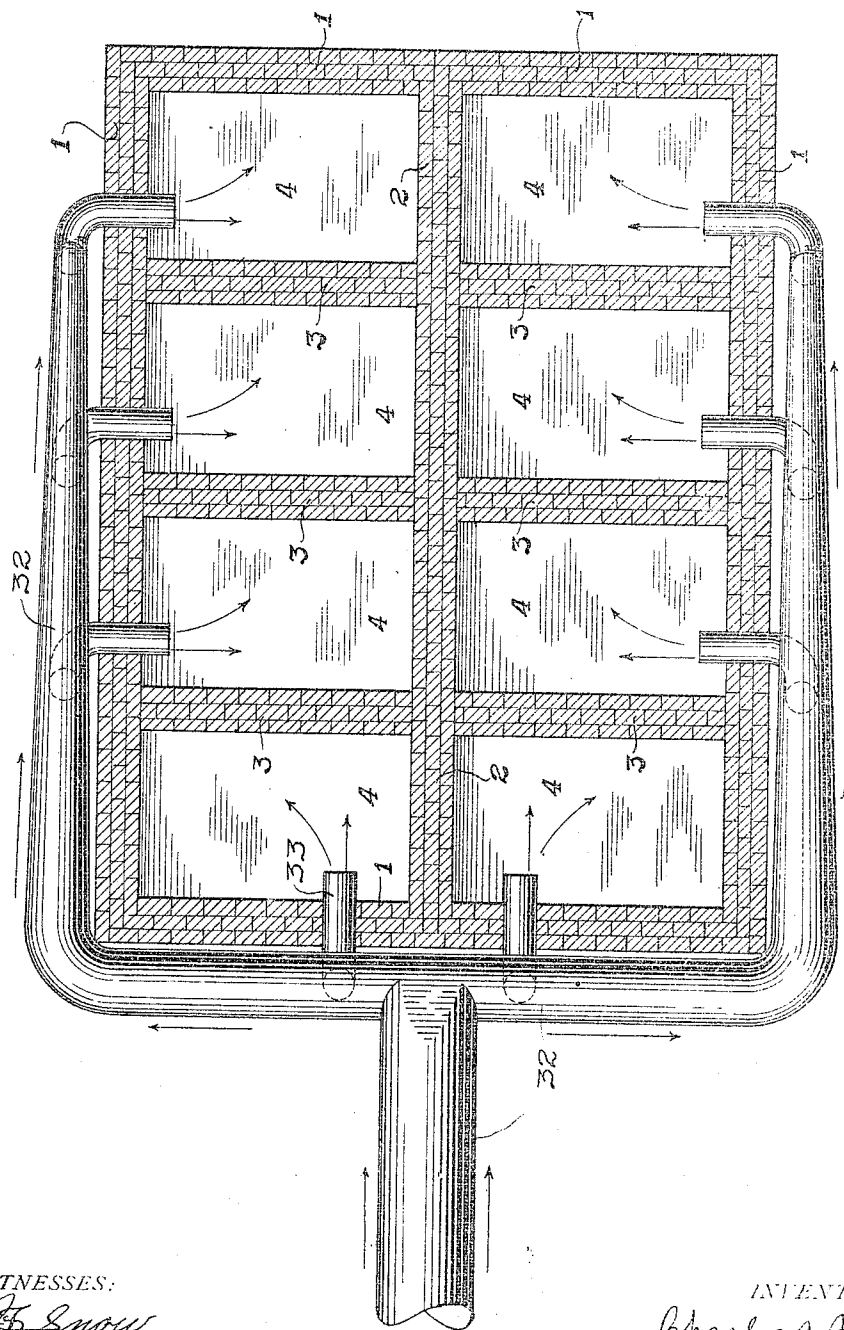


Fig. 4

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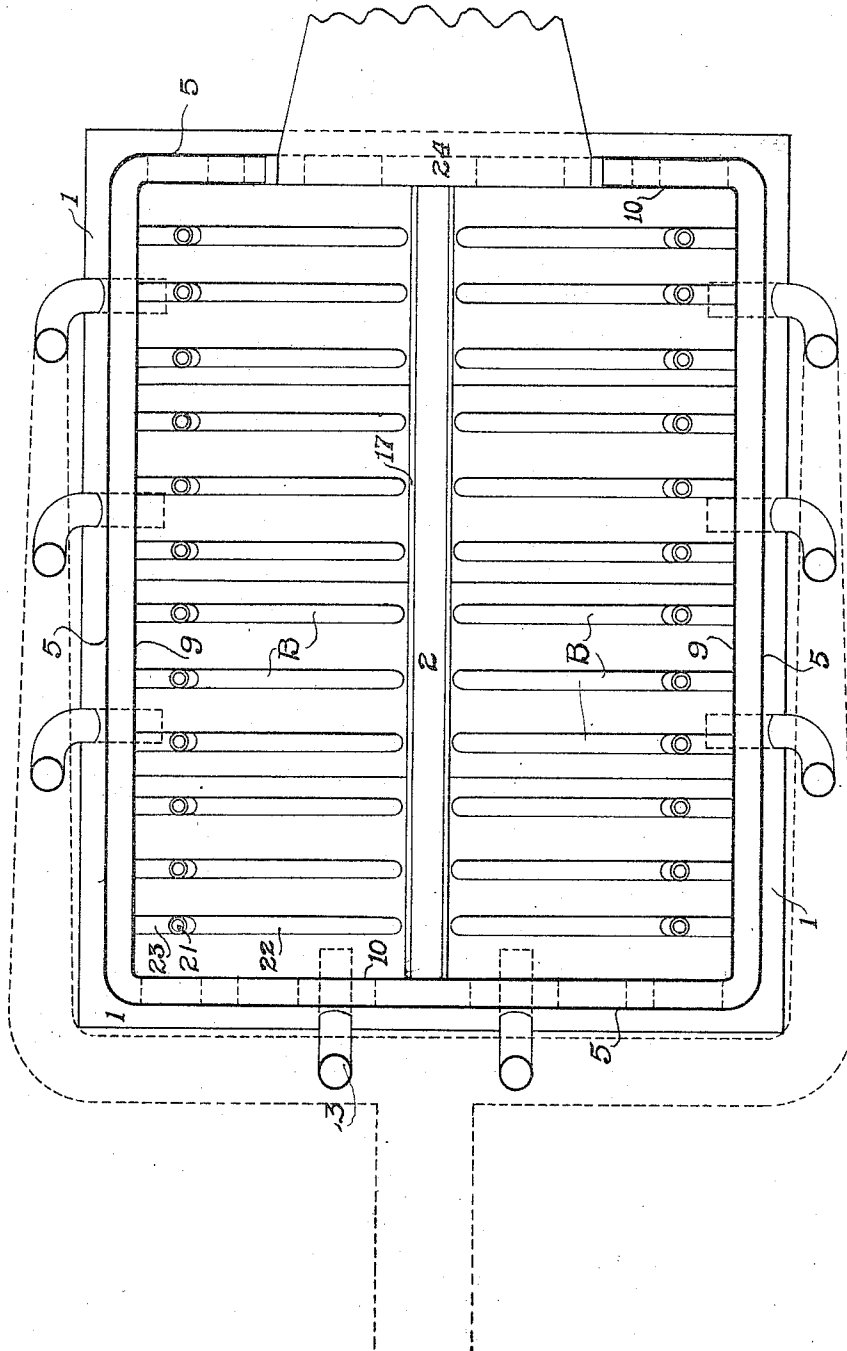
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 GARBAGE INCINERATING AND STEAM GENERATING SYSTEM.
 APPLICATION FILED DEC. 27, 1909.

