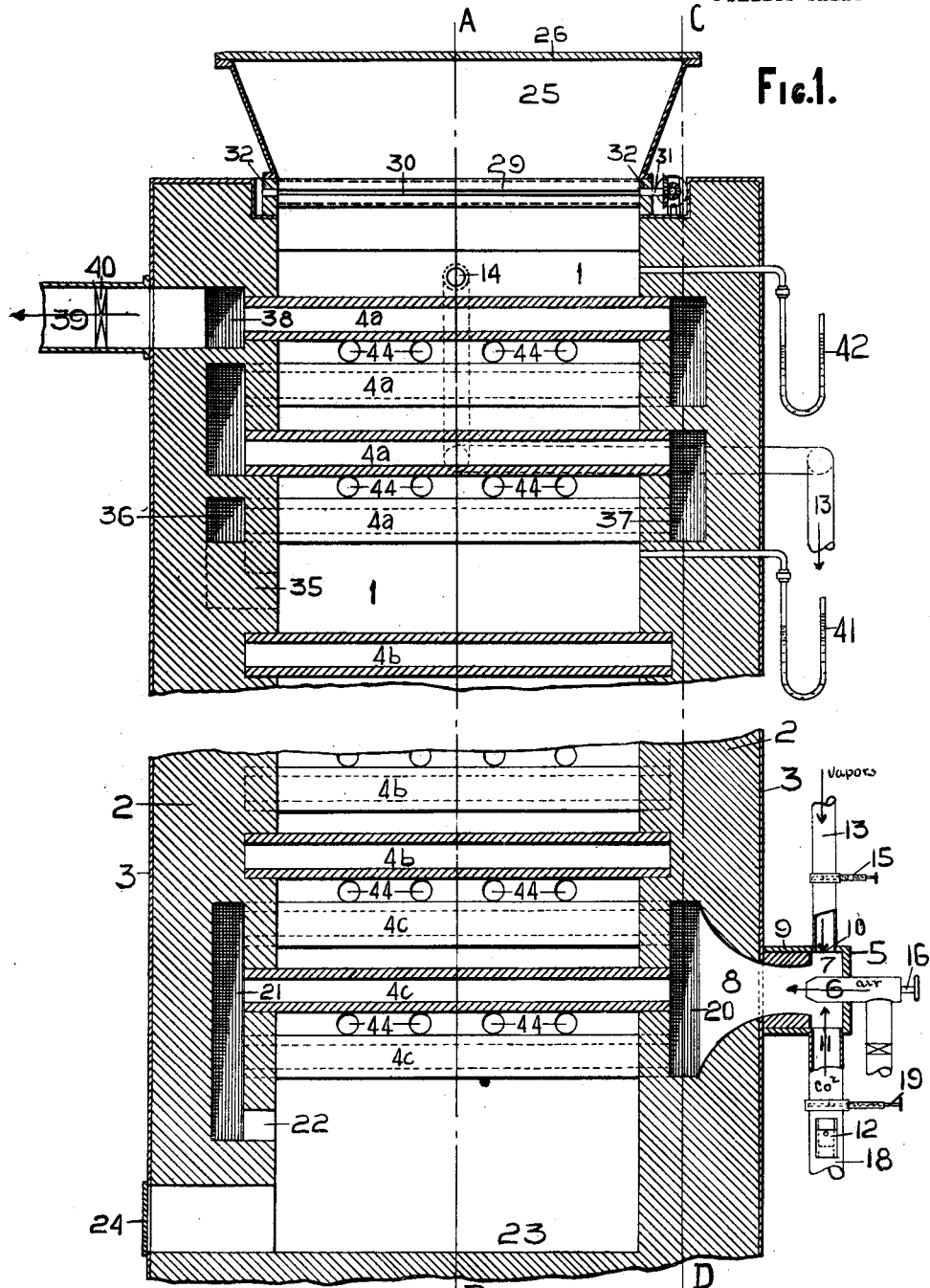


H. L. DOHERTY.
GAS PRODUCER.
APPLICATION FILED DEC. 27, 1909.

1,066,717.

Patented July 8, 1913.

