Nov. 24, 1931. W. E. TRENT 1,833,801

PROCESS OF AND APPARATUS FOR BAKING CARBONACEOUS MATERIALS

Filed Jan. 18, 1928 8 Sheets-Sheet 1

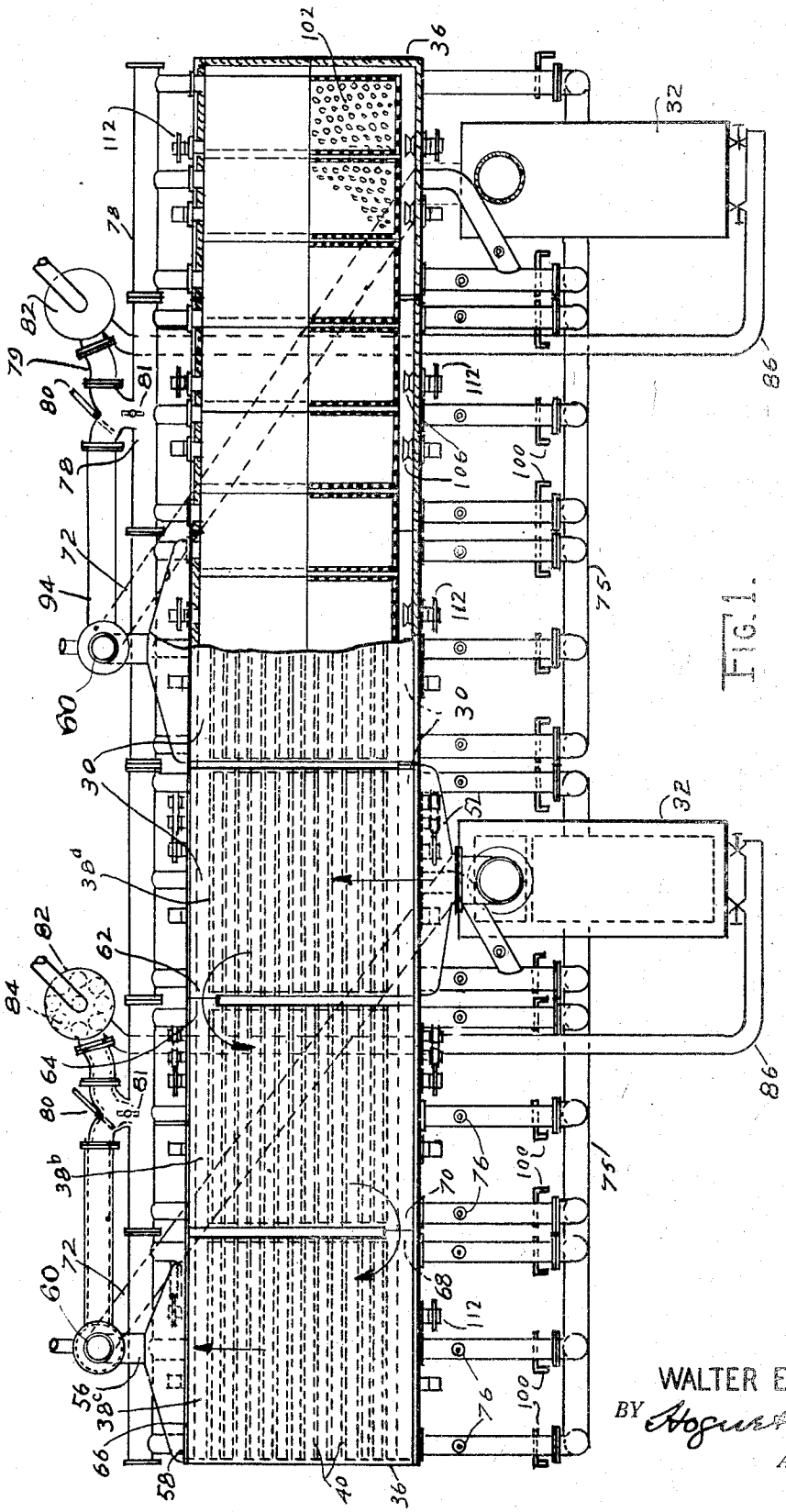


FIG. 1.

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PROCESS OF AND APPARATUS FOR BAKING CARBONACEOUS MATERIALS

Filed Jan. 18, 1928 8 Sheets-Sheet 2

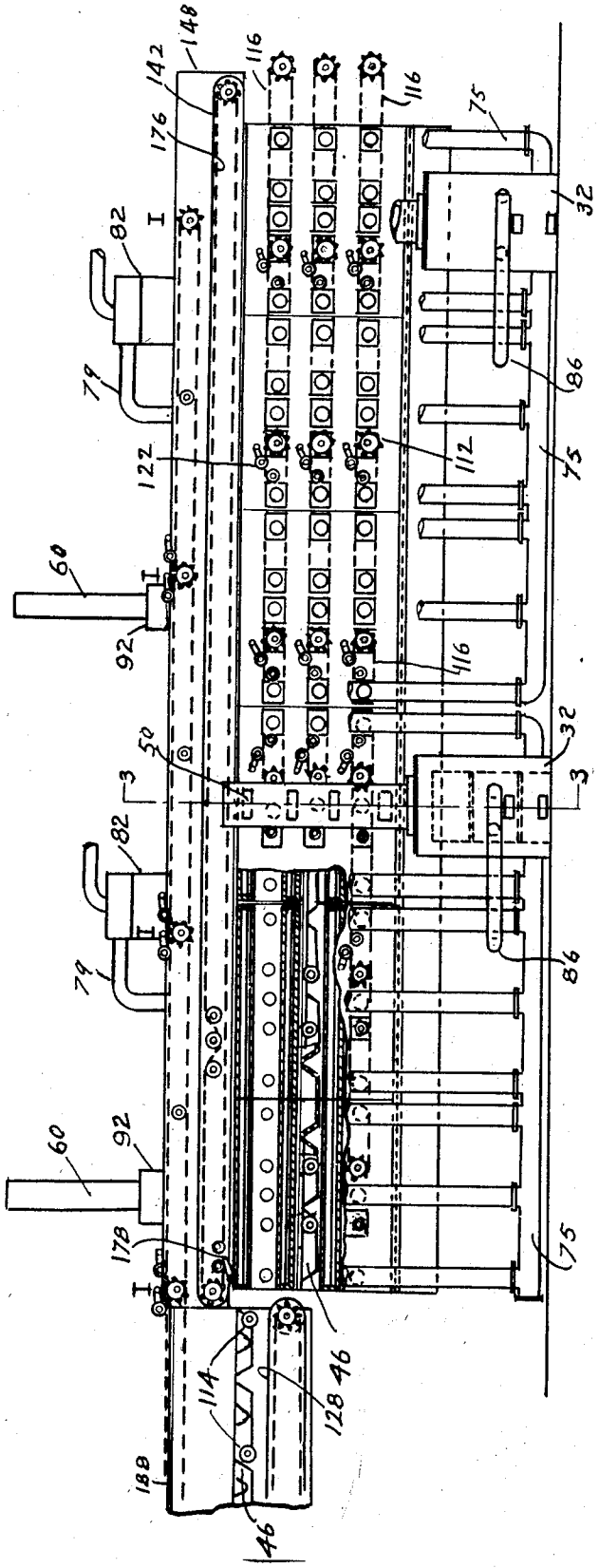


FIG. 2.

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PROCESS OF AND APPARATUS FOR BAKING CARBONACEOUS MATERIALS

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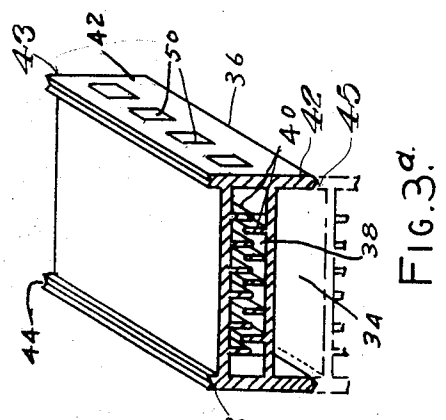


FIG. 3a.

FIG. 3.

