June 18, 1935. J. E. GREENAWALT 2,005,082

INCINERATOR FURNACE

Filed June 17, 1931 6 Sheets-Sheet 1

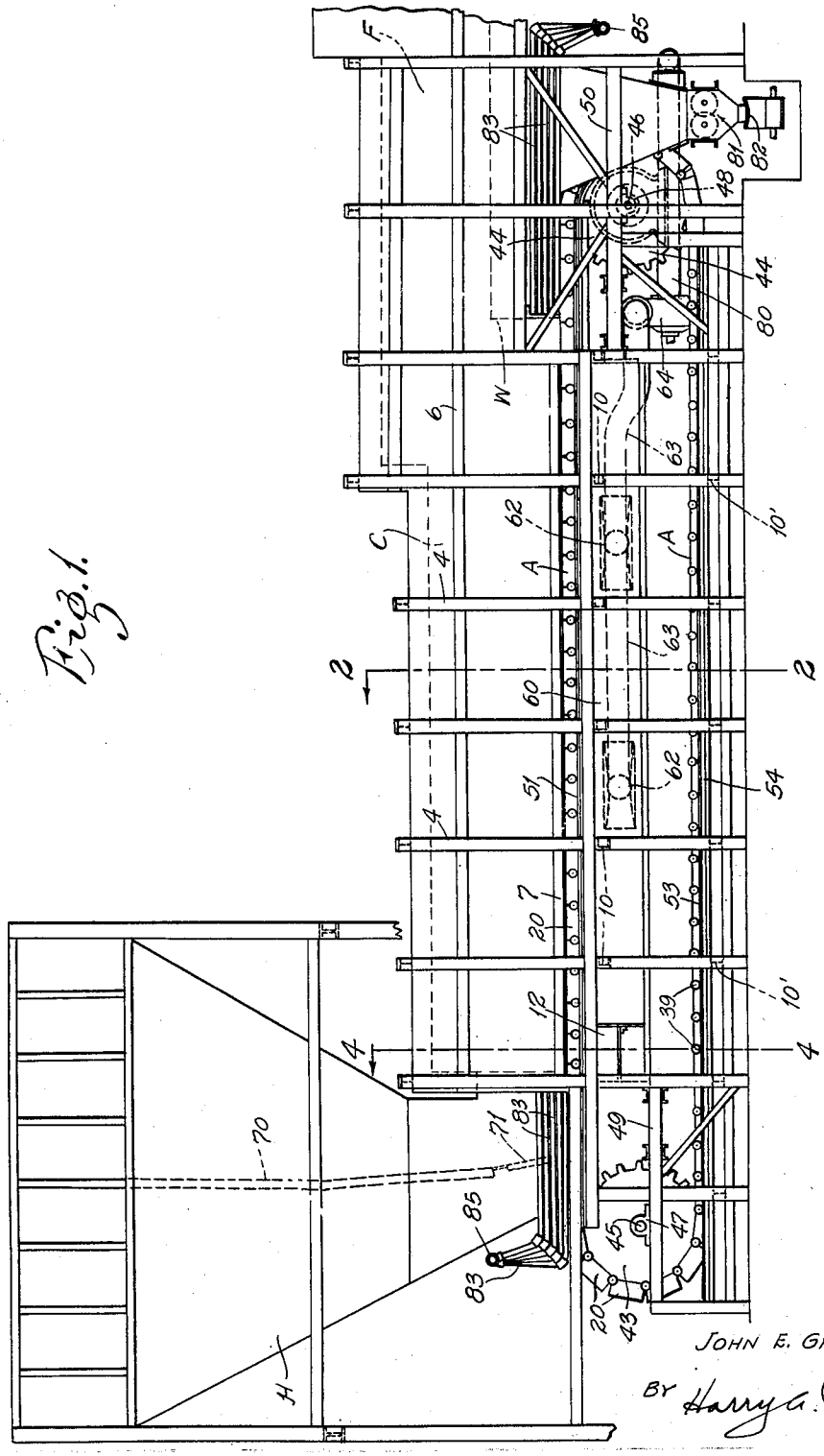

Fig. 1.

