Aug. 31, 1926.

G. W. SAATHOFF

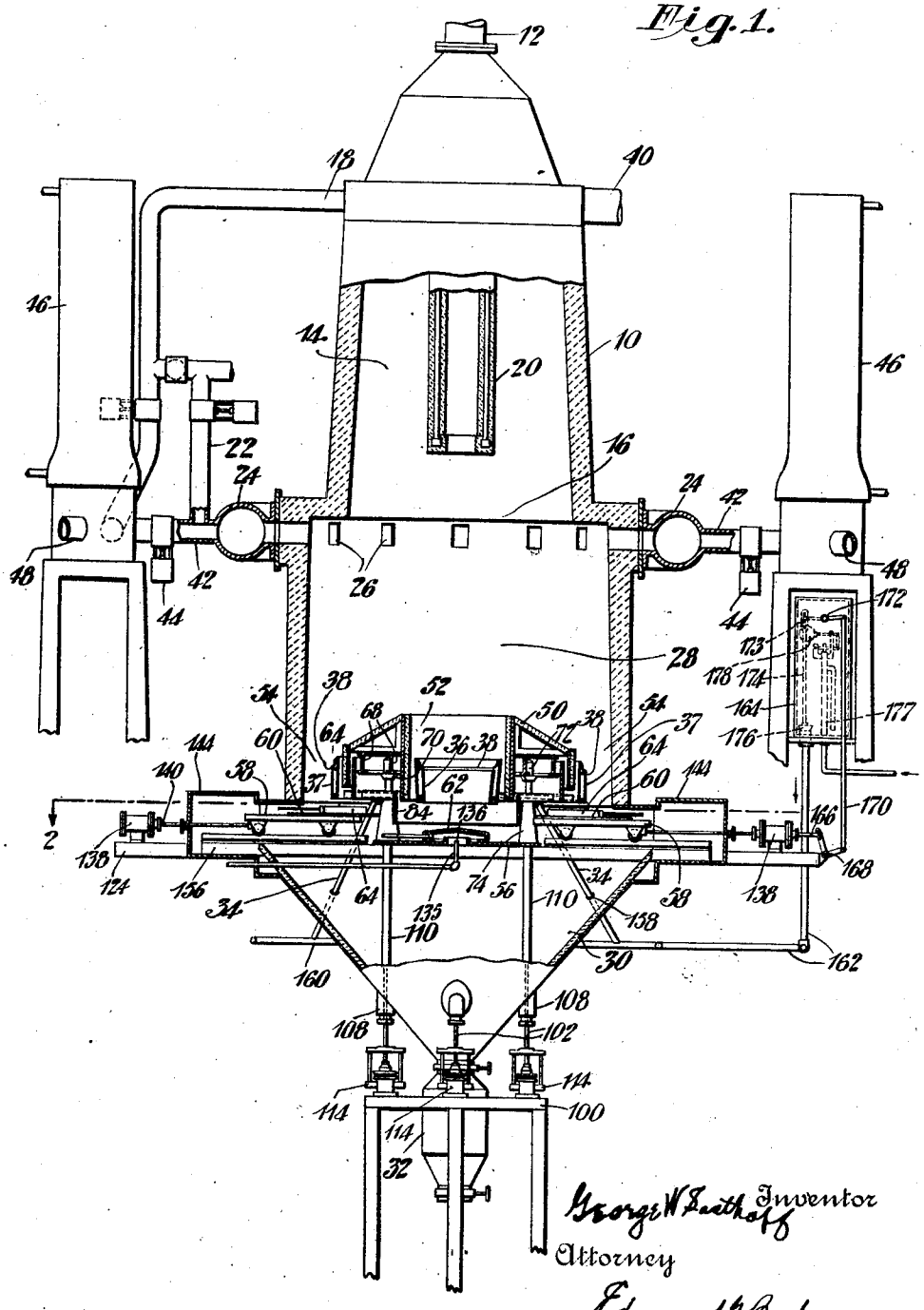
1,598,451

DISCHARGE MECHANISM

Filed Nov. 24, 1924

3 Sheets-Sheet 1

Fig. 1.