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PROCESS OF AND APPARATUS FOR BAKING CARBONACEOUS MATERIALS

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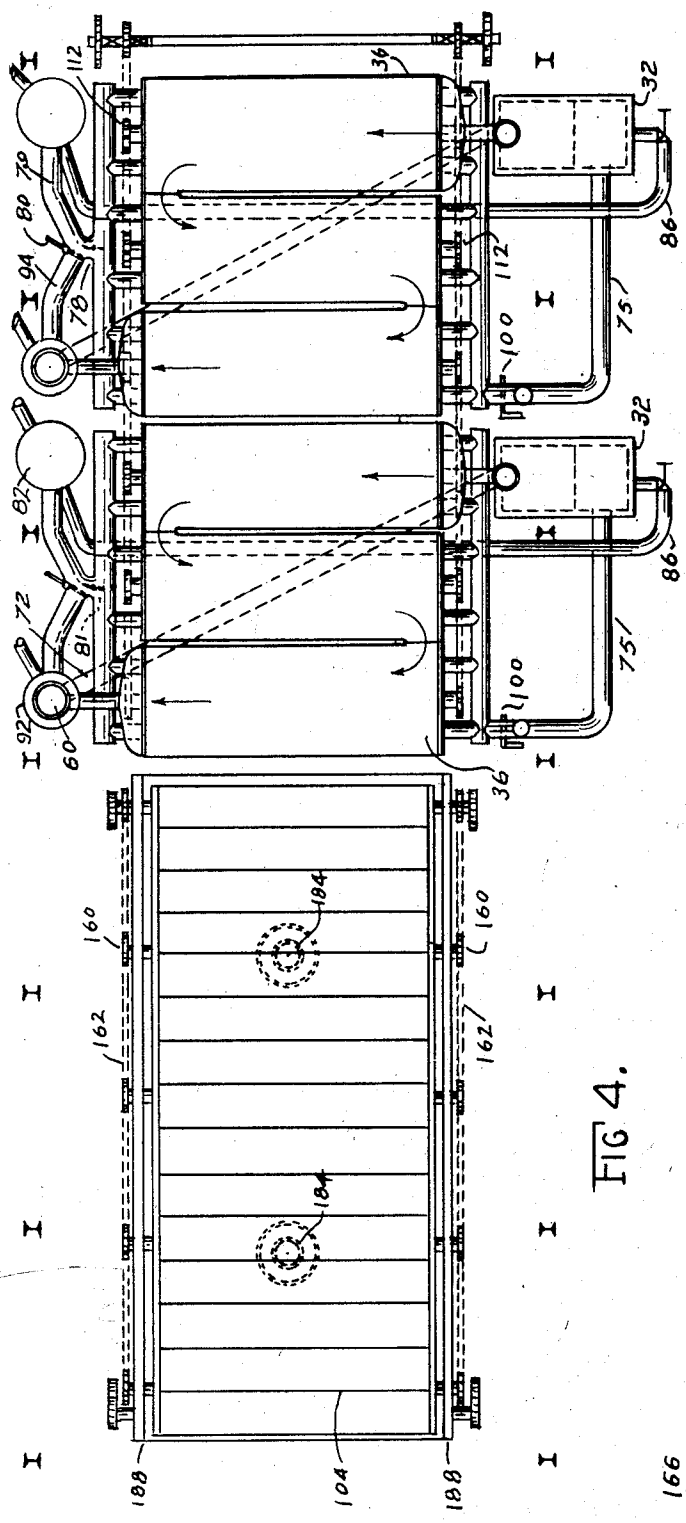


FIG 4.

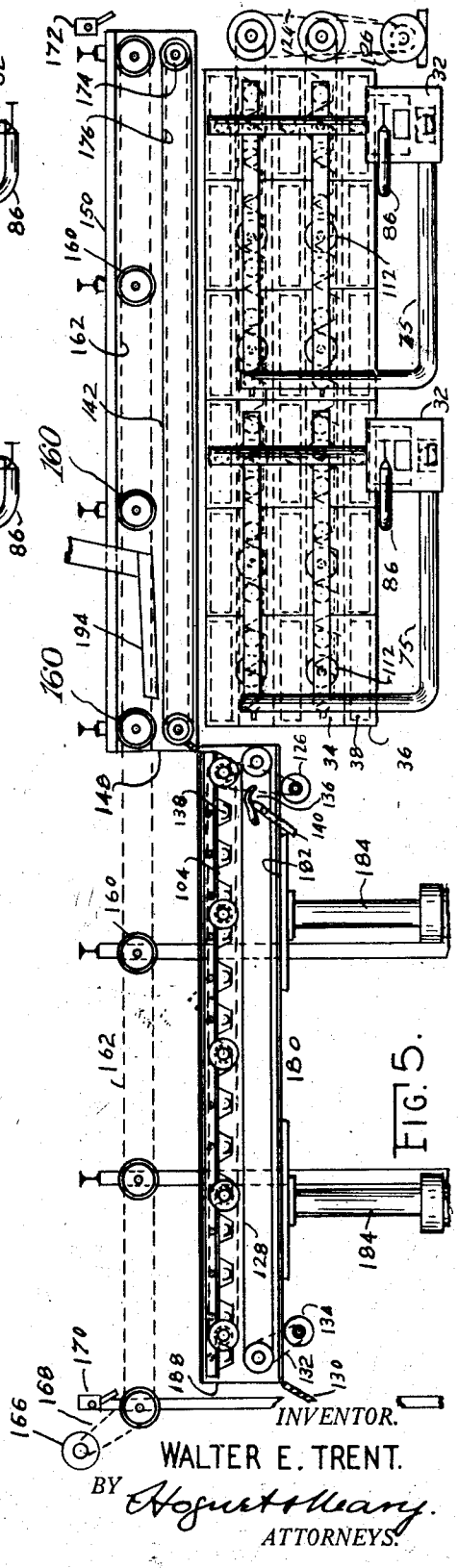


FIG. 5.

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PROCESS OF AND APPARATUS FOR BAKING CARBONACEOUS MATERIALS

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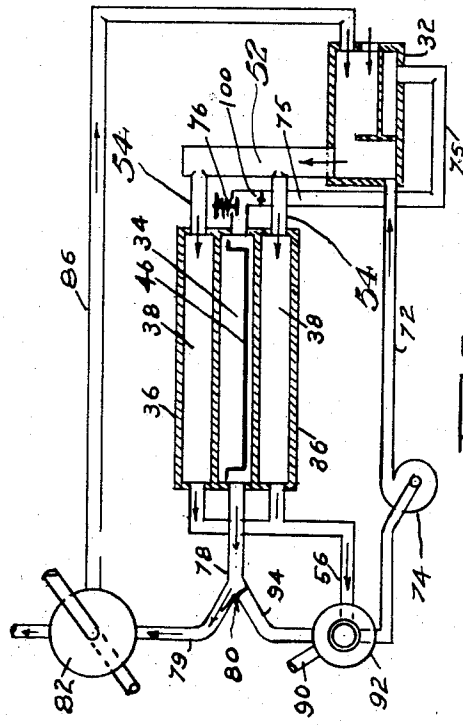


FIG. 7.

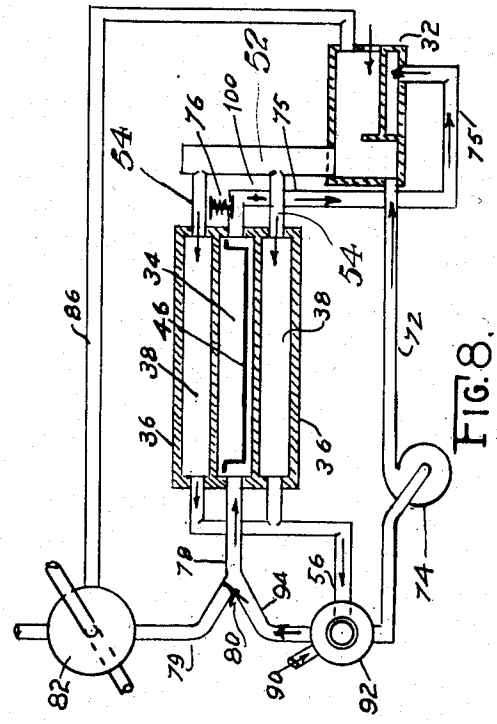


FIG. 8.

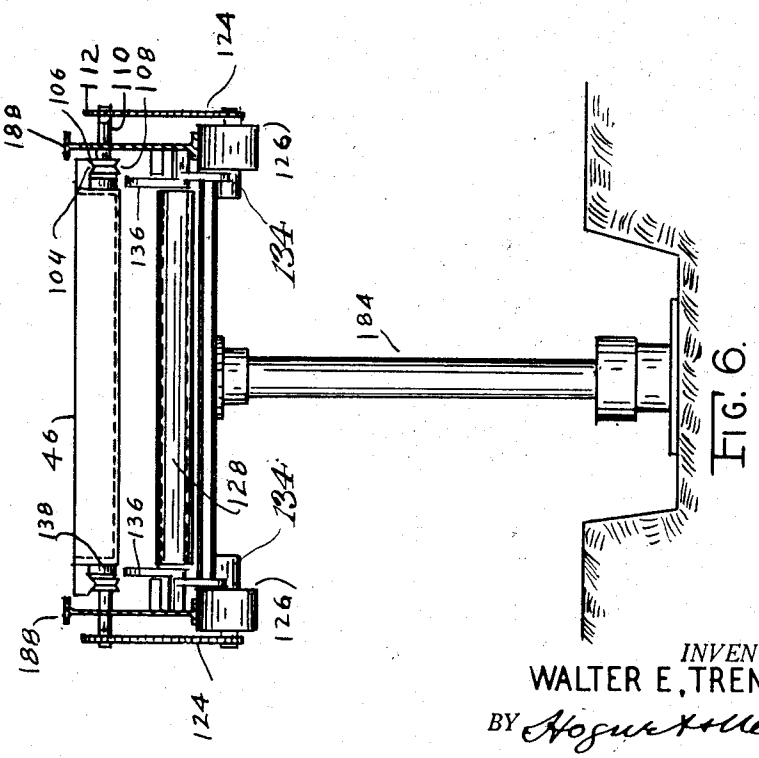


FIG. 6.

