Sept. 13, 1949. T. FERRO ET AL 2,481,504

TRAVELING GRATE INCINERATOR FOR CITY REFUSE AND THE LIKE

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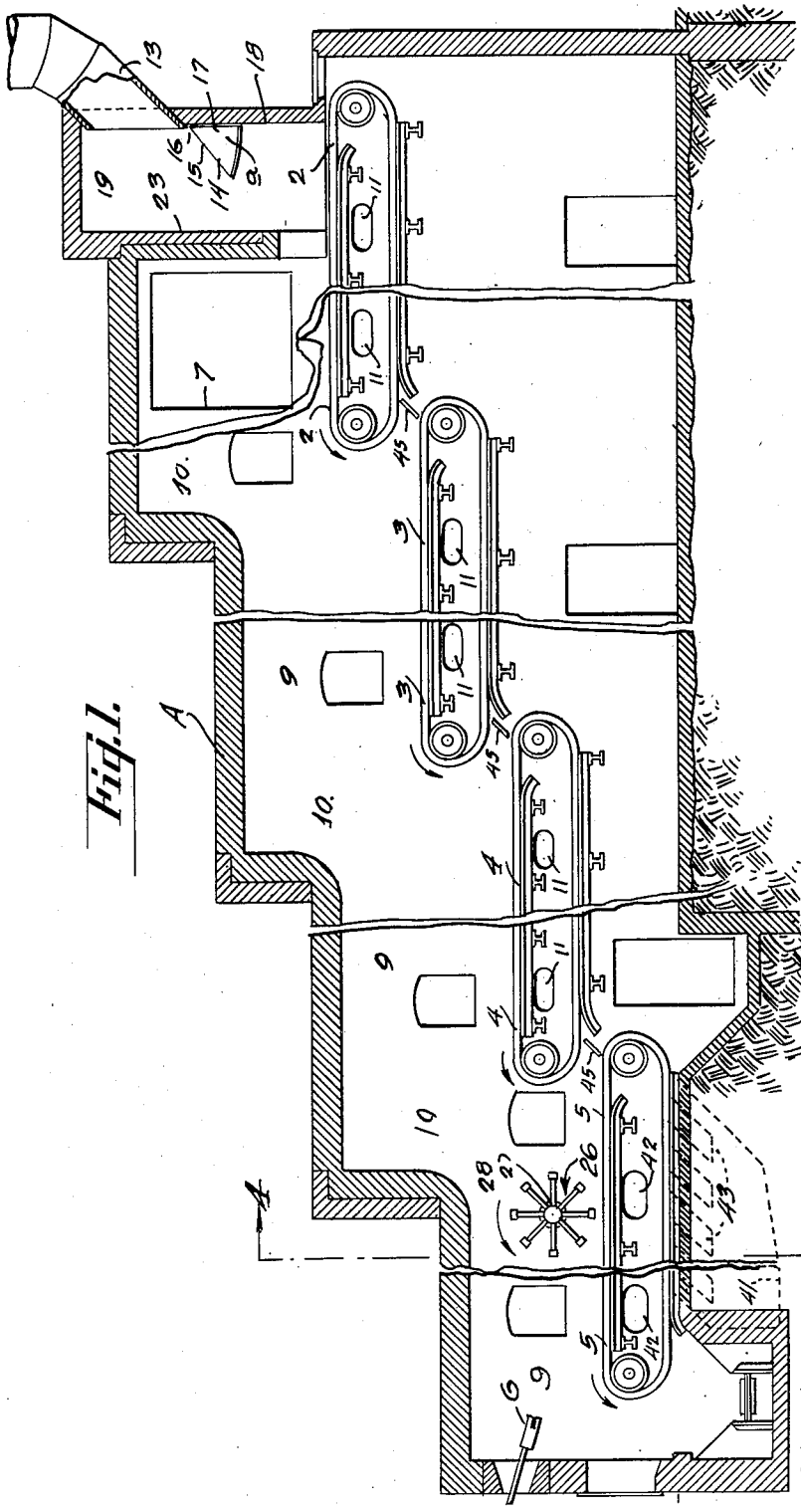


Fig. 1.

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Filed April 22, 1944 6 Sheets-Sheet 2

