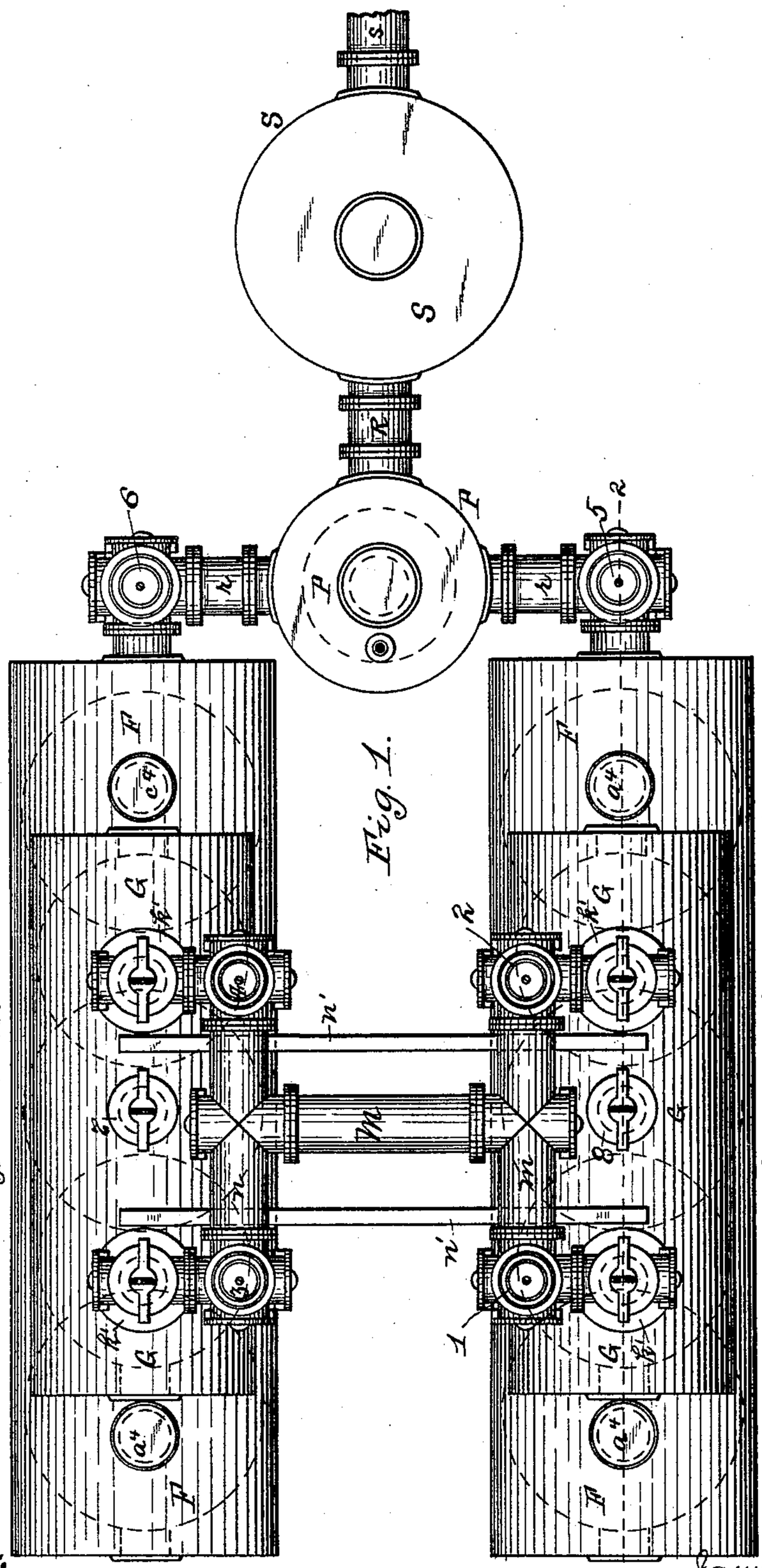
(No Model.) 3 Sheets—Sheet 1.

J. M. ROSE.

PROCESS OF AND APPARATUS FOR MANUFACTURING GAS.

No. 461,394. Patented Oct. 13, 1891.



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(No Model.) 3 Sheets—Sheet 2.

