No. 897,009. PATENTED AUG. 25, 1908.

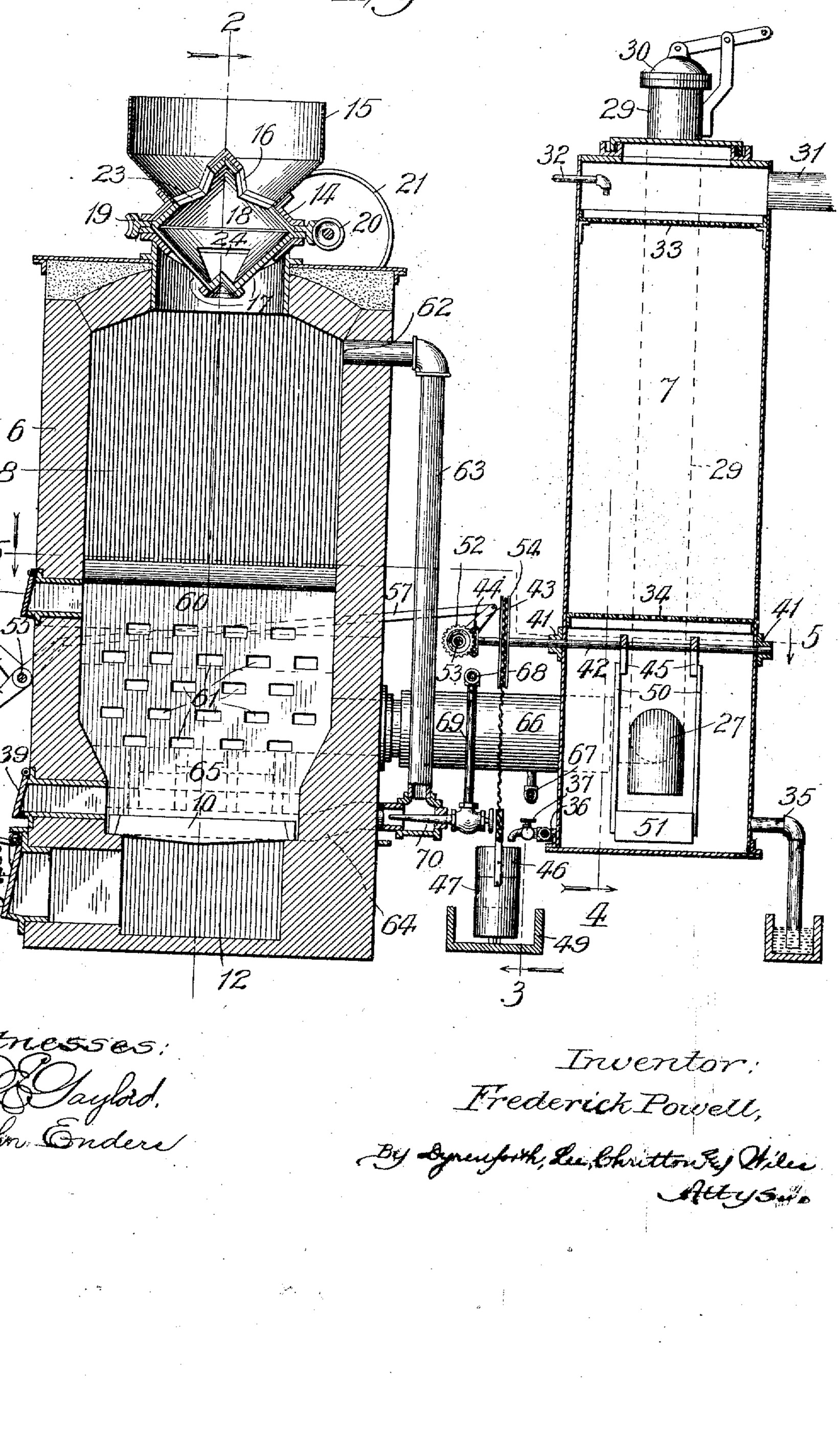
F. POWELL.

GAS PRODUCER.

APPLICATION FILED FEB. 6, 1908.

4 SHEETS—SHEET 1.

Fig. 1.