4 SHEETS—SHEET 1.



Witnesses:
W. J. Doherty
W. E. Berryman

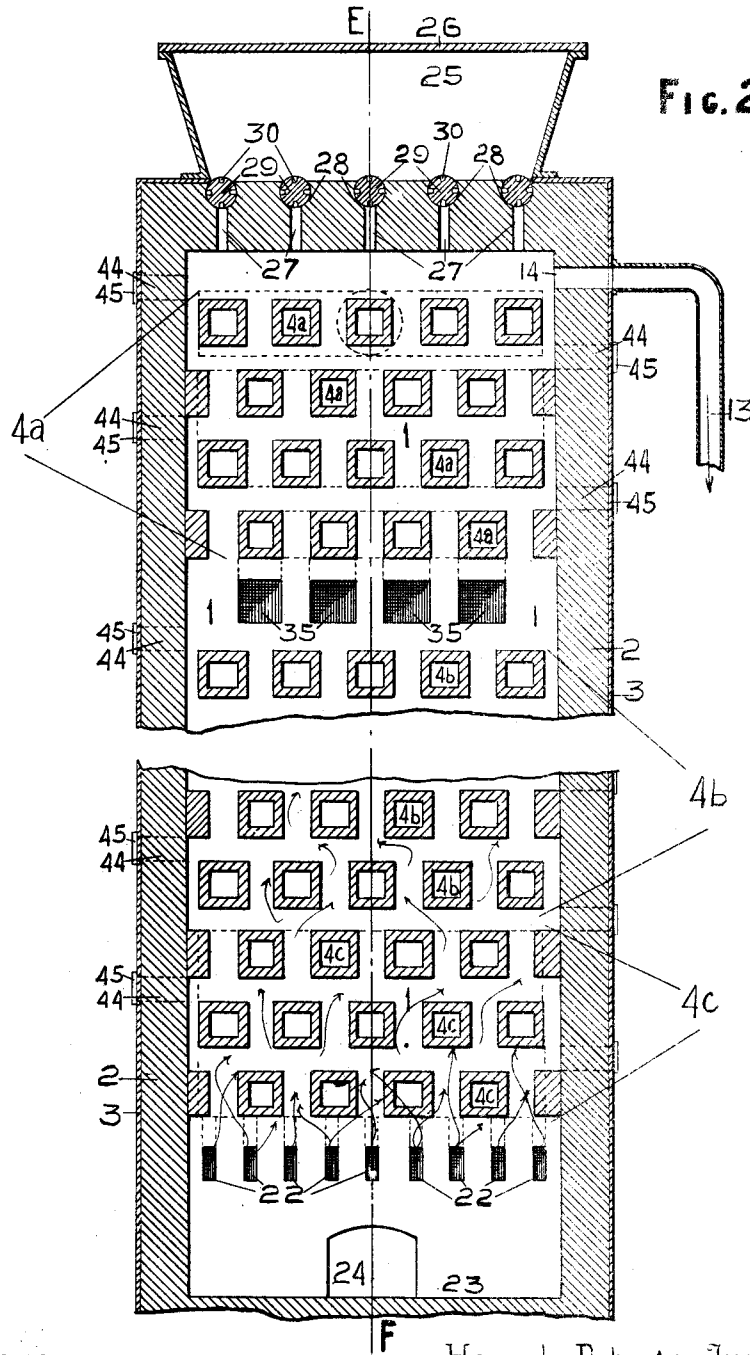
B. Henry L. Doherty, Inventor
By his Attorney *Frank S. Young*

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4 SHEETS-SHEET 2.