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3 Sheets-Sheet 2

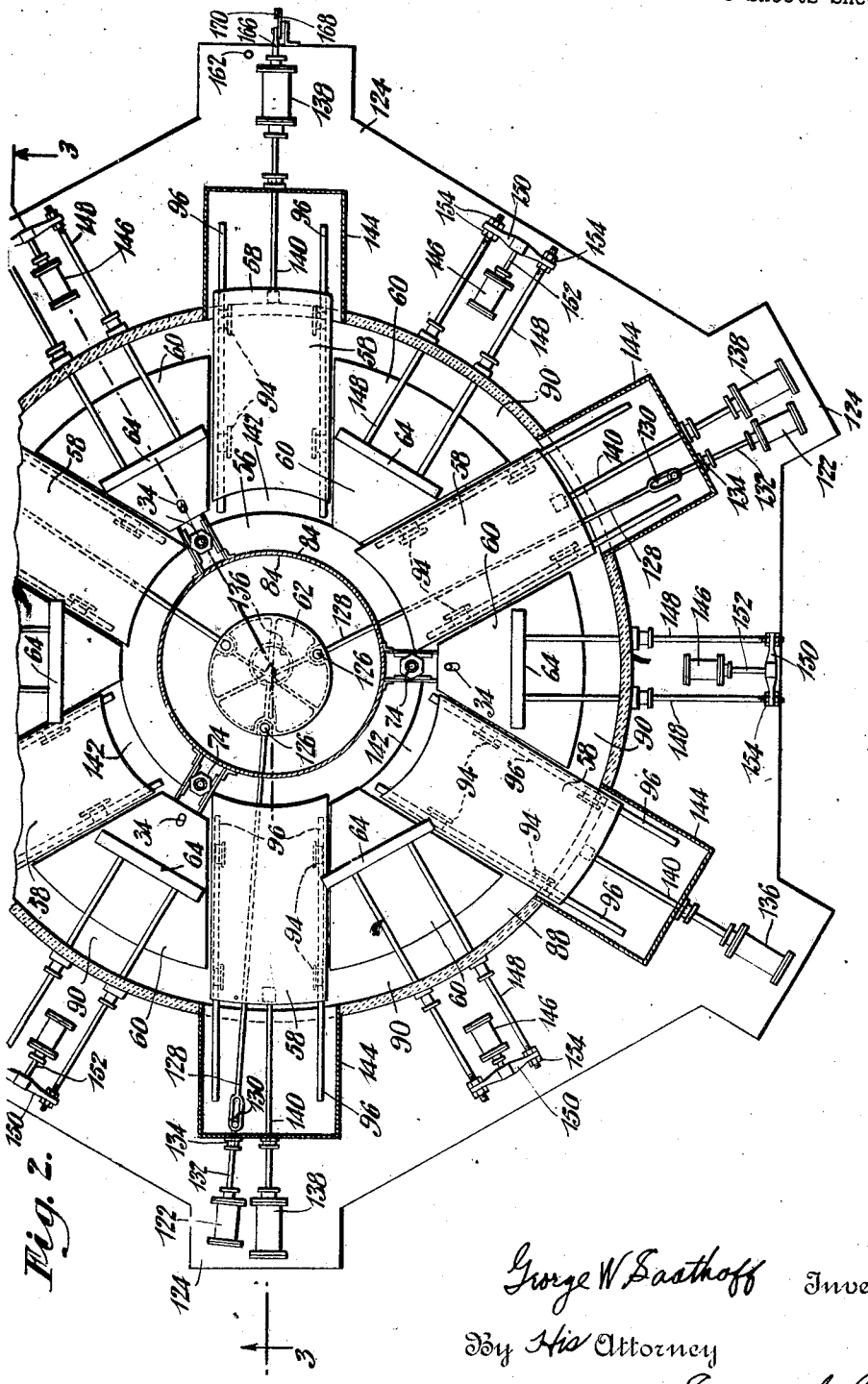


Fig. 2.

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DISCHARGE MECHANISM

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3 Sheets-Sheet 3

Fig. 3

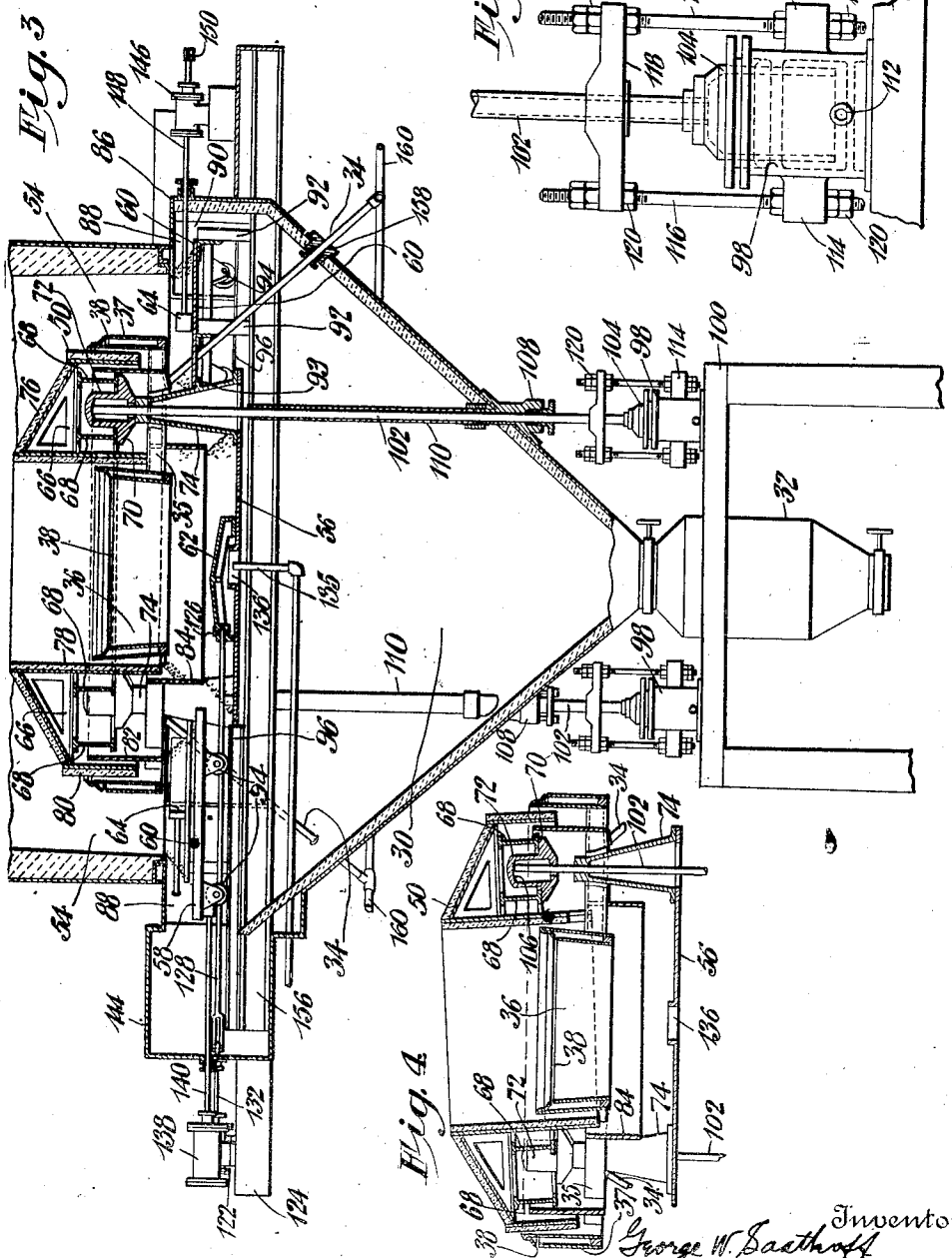


Fig. 5.