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INCINERATOR FURNACE

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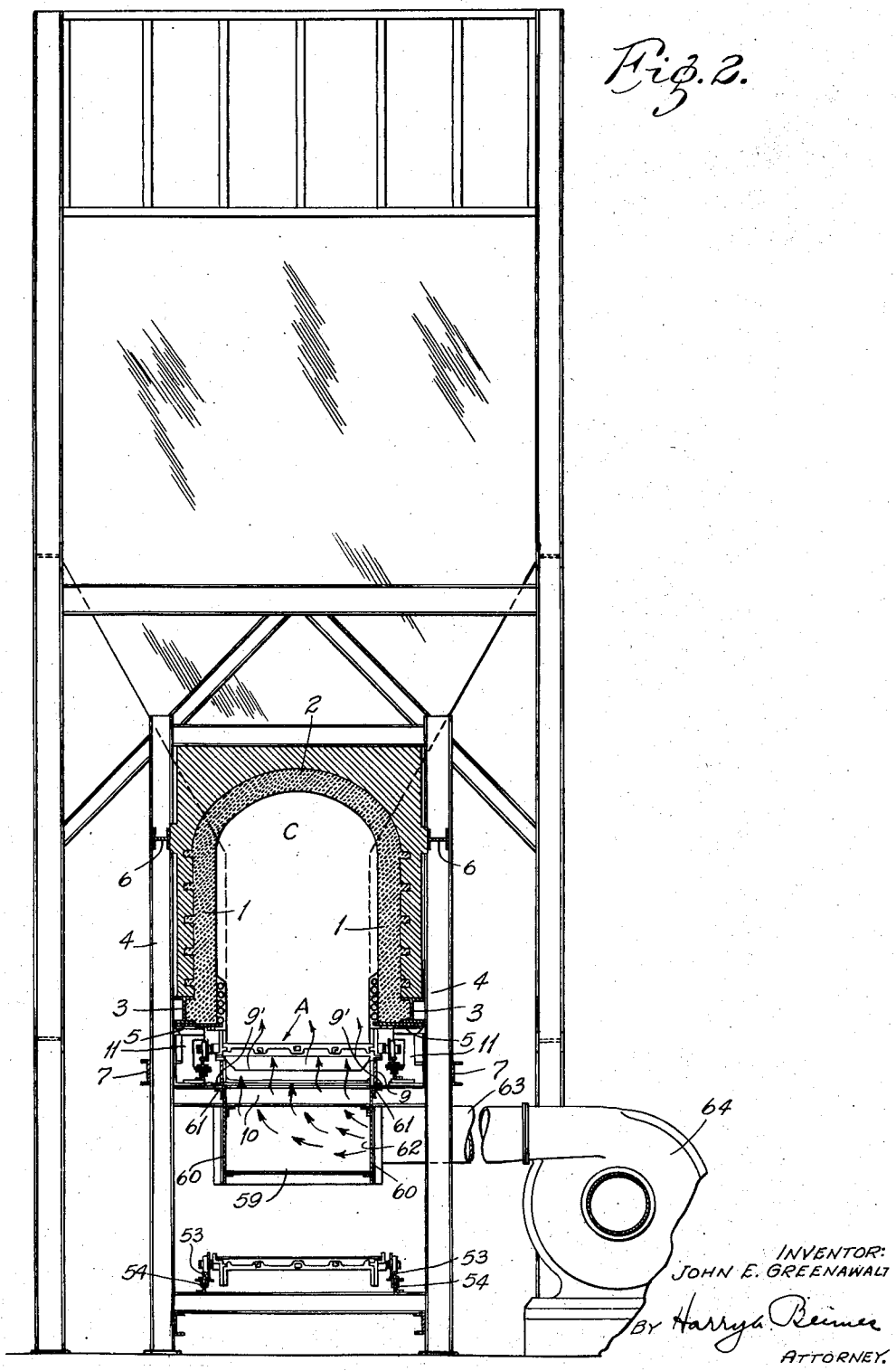
Fig. 2.