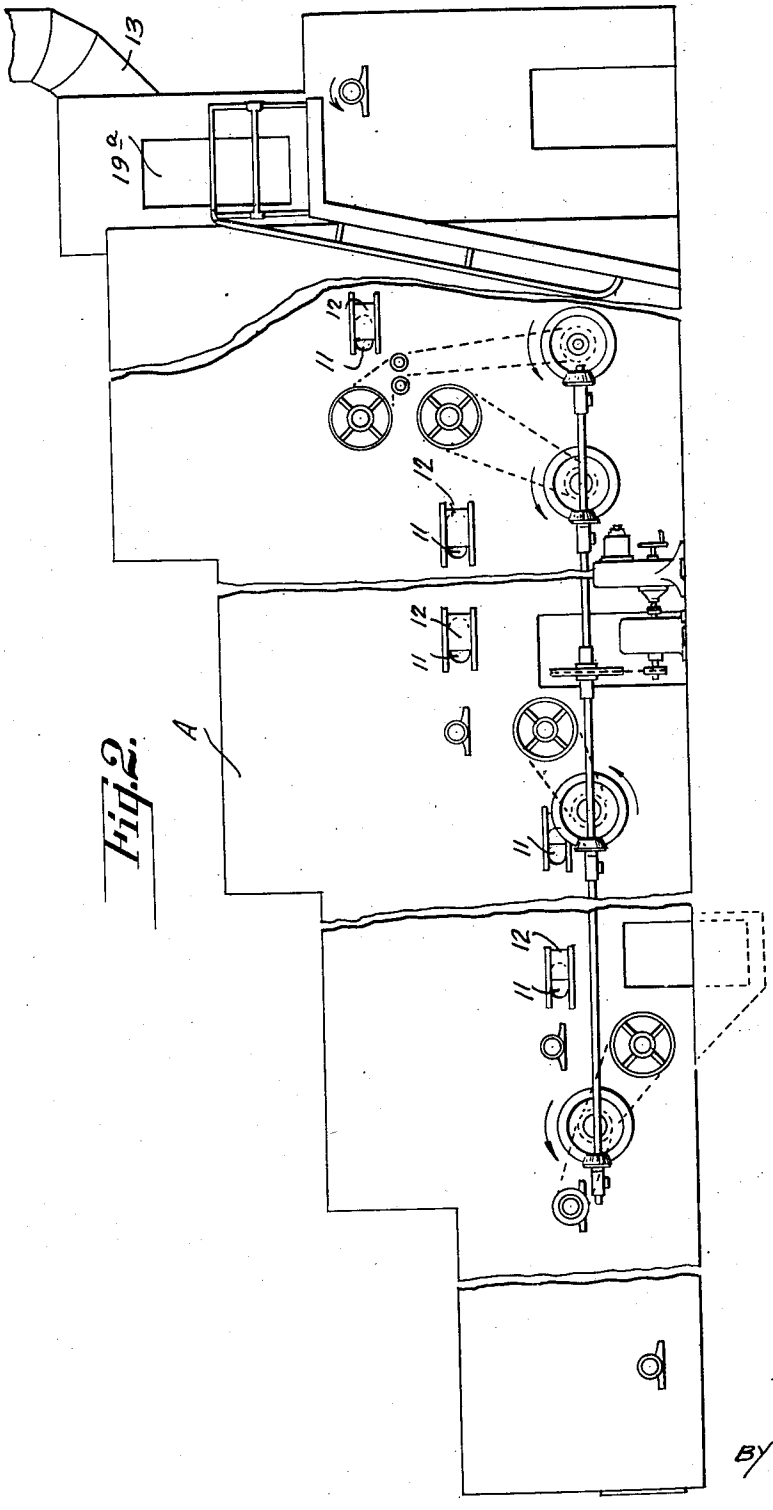


Fig. 2.

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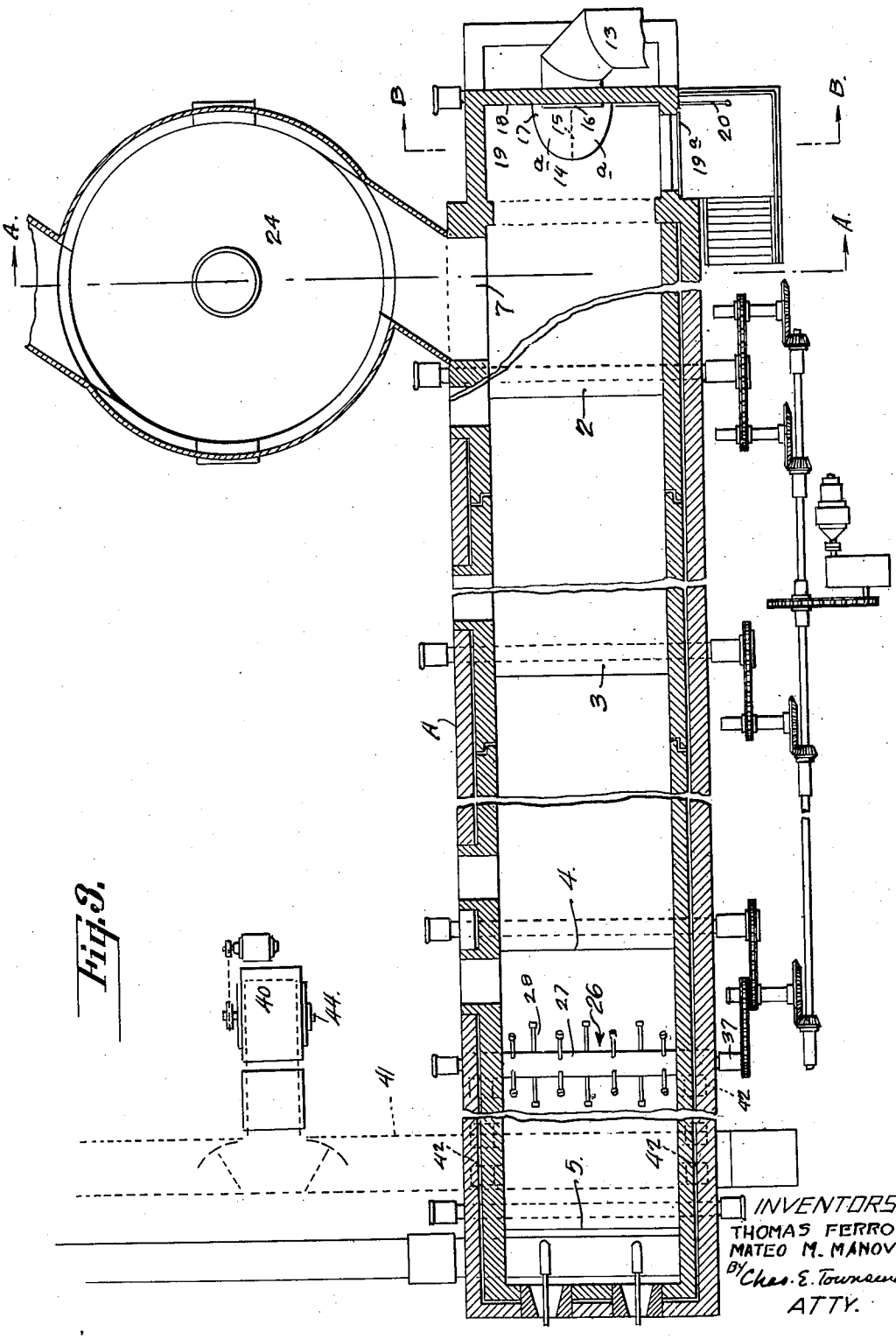


