(No Model.) 2 Sheets—Sheet 1.

C. D. HAUK.

MANUFACTURE OF ILLUMINATING GAS.

No. 560,990. Patented May 26, 1896.

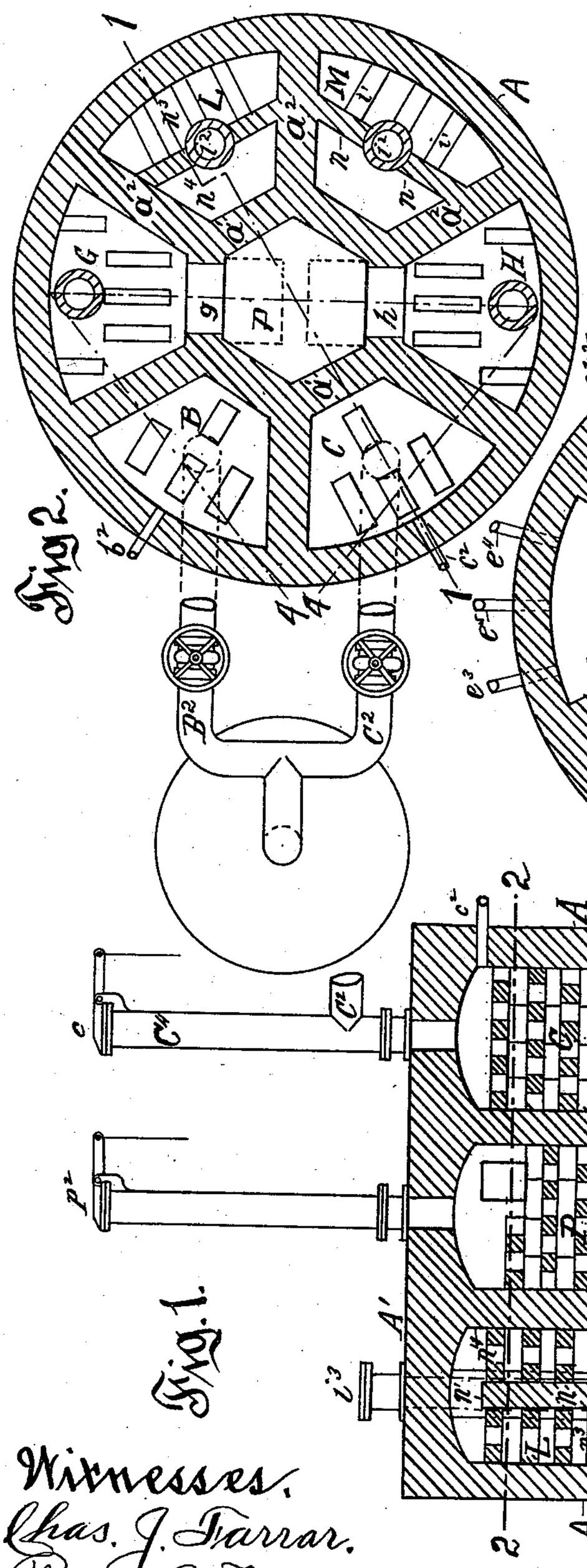

Fig. 2.

Fig. 1.