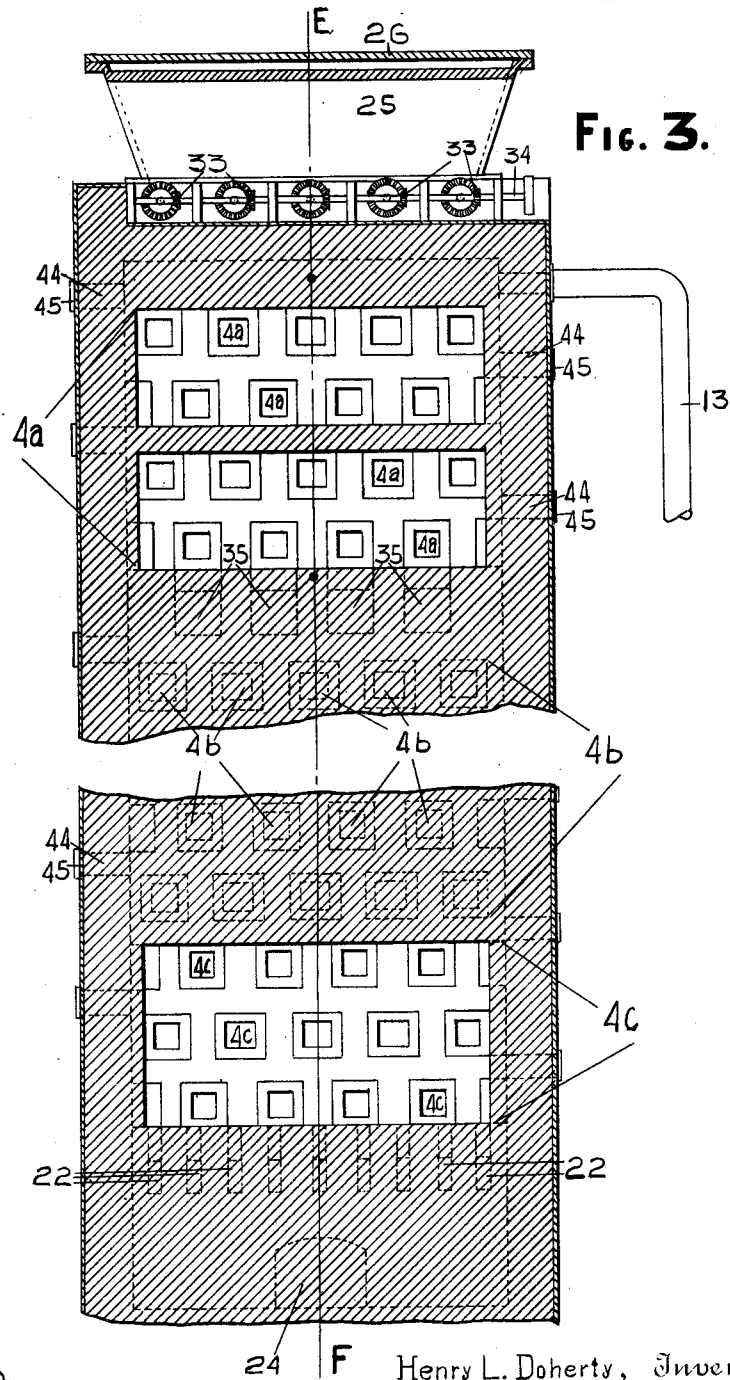
Witnesses:
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H. L. Berryman

Henry L. Doherty, Inventor
By his Attorney *Frank S. Young*

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4 SHEETS—SHEET 3.



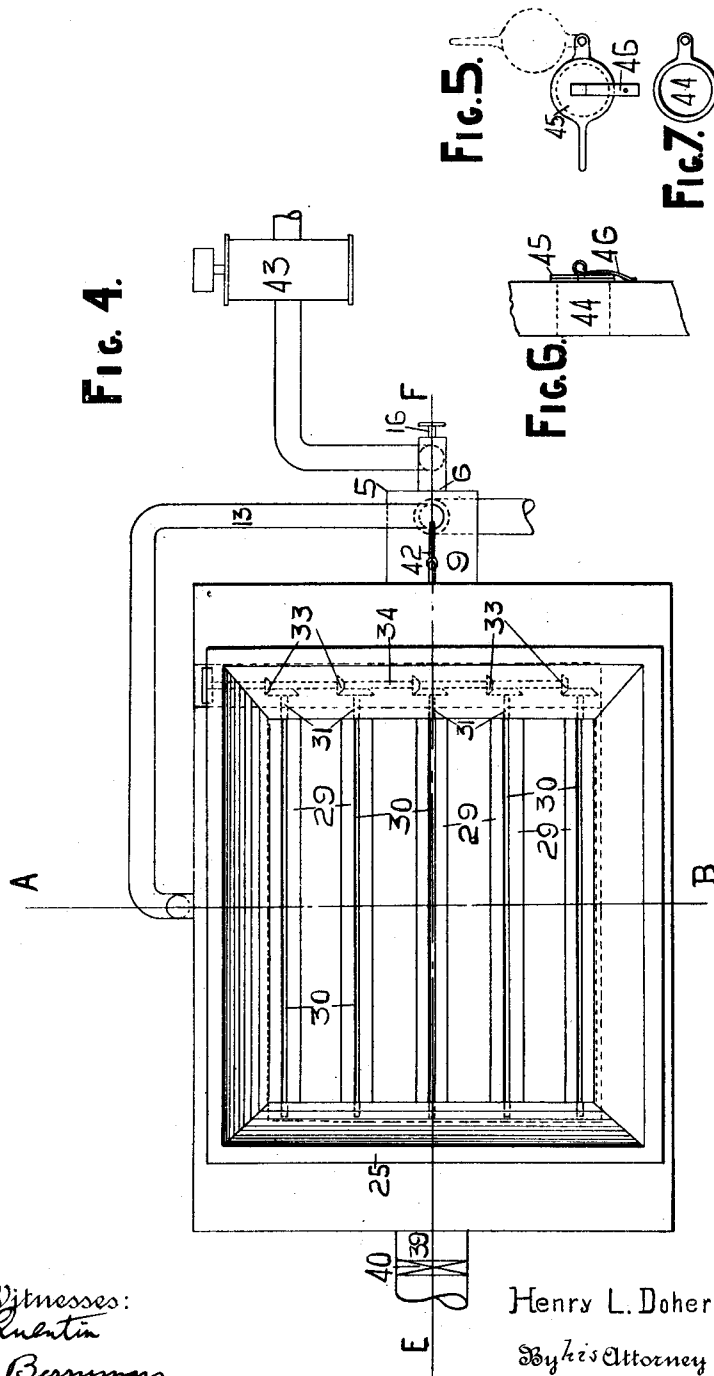
Witnesses.
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4 SHEETS-SHEET 4.