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PROCESS OF AND APPARATUS FOR BAKING CARBONACEOUS MATERIALS

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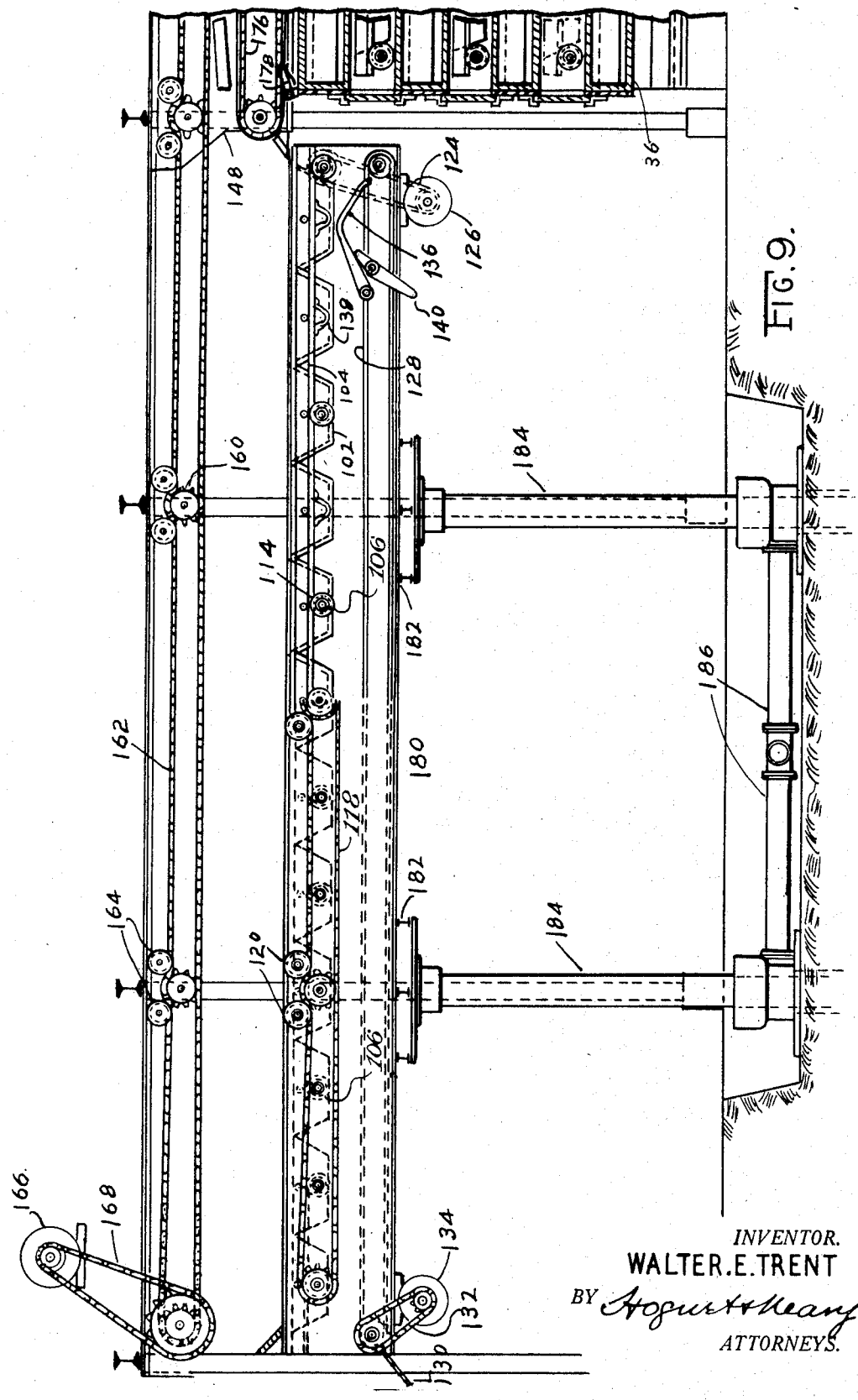


FIG. 9.

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PROCESS OF AND APPARATUS FOR BAKING CARBONACEOUS MATERIALS

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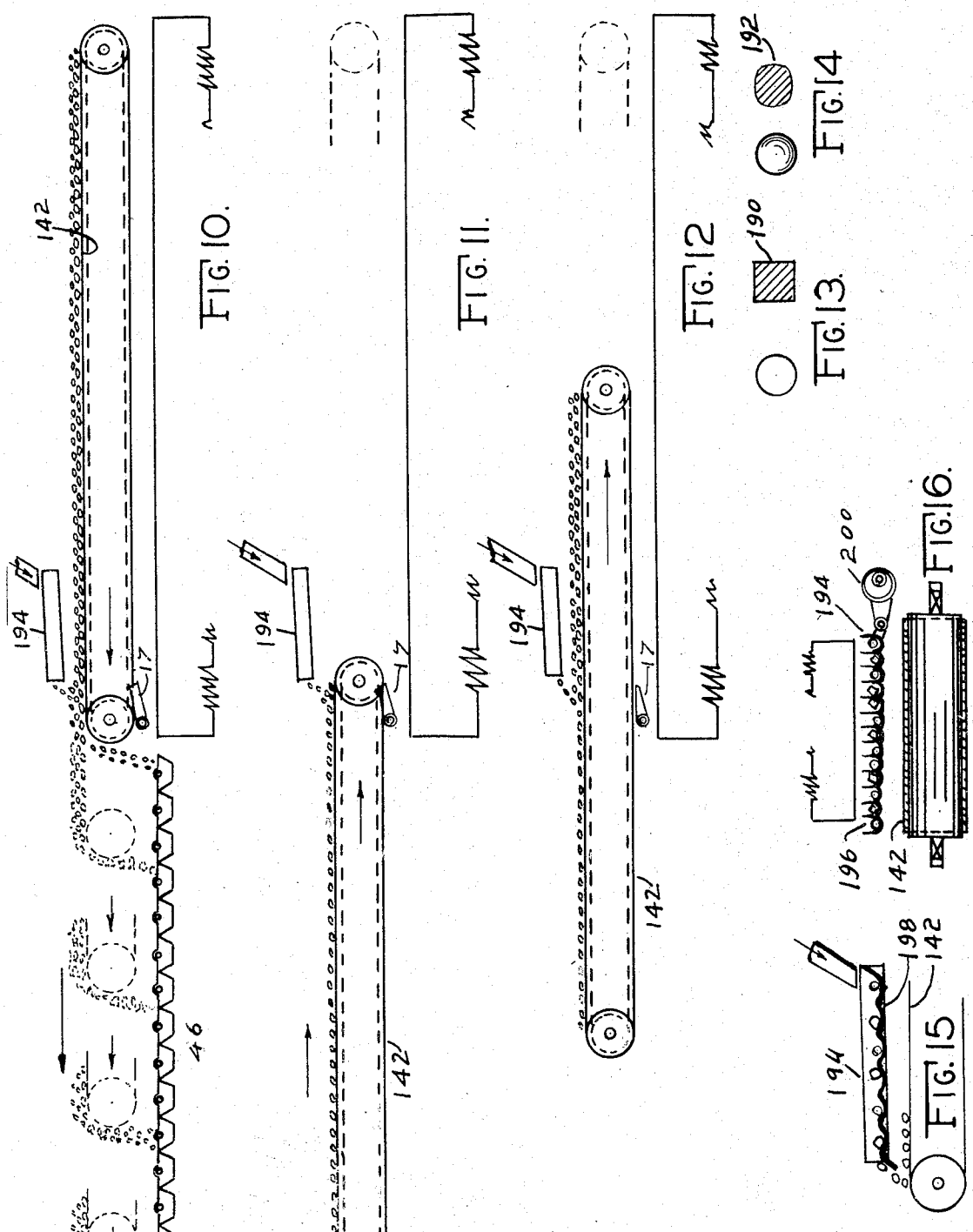


FIG. 10.

FIG. 11.

FIG. 12

FIG. 13.

FIG. 14

FIG. 16.

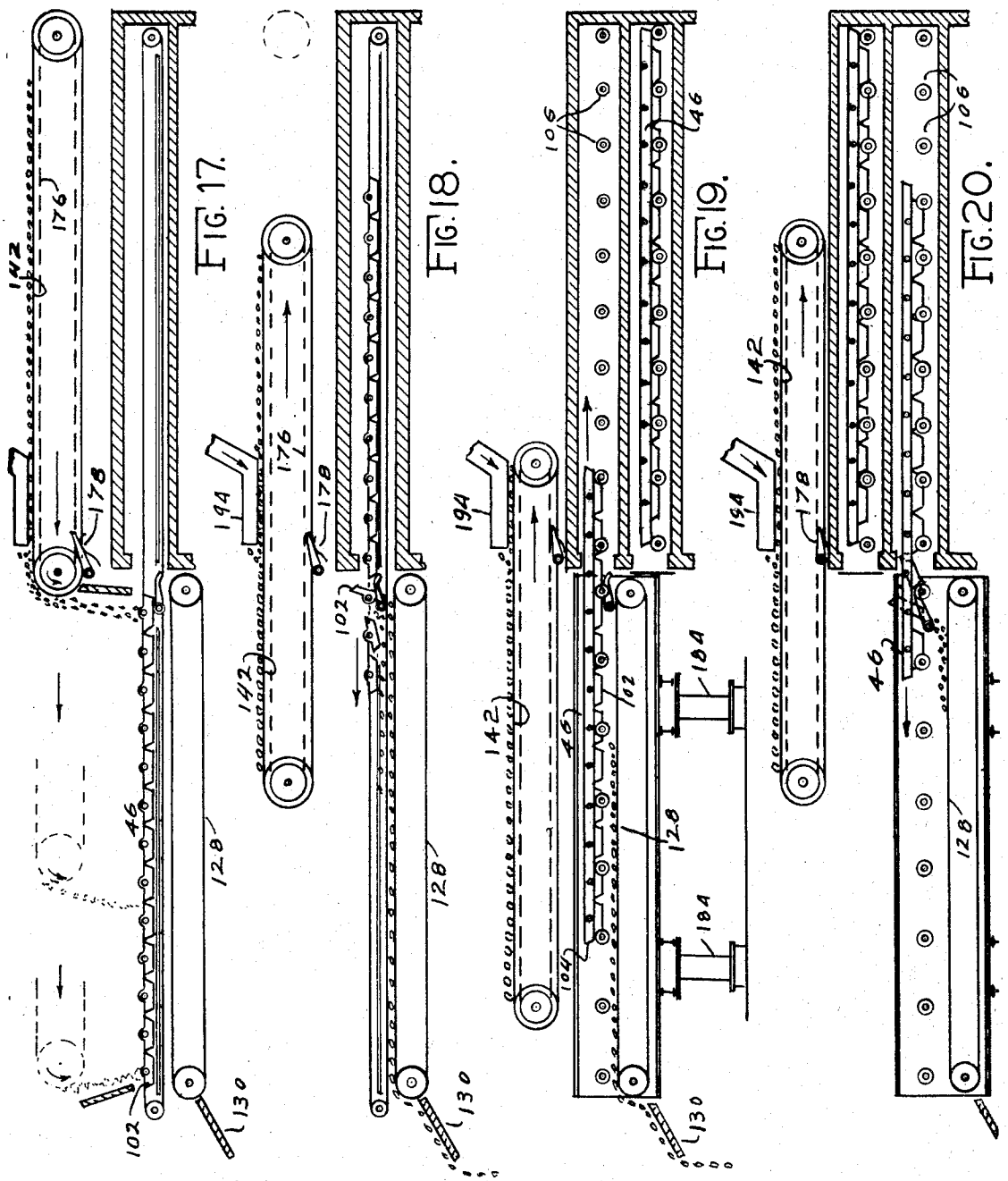
FIG. 15

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PROCESS OF AND APPARATUS FOR BAKING CARBONACEOUS MATERIALS

Filed Jan. 18, 1928 8 Sheets-Sheet 8



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UNITED STATES PATENT OFFICE

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PROCESS OF AND APPARATUS FOR BAKING CARBONACEOUS MATERIALS

Application filed January 18, 1928. Serial No. 247,675.