Fig. 4

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UNITED STATES PATENT OFFICE.

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DISCHARGE MECHANISM.

Application filed November 24, 1924. Serial No. 751,886.

This invention relates to discharge mechanisms, and more particularly to a discharge mechanism for removing coke and ash from gas generators of the shaft type.

Many types of discharge mechanisms have been developed for supporting fuel in a column in gas generators of the shaft type and for removing ash and unconsumed fuel periodically or continuously from the bottom of the column at rates which can be varied to secure uniform carbonization and/or gasification of the fuel during its passage through the shaft. Some difficulties have been experienced in designing apparatus which will accomplish these results and which will at the same time break up the compact masses of hard clinker which tend to build up in the lower portion of the shaft as the result of high temperatures maintained in the generator and of the great weight of the superimposed column of fuel.

In the type of shaft generator known as the Doherty gas shell fuel is passed continuously downward in a column through the shaft and is gasified by a blast of air or other combustion supporting gas introduced axially or peripherally of the mid portion of the column. Such generators are generally of large fuel treating capacity, and the fuel bed has such a large cross-section that a major portion of the combustion supporting gases are decomposed by reaction with the carbon of the fuel before they can penetrate into the section of the fuel bed farthest removed from the gas inlets, i. e., combustion takes place more rapidly in those sections of the charge nearest the gas inlets. Accordingly, another problem which arises in the operation of such generators is that widely different concentrations of ash and unconsumed fuel form in the axial and peripheral sections of the high temperature gasification zone. If the fuel charge is advanced at a uniform rate through the inner or axial and the outer or peripheral sections of the shaft some of the fuel will be discharged before it is consumed and/or the gas making capacity of the generator will be reduced.

Some discharge mechanisms for removing coke and ash from gas generators of the shaft type have been so designed that if the column of fuel in the shaft is blasted from the periphery toward the center the discharge of fuel from the base of the column by the mechanism is arranged to be more rapid at the periphery than at the center. On the other hand, if the fuel is blasted from the center toward the periphery, the discharging mechanism is arranged to provide a more rapid movement of the fuel in the center of the column than at the periphery of the column. These designs of fuel discharging mechanisms are intended to provide a discharge of fuel of uniform ash content, and to overcome the tendency for the ash and fuel to form large clinkers at and below the point where the heat is concentrated. Moreover, the discharge mechanisms which have been used heretofore generally include parts which move in a horizontal plane at the bottom of the fuel column. With such a motion the fuel is not agitated for any considerable distance above the mechanism and therefore the fuel has an opportunity to form large clinkers which build up on stationary parts of the discharge mechanism and obstruct the passage of fuel through the shaft. As any of these large clinkers approach the movable parts it is sometimes quite difficult to break them up into sufficiently fine condition so as to pass through the discharge mechanism. Furthermore, the discharge mechanisms above referred to are not well adapted for advancing fuel at a uniform rate through both the axial and the peripheral sections of the column in generators wherein the fuel is treated by both a central blast and a peripheral blast.

The primary object of the present invention is to provide a discharge mechanism for shaft generators by which fuel may be advanced continuously in a column through the shaft and thoroughly agitated throughout the full cross-sections of the lower portion of the shaft to prevent the building up of masses of clinker.

Accordingly one feature of the invention contemplates the provision of a number of independently movable and stationary elements mounted in the lower portion of the shaft in vertically separate horizontal planes and so arranged that the upper element can be rocked up and down in a substantially vertical path to keep fuel in the lower portion of the shaft in a state of turbulent

agitation, while other movable elements can be reciprocated through separate paths which in combination traverse substantially the whole cross-sectional area of the shaft.

Another object of the invention is to provide a fuel discharging mechanism for shaft generators by which fuel may be supported in a column in the shaft and advanced through axial and peripheral sections of the column at variable rates to counterbalance the ash concentration effect induced by introducing air axially or peripherally of the column.

To accomplish this object another feature of the invention contemplates the arrangement of the several groups of movably mounted and stationary fuel supporting and discharging elements in two main groups, the elements of one group being mounted in the central axis and those of the other about the inner periphery of the lower portion of the shaft; the division of the downwardly moving column of fuel into axial and peripheral channels before it reaches the chief fuel supporting elements of the discharge mechanism; and the operation of the movable elements at variable rates and through separate paths to remove uniform concentrations of ash and unconsumed fuel from the lower cross section of the column.

Another object of the invention is to provide a discharge mechanism for shaft generators by which fuel can be advanced at uniform or variable rates through axial and peripheral sections of the shaft and by which variable degrees of agitation can be imparted to fuel in the lower portion of the shaft.

To accomplish this object another feature of the invention contemplates separate control of the length of stroke and of the rate of movement of the driving mechanism of each of the axially and peripherally mounted movable elements of the discharge mechanism independently of each of the others, so that the movable elements can be displaced at uniform or variable rates through paths of uniform or variable length.

With these and other objects in view the invention consists of the discharge mechanism hereinafter described and particularly defined in the claims.

The various features of the invention are shown in the accompanying drawings, in which:—

Fig. 1 illustrates in vertical elevation, partly in section, a gas generator of the shaft type equipped with a coke discharging mechanism which embodies the preferred form of the invention;

Fig. 2 is a plan view of the lower part of the discharge mechanism taken on the section line 2—2 of Fig. 1;

Fig. 3 is a sectional elevation of the discharge mechanism, taken on the line 3—3 of Fig. 2;

Fig. 4 is a sectional elevation of the upper ring fuel agitating element of the discharge mechanism, illustrating the manner in which it is rocked up and down; and

Fig. 5 is a detailed elevation of one of the hydraulic engines by which the ring element is rocked.

