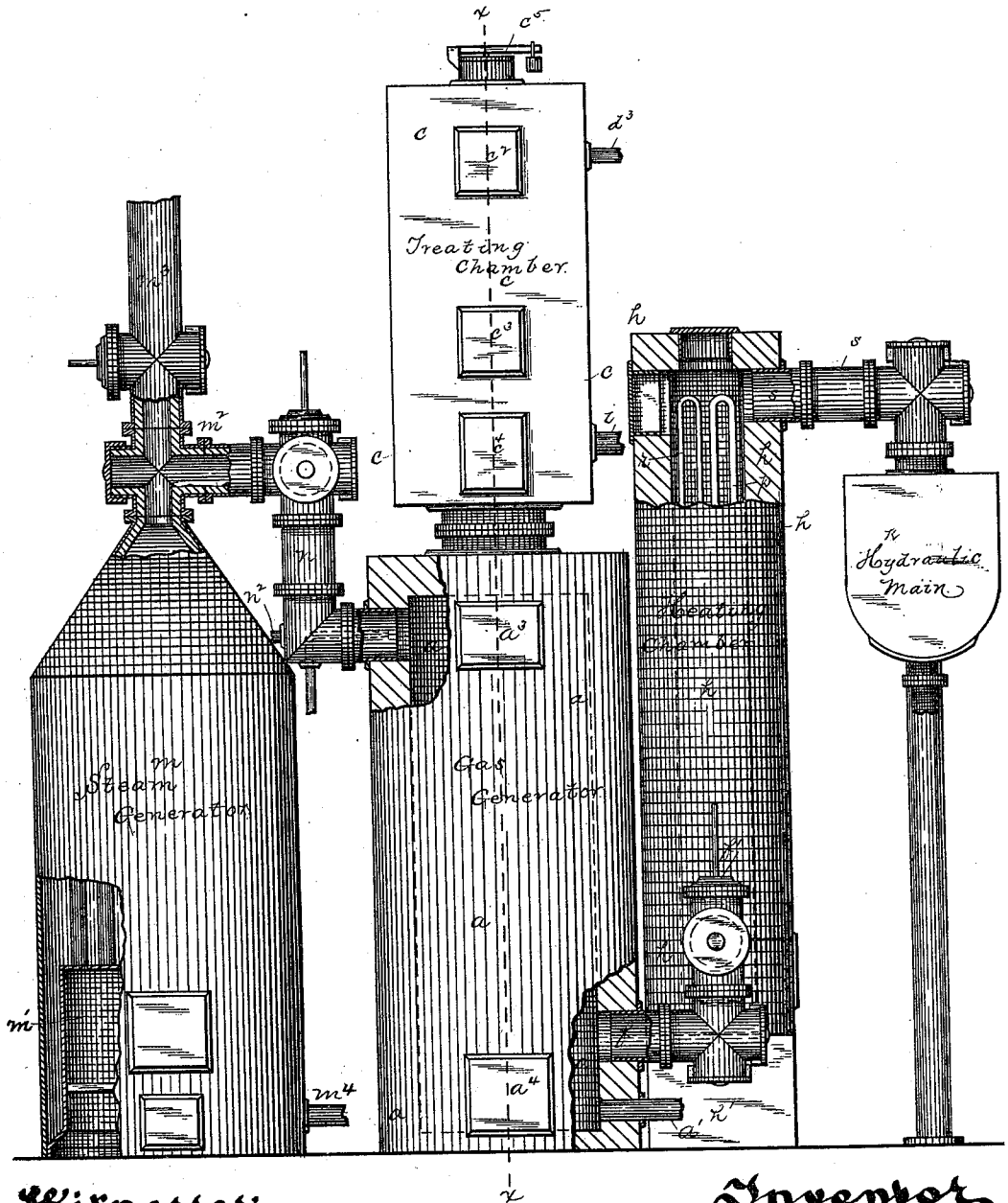
(No Model.) 3 Sheets—Sheet 1.

J. M. ROSE.

MANUFACTURE OF GAS.

No. 408,535. Patented Aug. 6, 1889.

Fig. 1.