Witnesses.
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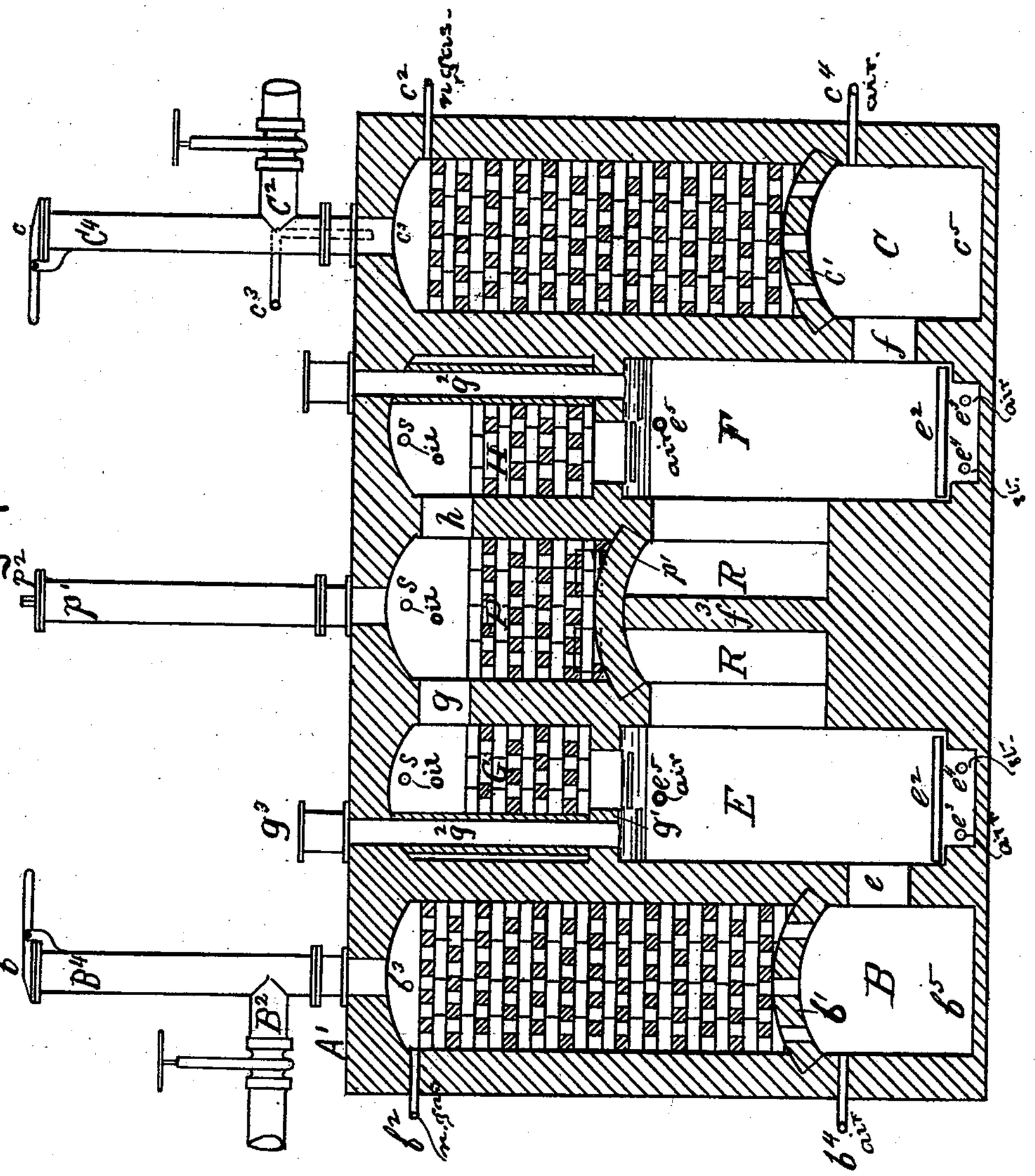
Fig. 4.



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UNITED STATES PATENT OFFICE.

CHARLES D. HAUK, OF CHICAGO, ILLINOIS.

MANUFACTURE OF ILLUMINATING-GAS.

SPECIFICATION forming part of Letters Patent No. 560,990, dated May 26, 1896.

Application filed April 8, 1895. Serial No. 545,017. (No model.)

To all whom it may concern:

Be it known that I, CHARLES D. HAUK, a resident of Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in the Manufacture of Illuminating-Gas; and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to the manufacture of illuminating-gas, and has special reference to the employment of natural gas as a basis for the illuminating-gas. Natural gas wherever obtained has been found to be composed very largely of marsh-gas, (containing eighty-five per cent. or more of this marsh-gas,) and while having high heating powers burns as an illuminant with a blue flickering flame, having but low illuminating powers. The reason for this is believed to be that there is not present sufficient free hydrogen to give toughness thereto and maintain the steady flame or sufficient carbon held in suspension to give sufficient illuminating power by its incandescence.