My invention relates to an apparatus for heating materials and particularly to an apparatus designed to bake amalgam briquettes in two stages according to the method disclosed in my co-pending application Serial No. 234,261, filed Nov. 18, 1927.

As stated, my invention is primarily designed for baking amalgam briquettes, preferably such as those made according to the teachings of my former Patents Nos. 1,464,164 and 1,464,165. My invention, however, is adapted in its broader aspects to heating other materials and contains certain features of charging and discharging and heat conservation, etc. which may be applied in other combinations. While my invention preferably comprises an oven having a plurality of heating chambers adapted to successively bake charges of material for substantially uniform times, it is apparent that certain features of my invention, particularly the heat conservation features and certain features of my loading apparatus, may be applied to an individual oven.

The heat conservation features of my invention include means for controlling the temperature of the heating gases by returning and mixing therewith a predetermined portion of the products of combustion; a condenser intermittently connectible to said oven and means to return the non-condensed volatiles and gases from said condenser as fuel to the fire box instead of exhausting them into the air; means to admit air to said oven and to lead the air and the volatiles evolved during the second stage of the heat treatment from the oven to the fire box, said means being connectible to said oven alternately with the condenser, to serve as an additional source of fuel and air for combustion during the second stage; and means to pass said air prior to its entry to said oven in counter-current heat interchange with the waste products of combustion of the fuel to preheat the same. In my preferred apparatus, I have embodied all these features into a device including a plurality of heating chambers so arranged that the charging and discharging features of my invention may be employed advantageously and the respective baking steps applied to the fuel contained in each oven successively.

Further objects of my invention relate to the specific construction of my multiple chamber baking oven. I provide a battery of normally closed horizontal baking ovens vertically disposed one above the other, each having one or more fuel containers removable from one end thereof for charging and discharging purposes. The ovens are vertically spaced from each other to provide horizontal transverse passageways for uniform application of heat thereto, and I preferably provide baffles or other means in said horizontal passageways to produce a turbulent flow of heating gases therethrough.

I further provide a multiple chamber baking oven which merely consists of a plurality of castings and which is thus very easy to construct and assemble. Each casting is so shaped as to define an enclosed transverse passageway preferably having baffles therein, and has legs substantially the length of the casting depending from each side thereof, and other legs extending upwardly from each side. The respective pairs of legs are provided with means at their outer extremities causing such castings, when assembled with other similar castings in forming a multiple chamber oven, to be held in fixed relation to one another. Such means may, for example, consist of longitudinal grooves or slots in the outer edge portions of certain legs and beveled portions on other legs so that when the castings are assembled the beveled portions of the legs on one casting will seat in the grooves or slots on the legs of an adjacent casting. By means of these castings it is a relatively simple matter to build up a baking apparatus comprising a battery of horizontal baking ovens vertically disposed one above the other, and a plurality of enclosed transverse passageways extending underneath each oven to impart indirect heat thereto. I preferably construct these castings with openings adjacent each side thereof to permit heating gases to be introduced on one side and caused to travel in zigzag paths around the baffles provided therein to better impart heat to ovens adjacent thereto.

Further novel features of my invention relate to the method of loading and unloading the fuel containers, particularly to the novel feature of changing the continuous feed from the extruding or briquetting machine, or the rounding-off machine if this is also employed, to an intermittent feed to each oven to load each respective oven with a substantially equal fuel charge.

In the method of continuously making amalgam as more particularly described in my co-pending application Serial No. 204,069, filed July 7, 1927, a continuous feed of raw amalgam comes from the amalgam plant through an extruding machine, and also if desired through my improved rounding-off machine. Due to the details of that process it functions most economically continuously, but if the baking operation is to be carried out with optimum conditions of safety, oil recovery and desired quality in the finished briquette according to the teachings of my application Serial No. 234,261, filed Nov. 18, 1927, hereinbefore referred to, it is essential that the two stages of baking must be completely separated. Hence it is necessary to provide means to change this continuous feed into an intermittent feed for each oven to load uniform charges of fuel in each oven. To change this continuous feed from the extruding and rounding-off machines to a suitable intermittent feed to the ovens, I preferably provide an endless conveyor which is adapted to be so operated and to be so moved relative to the extruding and rounding-off machines on the one hand and to a position adjacent the charging and discharging openings of the ovens on the other that the fuel charges are continuously received on to the conveyor from the extruding and rounding-off machines and discharged therefrom intermittently to containers being introduced into the ovens. I successively remove the fuel container or containers from each individual oven to a position underneath the conveyor, after subjecting the material in the respective fuel containers to a two-stage heat treatment, discharge the fuel charges carried by the conveyor thereinto, and return the fuel containers to their respective ovens at such substantially uniform periods of time that each oven will receive a substantially equal fuel charge from the conveyor, and I coincidently dump the contents of each fuel container while attaining its position underneath the conveyor to receive a green fuel charge. The principles of loading and unloading the fuel container from the conveyor may be employed, if desired, on an individual oven but are particularly adapted to successively load a battery of vertically-disposed ovens, and I therefore preferably mount fuel container supports or guideways and a discharging conveyor or other heated fuel receptacle on an elevator movable to positions underneath the outside position of the fuel container opposite its respective oven so that the baked fuel may be dumped therein without danger of breakage from a long fall. Further features of my invention relate to the means I preferably provide to attain a uniform charge of fuel on each loading conveyor.

As stated, my invention particularly relates to the heat treatment of amalgam briquettes. I have found in practice that if the amalgam briquettes are allowed to remain cylindrical the sharp edges thereof are liable to be broken off in use, thereby causing the briquettes to dust, for unless the heat treatment is very carefully regulated preferably in accordance with the teachings of my patent application Serial No. 234,261 the inside portions of the briquettes are apt not to be as hard as the outside portions and I have found that I can produce briquettes much less liable to break or dust in use if I round off the edges of the briquettes prior to the baking treatment. I therefore further provide in combination with my improved oven a novel type of means for rounding off the edges of the briquettes prior to subjecting them to the heat treatment.

These and such other objects of my invention as may hereinafter appear will be best understood from a description of an embodiment thereof such as is illustrated in the accompanying drawings.

In the drawings:

Figure 1 is a plan view, with a portion shown in section, of a battery of ovens constructed in accordance with the teachings of my invention, the loading and unloading means not being shown.

Figure 2 is a side elevation thereof partially in section and showing a portion of the loading and unloading means.

Figure 3 is a sectional view taken along the line 3—3 of Figure 2.

Figure 3*a* is a perspective view of an individual casting, a plurality of which form the battery of ovens in my preferred embodiment.

Figure 4 is a partially diagrammatic plan view of the ovens and the loading means.

Figure 5 is a side elevation of the parts of my invention shown in Figure 4.

Figure 6 is an end elevational view of the elevator for raising and lowering the discharging conveyor and the fuel container guide-way to positions opposite each respective oven.

Figure 7 is a diagrammatic view illustrating the paths of travel of the products of combustion and the distillation products during the primary stage of the heat treatment through one oven.

Figure 8 is a diagrammatic view illustrating the paths of travel of the products of combustion, products of distillation, and air

during the second stage of the heat treatment through one oven.

Figure 9 is a detailed side elevation of the loading and unloading portion of my apparatus.

Figures 10 to 12 are diagrammatic views illustrating the method of operating the loading conveyor to receive a uniform charge of fuel thereon prior to discharging it into its respective fuel container, Figure 10 showing the conveyor discharging into a set of pans adapted to be moved into an oven and hold the fuel during the baking operation, Figure 11 showing the conveyor receiving a continuous fuel charge at the completion of its loading operation in outside position just prior to starting to move to inside position, and Figure 12 showing the conveyor receiving a second layer thereon while moving to inside position and not revolving.

Figure 13 diagrammatically illustrates an end and section of an unrounded briquette.

Figure 14 diagrammatically illustrates an end and section of a briquette rounded according to the teachings of my invention.

Figure 15 is a longitudinal sectional view of the means I employ to round off the edges of the briquettes prior to discharging them on to the loading conveyor.

Figure 16 is an end elevation of the apparatus shown in Figure 15.

Figures 17 and 18 are detailed side elevations showing the action of the loading and unloading mechanism as applied to an individual oven, Figure 17 showing the set of pans in full outside position at the end of the dumping operation and the loading conveyor just starting to move outwardly over the pans to discharge the fuel briquettes carried thereby into the pans, dotted line representations also indicating the different positions the loading conveyor will occupy in moving outwardly over the set of pans to load them, and Figure 18 showing the pans moving to outside position and dumping their contents on to the unloading conveyor while the loading conveyor, restrained from revolving, is being moved inwardly to receive a layer of fuel thereon.