Fig. 3.

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Fig. 11.

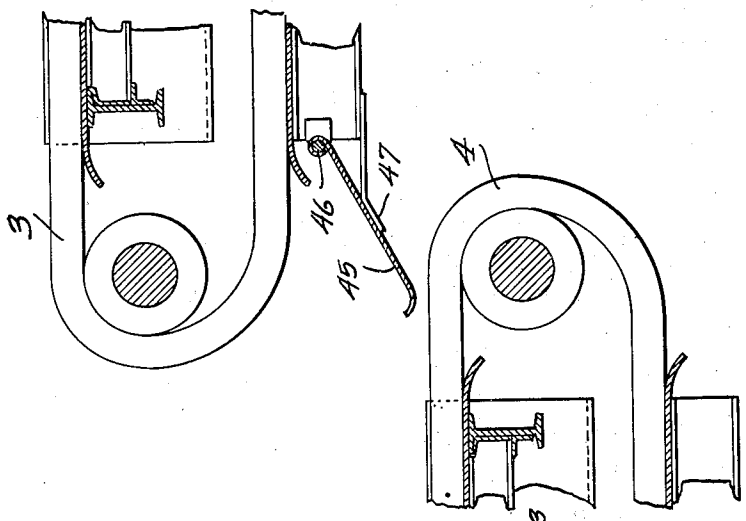
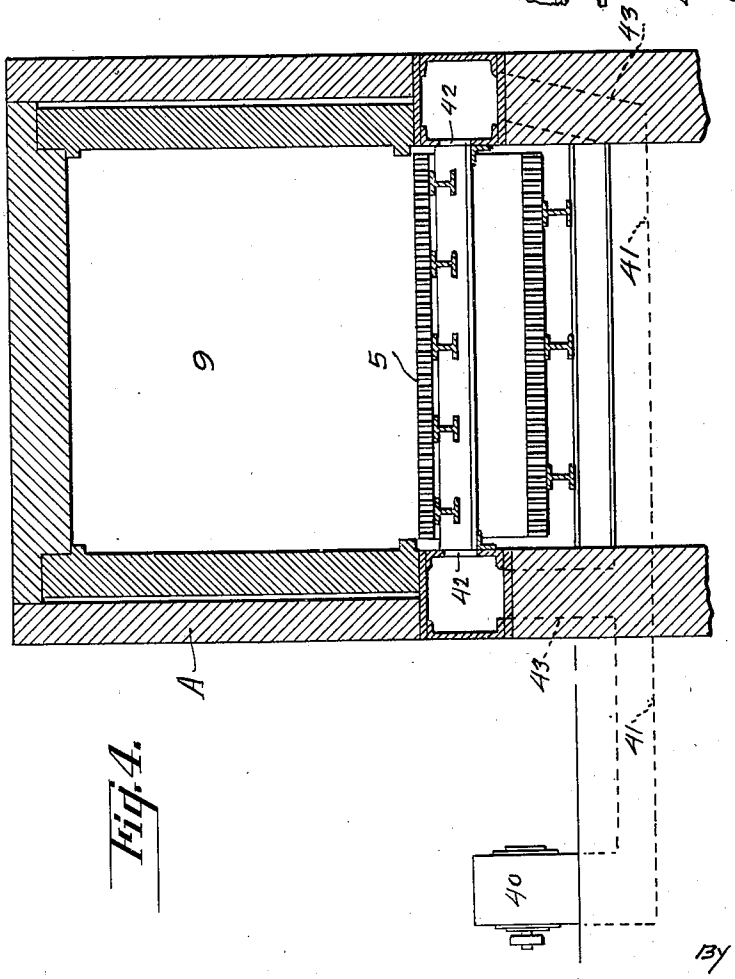


Fig. 4.



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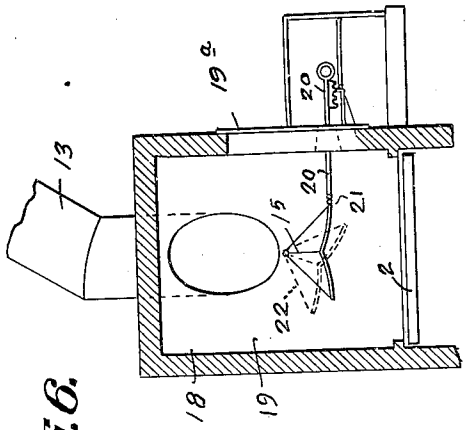


Fig. 6.

