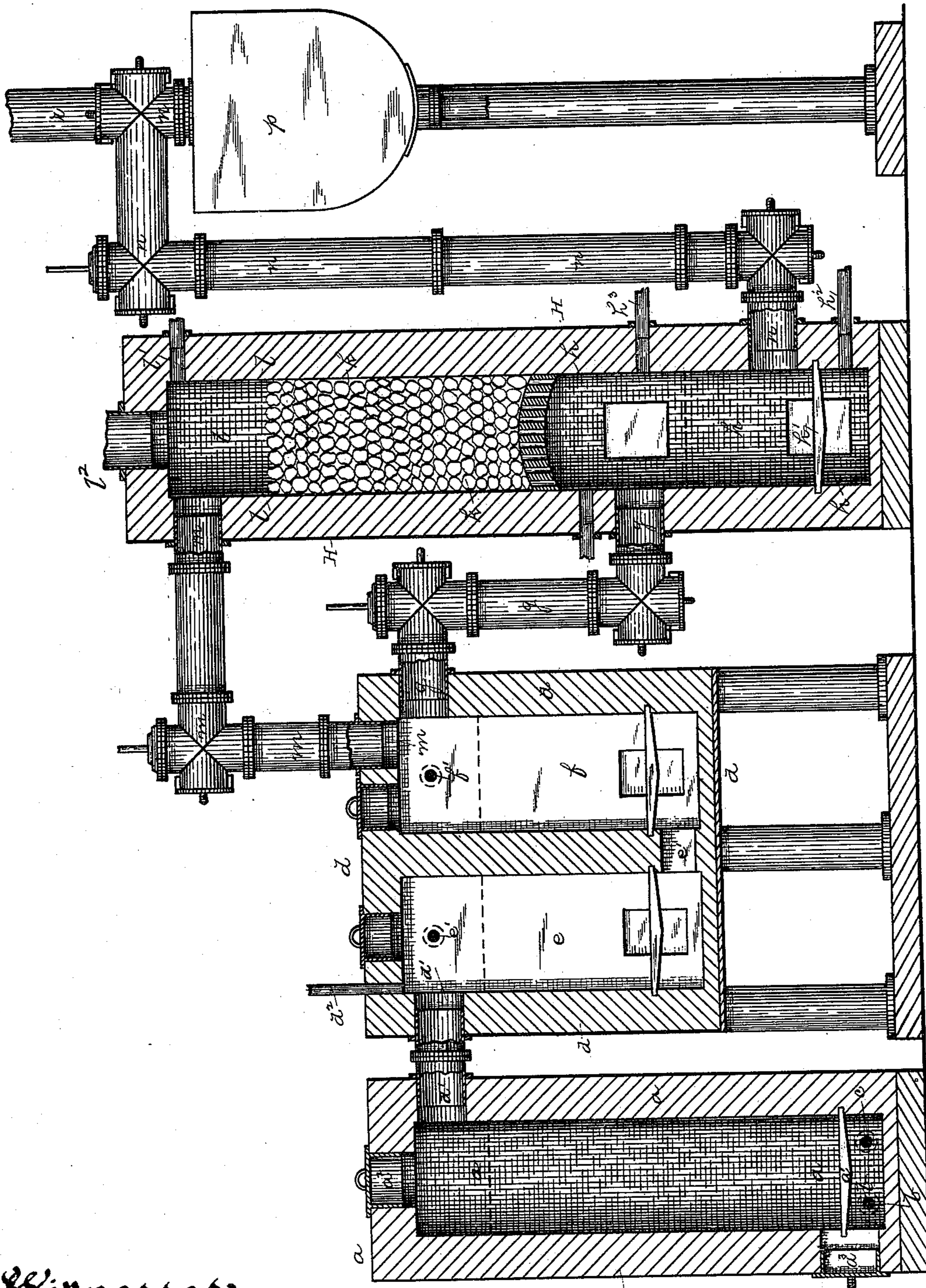


(No Model.)