994,686.

Patented June 6, 1911.

8 SHEETS—SHEET 5.



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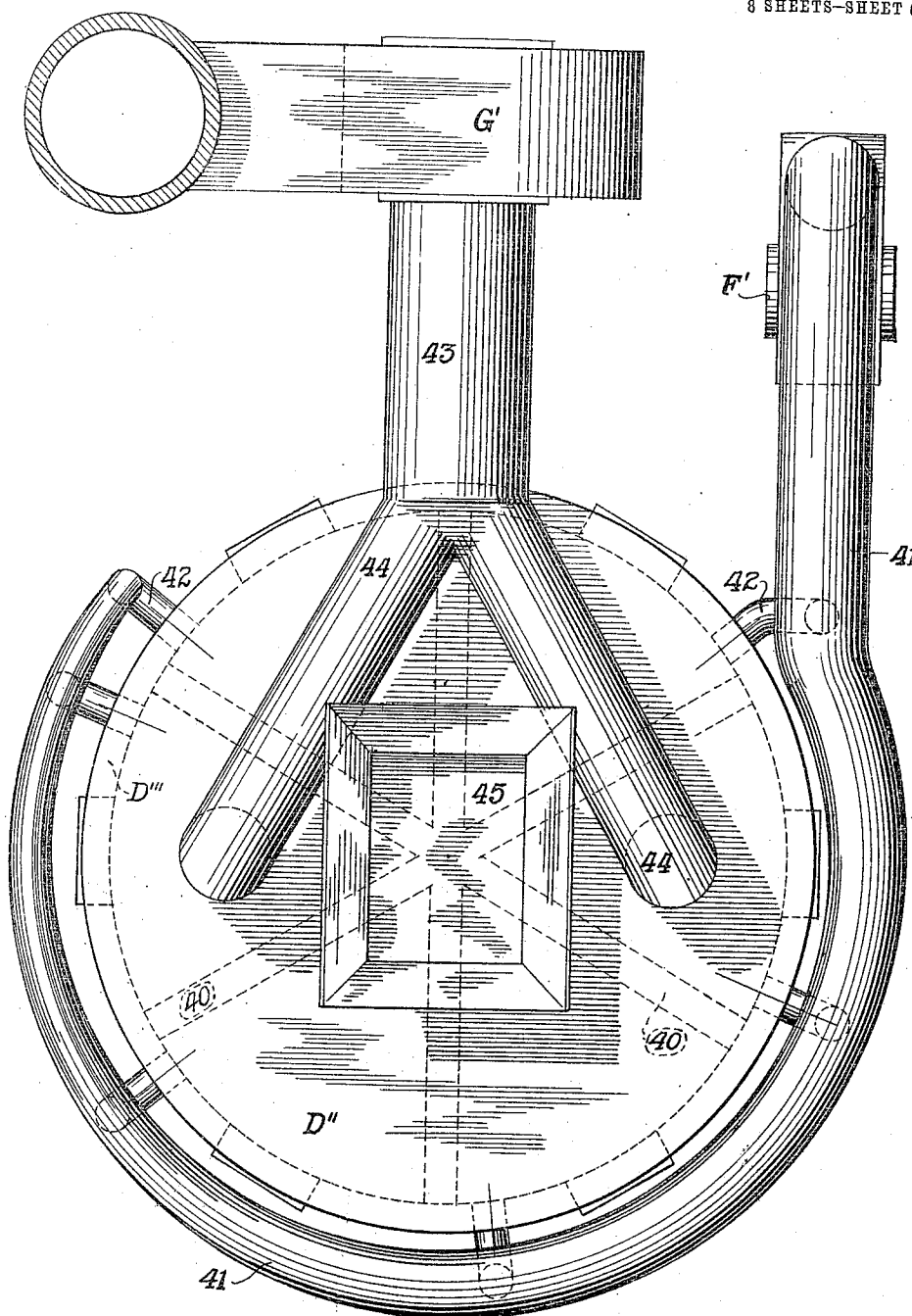
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APPLICATION FILED DEC. 27, 1909.

994,636.

Patented June 6, 1911.

8 SHEETS—SHEET 6.



WITNESSES:

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Fig. 6

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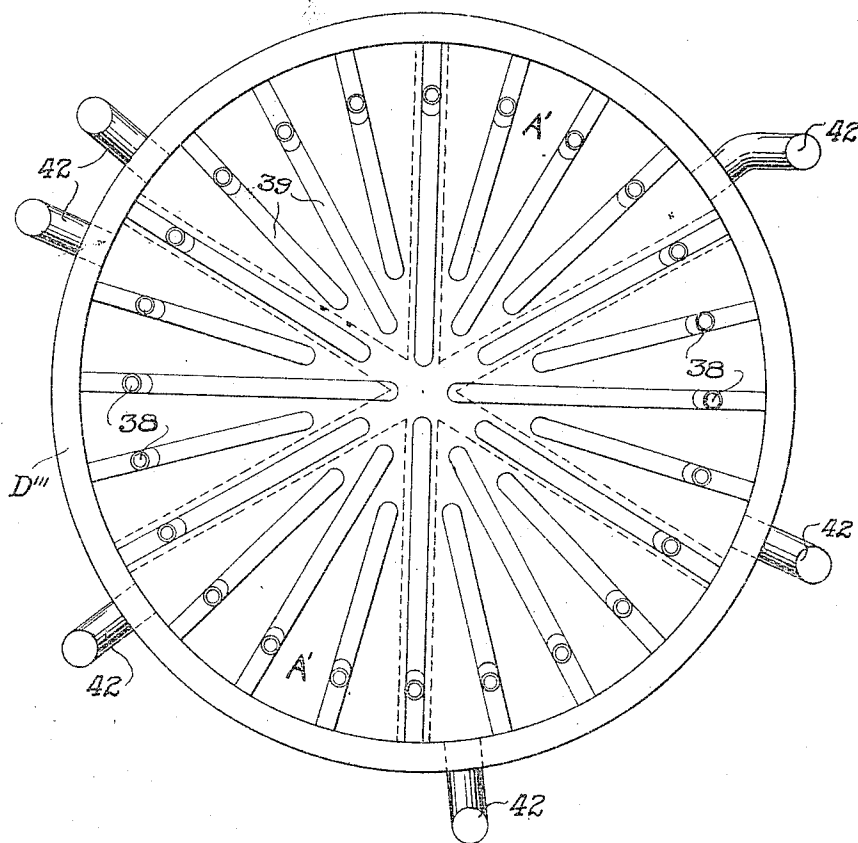


Fig. 7

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GARBAGE INCINERATING AND STEAM GENERATING SYSTEM.
994,636.

APPLICATION FILED DEC. 27, 1909.

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8 SHEETS—SHEET 8.

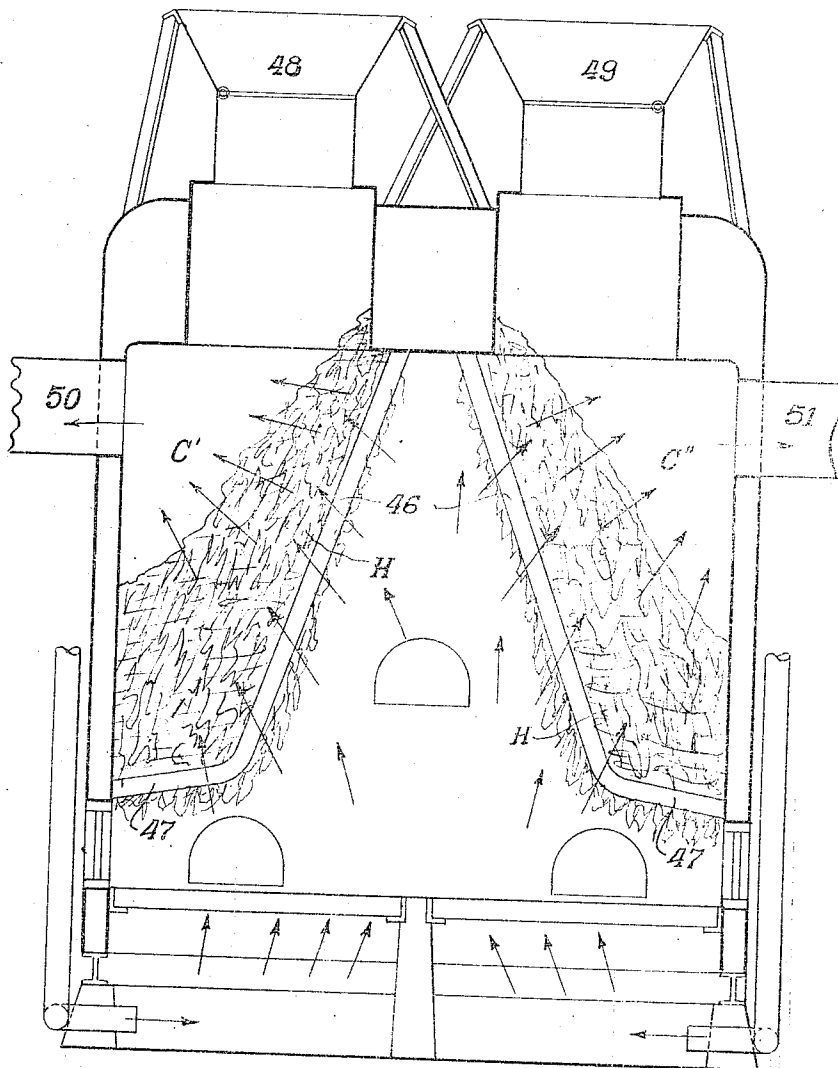


Fig. 8

WITNESSES:

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INVENTOR.

Charles A. Byrne

UNITED STATES PATENT OFFICE.

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FRANK DUNNING, OF OSSEO, MINNESOTA.

GARBAGE-INCINERATING AND STEAM-GENERATING SYSTEM.

991,636.

Specification of Letters Patent.

Patented June 6, 1911.

Application filed December 27, 1909. Serial No. 535,034.

To all whom it may concern:

Be it known that I, CHARLES A. BYRNE, a citizen of the United States, residing at Minneapolis, county of Hennepin, and State of Minnesota, have invented a new and useful Garbage-Incinerating and Steam-Generating System; and I do hereby declare the following to be a full, clear, exact, and concise specification thereof.

My invention relates to the class of furnaces known as incinerators or crematories; however, it is more particularly identified with that class of incinerators which are designed for drying and cremating garbage and other forms of refuse materials delivered thereto in a wet and uncombustible condition, it being also identified with water tube steam generators adapted for coöperation therewith.

In order to consume garbage and other forms of wet materials upon an economical and efficient basis, it is essential that means be provided for suspending same over a suitable fire grate upon which a conflagration is maintained, and by which said garbage is gradually dried and its condition rendered suitable for combustion. Of course it is highly essential that this process should be completed before the material is delivered upon the fire grate, otherwise it would tend to check the conflagration thereon or even extinguish same. It has been the universal practice heretofore to suspend the garbage in a position over the fire grate whereby the heat and gases, liberated from the conflagration thereon, will be directed over the surface of the suspended garbage during its passage to the flue. In this system of incineration, it is found that the heat is enabled to pass out the flue without sufficiently penetrating the garbage to become efficiently absorbed thereby, thus a considerable quantity of auxiliary fuel such as coal, wood, or oil is required to maintain a conflagration. It is also found that this system of incineration effects very incomplete combustion by reason of insufficient drying before its delivery upon the fire grate which also causes it to smolder issuing excessive volumes of dense smoke and obnoxious odors. As this system of incineration is incapable of maintaining continuous combustion from the fuel substance contained in the garbage delivered thereto, it is apparent that it would be impractical for performing the additional function of generating steam.