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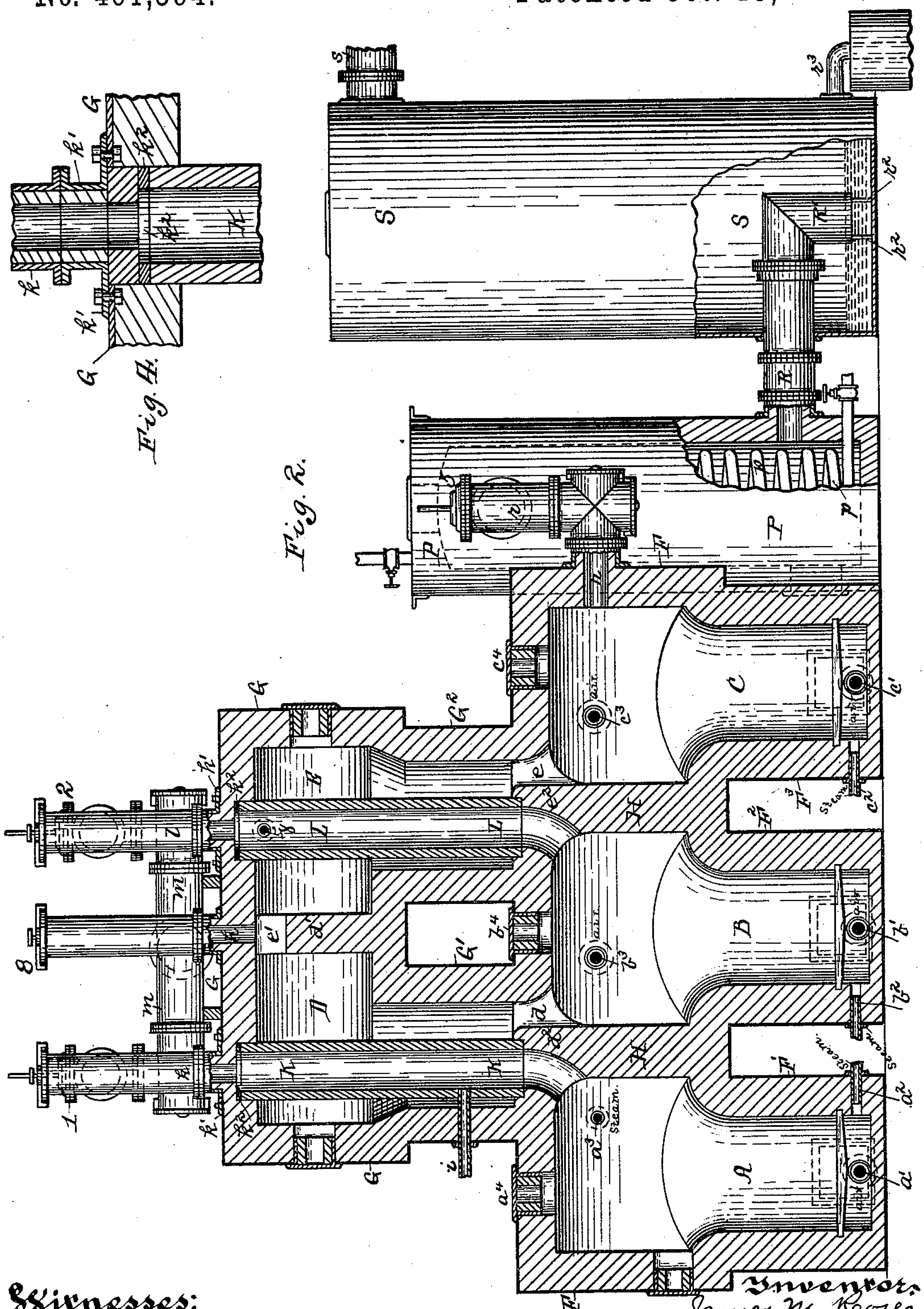

Fig. 4.

Fig. 2.

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(No Model.) 3 Sheets—Sheet 3.