J. M. ROSE.  
PROCESS OF MANUFACTURING GAS.

No. 408,534.

Patented Aug. 6, 1889.



Witnesses:  
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# UNITED STATES PATENT OFFICE.

JAMES M. ROSE, OF ALLEGHENY, PENNSYLVANIA.

## PROCESS OF MANUFACTURING GAS.

SPECIFICATION forming part of Letters Patent No. 408,534, dated August 6, 1889.

Application filed October 4, 1888. Serial No. 287,148. (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 has special reference to what is known as "generator" gas or "producer" gas, this gas being made by passing air or air and steam through a body of heated carbon—such as coal or coke—and forming combustion at the base of said mass, the products of combustion or carbonic acid so formed passing upwardly through the mass of carbon and heating the same, and taking up therefrom a further portion of carbon, so forming carbonic oxide, which composes the principal heating property of this generator or producer gas. As the air flowed or was forced into the body of carbon only the oxygen thereof entered into the gas so formed, the nitrogen of the air passing through unaffected and forming a large body of inert matter in the gas, which has heretofore remained in the generator or producer gas and weakened or diluted it to such an extent that it could only be economically employed close to the place of generation, as its heating properties were so low in proportion to its volume and the nitrogen rendered it so heavy that it could not well be forced through pipes, while it required previous heating to ignite, and for this reason could not be employed for domestic heating purposes.

The special objects of my present invention are to eliminate this nitrogen from the gas, and while so doing to add thereto other combustible gases, so as to form a fine quality of heating or fuel gas.

To these ends my invention consists, generally stated, in eliminating the nitrogen from and enriching the producer-gas by introducing steam into the heated producer-gas in the presence of an excess of hydrocarbon, and thereby causing the oxygen of the steam to unite with the carbons present, and the nascent hydrogen to unite with the heated nitrogen, forming ammonia-gas or like compound, and enriching the producer-gas with the hy-

drocarbons, and subsequently absorbing the ammonia-gas from the gases formed.

To enable others skilled in the art to practice my invention, I will describe the same more fully, referring to the accompanying drawing, which shows a longitudinal central section, partly in full lines, of apparatus suitable for carrying out my improved process.

In practicing my invention I employ a gas-generator in which a mass of coal, coke, or other carbon is blasted to incandescence, and in connection therewith a treating-chamber, a washing apparatus, and preferably a fixing-chamber, and the apparatus for making gas may be varied in many particulars of construction where these parts are employed.

In the accompanying drawing, which illustrates a gas apparatus well adapted for practicing my invention, and in which the said invention has been successfully carried out, I have illustrated a gas-generator *a*, a treating-chamber *d*, a casing *H*, containing a fixing-chamber, which communicates with said treating-chamber, and a washing apparatus *p*, said apparatus being fully illustrated and described in application for Letters Patent filed by me on May 9, 1888, Serial No. 273,280. In said apparatus the generator *a* is formed of a cylindrical casing suitably lined with fire-brick, and having at the base thereof the grate-bars *a'* and communicating therewith the air-blast pipe *b* and steam-pipe *c*, said generator having also the feeding-opening *a*<sup>2</sup>, closed by suitable door or valve, and the opening *a*<sup>3</sup> opposite the grate-bars for the purpose of removing clinkers from the mass of material supported on the grate-bars or ashes from the space below said grate-bars. The treating-chamber *d* is composed of two compartments *e f*, which are each provided with grate-bars and feeding ports or openings at the upper end and doors or openings at the base for the examination or removal of the material in said compartments. The treating-chamber *d* communicates with the gas-generator *a* through a port *d'*, which enters the upper end of said treating-chamber, and at the base of said chamber is the port *e'*, forming communication between the compartments *e f* thereof. At the upper end of said compartments *e* and *f* are the steam-injectors *e' f'*, which communicate with the steam-main, and also with suitable tank