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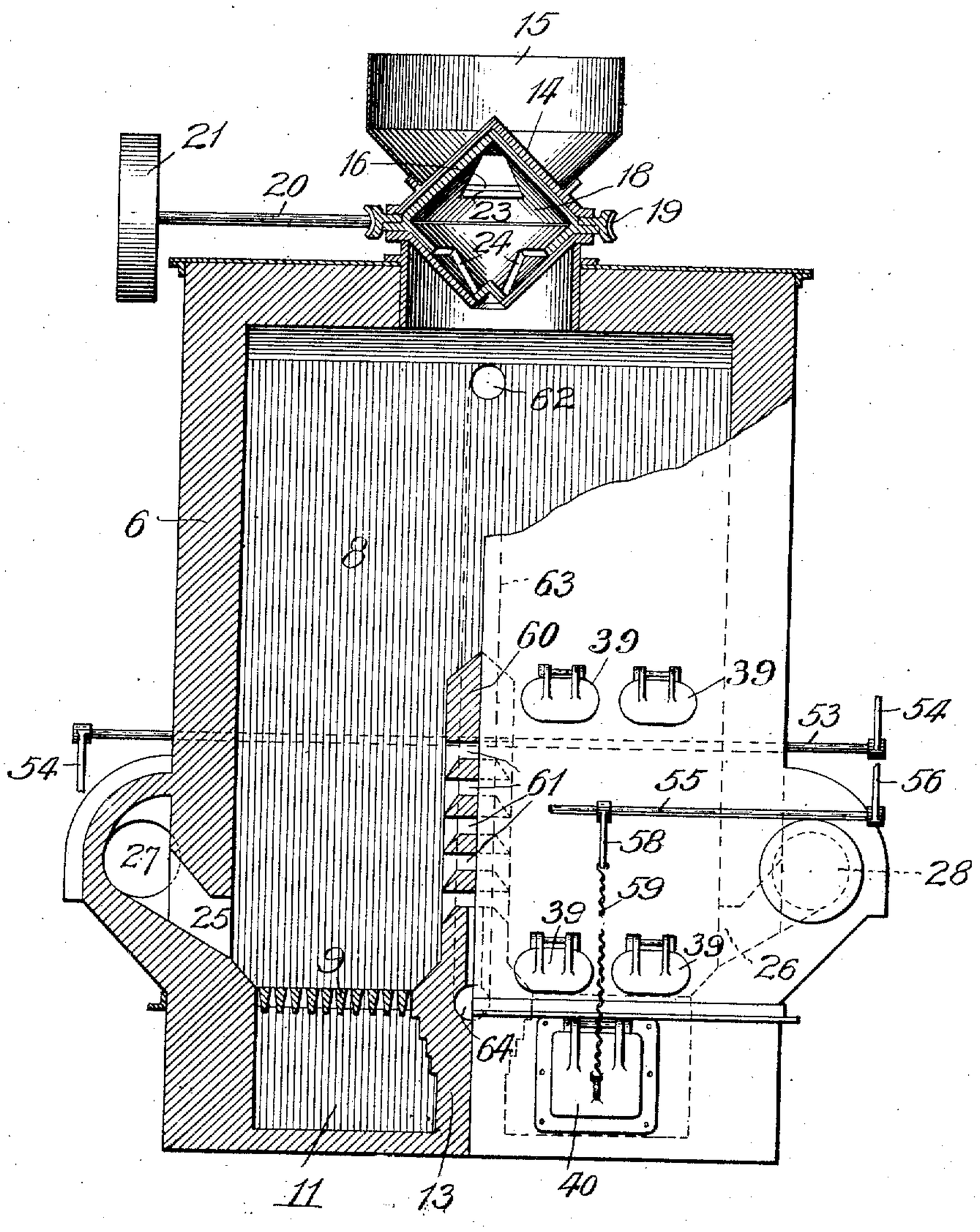
4 SHEETS—SHEET 2.

Fig. 2.



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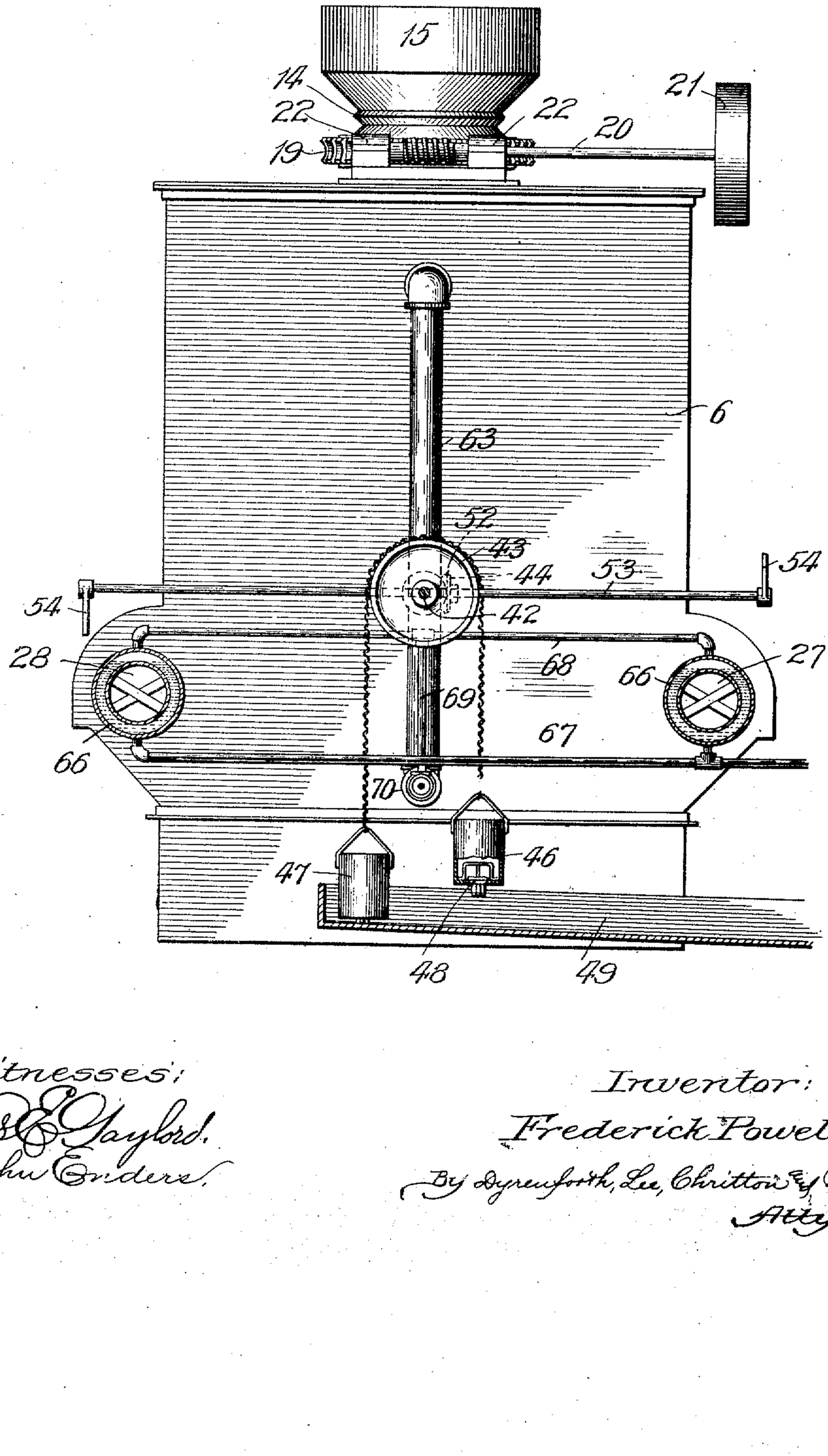
4 SHEETS—SHEET 3.