The object of the present invention is to provide a process for treating the natural gas and combining it with other gases in such way as to form a fixed illuminating-gas of high candle-power. The process might be briefly described as first heating and expanding the natural gas, and then passing it through a mass of heated carbon, from which it takes up the carbon particles; generating gas from coal in separate generators and intermingling the natural gas therewith after it has passed through the body of carbon; introducing hydrocarbons into the combined gases and then passing the combined gases and vapors through a second mass of heated carbon to fix them or render them stable, it being found that in this way the natural gas forms a union with the other gases generated, being itself expanded and increased in volume and by taking up the carbons or uniting with the hydrocarbons being so enriched in carbon as to form a high illuminant, while the flame produced is strengthened or "toughened," as it might be termed, and a steady-burning gas obtained.

My invention also comprises certain steps in the manufacture of the gas, as well as certain improvements in the apparatus for the manufacture of the same, all of which 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 longitudinal central section on the line 1 1, Fig. 2, of the gas apparatus suitable for practicing my invention. Fig. 2 is a horizontal section on the line 2 2, Fig. 1. Fig. 3 is a section on the line 3 3, Fig. 1; and Fig. 4 is a vertical section on the line 4 4, Fig. 2, the several chambers being spread out to illustrate more clearly the course of the gases.

Like letters of reference indicate like parts in each view.

In practicing the invention I employ at least three coal-chambers, one acting as a gas-generator and being raised to a high heat, while the other two are employed for the treatment of the gas at different stages, and I first expand the natural gas by suitable means and carry it through one body of coal at red heat, and then intermingle with it the gas generated from coal, preferring to introduce both water-gas and coal or distilled gas obtained in the same generator by passing steam through the incandescent coal, and also at intervals dropping small regulated quantities of bituminous coal onto the incandescent mass, and so distilling off the hydrocarbons therefrom. The gases are brought together under conditions which lead to a chemical change thereof, changing the character of the natural gas, increasing its volume and toughness. Into these combined gases I then introduce a liquid hydrocarbon, such as oil, and carry the combined gases and vapors through another body of coal sufficiently heated to fix the gases, producing a gas having the natural gas for its basis, but in which it has undergone a chemical change in the presence of the other gases and vapors, and a steady tough high illuminant is obtained. For this purpose any suitable apparatus may be employed; but that illustrated in the drawings has certain advantages, and I will now describe it.

The apparatus has the outer plate-metal casing A, having the lining a, and the central hexagonal cylinder a', from the angles of which the radial walls a^2 extend to the lining

a, dividing the portion surrounding the cylinder into six chambers, four of which communicate directly with the central chamber.

The chambers B C used for expanding the natural gas and fixing the resultant gases have arches b' c' some distance above the bases thereof, and the space above the same is filled with a suitable form of checker-work or loose refractory material to be heated. At the upper end of the chambers are the natural-gas inlets b^2 c^2, while leading from said chambers are the gas-outlets b^3 c^3, communicating with the gas-outlet pipes B^2 C^2. These same end chambers have also the relief-ports B^4 C^4, covered by suitable caps b c, which are opened for the purpose of blowing up the apparatus. Below the arches b' c', respectively, are suitable air-inlets b^4 c^4, employed for burning gas within the checker-work of the chambers B C in heating up the apparatus. The coal-chambers E F have above the same the checker-work chambers G H, employed both for heating and for carbureting the gas, while at the sides of the chambers E F are the generator-chambers I K, above which are the superheater-chambers L M, filled with checker-work, for superheating the gases formed in the generators I K. The checker-work chambers G H and L M lead into the central mixing-chamber P, formed within the central wall a'. The chambers B C above described communicate with the carbon-chambers E F some distance above the grate-bars through the horizontal ports e f, and in this way provide for the flow of the gases between these chambers. The ports e f, as shown, communicate with the chambers E F some distance above the grate-bars e^2 at the base thereof, and are provided with brick gratings e' f' to prevent the passage of the coal into the said chambers B C as far as practicable, the gratings being generally formed of vertical piers, as shown in Fig. 4. It will also be noticed that these passages lead from the chambers B C some distance above the bases thereof, the lower portions or pits b^5 c^5 of said chambers forming receptacles for any of the coal or ash which may pass from the coal-chambers. Each coal-chamber E and F is provided below the grate-bars e^2 with the air-inlet pipe e^3 and steam-inlet pipes e^4, it being expected, however, only to use the latter, either to cool the coal in the chambers when raised to too high a heat or in employing the chambers for generating gas in cases where the natural gas gives out. It is also provided with the air-inlet pipe e^5 in the upper part thereof.

