(No Model.) 2 Sheets—Sheet 1.

J. REESE.

PROCESS OF AND APPARATUS FOR PRODUCING GAS.

No. 309,251. Patented Dec. 16, 1884.

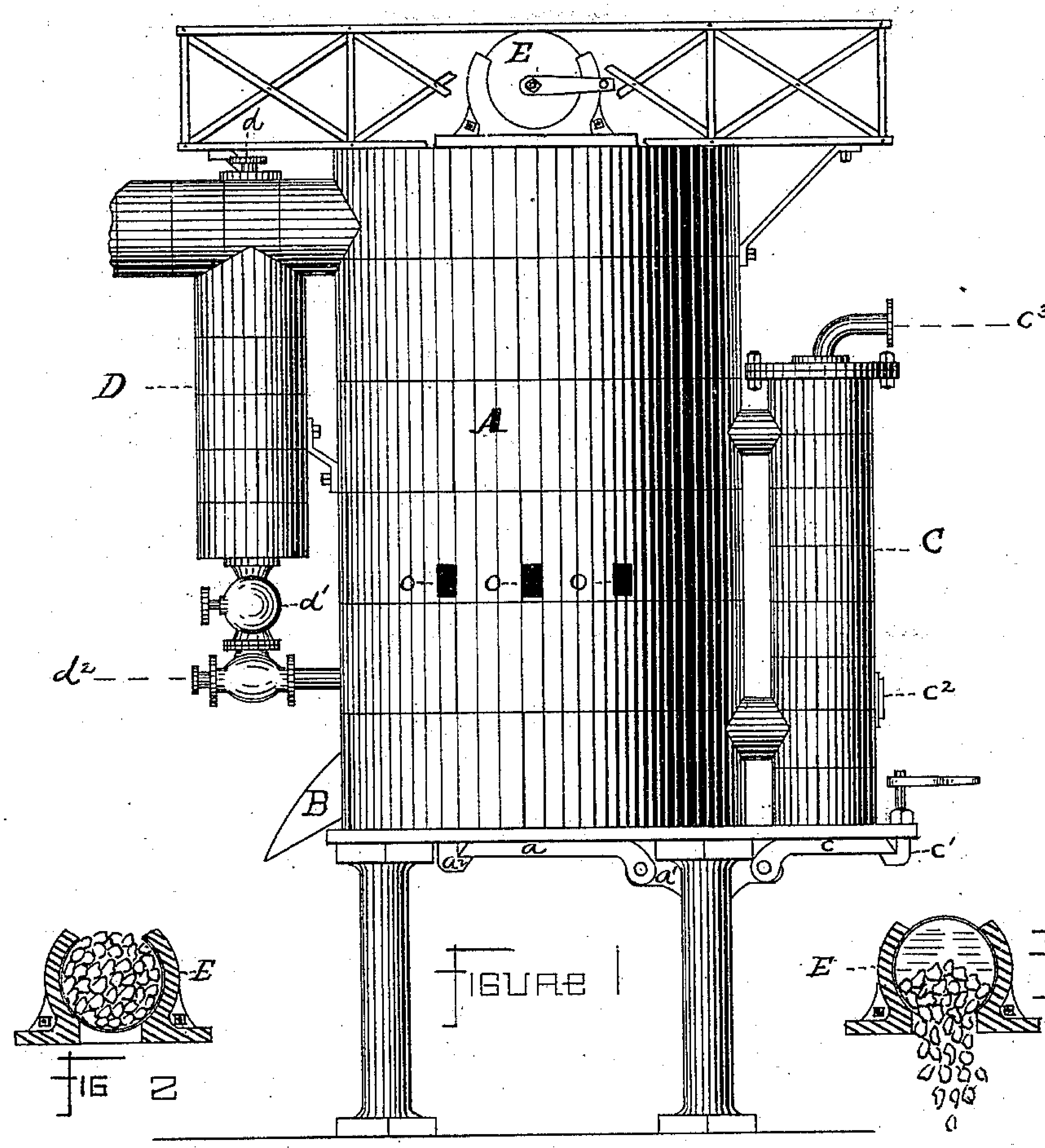

FIGURE 1

FIG 2

FIG 3

Witnesses
Walter Reese.
Josiah W. Ellis

Inventor
Jacob Reese
by his attorney
Frank M. Reese

(No Model.) 2 Sheets—Sheet 2.