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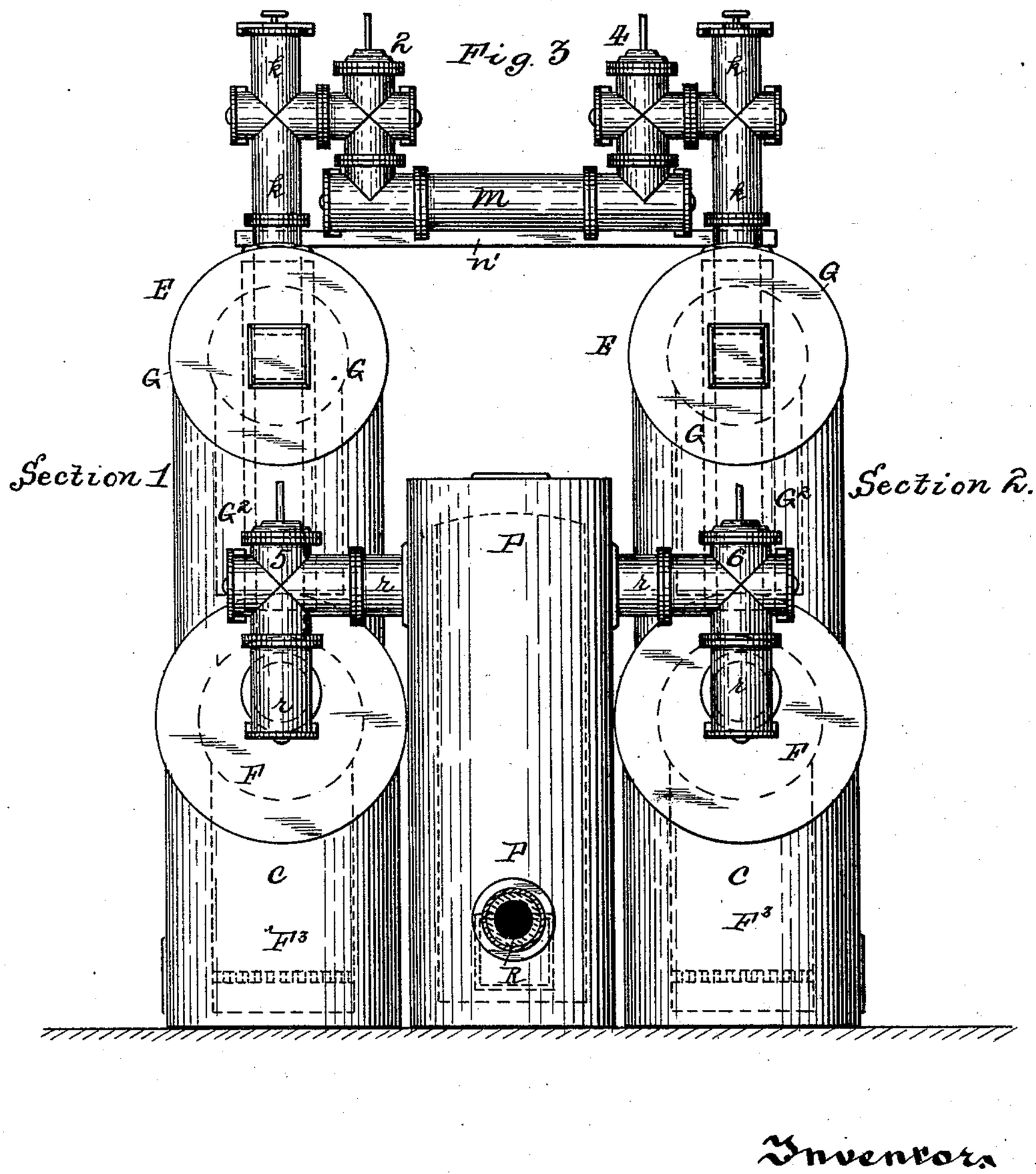

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UNITED STATES PATENT OFFICE.

JAMES M. ROSE, OF ALLEGHENY, PENNSYLVANIA.

PROCESS OF AND APPARATUS FOR MANUFACTURING GAS.

SPECIFICATION forming part of Letters Patent No. 461,394, dated October 13, 1891.

Application filed September 9, 1890. Serial No. 364,450. (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 Process of and Apparatus for 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 gas for fuel or illuminating purposes and to the apparatus to be employed in making the same, being, generally stated, certain improvements on the Rose gas manufacture as set forth in patents heretofore granted to me, (for example, Nos. 415,564 and 415,565, dated November 19, 1889.)

One of the objects of the present invention is to provide for the proper breaking up of the hydrocarbons employed to enrich the gas and the economical utilization of all such hydrocarbons.

Another object of the invention is to provide for the maintaining of the heat of the vertical cylinders, in which the hydrocarbons are broken up, so that the necessity of reversing the apparatus at frequent intervals is overcome.

