(No Model.) 2 Sheets—Sheet 1.

J. M. ROSE.

PROCESS OF MANUFACTURING GAS.

No. 403,383. Patented May 14, 1889.

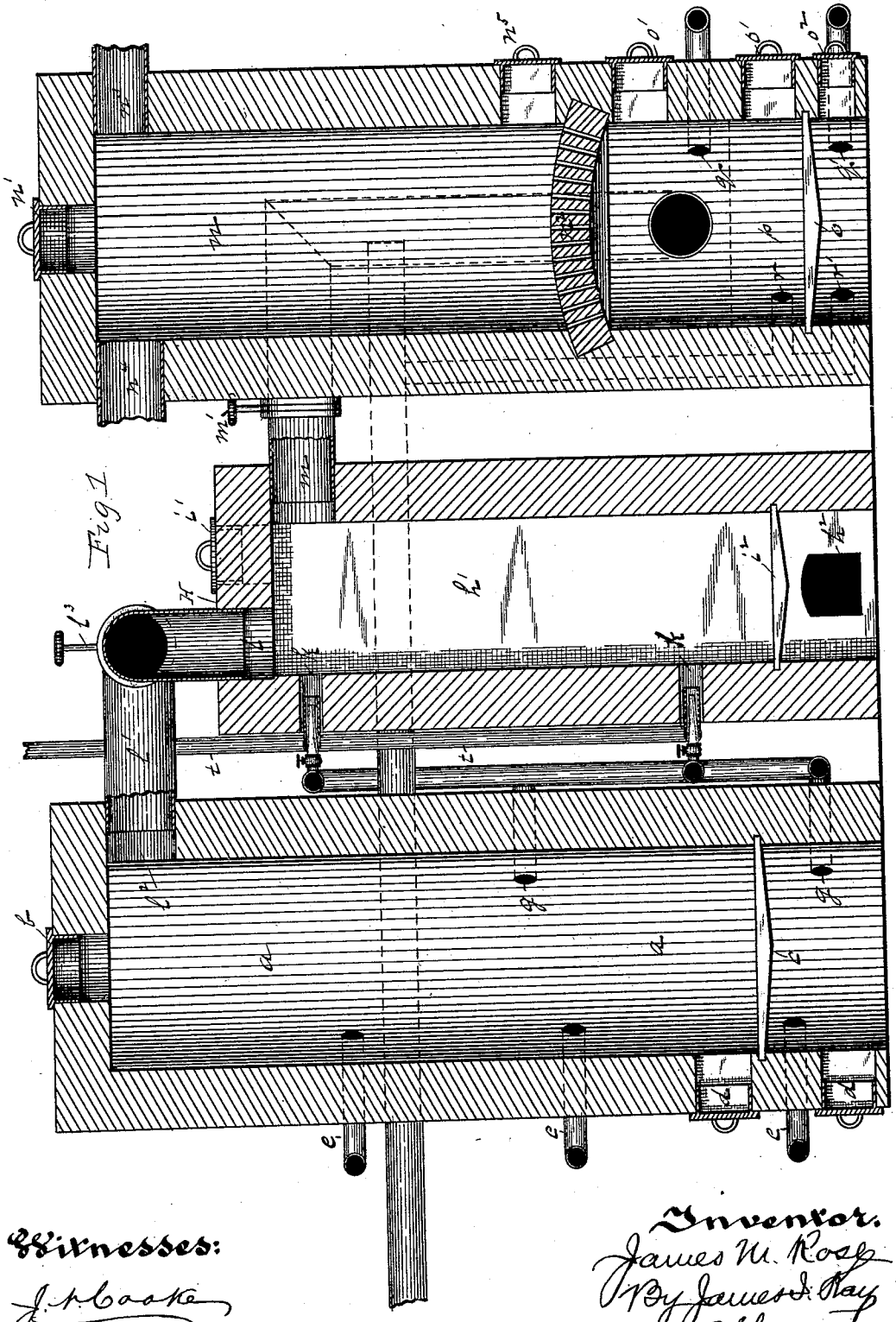

Fig 1

Witnesses:
J. R. Cooke
N. S. Stockwell

Inventor.
James M. Rose
By James D. Ray
Attorney

(No Model.) 2 Sheets—Sheet 2.