The chambers G and H have passages g h into the central chamber P. As the construction of the chambers in each is practically the same, I will letter them the same. Above the coal-chamber is the sectional arch g', which supports the checker-work in the chamber, while permitting the passage of the gases through the chamber, and extending from the top or working floor A′ of the apparatus is a coal-feeding chute g^2, which leads down from the working floor into the coal-chamber through the arch g'. At the top of the coal-chute is a suitable coal-feeder g^3, the special construction of which does not require illustration. It will be noticed that the coal-chute is formed at the outer edge of the checker-work chamber through which it passes. It is so located for the purpose of introducing the coal at the outer portion of the coal-chamber, so that it will extend at a downward incline toward the inner wall of that chamber and so that the gas in passing from the inlet-passage at the base of the chamber will naturally flow upwardly through the same in entering into the checker-work chamber above. In connection with this coal-chamber I have employed a by-passage to insure a free passage of the gas through this coal-chamber in case the bituminous coal which I prefer to employ should arch and cake over in such way as to interfere with the free passage of the gas directly through the same. For that purpose I employ the central portion of the apparatus below the chamber P, building up the central wall a' within the several chambers to about one-half the height of the chambers E and F and then forming above said wall a vertical cross-wall f^3, extending across the top of the central wall a' to the arch p', forming the base of the chamber P, and so forming on each side of the wall f' the by-passage R, having in front thereof a suitable grating r, which, as shown in Fig. 4, is preferably formed of a series of vertical piers. The by-passages R extend up close to the tops of the coal-chambers E F, and where the coal is maintained in the chambers about as indicated by dotted lines, in case it should cake over, as above stated, the gas can pass from the coal-chamber into the by-passage and around the caked surface of the coal therein, and then out of the by-pass and rise into the checker-work chamber above, or can pass in the opposite direction when passing downwardly through the coal-chamber, a free passage of the gases being always assured, and the objections to the use of soft or bituminous coal as a fixing material which has arisen from the caking of the coal and the forming of back pressure in the gas-generator being practically overcome.

The gas-generators I and K are of any suitable construction as may be found desirable for the formation of water-gas, and each chamber has the grate-bars k', the air-inlet k^2, and the steam-inlet k^3 below the grate-bars and the air-inlet k^4 near the upper part of the generator, with suitable doors for access to the chamber. The generators are separated from the superheating-chambers above them by arches i, through which are formed the passages i', permitting the flow of the gas from the generators into the superheaters, while the circular coal-chutes i^2 extend through the superheating-chambers, preferably in the center thereof, as shown, and have above the same the coal-feeders i^3, of

any suitable construction, the only requirement for such coal-feeders being that they shall be sufficiently gas-tight in their operation to permit of the feeding of the coal to the generators during the gas-making operation.

It will be noticed in Fig. 2 that extending across the superheaters from the coal-chute i^2 are the partition-walls n, which lead from the arch toward but not to the top of the superheating-chamber, the top line being shown at n', Fig. 1. The superheaters communicate with the central chamber P by means of passages o o near the bases of the superheating-chambers. The chambers n^3 n^4 on each side of the partition-wall are filled with checker-work, and in this way a circuitous course is provided for the gases or heated products through the superheaters up through the ports i' and upwardly in the outer space n^3, and thence downwardly in the inner space n^4, and thence into the chamber P. As shown in Figs. 1 and 4, the chamber P is filled with suitable gratings or open checker-work extending to or near the top thereof, the chamber having above the same the relief-outlet p', which is closed by a suitable cap p^2. It will be seen that all the gases are caused to intermingle in this chamber, the gases from the chambers G and H passing across the upper part through the passages g h, while the gases from the generators I and K, after passing through the superheaters L and M, enter the base of the mixing-chamber P and rise, so as to intermingle with the gases passing across the same. In the upper part of the mixing-chamber P, above the ports g and h, is the hydrocarbon-entrance s, which leads from any suitable tank or holder and is controlled by a suitable valve. Such hydrocarbon-entrances may, if desired, be formed in the chambers G H.

The gases after leaving the apparatus either pass to a thermal storage tank for generating steam and thence through a water seal to any suitable washing apparatus or in other desired course.