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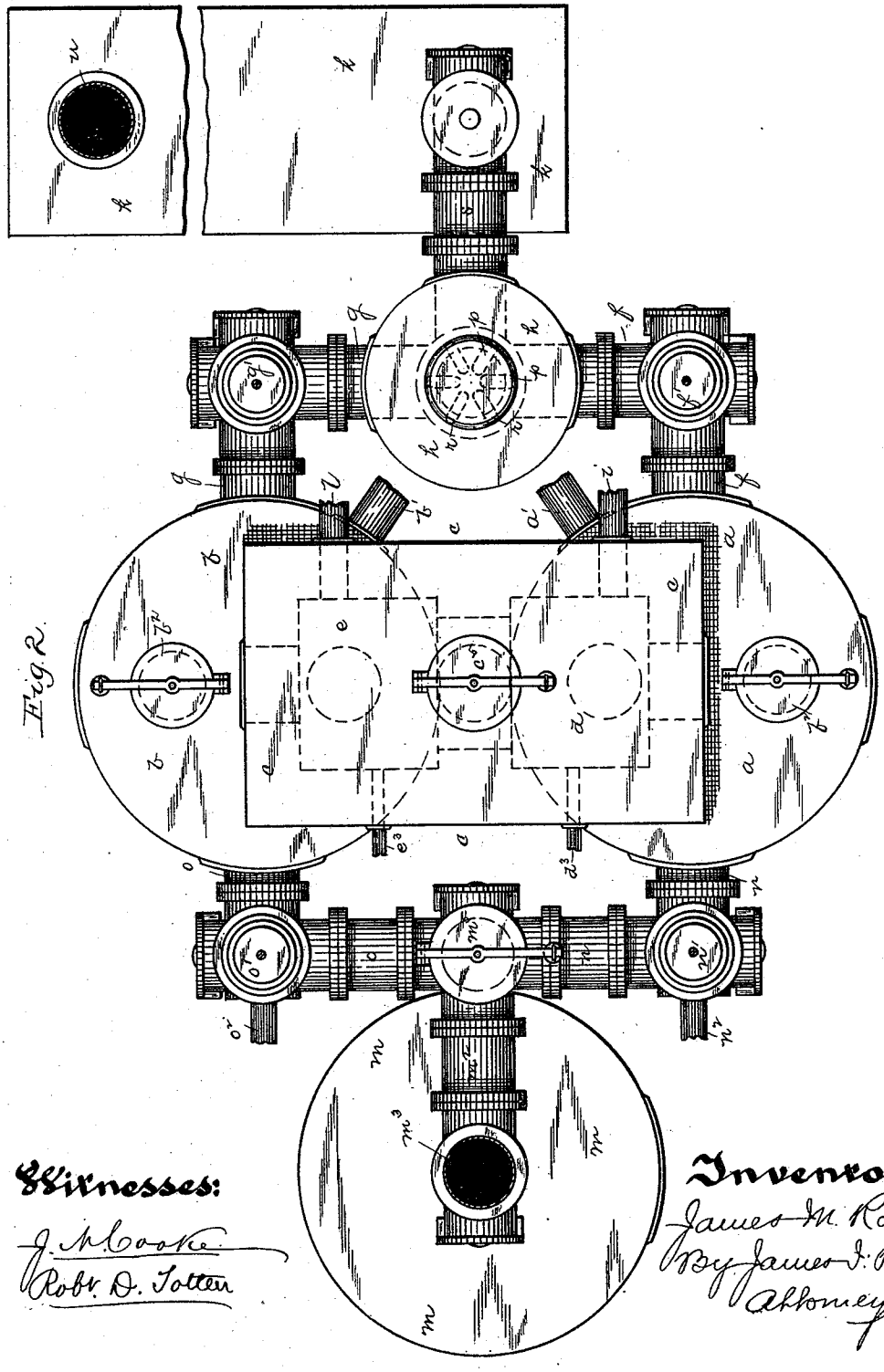

Fig 2.

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(No Model.) 3 Sheets—Sheet 3.