Figures 19 and 20 are side elevational views generally similar to Figures 17 and 18, showing how my invention is applied to a battery of vertically-disposed ovens, Figure 19 showing the fuel-loading conveyor moving to inside position while not revolving to receive a fuel charge thereon and the discharging conveyor and the fuel container guide-way moved to a position opposite the upper oven, the discharging conveyor revolving to remove the baked fuel therefrom, and the upper set of pans moving to inside position; and Fig. 20 showing the loading conveyor moving to similar position but with the unloading conveyor and fuel container or pan guide-way moved to a position opposite the second highest oven and the fuel container or pans from the second highest oven moving to outside position while dumping on the discharging conveyor.

In the drawings, wherein like characters of reference generally indicate like parts throughout, 30 generally indicates a battery of baking ovens constructed in accordance with the principles of my invention. Suitable means are provided for uniformly heating the battery of ovens, which in my preferred embodiment comprise a series of fire boxes 32, each being heated by the consumption of amalgam, superfuel, coal, gas, oil or other suitable fuel. The fire boxes are each of the same construction, two being shown, for the purpose of uniformly applying heat indirectly to the surfaces of the ovens to produce therein substantially uniform temperatures throughout their area.

In order that the working of my invention with its necessary connections may be more readily understood, I will first describe in detail the construction of the battery of ovens and then describe the heat conservation features thereof illustrating the flow of vapors and gases in connection with one baking chamber 34 as shown in Figures 7 and 8, at the same time indicating in detail the connections to the battery of ovens.

Although my battery of baking ovens 30 may be constructed in any suitable manner, in order that they may be readily made and readily put together I preferably construct the battery of baking ovens from a plurality of castings 36 as shown in Figure 3*a*. Each casting consists of an enclosed transverse passageway or heating chamber 38 preferably provided with means to produce a turbulent flow of heating gases therethrough. In my preferred embodiment said means preferably comprises a series of baffles 40 alternately attached to opposite sides of said passageway to cause the heating gases to follow a circuitous path on passage therethrough. I provide the legs 42, which preferably extend the full length of the casting 36 and depend from each side thereof. I also provide similar legs 43 extending upwardly from the upper side of the casting 36. These legs are shown as provided with slots or grooves 44 to interfit with beveled portions 45 on the legs 42 of the next adjacent casting 36. To form an individual oven 30 a plurality of these castings are laid end to end in layers to form a longitudinal baking oven comprising the baking chambers 34 between the adjacent legs 42, said baking oven 30 being adapted to receive, if desired, a removable fuel container or containers 46. As stated, my invention preferably includes forming a battery of horizontal baking ovens 30 vertically disposed one above the other and to this end I preferably form layers of said castings 36 on top of one

another with the legs 42 of one layer fitting into the slots 44 in the lower layer to form said battery of horizontal baking ovens 30 vertically disposed one above the other. (See Fig 3.) When the castings are assembled in this manner it is apparent that there will be a plurality of enclosed transverse heating passageways 38 extending underneath each oven to impart indirect heat thereto. As shown in Figure 3, hot products of combustion from the fire box 32 are led to the heating chambers or passageways 38, through openings 50 in one side thereof by means of a flue 52, which when a battery of ovens is employed is split into individual inlets 54 for each individual heating chamber 38. The products of combustion after passing through the chambers 38 over the baffles 40, and in doing so giving up a large proportion of their sensible heat, are led off through the outlets 56 from each individual heating chamber to the common stack or flue 60.

While the castings may be constructed with openings in their opposite side walls to provide a single pass of heating gases therethrough, as shown in Figs. 3 and 3*a*, I preferably join said castings together to provide zigzag passes for the heating gases underneath each oven to more thoroughly impart the heat thereto. Thus, as shown in detail in Figures 1 and 4, I preferably connect the fire box 32 with one end of a casting 36 having an open end 50 by means of a flue 52, which when a battery of ovens is employed is split into individual inlets 54 for each set of interconnecting heating chambers 38 as shown in Fig. 3. I preferably subject all the heating chambers in the battery to the same amount of heat, and for that reason the connections for each set of zigzag passes for the superimposed ovens are preferably similar. Where a plurality of zigzag passes are formed through the heating chambers 38 I preferably construct the set of heating chambers 38*a* opposite each individual fire box with the means to lead the products of combustion on the opposite side thereof to the next adjacent set of heating chambers 38*b*, and so in my preferred embodiment I preferably construct the heating chambers 38*a* with the openings 62 in one side thereof adapted to be in register with the openings 64 in the adjacent set of intermediate heating chambers 38*b*. Similarly the set of heating chambers 38*c* adjacent the common stack 60 are provided with the open ends 66 which converge into the outlets 56 leading to the stack 60. The heating chambers 38*c* are also provided with the openings 68 near the front ends thereof adapted to register with the openings 70 in the set of intermediate heating chambers 38*b*. It is thus apparent that in my preferred embodiment the heating gases will be passed from the flue 52 through the inlets 54 into the individual heating chambers 38*a*, and thence through the chambers 38*b* and 38*c* and out through the outlets 56 to the stack 60. The course of the products of combustion through the chambers 38, 38*b* and 38*c* will be further indicated by the arrows in Figs. 1 and 4.

The fire boxes 32 are all preferably kept at the same temperature so that the whole oven will be subjected insofar as possible to the same amount of heat. It is thus obvious that when assembled my improved baking device comprises a battery of normally closed horizontal baking ovens 30, each comprising the baking chambers 34 formed between the cooperating legs 42 and 43 of adjacent castings 36, vertically disposed one above the other, each oven having a fuel container 46 removable from one end thereof for charging and discharging purposes, and being vertically spaced from each other by the height of the heating chambers 38 which provide horizontal transverse passageways for a uniform application of heat thereto, a common heat inlet passageway 52 discharging into said transverse horizontal passageways or heating chambers 38 through the individual heat inlets 54, and a common heat outlet passageway 60 leading from said horizontal passageways 38 through the individual outlets 56.

In order to reduce the temperature of the heating gases issuing from the fire boxes 32 to keep the temperature in the heating chambers 38 at the desired level, I may, if desired, return part of the products of combustion from the flue or stack 60 beyond said oven to the fire box 32. In my preferred embodiment this means comprises the return pipe 72 leading from the stack 60 to the fire box 32, said return pipe 72 having a blower or other means 74 therein to return the desired portion of the flue gases to the furnace, where such gases dilute or mix with the hot combustion gases to temper or cool them to the desired temperature. The speed of the blower 74 thus controls or varies the quantity of flue gases that may be recirculated in this manner, thereby permitting the employment for this purpose of gases already heated to some extent instead of using cold air or gases with consequent loss of available heat units due to the fact that more fuel must be consumed in producing heating gases of the desired temperature when using the cold diluent gases than when heated gases are used.

As stated hitherto, my improved apparatus is peculiarly adapted for use in a two-stage treatment of amalgam briquettes according to the method described in my co-pending application Serial No. 204,069 of carbonizing or baking green amalgam masses or other types of coal-oil agglomerates for the purpose of forming a porous, smokeless fuel preferably with the recovery of the hydrocarbon oil used as a purifying agent. The method of said

application may be carried out in the apparatus of this present application, the baking operation taking place in the baking chambers 34 preferably successively during both the primary and the secondary stage of the heat treatment described therein in which different conditions preferably prevail, the apparatus herein disclosed being capable of carrying out in the distilling or baking chambers those changing conditions required in the operation of said method. Each fuel container 46 is filled with a series of carbonaceous fuel charges of a plastic nature which have been molded or otherwise shaped to the desired diameter and contour. Fuel containers so filled are inserted in the ovens 30 preferably successively in a manner and by the apparatus to be explained in more detail hereinafter. Each oven 30 is heated during both stages of the operation by the circulation of heating gases from the fire boxes 32 through the heating chambers 38. During this operation the interior portions of the distilling chambers 34 are preferably heated to a temperature near but less than 600° F. for from one to two hours, and preferably, as more fully explained in said application, in the presence of a limited amount of air. To insure that only a limited amount of air will be admitted to the distilling chambers 34 during this process I preferably provide in the pipes 75 connecting with the front ends of said chambers the individual valves 76 which may be adjustably set to admit the desired amount of air to each distilling or baking chamber during the initial stage of heat treatment. All of the other passages by which air or oxygen could enter the chambers 34 are closed.

During this first stage baking operation moisture is removed from the coal and the lighter constituents of the oil binder are likewise distilled or vaporized, preferably as described in said method application. As also more fully explained in the method application, in order to avoid danger of vapor fires and explosions, the initial stage of heat treatment is continued until no explosion will occur on the admission of more air, which in the baking of amalgam usually takes from one to two hours. The lighter constituents of the oil distilled from such amalgams are valuable light products of a condensible nature, such as gasoline, which products are recovered in the operation of my improved apparatus by being permitted to pass through the line 78 controlled by the two-way valve 80 to the line 79 leading to the condenser 82 as shown diagrammatically in one oven in Figure 7. The lighter ends of the condensible products passing through the condenser are condensed by the cooling action of water passing around the condenser pipes 84, and such condensed products may be continuously withdrawn from the condensers for subsequent use. Certain uncondensed products as well as fixed gases escape from the condensers 82 and I preferably pass such gases and products through the lines 86 to the fire boxes 32 where they may be consumed and assist in generating the heat necessary for carrying on the process. It is thus apparent that by manipulating the two-way valve 80 to open up the line 79 during the initial stage of the heat treatment, the condenser 82 and return pipe 86 may be intermittently connectible to each individual distilling chamber 34 to permit the recovery of volatiles and the utilization of the fuel values in heretofore lost products.