In the making of the illuminating-gas from the natural gas, together with the other manufactured coal-gases and hydrocarbons, I generally proceed as follows: In order to heat up the apparatus, fires are lighted in the coal-chambers E F and I K, the relief-ports B^4 C^4 and p' being opened, and as soon as the bodies of coal in said chambers are sufficiently kindled blast is turned on and the said bodies of coal raised to a high heat, air being admitted at the bases of the four coal-chambers, while the products of combustion from the generators I and K flow up through the superheaters L M to the mixing-chamber P and escape at the relief-port p'. Part of the products of combustion from the coal-chambers E and F will escape in the same course through the chambers G and H and part will pass through the ports e f into the expanding and fixing chambers B C. Air is admitted at proper places—for example, through the ports b^4 c^4 at the bases of the chambers B C, through the ports e^5 at the upper ends of the coal-chambers E F, and through the ports k^2 and k^4 in the generators I and K—so as to burn the gases formed in the coal-chambers for the heating up of the several bodies of checker-work and of the mixing-chamber. In order to bring the whole to the proper temperature, as can be determined through certain suitable peep-holes, the relief-ports can be closed or opened, so as to pass the gases and products of combustion in such course that the gases can be burned to heat the parts desired.

In the gas-making operation it is desirable that the chamber employed for heating and expanding the natural gas shall not be raised to too high a heat and that the coal-chamber through which the gas first passes shall be maintained at about a red heat, while the checker-work chamber into which the natural gas then passes shall be heated sufficiently high to maintain the heat of the gas; that the checker-work chambers employed for carbureting shall be at the usual carbureting heat; that the other body of coal through which the combined gases pass shall be at a full red heat, so as to cause the chemical change between and properly fix the gases, and that the fixing-chamber through which the gases last pass shall be at such heat as to assure the complete fixing of the illuminating-gas if it has not been accomplished in passing through the coal-chamber. It is also desirable that the coal in the generators I and K shall be at a high state of incandescence and that the superheaters L and M shall be as highly heated as practical to superheat the gases formed in said chambers.

The apparatus being brought to the proper condition for gas-making, I preferably proceed in the following way: The natural gas is largely composed of marsh-gas, which is condensed into less than half the natural volume of its constituents. The gas is passed into the chamber B, if that is the course of the gases through the apparatus, and is there heated and expanded, and it then flows into the coal-chamber E, where it passes through the red-hot carbon, preferably through a mass of heated bituminous coal. That coal still further expands the gas and enables it to take up carbon particles therefrom, which are held in suspension in the gas, and it then passes upwardly through the checker-work in the chamber G, being maintained at a high heat thereby, which assists in the subsequent chemical reaction of the gases and union with the hydrocarbons, and it flows across the top of the mixing-chamber P. Meanwhile gas is being formed in the two cupola-generators I and K, steam being admitted at the lower ends of said chambers to form water-gas, and it is preferred that at intervals in the gas-making operation small regulated quantities of bituminous coal shall be dropped from the coal-feeders down through the coal-chutes i^2