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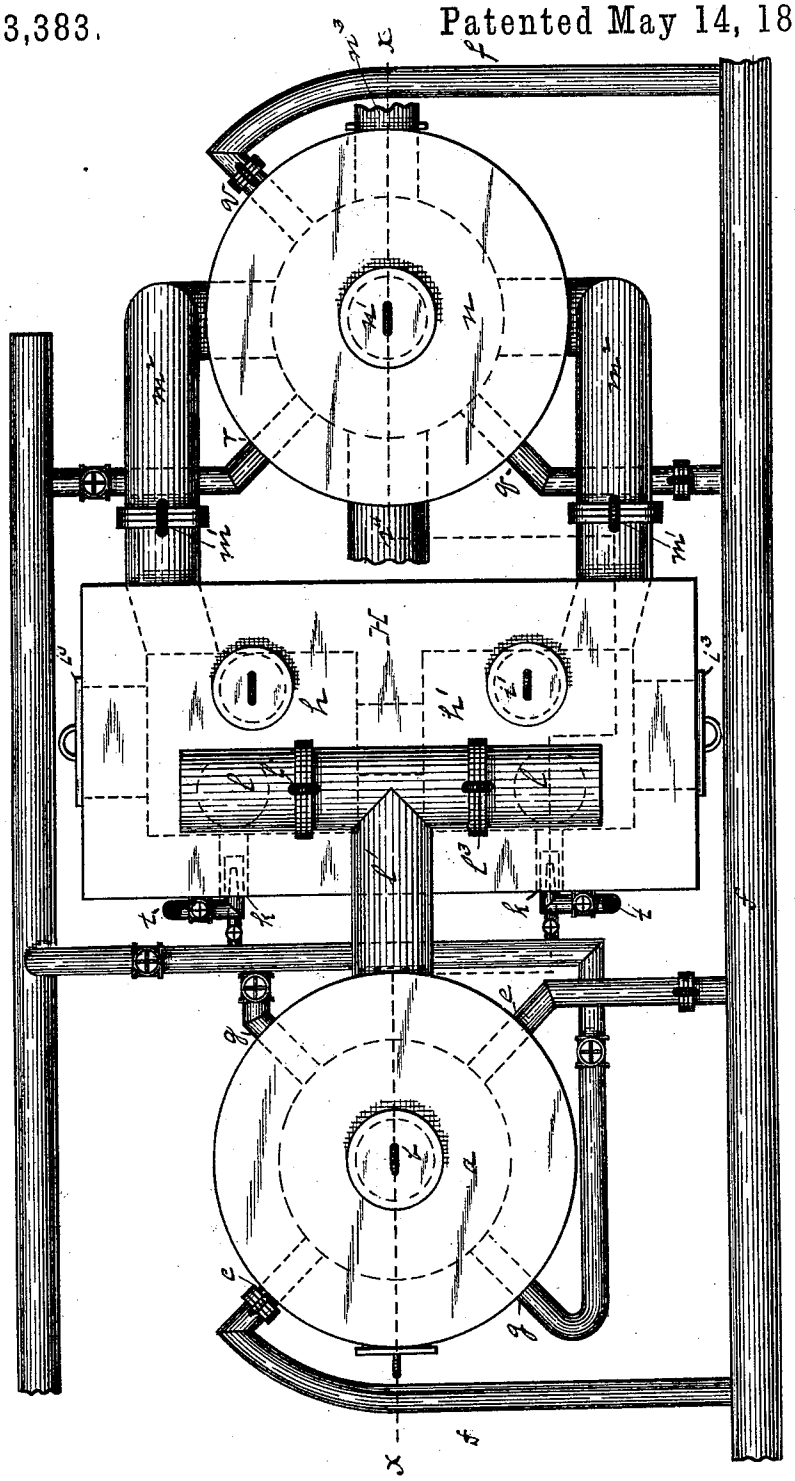

Fig 2.