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INCINERATOR FURNACE

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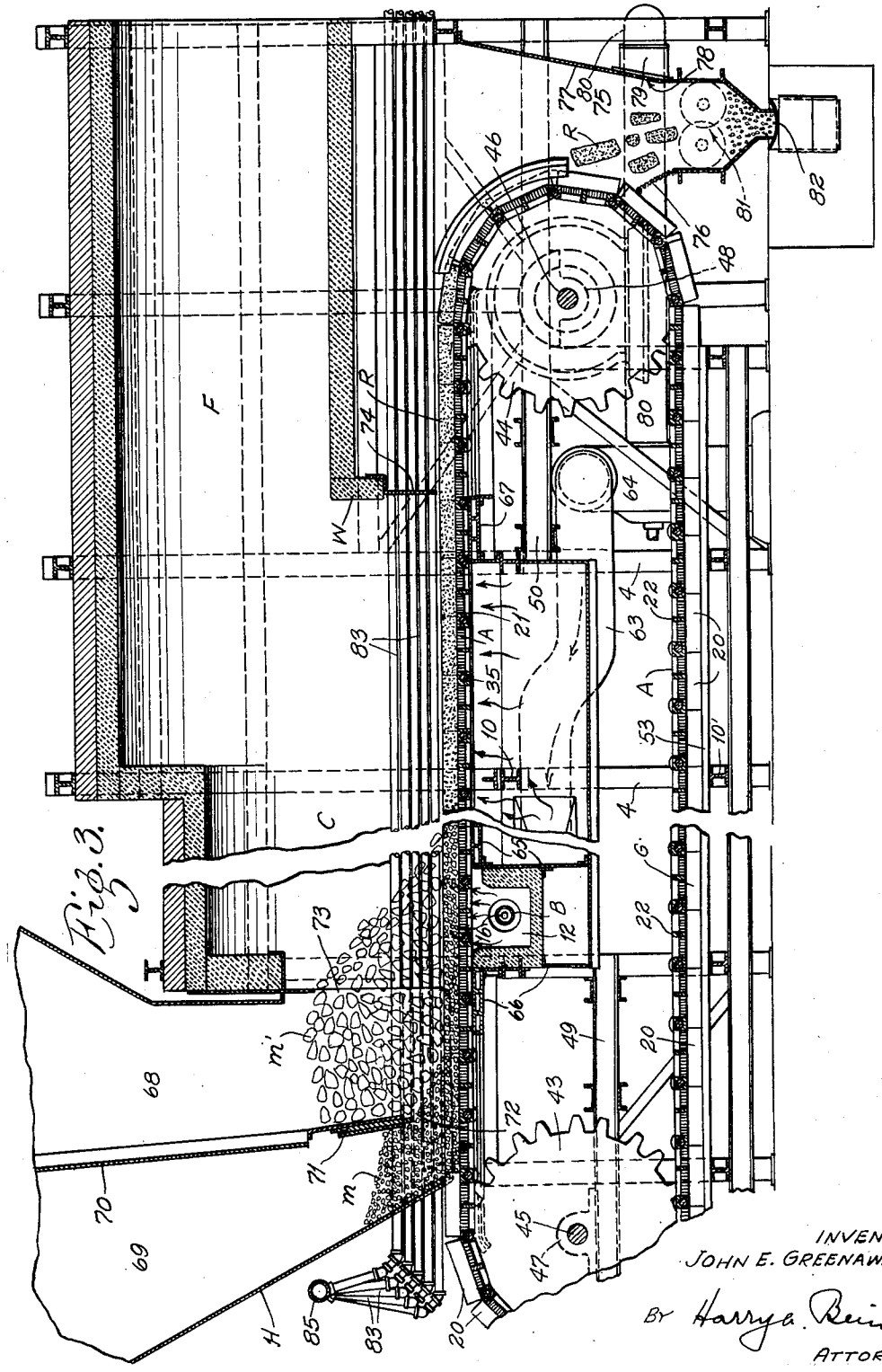

Fig. 3.

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INCINERATOR FURNACE

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Fig. 11.

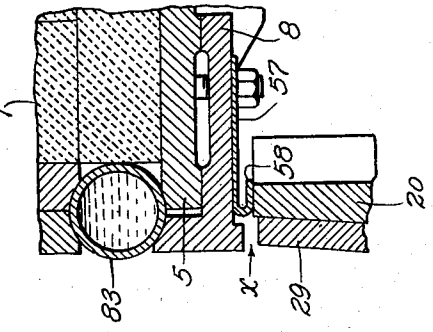

Fig. 4.

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Fig. 5.