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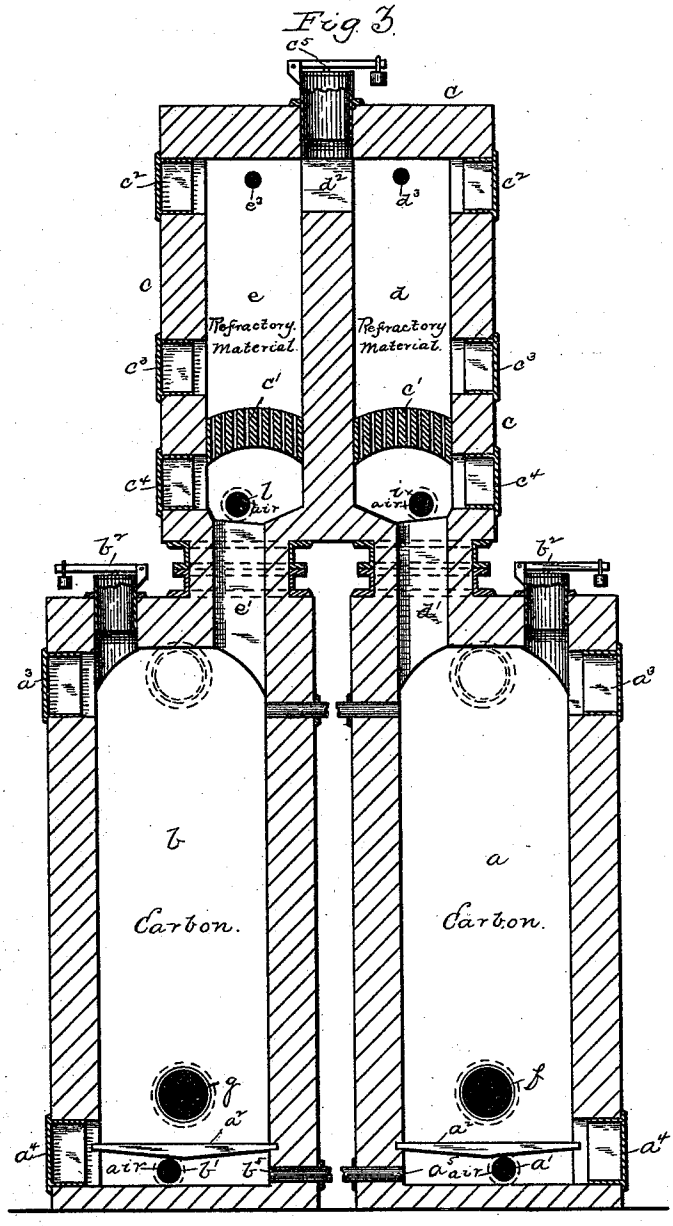
Fig. 3.



Witnesses:

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UNITED STATES PATENT OFFICE.

JAMES M. ROSE, OF ALLEGHENY, PENNSYLVANIA.

MANUFACTURE OF GAS.

SPECIFICATION forming part of Letters Patent No. 408,535, dated August 6, 1889.

Application filed October 16, 1888. Serial No. 288,286. (No model.)

To all whom it may concern:

Be it known that I, JAMES M. ROSE, a resident of Allegheny, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in the Manufacture of Gas; and I do hereby declare the following to be a full, clear, and exact description thereof:

My invention relates to the manufacture of gas, and especially to the manufacture of a fine quality of fuel or heating gas, its objects being to utilize the products of combustion employed in generating the steam as a basis for the manufacture of the gas by the further treatment of such products and to increase the proportion of carbon in gases generated from hydrocarbonaceous materials.

To these ends my invention consists, generally stated, in admitting a limited quantity of air to a body of heated hydrocarbons, and thereby causing the oxygen of the air to unite with the hydrogen of the heated hydrocarbon and setting free the carbon thereof to mix or unite together with gases passing through the heated hydrocarbons, thereby enriching the said gases in carbon, my invention being preferably employed in connection with the manufacture of generator or producer gases and during the enriching of the same by the addition of such hydrocarbons, and acting to increase the proportion of carbon in the gases obtained.