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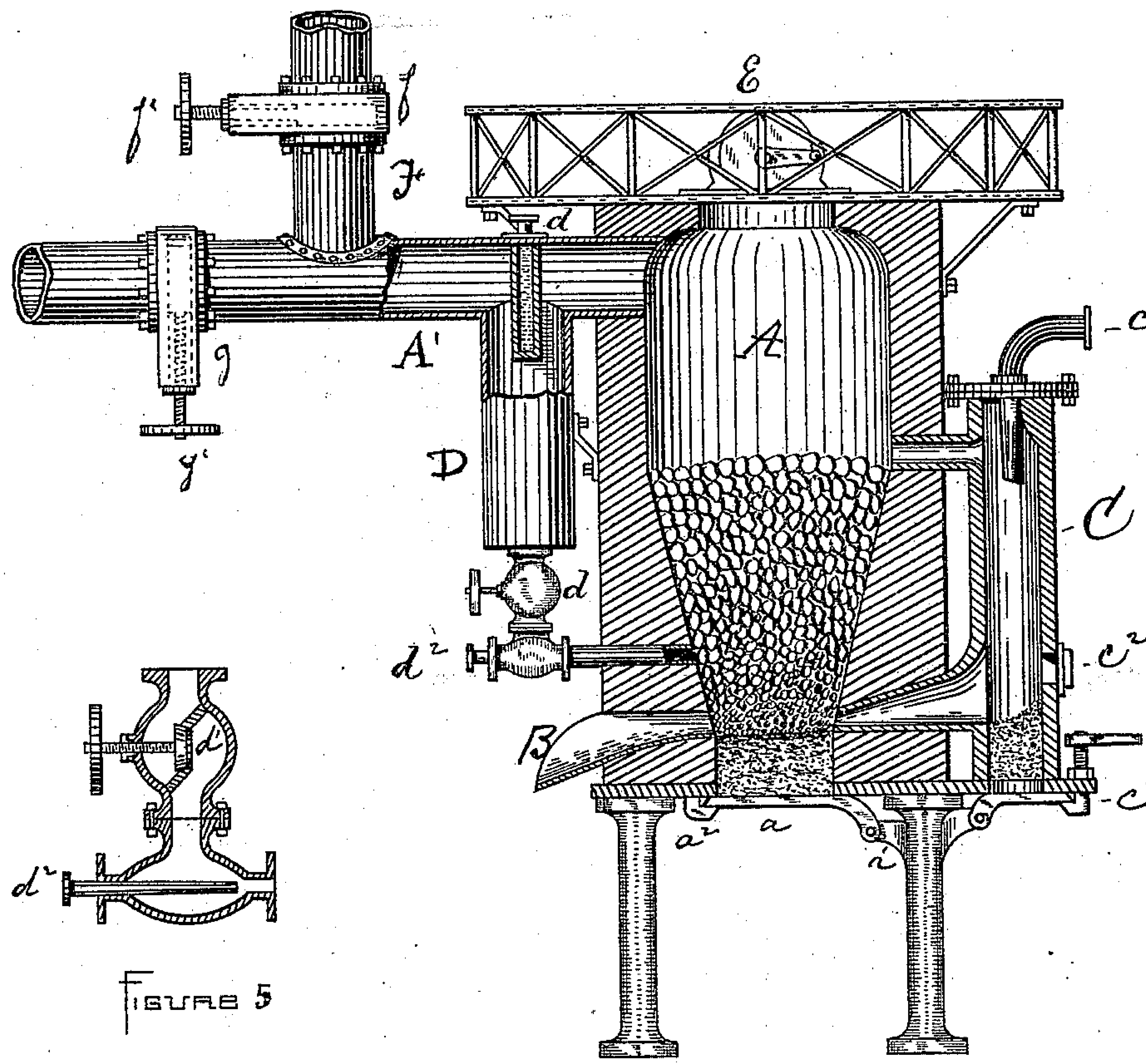

Figure 5

Figure 4

Witnesses—

Walter Reese

Jno. H. Moore

Inventor

Jacob Reese

N. PETERS. Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

JACOB REESE, OF PITTSBURG, PENNSYLVANIA.