As stated hitherto, the presence of air or oxygen is limited by means of the valves 76. The condensers 82 tend to form a partial vacuum in the heating chambers during the initial heat treatment which is desirable and which may be otherwise provided or supplemented by suction or other additional means, as it avoids having the fuel directly surrounded with saturated vapors which retard distillation of oil from the briquettes. It is also apparent that the air admitted through the valves 76 assists in moving the vapors out of the distilling or baking chambers 34.

According to the teachings of my method application, when this preliminary or initial heat treatment of the amalgam masses or other material being baked has continued a sufficient time so that no vapor fires or explosions will take place on the admission of more air and to recover an optimum quantity of oil, the atmosphere of the heating chambers 34 is then changed and the partially heated charges subjected to their final stage treatment. This second stage treatment preferably takes place in the presence of excess air and I therefore provide means to admit air to said distilling or baking chambers 34, which in my preferred embodiment comprises the air inlet pipe 90 through which air is admitted, if desired, under pressure. For purposes of heat conservation I preferably also provide means to pass said air in countercurrent heat interchange with the waste products of combustion being led from the oven to the stack to preheat said air. In my preferred embodiment said means comprises a heat interchanger, preferably consisting of the annular sleeve 92 surrounding the flue discharge pipe or stack 60. This sleeve communicates with the air inlet pipe 90 and with the line 78 through the line 94.

In the second stage of the process the two-way valve 80 is moved to a position to close the line 79 and to open the lines 94 and 78 leading into the baking chambers 34, thus shutting off the condenser and placing the baking chambers in communication with the heat interchanger so as to receive preheated air therefrom. A blower or other means may be employed to force the air into the baking chambers 34 if desired. As stated hitherto

all the ovens are preferably heated to a uniform heat but, particularly if bituminous coal is being distilled, the temperature during the second stage of the treatment may rise due to the exothermic reaction between the carbonaceous and/or oil fractions and oxygen. This reaction is controlled by limiting the amount of air admitted to the ovens or otherwise preferably so that the temperature of the fuel will not rise so high that the carbonaceous content of the fuel will show incandescence.

There is little condensible vapor, particularly if anthracite is employed, produced during the second stage of the operation and because of the fact that what vapor is produced is commingled with large quantities of air, etc., the condensation of such vapor during the second stage is usually not warranted. Consequently the gases removed during such stage pass through the lines 75 to the fire box 32 of the furnace. To permit of individual operation of the respective baking chambers 34, dampers 100 are placed in the lines 75. The products conducted through these lines consist of fixed gases, some distilled gases and heated air which has purposely been admitted, as explained, to the baking chambers 34. Of these products the heated air helps support combustion in the fire box while the uncondensed gases provide a fuel to assist in carrying on the process. As stated in said co-pending application, the second stage of the operation is continued for substantially one or two hours until the amalgam masses have attained the desired characteristics portrayed in said application whereupon the containers 46 containing the fuel charges are removed in any suitable manner after a proper manipulation of the various valves of the apparatus. As shown diagrammatically in Figures 7 and 8 it is obvious that the air inlet means to the baking chambers 34 and the lines 75 to conduct the air and volatiles from said baking chambers 34 to the fire boxes 32 are connectible to said heating chambers 34 alternately with the condenser 82 and simultaneously with each other.

Although I have described a battery of baking ovens it is obvious that insofar as certain features of heat conservation, etc. are concerned, these features are applicable to a single oven as shown diagrammatically in Figures 7 and 8. It is also apparent that my improved oven or battery of ovens, while primarily adapted for distilling fuel amalgam in two stages according to the teachings of my method application, may be employed to heat or bake other materials such as coal, etc.

As stated hitherto, in manufacturing amalgam according to the continuous amalgamation process of my application Serial No. 204,069, the amalgam is formed continuously, and led through the extruding machines and preferably through the rounding-off machines disclosed in this present application continuously, but in order that the proper baking of the amalgam may take place with optimum conditions of safety and for the production of the better type of amalgam briquettes, it is apparent that a two-stage baking treatment, the second in the presence of excess air, cannot take place continuously but must take place intermittently in two well defined separated stages, and further features of my invention therefore include an improved method of receiving material continuously and uniformly charging and discharging successively a battery of ovens. I believe I am first to provide a method of changing a continuous feed into an intermittent feed to provide in each oven 30 of the series a substantially uniform charge of material to be heated. My invention therefore includes a process of intermittently producing uniformly baked charges of prepared solid fuel from a battery of vertically-disposed baking ovens 30, each having a fuel container 46 removable from one end thereof and all subject to substantially uniform heat, while continuously feeding a uniform layer of material on to an endless conveyor overlapping one end of said battery, successively removing the fuel container 46 from the baking chamber 34 of each individual oven 30 to a position underneath said conveyor, dumping the contents of said conveyor thereon and successively returning the fuel container 46 to its respective oven 30 at such substantially uniform periods of time that each oven will receive a substantially equal fuel charge from the conveyor. Means are also provided for dumping the baked contents of each fuel container 46 while attaining a position outside of said oven underneath the conveyor to receive a fresh fuel charge. I therefore provide means to successively remove and return the fuel containers from and to each respective oven at the end of its respective baking period, means to dump the contents of each respective container while moving to a position outside of its respective oven, and means to continuously receive fuel and intermittently uniformly load it on to each respective container when it has been emptied of its previous charge and is in a loading position outside of its respective oven. It is thus apparent that each fuel container from each oven will be successively discharged and filled at regular successive time intervals, thereby permitting a continuous feel of fuel to the loading means hereinafter to be described.

Although any suitable type of fuel container 46 may be employed, I preferably employ a plurality of pans 102 arranged transversely between the V-shaped rods 104, longitudinally slidable to positions inside and

outside of the respective baking chambers 34 of the ovens 30. As shown in Figures 17 and 18, my invention may be employed for charging and discharging a single oven, but it is preferably employed as shown in Figures 19 and 20 and in the other figures for successively charging and discharging a battery of vertically-disposed horizontal ovens as more specifically described heretofore. I provide means for moving the pans 102 to positions inside and outside of the ovens 30 as explained hitherto and shown in detail in Figure 3. The pans 102 are mounted on the longitudinally-extending V-shaped rods 104 which are supported on the pulleys 106, provided with cooperating V-shaped grooves 108, on the inside of each distilling chamber. The pulleys 106 are mounted on shafts 110 extending through bearings in the sides of the castings 36, which shafts on their outer ends carry sprocket drive wheels 112. I also provide means for supporting said fuel containers when moved to positions outside of said oven, said means comprising a line of V-shaped grooves 108 on supporting pulleys 106 similar to those employed inside of said oven. The pulleys 106 outside of the oven are mounted in alignment, the same as those in the oven, and form an imaginary guide-way 114. It is apparent that when the fuel containers are moved to positions outside of the ovens the V-shaped pan-supporting rods 104 will ride on the guide-way 114 exteriorly of the ovens in similar fashion as it rides on the imaginary guide-way 115 formed by the upper surfaces of the V-shaped pulleys 106 within the baking chamber of each respective oven 30. The pulley shafts 110 for the pulleys 106 forming the guide-way 114 are provided with driving sprockets 112 the same as those mounted within the baking chambers.

To move the fuel containers 46 to positions inside and outside the baking chambers, I provide separate drive chains 116 adapted to mesh with the sprockets 112 permanently attached adjacent the sides of the respective baking chambers of the ovens for moving the fuel containers while inside of each individual chamber 34, and chain 118 outside of each oven for moving said fuel containers when outside of said oven. The chains 116 and 118 are provided, if desired, with tightener pulleys 120 and also with tighteners 122. The drive chains 116 and 118 may be driven in any suitable manner such as by the drive chains 124 driven respectively by motors 126. It is obvious that if desired all of the drive chains 116 for moving the fuel containers within the ovens may be driven by one motor 126 through a plurality of drive chains 124 (see Fig. 5). I also provide a heated material discharge receptacle for taking away the dumped contents of said pans which in my preferred embodiment comprises an endless discharging revolving conveyor 128 which revolves as desired underneath the outside position of said pans 102. Said conveyor 128 discharges into the chute 130 and is revolved for discharging purposes at the desired times by means of the drive chains 132 suitably operated by the motors 134. I also provide means to discharge the contents of the pans 102 on to the discharging conveyor 128 while the pans are riding on the rods 104 to positions outside of their respective ovens, said means preferably comprising the tripping lever 136 adapted to abut the cams 138 on each respective pan 102 to tip them up to dump them as shown more particularly in Figures 9 and 20, said tripping lever 136 being manually or automatically throwable into or out of tripping position by the lever 140.

To suitably charge the respective fuel containers 102 at predetermined time-controlled equal intervals and to change the continuous feed from the amalgamating and extruding machine to an intermittent feed to the respective ovens, I provide an endless loading conveyor 142 movable to positions above the outside positions of said pans 102, preferably automatically, said endless conveyor being approximately the length of each respective oven 30, and is shown in the drawings as supported for travel to and fro from a position above the oven 30 to a position above the outside positions of the pans 102. The conveyor is provided at intervals with the drive shafts 144, which in turn are supported in bearings 146 in the brackets 148 laterally depending from the longitudinal V-shaped guide-rails 150 adapted to register in cooperating V-shaped grooves 154 on the pulleys 156, which in turn are provided with shafts 158 extending to the drive sprockets 160 exterior thereof. The pulleys 156 are continuously driven by the chain 162 registering in the sprockets 160, which also are provided with suitable idlers 164 for taking up the slack therein and which may be suitably driven by the motor 166 through the medium of the drive chain 168. The pulleys 156 are in longitudinal alignment and therefore the upper surfaces of the V-shaped grooves 154 form an imaginary guide-way twice the length of an oven or conveyor in which the guide rails 150 supporting the conveyor are adapted to move. I also provide means to automatically reverse the directions of travel of the conveyor 142 so that it may be continuously moved to positions above the inside and outside positions of the fuel containers or pans. In my preferred embodiment said means comprises reversing switches 170 and 172, the reversing switch 170 being located at a point adjacent the extreme outside position attained by the conveyor 142 so that the outer end of one of the guide rails 150 may actuate it to reverse the motor 166 to reverse the direction of rotation of the

chain 162 to move the guide rails 150 inward, and the switch 172 being attached in similar fashion to abut the inner end of one of the guide rails 150 to reverse the direction of travel of the conveyor when said conveyor attains its innermost position immediately above the ovens 30, said switches 170 and 172 being preferably spring controlled to be automatically moved back to a position to again contact the end of one of the rods 150.