It also consists in commingling with the generator or producer gas heated waste products, such as formed in burning carbonaceous materials to heat a body of water and generate steam, and then recarburizing such waste products.

To enable others skilled in the art to practice my invention, I will describe the same more fully, referring to the accompanying drawings, in which—

Figure 1 is a side view, partly broken away, of the apparatus employed in practicing my invention. Fig. 2 is a top or plan view of the same; and Fig. 3 is a cross-section on the line *x x*, Fig. 1.

My invention may be practiced in any apparatus suitable for the purpose, and the apparatus shown herewith is simply described as one well adapted to produce the desired results.

Before describing the manner of practicing my invention I will describe the said apparatus, so that the improvements herein claimed may be more clearly understood.

The main portion of said apparatus consists of the two gas generators or chambers *a b*, which are set side by side, these two generators supporting the treating-chamber *c*, containing the two compartments *d e*, and the gas-generator *a* communicating through the port or flue *d'* with the compartment *d* of said treating-chamber, and the gas-generator *b* communicaning with the compartment *e* thereof through the flue *e'*, while said compartments *d e* communicate at the upper end of the treating-chamber through the port d^2. Each generator is provided with grate-bars a^2 and with suitable charging-doors a^3 and discharging or cleaning doors a^4 for removing the clinkers and ashes, and each chamber is provided with a safety-valve b^2, which is weighted to sustain a considerable pressure, as a high pressure is generally maintained within the apparatus.

The chamber *a* has the air-supply pipe *a'* communicating with the base thereof, and the generator *b* has a like pipe *b'*, these pipes being controlled by suitable valves and leading from suitable blast apparatus by which a high pressure is maintained, said chambers having also the steam-supply pipes a^5 b^5 communicating with the bases thereof, respectively, for the purpose hereinafter described. Leading from the said generator *a*, just above the grate-bars thereof, is the gas-eduction pipe *f*, while leading from the chamber *b* is the gas-eduction pipe *g*, said pipes *f g* each communicating with the heating-chamber *h*, through which the gases formed pass on the way to the hydraulic main *k* or to the storage-tank. The casings for the said generators *a b* are made of thick plate metal, so as to properly withstand the pressure generated within the apparatus, and also to sustain the weight of the treating-chamber *c*, which rests directly upon said generators *a b* and is supported thereby. The treating-chamber *c* has, as above set forth, two com-

partments d e, each compartment having the perforated arch c' and having doors c^2 c^3 c^4, the doors c^2 and c^3 being used for filling and removing the refractory materials employed therein for treating the gases—such as fire-clay balls, checker-work or irregular pieces of fire-brick, dolomite, limestone, or hard-burned coke, such materials resting upon the perforated arches c'—and the door c^4 being used for examining and repairing the portion of the chamber under the perforated arches c'. In said compartment d of the treating-chamber and under the perforated arch is the air-supply pipe i, and in the same part of the compartment e is the air-supply pipe l, these pipes leading from the air-blast apparatus, before referred to, and being controlled by suitable valves. In the upper parts of said compartments d e are the steam and hydrocarbon injectors d^3 e^3, respectively, for the introduction of steam and a suitable liquid hydrocarbon, such as coal-tar, asphalt, Lima oil, or like materials. The said treating-chamber c is also provided with the weighted relief or safety valve c^5, which may lead up from the port d^2 between said chambers d e, and so provides a means of relieving both said chambers.

Placed in front of the gas-generators in the apparatus above described is the steam-generator m, which can be of any desired construction, though a suitable vertical steam boiler or generator is preferred for the purpose, and this generator is provided with a suitable fire-chamber m', and its chimney-flue m^2 leads by suitable branch pipes n o to the upper part of the gas-generators a b, respectively, said branch pipes being controlled by the valves n' o', and so directing the passage of the products of combustion from said chimney-flue into either gas-generator a or b, as desired. The generator has also the escape-flue m^3, which can be controlled by suitable damper or valve to permit the direct escape of the products of combustion, and, if desired, a suitable relief-valve m^5 can be arranged either on said escape-pipe m^3 or in the chimney-flue m^2.