Fig. 3.



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4 SHEETS—SHEET 4.

Fig. 4.

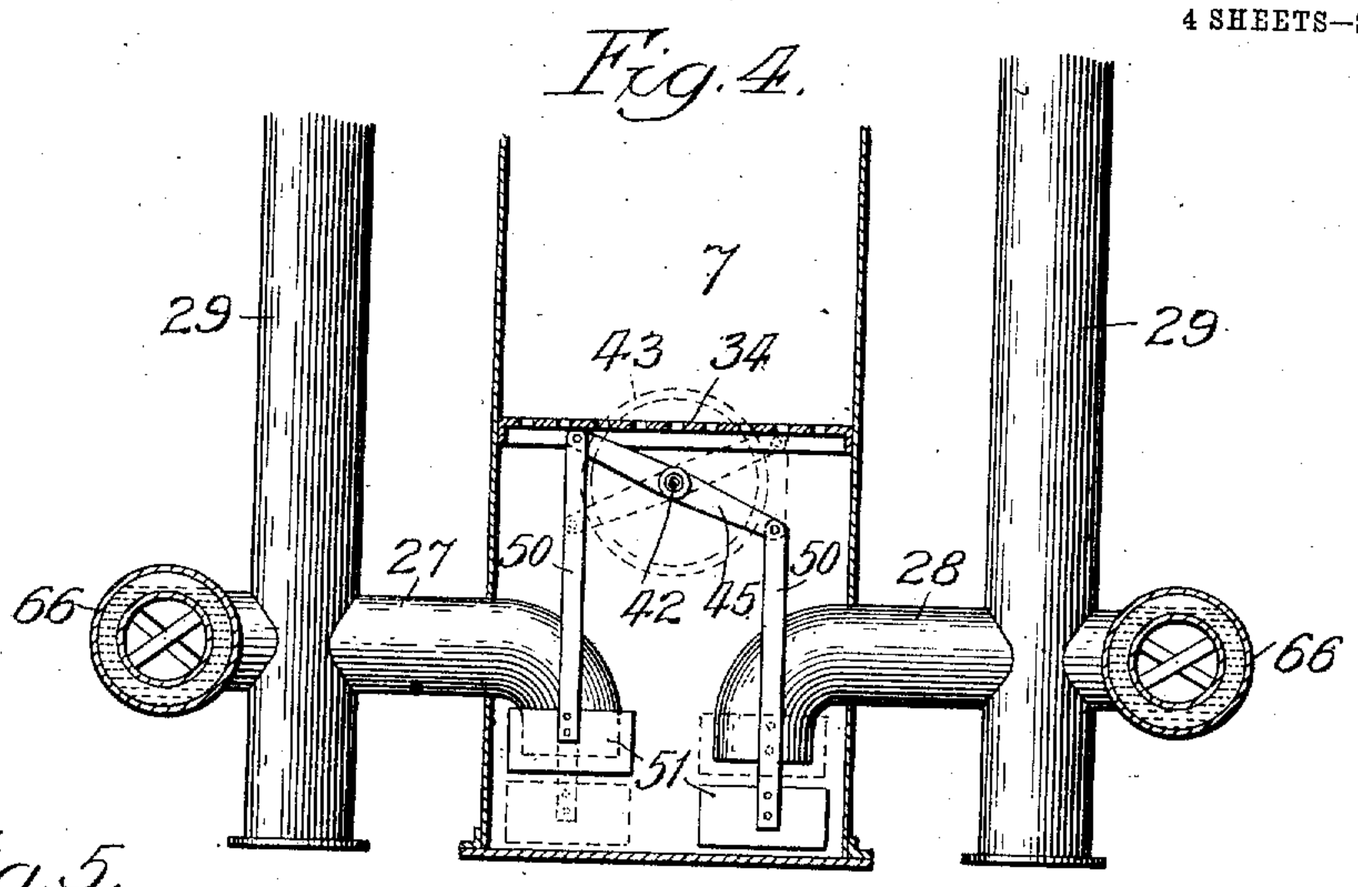
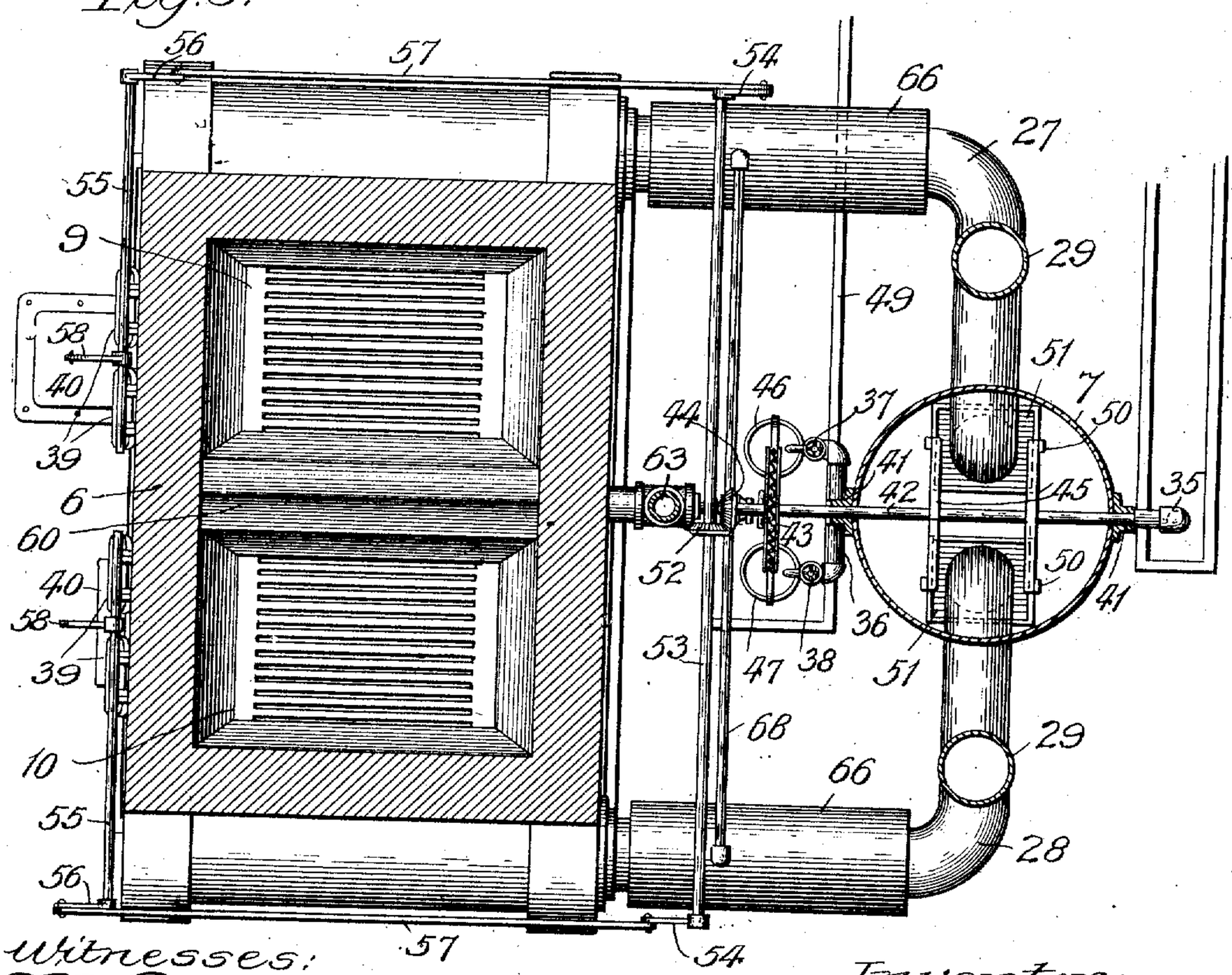


Fig. 5.



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UNITED STATES PATENT OFFICE.

FREDERICK POWELL, OF PORTLAND, OREGON.

GAS-PRODUCER.

No. 897,009. Specification of Letters Patent. Patented Aug. 25, 1908.

Application filed February 6, 1908. Serial No. 414,539.