My invention has for its object to provide an apparatus for incinerating garbage and generating steam by which the defects above referred to are practically overcome.

My invention is more particularly addressed to the provision of an apparatus adapted to operate in accordance with my new method of incinerating garbage, and various forms of wet refuse materials without the continual use of an auxiliary fuel, and provided with special means for generating steam, which means coöperates with the incineration of the garbage and enables the efficiency of the plant to be increased to an extent whereby the generation of steam is accomplished by the utilization of heat, liberated from the conflagration of said material, in excess of the heat required for the drying of all successive material delivered thereto. A divisional application, on the method, was filed May 24, 1910, Serial No. 563,224.

In attaining the object of my invention, I provide an improved apparatus comprising an upper grate and a lower grate inclosed within a suitable water jacket and crowned with a boiler or steam chamber. The lower grate is of an approved type of ordinary fire grate comprising closely spaced members which will allow the ashes and clinkers to fall into the ash pit thereunder. The upper grate comprises a double opposed series of water tube members connected at their upper ends to said boiler and at their lower ends to said water jacket, whereby a continual circulation therein may be effected, their configuration being such that a basket-like storage receptacle is formed upon which garbage may be delivered and suspended above the fire grate for drying in readiness for combustion. The spacing of said water tube members is such that the garbage when dried or partially consumed, will easily pass between said members thus effecting its delivery upon the fire grate; however, they also perform the function of a water tube steam generator as their arrangement over the fire grate enables them to readily absorb heat which generates the water contained therein into steam. The continual upward inclination of the water tubes from their point of connection with the water jacket, to their point of connection with the steam boiler establishes a continual circulation, thus heat absorbed in the lower portions

thereof is transmitted to their upper portions from which said heat is radiated to the garbage resting thereon, thereby increasing the efficiency of the drying process. I provide an outlet flue from which the heated gases pass from the combustion chamber into the stack, and means for supplying the fire grate with fresh air for the maintenance of the conflagration thereon, the arrangement of the garbage receptacle, or upper grate, being such as to cause the garbage stored thereon to be interposed within the course between the fire grate and the outlet flue, whereby the heat and gases arising from the conflagration upon the fire grate will be caused to penetrate and pass through said mass of garbage during its passage to the flue. The condition of garbage usually delivered to devices of this character is generally very wet and of various consistencies causing same to settle in a congealed mass thus rendering a certain resistance to the flow of heated gases therethrough. Thus, in order to set up a sufficient rate of flow of the heated gases through the suspended mass of garbage, to cause a practical rate of air draft for combustion, it is necessary to establish a difference of pressure between the draft openings underneath the fire grate and the flue leading from the receiving chamber. As the heat liberated by the conflagration upon the grate is practically absorbed by the process of drying garbage and the generation of steam, the gases passing into the flue from the combustion chamber contain insufficient heat to create an adequate displacement in the flue and stack to establish the requisite draft through the combustion chamber. By augmenting this force with an artificially induced draft, as a mechanically operated fan, it is still impossible to provide sufficient cubical displacement to create the requisite draft, owing to the lack of density and the expansion of the heated gases thus operated upon. By providing a forced draft of sufficient pressure to create the requisite difference of pressure between the draft openings and flue opening, a density of air known as "back-lash" would be formed in the combustion chamber which would seriously reduce the conflagration upon the fire grates. Thus it is obvious from the foregoing that the only practical method, by which the above result may be obtained, consists in the provision of both a forced draft and induced draft, acting in cooperative relation; of which said induced draft, operating on heated air and gases which are of highly expansive elasticity, would have a capacity relation of about four times the cubical displacement of the forced draft, which operates upon cold air, the expansion elasticity of which is comparatively small. Said relation of capacity is found to sufficiently compensate the interference of condi-

tions in the combustion chamber when the stoking doors are opened.

The invention further aims to accomplish the foregoing result by the utilization of steam or vapor energy, thus generated by the excess heat liberated from the combustion of garbage, for actuating the fans or other apparatus producing said artificially forced and induced drafts.

A great disadvantage in connection with the operation of a garbage incinerator is occasioned by the necessity of using fuel to heat up the incinerator and to dry the garbage until same is in condition for burning, consequently it is highly essential that the plant should be enabled to operate continually for a long period, however, it has been customary heretofore to allow the conflagration to subside to permit the removal of the ashes and clinkers accumulating under the fire grate, after which it is necessary to heat the plant using auxiliary fuel therefor before normal operation of consuming garbage may be resumed. In my improved method of consuming garbage, I obviate this condition by distributing the forced draft through a number of smaller conducting pipes, each of which are directed into a separate apartment underneath the fire grate, thus diffusing the application of the forced draft to the fire grates, and providing means whereby the forced draft may be checked for any one apartment while the refuse is removed therefrom without interfering with the conflagration over the other apartments.

To enable those skilled in the art to which my invention relates to more fully understand my improved method of consuming garbage and generating steam, and to make or use an incinerating plant embodying means whereby said method may be utilized, a garbage incinerating steam generator, illustrating the application of my invention to practical use, is set forth in the following specification and illustrated in the accompanying drawings; however, the actual scope of my invention is more particularly pointed out in the subjoined claims.

In the drawings: Figure 1 is a side elevation of a garbage incinerating plant embodying my invention, means for producing a forced draft and an induced draft being shown. Fig. 2 is a vertical longitudinal section thereof, showing the courses followed by the air currents between the forced and induced draft mechanism. Fig. 3 is a vertical cross section thereof, taken on the line 3—3 of Fig. 1. Fig. 4 is a horizontal sectional view showing the arrangement of the apartments underneath the fire grate and the method of distributing the draft thereto. Fig. 5 is a horizontal section taken on the line 5—5 of Fig. 3 showing the spacing and arrangement of the water tube grates thereunder. Fig. 6 is a plan view

of a cylindrical incinerator, also embodying my invention, showing certain modifications of the foregoing construction. Fig. 7 is a horizontal sectional view of same, showing the arrangement of the water tube grate therein. Fig. 8 is a vertical cross sectional view showing certain modifications in the construction of the water tube grates and the delivery of garbage thereto.