Leading into the pipes n o, respectively, at about the point where they enter the gas-generators a b, are the steam-supply pipes n^2 o^2, which act as injectors to carry the products of combustion into the gas-generators, and also supply a portion of steam to the upper part of the gas-generators, as is desirable in the gas-making operation. The heating-chamber h is formed of a long plate-metal cylinder supported upon suitable foundation h' and lined with fire-brick, as are all the other exposed portions of the apparatus, and the eduction-pipes f g communicate with the base of this heating-chamber, said pipes being controlled by the valves f' g' and carrying the gases formed in the apparatus into the base of said chamber. Arranged within this heating-chamber in suitable coil or return pipe form, as may be found best suited for the purpose, are the air-superheating pipes p and the steam-superheating pipes r, the said pipes having suitable connections with the air-blast apparatus and with the steam-generator, so that the air and steam passing through them are raised to a high heat before they are employed in gas-making, and at the same time a large portion of the heat of the gas generated in the apparatus is absorbed and carried back into the apparatus, so acting to save the heat and reduce the temperature of the gases after they are fixed or rendered stable, and before they enter the hydraulic main or washing apparatus k or the storage-tank. Leading from the upper end of said heating-chamber h is the pipe s, which communicates with the hydraulic main k, the main receiving the gases as they pass from the gas-generating apparatus and washing them and removing certain impurities or volatile matter therefrom, and the gases passing by the pipe u to the storage-tank.

In practicing my invention in the apparatus as above described the compartments d e of the treating-chamber c are filled with suitable refractory material—such as fire-clay balls of a few inches in diameter, checker-work, or dolomite, or limestone in irregular pieces, the fire-clay balls being preferred on account of the ease with which they can be removed—and these materials are preferably coated prior to placing them in said chamber with a heavy hydrocarbon—such as coal-tar or asphalt—the said chambers being filled from the perforated arches up about to the port d^2. The gas-generators a b are filled with coal or coke, and a suitable supply of liquid hydrocarbon—such as coal-tar in liquid form or Lima oil—is placed in the tanks leading to the injectors d^3 e^3. The apparatus being so arranged, fire is started in the steam-generator m and the gas-generators a b, and the valve controlling the escape-pipe m^3 of the steam-generator and the relief-valves b^2 of the gas-generators and c^5 of the treating-chamber are opened, so that the products of combustion from said steam-generator and gas-generator can have a free escape and will act gradually to heat the materials therein. As soon as a sufficient supply of steam has been generated the air-blast apparatus is started and the air-blasting applied to the steam-generator and to the gas-generators, this being continued until the apparatus is brought to a proper heat for gas-making, the body of coal or coke in the gas-generators being raised to a high heat, and the refractory material in the treating-chamber c being also highly heated. When the apparatus is ready for gas-making, the relief-valves are all closed, the valve u' between the steam-generator and gas-generator a and the valve g' in eduction-pipe g are opened, and the valves controlling the air-blast pipe a', steam-pipe n', steam-injectors d^3 e^3, and air-blast pipe m^4 are opened, all other valves remaining closed. The products of combustion from the fuel consumed