To all whom it may concern:

Be it known that I, FREDERICK POWELL, a citizen of the United States, residing at Portland, in the county of Multnomah and State of Oregon, have invented a new and useful Improvement in Gas-Producers, of which the following is a specification.

My invention relates to improvements in the construction of apparatus for use in the manufacture of producer gas from any kind of fuel, more especially from fuels containing volatile hydrocarbons and water, such as wood, lignite, bituminous coals, peat, sawdust, etc., with or without the addition of crude petroleum or other liquid fuel.

My object is to provide apparatus which will operate in a particularly economical, satisfactory and substantially continuous manner to produce from the fuel employed a uniformly good quality of gas.

In carrying out my invention I employ a gas producer furnace of the horizontal type the characteristic features of which are the admission of air, or application of blast, at one end-portion of an elongated fuel-chamber and withdrawal of the gas at the opposite end close to the grate, so that the draft is in a substantially horizontal direction through the fuel body. I provide this class of furnace with a gas-outlet at each end of its horizontally-elongated fuel-chamber and I also provide, preferably, automatic means for reversing the direction of draft at suitable intervals by admitting air first to one and then the other end-portion of the chamber at the same time closing and opening the corresponding gas-outlets alternately. The air is excluded from that side of the fuel-chamber which has its gas-outlet open for the time being, and the gas-outlet is closed on the side to which air is being admitted.

To insure the proper admission of draft to one side, or end-portion, only of the chamber at one time I divide the ash-pit and grate by a solid transverse wall thereby making two ash-pits and two grate-sections which are, by preference, symmetrically disposed with regard to the transverse axis of the furnace. For the purpose of diffusing the draft through the lower portion of the fuel-chamber I provide, preferably, and as an extension of the said wall, a porous baffling-wall above the grate-level which admits the passage through it of the horizontal draft and operates, in effect, to break up and diffuse the draft, causing substantially uniform combustion through approximately the lower one-third of the fuel-body in the fuel-chamber and thereby preparing a sufficient depth of incandescent fuel to insure the proper decomposition and fixing of the gases before they leave the apparatus. I also provide means for preventing the products of distillation formed in the upper part of the fuel from being drawn immediately downward toward the gas-outlets, this at the same time being a means for assisting diffusion of the draft through a considerable depth of the fuel-body. These effects are brought about by maintaining an induced draft or circulation upward through the fuel-body and downward through a by-pass leading from the top of the fuel-chamber to a passage formed in the said transverse dividing wall at or near the grate level and discharging through the openings of the porous baffling wall.

The withdrawing of distillation products above the fuel body and their introduction into the lower and hotter portion of the fuel is not in itself broadly new, but inasmuch as the contact of these distillation products with the incandescent fuel required to fix them acts to reduce the temperature of such fuel, tending thus to destroy its incandescence and render it incapable of effecting the desired results, it will be evident that the continuous introduction of the distillation products into the same mass of fuel, as has been the practice hitherto so far as I am aware, is apt not to be continuously effective. As the fixing or decomposition of the distillation products depends upon the temperature of the fuel into which they are discharged, means should be provided for intermittently raising the temperature of the fuel into which the said products of distillation are introduced. I obtain this result by the reversal of the draft causing the fuel on that side which has its air inlet open to be "blown up" and prepared to act efficiently as a fixing zone. The volatiles from the top of the fuel chamber are caused to pass horizontally through only the fuel on the side of the porous baffling wall opposite to that which has its air inlet open. The introduction of the volatiles at the point shown, midway between the air inlets, enables me to accomplish this alternate blowing up and fixing ac-

tion without complicated passages or valves for controlling the passage of the volatiles. I thus provide in a single fuel-chamber having a single fuel-admitting mechanism positive means whereby I secure in the fuel-body two zones in the same horizontal plane next the grate, each of which acts intermittently as a zone of combustion and of decomposition, and a zone of distillation above the other said zones the products whereof are compelled to pass through the then zone of decomposition.

The foregoing and other features of my improvement will be specifically described with reference to the accompanying drawings, in which—

Figure 1 is a vertical section of apparatus constructed with my improvements and designed more especially for the manufacture of producer gas from solid or a mixture of solid and liquid fuel; Fig. 2, a view partly in broken elevation and partly in section, the section being taken on line 2 in Fig. 1; Fig. 3, a partly sectional elevation, the section being taken on line 3 in Fig. 1; Fig. 4, a broken section of the gas-scrubber taken on line 4 in Fig. 1; and Fig. 5, a broken plan section taken on irregular line 5 in Fig. 1.

6 is the furnace portion of my improved apparatus and 7 the gas scrubber. The furnace contains a single fuel-chamber 8 having the two grate-sections 9, 10, which overlie separate ash-pits 11, 12 separated from each other by a dividing-wall 13. At the top and center of the fuel-chamber is fuel-feeding mechanism which may be constructed as shown. It has a casing-portion 14 formed of two conical sections surmounted by a hopper 15 and having openings 16 and 17 communicating respectively with the hopper and fuel-chamber.