Witnesses:
H. L. Doherty
H. L. Berryman

Henry L. Doherty, Inventor
By *his Attorney* *Frank S. Young*

UNITED STATES PATENT OFFICE.

HENRY L. DOHERTY, OF NEW YORK, N. Y.

GAS-PRODUCER.

1,066,717.

Specification of Letters Patent.

Patented July 8, 1913.

Application filed December 27, 1909. Serial No. 535,037.

To all whom it may concern:

Be it known that I, HENRY L. DOHERTY, a citizen of the United States, and a resident of New York city, in the county of New York and State of New York, have invented certain new and useful Improvements in a Gas-Producer, of which the following is a specification.

This invention relates to gas producers, and, particularly, to apparatus of that character which is specially adapted to gasifying fine or slack coals.

The object of my invention is the furnishing of an apparatus for the purpose stated which will overcome the difficulties due to the fine character of the material and the large percentage and easy fusibility of the ash of such coal.

In the accompanying drawings, I show a design of a producer embodying my invention although the construction of the producer may be considerably modified without departing from the principles involved in my invention.

Figure 1 is a vertical section through my gas producer on a plane through the line E F of Fig. 2. Fig. 2 is a vertical section through a plane at right angles to the plane of Fig. 1, passing through the line A B of that figure. Fig. 3 is a vertical section through the line C D of Fig. 1. Fig. 4 is a plan of the apparatus showing the blower which supplies the air under pressure to the injector. Figs. 5, 6 and 7 are detail views of the gates closing the poke holes.

The construction and method of operation of my invention are as follows:

In the preferred form of my invention the producer consists of a chamber of rectangular section 1, inclosed by thick walls 2, of fire clay or other refractory material. An outer steel shell 3, incloses the walls 2. Cross-flues preferably, though not necessarily, of rectangular cross-section, extend across the gas-making chamber 1. These are set in tiers, the flues 4^a, 4^b and 4^c on adjacent tiers are set staggered in relation to each other so that material sliding off the tops of the flues in the upper tier will fall upon and be intercepted by the cooperating flues of the lower tier. The upper group of flues, which I will designate 4^a, occupy what may be

called the distillation or carbonizing zone of the gasifying chamber 1. The flues of middle group 4^b, occupy the upper part of the gas making zone while the lowest group 4^c occupies the lower part of that zone. The parts 4^b act simply as shelves and may be made of flat tiles or made solid instead of hollow if preferred. The parts 4^a and 4^c, on the other hand, exercise two functions, one of these is to act as intercepting shelves, the same as 4^b in order to prevent the fine coal falling freely through the producer chamber, and the other is to furnish passage for, in the one case, the finished producer gas through the carbonizing zone and, in the other, the draft current supplied for maintaining combustion in the producer through the gasifying zone of the latter.

An injector 5, furnishes the means for introducing the draft current into the gas producing chamber 1. This injector comprises an air nozzle 6, induction chamber 7, divergent-nozzle discharge passage 8, inclosing box 9, an inlet 10 for distillation gases, an inlet 11 for products of combustion and air and a supplementary air inlet 12. 10, is connected by the pipe 13, with the opening 14, at the upper part of the carbonizing zone of the gas producing chamber 1. A valve or damper 15 on 13 serves to regulate (in connection with the air regulating valve 16, on nozzle 6) the volume of gas withdrawn from the carbonizing zone and injected into the draft current. A pipe 18, having a valve 19, connects the inlet 11 with some source (not shown) of combustion gases. This source may be the exhaust from a gas engine, flue gas from a furnace, gas from a lime or cement kiln, etc. A cross-flue 20, in the wall of the chamber 1 receives the draft current discharged from 8, and distributes it to the several flues 4^c whose interior passages are in communication with 20. The draft current passes through the flues 4^c and discharges into a flue or narrow chamber 21 in the opposite wall of chamber 1, which corresponds in position to flue 20. The lower part of 21 communicates with the passages or nostrils 22 through which the draft current discharges into the chamber 1.