in the steam generator m then pass through the pipes or flues m^2 n into the gas-generator a, the current thereof being induced by the steam-jet through the pipe n^2, these heated products, where coal is used as fuel, consisting principally of carbonic acid, carbonic oxide, and the nitrogen carried in by the air, which is highly heated in said steam-generator. At the same time as the air under pressure passes up through the body of carbon in the generator a it generates what is known as "generator" or "producer" gas, and this gas passes upwardly through the flue d' into the compartment d of the treating-chamber c, containing the refractory material, which has preferably been coated, as above set forth, and as said gases pass upwardly through said chamber steam and liquid hydrocarbon are admitted to the same through the steam-injectors d^3 or e^3, or both, so supplying to said gases a body of steam and liquid hydrocarbon. Where, however, the body of refractory material through which the gases pass is coated, as above set forth, a heavy hydrocarbon from which the gases can absorb the volatile matter is provided even without the introduction of the liquid hydrocarbon, and if desired a pulverized coal-dust or asphalt or other suitable solid heavy hydrocarbon can be injected within said chamber, so as to provide the necessary hydrocarbon to said gases. As the air passes up through said body of coal or coke in the generator it is evident that on account of the excess of carbon therein all the oxygen of the air is taken up by the carbon, and consequently little or no free oxygen passes upwardly with the gases, and as the gases pass through or in the presence of said hydrocarbon introduced in any of the ways above set forth it is evident that they would naturally take up therefrom the light hydrocarbon gases, the proportion of carbon in said gases being regulated by the proportion of carbon contained in the generator-gas and in the gases volatilized thereby from the hydrocarbon introduced. It is desirable, however, to increase the proportion of carbon in said gases and enrich them in carbon, the necessity of an increase in the proportion of carbon being the more important because the products of combustion passing from the steam-generator into the upper part of the gas-generator a are composed to a large extent of carbonic-acid gas, and it is desirable to increase the proportion of carbon to enrich such gases and by causing them to take up a further portion of carbon convert them into carbonic oxide. For these purposes just below the perforated arch I admit through the air-blast pipe i a limited quantity of air to produce a light combustion of the hydrocarbonaceous materials within the treating-chamber. As the hydrocarbonaceous material in said chamber is heated, especially that supported upon the refractory material, and as the air enters said chamber, the hydrogen of the hydrocarbons, having under such conditions a greater attraction for the oxygen of the air than has the carbon, will take up the greater portion of the oxygen to the exclusion of the carbon, the heated hydrocarbons being thus separated, a rich carbon gas or vapor of great density being formed by the carbon thus set free, which carbon in passing upwardly with the other gases unites with the carbonic acid or other gases having an affinity therefor or passes through the treating-chamber with the mass of gases to enrich them in carbon. In order that this may be more clearly understood, the following explanation is given: Though where steam passes into the presence of a heated carbon (such as in forming water-gas) the carbon has a greater affinity for the oxygen than has the hydrogen, yet where oxygen and a hydrocarbon are brought together the hydrogen has a greater affinity for the oxygen than has the carbon at that temperature and unites therewith, the resultant products being water-vapor, and the carbon-vapor being set free, and this reaction generating heat. The steam so formed is converted into water-gas by union with the carbon in passing through the other treating or fixing chambers of the apparatus, and the carbon-vapor, being raised to a higher heat in passing through said chambers, unites with the carbonic acid to form carbonic oxide, and also with the hydrogen of the steam admitted to said chambers to form hydrocarbon gas. The gases so formed pass upwardly through the compartment d and downwardly through the compartment e of the heating-chamber c, all the air admitted through the pipe i being thus consumed within said chambers, and by uniting with the hydrogen increasing the proportion of carbon in the gases, and the gases generated pass downwardly through the body of incandescent carbon in the generator b, the said gases being fixed and rendered stable in said body of incandescent carbon, while at the same time any undecomposed steam is broken up to unite with the gases and any carbonic acid which might have passed through the treating-chamber without being converted into carbonic oxide is in said mass of incandescent carbon converted into carbonic oxide, and thus adds to the body of gases useful for heating purposes. The gases pass outwardly through the eduction-pipe g and rise through the heating-chamber b, where a large portion of the heat of said gases is absorbed by the air and steam passing through the pipes within said chamber, and this heat is thus carried back into the apparatus, the gases then passing through the pipe s into the hydraulic main k, and after having been washed therein being carried to the storage-tank through the pipe u. This is continued until the body of incandescent carbon in the generator b is so lowered in heat that it will not properly fix

the gases or act to convert the carbonic acid into carbonic oxide when the valves n' and g' and the valves controlling the pipes a', i, and w^2 are closed, the valves o' and f' and the valves controlling the pipes b' and o^2 are opened, in which case the air passes upwardly through the body of carbon in the generator b and the products of combustion from the steam-generator m pass to the upper part of this generator b, being assisted in their flow by the steam-jet from the pipe o^2, the products of combustion and gases then passing upwardly through the flue e' and through the treating-chamber c, rising through the compartment e, and pass downwardly through the compartment d, and during their passage a limited quantity of air being admitted through air-blast pipe l, the gases then passing downwardly through the body of incandescent carbon in the generator a and escaping through the eduction-pipe f, and the action of the apparatus being thus reversed, as is found necessary, according to the heat of the bodies of carbon in the generators a b, the air-blast through said generators heating the said bodies of carbon to incandescence, while the passage of the gases through same for fixing purposes reduces said heat, and the apparatus being reversed, as found necessary, to properly treat the gases.