The shaft generator illustrated in Fig. 1 of the accompanying drawings comprises an upright cylindrical shell 10 with a refractory lining into which fuel is fed intermittently or continuously through a charging neck 12. The fuel is supported in a column in the generator, and as it advances downwardly it passes through an annular heating and distilling zone 14 in the upper part of the shaft wherein it is gradually heated and carbonized by an upwardly flowing current of hot gases. From the heating and distilling zone the fuel passes into a high temperature gasification zone 16 in the central part of the shaft wherein a part or all of the coke product of the carbonization is burned by a blast of combustion supporting gases introduced into the shaft either through a conduit 18 and a central blast inlet 20, or through a conduit 22, a bustle pipe 24, and circumferential nostrils 26. When the axial inlet 20 is used for blasting part or all of the exhaust blast gases are withdrawn from the shaft through the circumferential nostrils 26. When the blast gases are introduced through the circumferential nostrils 26 part or all of the exhaust blast gases are removed through the central inlet 20. Any exhaust blast gases that do not go through nostrils 26 or inlet 20 during these periods of air blasting are drawn upwardly through zone 14 to heat and carbonize fresh fuel, and are then removed from the top of the shaft. Any coke remaining after this treatment together with the ash formed by combustion of the fuel passes downwardly through a cooling zone 28 in the lower portion of the shaft and is gradually cooled and quenched by contact with steam or other heat transferring gas. The ash and/or coke are removed in small portions from the bottom of the column by a discharging apparatus which also serves to support the fuel in a column and to agitate the fuel in the lower portion of the shaft.

The coke and ash removed from the bottom of the column by the discharge mechanism drops into a refractory lined hopper 30 which comprises the bottom of the shell, and from hopper 30 a portion is periodically removed through a sealed discharge chamber 32. A heat transferring medium, preferably steam or water, is introduced into the generator through pipes or hollow support rods 34, with the particular object of cool-

ing and quenching the coke and ash in the lower portion of the generator as well as to provide additional means by which to control temperatures in the gas making zone of the fuel column. The pipe 34 conducts the water (or other cooling medium) upwardly past the fuel supporting elements of the discharge mechanism and into hollow distributing arms or brackets 35. These distributing brackets serve likewise as supports for fuel guides and screens and for other stationary members of the discharge mechanism. The cooling water passes through brackets 35 (there being three of these brackets in the design illustrated. See Figs. 2 and 3) into the hollow cores of two ring-shaped fuel screens 36 and 37, wherein the water is vaporized by heat transferred through the walls of the screen from the surrounding fuel. The steam thus produced enters the fuel in the lower sections of the column through small annular nozzles or openings 38 near the top of each ring. As this steam (or other heat transferring medium) leaves rings 36 and 37 through the nozzles 38 it distributes itself evenly throughout the cross section of the lower portion of the fuel column. As it rises through the lower portion of the shaft the steam quenches the fuel and returns a major portion of the sensible heat of the discharging fuel to the hot gasification zone of the shaft. A part of the gases formed in the high temperature gasification zone are passed upwardly through the upper portion of the column to carbonize and preheat the fuel, and the mixture of these gases with the volatile products of the fuel and the heat transferring gas is drawn off through a rich gas outlet 40 in the top of the shaft. The waste blast gases from water gas manufacture and part of the similar lean gases of producer gas manufacture are withdrawn either through the axial inlet 20 and conduit 18 or through the peripheral nostrils 26 and bustle pipe 24—depending on whether the fuel is treated to a peripheral or an axial blast, and are preferably conducted through conduits 42 and hot valves 44 into waste heat boilers 46 where their sensible heat is abstracted and utilized in generating steam. The cool waste blast or lean gases may then be preferably passed through conduits 48 into preheaters or regenerators (not shown) where they can be burned and their heat of combustion recovered and utilized in preheating blast air and in superheating steam.

The discharging device serves to support the column of coal, coke, and ash in the generator, to thoroughly agitate the fuel throughout the cross sectional area of the lower portion of the column, and to remove coke and ash periodically or continuously from axial and peripheral sections of the bottom of the column at variable or uniform rates. It is made up of six separate sets of movable and stationary elements which are positioned in the lower portion of the shaft in two main groups, one of which is mounted axially of the shaft and the other mounted peripherally of the shaft. Above the movable and stationary supporting elements is mounted a movable agitating ring 50 which is positioned centrally of the shaft. The fuel in the lower portion of the column is thoroughly agitated by an up-and-down-rocking motion which is imparted to this ring structure, and being positioned above the other elements of the mechanism the ring also serves to divide the lower portion of the downwardly moving column of fuel into two streams, one of which passes through its central core 52 while the other is deflected into an annular passage or channel 54 between its outer rim and the inner wall of the shaft.

The column of fuel is supported in the shaft chiefly by a central stationary plate 56 and by a number of radially arranged movable platforms 58 and stationary tables 60. The plate 56 lies directly beneath the agitating ring and is vertically spaced therefrom, and the area of its upper surface is sufficient to support positively any fuel in the axial portion of the column and in the core 52 of the ring structure. A scraper 62, which is movably mounted on the upper surface of the plate 56 and is oscillated back and forth thereon, gradually pushes ash and coke toward and over the outer edges of the plate. The ash and unburned coke in the peripheral section of the charge is gradually pushed into the annular channel 54 and onto radially arranged platforms 58 and tables 60 by the rocking motion of the agitating ring and the weight of the overlying column of fuel.