PROCESS OF AND APPARATUS FOR PRODUCING GAS.

SPECIFICATION forming part of Letters Patent No. 309,251, dated December 16, 1884.

Application filed December 24, 1881. (No model.)

To all whom it may concern:

Be it known that I, JACOB REESE, a citizen of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a certain new and useful Process of and Apparatus for Producing Gas; and I do hereby declare the following to be a full, clear, and exact description thereof, reference being had to the accompanying drawings, forming a part thereof, in which—

Figure 1 indicates a front elevation of an improved apparatus adapted to the use of my invention, showing a producer having a closed bottom resting on a hinged bottom plate, a slag-vent for the exit of the ashes when fused, an exterior combustion-chamber, a condensing apparatus to condense the unfixed gases, a steam-injector to force the condensed matter into the incandescent portion of the fuel, and a feeding device to supply fuel to the producer. Fig. 2 indicates a cross-section of the feeding apparatus, showing the position of the fuel-hopper immediately after or when being charged. Fig. 3 indicates a cross-section of the same, showing the position of the hopper when revolved so as to bring its opening in line with the opening of the hopper-sheath, to allow the discharge of the fuel into the producer without the escape of the gas from the same. Fig. 4 on Plate 2 indicates a sectional elevation of the gas-producer and an elevation, partly in section, of its condenser. Fig. 5 is a vertical section showing the local relation of the condenser-valve to its case and screw-stem.

Like letters of reference indicate like parts wherever they occur.

My invention consists, first, in a new and useful process for producing fixed combustible gases at a low temperature from solid fuel by charging fresh fuel on top of a mass of incandescent coke contained within a closed producer, withdrawing a portion of the vapor rising therefrom, consuming it in an exterior gas-combustion chamber, forcing the resultant products of combustion into and through the column of fuel in the producer, and, finally, condensing the unfixed gases arising from the producer by a separate condensing-chamber, and returning the products of condensation into the incandescent portion of the fuel; secondly, in an improved gas producing and purifying apparatus adapted to the use of said process.

The objects of the invention are principally, first, to convert the entire combustible matter of the fuel into fixed gases containing a maximum amount of static caloric, (latent heat,) or to convert the volatile matter of the fuel into illuminating-gas and the fixed carbon into gas for heating purposes; secondly, to produce carbonic oxide (CO) without the presence of (CO_2) carbonic acid.

Heretofore in the operation of all gas-producers known to me it has been found impossible to prevent the formation of carbonic acid, (CO_2,) on account of the manner of admitting air into the producer. An analysis of the gases resulting from the operation of the best producers shows that from twenty to twenty-five per cent. of the carbon of the fuel is converted into carbonic acid, (CO_2,) and, as the producer must be stopped during cleaning, considerable time is lost and the producer fills up with air, which causes the formation of a large quantity of carbonic acid when it is again started. In addition to the loss of fuel in the production of CO_2 is the loss of combustible matter escaping with the ashes, and, as the cleaning operation must be frequently performed, from five to fifteen per cent. of the fuel is lost in this manner. In addition to the preceding drawbacks is the fact that considerable trouble and annoyance is had from the condensation of tar matter in the gas pipes and flues.

In the production of illuminating-gases in closed retorts from five to thirty per cent. of the gases produced are condensed and withdrawn as tar; but in the use of my process I am enabled to convert the tar into fixed gases without the use of external fuel to heat up the retorts.

I shall now describe the construction of the improved apparatus: so that others skilled in the art to which it appertains may construct and use the same to carry my invention into practice.

In the drawings, A indicates a cylindrical gas-producer, having an external shell of plate iron and lined internally with fire-brick. The producer is provided with a solid bottom composed of silica or fire-brick supported on a hinged bottom plate, *a*, which is attached to an arm, a', on one of the supports of the producer, and is retained in position when swung up by means of a clamp, a^2.

B indicates a slag vent or opening, to admit the exit of the scoria or ashes when melted during the operation of the producer.

C indicates an exterior cylindrical gas-combustion chamber having an external shell of plate-iron, and lined internally with ganister or fire-brick. This gas-combustion chamber is also provided with a solid bottom of refractory material, which rests on a hinged bottom plate, c, which is retained in position by a clamp, c', which is provided with a handle at its upper end to admit of turning to release the bottom plate, c, and allow it to swing down when it is desired to open the combustion-chamber for repairs or other purposes.