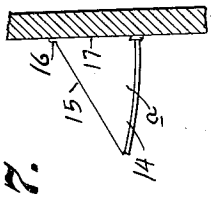


Fig. 7.

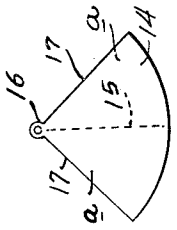


Fig. 8.

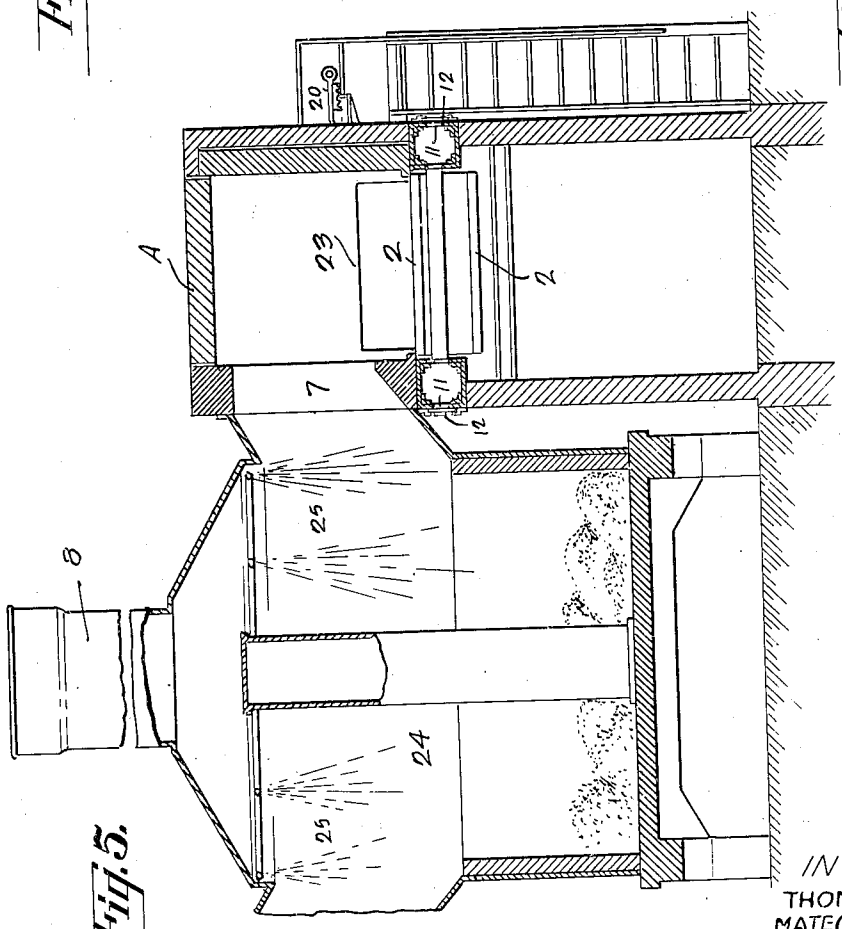


Fig. 5.

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TRAVELING GRATE INCINERATOR FOR CITY REFUSE AND THE LIKE

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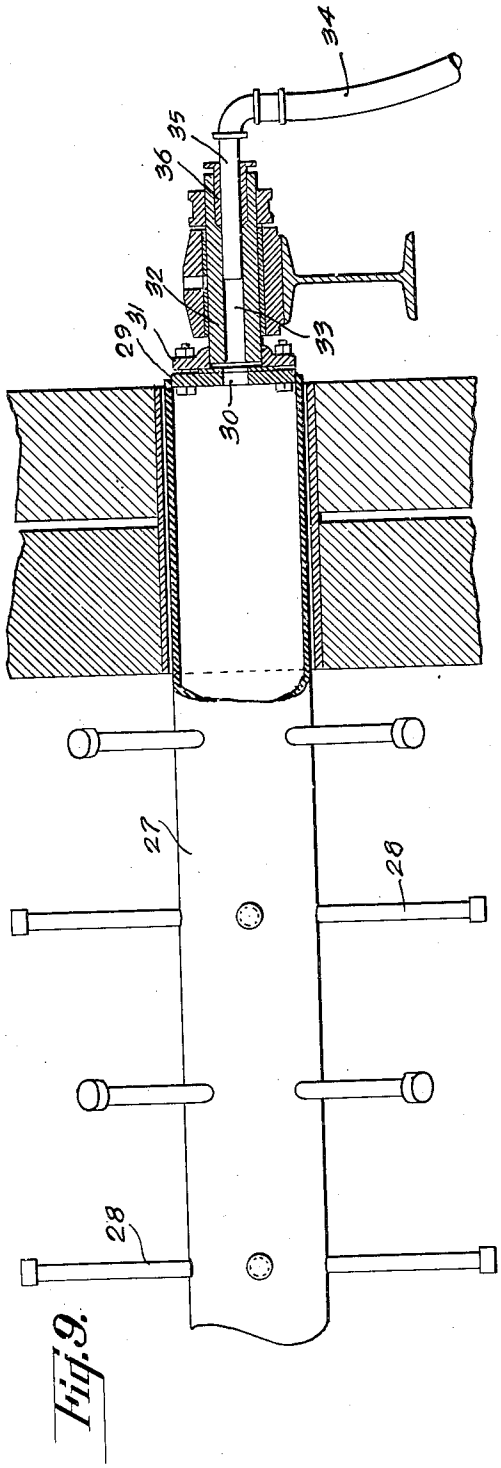


Fig. 9.