Witnesses:
J. M. Cooke
N. S. Stockwell.

Inventor.
James M. Rose
By James D. Ray
Attorney

UNITED STATES PATENT OFFICE.

JAMES M. ROSE, OF ALLEGHENY, PENNSYLVANIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE NATIONAL HEAT AND POWER COMPANY, OF NEW JERSEY.

PROCESS OF MANUFACTURING GAS.

SPECIFICATION forming part of Letters Patent No. 403,383, dated May 14, 1889.

Application filed February 23, 1888. Serial No. 264,984. (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 Process of Manufacturing Gas; and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to the manufacture of a cheap fuel-gas, its object being to utilize all or practically all the combustible gases driven off from a body of coal or coke, both in the process of raising the same to incandescence and in the process of forming a gas after the same has been raised to a sufficient heat for the decomposition of the steam, as well as at the same time to provide a sufficient amount of hydrocarbons in said fuel-gas to lower the burning-point of the same and to give the gas a diffusive power, so that it will disseminate through the mass of material to be heated or distribute itself through the furnace, metallurgical or otherwise, in which it is employed, while at the same time the resultant gas is as free as practicable from inert gases, such as nitrogen. It is well known that the ordinary producer-gas, formed by the passage of air through a mass of coal in which a slow combustion takes place, contains a very large proportion of nitrogen, and this nitrogen is incombustible and not only adds to the volume to be carried through the pipes, but at the same time raises the point of combustion of the gas, so that it is practically necessary to heat this gas, as in regenerators, to obtain any good result from the same as a heating agent. For this reason, for the manufacture of fuel-gas for transportation, it has not been considered desirable to utilize the products of combustion obtained in raising the coal to an incandescence, and thus a part of the gas obtained and also a large part of the heat units of the gas are permitted to escape with these products of combustion.

The object of my invention is to produce a gas in which these products of combustion, or the greater part of them, are utilized, and yet which possess substantially all the desirable qualities of a fuel-gas.

To these ends it consists, generally stated, in carrying the products of combustion obtained in raising a mass of carbon to incandescence in one generator through a mass of refractory material, and during their passage introducing liquid or solid hydrocarbons into said products and said refractory material in such quantity as to coat the refractory material, and then passing the gases so obtained through a mass of fixing material previously heated by the products of combustion from another mass of incandescent carbon and finally to the gas-holder, and after this operation is completed passing steam through both bodies of incandescent carbon, carrying the gas from one such body through the coated refractory material and mixing the gases obtained with the gases from the other body of incandescent fuel, and then passing the mixed gases through the fixing material and into the gas-holder, where they intermingle with those obtained from the first step of the process. The resultant gases contain a large portion of hydrogen, light hydrocarbons—such as marsh-gas and olefiant gas—carbonic oxide, together with a moderately small portion of nitrogen, the combustible gases—namely, hydrogen, hydrocarbons, and carbonic oxide—being, however, very largely in excess, and on account of the presence of a large portion of hydrocarbons the resultant gas having a low burning-point and possessing all the necessary qualities of a good fuel-gas.

My invention also consists in certain steps or sub-processes relating to the process above described, as will be hereinafter more fully and specifically set forth.

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 longitudinal section on the line *x x*, Fig. 2; and Fig. 2 is a top or plan view of an apparatus suitable for practicing my invention.

Like letters of reference indicate like parts in each.

My improved gas-making process can be carried on in any apparatus suitable for the

purpose, the apparatus illustrated in the accompanying drawings, which is fully described in an application for patent filed by me on the 23d day of January, 1888, Serial No. 261,693, being well adapted for the purpose, and I will describe my invention in connection therewith.