A further object of the invention is to bring the resultant gases into an atmosphere of hydrogen and carbonic acid after the introduction of the hydrocarbon and so facilitate the union of the nascent hydrogen with the hydrocarbons in the form of marsh and like hydrocarbon gases.

In the practice of my invention the process preferably followed, and which forms part of the subject-matter of this application, consists in passing air through one mass of heated carbon to form generator-gas and introducing a portion of hydrocarbons into such generator-gas, at the same time passing steam through a body of heated carbons to form hydrogen and carbonic oxide or water-gas and introducing a portion of hydrocarbons into the water-gas, commingling the gases, and then introducing a further portion of hydrocarbons into the commingled gases, passing the resultant gases into an atmosphere of nascent hydrogen and carbonic oxide and fixing the gases, it being found that by introducing small or limited quantities of hydrocarbons at intervals into the gases instead of introducing the main bulk of the hydrocarbons at one time the chilling action of the hydrocarbon upon the gases or upon the body of incandescent coal or the gas-making apparatus itself is overcome, while the hydrocarbons are so thoroughly broken up that the heavier portions thereof as well as the lighter portions are utilized to enrich the gas, great economy in the use of the hydrocarbons being obtained in this way, and that by the introduction of the resultant gases just after the breaking up of the hydrocarbons into an atmosphere of nascent hydrogen and carbonic oxide the most favorable conditions for the union of the hydrogen with the hydrocarbons and the formation of marsh, olefiant, and analogous gases are obtained.

In the gas apparatus also embodying my invention I prefer to employ three cupola generators and two vertical chambers extending above the same, two of the cupola generators communicating with the bases of the vertical chambers, which communicate with each other at the top, and two vertical cylinders communicating at the base with two of the generators and each cylinder extending through one of the vertical chambers and communicating with the pipes or passages at the top, it being found that in such construction the necessary facilities are provided for the breaking up of the limited quantities of hydrocarbons in the manner above described, as well as for the introduction of the resultant gases into the atmosphere of hydrogen and carbonic oxide produced in one of the generators, while the apparatus may be maintained at a higher and more even heat by the heated gases which are caused to flow around the cylinders in such way as to maintain the heat thereof.

The particular invention desired to be covered in the present application will be hereinafter described and claimed.

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 plan view of apparatus embodying my invention. Fig. 2 is a longitudinal section on the line 2 2, Fig. 1, the valve mechanism being shown in side view and part of the apparatus being broken away. Fig. 3 is an end view of the appara-

tus, the scrubber being removed; and Fig. 4 is an enlarged detail section showing the connection between the cylinder and case.

Like letters and figures of reference indicate like parts in each.

In the construction of the apparatus I prefer to employ horizontal cylindrical casings, having vertical casings depending therefrom, as described in an application for patent filed by me on the 6th day of January, 1890, Serial No. 336,010, as such construction is believed by me to give the greatest strength in proportion to the cost and to be the most desirable form of the apparatus. I have therefore illustrated the same in the drawings of the present application, though it is to be understood that the apparatus is not limited to that particular form, it being intended to cover the same in any suitable form or construction of chamber.

In said apparatus I prefer to employ two sets or sections of the apparatus, both sections being the same in construction, so that I will only describe one of them in detail. In each section I employ three cupola chambers A B C and above the same the vertical chambers D E. In the drawings these generators and chambers are inclosed within horizontal cylindrical casings having vertical casings or legs depending therefrom, the upper portions of the three generators A B C being inclosed within horizontal cylindrical casing F, from which depend the three casings $F' F^2 F^3$, while the upper parts of the vertical chambers D E are inclosed within the horizontal cylindrical casing G, from which depend the vertical casings $G' G^2$, which rest upon and are secured to the upper part of the horizontal casing F. These casings are formed of heavy iron or steel plate and so inclose the gas-making apparatus and enable the same to sustain even any heavy pressure which may be generated within the same, while they form a durable and properly-braced structure for the inclosing of the several generators and chambers of the gas apparatus. The several casings are suitably lined with fire-brick of proper shape, it being preferred that a filling of asbestus, mineral wool, or of suitable ash or like non-conducting material be well packed in slight spaces or interstices left between the casing and the fire-brick lining so as to prevent the passage of gas into any such space and as far as possible to prevent the radiation of heat, it being also found that this lining of non-conducting material, together with brick-work, forms a solid structure, which is properly supported by the metal casings. The lower casing F, with its depending casings, is also divided into the three cupola generators A B C by the walls H, the cupola generators thus formed having a lower portion which is cylindrical in horizontal section and an enlarged upper portion cylindrical in vertical section, such form being specially desirable, as it carries the body of coal within the upper part of the cupola out over that on the lower part thereof and prevents the passage of any air or steam outwardly along the walls of the generator without passing through the bed of coal contained therein. Each cupola generator is provided with suitable grate-bars and each is provided with an air-blast pipe, such as $a' b' c'$, and with a steam-pipe, such as $a^2 b^2 c^2$, at the base thereof, while in the upper part of said cupola generators are inlets, as at $a^3 b^3 c^3$, the inlet a^3 being generally employed for the admission of steam, while the inlets $b^3 c^3$ are generally employed for the admission of air, though they may be employed for either purpose. The several generators are also provided with suitable feeding-ports, as at $a^4 b^4 c^4$, at which ports I prefer to employ suitable feeding mechanism by which the coal may be fed to the generators, while the escape of gases is prevented.