As will be more apparent from the description of the operation of the loading conveyor, it is necessary to revolve said loading conveyor 142 when moving to a position above the outside position of the pans 102 in order to dump the contents thereof on to the pans 102 and to prevent the rotation of said conveyor 142 while moving to inside position to build up the desired charge thereon. To this end I provide the sprockets 174 on the ends of the drive shafts 144 and train thereover the chain 176. A pivoted pawl 178 so situated as to enmesh with the chain 176 when the conveyor 142 is moving to outside position to cause revolution thereof and to slide over said chain without engaging it so as to not to permit said chain and attached conveyor to revolve when moving to inside position is also provided.

I have hitherto described the necessary parts of the loading mechanism for loading an individual oven. However, where a battery of horizontal baking ovens vertically disposed one above the other are to be charged and discharged, it is desirable, in order that the fuel charges may not be dropped to any great distance thereby causing distortion thereof, and for purposes of heat conservation, to move the fuel container imaginary guide-way 114 and the discharging conveyor 128 vertically up and down preferably simultaneously, so that the imaginary guide-way 114 may take positions immediately opposite the imaginary guide-way 115 within the baking chamber of each respective oven and the fuel containers or pans may be moved directly outwards from one guide-way to the other with the discharging conveyor immediately below the guide-way 114. To this end I provide the elevator 180 which has the platform 182 vertically movable up and down by means of the hydraulic plungers 184. The plungers 184 are preferably suitably connected together so as to be simultaneously operated by the same hydraulic means 186 to equalize the pressure in each plunger and to uniformly and horizontally lift the platform 182. The V-shaped supporting pulleys 104 forming the imaginary guide-way 114 and the shafts for moving and supporting the discharging conveyor are suitably mounted in the girders or other supporting means 188 mounted on each side of the elevator platform.

As stated hitherto, my invention is particularly adapted for baking amalgam briquettes. Amalgam briquettes 190 when extruded through the ordinary extruding machine are normally cylindrical as shown in Figure 13, and square or rectangular in longitudinal section. I have discovered, particularly if the briquettes are not thoroughly carbonized throughout, that by merely having the outer surface hardened the square edges of the briquettes are apt to break off leaving a soft inner portion which is apt to dust and crumble in use, and I have found that the briquettes can be made more self-sustaining and non-dusting and can be more easily handled if the edges thereof are rounded off in manufacture, as in the briquette shown in Figure 14 at 192. To this end I provide as shown in Figures 15 and 16, preferably in combination with the rest of my apparatus, means to round off the edges of said briquettes before delivery to said loading means. Said means for rounding off the surfaces of the briquettes comprises a table 194 having a plurality of channels 196 slightly larger than the briquettes, extending longitudinally across the upper surface thereof and preferably downwardly inclined, having irregular wavy surfaces formed by the protuberances 198 therein. In order to shake the table to round off the edges of the briquettes I provide means to vibrate said table laterally preferably in a horizontal plane such as the eccentric drive 200.

The operation of my invention is apparent from the above description of my improved apparatus. After the amalgam masses have been formed in the manner described in my prior patents above referred to they are continuously molded into forms of predetermined contour preferably in the shape of cylindrical briquettes as shown in Figure 13 by passing through an extruding machine. In order to round off the edges of the briquettes to make them more easy to handle and less dusting in use, particularly if the briquettes are not uniformly hardened throughout in accordance with the teachings of my method application Serial No. 234,261, I preferably round off the edges of said briquettes from the cylinders shown at 190 to the general elliptical shape shown in Figure 14 by passing them through the vibrating table 194 or other means employed for this purpose, from which they are continuously discharged on to the loading conveyor 142.

As stated hitherto I preferably subject successive charges of briquettes to heat treatments of similar time-controlled duration and I therefore preferably divide the number of ovens in the battery, less one needed for loading and unloading purposes, into the time necessary to subject the briquettes to the desired two-stage heat treatment, and I arrange to continuously feed the briquettes on to the loading conveyor and to intermit-

tently discharge them therefrom to the fuel containers or pans and introduce such containers into their respective ovens at intervals determined by the calculation above indicated. I therefore preferably first load any oven, say the upper one, and then successively discharge the other ovens in cycles of uniform baking periods. As shown in Figures 9, 10 and 17 the elevator 180 is first raised to a position so that the guide-way 114 will be substantially opposite the guide-way 115 in the baking chamber of the upper oven 30, the discharging conveyor being simultaneously raised therewith to a position immediately below it. The motors 126 are then turned on to move the upper fuel container 46, comprising a set of pans 102, to a position outside the upper oven 30, the guide rails 104 moving from the imaginary guide-way 115 inside the oven to the imaginary guide-way 114 outside the oven, the lever 140 having been adjusted so that the tripping lever 136 will abut the cams 138 on each respective pan 102 so as to cause the contents of each individual pan to be dumped on to the discharging conveyor 128, as shown more particularly in Figures 18 and 20.

While the pans 102 are being dumped the loading conveyor 142 is moving to inside position as shown in Figures 12, 18 and 20. It is apparent that when the pans 102 have attained their outside position they have completely dumped the contents thereof on to the discharging conveyor 128 and the loading conveyor will have attained its innermost position, the position shown in Figure 17 or as shown by dotted lines in Figures 11, 12 and 18. After the contents of the pans 102 have been completely dumped on to the discharging conveyor 128 the motor 134 for discharging the same may be switched on thereby permitting said discharging conveyor to revolve and discharge its contents through the chute 130, or, if desired, the discharging conveyor may be operated as the pans 102 move to their outside position. When the pans 102 have attained their outside position as shown in Figures 10 and 17 the apparatus is so set up that the loading conveyor will start to move from inside to outside position and the pawl 178 will then engage the chain 176 to cause revolution of the conveyor 142. It is apparent that the conveyor 142 will revolve to discharge the contents thereof uniformly into the pans 102, while moving to its outside position. A uniform charge of fuel is thus distributed therefrom into each respective pan, as more particularly shown by dotted lines in Figures 10 and 17. As the distance from said conveyor 142 to said pans 102 is so small it will not distort the green briquettes to any appreciable degree. When the loading conveyor 142 has attained its outside position it is apparent that it will have completely discharged its contents uniformly into the pans 102 and will also have a single uniform layer of green fuel thereon as shown in Figure 11, and that it will have tripped the switch 170 to cause the motor 166 to reverse, thereby changing the direction of travel of the chain 162 so as to move the conveyor 142 from outside to inside position.

After the pans 102 have been uniformly filled with briquettes, it is apparent that the motors 126 for driving the outside and inside drive chains 116 and 118 for the pans respectively, may be so switched on as to drive the chains in a direction proper to move the pans to inside position. The moving of the pans 102 to inside position preferably takes place at a quicker rate than the movement of the conveyor, for a reason to be explained later. While the loading conveyor 142 is moving to inside position, as more particularly shown in Figure 12, the fuel briquettes are continuously discharging thereon to form a second layer of fuel thereon and it is apparent that when the fuel conveyor has attained its inside position, as shown in Figure 10, it will have a double layer of briquettes or other fuel thereon. It is apparent, however, that two distinct layers may not be formed as the upper layer may sift down between the lower layer, or if timing conditions are not exactly right two full layers may not be formed.

While the loading conveyor 142 is attaining its inside position and after the upper pans 102 have been returned to the upper oven 30, the hydraulic elevator is then manipulated so that the imaginary guide-way 114 thereof will be opposite the imaginary guide-way 115 inside the next highest oven 30. The removable container 46 or pans 102 from said next highest oven 30 are then moved to outermost position by means of proper rotation of the motors 126 driving respectively the inside and outside chains 116 and 118 to completely move said pans from the next highest oven on to the elevator 180, and to simultaneously dump the contents thereof, in a manner explained, on to the discharging conveyor 128. The elevator 180 is then moved to a position opposite the upper oven and immediately below the loading conveyor 142 before the loading conveyor 142 attains its full inside position. When the loading conveyor reaches its full inside position it trips the switch 172 to cause a reversal of the motor 166 and consequent movement of the conveyor to outside position to dump the contents thereof into the pans 102 from the next highest oven 30 on its way. It is apparent that as the conveyor moves to outermost position a third layer of green fuel will be laid thereon temporarily so as to permit dumping of three layers of fuel into the pans 102. It will be understood that in referring to the disposal of three layers of briquettes on to the loading conveyor I do not mean to