directly onto the mass of incandescent fuel in these generators, and the high heat of the fuel in connection with the high heat of the feeding-chutes and the surrounding walls immediately distils off the volatile hydrocarbons from this bituminous coal, so that the gases passing from the cupolas are combined water-gas and coal-gas or distilled gas. The same method is also practiced in the coal-chambers E or F when the natural gas is passing through the same. The gases rise into the superheaters L and M, and are in this way raised to a high heat by being brought into contact with the highly-heated checker-work therein in their upward and downward courses through the superheaters, the gases flowing finally through the ports *o* into the mixing-chamber P and rising through the same and intermingling with the natural gas, which has previously been expanded and passed through the body of coal, as above described. The water-gas, coal-gas, and natural gas are mingled in the upper part of this chamber while held at a high heat, and the highly-heated natural gas carrying the coal particles in suspension, as above described, forms a chemical union with the other gases, the hydrogen of the water-gas and the hydrocarbons of the coal-gas as well as the carbonic oxid while in the nascent state readily uniting with the heated natural gas and imparting to it toughness and stability, and as they combine with it, providing for such union as will permit the marsh-gas, which in its form is condensed into less than one-half the natural volume of its constituents, to expand, the whole forming a combined hydrogen, hydrocarbon, and a carbonic-oxid gas of high quality. In connection with such combination and in order to increase the candle-power of the gases as may be found desirable I spray into these combined gases, by suitable means, any suitable liquid hydrocarbon, such as oil, and this oil being quickly vaporized is commingled with the other gases, the high heat of the coal-gases formed assisting in breaking it up and causing its union with the other gases. The gases together pass down through the carbureting-chamber H and through the mass of heated coal in the coal-chamber F, in which the gases are fixed and any carbonic-acid gas converted into carbonic oxid, while as the gases are brought into intimate contact with the red-hot coal they will take up in suspension further particles of carbon. The gases may then be carried through the fixing-chamber C, which will insure the stability thereof, and escape through the outlet c^3. This final passage through this said chamber C is not always necessary, and where the gases are sufficiently fixed in passing through the coal-chamber they may be passed through said chamber C simply to store heat for the expansion of the natural gas when the course of the gases through the apparatus is reversed. The gas produced is found to be a fine illuminant, burning well in the ordinary burner, being tough, and giving a steady flame, and as a large portion of the gas is formed from the natural gas, which is cheap in cost and which is so expanded as to more than double its volume, an exceedingly cheap gas can be formed. After a single run has been made in this way, in order to reheat the apparatus and bring it to the proper condition for gas-making the supply of natural gas, oil, and steam is cut off and the outlet-pipe C^2, through which the gas escapes, is also closed. The chamber C is in proper condition for the expanding of the natural gas and requires no further heating, while the coal in the chamber F is about the proper temperature for the passage of the natural gas through the same and generally requires no other heating, though a blast of air may be admitted to the same for a short time, if necessary. The relief-port B^4 of the chamber B is opened and the air-blast is admitted to the cupola-generators I and K, so forming generator-gas in those generators, which is first burned to heat the superheaters L M above the same, the highly-heated products passing first through the mixing-chamber P and then down through the checker-work G and then through the body of coal in the chamber E. In passing through this latter chamber some of the waste products are reconverted to carbonic oxid, while serving at the same time to raise that chamber to the desired heat for fixing, and the products pass through the port *e* into the chamber B, and are burned at the base of that chamber, so as to heat the checker-work therein where that chamber is employed as a fixing-chamber; but if it is not to be so employed they are simply permitted to pass through and escape from the same.

The apparatus having been brought to the proper heat, the escape-port B^4 is closed and the gas-outlet port B^2 is opened, so as to permit the flow of gases to the tank. Steam is admitted to the cupola-generators and natural gas to the upper end of the chamber C, and the gas-making operation above described is repeated, the gases, however, passing in the opposite direction to that above described.

In the making of the gas I prefer to employ bituminous coal in the chambers E F and introduce the bituminous coal into the same in small quantities at intervals during the gas-making operation, and the gas in passing through the heated coal in said chambers carries off with it the gases distilled from this coal by the heated mass of coal on which it rests and by the heat of the treating-chambers. As this coal is liable to cake over, so as to prevent the free passage of the gases through the same and to cause back pressure which might lead to accident, the by-passes R above described are employed, and in case of the caking over of the coal the gases can pass off into such by-passes and around the top surface of the coal and back again into the chamber, all fear of back pressure by such caking of the coal being prevented.

This improvement is of importance in any gas-making process where bituminous coal is employed in the fixing-chamber and overcomes one of the most serious objections in the use of that coal for that purpose.

The apparatus above described, while especially applicable to the combining of the natural gas with the other gases in the formation of an illuminant, has the further advantage that in case the supply of natural gas gives out it provides an efficient method of forming gas entirely from coal and oil, in which case the coal-chambers E and F are used, one for the formation of water-gas in the same way as the chambers I and K and the other for the fixing of the gases, and for that purpose the steam-inlets at the bases of the chambers E and F are provided.