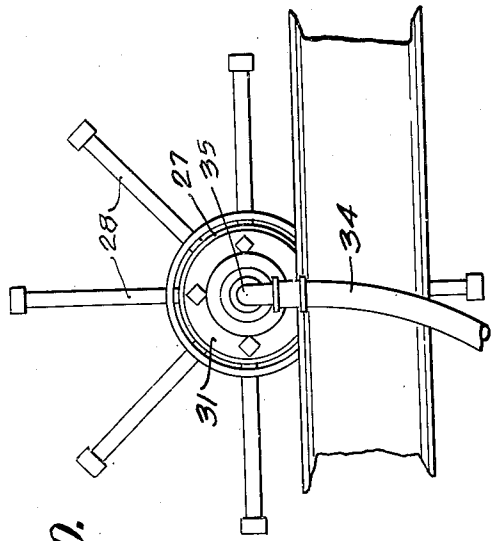


Fig. 10.

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Patented Sept. 13, 1949 2,481,504

UNITED STATES PATENT OFFICE

2,481,504

TRAVELING GRATE INCINERATOR FOR CITY REFUSE AND THE LIKE

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Application April 22, 1944, Serial No. 532,234

7 Claims. (Cl. 110—7)

1

This invention relates to garbage incinerators and particularly to a traveling grate type of furnace, as distinguished from the usual floor furnace type, rotary kiln type, etc., and which has demonstrated itself by actual full-size operation to be capable of large capacity and high efficiency.

Among the objects of the present invention is the provision for as nearly complete combustion as is possible in apparatus of this character.

The smoke nuisance from most garbage and refuse-incinerating plants is a constant source of complaint on the part of the affected public. Much effort has been expended in seeking to alleviate or lessen this difficulty. The present invention has, in practice on a large scale burning sixteen tons per hour average, demonstrated the ability to effect complete burning of the usual run of city garbage, kitchen refuse and community waste with an almost total absence of smoke.

This desirable result is attributed, in large measure, to the arrangement of a series of traveling grates in echelon formation and means for distributing air for combustion through the full length of the unit, and at the same time providing space and time for the generated gases to expand periodically in their course of travel with consequent reduced rate in velocity of travel to allow the uncombusted solids, carried in suspension, to settle and become redeposited on the grates for further incinerating action.

Other objects and advantages will appear from a description of the apparatus.

Having reference to the accompanying drawings:

Fig. 1 is a longitudinal, vertical schematic section through the furnace and the center of the chain grates.

Fig. 2 is a side elevation of the incinerator, the supporting structure and certain non-essential details being omitted.

Fig. 3 is a plan view, in partial section, on top of grates, with top of furnace removed.

Fig. 4 is a typical cross section on an enlarged scale through the furnace at points 4—4 in Fig. 1 of the drawings.

Fig. 5 is a cross section on line A—A of Fig. 3.

Fig. 6 is a cross section on line B—B of Fig. 3.

Fig. 7 is a detail elevation of the spreader-plate for distributing the entering material evenly over the initial grate.

Fig. 8 is a plan view of a blank for the spreader-plate.

Fig. 9 is a detail of the lump-breaker assembly.

Fig. 10 is an end view of the lump-breaker assembly with the side walls of the furnace not showing.

Fig. 11 is a detail in vertical section of the adjacent ends of two grate members, showing arrangement of draft baffle.

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The furnace A in Fig. 1 is an elongated, massive structure of suitable construction, with reinforced fireproof walls and ceiling, and adapted to house a series of horizontally disposed, stepped, endless traveling grates 2, 3, 4 and 5, on which the garbage is progressively advanced through the furnace from its delivery onto the first of said grates 2 until its final discharge as ash and clinker from the last grate 5.

These grates are of conventional design, but are arranged in stepped or echelon formation, with each grate delivering its load of refuse onto a successive grate, the last grate 5 being adjacent to the source of heat provided by the oil or gas burners 6. The grates all travel at uniform speed and are driven in unison by any suitable conventional means from any appropriate source of power, not believed necessary to be shown in every detail but illustrated schematically in Figs. 2 and 3.

A special characteristic of this furnace is that each grate traverses an individual section or combustion chamber of the furnace interior, which sections or chambers are correspondingly stepped and collectively constitute a continuous combustion space.

In an operating unit embodying this invention, the overall length and width of the furnace interior are determined by the quantity of garbage to be incinerated per unit of time and by the moisture content of the garbage in its initial state as delivered on the first grate. A satisfactory result may be obtained by allowing from twenty to twenty-five minutes' time to burn one cubic foot of garbage having a moisture content of about 65% by weight, and a speed of from two to four feet per minute at the chain grates. The preferable number of chain grates should not be less than three and the preferable length of each grate should not be more than twenty-four feet. The preferable width of the grates should not be less than four feet nor more than six feet. The cross sectional area above each grate should be proportional to the volume of smoke and water vapor produced at each grate, and the velocity of the combined volume of smoke and vapor should not exceed 700 F. P. M. through the hottest section of the grate, increasing to not over 1800 F. P. M. through the coolest section.