C^2 indicates a small door on the side of the combustion-chamber, at a point directly opposite the lower flue leading from the combustion-chamber into the base of the producer, for the purpose of admitting the entrance of a tool to clean the flue or to force an opening for the entrance of the products of combustion into the base of the fuel, if necessary, during the operation of the producer.

C^3 indicates a blast-tuyere, which projects down into the combustion-chamber to a point slightly below the bell-mouthed opening of the gas-flue leading from the combustion-chamber into the upper part of the producer.

D indicates a cylindrical condensing-chamber, attached to the producer by suitable braces, and connected at its upper end to the gas-main. This condensing-chamber is provided with a water-diaphragm, d, which is attached to the gas-main, and projects down into the upper portion of the condenser, as shown in Fig. 4, so as to cause the gases to flow down into the condenser and around both sides of the water-diaphragm after leaving the producer.

d' indicates a globe-valve attached to the bottom of the condenser, to admit the flow of the tarry matter, when desired, into a steam-injector, d^2, which may be operated so as to force the same into the incandescent fuel at the lower part of the producer.

E indicates a fuel-feeding apparatus attached to the upper part of the producer. This fuel-feeding apparatus consists of a cylindrical hopper having a longitudinal opening on a part of its periphery, and is provided with a crank, to revolve it within a stationary sheath composed of two segments of an iron cylinder provided with suitable flanges at their lower sides, which are fastened to the sides of the fuel-hole in the top of the producer.

The operation of my improvement is as follows: A charge of coke is put into the producer and lighted, and the air-blast is injected into the combustion-chamber. When the charge of coke becomes incandescent and the walls of the producer are thoroughly heated, a charge of fresh fuel is filled into the hopper. It is turned one-half of a revolution, so as to bring the opening of the hopper in line with the lower opening in the sheath, and the fuel drops down on top of the incandescent coke. The blast may then be shut off, if desired, and the heat from the coke and walls of the producer will vaporize the volatile matter of the fuel, which will pass into the upper part of the producer as illuminating-gas, and may be withdrawn into a separate receiver and purifier; or the blast may be kept on continuously and the gases from the volatile matter may be allowed to mix with the gas produced from the fixed carbon of the fuel. In the latter case the tarry matter of the gas coming in contact with the water-diaphragm is condensed and deposited in the tar-chamber of the condenser, and may be forced into the incandescent fuel by means of the steam-injector. In this case the steam is decomposed, the hydrogen passes off as hydrogen gas, and the tar is decomposed into CO (carbonic oxide) and hydrogen gas.

When the volatile matter of the fuel has been converted into illuminating-gas and withdrawn, as in the first instance, the air-blast may be forced through the tuyere into the combustion-chamber, (which will cause a partial vacuum at the upper portion of the chamber, and draw in a portion of the gases from the upper part of the producer,) combustion of the gases takes place, and the resultant products of combustion are forced into the base of the fuel-chamber and through the column of fuel. In this operation the CO (carbonic oxide) drawn into the combustion-chamber and there consumed into carbonic acid (CO_2) gives out five thousand six hundred and seven (5,607) units centigrade of sensible heat from each pound of carbon so consumed, and the carbonic acid coming in contact with the incandescent fuel is again decomposed to CO, and the five thousand six hundred and seven (5,607) units of sensible caloric developed in the combustion-chamber and forced into the base of the fuel-chamber are entirely occluded in the carbonic oxide (CO) then formed.

In the reduction of carbonic acid to carbonic oxide an equivalent amount of carbonic oxide is formed from the fixed carbon of the fuel, and in this chemical action two thousand four hundred and seventy-three (2,473) units of caloric are converted from latent to sensible heat.

In the use of coal containing five per cent. of hydrogen, eighty-four per cent. of carbon, three per cent. of nitrogen, and eight per cent. of ash, thirty-five per cent. of volatile hydrocarbon gas is produced and sixty-five per cent. of coke remains as a residuum. In this sixty-five per cent. of coke there is fifty-four per cent. of fixed carbon.