or tanks containing hydrocarbons, the hydrocarbons introduced into this part of the apparatus being preferably heavy hydrocarbon—such as coal-tar or asphaltum, though  
 5 other hydrocarbons may be employed—and for some purposes in carrying out my process only steam is injected through the injector  $e'$ , as hereinafter described. Communicating with the entrance end of the treating-chamber  $d$  is the air-blast pipe  $d^2$ , to admit a limited quantity of air at the entrance of the  
 10 treating-chamber to unite with the hydrogen of the hydrocarbons and set free the carbon to enrich the gas, as described in an application filed October 16, 1888, Serial No. 288,286. Leading from the compartment  $f$  of the treating-chamber  $d$  is a pipe or flue  $g$ , which communicates with the casing H at about the center thereof, said casing being employed,  
 20 as described in said application Serial No. 273,280, for treating and fixing the gases, and having at the base thereof the chamber  $h$ , provided with the grate-bars  $h'$ , supporting a body of coal or other suitable carbon, and  
 25 forming what will hereinafter be referred to as the "carbon-chamber," the pipe or flue  $g$  communicating with said chamber above said grate-bars, as shown. Above said carbon-chamber is supported, in any suitable manner,  
 30 a mass of fire-brick or other suitable refractory material, forming the fixing-chamber  $k$ , this material being supported on a perforated arch or built up within the casing in suitable manner, so as to permit the passage  
 35 of the gases through the mass thereof. Above the same is a space or chamber  $l$ , with which a suitable pipe  $m$ , leading from the compartment  $f$  of the treating-chamber  $d$ , communicates, and suitable steam-injector  $l'$ , for admitting steam and liquid hydrocarbons, communicates with said chamber  $l$ . The said  
 40 casing H has also the air-blast pipe  $h^2$  below the grate-bars  $h'$  thereof and the air-blast pipe  $h^3$  above the carbon-chamber  $h$ , and  
 45 leading from said carbon-chamber  $h$ , close to the grate-bars thereof, is the eduction-pipe  $n$ , which leads to the hydraulic main  $p$  or other suitable washing or scrubbing apparatus, the pipe  $n$  dipping into the water or liquid contained within said hydraulic main and the  
 50 pipe  $r$  leading from said hydraulic main to the storage-tank.

If desired, the hydraulic main, or a suitable compartment therein, may be lined with lead,  
 55 so as to resist the action of the acids, and may contain a solution of sulphuric acid or other suitable acid in order to unite with the ammonia-gas passing from the apparatus, as hereinafter described, and form sulphate of ammonia or other salt. At suitable places in the apparatus relief-valves may be placed, and these relief-valves weighted to resist a comparatively high pressure.

When the apparatus so constructed is  
 65 utilized in practicing my invention in preparing it for the making of gas, the generator  $a$  is filled with coal or coke, an ordinary

gas-house coke being suitable for the purpose, and the compartments of the treating-chamber are filled with suitable refractory  
 70 material, such as fire-clay balls, checker-work, limestone, dolomite, or hard-burned coke, the fire-clay balls being preferably employed, as they can be more easily removed from said chamber. This refractory material is  
 75 preferably first coated with a heavy hydrocarbon—such as coal-tar or asphaltum, or both—though for the purpose of my invention the refractory material may be employed without coating, and the hydrocarbons may  
 80 be fed to said chamber in any other suitable way. The carbon-chamber  $h$  of the casing H is also filled with a suitable carbon, anthracite or bituminous coal or coke being well suited for the purpose.  
 85

The air-blast employed in gas-making is generated by any suitable blower, a pressure-blower being preferred in order to force the gases through the apparatus, and the steam and air are both preferably superheated by  
 90 any suitable means.