This apparatus, illustrated in the drawings, consists, generally stated, in a generator-chamber, a double limestone-chamber or hydrocarbon-generator containing a mass of limestone or other refractory material, the two compartments of which are connected to said generator-chamber and with each other, and a combined generating and fixing chamber connected to each compartment of the limestone-chamber. The generator-chamber *a* is provided with a charging port or ports, *b*, in the top or roof thereof, for the charging of the coal or other carbonaceous fuel therein, grate-bars *c* near the base thereof for the support of said carbon, discharging outlets or doors *d*, both above and below said grate-bars for the withdrawal of the ashes, and a series of air-inlet pipes, *e*, both above and below the grate-bars for the entrance of the air-blast employed in raising the fuel in this chamber to incandescence, these air-inlets being supplied by a suitable air-main, *f*, leading from the blower or fan. The generator-chamber *a* is also provided with one or more steam-inlet pipes or nozzles, *g*, preferably on opposite sides for the admission of steam into the chamber to make water-gas when the fuel has become incandescent. Contiguous to this generator-chamber, and preferably in front of the same, is placed the double chamber H, having two compartments, *h h'*, placed side by side, and each of said compartments is provided with a gas-inlet, *i*, preferably on the top thereof, with charging-ports *i'*, also on the top, for the charging into the compartment of the limestone or other refractory material, grate-bars i^2 near the base for the support of said material, and discharging-doors i^3 on the side for the discharge of the same. These compartments *h h'* are also each provided with steam-inlets *k*, preferably near the top and above the grate-bars, for the admission of steam therein at the proper time, these inlets being preferably in the form of an injector, which has a connection through a pipe, *t*, with a tank (not shown) containing liquid hydrocarbon.

The gas-inlet *i* of each compartment is connected to a suitable cross-pipe, *l*, which is itself connected by a pipe, *l'*, with a gas-outlet, l^2, in the upper part of the generator-chamber *a*, those connecting between the generator-chamber and the limestone-chamber being provided with suitable valves, l^3, so that the products of combustion and gases coming from the generator-chamber *a* may be carried into either compartment *h* or *h'*. The compartments *h h'* are connected together at their lower part, preferably below the grate-bars, by a fuel-passage, h^2, to permit the flow of combustible fluids from one to the other, as hereinafter set forth, the compartments being also provided with suitable outlets, *m*, controlled by suitable valves, *m'*, for the escape of the gases therefrom. By this arrangement of the compartments of the limestone-chamber the products of combustion and gases formed in the generator can be compelled to pass down through one compartment and thence up through the other compartment, heating the material therein, and finally passing out through the outlet *m* of that compartment to the combined generating and fixing chamber *n*, and the course of the products of combustion and gases formed in the generator *a* can be reversed, passing in the opposite direction through said compartments, so that about all the heat is absorbed from the products of combustion while they are passing through the two compartments of the limestone-chamber, on account of the large amount of surface exposed to them, while at the same time the mass of limestone or refractory material contained in these chambers can be maintained at a substantially even heat, which is very desirable, as hereinafter more fully set forth.

The third chamber *n* in the apparatus is placed in front of the double chamber H and contiguous thereto, this chamber being employed for the purposes of assisting the draft through the refractory material in the double chamber, utilizing the waste products and hydrocarbon vapors discharged from said chamber in heating the refractory material employed in fixing the gas formed, generating a further proportion of hydrogen and carbonic oxide, and fixing all the gases obtained. The chamber *n* is provided with the charging-port *n'* in the roof for charging of the fixing materials therein, a perforated arch, *n*, for the support of the fixing material, and gas-outlets n^3 n^4, the one for the escape of the products of combustion and the other to carry the gases formed to the holder. It is also provided with grate-bars *o* near the base for the support of the mass or bed of coal or other carbonaceous fuel, for the purposes hereinafter described, the chamber having, for the purpose of withdrawing the charge of fixing material, an outlet or door, n^5, above the arch n^2, and similar outlets, *o' o²*, above and below the grate-bars, for the charge of fuel on said grate-bars and the withdrawal of ashes from the chamber.