In a unit recently constructed and now in actual operation the overall length of the furnace interior is approximately eighty-four feet. The width of the grates, corresponding to the approximate width of the furnace chamber, is approximately six feet. The lengths of the individual grates vary slightly but average approximately twenty feet.

The temperature in the sections varies from approximately 1400° Fahrenheit to 1600° Fahrenheit adjacent to the burners 6 to approximately

600° Fahrenheit to 700° Fahrenheit in chamber 10 adjacent to the outlet 7 for the gases into a stack 8. Each of said sections of the furnace chamber comprises, essentially, two parts of different cross-section; a part 9 of smaller cross section and a part 10 of larger cross-section. The portions 10 are each approximate to the delivery end of each of the traveling grates 2, 3, 4 and 5 and extend over approximately one-third of the length of the succeeding grates 3, 4 and 5, so that each portion 10 constitutes, in practice, an expansion and precipitation chamber, whereby the velocity of travel of the gases through the furnace from the burner end of the furnace towards the stack outlet is temporarily reduced and the gases allowed to expand, cool slightly as they travel against the incoming cold garbage, and drop their suspended solids. The greatest cross section is in the initial or entrance chamber to grate 2, where the garbage is received into the furnace and most remote from the source of heat of burners 6. These solids, falling onto the grates, are moved forward towards zones of increasing heat and are gradually consumed or reduced to ash or clinker.

The dimensions of the sections 9 and 10 of the furnace space vary progressively from the burner end of the furnace, adjacent to the grate 5, to the opposite end of the furnace.

Based on the foregoing data, the operative unit has the following critical dimensions:

Chamber 9 over grate 5 is approximately 17′ x 6′ x 4′;

Chamber 10, which encloses the receiving end of grate 5, is approximately 8′ x 6′ x 7′;

Chamber 9 over grate 4 is approximately 14′ x 6′ x 5′;

Chamber 10 over the receiving end of grate 4 is approximately 6′ x 6′ x 8′;

Chamber 9 over grate 3 is approximately 14′ x 6′ x 5′ 3″;

Chamber 10 over the receiving end of grate 3 is approximately 6′ x 6′ x 9′;

Chamber 19 over the initial grate 2 is approximately 6′ x 6′ x 6′; and

Chamber 10 over the receiving end of grate 2 is approximately 7′ x 6″ x 6′ x 8′.

These figures, of course, would vary in units of different sizes and capacities. The present apparatus has a demonstrated capacity for burning approximately sixteen tons of miscellaneous garbage and refuse per hour.

An apparatus of this character must be designed on the assumption that it is handling the worst garbage with a large assortment of kitchen refuse, with very considerable water content and normally producing, when incinerated, a tremendous volume of smoke as compared with dry garbage.

Normally, the apparatus herein described is operated so that complete combustion is effected in from twenty to twenty-five minutes, more or less, figuring the time that it takes the material to be burned to travel from the point where it is first delivered onto grate 2 until it is discharged as ash or clinker from grate 5. Only the products of evaporation and the lighter colorless gases issue from the stack.

The combustion of the gases in their progress through the furnace is aided and accelerated by the admission of regulated quantities of air through both sides of the furnace and at points just below the top of the traveling grates 2, 3 and 4 through air ports 11 which are controlled by slide gates 12.

For the grate 5 the air is supplied by the air blower 40 through air trench 41 to the bottom of the side walls of the furnace A and into a manifold 43 and thence through air ports 42 on the inside face of these walls to points as noted on Figs. 1–3 for the grates 2, 3 and 4. The blower can be of any conventional design, having a conventional flow control, indicated at 44, and a capacity of not less than 760 C. F. M. at about ¾″ S. P. per ton of garbage to be burned per hour. Thus the air for combustion is distributed in proper regulated quantity and uniformly through the full length of the unit, whereby a very satisfactory degree of combustion is obtained. These air ports are disposed, preferably three on each side to each grate except the first or grate 2 in the initial feed chamber where it may require only one or two. The admission of air through ports 11 is manually controlled with relation to the burner draft, so that the gases travel through the furnace at a speed of approximately seven hundred feet to eighteen hundred feet per minute, as described above.

The smoke given off of grate 5 nearest the burner is heavier and denser than at any other place in the furnace, progressively decreasing in density as the stack-end of the furnace is approached; the nearer the stack the more steam arises, resulting in the final and complete dehydration of the material on the grates by the time it entered the zones of greatest heat where it is fully combusted or reduced to ash and clinker.

Referring to Figs. 1 and 11, it will be noted that at the lapping end of grates 2 and 3, 3 and 4, and 4 and 5, there is a draft stop or baffle plate 45 to prevent the flowing gases from carrying the garbage outside the combustion chamber and beneath the upper grate. The draft stop or baffle is a steel plate extending the full width of the furnace. The top edge of the plate is hinged or otherwise suspended, as at 46, from the return rails of the traveling grates and the bottom edge is left free and slightly above the top of its lower grate, the plate resting by gravity on the shelf member 47.

An important feature of this invention lies in the means for equally distributing the incoming garbage to the traveling incinerator floors provided by the grates.