18 is a feeder in the form of a hollow double cone which fills out the interior of the casing 14 and rotates freely in the horizontal direction having a surrounding flange passing between the casing sections provided with a circumferential worm-gear 19 at which it is engaged by a worm-shaft 20 which is driven by a pulley 21 and is journaled in bearings 22 integral with the sections of the casing 14. The feeder has openings 23 in its upper side and openings 24 in its lower side.

In operation as the feeder is rotated by the worm-shaft 20 the openings 23 register with the openings 16 causing the hollow feeder to be filled with fuel from the hopper. In the further rotation of the feeder the openings 23 are closed, after which the openings 24 register with the openings 17 causing fuel to discharge from the feeder into the fuel-chamber 8. The supply of fuel to the fuel-chamber is governed by the speed of rotation of the feeder, and the construction is such that fuel may be fed in desired quantity and with desired regularity without permitting the material escape of gas from the fuel-chamber.

At opposite ends of the elongated fuel-chamber, close to the grates, are the gas-outlets 25, 26 communicating respectively with outlet-pipes 27, 28 which have turned-down ends opening into the lower part of the scrubber 7. Rising from the pipes 27, 28 are draft stacks 29 provided at their upper ends with dampers 30 which are only open during the initial starting of the furnace. The scrubber has a gas-outlet pipe 31 and a water-inlet 32 in its top portion, and contains upper and lower perforated diaphragms 33, 34 located as shown. In one side of the scrubber near its base is a drainage-pipe 35, and in the opposite side at a lower level is another drainage-pipe 36 carrying faucets 37, 38.

Extending through the front wall of the furnace above the grates are stoke-openings which are closed by doors 39. The only admission of draft to the fuel-chamber is through the ash-pits and they are provided with openings closed by vertically-swinging doors or valves 40.

Fulcrumed in bearings 41 in the opposite walls of the scrubber is a rock-shaft 42 carrying a sheave 43, a bevel-pinion 44 and two pairs of oppositely-extending crank-arms 45 all in the relative positions shown. Passing over the sheave 43 is a chain carrying at opposite ends buckets 46, 47. The buckets 46, 47 are each provided with an opening in its base closed by a check-valve 48 having a stem extending below the bottom of the bucket. The bucket 46 hangs beneath the faucet 37 and the bucket 47 hangs beneath the faucet 38, and beneath the buckets is a water-discharging trough 49. Suspended from the ends of the crank-arms 45 are pivotal links 50 carrying water-holding pans or buckets 51 for alternately sealing the ends of the gas-conducting pipes 27, 28 and operating as opening and closing valves therefor. When, for example, the rock-shaft is turned to the position indicated in the figures, one pan 51 closes the mouth of the pipe 27 and the other pan 51 is lowered to open the mouth of the pipe 28, as indicated by full lines in Fig. 4. When the shaft 42 is rocked to its limit in the other direction one pan 51 closes the pipe 28 and the other pan 51 opens the pipe 27, as indicated by dotted lines in Fig. 4. The bevel-pinion 44 engages a bevel-pinion 52 on a rock-shaft 53 extending beyond the end-walls of the furnace 6 where it carries cranks 54.

Extending horizontally across the front of the furnace, in the position shown, are rock-shafts 55 parallel with the shaft 53 and provided beyond the ends of the furnace 6 with cranks 56 which are connected by rods or links 57 with the respective cranks 54. On the shafts 55 above the doors 40 are cranks 58 connected by chains 59 with lugs on the

said doors. The connections described between the rock-shaft 42 and doors 40 are such that when the shaft is rocked in one direction to close the pipe 27 and open the pipe 28, as described, the door 40 of the ash-pit beneath the grate-section 9 is opened and the door of the ash-pit beneath the grate-section 10 is closed, whereby the draft will be through the grate 9 and more or less horizontally across the fuel chamber to the outlet 26, thence through the pipe 28 to the scrubber.

During the operation of the furnace a constant supply of water enters the scrubber from the pipe 32 falling upon the perforated diaphragm 33 and sprinkling downward onto and through the coke with which the space between the perforated diaphragm 33 and 34 is filled, reaches the base of the scrubber and flows out through the pipe 36. When the water rises to a sufficient depth in the base of the scrubber it will overflow through the pipe 35. The water flowing out through the pipe 36 is discharged from the faucets 37, 38 into the buckets 46, 47 respectively. The rocking of the shaft 42, as described, is produced by the filling and emptying of the said buckets 46, 47 alternately. When the bucket 46, for example, is raised, as indicated in Fig. 3, its valve 48 closes by gravity; and as at the same time the bucket 47 is lowered the stem of its valve 48 strikes the base of the trough 49 and opens said valve. The valves 48 when opened permit the escape of water from the buckets much faster than water can enter the buckets from the faucets. When the bucket 46 is filled or nearly filled with water from the faucet 37 it overcomes the resistance to rocking of the shaft 42 and descends quickly to the trough 49, where it immediately commences to empty. This rocking of the shaft 42 raises the then empty bucket 47 to close its valve 48 and cause it to be filled from the faucet 38 until its weight overcomes the resistance to rocking of the shaft 42. The reversal of draft through the fuel-chamber is thus brought about intermittently at intervals governed by the flow of water from the faucets which may be easily regulated.