The vertical chambers D E communicate at their bases by the ports d e in the cross-walls d^2 e^2, with the cupola generators B C. Said vertical chambers are separated by the division-wall d', but having a communicating port or passage e' at the upper end of said wall. Extending through the vertical chamber D is the vertical cylinder K, formed of metal or fire-clay, said cylinder communicating at its base with the cupola generator A and at its upper end with the pipe k, which is controlled by the valve 1, opening through said valve into the side pipe m, extending above the casing G. A like vertical cylinder L communicates at its base with the cupola generator B and extends through the vertical chamber E, communicating at its upper end with the pipe l, which, through the valve 2, communicates with said side pipe m.

In order to introduce the vertical cylinders within the vertical chambers, openings are made in the top of the casing G of sufficient size to permit the introduction of the cylinders, the cylinders being lowered into and resting on cross-walls d^2 e^2 at the bases of the vertical chambers D E, the upper end of the cylinders fitting within the top lining of the casing G, and after the lining around the upper end of and above the cylinders is completed a cap k' is bolted to the casing above said opening, as shown, so securing the cylinders in place and arranging for their easy removal from the apparatus when necessary. The pipe k may be secured to said cap k', which carries a collar to which the pipe k is bolted, (the said cap being shown more particularly in Fig. 4.) A small space is left between the upper end of the cylinder and the top lining of the casing G, in which is packed asbestus, mineral wool, or like elastic non-combustible material, as at k^2, this packing preventing the passage of gases around the joint and at the same time, as it is elastic, permitting the expansion and contraction of the cylinder under the different temperatures to which it is exposed.

As before stated, the two vertical chambers,

or, as they may be termed for convenience, "cylinder-chambers," D E communicate through the port or passage *e'*; and to provide for the escape of waste products from said chambers in heating up the same I provide the escape-flue *h*, leading from said passage, the said flue being covered by a removable cap, (said cap being marked 8 in section 1 and marked 7 in section 2,) so that the flue may be opened or closed as found desirable, this cap being preferably arranged in the form of a weighted valve, so that the escape-flue may be opened and closed as desired. The cylinder-chambers D E may be filled with checker-work, loose refractory material, or with deflecting walls, so as to store the heat therein and hold the heat around the cylinders passing through the chamber.

Communicating with the cylinder K is the inlet for hydrocarbons, as at *i*, this inlet preferably communicating with said cylinder rather near the base thereof, so that the hydrocarbons introduced shall be vaporized and carried up by the gases passing up through said cylinder, the hydrocarbons being preferably sprayed through said inlet by a steam-jet. In the same manner at the upper end of the cylinder L is a like inlet *j* for hydrocarbons, this inlet being formed at the upper end of the cylinder, as the gases descend through the same, as hereinafter described, and the hydrocarbons introduced therefore traveling the entire length of the heated cylinder. The upper end of the pipes *k l* are closed by suitable caps, which may, if desired, be formed as relief-valves, or may be clamped down, being only opened when it is desired to clean out the pipes.