imply that the three layers are necessarily exactly superimposed one above the other, but rather that briquettes have been deposited on the conveyor continuously during three passes thereof beneath the discharge outlet from the briquetting machine or from the rounding-off machine. In practice the briquettes of the second and third layers may actually sift down between the briquettes of the first layer so that substantially a single layer, or at most two layers, results. In dumping the briquettes into the fuel containers 46 or pans 102 the relative positions of the respective briquettes will not, of course, be maintained. However, in general, satisfactory results as respects circulation of gases about and through the loaded containers will result if conditions are so controlled as to produce a charge of a thickness corresponding to that of two layers of the briquettes. The hydraulic elevator 180 is preferably raised to its uppermost position for several reasons, among others to obviate a fall of any substantial distance for the green fuel from the loading conveyor 142 into the respective fuel pans 102 and thereby to prevent distortion of the green fuel. The unloading conveyor is raised and lowered simultaneously therewith so that the heat from the heated briquettes temporarily lying thereon immediately below the pans 102 will prevent them from appreciably cooling off before being reinserted in their respective ovens 30. By simultaneously moving the discharging conveyor 128 with the imaginary guide-way 114 any great drop of baked briquettes in their discharge from the pans 102 with resulting dusting or distortion thereof is prevented. The discharging conveyor is, however, always maintained in position for discharge to the chute 130. The operation is continued in the manner hereinbefore described, loading successively each respective oven in time-controlled periods. The speed of movement of the loading conveyor from outside to inside position is so regulated that the time required for such movement will always exceed the time required to move the elevator 180 from uppermost position immediately beneath said conveyor 142 to return the fuel container 46 or pans 102 to the next to the lowermost oven, then to a position opposite the lowermost oven to receive the fuel container therefrom while dumping the contents thereof on to said discharging conveyor 128 and then raising said fuel container from the lowermost oven to the uppermost position of said elevator immediately underneath said loading conveyor 142 before said loading conveyor 142 starts to move to outside position to discharge its contents into said fuel container from the lowermost oven. It is thus apparent that I am enabled to successively load and unload at successive time-controlled intervals fuel charges to a battery of vertically disposed baking ovens. Although the loading and unloading features of my invention are particularly designed for use in baking amalgam briquettes, it is obvious that they may be employed for loading a battery of ovens for heat treating any type of material, or that the loading conveyor with proper speed regulation may be employed for changing a continuous feed into an intermittent feed for a single oven, as more particularly shown in Figures 10, 11, 17 and 18, in which case, of course, the necessity for the elevator and vertical movement of the guide-way 114 and discharging conveyor 128 may be dispensed with.

As stated hitherto the heat conservation features of my invention are also particularly adapted for a two-stage treatment of fuel, preferably amalgam, but I believe that certain features thereof are broadly new in any type of oven as well as certain loading and unloading features of my invention and that they are equally applicable either to a single oven or to a battery of ovens adapted to function successively to give uniform charges of fuel successive uniform time-controlled heat treatments.

It is understood that my invention is not limited to the specific embodiments shown and that various deviations may be made therefrom without departing from the spirit and scope of my appended claims.

What I claim is:

1. In combination, a chamber for receiving material containing a volatile content to be heated, a firebox, means for leading products of combustion from said firebox through passages adjacent said chamber for indirectly heating the same to remove volatiles from such material, means independent of said chamber for returning without passage through the chamber controlled amounts of said products of combustion issuing from said passages and mixing them with products of combustion being introduced thereto and means for introducing to the fire box a portion of the volatiles removed for consumption therein to generate gases to mix with the products of combustion returned to the fire box.

2. In combination, a chamber for receiving material to be heated, a firebox having a flue for the products of combustion passing in proximity to said chamber for indirectly heating the same, means for returning part of the products of combustion from said flue beyond said chamber to the firebox to reduce the temperature thereof, means to admit air to said chamber, means to pass said air in countercurrent heat interchange with the waste products of combustion in said flue beyond said chamber to preheat said air, and means leading directly from said chamber to said firebox to lead air and volatiles from

said chamber connectible to said oven simultaneously with the opening of said air inlet means.

3. In combination, a chamber for receiving material to be heated, a firebox having a flue for the products of combustion passing in proximity to said chamber for indirectly heating the same, means for returning part of the products of combustion from said flue beyond said chamber to the firebox to reduce the temperature thereof, means to admit air to said chamber, means to pass said air in countercurrent heat interchange with the waste products of combustion in said flue beyond said chamber to preheat said air, a condenser, a valve operable to connect or disconnect the condenser with the chamber, and means to lead non-condensed volatiles and gases from said condenser to said firebox, and means leading directly from said chamber to said firebox to lead air and volatiles from said chamber connectible to said chamber to said fire box.

4. In combination, a chamber for receiving material to be heated, a firebox having a flue for the products of combustion passing in proximity to said chamber for indirectly heating the same, a vapor outlet for said chamber, a condenser connected to said outlet, means to lead non-condensed volatiles and gases from said condenser to said firebox, means for disconnecting said condenser from said outlet, and means for introducing air to said chamber through said outlet when the condenser is disconnected therefrom.

5. In combination, a chamber for receiving material to be heated, means for indirectly heating said chamber, a condenser connectible to and disconnectible from said chamber, means to lead controlled amounts of air to said chamber while the condenser is connected thereto, means for introducing a larger amount of air to said chamber when the condenser is disconnected therefrom, and means for leading non-condensed volatiles and gases from said condenser to the heat-producing means.

6. A baking device comprising a plurality of castings each having an enclosed transverse passageway, baffles in said passageway, legs substantially the length of the casting depending from each side thereof and slotted portions carried on the upper side thereof immediately above each leg, said casting being disposed end to end in layers with the legs of the upper layers fitting into the slots in the lower layers to form a battery of horizontally-disposed elongated baking ovens vertically disposed one above the other and a plurality of enclosed transverse passageways extending underneath each oven to impart indirect heat thereto, certain of said castings having closed ends and communicating with adjacent castings to form a plurality of zigzag passes for the heating gases underneath each oven.

7. A baking device comprising a plurality of castings each having an enclosed transverse passageway, legs substantially the length of the casting depending from each side thereof and slotted portions carried on the upper side thereof immediately above each leg, said castings being disposed end to end in layers, with the legs of the upper layers fitting into the slots in the lower layers to form a battery of horizontally-disposed elongated baking ovens vertically disposed one above the other and a plurality of enclosed transverse passageways extending underneath each oven to impart indirect heat thereto.

8. A casting for use in making an oven comprising walls defining an enclosed transverse passageway, baffles depending from opposed walls into said passageway, legs substantially the length of the casting depending from each side thereof, slotted portions carried on the upper side thereof immediately above each leg, and openings communicating with said passageway.

9. A casting for use in making an oven comprising walls defining an enclosed transverse passageway, legs substantially the length of the casting depending from each side thereof, slotted portions carried on the upper side thereof immediately above each leg, and openings communicating with said passageway.

10. A casting for use in making an oven comprising walls defining an enclosed transverse passageway having baffles therein, legs substantially the length of the casting extending from opposite sides thereof, the extremities of one pair of legs being slotted and the extremities of the other pair being shaped to fit into such slotted portions of an adjacent casting when assembled into an oven structure.

11. A casting for use in making an oven comprising walls defining an enclosed transverse passageway, legs substantially the length of the casting extending from opposite sides thereof, the extremities of one pair of legs being slotted and the extremities of the other pair being shaped to fit into such slotted portions of an adjacent casting when assembled into an oven structure.

12. A baking device comprising a plurality of castings adapted to be superimposed, each casting having a passageway for heating gases and a heating chamber, said passageways and heating chambers being disposed in axial alignment with adjacent superimposed rows of castings, means for admitting heating gases to each of said passageways, means for supporting material to be treated in said chambers, a furnace, and means independent of said chambers for returning a portion of the products of combustion pass-

ing through said passageways to said furnace without passage through the chambers.

13. A baking oven comprising a series of castings arranged one upon the other in longitudinal rows, each casting having a heating chamber therein and a fuel passageway surrounding said chamber, the heating chambers and passageways of the castings of one row being in axial alignment with the heating chambers and passageways of the castings of the adjacent row, and means for feeding heating gases to said passageways, comprising a furnace, and means independent of the chambers for returning a portion of the gases after passage through said passageways to said furnace without passage through the chambers.

14. In combination, a chamber for receiving material to be heated, a firebox having a flue for the products of combustion passing in proximity to said chamber for indirectly heating the same, means to admit air to said chamber, a condenser communicating with said chamber, means for leading uncondensed gases from said condenser to said firebox, and a direct communication between said chamber and said firebox for passing air and volatiles from the former to the latter.

15. In combination, a chamber for receiving material to be heated, a firebox having a flue for the products of combustion passing in proximity to said chamber for indirectly heating the same, means for returning part of the products of combustion from said flue beyond said chamber to the firebox to reduce the temperature thereof, means to admit air to said chamber, a condenser communicating with said chamber, means for passing uncondensed gases from said condenser to said firebox, and means for passing air and volatiles from said chamber to said firebox.

16. In combination, a chamber for receiving material to be heated, a firebox having a flue for the products of combustion passing in proximity to said chamber for indirectly heating the same, means for returning part of the products of combustion from said flue beyond said chamber to the firebox to reduce the temperature thereof, means to admit air to said chamber, and a direct communication between said chamber and said firebox for passing air and volatiles from the former to the latter.

17. In combination a chamber for receiving material to be heated, a firebox having a flue for the products of combustion passing in proximity to said chamber for indirectly heating the same, a vapor outlet for said chamber, a condenser connected to said outlet, means for disconnecting said condenser from said outlet, means for introducing air to said chamber through said outlet when the condenser is disconnected therefrom, and means for passing air and volatiles from said chamber to said firebox.

18. In combination, a chamber for receiving material to be heated, a firebox having a flue for the products of combustion passing in proximity to said chamber for indirectly heating the same, a vapor outlet for said chamber, a condenser connected to said outlet, means for disconnecting said condenser from said outlet, means for introducing air to said chamber through said outlet when the condenser is disconnected therefrom, means for passing air and volatiles from said chamber to said firebox and means for passing uncondensed gases from said condenser to said firebox.

In testimony whereof, I have signed my name to this specification this 16th day of December, 1927.

WALTER E. TRENT.