The garbage or refuse for the incinerator is delivered from the usual conveyer and sorting means, illustrated in Letters Patent No. 2,257,567, of September 30, 1941, but not necessary to be shown here, through a feed pipe or chute 13. Inasmuch as this material comes into the furnace through chute 13 at varying velocities and in varying quantities, due to the changing variety of the garbage itself, it is necessary, in order to prevent the entering garbage from piling up at any particular point on the limited area of the receiving grate 2, that some suitable means be devised by which a proper distribution and leveling off of the garbage on the grate could be effected without an operator having to attempt such distribution by means of a rake or otherwise.

To that end, we have devised a special form of distributing plate 14, of peculiar design in cross section but so disposed, wtih relation to the outlet from the chute 13, that the garbage received upon the plate is divided, diverted and spread in such fashion that an even distribution of the garbage on the grate is effected, this even distribution thereafter being maintained uniform throughout the travel of the garbage through the furnace. Plate 14 is of sheet metal, which, before

being bent, is substantially in the form of a segment of a circle with the two sides or lateral edges of the segment subtending an angle of approximately 90° (see Fig. 8). The plate is folded or bent into proper shape along the radial median line 15 into approximately two equal sloping sections *a*—*a*, disposed at approximately 90° from each other. The plate thus shaped is suitably pivoted at the apex 16 to a fixed part of the furnace immediately below the outlet of the chute 13 and centrally thereof and with the lateral edges 17 resting freely against the back wall 18 of a garbage-receiving compartment 19.

In order to shift the position of this distributing plate conveniently from a point exteriorly of the compartment 19 any suitable means may be provided. As here shown, a slide rod 20 extends through the side wall of compartment 19, into the compartment, and is loosely attached to the plate 14, as at 21, so that the plate may be moved in an arc about its pivot 16 into any desired position from normal, represented for instance in Fig. 6 by dotted lines 22. By this means, if garbage is coming in more to one side of the chute 13 than to the other, the plate can be moved about its pivot 16 to vary the pitch and position of one or the other of the surfaces *a*. In such a case the garbage slides along that surface which has the greater inclination. Observation of the behavior of the incoming garbage may be observed from time to time through the door 19a in compartment 19.

With the plate in normal position so that the pitch of each side *a* is aproximately the same, the garbage slides over both surfaces, as well as down the middle, and by appropriate manipulation of the slide rod 20 the leveling off of the garbage one the grate is accomplished.

The receiving compartment is partially cut off from the interior of the furnace proper by the baffle wall 23 which has its bottom edge suitably positioned above the grate and the incoming garbage to allow the latter freely to pass and at the same time allow very little of the heat or gases of the furnace proper to escape into the receiving compartment. The outlet for the steam, gases and remaining smoke from the furnace interior is through the port 7 into a precipitation tank 24, of conventional design, where the gases and any solid particles in suspension are subjected to a centrifugal action and to water sprays 25, resulting in a knocking down and deposit in the tank of all such products not in gaseous form. The remaining scrubbed gasses pass up the stack 8 so that when they issue from the stack they are almost invisible to the naked eye and, besides, are harmless and unobnoxious.

Another important feaure of this invention is the provision of a lump-breaker, indicated at 26 (Fig. 1) and shown in detail in Figs. 9 and 10. Such a device is made necessary due to the fact that there is often mixed with the refuse material undergoing incineration lumpy articles like books, tightly bound bundles, clinker, and the like, which are not broken up by merely tumbling from one grate to the other but require more forceful means to disintegrate them so that the uncombusted portions may be thoroughly consumed.

To this end, at some suitable point in the course of travel, preferably over grate 5 where the heat is greatest, we dispose said lump-breaker which, in practice, consists of a crosswise extending roller, comprising a hollow axle 27 with a series of staggered arms 28, whose orbits of

movement are slightly above and out of contact with the top flight or floor portion of the grate 5 immediately beneath. The axle of the breaker is preferably of heavy metal eight-inch pipe, the length of which is sufficient not only to extend over the full width of the grate but to project through the walls of the furnace A and to be journaled, driven and water-cooled from outside the furnace preferably as follows:

Each end of the pipe outside the furnace walls has welded to it an end plate 29, with a central opening 30. Bolted and welded to each plate 29 is a flange 31, which, in turn, is welded to a shaft or pintle member 32, having a central bore 33 in continuation with the opening 30 in plate 29, through which a cooling fluid may be admitted to pipe 27 from a suitable source of supply through a metallic hose 34 and a pipe section 35. The latter is made to have a snug running watertight fit inside shaft 32 by means of a packing gland 36.

The breaker arms 28 consist of pipe sections which are screwed in or otherwise attached at intervals to pipe 27 in staggered relation and capped at the ends, as shown, permitting the fluid for cooling purposes to enter the arms from the axle pipe 27. This breaker is operated to rotate in a reverse direction to the travel of the underneath top flight or floor portion of the grate.

As seen in Figs. 2 and 3, the drive for this lump-breaker may be provided by an extension 37 from the drive end of the chain grate 5, or in any other suitable manner.

We claim:

1. An incinerator for city refuse and the like comprising, in combination, a furnace enclosing a continuous horizontally disposed series of chambers, the tops of said chambers being arranged in stepped formation, a series of correspondingly arranged, stepped traveling grates in said chambers whereby refuse received upon the topmost of the grates is delivered successively to the grates below, means to feed refuse into said furnace and onto the topmost grate, heating means at the lowermost of said chambers, the chamber spaces in the furnace over each grate being of successively decreasing cross sections, the greater of said cross sections being at the feed end of the respective grate, whereby the heat and the products of combustion carried by the heated gases are allowed gradually to expand as the said gases progress above said traveling grates through the furnace from one chamber to the other, and an outlet for said gases arranged above the topmost grate.