As above stated, I employ two sets of the apparatus such as above described, and in the description of the same will refer to the one set of the apparatus as "section 1," and to the other set of the apparatus as "section 2," the construction of each section being identical, so that a detailed description of the second section is not deemed necessary. The cylinders of section 2 are controlled by valves which for convenience of description are marked 3 4, these valves controlling the communications with the side pipe *n*, and the two side pipes *m* and *n* communicate with each other by a cross-pipe M, as in the operation of the apparatus it is desirable to operate the two sections together. The pipe connections above described—that is, the side pipes and the connecting pipe M—are properly supported by the bars *n'*, extending between the two sections and resting on the top casings G thereof, and the side pipes resting on said bars.

For the purpose of superheating the steam employed in the manufacture of gas I preferably employ a superheater P, which is located at one end of the apparatus and between the two sections thereof. The superheater is formed of a suitable casing properly lined with fire-brick and contains a suitable coil or system of return-pipes, as at *p*, into which the steam passes and from which it is carried to the several steam-inlets of the gas-making apparatus. The eduction-pipes leading from the gas-making apparatus communicate with one end of the superheater, these pipes leading from the cupola generators C of each section, the eduction-pipes being marked *r* and being controlled, respectively, by the stop-valves 5 and 6. In the drawings the eduction-pipes *r* are shown as leading from the upper portion of the cupola generators, this being found desirable in the manufacture of some classes of gas, such as illuminating-gas, where it is not desired to carry the gas formed through a body of incandescent carbon. Where, however, it is desired to carry the resultant gas through such a body of incandescent carbon, such as to further fix the gases or to convert any carbonic acid into carbonic oxide, the eduction-pipe may lead from the lower part of the cupola generator C, this only requiring a longer eduction-pipe than that shown. In the drawings the eduction-pipes communicate with the upper end of the steam-superheater P, and the gas-outlet pipe R leads from the lower end of the steam-superheater into the scrubber S, the heated gases being thus carried through the superheater and around the steam-coil, being in this way utilized for the superheating of the steam, while their temperature is considerably lowered before they pass into the scrubber. The outlet-pipe R leads into the base of the scrubber S, and its lower end extends downwardly toward the base thereof, as at R', so as to cause the gases to pass through the water seal at the base thereof, the lower end of the pipe R' being supported on legs r^2 at the proper height at the base of the scrubber and the proper height of water seal being maintained in the scrubber by the feeding of water thereto, the overflow-pipe from the scrubber being shown at r^3. Any suitable form of scrubber may be employed, it not being considered necessary to illustrate the internal construction of the scrubber. The outlet-pipe *s* leads from the upper end of the scrubber to the storage-tank.

I have but briefly described the superheater P and the scrubber S, as neither form any part of the subject-matter of the present application.

In the manufacture of gas according to my improved process and in the apparatus above described fire is started within and coal is fed to the several cupola generators of the two sections of the gas apparatus, an air-blast being continued through the same, so as to heat up the apparatus. The relief-valves 7 and 8, controlling the escape-outlets *h*, are opened and generator-gas formed in the generators B and C, air being fed to the same through the inlets b^3 c^3, and the gases burning within the cylinder-chambers D E and escaping through the outlet-passages *h*. The generator-gas formed in the cupola generators A of each section pass upwardly through the cylinders

K, so acting to heat the same, and they thence pass over through the side pipes *m* or *n* and down through the cylinders L into the upper part of the cupola generators B, commingling with the generator-gas formed therein and burning within the cylinder-chamber D to assist in heating the same and heating the cylinders K. This is continued until the cupola generators are properly filled and the apparatus is brought to the proper heat ready for gas-making, when the relief-valve 8, controlling the flue *h* of section 1, is closed, the relief-valve 7, controlling the flue *h* of section 2, being left open and the air-blast being continued to the cupola generators B C of section 2, so as to maintain the heat in said section. The valve 4, controlling the cylinder L of section 2, and the valve 6, controlling the eduction-pipe *r* of section 2, are then closed, the valves 1, 2, 3, and the valve 5, controlling the eduction-pipe *r* of section 1, being opened. The air-blasts to the cupola generator A of section 2 and the cupola generators B C of section 1 are cut off, steam being fed to said several cupola generators.