The draft current which I supply to maintain combustion in my producer consists of

a mixture of air, products of combustion, and the gases and heavy vapors distilled from the raw coal in the upper or carbonizing zone of chamber 1. When the fuel used is bituminous in character heavy tarry vapors are distilled from the coal immediately after it enters the producer. In producers of the ordinary type this tarry matter being distilled from the coal in the immediate vicinity of the gas outlet from the producer is immediately drawn off from the producer in the gas current. When the gas made is burned in a boiler furnace, lime kiln or cement kiln, etc., the presence of the tarry vapors is of no serious moment although even in this case great annoyance is usually caused by the deposit of carbon and pitch in the flues. When, however, the gas is to be used in gas engines the removal of this tarry matter is an imperative necessity. This entails the use of more or less cumbersome and expensive apparatus, and always occasions serious irregularities and annoyances in the operation of the gas engines and producers. As will be seen, in the gas producer which is the subject of this application, I avoid the presence of tar and heavy vapors in the gas by providing means for withdrawing the distilled matters independently of the producer gas and injecting them into the bottom of the gasifying chamber where they are subjected to a sufficiently high temperature to "crack" them. In fact, while this is not an object of my invention, it is probable that the tarry vapors are consumed in passing through the flues 4^a in the draft current, but since the products of such combustion will be reduced by the incandescent carbonaceous matter resting on the tops of flues 4^a, the ultimate products from the tarry vapors will still be the combustible hydrogen and carbon monoxid. Owing to the fact that the draft current contains a large proportion of combustion gases and that the proportion of distilled vapors is comparatively small the temperature developed within the flues 4^a would be quite moderate since the velocity of combustion would be very low and there would be a very large proportionate volume of inert gas to absorb the heat developed. The purpose of adding combustion gas to the draft current is to regulate and moderate the temperature developed in the producer to a point below the sintering temperature of the ash of the fuel, as described in my Letters Patent 829,105, dated August 21st, 1906, and others. By using this method of temperature control I am able to burn even a very impure slack to a light powdery ash which is very easily handled, and falls from shelf to shelf until it falls into the ash chamber 23, and can be withdrawn through the ash door 24.

The slack coal is charged into the hopper

25, provided with a cover 26. A plurality of charging slots 27 are built in the top of chamber 1, which are connected at the top with semi-cylindrical casings 28, in which work feed rolls 29. These rolls 29, have longitudinal grooves 30, and axles 31, which work in bearings 32. Bevel gears 33, driven from the shaft 34 cause the rotation of the feed rolls. As the rolls revolve, the grooves occupying, momentarily, the upper surface of the rolls fill themselves with the slack coal. As the revolution of the rolls carries each groove over the cooperating charging slot the slack discharges from the grooves and falls through the charging slots 27, on to the shelves formed by the upper tier of cross-flues 4^a. As the slack accumulates on the shelf-tops of 4^a and piles up above its angle of repose it slides off and falls through the open spaces between the flues onto the tops of the next tier of flues. From this position it is displaced, as before, and falls onto the tops of the next tier and so on to the bottom. The draft current introduced through the nostrils 22, passes up the chamber through the shower of falling coal and over the layers of coal on the shelves, its free oxygen uniting with the carbon of the fuel, while its water vapors and carbon dioxid are dissociated with the formation of carbon monoxid, and hydrogen and carbon monoxid, respectively. The producer gas leaves the gasifying chamber 1 through the ports 35 and enters the flue 36. This flue, 36, acts as a cross-connection of all the flues 4^a which are in the tier immediately above the discharge ports 35. The producer gas discharging through 35, heretofore, passes into that tier of the flues 4^a and flows across the chamber 1 and into the cross-flue 37 in the opposite wall of the chamber 1. 37 cross-connects the discharge ends of this tier of flues 4^a and also the corresponding ends of the flues 4^a of the tier next above. The producer gas thus flows from the lowest tier of flues 4^a to the next tier above, passing therethrough in the reverse direction to the side of the producer on which the ports 35 are located, thence to the other side of the producer through the flues 4^a on the tier next above and so on until it enters the cross flue 38, from which it discharges through the off-take 39. A valve 40, on 39, serves to shut off the discharge of gas whenever necessary, *e. g.* when "banking" the producer. The hot gas passing through the flues 4^a gives up part of its sensible heat to the flue walls from which it is transmitted to the slack coal resting upon the flues. Heat also reaches the coal by radiation from the hot gasifying region of the producer and from the hot walls. It is possible also to draw a portion of the hot producer gas from the gasifying zone up through the carbonizing