Referring to the drawings in detail, similar characters of reference indicate like parts throughout the specification and the several views of the drawings.

In accordance with my invention the heat of the combustion of dry garbage, after its delivery upon the fire grate, is forced through the garbage suspended in the receiving chamber, rendering same in a suitable condition for combustion, after which it is delivered upon the fire grate causing the continuance of the conflagration thereon, the heat generated by combustion in excess of that required for drying garbage being utilized in the generation of steam.

The embodiment of my invention illustrated, consists of an apparatus for consuming garbage and utilizing heat liberated by the conflagration thereof for the generation of steam and for drying the subsequent supply of garbage as delivered therein. This apparatus comprises in general, a combustion chamber A and its fire grate; an auxiliary grate B comprising spaced watertube members arranged in cooperative relation with the fire grate and of suitable configuration to form a basket-like receptacle or receiving chamber C, into which garbage is delivered and stored for drying until rendered suitable for combustion; a steam boiler D crowning the combustion and receiving chambers, and its water jacket D' continuing downwardly therefrom and inclosing said combustion and receiving chambers, and to which the watertube members of said grate B are connected; and a suitable chamber E arranged beneath the combustion chamber and adapted to receive all ashes, clinkers, and refuse from the combustion upon the fire grates.

In order to render the above apparatus operative, I provide a forced draft system F adapted to maintain a supply of fresh air at a predetermined pressure in the chamber E, and an induced draft apparatus G adapted to draw the products of combustion from the combustion chamber A and the receiving chamber C, and to maintain a negative pressure at the flue opening. Said induced draft apparatus G is thus adapted to cooperate with the forced draft apparatus F to establish a flow of air and products of combustion from the chamber E, through the chambers A and C, to the flue opening, thereby supplying the requisite fresh air for the conflagration within the combustion

chamber and inducing a current of heated air, gases, and other products of combustion to flow through the chamber C effecting positive penetration of the garbage suspended therein, during which a portion of the heat of conflagration is applied to the water jacket D' and the water tube grate B and absorbed by the liquid therein, and the remaining heat is thus enabled to become uniformly distributed throughout said garbage, drying same and rendering its condition suitable for combustion.

Referring now to the drawings and in particular to Figs. 2, 3, and 4, 1 represents a suitable foundation upon which the various parts of the apparatus are mounted and is of suitable proportions to efficiently support the entire apparatus which depends thereon, and also incloses the chamber E. 2 indicates the central longitudinal foundation member being a continuance of the end portions of the foundation member 1, from which extends a series of transverse foundation members 3 dividing said chamber E into separate apartments 4, the purpose of which will be hereinafter set forth.

In the steam boiler structure, as shown in Figs. 1, 2, 3, and 5 of the drawings, the steam chamber D is inclosed by the upper portion of the shell 5, the crown sheet 6, and the vertical side sheets 7 of the passage 8 extending through the central portion of the steam chamber and through which garbage is delivered into the receiving chamber C, as will be hereinafter set forth. The water jacket D' is practically rectangular in form, in accordance with the general design of this apparatus, and provides a continuous water space inclosing the combustion chamber and forms a practically downward continuation of the steam chamber D. Said water jacket is inclosed by the outer shell 5, the fire sheets 9 extending upon either side of the combustion chamber, the fire sheets 10 at either end of the combustion and receiving chambers, and the bottom sheet 11 at the base which depends upon the I beam or plate 12 which is mounted upon the foundation wall 1. In order to enable the boiler structure to withstand sufficient pressure of steam or vapor energy to be utilized for power or heating purposes, the various sheets inclosing same are reinforced by means of suitable stay-bolts 13 which may be secured therein in accordance with any approved method. The feed-pipe 14 communicates with the lower portion of the chamber D' by which the water or liquid supply of the generator is replenished, it being desirable that an established level be maintained at a point above the crown sheets, as 15. The steam line 16 leads from the upper portion of the steam chamber D and is adapted to convey steam or vapor energy therefrom to its place of utilization,

a portion of which is used to impel the mechanism for producing said forced and induced drafts, and for operating the injectors or pumps which maintain the water or liquid supply within the generator. The longitudinal foundation member 2 extends to a higher plane than the upper surface of the foundation member 1 and is provided upon either side at its extreme upper portion with the longitudinal angle members 17, the horizontal flanges of which are turned outwardly; and upon the inward faces of the fire sheets 9 are provided corresponding angle members 18 extending parallel to the angle members 17 and in substantially the same horizontal plane, the flanges being turned inwardly thus providing seats for the fire grate members 19. Said fire grates 19 may be of any approved type or pattern, but, as no particular construction of fire grate is required other than that necessary for operative use in connection with the burning of fuels for which this device is particularly adapted, no detailed description thereof is deemed necessary herein.

While some of the advantages of my invention may be realized by the use of various forms of suspension grates, or water tube steam generating grates, arranged in coöperative relation with the combustion chamber in connection with apparatus constructed in accordance with my invention, the most satisfactory results can only be attained, as will hereinafter become more fully apparent, by the use of a water tube steam generating grate in which a certain portion thereof extends openly through the combustion chamber, receiving liquid from the steam and water reservoir chamber, and arranged to intercept the flow of the products of combustion, absorbing a portion of the heat liberated by the conflagration upon the fire grate, whereby said liquid is gradually heated from its lowest point of circulation, as 20, to the point 15 where it is transformed into vapor, and in which a comparatively small quantity of liquid is maintained at the temperature of vaporization corresponding to the pressure at which the steam generating apparatus is operated, a greater portion being used for the storage and transmission of heat from the combustion chamber to the garbage in the receiving chamber.

In accordance with the best embodiment of the apparatus, the water tube grate comprises a liquid heating and vaporizing portion which extends but slightly upwardly from its point of connection to the lower portion of the water jacket, and a portion extending upwardly therefrom being connected to the crown portion of the steam chamber, and adapted to convey the steam or vapor energy thus generated therefrom to said steam chamber. Said upper portion

is preferably adapted to support the garbage when suspended over the fire grate for drying, and as the garbage depending thereon is generally of such consistency as to form close contact over practically the entire surface of said water tubes, the heated water circulating therethrough is enabled to compensate variable conditions of heat arising during the process of drying said garbage, wherein inefficient heat for the drying of said garbage will be augmented by the heat radiated from said water tubes thereby aiding in the drying of said garbage, however, when the heat applied thereto is in excess of that required for the drying of the garbage, the excessive heat will be absorbed by the liquid therein and thus conveyed to the steam chamber, thereby increasing the rate of vaporization of steam to be used for power purposes, and also increasing the efficiency of the apparatus. These conditions are best realized in a water tube steam generating grate comprising a number of individual water tube members forming a practically continuous passage from their points of connection with the crown portion of the steam chamber to their points of connection with the lower portion of the water jacket, said passage extending continually upwardly whereby a continuous thermal circulation of water may be established during the operation of the apparatus, which also prevents clogging of said passage by the formation of "scale" or other residual matter.