The calorific power of one pound of this fuel may be summed up as follows: five per cent. of hydrogen, seventeen hundred and thirty-three units centigrade, thirty per cent. of carbon combined with hydrogen in the volatile matter, two thousand four hundred and twenty-four units centigrade, fifty-four per cent. of fixed carbon in the coke, four thousand three hundred and sixty-three units centigrade, making a total of eight thousand five hundred and twenty (8,520) units centigrade. Of this eight thousand five hundred and twenty units centigrade contained in the coal thirteen hundred and thirty-five (1,335) units centigrade are set free as sensible heat in converting the fifty-four per cent. of fixed carbon into carbonic oxide, (CO,) and seven thousand one hundred and eighty-five (7,185) are carried over in the gases as static or occluded heat, thus showing that sixteen per cent. of the static (latent) caloric of the fuel is developed into sensible heat, and eight-four per cent. is occluded in the gases as static, (occluded,) to be developed during their final combustion.

When the gas produced is to be used direct for heating purposes, the entire amount of caloric, both as sensible and latent heat, may be utilized with the exception of what may be lost by radiation; but when the volatile matter of the fuel is to be used as illuminating-gas, it will require to be passed through a washing and purifying operation, which will condense a considerable portion of it into tar, and the sensible heat will be lost by condensation and radiation; but the tar may be injected into the incandescent portion of the fuel and converted into carbonic oxide and hydrogen gas, as before stated.

When all the combustible matter of the fuel is to be converted into gases for heating purposes, the air-blast is continuously injected into the combustion-chamber, and charges of fuel are fed into the producer at proper intervals to keep the column of fuel of a sufficient height to reduce the carbonic acid to carbonic oxide. In this operation the admission of the blast will cause a partial vacuum at the upper portion of the combustion-chamber, and the vapor drawn into it will be partly composed of hydrocarbon gases, and the resulting products of combustion will be carbonic acid and steam. When these products are forced into the incandescent fuel, the CO_2 (carbonic acid) is decomposed to CO, (carbonic oxide,) the steam is decomposed, the hydrogen is set free and passes off with the gases, while the oxygen of the steam unites with a portion of fixed carbon forming CO, (carbonic oxide.) In this case, as in those before mentioned, the caloric developed in the combustion-chamber is again occluded in the decomposition of the fuel and recomposition of the gases.

In conducting the preceding operation, it may be observed that the products of combustion (steam and carbonic acid) which are forced into the base of the producer may be obtained by other means than by the combustion of a portion of the gases from the producer, as before described.

In the operation of the producer, when illuminating-gases are to be produced from the volatile matter of the fuel, the hopper is charged, turned over, and the fuel is dropped on top of the incandescent coke. The air-blast is excluded from the combustion-chamber, and the volatile matter of the fuel is vaporized by the heat from the incandescent coke and from the walls of the producer. These hydrocarbons may be withdrawn into a gas-receiver by any suitable means, and the air-blast may be again let on into the combustion-chamber until the fixed carbon of the fuel is converted into CO, (carbonic oxide.) Thus it will be seen that the producer may be used for the production of both illuminating and heating gases from the same charge of fuel.

When the entire product of the fuel is to be used for heating purposes alone, the blast may be injected continuously into the combustion-chamber. In either case, however, the temperature at the base of the fuel will be generally sufficiently high to fuse the slag and cause it to flow in a liquid condition out of the slag-vent; but in some cases, where the ash of the fuel is highly silicious, it may be necessary to charge a little lime or oxide of iron, or of both, to facilitate the fusion of the slag. Although the temperature at the base of the fuel will be sufficiently high to fuse the slag, that of the escaping gases will be very low, as five pounds of gas are produced from each pound of fuel consumed; and as thirteen hundred and seventy-five (1,375) units centigrade of sensible heat will be developed from each pound of fuel charged, it will be seen that less than two hundred and sixty-seven (267) units centigrade will be present in each pound of escaping gas, as a portion of the sensible heat will be taken up by the slag and a portion will be lost by radiation from the walls of the producer. To secure these results, however, it is necessary that the column of fuel in the producer should be of sufficient height to decompose all the carbonic acid to carbonic oxide, and thus occlude all the caloric developed in the gas combustion chamber. If the column is not of sufficient height, a portion of the carbonic acid will be carried over, as well as the sensible heat developed in the production of the same, and thus create a much higher temperature in the top of the producer. The height of the column of fuel will range from three (3) to twenty (20) feet, depending on the velocity of combustion in the gas-combustion chamber and the rapidity of the ascension of the gases through the incandescent fuel. Thus when a small amount of gas is desired, a short column of fuel may be used to advantage; but when a larger volume is desired, a larger amount of air must be forced into the combustion-chamber and a higher column of incandescent fuel is kept constantly in the producer.