zone, assisting in the heating of the coal, down through the pipe 13 and injector 5 into the bottom of the producer. When the quantity of volatile matter in the coal is greater than can be distilled by the heat transmitted from the flues 4^a, this method of working permits of the complete carbonizing of the coal before it reaches the level of the ports 35, even though the heating effected by the flues 4^a is not sufficient to accomplish this end.

It is to be understood that I do not limit myself to the number of flues shown. The number of flues and dimensions of the producer should, of course, be determined by the estimated capacity of the producer and the quality of the fuel to be used in the producer. For coke or anthracite, for instance, the carbonizing zone may be restricted as shown in the drawings. For a bituminous coal, on the other hand, a much larger (higher) carbonizing zone should be provided.

Pressure gages—simple U tubes as shown—41 and 42, indicate the pressures in chamber 1 at the level of the producer gas and distillation gas off-takes, respectively. A blower, 43, serves to supply the compressed air or combustion gases to the nozzle 6. Poke-holes 44, having covers, 45, provided with seating springs, 46, provide access to the interior of the producer for the purpose of observation or cleaning the shelves, 4^a, etc.

In cases where the combustion gases used contain a large proportion of free O and the injector cannot draw in a sufficient proportion of CO₂ when using air in the nozzle, the combustion gases may be compressed instead of the air and used as the inductive blast through the nozzle 6.

In the ordinary method of operating my producer I aim to withdraw through 14, only the gases which are evolved in the carbonizing zone. This end is brought about with substantial accuracy when the gages 41 and 42 indicate the same pressure. The pressures at the respective levels can be regulated by the adjustment of valves 15, 16 and 19, and the pressure of the blast supplied to nozzle 6, when the pressure in the discharge conduit 39, is constant. Should the fuel used contain more volatile matter than the producer was designed to drive off from the coal it may be advisable, as before mentioned, to circulate a portion of the finished producer gas through the carbonizing zone to aid in the carbonization of the coal. In this case the inductive effect on pipe 13 is increased by the appropriate means until the gage 42, shows a slightly lower pressure (higher partial vacuum) than gage 41. This causes the diversion of part of the gas which would

otherwise discharge through ports 35, into the carbonizing zone.

As hereinbefore stated, this producer is designed for the gasification of slack bituminous coal, coke, etc., or anthracite culm. It is obvious, however, that by crushing the coal I may use "run of mine" or any size of coal whatever.

Having described my invention, what I claim is:—

1. In a gas producer the combination of a gasifying chamber, a plurality of cross-flues in the upper part of said chamber above the passages for withdrawing producer gas from said chamber, means for continuously feeding coal onto said plurality of cross-flues in the upper part of said chamber uniformly along the length thereof, the tops of said flues being adapted to form shelves, said flues being arranged in tiers, the flues of adjacent tiers being arranged in staggered relation to each other so that the tops of the flues of the lower of two adjacent tiers intercept the material falling from the flues of the upper tier, flues in the walls of said gasifying chamber, connecting the flues of one tier at one end with the flues of the tier above and at the other end with the flues of the tier below, a flue in one of said lateral walls connecting the discharge ends of the flues in the lowermost tier, and a plurality of passages for the withdrawal of producer gas connecting said flue with the said gasifying chamber.

2. In a gas producer the combination of a gasifying chamber, a plurality of cross-flues in the upper part of said chamber, said cross-flues being located above passages for withdrawing producer gas from said chamber, the tops of said flues being adapted to form shelves, said flues being arranged in tiers the flues of adjacent tiers being arranged in staggered relation to each other so that the tops of the flues of the lower of two adjacent tiers intercept the material falling from the flues of the upper tier, means for continuously feeding coal onto each of the flues in the upper tier of said plurality of cross-flues, flues in the walls of said gasifying chamber, connecting the flues of one tier at one end with the flues of the tier above and at the other with the flues of the tier below, a flue in one of said lateral walls connecting the discharge ends of the flues in the uppermost tier, a gas off-take communicating with said flue, a flue connecting the inlet ends of the flues in the lowermost tier, a plurality of passages for the withdrawal of gas connecting the said flue with the said gasifying chamber, a draft-producing means connected with the lower part of said gasifying chamber, said draft-producing means having connections to the upper part of said chamber. to a

source of products of combustion, and to the atmosphere, and a means for withdrawing from said gasifying chamber the ash formed therein.