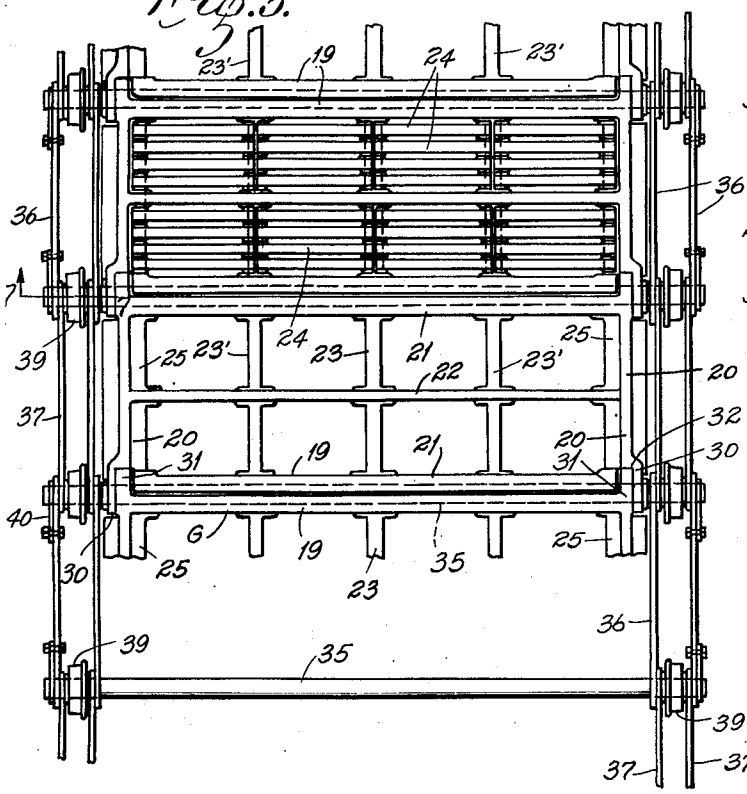


Fig. 6.

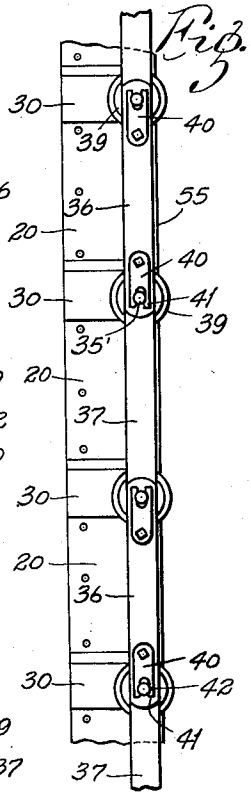
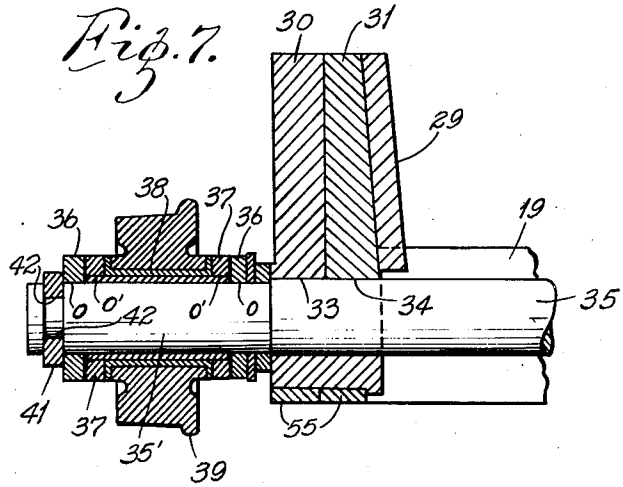


Fig. 7.



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June 18, 1935. J. E. GREENAWALT 2,005,082

INCINERATOR FURNACE

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Fig. 8.

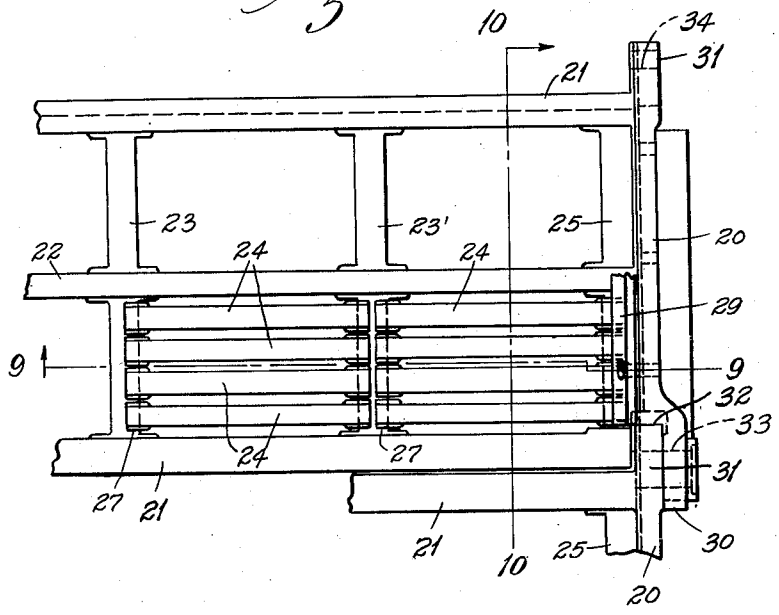


Fig. 9.