The platforms 58 and tables 60 are mounted below the outer edge of the ring structure and have their outer edges overlapped by the inner lining of the shell and their inner edges overlapped by the outer rim of the ring. The platforms and tables are disposed alternately about the peripheral space between ring 50 and the inner wall of the shaft, (see Fig. 2) and the combined area of their upper surfaces is sufficient to positively support fuel in the peripheral sections of the shaft and in the annular passage or channel 54. Ash and unconsumed fuel supported on the upper surfaces of the peripheral tables is displaced at intervals over their edges by plows or scrapers 64, one of which is movably mounted on the upper surface of each table and is reciprocated back and forth thereon. Some of the ash and unconsumed fuel which is displaced by the plows 64 falls directly into hopper 30, while the rest is pushed onto the mov-

able platforms 58. The platforms 58 are reciprocated back and forth in horizontal paths which extend radially of the shaft axis, and by this motion coke and ash is discharged at intervals over the front edges of the platforms and falls into hopper 30.

The upper element or agitating rings 50 (see Fig. 3) is built about a frame 66 of triangular cross section, and this frame is supported by two circular I-beams 68. The I-beams in turn rest on knees 70 of three hollow thrust caps 72, and each of the thrust caps rests loosely on and registers with the top of one of three supporting stands 74. The long upper side of the frame 66 carries a truncated-cone-shaped fuel bearing surface 76 which is faced with refractory. A refractory faced depending cylindrical apron 78 hangs from the short side of the frame and forms the axial fuel passage or core 52 of the agitating ring. Another depending refractory faced apron 80 is hung from the outer corner of frame 66 and forms with the interior lining of the shell the annular fuel passage 54. The stands 74 support the hollow distributing brackets 35 for the cooling medium, previously described, and in addition to the hollow ring-shaped fuel guards 36 and 37 these brackets also support a cylindrical fuel screen 82 on the inner side of apron 80 and an inner depending cylindrical screen 84 immediately beneath apron 78. Screens 82 and 84 serve with the water vaporizing screens 36 and 37 to protect the lower portion of the agitating ring 50 from abrasion and from clogging up with fuel, ash and clinker, and at the same time they serve as guiding channels through which fuel which has passed axial core 52 and annular passage 54 is directed in its downward passage onto the supporting surfaces of the centrally mounted plate 56 and the radially arranged platforms 58 and tables 60.

The stationary peripheral tables 60 have horizontal triangular shaped fuel supporting surfaces, (see Fig. 2). Each of these tables lies between adjacent edges of two of the movable platforms 58, and the combined surface area of the tables is such that any fuel passing through annular passage 54 which does not flow onto platforms 58 is positively supported on the surfaces of the tables. A peripheral flat arch 86, (see Fig. 3) forms an enlargement or chamber 88 in the cross sectional area of the shaft adjacent the tables 60, and the outer edge or base of each table extends into this chamber a sufficient distance so that the fuel and ash expanding from the passage 54 will stand on its natural angle of repose without falling over the tables' outer edges except when positively displaced by plow 64. The depth of the enlargement 88 is sufficient to leave a space or channel 90 between the outer edge of each table and the inner lining of the enlargement through which fuel which is pushed over the outer edge of the table by the plow 64 can drop into hopper 30. Each of the tables 60 is supported by columns 92, and the inner short edge of every other table is also supported by brackets 93 on the stands 74. The inner edge or apex of each of these tables extends radially of the shaft a sufficient distance so that the agitating ring 50 overlaps it, and the fuel which has passed through annular passage 54 and the apron 80 of the ring structure is therefore positively supported on the surface of the tables 60 and on the movable platforms 58 as it expands on its natural angle of repose.

The movable platforms 58 fill the rectangular spaces which lie between the edges of adjacent tables 60. The fuel supporting surface of each platform has a rectangular shape and lies in a plane slightly lower than the fuel supporting surface of tables 60, (see Fig. 3), so that the scrapers 64 can reciprocate across the surfaces of the tables without obstruction. Each platform is supported on trucks 94, the wheels of which engage tracks 96 which extend radially of the shaft axis (Fig. 2).

The driving mechanisms by which the several movably mounted elements of the discharge mechanism are operated are all situated on the outside of the shell where they can be easily reached without interfering with operations in the interior of the shell. The mechanism by which the upper element or agitating ring 50 of the discharge mechanism is rocked up and down consists of three pneumatic or hydraulic engines 98 mounted on a platform 100 beneath the hopper 30. Each of the engines 98 rests on the platform with its major axis directly beneath one of the stands 74. The stands 74 are supported by and disposed at regular intervals about the upper surface of the axially mounted plate 56 (see Fig. 2), and the top of each stand is drilled with a hole which registers with another hole in the base of the corresponding hollow thrust cap 72 (see Fig. 4). The hole through the top of each stand 74 serves as a guide bearing for a piston rod 102 which is attached to the piston 104 of the corresponding engine 98. The inner bearing face 106 of each of the caps 72 is rounded and lined with smooth bearing metal, so that it offers a minimum frictional resistance to any side thrust motion of the rounded end of the corresponding piston rod. Each of the piston rods 102 is vertical and enters the base of the shell through a packing gland 108, and each rod is protected by a casing 110 from the abrasive and corrosive action of the fuel and gases in the bottom of hopper 30. The piston 104 of each engine is hollow and open at the lower end, as are also the corresponding piston rods 102 (see