3. In a gas-producer the combination of a gasifying chamber, a plurality of cross-flues in the upper part of said chamber the tops of said flues being adapted to form shelves, said flues being arranged in tiers, the flues of adjacent tiers being arranged in staggered relation to each other so that the tops of the flues of the lower of two adjacent tiers intercept the material falling from the flues of the upper tier, flues in the walls of said gasifying chamber connecting the flues of one tier, at one end with the flues of the tier above and at the other end with the flues of the tier below, a flue in one of said lateral walls cross-connecting the discharge ends of the flues in the uppermost tier, a gas off-take communicating with said flue, a flue cross-connecting the inlet ends of the flues in the lowermost tier, a plurality of gas off-takes connecting said cross-connection with said gasifying chamber, a plurality of shelves in said gasifying chamber below said plurality of passages said shelves being set in staggered relation to each other and being substantially parallel to the plurality of cross-flues in the upper part of said gasifying chamber, and a draft-producing means connected with the lower part of said gasifying chamber, said draft-producing means having connections to the upper part of said gasifying chamber, to a source of products of combustion, and to the atmosphere.

4. In a gas producer the combination of an inclosed gasifying chamber, means for feeding coal to the upper part of said chamber, a plurality of cross-flues in the upper part of said chamber, the tops of said flues being adapted to form shelves, said flues being arranged in tiers, the flues of adjacent tiers being arranged in staggered relation to each other so that the tops of the flues of the lower of two adjacent tiers intercept the material falling from the flues of the upper tier, flues in the walls of said gasifying chamber connecting the flues of one tier at one end with the flues of the tier above and at the other end with the flues of the tier below, a flue in one of said lateral walls cross-connecting the discharge ends of the flues in the uppermost tier, a gas off-take communicating with said flue, a flue cross-connecting the inlet ends of the flues in the lowermost tier, a plurality of shelves in said gasifying chamber below said plurality of passages, said shelves being set in staggered relation to each other and being substantially parallel to the plurality of cross-flues in the upper part of said gasifying chamber, a plurality of cross flues in the lower

part of said gasifying chamber, the tops of said flues being adapted to form shelves, said flues being arranged in tiers, the flues of adjacent tiers being arranged in staggered relation to each other so that the tops of the flues of the lower of two adjacent tiers intercept the material falling from the flues of the upper tier, flues in said lateral walls, each of said flues being in communication with said plurality of cross-flues, one of said flues being in communication with the discharge passage of a draft-producing means, a plurality of passages connecting the other of said flues with the gas-producing chamber in the lower part thereof, and a draft-producing means for introducing the combustion-supporting draft-current into said gas producer, a passage connecting the inlet passage of said draft-producing means with the upper part of said gasifying chamber, a passage connecting the inlet passage with a source of products of combustion, means for indicating the pressure in the gasifying chamber at the level of said gas off-takes and means for indicating the pressure at the top of said chamber.

5. In a gas producer the combination of a gasifying chamber, means for feeding coal to the upper part of said chamber, a plurality of staggered shelves set substantially horizontally in said chamber, adapted to retard the fall of said coal through the said chamber, poke-holes in the end walls of said chamber adapted to permit the insertion of tools to remove accumulated matter from shelves, a draft-producing means having its discharge passage connected with the lower part of said chamber, a passage connecting the inlet passage of said draft-producing means with the upper part of said gasifying chamber, a valve on said passage, a passage connecting said inlet passage with a source of products of combustion, a valve in said passage and an air-damper in said passage, means for withdrawing from said chamber the gas formed therein and means for withdrawing the ash from said chamber.

6. In a gas generator, in combination, a coal carbonizing chamber occupying the upper part of said gas generator, a plurality of cross-flues located in said carbonizing chamber but not in direct communication with said chamber, the said cross-flues being arranged in tiers, passages connecting the flues of the lowermost of said tiers with the said carbonizing chamber, passages connecting the flues of each tier of said cross-flues with the next adjacent tier above, and a gas off-take passage communicating with the flues of the uppermost of said tiers.