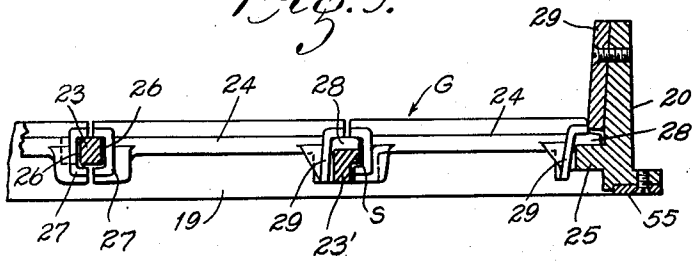
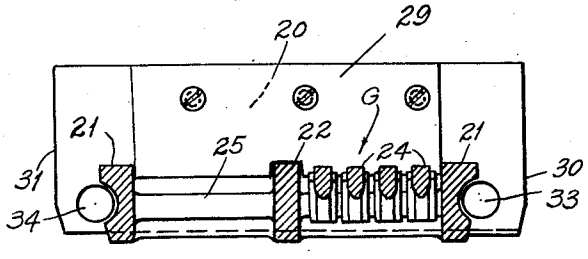


Fig. 10.



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Patented June 18, 1935 2,005,082

UNITED STATES PATENT OFFICE

2,005,082

INCINERATOR FURNACE

John E. Greenawalt, New York, N. Y.

Application June 17, 1931, Serial No. 544,973

4 Claims. (Cl. 110—8)

My invention has relation to improvements in incinerating furnaces and it consists in the novel features of construction more fully set forth in the specification and pointed out in the claims.

The furnace is particularly adapted for the burning of refuse including garbage and has for its principal object the provision of means for causing the refuse material to travel through the combustion chamber of the furnace, during which travel the material (ordinarily containing considerable moisture) has an opportunity to dry so that combustion thereof may be complete. Another advantage of the travel of the material through the furnace is that the feeding of the material into the combustion chamber and the discharge of the clinker residue from the furnace may be automatic, completely eliminating manual labor in the performance of these operations.

Heretofore incinerating furnaces for the purpose of burning garbage and other refuse have presented two main problems, the one involving the drying of the wet refuse so that it might be burned and the other the ejecting of the clinker, produced in the incinerating operation, from the furnace. The first problem has been met by the provision of a drying hearth, or equivalent device, on which the wet material is laid out before being charged into the furnace, but up to the present time no satisfactory method has been evolved for removing the clinker from the furnace without exposing the furnace to the cooling effect of the atmospheric air.

I have overcome these difficulties by providing a furnace in two sections, one of which embodies the combustion chamber, and the other embodies the grate adapted to travel beneath the combustion chamber, said grate carrying the material from the charging end of the combustion chamber entirely through said chamber and automatically dumping the resulting clinker into the receiving hopper.

It is a further object of my invention to provide a furnace having a traveling grate on which the material may be fed in graded components, and that component which is more readily kindled is charged directly on the grate and ignited by a suitable igniting device just as the charge of material enters the combustion chamber of the furnace. Since the lower part of the furnace travels beneath the upper stationary part, means of course are provided to establish a substantially air-tight joint between the relatively movable sections.

Further objects of the invention are to dispose the actuating parts for the traveling grate entirely outside the influence of the combustion chamber so they will not be exposed to the heat thereof; and to arrange beneath the traveling grate an air-box for causing a blast of air to pass upwardly through the grate and the superincumbent charge for supporting the combustion thereof. It is also the object of the present invention to collect the clinker as it is discharged from the traveling grate and prepare said clinker for further treatment, such as the manufacture of concrete blocks for building purposes; and it is also one of my objects to reclaim the heat units resulting from the incinerating operation and conduct the hot gaseous products of combustion from the combustion chamber through the passes of a boiler where this heat is converted into energy.

Other advantages inherent in the invention will be better apparent from a detailed description of the same in connection with the accompanying drawings in which:

Figure 1 is a side elevation of the furnace; Fig. 2 a vertical cross-section therethrough taken on the line 2—2 of Fig. 1; Fig. 3 is a vertical middle longitudinal section through the furnace with parts broken away; Fig. 4 is a vertical section through the furnace taken on the line 4—4 of Fig. 1; Fig. 5 is a top plan of the traveling section of the furnace comprising the conveyor, the pallets and the grate bars; Fig. 6 is a side elevation of the structure shown in Fig. 5; Fig. 7 is a cross-sectional detail taken on the line 7—7 of Fig. 5; Fig. 8 is an enlarged top plan of a portion of connected pallets and some of the grate bars supported thereby; Fig. 9 is a cross-sectional detail taken on the line 9—9 of Fig. 8; Fig. 10 is a cross-sectional detail taken on the line 10—10 of Fig. 8; and Fig. 11 is an enlarged portion of the vertical section in Fig. 4 showing a detail thereof.