In making gas the air-blast is continued to the cupola generator A of section 1, so forming generator-gas in said cupola generator, which passes upwardly through the cylinder K above the same, and at the same time any suitable hydrocarbon—such as oil, coal-tar, or asphalt—is fed through the pipe *i* to said cylinder, only a small proportion of hydrocarbon being fed to said cylinder, the amount fed being about one-third of that required in forming the resultant gas, and such small quantity being such as can be easily and quickly broken up within the cylinder, so that all the hydrocarbon so introduced is utilized in gas-making, and the quantity fed is not sufficient to have any great effect in cooling down either the gases or the body of carbon or the highly-heated cylinder. The generator-gas and the hydrocarbons introduced into the same then pass upwardly through the pipe *k* and through the valve 1 into the pipe *m*, and thence through the valve 2 into the pipe *l*, and thence into the vertical cylinder L. At the same time steam is introduced into the cupola generator A of section 2, forming hydrogen or carbonic oxide, or "water-gas," as it may be termed, and at the same time superheated steam may be fed through the inlet a^3 of said generator, if desired. As this gas passes up through the cylinder K above the generator like hydrocarbons are sprayed in like small quantities into the gases, and the gases and hydrocarbons pass upwardly through the valve 3 into the pipe *n*, thence through the cross-pipe M into the pipe *m*, and thence through the valve 2 through the pipe *l* into the vertical cylinder L, so commingling with the gases formed in generator A of section 1. As these commingled gases enter the cylinder L a like small quantity of hydrocarbons is sprayed into the upper end of said cylinder and is broken up by the heat thereof and the heat of the gases, passing down with said commingled gases into the upper portion of the cupola generator B of section 1 and entering into an atmosphere of hydrogen and carbonic oxide formed within the cupola generator B of section 1 by the passage of steam through the heated carbon therein. It is thus seen that the gases obtained from the hydrocarbons are brought immediately into contact with the nascent hydrogen or the water-gas formed in said cupola generator B in a highly-heated condition and in the proper condition for the union of said hydrogen with the hydrocarbons to form marsh, olefiant gas, and analogous hydrocarbon gases, this union causing the formation of a large volume of such gases. The resultant gas then passes upwardly into the vertical chamber D and through the passage *e'* into the vertical chamber E, and thence through the port *e* into the upper portion of the cupola generator C, where they again enter a like atmosphere of hydrogen and carbonic-oxide or water gas which is being formed by the passage of steam through the incandescent carbon in said cupola generator, and they pass thence through the pipe *r* into the superheater. In this course the gases are caused to pass through the highly-heated checker-work or like heat-retaining medium in the cylinder-chambers D E and are fixed thereby, and at the same time, as the gases are in a highly-heated state while being so fixed, they act also to maintain the heat around the cylinder K L in said chambers, so that the necessity of reversing the apparatus on account of the cooling of said cylinders, except at long intervals, is overcome. It will be noticed that in this operation generator-gas is carried upwardly through the cylinder K of section 1, said gas not being liable to quickly chill said cylinder, while at the same time water-gas is being carried upwardly through the cylinder K of section 2, and the heat in said cylinder is being maintained by the combustion of the generator-gases formed in cupola generator B of section 2, so that the formation of water-gas in cupola generator A of section 2 can be maintained for a comparatively long period.

Where the gas is desired for illuminating purposes, it is not carried through any body of highly-heated carbon, and therefore the resultant gas contains a very large portion of hydrocarbon gases—either marsh-gas or olefiant gas—which is very desirable for illuminating purposes. Where, however, any large body of carbonic acid has been formed in the making of the gas, such as by an excess of steam fed to the gases for the purpose of obtaining the free hydrogen therefrom, the gases may be passed downwardly through the incandescent carbon in the cupola generator C of section 1 and withdrawn through an eduction-pipe at the base thereof, so as to convert the carbonic acid so formed into carbonic oxide and to further fix the gases, and in such case

steam may be admitted through the inlet c^3 in the upper part of said cupola generator C.

When it is found necessary to reverse the apparatus on account of the cooling down of generator A of section 2 and of the generators B C and cylinders K L of section 1, the apparatus is reversed in the ordinary way, the air-blast to generators A of section 1 and generators B C of section 2 being cut off, the valve 4 being opened and the valve 2 being closed, the eduction-valve 5 being closed and the eduction-valve 6 being opened, the relief-valve 7 of section 2 being closed and the relief-valve 8 of section 1 being opened. Steam is then fed to cupola generator A of section 1 and cupola generators B C of section 2, which have been highly heated by the air-blast, and air is fed to cupola generator A of section 2, while the small portions of hydrocarbons are sprayed to both cylinders K and to cylinder L of section 2, the operation being the same as above described. At the same time a small air-blast is fed to the cupola generators B C of section 1 and burned within the chambers D E of section 1 to heat up the same, ready for the next reversal of the apparatus.