7. In a gas generator, in combination, a coal carbonizing chamber occupying the upper part of said gas generator, a plurality of cross-flues located in said carbonizing

chamber but not in direct communication with said chamber, said cross-flues being adapted to form shelves for intercepting and sustaining fuel and being arranged in tiers, passages connecting the corresponding ends of the flues in the lowermost of said tiers with the said carbonizing chamber, passages connecting the other ends of the said flues in the lowermost tier with the next higher tier, passages connecting these latter with the flues of the tier above, and so on, and a gas off-take passage in communication with the flues of the uppermost of said tiers.

8. In a gas producer, the combination of a gas-generating chamber, an off-take for drawing off the finished producer gas from said gas-generating chamber, said gas off-take being located in approximately the upper third of said gas-generating chamber, a plurality of flues forming a plurality of return-bend passages for the passage of the said finished producer gas through the upper third of said gas-generating chamber, the said flues being set in tiers, the flues of each tier being in staggered relation to the flues of the adjacent tiers, the tops of the said flues being adapted to support the freshly charged coal for said gas producer, whereby the said coal is subjected to distillation by the heat of the finished producer gas, a flue connecting the discharge ends of the flues of the uppermost of said tiers, and a producer gas eduction passage opening out of the said connecting flues.

9. In a gas producer, the combination of a gas-generating chamber, a plurality of off-take passages for drawing off the finished producer gas from said gas-generating chamber, said gas off-takes being located in approximately the upper-third of said gas-generating chamber, a plurality of flues forming a plurality of return-bend passages for the passage of the said finished producer gas through the upper third of said gas-generating chamber, the said flues being set in tiers, the flues of each tier being in staggered relation to the flues of the adjacent tiers, and the tops of the said flues being adapted to support the freshly charged fuel in said gas producer, whereby the said coal is subjected to distillation by the heat of the finished producer gas, a plurality of means for charging fuel, one of said fuel-charging means cooperating with each of the flues of the uppermost of said tiers and adapted to distribute the said fuel uniformly along the length of said flues, a flue cross-connecting the discharge ends of the flues of the uppermost of said tiers, and a producer-gas eduction passage opening out of the said connecting flue.

10. In a gas producer, the combination of a gas-generating chamber, a plurality of off-

take passages for drawing off the finished producer gas from said gas-generating chamber, said gas off-takes being located above the middle of said gas-generating chamber, a plurality of approximately flat-topped transverse flues in the upper part of said chamber, the said transverse flues being arranged in tiers, the flues of adjacent tiers being set in staggered relation to each other, a cross flue in the walls of said gas-generating chamber cross-connecting the said gas off-take passages and the flues of the lower of said tiers, a cross-flue in the opposite wall of said chamber cross-connecting the opposite ends of the flues of said lower tier and the corresponding ends of the flues of the next tier above, and similar cross-flues in the said walls of said chamber connecting the flues of each of the other tiers at one end with the flues of the underlying tier and at the other end with the flues of the overlying tier, a flue cross-connecting the discharge ends of the flues of the said upper tier, and an eduction passage for producer gas opening out of the latter of said cross-flues, whereby the hot producer gas from the middle zone of the said gas-generating chamber is led through the upper part of said chamber and caused to give up part of its heat to the fresh coal charged into said chamber, a coal-charging means cooperating with each flue of the uppermost of said tiers and adapted to charge coal uniformly along the length of the flue, and means for injecting into the lower zone of said chamber the products distilled from the fresh charge in the upper part of said chamber.

11. In a gas producer, the combination of a gas-generating chamber, a plurality of off-takes for the gas generated in said chamber, said gas off-takes being located above the middle of said gas-generating chamber, a plurality of transverse flues in the upper part of said gas-generating chamber for conducting the gas withdrawn through said gas off-takes through the upper part of said chamber, said transverse flues forming shelves for supporting the fuel freshly charged into said gas-generating chamber, whereby the said freshly-charged fuel is subjected to destructive distillation by the heat transmitted to said fuel from said gas through the tops of said flues, a plurality of shelves in the middle portion of said gas-generating chamber, said shelves being set in staggered relation to each other and adapted to support the fuel after the same has passed through the said distilling region, and a plurality of transverse coaling flues below said plurality of shelves, the said coaling flues being adapted to form shelves for supporting the fuel and ash discharged from the said middle portion of said gas-

generating chamber, and conduits for the
entering combustion-supporting draft cur-
rent, whereby the relatively cool draft cur-
rent protects the said flues from the heat of
5 the combustion taking place in the said
lower portion of said gas-generating cham-
ber.

Signed at New York city in the county of
New York and State of New York this 23rd
day of December A. D. 1909.

HENRY L. DOHERTY.

Witnesses:

W. J. QUENTIN,
W. G. BERRYMAN.