2. In an incinerator for city refuse and the like comprising, in combination, an elongated furnace having a horizontally connected series of combustion chambers, the tops of said chambers being arranged in stepped formation, correspondingly arranged, stepped traveling grates, whereby the refuse relivered onto the topmost initial grate is delivered successively to the grates below, means to feed refuse into said furnace and onto the topmost grate, and means at the lowermost grate for heating the furnace to effect incineration, the chamber spaces over each grate being of successively decreasing cross-section, the greater of said cross-sections being at the feed end of the grate, the smallest cross section being located adjacent to the heating means and the largest cross section located adjacent to the refuse receiving end of said furnace, whereby the products of combustion are permitted to expand

gradually as they pass continuously over said traveling grates from one chamber to the other in their travel through the furnace, said furnace having a gas and smoke outlet from the topmost initial chamber, said latter chamber divided into two compartments, one of which is a refuse-receiving compartment with means in said compartment for distributing the incoming refuse evenly over the grate.

3. An incinerator for city refuse and the like, comprising, in combination, a furnace enclosing a continuous horizontally disposed series of chambers the tops of said chambers arranged vertically in echelon, a series of correspondingly arranged stepped traveling grates in said chambers whereby refuse received upon the topmost of said grates is delivered successively to the grates below, means to feed refuse into said furnace and onto the topmost grate, said grates forming with the tops and side walls of corresponding chamber an operating space of successively decreasing cross section from the topmost grate to the lowermost of said grates, heating means applicable at the lowest of said chambers and adapted to diffuse its heat successively over the grates above, means for admitting air beneath and at the sides of the lowermost of said series of grates, air distributing means disposed along the length of the furnace at the sides of the other grates, and means for regulating said last named air distributing means.

4. An incinerator for city refuse and the like, comprising, in combination, a furnace enclosing a continuous horizontally disposed series of chambers the tops of said chambers being arranged vertically in echelon, a series of correspondingly arranged, stepped, endless, traveling grates in said chambers, said grates movable longitudinally within said chambers whereby refuse received upon the topmost of said grates is delivered successively to the grates below, means to feed refuse into said furnace and onto the topmost grate, said grates forming with the tops and side walls of corresponding chambers operating space of successively decreasing cross section from the topmost grate to the lowest said grates, the largest cross section being located above the topmost grate and the smallest cross section above the lowest grate, heating means applicable at the lowest of said chambers and adapted to diffuse its heat successively over the grates above, air distributing means for combustion disposed along the length of the furnace at successive grate levels, distributing means located adjacent to the refuse receiving end of said furnace whereby the refuse is uniformly distributed on said grates, and an exit for the gases of combustion adjacent to the point of entry of the refuse into the furnace.

5. An incinerator for city refuse and the like, comprising, in combination, a furnace enclosing a continuous horizontally disposed series of chambers the tops of said chambers being arranged vertically in echelon, a series of correspondingly arranged, stepped, traveling grates in said chambers whereby refuse received upon the topmost of said grates is delivered successively to the grates below, means to feed refuse into said furnace and onto the topmost grate, said grates forming with the tops and side walls of corresponding chambers operating space of successively decreasing cross section from the topmost grate to the lowermost grate, the largest cross section being located above the topmst grate and the smallest cross section above the

lowest grate, heating means applicable at the lowest of said chambers and adapted to diffuse its heat successively over the grates above, means for admitting air beneath and at the sides of the lowermost of said series of grates, distributing means located adjacent to the refuse receiving end of said furnace whereby the refuse is uniformly distributed on said grates, air distributing means disposed along the length of the furnace at the sides of the other grates, and means for regulating said last named air distribtuing means.

6. An incinerator for city refuse and the like, comprising, in combination, a furnace enclosing a continuous horizontally disposed series of chambers the tops of which are arranged vertically in echelon, a series of correspondingly arranged, stepped, endless, traveling grates arranged so that the feeding end of one grate is in substantial vertical alignment with the discharge end of an adjacent grate, said grates forming with the tops and side walls of corresponding chambers operating space of successively decreasing cross section from the topmost grate to the lowermost grate, the largest cross section being located above the topmost grate and the smallest cross section above the lowest grate, means to feed refuse into said furnace and onto the topmost grate, and heating means located adjacent to said lowermost grate.

7. An incinerator for city refuse and the like, comprising in combination a furnace enclosing a continuous horizontally disposed series of chambers, the tops of said chambers being arranged in vertically echeloned formation, a series of endless traveling grates in said chambers positioned in stepped formation corresponding to the formation of the tops of the chambers whereby refuse received upon the topmost of said grates is delivered successively to the grates below, said traveling grates being arranged to form with the top of said chambers an operating space of successively decreasing height from the chamber housing the topmost grate to the chamber housing the lowermost grate, means to feed refuse into said furnace and onto the topmost grate, heating means applicable at the lowest of said chambers and adapted to diffuse its heat successively over the grates above, air distributing means for combustion disposed along the length of the furnace at successive grate levels, and an exit for the gases of combustion adjacent to the point of entry of the refuse into the furnace.

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