The space above the bed of fuel on the grate-bars and below the arch n^2 forms a mixing-chamber, *p*, in which the gases coming from the limestone-chambers and those generated from the bed of fuel on the grate-bars *o* are intermingled. Leading from each compartment *h h'* of the double chamber H are the pipes m^2, which communicate with the mixing-chamber *p* above the grate-bars *o*, so carrying any waste products or gases from the said compartments *h h'* into the chamber *n* above the bed of fuel. To supply the necessary air to mix with the products of com-

bustion and hydrocarbon vapors as they come over from the limestone-chamber, to insure the combustion of the same, one or more inlets, q, are arranged in the chambers p above the grate-bars o and below the arch n^2, and one or more air-inlets, q', are arranged below the grate-bars to supply air for the burning of the fire on said bars, both inlets being connected with blast-pipe f. Suitable steam-supply pipes or inlets, r r', are also connected with chamber n above and below the grate-bars.

The gas-generator a is filled with coke, coal, or other carbonaceous material. The double chamber H is filled with limestone, dolomite, or other suitable refractory material, this refractory material being preferably coated with a heavy hydrocarbon—such as asphaltum or coal-tar—and the two compartments of the chamber being filled with this mass of broken refractory material so coated forming a chamber impregnated with a heavy hydrocarbon. The pipe t communicates with a tank containing a liquid hydrocarbon—such as crude petroleum—which is introduced in the said chamber through the injector k, as hereinafter described, the said hydrocarbon being preferably sprayed into the refractory material both at the top of each chamber and at or near the bottom of the same.

In the chamber n, supported on the grate-bars o, is a mass of coal or coke or other suitable carbonaceous fuel, forming a bed which fills the lower part of the chamber p, leaving a combustion and mixing chamber above said bed and below the perforated arch n^2, and supported by said arch is a mass of fixing material—such as limestone or dolomite, or in some cases lime may be employed for this purpose. When limestone or dolomite is employed in said chamber, it may be desirable to employ intermingled with or in alternate layers with the same a hard gas-carbon, such as the gas-carbon obtained from gas-retorts in the gas-making process—or other carbon which will not readily disintegrate, to provide a body of carbonaceous material within the fixing material from which any carbonic acid passing through the same may take up a further part of carbon, as described in the application filed by me of even date herewith, Serial No. 264,982.

In carrying out my improved process of making fuel-gas, air is first admitted through a pipe, q', below the grate-bars o in the chamber n, and the bed of fuel on said grate-bars is ignited and the products of combustion therefrom pass upwardly into the combustion-chamber p, where a further portion of air is added to the same, so that the products of combustion burn and pass up through the fixing material in the upper part of the chamber n, raising the same to the desired heat, the waste products being permitted to escape through the purge-valve n^3. This is continued until the said bed of fuel is raised to a sufficient heat to heat and ignite the cold gases or products of combustion passing over the same, when the air-blast is turned into the chamber a, and, passing through the ignited fuel therein, the products of combustion from said chamber are carried through the mass of refractory material in the hydrocarbon-generator H and into the combustion-chamber p of the generating and fixing chamber n. These products are heated in this chamber p and consumed therein until the hydrocarbon-generator is raised to a sufficient heat to vaporize the liquid hydrocarbon introduced therein, when the supply of air to the bed of fuel on the grate-bars o is cut off, so that combustion within said chamber n ceases. The purge n^3 is then closed and the valve n^4 to the gas-holder opened. As soon as this is done the liquid hydrocarbon is sprayed by steam into the products of combustion as they pass from the first generator a into the hydrocarbon-generator H, this spraying being done preferably in the upper part of said hydrocarbon-generator, where the said products of combustion enter the same, and where a double chamber—such as shown—is employed the liquid hydrocarbon may be sprayed into the mass at different points—such as at the top of the compartment into which the products of combustion enter, at or near the base of said compartment, and within the lower part of the other compartment. As this liquid hydrocarbon enters the products of combustion it is vaporized by the same, forming a large body of light hydrocarbons, while the heavy hydrocarbons so carried are deposited upon the loose refractory material within this generator, so serving to coat or (if the refractory material has been coated before its introduction) to further coat the surface of the same and maintain a proper impregnation of the refractory material within this chamber with heavy hydrocarbon for the subsequent gas-making process, the hydrocarbons being introduced in sufficient quantity to coat and maintain the coating of the body of refractory material. Part of the steam entering with the liquid hydrocarbon will be decomposed in the hydrocarbon-generators, though part of it will pass over with the gases and be decomposed in the fixing-material, as hereinafter described. The products of combustion pass from this chamber or generator H to the generating and fixing chamber n, carrying with them the light hydrocarbon vapors and the gas formed from the steam, together with any steam not yet decomposed, these gases and vapors entering the mixing-chamber p, and rising from said chamber through the mass of heated fixing material supported by the arch n^2, in which the steam is decomposed, passing through the valve n^4 into the gas-holder, the heat of the fixing material uniting the gases and forming a permanent gas thereof. During these steps of the process, as the one body of fuel was nearly heated up and the other body of fuel entirely heated up be-