When it is desired to heat up the apparatus for making gas in accordance with my invention, the air-blast is turned on both to the gas-generator  $a$  and to the carbon-chamber  
 95  $h$ , and the masses of carbon in said chambers are ignited, the air-blast from the generator  $a$  passing upwardly through the mass of carbon therein and causing a combustion of part thereof and a rapid heating up of said  
 100 mass of carbon, and the products of combustion pass over through the treating-chamber  $d$ , acting by direct contact with the refractory material contained therein to heat the same, while the said products pass over  
 105 through the pipe or flue  $g$  into the casing H above the heated carbon in the carbon-chamber  $h$ , where they intermingle with the air from the blast-pipe  $h^3$ , and are heated and ignited by the mass of carbon in said chamber and unite with the gases formed therein,  
 110 the heated products passing upwardly through the fixing material in the fixing-chamber  $k$  and raising it to a high heat, and said products escaping through the purge-valve  $l^2$ . This is continued until the mass of carbon in the chamber  $h$  is brought to a high state of incandescence and the fixing material in the chamber  $k$  is properly heated,  
 115 the refractory material in the chamber  $d$  being heated to some extent, but not as highly as the other parts of the apparatus, and the apparatus is then ready for gas-making. The purge-valve  $l^2$  and air-blast pipes  $h^2$   $h^3$  are then closed, the valve in the eduction-pipe  $n$   
 120 is opened, the valve in the pipe  $g$  closed, and the valve in the pipe  $m$  opened. The air-blast is then continued through the mass of carbon in the gas-generator  $a$ , forming what is known as "generator" or "producer" gas,  
 125 this gas consisting, principally, of carbonic oxide from the union of the oxygen of the air with the carbon and nitrogen, of which there is a large proportion, the nitrogen being of

course simply an inert matter and acting to weaken or dilute the generator-gas, but the nitrogen being highly heated in its passage through said mass of heated coke. These gases then pass over into the treating-chamber *d* and through the mass of refractory material contained therein, and thence through the pipe or flue *m* to the casing *H*, and through it to the eduction-pipe *n*. In their passage, as they enter the treating-chamber *d*, a portion of steam, which is preferably superheated, is fed thereto through the injector *e'*, this steam being decomposed by the high heat of the gases and of the refractory material at the entrance of said treating-chamber, which part of said chamber is generally maintained at a very high heat, and as there is an excess of the carbon in the hydrocarbons present the oxygen of the steam unites either with the carbonic oxide of the generator-gas or with the hydrocarbons supported on said refractory material or introduced into the said treating-chamber—such as by the injection of hydrocarbon through the injector *e'* with the steam—while the hydrogen from the steam is set free, and so far as can be ascertained this hydrogen unites with the heated nitrogen passing over from the gas-generator it being found that ammonia-gas is formed and that the nitrogen is changed so as to be brought into a condition in which it can be easily separated from the gases, and therefore eliminated from the generator or producer gas. If desired, this body of superheated steam, either with or without suitable hydrocarbons, can be fed at different points in the treating-chamber—such as through the injector *e'* and the injector *f'* thereof—as well as in the chamber *l* at the upper end of the casing *H*, before the gases pass through the fixing-chamber *k*, the process having been so practiced, and it being found that in so doing practically all the nitrogen contained with the generator-gas is so changed that it can be removed therefrom, and that a large portion of ammonia-gas is formed. It is believed, however, that the mass of such ammonia-gas is generated at the entrance to the treating-chamber, the temperature at this part thereof being very high and the treating-chamber gradually decreasing in heat, and the ammonia-gas being, so far as has been ascertained, generated in that part of the treating-chamber having the highest heat, and in passing into the cooler compartment of said treating-chamber being rendered stable, so that it is not subsequently broken up in passing through the highly-heated fixing-chambers. If desired, during the process a limited quantity of air may be admitted at the entrance end of the treating-chamber, as described in an application filed October 16, 1888, Serial No. 288,286, this serving the double purpose of maintaining the high heat at the entrance end of the treating-chamber and of increasing the proportion of carbon in the gases, though it is found by experience that the generator-gases passing over