Fig. 5) and in operation each of the pistons is actuated by the admission of water, air or other fluid medium under pressure into the cylinder casing through intakes 112. The actuating fluid, preferably water, circulates through the core of the piston rod and serves as a cooling medium therefor, and the rate at which it is admitted and exhausted into and from the cylinder casing through intakes 112 governs the speed at which the engine operates. Each of the engines 98 operates on an alternate cycle with each of the others. On the forward stroke of each engine the upper closed end of its piston rod bears against the face 106 of the corresponding thrust cap and raises the agitating ring above the top of the corresponding stand 74, but since at this time the other two engines are not operating on their upward stroke, one of the other thrust caps will always rest on the top of its corresponding stand. Consequently, the ring will be tipped on the up stroke of each engine, and as the engines operate on alternate cycles the motion imparted to the agitating ring will be a rocking up-and-down motion (see Fig. 4). This rocking motion keeps the fuel above the ring structure in a turbulent state of agitation. The degree of agitation is controlled by varying the speed at which the engines operate and by increasing or decreasing the length of their stroke. Wings 114, (see Fig. 5), are cast integral with the cylinder casing of each engine, and each of the wings is drilled for bolts 116 which pass through a check-yoke 118. This check-yoke straddles the piston rod and by means of nuts 120 the lengths of the bolts are adjusted to draw the check-yoke closer or move it farther away from the upper end of the cylinder casing. The check yoke acts as a buffer-plate for the upper closed end of the piston, and by varying the position of the yoke with respect to its distance from the cylinder casing the length of the stroke of each piston may be readily adjusted to meet varying conditions of operation. The length of the stroke of each piston governs the distance through which the agitating ring is raised above the top of the corresponding stand 74 during the up-stroke of the engine.

The driving mechanism which operates the scraper element 62 by which the rate of advance of fuel through the axial portion of the shaft is governed comprises three hydraulic or pneumatic engines 122 (see Fig. 2) mounted on brackets 124 around the periphery of the outside of the shell 10. Three crank pins 126 are set in the frame of the scraper at regular intervals about its circumference, and to each crank pin is attached one end of a radially extending crank arm 128. Each of these crank arms is connected at its opposite end by a loose-pin-joint 130 to piston rod 132 of the corresponding driving engine—each piston rod entering the shell through a packing gland 134 in the shell lining. The engines 122 are operated on alternate cycles, i. e., while one is on a forward stroke one of the others is on a back stroke, so that the scraper is continually oscillated in a circular or oval path across the surface of plate 56 and some of the fuel supported on the surface of the plate is continually forced over its outer edge into hopper 30. The length of the stroke of each of these engines can be adjusted independently of that of each of the others, and the length of its stroke and the rate at which each engine operates governs the rate at which fuel is advanced through the axial portion of the generator and discharged over the edge of plate 56. The scraper is hollow, and is water cooled by a spray 135 which plays on its interior through an axial opening 136 in the center of plate 56.

The driving mechanisms by which platforms 58 are reciprocated comprise pneumatic or hydraulic engines 138 disposed radially of the shaft on brackets which are placed outside the shell lining. Each platform has its own driving engine, and each of the engines has a hollow open-ended piston, similar in design to the pistons of engines 98, which is connected by a piston rod 140 to the corresponding platform. On the forward stroke of the piston the platform is advanced to its forward position, at which time fuel in the peripheral portion of the charge and in the annular passage 54 is positively supported on its surface. On the back stroke of the piston, however, the platform is withdrawn, leaving an opening 142 (see Fig. 2) between its inner edge and the outer edge of the plate 56, through which fuel drops into hopper 30. Depending on the length of the piston stroke and on the rate at which it is reciprocated variable amounts of fuel can be discharged from the annular space 54 over the front edges of the platforms 58, and accordingly fuel can be advanced downwardly through the peripheral sections of the shaft at a controlled rate which may be faster or slower than the rate at which fuel is advancing through the axial portion of the shaft. The platforms may be reciprocated either on the same or on alternate cycles. A box-like offset 144 is built into the wall of the shaft behind each platform, and each box has an area large enough so that the corresponding platform can enter it during the back stroke of the driving engine.

The plows 64 are reciprocated by pneumatic or hydraulic engines 146 which are mounted about the external periphery of the shaft. Each of the scrapers is hollow and water cooled and is attached by water cooled connecting rods 148 to a yoke 150, which in turn straddles the piston rod 152 of the cor-

responding engine. The position of the yoke 150 with respect to its distance from the end of the cylinder casing is adjustable by means of nuts 154 on the connecting rods, so that the length of the stroke of the piston can be varied. The speed at which the engines 146 are operated and the length of the stroke of the scrapers 64 both being variable, it is readily apparent that the rate at which fuel is passed downwardly through the peripheral portion of the shaft and pushed over the edges of table 60 is easily regulated.

The discharge mechanism is supported in the shaft by girders 156, each of which is preferably provided with expansion seats and is supported by the same columns which support the generator shaft. Plate 56 rests directly on these girders, while the other elements of the discharge mechanism are supported at various distances above the girders by stands 74, columns 92 and by trucks 94, as previously mentioned.