Rising from the ash-pit dividing-wall 13 to a height, approximately, one-half that of the chamber 8 is a baffling-wall 60 formed, preferably, as indicated and presenting openings or passages 61. The series of passages 61 extend to or above the top of the zone of incandescence which it is desired to maintain and operates as a means for breaking up and diffusing the drafts of products of combustion passing from the zone of combustion to the fixing zone.

Extending from a port 62 in the upper part of the fuel-chamber above the fuel-level is a pipe 63 leading to a passage 64 cored in the wall 13 at about the grate-level. Branch-passages 65 extend from the passage 64 to the lower series of openings or passages 61 through the baffling-wall. Surrounding the pipes 27, 28 between the furnace and scrubber are steam-generating jackets 66 communicating at their lower sides with a water supply pipe 67. A pipe 68 connected with the tops of the steam-jackets communicates with a pipe 69 terminating in an injector 70 which enters the lower end of the pipe 63 pointing in the direction of the said passage 64. The hot gases passing through the pipes 27, 28 generate steam in the jackets 66 which is injected into the passage 64 thereby inducing draft or circulation with the result that products of distillation are withdrawn from above the fuel-level and forced into the lower passages 61. These products of distillation pass thence with the main draft in one direction or the other to and through the then fixing zone to the then gas-outlet. The introduction of steam with the hydrocarbons furthermore results in the production of water-gas by contact with the incandescent fuel.

In thus describing my apparatus I do not wish to be undertood as confining myself to the particular form of the details shown in the drawings. It is obvious that the ash-pits may be water sealed and that the grates may be of any one of a number of known forms or omitted entirely, allowing the fuel to rest on the accumulated ashes which will form the necessary supports for the fuel. The air may be admitted to the ash-pits under pressure from a blower or injector to operate the producer under forced draft instead of induced draft or suction. The auxiliary internal draft or circulation may be accomplished with a fan instead of a steam jet, and in the case of fuels containing a sufficient percentage of moisture the fan would be preferable. In such case the steam generated in the jackets would run the fan. Such modifications and others may be made without changing the essential form of my apparatus or the functions of the several parts.

The method of operating my apparatus is as follows:—The valves 30 and both ash-pit doors being open, a fire is kindled on the grates, fuel for this purpose sufficient to fill the chamber about two-thirds full being introduced quickly through the feed opening, the feed mechanism being temporarily lifted from its position by means of a convenient hoist. As soon as the fire is started this is lowered again in position closing the opening. The draft is now naturally through the pipes 27 and 28 and the stack 29. This preliminary firing is continued until the fuel on both sides of the fuel-chamber has become thoroughly incandescent to a sufficient depth and the volatile constituents burned or driven out as shown by the disappearance of the thick smoke at the valves 30. The fuel

in the lower part of the chamber is then residual or fixed carbon of the original fuel and is prepared to decompose and fix the volatile constituents from fresh fuel afterwards introduced.

If the fuel to be used in the producer is very low in fixed carbon, as may be the case with some lignites, for which my apparatus is more especially intended, the first preliminary firing may be done with coke, anthracite coal or charcoal, thereby more quickly securing the necessary bed of incandescent fixed carbon absolutely necessary for the proper fixing of the gas. The preliminary firing will at the same time begin the generation of steam. One ash-pit door and the corresponding valve 30 on the opposite side are now closed, causing the draft to pass as intended in the regular operation. Combustible gas will soon reach the open valve 30, which is then closed and the operation repeated with the other valve and air inlet until gas has filled the pipes 27 and 28 and the stacks 29. The scrubber is supposed to have been filled with coke and the water turned on when the fire was started in the producer. The feeding of the regular fuel has in the meantime been started and the steam turned on at 70. If an exhaust fan is employed attached to the gas pipe from the scrubber, it is now started. The automatic reversing apparatus is also set in operation. If the gas is used directly in an engine a small exhaust fan attached so as to be worked by hand will bring the gas through to the engine, which when once started keeps up the draft by suction.

In case it is desired to use a liquid fuel for the purpose of enriching the gas, such liquid fuel is mixed with the solid fuel and fed with it. The liquid fuel being volatilized in the zone of distillation the resulting gas is drawn down through the by-pass as described, and passes with the added steam through the fixing zones. The fuel must of course have sufficient fixed carbon to keep up the supply in the fixing zones.

It may be stated that the periodical reversal of the horizontal draft by the method which I employ, with the addition thereto of auxiliary induced up-draft effected through the agency of the injector or fan, causes the usual reactions of the producer (namely, the burning of carbon to carbonic acid by the direct combustion of the fuel in contact with air on one side and the decomposition into carbon monoxid by passage through the body of incandescent fuel on the other side) to be better and more uniformly secured than is possible in any other producer gas apparatus of which I am aware. At the same time, the volatile constituents of the fuel are converted into fixed gases without loss or waste, and without the necessity for any auxiliary cleaning apparatus other than the usual scrubber to prepare the gas for use.