In case it is desired to produce gas of an illuminating quality only, a producer competent to sustain a high column of fuel should be used. In this case a small portion of coke should be charged into the producer and heated to an incandescent temperature, and the gases arising from this action should be allowed to escape into a suitable stack through pipe A, having the valve mechanism $g\ g'$. When the producer becomes sufficiently heated, fresh coal is charged into the producer, the stack F is then closed by its valve mechanism $f'\ f''$, and the valve to a gas-receiver opened. The heat from the incandescent coke and from the walls of the producer volatilizes the volatile matter of the fresh fuel into hydrocarbons. This gas is then drawn into the receiver, its valve is closed, and the stack-valve is opened. The air-blast is then let on, and the coke and the walls of the producer are again raised to a high temperature, and the valves are again reversed and a charge of fresh fuel is fed through the hopper into the producer. Thus it will be observed that a continuous series of intermittent operations may be performed by alternately heating up the coke and walls of the producer and then charging fresh fuel, vaporizing the volatile matter, and withdrawing the gas. When the column of coke resulting from these operations has accumulated until it reaches nearly to the top of the producer, the caps covering the openings O O O are withdrawn and steel bars are inserted into the openings and forced through the fuel. The bottom plate is then lowered, the coke below the sustaining-bars is withdrawn, and the bottom is closed, and the sustaining-bars are withdrawn, and the coke above the bars drops onto the bottom, which has again been raised and fastened into position. The operation of heating the coke and producer and then producing illuminating-gas may be repeated in the manner before stated, so that coke and illuminating-gas may be produced from the fuel with but slight loss and without any external heating arrangement.

The advantages of my invention are, first, the entire combustible matter of the fuel may be converted into fixed gases for heating purposes; secondly, the entire volatile matter of the fuel may be converted into and withdrawn as illuminating-gas, if desired, and the fixed carbon of the fuel may then be converted into gas for heating purposes; third, the operation may be continuous, as no stoppage is necessary for charging the fuel or while cleaning, as the ash is caused to flow out of the slag-vent in a fused condition; fourth, the entire combustible matter of the fuel may be converted into carbonic oxide and hydrocarbons; fifth, the gas may be produced free fror carbonic acid.

In the operation of my improvement, whe the blast is blown into the combustion-cham ber it will cause a slight pressure of gas in th producer, and when the blast is shut off th vapor arising from the volatile matter of th fresh fuel charged will also produce a sligh pressure, so that it will be perceived that i both cases a sufficient pressure will be had t prevent the admission of atmospheric air int the producer.

Having described my invention, what claim, and desire to secure by Letters Patent is—

1. The process of manufacturing fixed gases which consists in first charging fresh fuel o top of a mass of incandescent coke in a close producer; secondly, withdrawing a portion o the vapor arising therefrom and consuming i in an exterior combustion-chamber; thirdly forcing the resultant products of combustio through the fuel in the producer, and, fourthly, condensing the unfixed gases arising from th products by a separate condensing-chamber, and returning the condensed products into th incandescent portion of the fuel, substantially as described.

2. The combination, with a gas-producer, A, a gas-main, A', and a steam-injector, d^2, of the condenser D, connected with the gas-main at its upper end and at its lower end with the injector by valved piping, as and for the purpose set forth.

3. The combination of a closed producer, two exterior side chambers, of which one is provided with means for burning and the other for condensing gases, pipes for connecting each chamber with the upper and lower portions of the producer, a blast-pipe in the upper part of the combustion-chamber, and a steam-injector between the condenser and the producer, all constructed and arranged to allow the whole combination to be used, substantially as described.

In testimony whereof I have hereunto set my hand.

JACOB REESE.

Witnesses:
FRANK M. REESE,
JAMES H. PORTE.