During the entire gas-making operation the resultant gases are passed continuously through the superheater P, so as to superheat all the steam required.

One of the principal advantages obtained by my invention is the perfect breaking up of the hydrocarbons on account of the number of points at which the hydrocarbons are injected and the small quantity of hydrocarbons injected at each point, as in this way all the hydrocarbons injected can be broken up into the desired gases and properly intermingled with the generator-gas and water-gas formed, and the rapid chilling or cooling down of the apparatus or of the bodies of heated carbon from the hydrocarbon introduced is prevented and the same result obtained by the use of about one-half the quantity of hydrocarbons, it being found that where large quantities of hydrocarbons are introduced at any one point they act to chill down the apparatus much more rapidly even than steam or water, and that when the apparatus is chilled only the lighter portions of the hydrocarbons are broken up, the heavy portions thereof coating the apparatus and not being utilized for gas-making.

Another advantage is found in the passage of the hydrocarbon gases into an atmosphere containing nascent hydrogen, as above described, this leading to the formation of larger portions of hydrocarbon gases, such as marsh-gas or olefiant gas.

Another advantage is found in the maintaining of the heat from the cylinders in which the hydrocarbons are being broken up by the passage of the heated gases around said cylinders through the chambers D and E, it being found that said chambers can be maintained at a high heat for a much longer period by carrying the gases in such course.

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

1. The herein-described process of making gas, consisting in forming generator gas and introducing hydrocarbons into the same, forming water-gas and introducing hydrocarbons into the same, commingling the gases and introducing hydrocarbons to the commingled gases, then passing the resultant gases into an atmosphere of hydrogen and carbonic-oxide or water gas and fixing the gases, substantially as and for the purposes set forth.

2. The herein-described process of making gas, consisting in forming generator-gas and introducing hydrocarbons into the same, forming water-gas and introducing hydrocarbons into the same, commingling the gases, and introducing hydrocarbons into the commingled gases, substantially as and for the purposes set forth.

3. The herein-described process of making gas, consisting in forming generator-gas and introducing hydrocarbons into the same, forming water-gas and introducing hydrocarbons into the same, and commingling the resultant gases, substantially as and for the purposes set forth.

4. The herein-described process of forming gas, consisting in carrying commingled generator-gas, water-gas, and hydrocarbon gas into an atmosphere of nascent hydrogen and carbonic-oxide or water gas, substantially as and for the purposes set forth.

5. The herein-described process of forming gas, consisting in carrying commingled generator-gas, water-gas, and hydrocarbon gas into an atmosphere of nascent hydrogen and carbonic-oxide or water gas, and then fixing the resultant gases, substantially as and for the purposes set forth.

6. A gas-making apparatus having the cupola generators provided with air and steam inlets and having two vertical chambers extending above the generators, said chambers communicating at the base with two of the generators and at the top with each other and each chamber having therein a vertical cylinder, the two cylinders communicating at the top with each other and each cylinder communicating at the base with one of said generators, substantially as and for the purposes set forth.

7. A gas-making apparatus having two cupola generators provided with air and steam inlets and having two vertical chambers extending above the same, said chambers communicating at the top with each other and one of said chambers communicating at the base with one of said generators, each chamber having therein a vertical cylinder, the two vertical cylinders communicating with each other at the top and each vertical cylinder communicating at its base with one of said cupola generators, and one of said chambers being provided with a gas-outlet, substantially as and for the purposes set forth.

8. A gas-making apparatus having a cupola

generator provided with air and steam inlets and having two vertical chambers above the same, said chambers communicating at the top with each other, and one of said chambers communicating at the base with the generator and the other chamber having therein a vertical cylinder communicating at the base with the generator, substantially as and for the purposes set forth.

9. A gas-making apparatus having two sections, each provided with two cupola generators having air and steam inlets and with two vertical chambers above the same, one of said chambers communicating at the base with one of said generators, each chamber having therein a vertical cylinder, and the two vertical cylinders communicating with each other at the top by side pipes, and each cylinder communicating at its base with one of said cupola-generators, the second chamber being provided with a gas-outlet, and said apparatus having a pipe connecting said side pipes so as to connect said sections, 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:
WILBUR F. REEDER,
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