The hollow support rods 34 enter the ash hopper 30 through stuffing boxes 158 and are all connected to a manifold 160 positioned on the outside of the generator. A pipe 162 connects this manifold to a water storage tank 164 (see Fig 1). A piston rod extension 166 passes through the cylinder head of one of the driving engines 138 of platforms 58, and is connected by a pin to one arm of the bell crank 168. The other arm of the bell crank is connected through a rod 170 to one arm of a bell crank 172. The shaft of the bell crank 172 is supported by a bearing and stuffing box in the side wall of tank 164 and the end of the shaft which extends into the tank is attached by another arm through a pin and loose sleeve joint 173 to the upper end of a vertical rod 174. Rod 174 either comprises, or is connected to, the stem of a large float valve 176 having its seat in the base of the tank at the inlet of pipe 162. By means of these various links the motion of engine 138 and platform 158 is transmitted to the stem of valve 176 and the valve is lifted off its seat on each backward or outward stroke of the engine. By means of the sliding pin joint 173, the engine may complete its forward stroke without closing the valve, that is the valve 176 will remain open after the platform 58 has again moved into its forward position. The valve 176 is closed and a fresh charge of water is simultaneously admitted to the tank through a water inlet 177 by means of the action of float 178, acting through an auxiliary tripping mechanism and links similar to those used in the common type of toilet flush tanks. A regulated volume of water is admitted to tank 164 through inlet 177 each time the flush tank mechanism operates, and each time the platform 58 is withdrawn from its forward position into box 144 the valve 176 at the inlet of pipe 162 is unseated and the tank full of water passes through manifold 160 and rods 34 into the hollow fuel screens 36 and 37 and after its vaporization therein the steam formed enters the base of the fuel column through the circumferential nozzles 38. By this arrangement the admission of water into the base of the fuel column in shaft 10 is timed to correspond with the periodic movements of the platforms 58 of the discharge mechanism. While the admission of water vapor to the base of the fuel column has been described and illustrated as controlled by the operation of one of the driving engines 138, such admission of water need not necessarily be controlled by any particular engine 138, and the admission of water may be made dependent on the operation of one of the driving engines 146 of plows 164 without departing from the spirit of the invention. Likewise the use of cooling water is not necessarily limited to those elements of the cooling mechanism which have been described and illustrated as water cooled, but this use may be extended to include elements in which no provision for water cooling has been illustrated or particularly described. Thus for example the driving mechanisms and connections for scrapers 62, and the fuel supporting plates of tables 60 and of movable platforms 58 may be designed and equipped for cooling by a positive circulation of water therethrough.

The number of elements comprising the discharge mechanism may be increased or diminished without departing materially from the true scope of the invention; nor is the manner in which the several elements are arranged within the generator material, so long as the number of elements chosen and the manner in which they are disposed and operated will carry out the objects outlined above. The chief functions to be performed by a discharge mechanism coming within the scope of the invention are— first,—to thoroughly agitate the fuel throughout the lower portion of the generator so as to prevent its obstruction by masses of clinker; and—second,—to advance fuel either uniformly or at variable rates through the axial and peripheral sections of the generator so as to discharge substantially uniform concentrations of ash and unconsumed fuel from each cross section of the lower portion of the shaft.

One of the principal advantages obtained by using the preferred form of discharge mechanism described above is that each of the stationary elements has a movable element mounted thereon which is reciprocated or oscillated across its face at such frequent intervals as to afford no opportunity for clinker to amass and build up thereon. Another advantage is that each of the movable elements of the above mechanism is actuat-

ed by its own individual driving engine, and the speed at which each engine operates and its length of stroke can both be adjusted to set up the required degree of agitation in the lower portion of the fuel column and to advance the fuel at uniform or variable rates through the axial and peripherial sections of the high temperature zone. As a result of this control substantially uniform concentrations of ash and unburned fuel can always be discharged from the entire cross section of the lower portion of the column in the generator, no matter what mode of air blasting is used in the high temperature zone. Another advantage obtained by agitating the lower portion of the fuel column is that the charge is kept in an open and porous condition with the result that the heat transferring gases introduced through the vaporizing elements of the discharge mechanism can distribute themselves uniformly through the fuel throughout the cross section of the charge.

The arrangement whereby water, steam or other cooling medium can be introduced into the lower portion of the fuel column constitutes one of the advantageous features of the present apparatus. Thus by this arrangement the surfaces of the fuel guides and screens directly exposed to the hot fuel in the lower portion of the shaft can be water-cooled, and the steam formed by a vaporization of the water in these screens can be admitted directly into the fuel at the base of the column above and out of contact with the metal portions of the discharge mechanism.

A shaft generator equipped with this preferred form of discharge mechanism can be operated with axial air blasting, with peripheral air blasting, or with both axial and peripheral air blasting with equal facility, since the elements of the mechanism are arranged in two main groups, one in the axial and the other in the peripheral section of the shaft, and the rate at which the movable elements of each group are operated can be varied to pass uniform or variable volumes of fuel through the axial and peripheral channels 52 and 54.

The preferred form of the invention having been thus described, what is claimed as new is:

1. A discharging device comprising a number of movable and stationary elements overlapping each other and mounted in vertically spaced groups, means for moving an upper axially mounted element through a vertical path, and separate means for moving other axially and peripherally mounted movable elements in horizontal paths.

2. A discharging device comprising a number of groups of stationary and movably mounted elements forming in combination a complete closure for a shaft and arranged in vertically separated horizontal planes, each stationary element having a movable element mounted on its upper supporting surface to discharge fuel over its edge and to prevent the building up of masses of clinker thereon.

3. A discharging mechanism comprising a number of vertically spaced groups of stationary and independently movable elements disposed axially and radially about the central axis of a shaft and serving in combination as a positive support for a column of material, and separate means for operating each of said movably mounted elements independently of each of the others.

4. A discharging mechanism arranged to support a column of fuel in a shaft, to agitate fuel throughout the lower cross section of the column and to discharge uniform concentrations of ash and unconsumed fuel from the bottom of the column comprising a number of stationary and movably mounted elements disposed in the central axis and about the inner periphery of the shaft in two main groups, the axially mounted group comprising an upper movable agitating ring, a lower stationary supporting plate, and a movable scraper mounted on the upper surface of the supporting plate, and the peripherally mounted group comprising a number of movable platforms, a number of stationary tables, and a number of movable plows mounted on the top surfaces of the stationary tables.

5. A discharging mechanism arranged to support material in a column and to advance it through a shaft comprising a stationary horizontal plate having its center in the major axis of the shaft, a movably mounted agitating ring overlapping said plate and vertically spaced therefrom, said ring having its core in the central axis of the shaft, means for imparting a rocking motion to the agitating ring, and means for displacing material over the edges of the plate.