What I claim as new and desire to secure by Letters Patent is—

1. In a gas-producer, the combination with the fuel-chamber and fuel-supports therein of valved gas-outlet passages communicating with opposite sides of the chamber above the plane of said fuel-supports, valved air-inlet passages at opposite sides of the center of the chamber and entering the latter below the plane of said gas-outlets, the whole being constructed and arranged to direct the air from each inlet, alternately, into the adjacent portion of the fuel-bed and in approximately horizontal direction through the remainder of the bed to fix the gas, the fixed gas discharging at the open valved outlet farthest removed from the air-supplying air-inlet, the other air-inlet and gas-outlet being meantime closed.

2. In a gas-producer, the combination with the fuel-chamber of valved gas-outlets in opposite sides thereof, a fuel-support in said chamber between said outlets, valved air-inlets at opposite sides of the center of the chamber, and means operating automatically to open and close the gas-outlet and air-inlet valves intermittently, the whole being constructed and arranged to direct the air from each inlet, alternately, into the adjacent portion of the fuel-body and in approximately horizontal direction through the remainder of the bed, the fixed gas discharging at the open valved outlet farthest removed from the air-supplying air-inlet, the other air-inlet and gas-outlet being meantime closed.

3. In a gas-producer, the combination with the fuel-chamber of valved gas-outlets in opposite sides thereof, fuel supports in said chamber between said outlets, a baffling-wall between said supports extending to a plane above said outlets and provided with a plurality of gas-passages through it, substantially as described, and valved air-inlets at opposite sides of the said baffling-wall, the whole being constructed and arranged to direct the air from each inlet, alternately, into the adjacent portion of the fuel-bed and in approximately horizontal direction through the said baffling-wall and remainder of the bed to fix the gas, the fixed gas discharging at the open valved outlet farthest removed from the air-supplying air-inlet, the other air-inlet and gas-outlet being meantime closed.

4. In a gas-producer, the combination with the fuel-chamber and fuel-supports therein, of valved gas-outlets in opposite sides of said chamber above the plane of said fuel-supports, valved air-inlets entering opposite sides of the center of the chamber below the plane of said gas-outlets, the whole

being constructed and arranged to direct the air from each inlet, alternately, into the adjacent portion of the fuel-bed and in approximately horizontal direction through the remainder of the bed to fix the gas, the fixed gas discharging at the open valved-outlet farthest removed from the air-supplying air-inlet, the other air-inlet and gas-outlet being meantime closed, and means for withdrawing products of distillation from above the mass of fuel in the fuel-chamber and discharging them into the lower portion of the fuel-bed between said air-inlets.

5. In a gas-producer, the combination with the fuel-chamber and means for feeding fuel thereto, of valved gas-outlets in opposite sides of the chamber, fuel supports in said chamber between said outlets, valved air-inlets at opposite sides of the center of the chamber, a porous baffling-wall in said chamber between the said supports, and means for withdrawing products of distillation from above the mass of fuel in the fuel-chamber and discharging them into the porous baffling-wall.

6. In a gas producer, the combination with the fuel-chamber and fuel-supports therein, of valved gas-outlets in opposite sides of the chamber above the plane of said fuel supports, valved air-inlets entering opposite sides of the center of the chamber below the plane of said gas-outlets, opening and closing means for the air-inlet and gas-outlet valves operating to change the direction of draft horizontally through the fuel-bed, and steam-injecting means operating to withdraw the products of distillation from above the mass of fuel in the fuel-chamber and discharge them into the lower portion of the fuel-bed between said air-inlets.

7. In a gas-producer, the combination with the fuel-chamber and means for feeding fuel thereto, of valved gas-outlets in opposite sides thereof, fuel-supports in said chamber between said outlets, a porous baffling-wall in said chamber between said supports, valved air-inlets at opposite sides of said baffling-wall, and steam-injector means operating to withdraw products of distillation from above the mass of fuel in the fuel-chamber and discharge them into the said porous baffling-wall.

8. In a gas-producer, the combination with the fuel-chamber of valved gas-outlets in opposite sides thereof, a fuel-support in said chamber between said outlets, valved air-inlets at opposite sides of the center of the chamber, and hydraulically-actuated opening and closing means for said gas-outlet and air-inlet valves, the whole being constructed and arranged to direct the air from each inlet, alternately, into the adjacent portion of the fuel-bed in approximately horizontal direction through the remainder of the bed to fix the gas, the fixed gas discharging at the open valved outlet farthest removed from the air-supplying air-inlet, the other air-inlet and gas-outlet being meantime closed.

9. In a gas-producer, the combination with the fuel-chamber and gas-scrubber, of valved gas-outlets in opposite sides of said chamber leading to said scrubber, a fuel-support in said chamber between said outlets, valved air-inlets at opposite sides of the center of the chamber, and means for opening and closing said gas-outlet and air-inlet valves, alternately, to change the direction of draft horizontally through said chamber, actuated by water discharged from said scrubber.

FREDERICK POWELL.

In presence of—
A. LITTLE,
H. E. COWGILL.