I am thus enabled by my invention to carbonize the gases formed by taking advantage of the fact that the hydrogen of the hydrocarbons when heated has a greater affinity for the oxygen than has the carbon thereof, and as both are present, and as the supply of oxygen is limited, the hydrogen takes up the greater portion of the oxygen to the exclusion of a greater part of the carbon, and the hydrocarbons are separated, a rich carbon vapor or gas of great density passing off with the other gases, and in so doing I am enabled not only to enrich these gases in carbon, but to recarbonize the products of combustion formed in generating the body of steam necessary for practicing the invention and to reconvert the said products of combustion into useful gases, and I am also enabled thereby to set free more rapidly the hydrocarbons employed as a coating for the refractory material in the treating-chamber by providing a limited quantity of air for union with the hydrogen, and thus freeing the carbon, and in gas-making the more volatile parts of the liquid hydrocarbon introduced into the apparatus will be carried off by the gases, while the heavier portions thereof, which serve to coat or recoat the refractory material, may by my present invention be set free, as above described, and utilized in making gas.

Though the general arrangement of the apparatus above described is considered the best in practicing my invention, it is evident that it can be practiced under any conditions in which the gases are brought into the presence of the hydrocarbons, either by spraying or where a solid hydrocarbon or coal-dust is employed, or by the coating of blocks or pieces, which will expose the said hydrocarbon in a heated condition to the air admitted, and it is also evident that, if desired, my invention may be employed with the ordinary water-gas process, either in connection with the manufacture of generator or producer gas, as above described, or separately therefrom, the steam being admitted to the generators through pipes a^5 b^5, as shown in the drawings. I am also enabled by my invention to utilize the products of combustion from the steam-generator for gas-making purposes, and this at practically no extra cost, recarbonizing and treating them when in a heated condition, and I so reduce the cost of generating steam to a minimum, and am enabled in some cases to even profit by the gases formed in the generation of such steam.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The herein-described process of forming gas, consisting in passing air through a mass of heated carbon and introducing into the gases so formed heated waste products of combustion, (such as formed in burning carbonaceous materials to heat a body of water,) then passing such gases and waste products through or in contact with heated hydrocarbons and admitting thereto a limited quantity of air, and subsequently passing the resultant gases through a body of heated fixing material, substantially as and for the purposes set forth.

2. The herein-described process of forming gases, consisting in passing air through a body of incandescent carbon and the resultant gas through or in the presence of heated hydrocarbon and during such passage admitting to such gases a limited quantity of air, whereby the oxygen unites with the hydrogen and the carbon is set free to enrich the gas, substantially as and for the purposes set forth.

3. The herein-described process of forming gas, consisting in admitting a limited quantity of air to a body of gases passing through or in the presence of heated hydrocarbons, whereby the oxygen of the air unites with the hydrogen of the hydrocarbon and carbon is set free to enrich the gases, substantially as and for the purposes set forth.

4. The herein-described process of forming gas, consisting in admitting a limited quantity of air to a body of gases passing through or in the presence of heated hydrocarbons, whereby the oxygen unites with the hydrogen and the carbon is set free to enrich the gases, and subsequently passing such gases through heated fixing material to render them stable, substantially as and for the purposes set forth.

5. The herein-described process of forming gas, consisting in passing air through a mass

of heated carbon and introducing into the gases so formed heated waste products of combustion, (such as formed in burning carbonaceous materials to heat a body of water,) commingling the gases, and subsequently recarburizing said waste products of combustion, substantially as and for the purposes set forth.

In testimony whereof I, the said JAMES M. ROSE, have hereunto set my hand.

JAMES M. ROSE.

Witnesses:
WM. P. MERCER,
BENJ. W. HAINES.