fore the gas-making process was commenced, the proportion of nitrogen entering the generator is not so large as in the manufacture of the ordinary producer-gas, and in the practical working of the process substantially all of this nitrogen is caused to unite with the hydrogen or hydrocarbons and eliminated from the gas formed. During the time when this producer-gas is being made, if desired, the portion of air fed to the gas-generator *a* may be reduced, and a small portion of steam—not sufficient, however, to effect the temperature of said chamber—be admitted thereto, this steam being decomposed in the lower part of the chamber and providing oxygen for the combustion of the fuel therein, while at the same time a further portion of hydrogen is added to the producer-gas. This admission of steam, however, to the gas-generator *a* does not form any part of my invention. The proportion of liquid hydrocarbon fed to this chamber during this part of the process can, of course, be regulated according to the amount of hydrocarbon gas to be formed with the producer-gas and the amount of heavy hydrocarbon to be deposited upon the loose refractory material contained in the hydrocarbon-generator. In carrying on this process it is preferred that superheated steam be employed, as it will not reduce the temperature of the hydrocarbon-generator so much as steam of the ordinary heat. The manufacture of this producer-gas is continued until the gas-generator *a* is raised to incandescence as proper for the decomposition of the steam, when the supply of air is cut off therefrom, and the supply of liquid hydrocarbon to the hydrocarbon-generator is also cut off. Steam is then admitted to the gas-generator *a*, and in passing up through the body of incandescent fuel therein it is decomposed, the hydrogen and carbonic oxide formed passing over into the hydrocarbon-generator, in the upper end of which a further portion of steam is generally introduced, being decomposed by the highly-heated refractory material in the upper part thereof, and the nascent hydrogen uniting with the heavy hydrocarbon held in suspension by the loose refractory material, and so forming marsh or olefiant gases. The gases passing through this hydrocarbon-generator thus take up a large amount of hydrocarbon contained therein, and form with it these desirable marsh and olefiant gases, and the resultant gases pass over into the mixing-chamber *p* of the generator and fixing chamber *n*. At the same time steam is admitted to the bed of highly-heated carbon on the grate-bars *o* of said chamber *n*, when an additional portion of hydrogen and carbonic oxide is formed, as described by me in an application filed of even date herewith, Serial No. 264,962, and the gases coming from the hydrocarbon-generator H and rising from this highly-heated fuel are mixed in the chamber *p*, and from thence pass up through the fixing material above the arch *n*, in which they are united to form a permanent gas, the gases passing thence into the gas-holder, where they are intermingled with the gases formed by the first part of the process. This part of the process is continued until the heat of the bodies of incandescent fuel is lowered so that they will not decompose the steam when the steam-supply is cut off and air is first admitted to the chamber *n* above and below the grate-bars *o*, the valve n^4 to the gas-holder being closed and the purge-valve n^3 being opened. When the bed of coals and fixing material in said chamber are sufficiently heated to ignite the products of combustion coming from the chamber *a* through the hydrocarbon-generator H, air is admitted to said chamber *a*, and the process is continued, as above set forth.