6. A discharging mechanism comprising a stationary plate mounted with its center in the major axis of a shaft, a disc-shaped scraper movably mounted on the top surface of the plate, means for oscillating the scraper across the surface of the plate to displace material supported thereon, a number of stationary tables disposed at regular intervals about the inner periphery of the shaft and vertically spaced from the axially mounted plate, a plow movably mounted on the top surface of each of the peripherally disposed tables, and separate means for reciprocating each of the plows across the surfaces of the tables to displace material supported thereon.

7. A discharging mechanism comprising a horizontal stationary plate mounted axially of a shaft, a number of stationary ta-

bles supported at regular intervals about the inner periphery of the shaft and vertically spaced from the axially mounted plate, a number of movably mounted platforms disposed alternately with said peripherally supported tables about the inner periphery of the shaft and arranged to support material unsupported by said tables, means for at intervals displacing material over the edge of the axially mounted plate, separate means for at intervals displacing material over the edges of each of said peripherally supported tables, and separate means for reciprocating each of the movably mounted platforms at intervals to permit material to flow between the platforms and the axially mounted table.

8. A discharging mechanism comprising an upper movable agitating ring and a lower stationary plate mounted axially of a shaft in vertically separated horizontal planes, the surface area of said plate being sufficient to support material passing through the axial core of the ring, a series of stationary tables and a series of movable platforms mounted peripherally of the shaft and vertically spaced from the axially mounted plate and the agitating ring, the combined area of the top surfaces of said peripherally mounted tables and platforms being sufficient to positively support any material in the shaft not supported by the axially mounted plate and ring, and separate means for at intervals displacing material supported by each of said elements.

9. A discharging mechanism forming a complete closure for a shaft comprising an upper movable agitating ring and a lower stationary supporting plate mounted in the central axis of the shaft in vertically separated horizontal planes, a number of stationary supporting tables and a number of movably mounted platforms supported alternately between the inner wall of the shaft and the outer rims of the axially mounted ring and table, means for rocking the ring up and down, means for reciprocating the platforms, means for at intervals displacing material supported by the axially mounted plate, means for at intervals displacing material supported by each of the peripherally supported tables, and means for separately controlling the length of stroke and the rate at which each of the said rocking, reciprocating and displacing means is actuated.

10. A discharging mechanism comprising an agitating ring movably mounted in the central axis of a shaft, said ring having an axial core and an outer rim spaced from the inner wall of the shaft, means for imparting a rocking motion to said ring to agitate material in the shaft and to deflect material through its core and through the peripheral channel between its rim and the wall of the shaft, means for supporting material passing through the core of the ring, means for supporting material passing through the peripheral channel, and separate means for causing material to flow past all said supporting means.

11. A discharging device comprising an agitating ring and a stationary plate supported in the central axis of a shaft in vertically separated horizontal planes, a number of stationary tables and movably mounted platforms disposed alternately about the inner periphery of the shaft and having their outer edges overlapped by the inner wall of the shaft and their inner edges overlapped by the outer rim of the agitating ring, a disc-shaped scraper movably mounted on said axially supported plate, a plow movably mounted on the surface of each of said peripherally disposed tables, means for causing the ring to rock up and down, means for reciprocating said peripheral platform, means for oscillating said disc scraper, and means for reciprocating said plows.

12. A discharging device comprising an agitating ring movably mounted in the major axis of a generator shaft on a number of supporting stands, a driving mechanism for the ring comprising a number of engines mounted directly beneath the supporting stands and outside the generator shell, an inverted open-end hollow piston in each engine, a vertical piston rod attached to each of said pistons and passing through the top of the corresponding supporting stand, a number of hollow thrust caps about the base of the ring structure, each cap having a rounded bearing surface to receive the upward thrust of a piston rod, means for controlling the rate at which each engine is actuated on an alternate cycle with each of the other engines to impart an up-and-down-rocking motion to the ring structure, and means for regulating the length of stroke of each engine.

13. A discharging mechanism comprising an agitating ring movably mounted in the central axis of a shaft on a number of supporting stands, said agitating ring having a refractory faced fuel supporting surface built in the shape of a truncated cone, a refractory faced cylindrical core, and a refractory faced cylindrical apron depending from its outer rim, means for at intervals raising the ring structure above one or more of its supporting stands to impart an up-and-down-rocking motion thereto, a stationary plate supported axially of the shaft beneath and spaced from the agitating ring, a number of stationary tables and movably mounted platforms supported alternately about the inner periphery of the shaft and serving in combination to support material not positively supported in the shaft by the

axially mounted table and agitating ring, and means for at intervals discharging material over the edges of each of said tables and platforms.

14. A discharging mechanism comprising a movably mounted agitating element and a number of stationary and movably mounted supporting and discharging elements positioned in close functional relationship in the lower portion of a shaft, separate driving mechanisms for imparting motion to each of said movably mounted elements, means for introducing a cooling medium into the driving means and movably mounted elements of the discharge mechanism, stationary screens adjacent the lower exposed portions of the agitating element, and means for introducing a cooling medium through the cores of said screens into the lower portion of a column of material immediately above said supporting means.

15. A discharging mechanism comprising a movably mounted agitating element and a number of stationary and movably mounted supporting and discharging elements arranged in vertically separated planes about the vertical axis of a shaft, individual driving mechanisms for moving each of said movably mounted elements, means for introducing water into the driving mechanisms and into the several elements of the discharge mechanism, means for introducing water vapor from some of the elements of the discharge mechanism into the lower portion of a column of material in the shaft, and means for timing the periodic introduction of water into the driving mechanisms and elements of the discharge mechanism to correspond with the periodic operation of the discharging elements.

In testimony whereof I affix my signature.

GEORGE W. SAATHOFF.