Referring to the drawings 1, 1 represents the side walls of the furnace surmounted by the arched roof 2, said walls and roof enclosing a long tunnel-like combustion chamber C. The furnace walls are carried by longitudinally extending I-beams 3, 3 structurally secured to the vertical I-beams 4, 4 equally spaced along the sides of the furnace wall and also serving as buck-stays for the furnace. Bracket members 5, 5 are secured to the bottom flanges of I-beams 3, 3 and extend inwardly slightly more than the thickness of the furnace walls 1, 1 and help to carry said walls. Opposite buck-stays 4, 4 are connected at the top by I-beams 6, and the buck-stays on each side of the furnace are maintained in spaced re-

lation by channels 7. Thus, the walls 1, 1 and furnace roof 2 which together constitute the upper section of the furnace are carried by the I-beams 4, 4 through the overhanging brackets 5, 5 beneath which the traveling section A of the furnace operates.

The traveling section A of the furnace operates immediately below wall plates 8, 8 secured to brackets 5, 5 which extend slightly beyond the inner edge of said brackets. Said section A operates in intimate relation with longitudinally extending channels 9, 9 below the plates 8, 8 and spaced therefrom, said channels being carried by a series of I-beams 10 extending between opposite buck-stays 4, 4 and secured thereto. These channels are rigidly held in their properly spaced relation by cross-beams 11, 11 equally spaced along the length of the channels. An igniting furnace, or fire-box, 12 is disposed between channels 9, 9 beneath the feed end of combustion chamber C, and a burner B is fitted into one end of the fire-box. Said burner B comprises a nozzle 13 connected to an air supply pipe 14 leading from air compressor 15, and a liquid fuel atomizer 16 is positioned within the nozzle 13, said atomizer being connected to a suitable source of liquid fuel supply by means of a pipe 17 and hose connection 18. It will be observed that the igniting furnace 12 is disposed immediately beneath the traveling section A of the furnace and comprises essentially a combustion chamber C' in which the fuel and air from the burner B are thoroughly mixed. The compressor 15 forces the air into the chamber C' under sufficient pressure to completely fill said chamber with flame and cause said flame to be expelled through the open top of the combustion chamber and impinge upon the material carried by the grate G mounted in the section A of the furnace.

The traveling section of the furnace comprises a series of pallets 19, the side walls 20, 20 of which are connected by cross-bars 21, 21 and 22. A series of grate supporting bars 23, 23', 23' extend between the intermediate bar 22 and marginal bars 21, 21 and grate bars 24 are arranged in juxtaposition between grate supporting bars 23, 23' and between grate supporting bar 23' and a flange 25 projecting inwardly from each side 20 of the pallet 19. Each of the grate bars 24 is formed with a channel 26 and a laterally extending boss 27 at one end, and a flange 28 and laterally extending boss 29 at the opposite end. In assembling the grate bars in the pallets a row of bars is disposed between grate supporting bars 23 and 23' so that the bar 23 traverses channels 26 and the flange 28 rests upon grate supporting bar 23'. When the outside rows of grate bars 24 are put into place their channels 26 receive the shoulder *s* of grate supporting bar 23' and flange 28 of the abutting grate bar. The flanges 28 of the outside grate bars 24 rest upon flanges 25 of the pallet side 20, the outer ends of these grate bars being held in place by dead plates 29 secured on the inner surfaces of sides 20 of the pallets. The sides 20 of the pallets extend beyond the cross-bars 21, 21, extension 30 lying in the plane just outside that in which extension 31 lies and a recess 32 is formed between extension 30 and cross-bar 21 to receive the extension 31 of the next adjacent pallet. Thus, extension 30 and extension 31 overlap and are provided with openings 33 and 34 respectively through which shaft 35 passes as shown in Fig. 7. Shafts 35 thus form pivotal connections between adjacent pallets and are connected by chains made up of links 36, 36 and links 37, 37 through the respective openings *o*, *o*, *o'*, *o'* of which the reduced extremities 35' of the shafts extend. Over the extremities 35' of each shaft and between links 37, 37 there is a bushing 38 on which is mounted a wheel 39. The links 36 and 37 of the chain that carries the pallets 19 are held in assembled relation by lock washers 40 bolted (as shown in Fig. 6) to outside links 36 and each having its bifurcated extremity 41 traversing oppositely disposed notches 42 in the extremity 35' of the shaft.