into the treating-chamber maintain it at a sufficient heat for the practice of the process. In said apparatus, after the gases have passed through the treating-chamber, they pass first through the mass of fixing materials in the chamber *k*, and thence downwardly through the mass of carbon in the carbon-chamber *h*, any suitable liquid hydrocarbon—such as Lima oil—being fed to the gases before they pass into the fixing-chamber to carburet or enrich them, if it is so desired, and in passing through said chambers they are first fixed or rendered stable by the heat of the refractory material therein, and this fixing of the gases insured in the body of heated carbon, which also acts to recarbonize any carbonic acid which may have been formed in passing over through the apparatus and convert it into carbonic oxide. The gases then pass through the pipe *n* into the hydraulic main or washing and scrubbing apparatus *p*, and as the gases are delivered into the body of water contained therein the ammonia-gas which has been generated as above set forth is taken up by the water, and thus absorbed from the gases generated, leaving the gases practically free from nitrogen, the gas generated as above described and passing through the pipe *r* to the storage-tank being composed, principally, of marsh-gas, carbonic oxide, and hydrogen, and being found practically free from either nitrogen or carbonic acid. If desired, the hydraulic main or a compartment therein through which the gas is carried may contain a solution of sulphuric or other suitable acid to unite with the ammonia-gas, and thus sulphate of ammonia or other such substance may be formed and the ammonia-gas eliminated in this manner.

I have found that the apparatus above described is well adapted for practicing my invention, it being found preferable to employ two casings *H*, containing the chambers above described, and to pass the gases through one while the other is being heated, and thus maintain the fixing materials and carbons through which the gases pass in their way to the hydraulic main at an even heat, and at the same time conducting the generation of gas continuously. Other forms of apparatus are, however, suitable for practicing my said process—such, for instance, as an apparatus in which the drafts may be reversed, the current being carried from one gas-generator through the treating-chamber, and thence through a mass of heated incandescent carbon such as contained in the carbon-chamber *h*, to fix the gases and to recarbonize any carbonic acid passing over, and this being continued until the heat of said mass of carbon is so lowered that it will not properly act for such purposes, and the current then reversed, such as by passing the air-blast into said carbon-chamber *h*, thence through said treating-chamber in the opposite direction, and thence through the other generator to fix the gases and recarbonize the carbonic acid.

I find by my invention that I am enabled to eliminate practically all the nitrogen from the generator-gases and to form by this generator-gas process, which is known to be the  
5 simplest and cheapest method of making gas, a gas of fine quality for heating and fuel purposes, and which can be easily enriched, either in the process of eliminating the nitrogen or by the addition of suitable enriching agents,  
10 to form a fine quality of illuminating-gas; and as I thus eliminate from the generator-gas the nitrogen, which has been the principal objectionable feature therein, I am able to form a gas at a very much lower cost than any such  
15 gases have heretofore been manufactured. The gas formed has by practical tests been found to possess very high heating properties and to be stable, to be of low specific gravity and easy flowing, and to have practically all the desirable qualities of a heating  
20 or fuel gas.

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

1. The herein-described process of eliminating  
25 nitrogen from and enriching producer-gas, consisting in introducing steam into the heated producer-gas in the presence of an excess of hydrocarbons, and thereby causing the

oxygen of the steam to unite with the carbons present and the nascent hydrogen to unite  
30 with the heated nitrogen, forming ammonia-gas or like compound, and enriching the producer-gas through the hydrocarbons, and subsequently absorbing the ammonia-gas from the gases formed, substantially as set forth. 35

2. The herein-described process of eliminating nitrogen from and enriching generator or producer gas, consisting in introducing steam into the heated producer-gas in the presence of an excess of hydrocarbon and passing the  
40 gases or vapors through a heated mass of refractory material, which gradually reduces in temperature from the entrance end toward the delivery end thereof, and wherein the nascent hydrogen unites with the heated ni- 45 trogen, forming ammonia-gas or like compounds, and subsequently absorbing the ammonia-gas from the gases formed, substantially as and for the purposes set forth.

In testimony whereof I, the said JAMES M. 50 ROSE, have hereunto set my hand.

JAMES M. ROSE.

Witnesses:

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