As shown in the drawings (see Figs. 2, 3, and 5), the water tube grate is formed of a plurality of pipe members B which are preferably in form of vertically extending portions 21, the upper ends of which are connected to the crown sheets 6, and each of the lower portions continuing therefrom in form of an inwardly disposed horizontal V approaching the central portion of the chamber, the upper portion 22 extending inwardly and slightly downwardly, and the lower portions 23 extending outwardly and downwardly, and is connected to the fire sheets 9 of the water jacket from which liquid is received for heating purposes, as hereinbefore set forth. Said portions 21 and 22 are adapted by their configuration to serve not only in a capacity of water tube generator or radiator but also as a means for suspending the garbage in a suitable position over the fire grates, and to cause same to intercept the flow of the products of combustion from the conflagration to the flue opening 24, and, for convenience of reference, will be considered as dividing the combustion chamber A from the receiving chamber C. Thus the lower portions 23, being openly disposed over the fire grates of the combustion chamber A, properly constitute the heat absorbing portions of said

water tube grates, while the upper portions 21 and 22 serve chiefly as the heat radiating portion while also serving in the capacity of a basket-like receptacle for receiving and supporting the garbage over the fire grates.

With this construction, the products of combustion are uniformly subjected to the action of successively cooler heat-absorbing surfaces, being first intercepted by the heat-absorbing portions 23, above which the combustion chamber is extremely narrow whereby it is next applied to the heat absorbing surfaces of the fire sheets 9, after which it engages the portions of garbage projecting through the upper portions 21 and 22 of said grate, being also subject to the heat absorbing surface of said portions 21 and 22 in accordance to the temperature relation thereof, from whence it penetrates the mass of garbage contained in the receiving chamber C, during its passage to the outlet flue 24, in which it first penetrates the portion of garbage lying nearest the combustion chamber after which it gradually penetrates the successively cooler portions of the garbage more recently deposited therein. It is obviously apparent that this method of heat distribution enables a high percentage of heat to be utilized which is very essential for maintaining a continuous operation thereof without the use of auxiliary fuel after a normal state of operation has been established.

The flue opening 24 extends through the end portion of the water jacket and effects communication between the chamber C and the stack 25, it being essential that the place of its entrance into the receiving chamber should bear a suitable relation to the arrangement of said water tube grate B, whereby the mass of garbage suspended by said grate will be caused to completely intercept the course of flow of the products of combustion from the chamber A to said flue opening 24. At the upper portion of said receiving chamber C the vertical passage 8 extends through the steam chamber, as hereinbefore set forth, in connection with which I provide a hopper 26 for receiving the garbage and causing same to be delivered in position upon the water tube grate B, said hopper being provided with a trap door device as 27 preferably embodying means for maintaining a closed position and adapted to permit the downward passage of garbage therethrough and to prevent the issuance of obnoxious odors and gases therefrom. Said means for maintaining a closed position of the trap door 27 may be of any desired construction, being shown herein in form of a weight lever 28 which should be enabled to resist the suction created in the flue opening by the induced draft apparatus which establishes a corresponding vacuum within the receiving chamber C and passage

way 8, as will be more fully hereinafter set forth.

In the mechanical design of the water tube grate, the pipe members B are arranged in suitable relation of spacing to suspend wet garbage, of average consistency, over the conflagration and to enable same to freely discharge therethrough upon the fire grate as it becomes dried and in suitable condition for combustion. The portion of garbage more directly subjected to the intense heat of the combustion chamber generally becomes partially consumed, while thus suspended, and crumbles, thereby effecting its delivery upon the fire grate; however, under certain circumstances, the garbage becomes caked and clings in congealed masses to the water tube grate. Stoking doors 29 are provided at each end of the combustion chamber and arranged to open into that portion of the combustion chamber between the water tube grate members and the sidesheets 9. Thus means are provided whereby the water tube grates may be cleared of the clinging masses of partially consumed garbage by the manipulation of suitable rake like tools, and otherwise enable the operator to view the condition of garbage combustion. At each end of the receiving chamber C, and at the lower central portions thereof, stoking doors 30 are provided for convenience of gaining access to the receiving chamber C, when empty, to clean the water tube grates or make repairs.

It should be noted that in the former methods of the incineration of garbage, it has been customary to deposit the garbage as received in a large store tank for which suitable quantities were intermittently delivered into the combustion chamber of the incinerator. This practice introduces unsanitary conditions caused by the odors arising from the decomposition of the material remaining therein and more especially by residual portions of material clinging to the side walls of said storage tank causing poisonous fumes and odors to be liberated into the atmosphere during each occasion of opening said tank for the purpose of depositing additional garbage therein. By the embodiment of this invention the receiving chamber C may be formed in suitable dimensions to receive and store the entire supply of garbage directly as received from the carts or vehicles by which same is collected, thereby obviating the unsanitary conditions hereinbefore referred to by the use of an auxiliary receiving tank.