As this apparatus is capable of use in forming other gases, in the same way the other forms of apparatus may be employed in forming the illuminant with natural gas as a basis, and as in such forms of apparatus the expanding-chambers B C may not be present the natural gas can be expanded in other ways, such as by carrying the natural-gas pipe from the eduction-pipe, as illustrated to the right of Fig. 4, the natural gas being in this way expanded before it is introduced into the first coal-chamber, the other steps of the process being carried out either in the present apparatus or other apparatus suitable for the purpose. The natural gas may also be expanded by carrying the pipe through the outlet-pipe for the gases formed in the apparatus, as indicated in dotted lines, Fig. 4.

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

1. A process for forming an illuminating-gas consisting in heating and thereby expanding natural gas, then passing it through a body of heated carbon, generating in a separate generator a combined distilled coal and water gas, superheating the same and intermingling it with the heated and expanded natural gas, introducing liquid hydrocarbons into the combined gases and passing the combined gases and vapors through a body of heated carbon, and then passing them through heated refractory fixing material, substantially as set forth.

2. The steps in the process of forming an illuminating-gas, consisting in first heating and thereby expanding natural gas without other gases or vapors and then passing it through a body of heated carbon, and subsequently introducing hydrocarbon into the gas and fixing the same, substantially as set forth.

3. The steps in the process of forming an illuminating-gas consisting in first heating and expanding natural gas without other gases or vapors, then passing it through a body of heated carbon, intermingling therewith gases generated from other coal, and introducing hydrocarbons into the combined gases and fixing the same, substantially as set forth.

4. The steps in the process of forming an illuminating-gas consisting in heating and expanding natural gas without other gases or vapors, passing the same through a body of heated carbon, intermingling gases generated from other coal therewith, introducing liquid hydrocarbons into the combined gases and passing the same through a body of heated carbon, substantially as set forth.

5. The steps in the process of forming an illuminating-gas, consisting in heating and expanding natural gas without other gases or vapors, passing the same through a body of heated carbon, intermingling therewith water-gas generated from a body of coal, introducing liquid hydrocarbons into the combined gases and passing the same through a body of heated carbon, substantially as set forth.

6. The steps in the process of forming an illuminating-gas consisting in passing natural gas without other gases or vapors through a body of heated carbon, then intermingling gases freshly generated from coal with the natural gas, introducing hydrocarbons into the combined gases, and passing the same through a body of heated carbon, substantially as set forth.

7. An apparatus for the manufacture of gas having a central mixing-chamber, coal-chambers on each side thereof and communicating therewith, checker-work chambers communicating with the coal-chambers and with the outlet-pipes, and gas-generators having ports communicating with the central mixing-chamber, substantially as set forth.

8. An apparatus for the manufacture of gas having a central mixing-chamber, coal-chambers on each side thereof and communicating therewith, checker-work chambers communicating with the coal-chambers and with the outlet-pipes, and gas-generators having ports communicating with the central mixing-chamber, said several chambers being arranged in the same casing and around the mixing-chamber, substantially as set forth.

9. An apparatus for the manufacture of gas having coal-chambers and checker-work chambers above the coal-chambers, gas-generators and superheaters containing checker-work above the gas-generators, a mixing-chamber in the central part thereof between the checker-work chambers and with which the several checker-work chambers communicate, and gas-outlets leading from the coal-chambers, substantially as set forth.

10. An apparatus for the manufacture of gas, having a coal-chamber and having at one side of said coal-chamber a by-passage communicating therewith and providing for the passage of the gas around the upper part of the mass of coal, therein, substantially as set forth.

11. An apparatus for the manufacture of

gas having a gas-generator therein, an arch above the same, and a superheater above the arch, a cylindrical coal-feeding chute passing centrally through the superheater, and vertical walls extending from the arch upwardly on each side of the coal-feeding chute toward but not to the top of the superheater, and having passages extending through the arch on one side of such walls and a horizontal passage leading from the superheater near the base thereof on the other side of said walls, substantially as set forth.

12. An apparatus for the manufacture of gas having a casing containing two coal-chambers with checker-work chambers above the same, and two generators with superheaters above the same containing checker-work, and a mixing-chamber centrally between said checker-work chambers in the upper part of the casing, and with which the checker-work chambers communicate, and a relief-outlet above said mixing-chamber, substantially as set forth.

In testimony whereof I, the said CHARLES D. HAUK, have hereunto set my hand.

CHARLES D. HAUK.

Witnesses:
JAMES I. KAY,
ROBERT C. TOTTEN.