The parts just described constitute the traveling section of the furnace, and it will be observed that the sides 20, 20 of the pallets collectively form the bottom of the side walls of the furnace. The conveyor chain and supporting wheels for propelling this part of the furnace are mounted outside of the furnace walls and are therefore not subjected to the heat in the combustion chamber C. The chain carrying the pallets 19 is of the endless conveyor type and is adapted to travel over a sprocket 43 somewhat in front of the feed end of the furnace and a sprocket 44 beyond the discharge end of the furnace, said sprockets being mounted on shafts 45 and 46 respectively supported in bearings 47 and 48 by suitable structural members 49 and 50. The pitch of the teeth of the sprockets 43 and 44 corresponds with the spacing of the wheels 39 so that as the chain travels over the sprockets these wheels will mesh with the sprocket teeth. The top run of the pallets and chain is supported by rails 51, 51 on structural members 52 which in turn are carried by the transverse I-beams 10, the wheels 39 traveling over these rails. The bottom run of the pallets and conveyor is supported by rails 53, 53 carried by structural members 54 which are in turn supported by transverse I-beams 10' spaced some distance below the I-beams 10, wheels 39 traveling over these rails as the pallets are returned to the feed end of the furnace.

During the operation of the furnace it is desirable that no cold atmospheric air be admitted into the combustion chamber C, for which reason the bottom surfaces of the sides 20 of the pallets are provided with wearing strips 55 adapted to make light contact with wearing strips 56 disposed on the top surface of the channels 9. The weight of the pallets, together with the charge of material resting on the grate G is not entirely on the wearing strips 55 and 56, but on the rails 51, 51. However, in making the clearance between stationary wearing strip 56 and the movable wearing strip 55 as slight as possible there is bound to be some contact between these parts. A working clearance must also be maintained between the top surface of pallet sides 20 and wall plates 8 (as shown in Fig. 11) so that a slight space *x* between these relatively movable parts cannot be avoided. This space, however, is closed against the influx of atmospheric air by a sealing element 57 in the form of a metallic strip secured to the plate 8 near its outer edge, said strip having its inner edge 58 bent over so as to form a yielding seal between the pallets and the wall plate 8.

A wind-box 59 is arranged beneath the traveling section of the furnace extending from the igniter 12 rearwardly substantially the full length of the combustion chamber C, said wind-box having its sides 60, 60 secured to the bottom flanges 9', 9' of the channels 9, 9 by means of angle strips 61, 61. Thus the channels 9, 9 form an extension upwardly from the walls 60, 60 of the wind-box

so that in effect the wind-box is immediately beneath the traveling grate G of the furnace. There are a plurality of intakes **62, 62** in one wall **60** of the wind-box, said intakes being connected by a conduit **63** to a fan **64** for maintaining a suitable pressure of air within the wind-box and against the under side of the grate G. Immediately beneath the grate G and adjacent to the front and rear walls of the igniter **12** are dead-plates **65** and **66** to prevent the disturbance of the flaming particles issuing from the igniter-box **12** by air currents passing through the grate at the sides of said igniter-box. It is desirable that the flame issue from the igniter and pass directly upwardly into the material on the grate G so as to concentrate on a comparatively narrow strip. There is also a dead-plate **67** immediately beneath the grate G at the rear end of the wind-box **59** similar to the dead plate **65** for the purpose of preventing the escape of the air pressure through the grate into the atmosphere. The flow of air that passes from the wind-box upwardly through the grate is thus sealed against escape at the margins of the wind-box and directed upwardly through the material on the grate and into the combustion chamber C throughout its entire extent.

At the intake end of the furnace a hopper H is arranged with two compartments **68** and **69** separated by a partition **70** at the lower end of which is an adjustable extension **71** for the purpose of regulating the width of the opening **72** through which the material discharges from compartment **69** onto the grate G. The material *m* reaching the grate through the hopper **69** has been graded as to size and consists of mixed pieces of refuse matter previously screened so that the pieces are of a size that when arranged in a layer will constitute a layer of substantially uniform density. I have found that if the refuse (which contains a large percentage of ashes and unburned coal) is confined to particles of a size between $\frac{3}{16}$'' and 2½'' it will form an ideal layer on which to charge the ungraded refuse material *m'*, that is, all the mixed refuse above 2½'' in size which is discharged from the compartment **68** onto the layer *m* of graded material. As the grate G travels from beneath the hopper H into the combustion chamber C the material *m* and *m'* will be carried through the opening **73** into the combustion chamber C. As soon as the layer *m* comes over the igniter **12** the intensely hot flaming particles from said igniter will be forced upwardly against the bottom of said layer and into it, effecting ignition thereof; and since the travel of the grate G is continuous, ignition at the bottom of the layer *m* is also continuous, the layer being ignited as rapidly as it comes within the influence of the igniter. Immediately after the layer *m* is ignited it moves over the wind-box **59** and the combustion of the material is greatly accelerated by the blast of air that now passes through it. Throughout the entire travel of the material through the combustion chamber C it is subject to the air blast from air-box **59** and combustion proceeds accordingly. Since there is considerable moisture in the refuse matter before it is charged onto the grate G, the combustion thereof will be comparatively slow for a short period after ignition, but by the time the material has progressed approximately one-third the distance through the combustion chamber C the moisture has been sufficiently expelled to enable combustion to proceed more rapidly. Obviously, the heat of combustion of the material in the layer *m* will cause the more easily kindled particles of the mass of material *m'* to be ignited so that there will also be combustion in this mass of material when carried into the combustion chamber. That part of the charge which has reached approximately the middle of the combustion chamber C will have had practically all of its free moisture driven from it so that combustion of both the material *m* in the bottom layer and the materal *m'* superincumbent thereon will be intense from the middle of the chamber C to the rear end thereof. The heat of combustion becomes so intense near the rear end of the combustion chamber C that all gases traveling through the combustion chamber are oxidized and purified and the gaseous products of combustion will be absolutely free from any odor by the time they reach the flue F, which may serve to conduct these gaseous products of combustion to a suitable boiler where the heat units may be recovered therefrom.