By interposing garbage within the course of flow of the products of combustion to the flue opening, a considerable resistance is created, according to the consistency and quantity of garbage intercepting said course of flow. As the consistency of garbage for any one community is generally compara-

tively constant, and as the quantity of garbage delivered upon said water tube grate during established intervals is practically constant, an average resistance, by the garbage to the flow of the products of combustion, may be predetermined for any single plant, according to its capacity and the community in which it operates, and considered as a constant value. Said resistance value while varying somewhat according to climatic conditions and according to the comparative rate of capacity and load is almost invariably sufficient to check the flow of the products of combustion and render it highly impractical to maintain a conflagration upon the fire grate by natural draft. Thus, in order to maintain a comparatively constant draft through said combustion chamber and through said garbage, it is necessary to employ artificial means for establishing a difference of pressure between the draft opening and the flue opening. If a condition of absolute vacuum were established at the flue opening to cooperate with atmospheric pressure at the draft opening, a difference of pressure of approximately 15 pounds per square inch would be obtained between said draft and flue openings, which is not sufficient to create a practical rate of draft through said combustion chamber, owing to the resistance of said garbage. By producing a positive pressure at the draft opening sufficient to cooperate with the negative pressure at the flue opening created by displacement in the stack, said positive pressure would create a condition known as back-lash within the combustion chamber which would seriously affect the conflagration upon the fire grate. Thus, it is readily seen that in order to produce the most efficient results, it is necessary that in establishing a positive pressure at the draft opening and a negative pressure at the flue opening, the respective values of each should bear a corresponding relation to the normal values of atmospheric pressure at said draft and flue openings. To maintain this condition within my improved apparatus, I provide artificially forced and induced draft devices, of which the induced draft device has an increased capacity relation to said forced draft corresponding to the variations in the conditions of air, vapor, or gases, upon which the respective devices operate. Owing to the expansive elasticity of the products of combustion, also its increase in quantitative relation to the fresh air admitted by the forced draft, to the combustion upon the fire grate, the capacity of the induced draft apparatus should be about five times that of the forced draft apparatus. As herein shown the forced draft apparatus F comprises a blow-fan 31 having intake communication with the external atmosphere and adapted to deliver air at a predetermined pressure into the feed pipe 32 from

which is derived a number of smaller conducting pipes 33, each of which deliver a proportionate quantity of air into a separate apartment 4 of the draft chamber underneath the fire grate. Said blower-fan may be of any capacity or size, in accordance with the general capacity of the incinerating apparatus for which it is to be used, and is operated by means of any suitable source of power. I provide each of said conducting pipes 33 with a damper or gate 34 by which the flow of air to its respective apartment may be checked, whereby ashes and other refuse, from the conflagration upon the fire grate may be removed from said apartment without interfering with the continuance of conflagration upon the portions of the fire grate over other apartments. The means herein shown for establishing a negative pressure at said flue opening consists of a suction fan 35, of which the intake opening communicates with the flue opening 24 through the conducting pipe 36, and its exhaust opening communicates with the stack 25 through the conducting pipe 37. Said induced draft apparatus, as hereinbefore stated, should have a capacity relation of about five times that of the forced draft apparatus, whereby a balanced relation of energy is applied by the respective forced and induced draft apparatus of combined capacity to maintain a predetermined rate of draft through said combustion chamber and through said garbage suspended upon said water tube grate. In accordance with my invention, broadly considered, any suitable means may be used for maintaining a predetermined difference of pressure between said draft and flue openings, however, the means herein shown are more especially adapted for the respective functions to be performed, and may be conveniently actuated by motive agent which is rendered operative by the delivery thereto of steam or vapor energy from said steam generator.

It is obvious from the foregoing that the combustion chamber may be greatly varied in its configuration without departing from the principles of my invention. In Figs. 6 and 7 of the drawings, I have herewith illustrated a garbage incinerating apparatus in which the combustion chamber is cylindrical in form. This apparatus comprises a steam generator D' and a water jacket D'', continuing downwardly therefrom, forming a cylindrical inclosure or combustion chamber A', adapted to perform certain functions which correspond with those of the combustion chamber A of the foregoing construction. Within the combustion chamber, I provide a water tube grate comprising a concentric series of water tube members 38, the upper portions of which are connected to the steam generator D' and the lower portions 39 extending in form of radially

disposed V's, the apexes of which approach the general portion of the combustion chamber and the extreme lower portions of which are connected to said water jacket D'', whereby a continual circulation of vaporizing liquid may be maintained through said water tube members, said water jacket, and said steam generator. In accordance with this method of construction, the water tube grate provides a cylindrical basket-like receptacle adapted to receive garbage and suspend same in suitable relation above the fire grate, and has the special advantage that in suspending garbage in this manner, uniform spacing thereof from the water jacket is maintained at all corresponding points, whereas in the former construction the garbage deposited at either end of the receiving chamber is maintained in direct contact with the corresponding portion of the water jacket. The draft chamber underneath the fire grates is divided into individual apartments by means of radially extending walls 40, indicated by dotted lines in Fig. 6 of the drawings; and into each of said apartments, communication is effected with the forced draft apparatus F', through the main conducting pipe 41 and the individual distributing pipes 42. The induced draft apparatus G' as herein shown does not materially vary from the construction hereinbefore set forth. Its intake opening communicates with the combustion and receiving chambers through the conducting pipe 43 and the two smaller conducting pipes 44, each of which extend downwardly through the steam generator D'' to their respective flue openings upon either side of the centrally disposed garbage hopper 45, thus providing a means for diffusing the application of negative pressure to the receiving chamber. It will be seen from the above, that modifications may be also effected in the details of construction of said water tube grate. In accordance whereof I have herewith set forth a modified construction in Fig. 8 of the drawings, in which the water tube grate comprises a series of spaced water tube members; each of which comprises an upright portion 46, the upper portion of which is secured to the steam generator, at a point near its longitudinal line of center, from which it extends in a downwardly and somewhat outwardly course, its lower portion 47 continuing therefrom in an approximately horizontal course and is connected at its extreme lower portion to the water jacket. In accordance with this construction, two receiving chambers C' and C'' are formed, each of which is adapted to receive and store garbage to be suspended above the fire grate, and are respectively provided with means for delivering garbage therein, as the receiving hoppers 48 and 49. Said receiving chambers are also provided

with outlet flue openings 50 and 51 through which the products of combustion pass during their course of flow to the stack. It is readily seen that a mass of garbage, as herein indicated by H, when disposed upon the water tube grate members would effectually intercept all course of flow of the products of combustion from the combustion chamber to the flue openings 50 and 51, whereby penetration thereof by the products of combustion would be effected, as indicated by the arrows.