I have described in the specifications the use of liquid hydrocarbons for introduction into the products of combustion and upon the refractory material, and for general purposes I prefer to employ the hydrocarbons in a liquid form. I include, however, within my invention solid hydrocarbons—such as asphalt—which can be pulverized or broken into small pieces and introduced in this state by suitable means into the hydrocarbon-chambers.

By this gas-making process I am enabled at a low cost to utilize the larger portion of heat units of the fuel for the manufacture of gas, the only portions lost being those employed in the preliminary heating of the apparatus, and these portions being permitted to escape because they would carry a great portion of nitrogen into the gas.

In making gas as above described a very large volume of gas is obtained, and this gas is much richer than the ordinary fuel-gas heretofore obtained, being composed of hydrogen, carbonic oxide, marsh-gas, and some other hydrocarbon gases, together with a small proportion of nitrogen and a little carbonic acid, the hydrogen, carbonic-oxide, and marsh-gas and other hydrocarbon gases forming much the larger proportion of the resultant gases, and the volume of nitrogen being reduced to a low percentage. On account of the large proportion of marsh and hydrocarbon gas contained in the resultant product the point of combustion of the gas is greatly lowered and its heating properties, especially for domestic purposes, increased largely in value, as the marsh-gas gives to the resultant product the power of diffusion through the mass of material to be heated, which is the great point of value found in natural gas for domestic heating purposes.

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

1. The herein-described process of making fuel-gas, consisting in carrying the products of combustion obtained in raising one mass of carbon to incandescence through a mass of refractory material and during their passage introducing a hydrocarbon into said products

and said refractory material, and then passing the gases so obtained through a mass of fixing material previously heated by the products of combustion from another mass of ignited carbon and thence to the gas-holder, and subsequently passing steam through both bodies of incandescent carbon, carrying the gases from one such body through the coated refractory material, mixing them with the gases from the other such body, and passing all the gases through the fixing material and into the gas-holder to mingle with those obtained from the first steps of the process, substantially as and for the purposes set forth.

2. The herein-described process of making fuel-gas, consisting in carrying the products of combustion obtained in raising a mass of carbon to incandescence through a mass of refractory material, and during their passage introducing liquid or solid hydrocarbons into said products and said refractory material in such quantity as to coat such refractory material, and then passing the gases so obtained to the gas-holder, and subsequently passing steam through said body of incandescent carbon and the gases obtained through said coated refractory material, and thence to the gas-holder to mingle with those obtained from the first steps of the process, substantially as and for the purposes set forth.

3. The herein-described improvement in the art of making fuel-gas, consisting in raising a mass of carbon to incandescence, carrying the heated products therefrom through a mass of refractory material, and during their passage introducing liquid or solid hydrocarbons into said products and said refractory material in such quantity as to coat such refractory material, and then passing the gases so obtained through a mass of heated fixing material, substantially as and for the purposes set forth.

4. The herein-described process of making fuel-gas, consisting in raising a mass of carbon to incandescence, and carrying the heated products therefrom through a mass of refractory material and during their passage introducing liquid or solid hydrocarbons into said products and said refractory material in such quantity as to coat such refractory material, substantially as and for the purposes set forth.

5. The herein-described steps in the manufacture of fuel-gas, consisting in carrying the products of combustion from one mass of incandescent carbon through a mass of fixing material to heat the same, then raising another mass of carbon to incandescence and carrying the heated products of combustion from said second mass through a mass of refractory material and during their passage introducing a hydrocarbon into said products and said refractory material, and then passing the gases so obtained through said mass of fixing material previously heated, as aforesaid, and thence to the gas-holder, 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:
RICHARD S. CHILD, Jr.,
ABNER J. DAVIS.