The rear end of the combustion chamber C terminates in a bridge wall W from which there is suspended a hinged gate **74**, the lower end of which may rest upon the clinker R forming the residue in the pallets **19** as they leave the combustion chamber C. The pallets then carry this clinker R around the sprocket **44** into a receiving hopper **75** into which the clinker is automatically dumped from the pallets as they are tilted. By the time the pallets leave the hopper **75** they have been emptied, in which condition they start their return trip back to the front end of the furnace.

The wall **76** of hopper **75** is perforated as shown and the opposite wall **77** thereof is provided with a grid **78** over which a box **79** is disposed. The box **79** is connected to the intake of fan **64** by a pipe **80** so that said fan will draw its supply of air from the hopper **75** which the air enters through the perforated wall **76**. As the air rushes through the hopper **75** and through the spaces between the lumps of clinker R therein it will greatly reduce the temperature of this clinker. A suitable crusher **81** may be disposed below the hopper **75** for breaking the clinker into small particles before it is discharged onto conveyor **82** which carries the finely divided clinker away for subsequent treatment.

In order to protect the inner surface of the furnace walls from the intense heat generated in the combustion chamber C, I provide at the bottom of each wall **1** a bank of water circulating pipes **83**, said pipes being held to the wall by suitable hangers **84** and leading to a main **85** at the front end of the furnace and a main **86** at the rear end of the furnace.

Having described my invention I claim:

1. A furnace comprising a stationary section and a traveling section subjacent thereto, said stationary section enclosing a combustion chamber, said traveling section comprising a series of connected pallets having side walls collectively forming the lower part of the furnace walls, a grate in each of said pallets, driving means and supporting means outside the furnace walls for moving said pallets through the combustion chamber, means for feeding material into the pallets at one end of the combustion chamber, means for dumping the pallets at the opposite end of the combustion chamber, a stationary igniter beneath said pallets near the inlet end of the combustion chamber and means for causing a supporter of combustion to traverse the pallets and material therein.

2. A furnace comprising a stationary section having a combustion chamber therein and a traveling section operable below said combustion chamber, said traveling section comprising an endless chain of pallets, means for driving said chain of pallets, means outside the furnace walls for supporting said pallets as they travel beneath the combustion chamber, means for feeding material into the pallets at one end of the combustion chamber, means for dumping the pallets at the opposite end of the combustion chamber, a stationary igniter immediately beneath the pallets near the inlet end of the combustion chamber, a wind-box extending beneath the pallets from the igniter to the dumping end of the pallets, means for sealing the joint between the pallets and the stationary furnace section, and means for sealing the joint between the pallets and the wind-box.

3. A furnace comprising a stationary section and a traveling section subjacent thereto, said stationary section enclosing a combustion chamber, said traveling section comprising a movable grate having side walls collectively forming the lower part of the furnace walls, driving means and supporting means outside the furnace walls for moving said grate through the combustion chamber, means for feeding material onto the grate at one end of the combustion chamber, means for dumping the grate at the opposite end of the combustion chamber, a stationary igniter beneath said grate near the inlet end of the combustion chamber and means for causing a supporter of combustion to traverse the grate and material thereon.

4. A furnace comprising a stationary section enclosing a combustion chamber, a traveling section subjacent thereto and forming the bottom of said combustion chamber, said traveling section including a grate, means for feeding material onto said grate at the beginning of its travel under the combustion chamber, means for igniting the material, a wind-box beneath the grate and adjacent to the igniting means, means for sealing the joint between the stationary furnace section and the traveling section, and means for sealing the joint between the traveling section and the wind-box.

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