The operation of the various mechanical features of the apparatus shown having been described in connection with the construction thereof, it only remains to point out how the different parts of the apparatus cooperate to produce the desired results. In establishing operative conditions within said apparatus, it is first necessary to supply the steam generator and water jacket with a vaporizing liquid, which should approach an approximate level as indicated by 15 within the steam generator, which would properly protect the crown sheets 6 from becoming overheated. A conflagration is then established upon the fire grate, using any suitable fuel as wood, or coal. The heat liberated from said conflagration is applied to the heat absorbing surfaces of the water tube grate B, to the crown sheets 6, and the fire sheets 9 and 10, which heat is absorbed by the liquid contained within the generator thereby generating steam or vapor energy. When a suitable pressure of steam or vapor energy is obtained in the steam generator, a supply of garbage is then delivered into the receiving chamber through the hopper 26 and is deposited upon the water tube grate in such a manner as to intercept the flow of the products of combustion through the combustion chamber to the flue opening. In order to maintain a requisite rate of draft from the combustion chamber to the flue opening, and which is adequate to overcome the resistance created thereto by said garbage, a difference of pressure is established at the draft and flue openings by the use of the forced and induced draft apparatus, the motive agent therefor being rendered operative by the utilization of steam previously generated before the delivery of garbage to the water tube grate. It results from the delivery of an initial supply of garbage upon the water tube grate, that an excessive amount of heat will be required to establish an operative rate of vaporization, consequently, a portion of the heat stored by the vaporizing liquid is radiated to the garbage, which is in direct contact with the portions 21 and 22 of the water tube grate members B, and generally causes more or less of a reduction of the pressure of steam within the generator, owing to the radiation of heat, to the gar-

bage from the liquid contained therein. During this process of establishing a combustible condition of the garbage, the conflagration upon the fire grate should be excessive, whereby sufficient heat is applied to the heat absorbing surfaces of the water jacket to maintain a uniform rate of vaporization within the steam generator and to also provide for the radiation of heat to the garbage from the water tube grate. Said radiation of heat from the water tube grate causes a thermal circulation to take place whereby the liquid within the water tube grate flows downwardly until it passes into the water jacket, wherein it is subjected to the influences of the heat absorbing surfaces of the fire sheets 6, and, owing to its condition of increasing temperature, it then flows upwardly into the steam generator. As a portion of the garbage nearer the combustion chamber becomes rendered suitable for combustion, it is gradually delivered upon the fire grate thereby augmenting said conflagration, however, said delivery may be also effected by means of human aid as hereinbefore set forth. When the combustible condition of said garbage is increased, and the demand for the application of heat-energy thereto is correspondingly decreased, the flow of the products of combustion through said water tube grate and the garbage, thereon provides an application of heat to said water tube grate which is of a higher degree than the heat of the liquid therein, thereby establishing a condition of heat absorption by said water tube grate, as well as the water jacket, which reverses the circulation of said liquid and utilizes the excessive heat for the generation of steam or vapor energy.

One of the chief advantages of my invention resides in its ability to incinerate garbage; utilize a portion of the heat liberated from the combustion thereof for the drying of successive garbage; and for utilizing all heat liberated from said conflagration, in excess of that required for the drying of said garbage, for the generation of steam or vapor energy, which is adapted to effect the operation of the forced and induced draft apparatus, and, in addition to which, it is adapted to deliver a supply of steam or vapor energy at a suitable pressure and temperature to be utilized for heating or power purposes. Thus my invention provides a means for cheapening the cost of incinerating garbage and for rendering the process thereof useful for generating power of sufficient value to practically offset the cost of collecting and delivering garbage thereto. The condition of garbage varies according to conditions of different localities; and when operating under more favorable conditions, my invention enables the process of

incinerating garbage to be conducted upon a profitable basis.

It is obvious from the foregoing, that modifications may be effected in the construction hereinbefore set forth without departing from the true and original purport of my invention, therefore I do not confine the scope of the appended claims to the details of construction hereinbefore set forth.

Having thus described my invention, what I claim and desire to secure by Letters Patent of the United States is the following:

1. An apparatus for incinerating garbage comprising in combination, a single combustion chamber having an outlet, a fire grate therein, means supplying forced draft to said grate, positive mechanical means communicating with said outlet for maintaining an induced draft, and means in said chamber for suspending the garbage over and closely adjacent the grate at a point between the grate and the outlet whereby products of combustion from the grate penetrate and pass through the garbage.

2. An apparatus for incinerating garbage comprising in combination, a single combustion chamber having an outlet, a fire grate therein, means supplying forced draft to said grate, positive mechanical means communicating with said outlet for maintaining an induced draft, said induced draft means having a greater capacity than said forced draft means, and means in said chamber for suspending the garbage over and closely adjacent the grate at a point between the grate and the outlet whereby products of combustion from the grate penetrate and pass through the garbage.

3. An apparatus for incinerating garbage comprising in combination, a single combustion chamber having an outlet, a grate for said chamber, means supplying forced draft to said grate, positive mechanical means communicating with said outlet for maintaining an induced draft, and means in said chamber for suspending the garbage over and closely adjacent the grate and at a point between the grate and the outlet, said suspension means being arranged and disposed to cause the garbage to form a partition between said grate and outlet.

4. An apparatus for incinerating garbage comprising in combination, a single combustion chamber, means in said chamber for suspending the garbage horizontally thereacross to form a partition, a grate below and closely adjacent the garbage partition, forced draft means for said grate, and positively acting mechanical induced draft means communicating with said chamber above said garbage partition.

5. An apparatus for incinerating garbage comprising in combination, a single combustion chamber, means in said chamber for

suspending the garbage horizontally thereacross to form a partition in the same, a grate below and closely adjacent the garbage partition, forced draft means for said grate, and positive mechanical induced draft means communicating with said chamber above said garbage partition, the capacity of said induced draft means exceeding the capacity of said forced draft means.

6. An apparatus for incinerating garbage comprising in combination, a single combustion chamber, means in said chamber for suspending the garbage thereacross to form a partition therein, a grate on one side of the garbage partition and closely adjacent thereto, forced draft means for said chamber, and positive mechanical induced draft means communicating with the chamber on that side of the garbage partition opposite said grate.

7. An apparatus for incinerating garbage comprising in combination, a combustion chamber provided with a fire grate structure and an inlet source of supply of air

delivering wholly below the grate and constituting the sole and only air inlet to the combustion chamber, positive mechanical means acting upon all of the air passing through said inlet to force the inlet draft, a single outlet above the grate constituting the sole means of discharge of air and the products of combustion from said chamber, means interposing a garbage partition between said grate and outlet, and positive mechanical means cooperating with said first named positive mechanical means and producing a forced induced draft and positively acting upon all of the air and products of combustion discharging through said outlet.

In testimony whereof, I have hereunto set my hand and affixed my seal in the presence of the two subscribing witnesses, this 30th day of October, 1909.

CHARLES A. BYRNE. [L. s.]

Witnesses:

C. A. SNOW,

J. H. ALTMANN.