(No Model.) 7 Sheets—Sheet 1.

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R. S. COLLINS, Administratrix, & W. J. COLLINS, Administrator, of J. H. COLLINS, JR., Deceased.

PROCESS OF MANUFACTURING GAS.

No. 463,139. Patented Nov. 17, 1891.

Fig. 1.

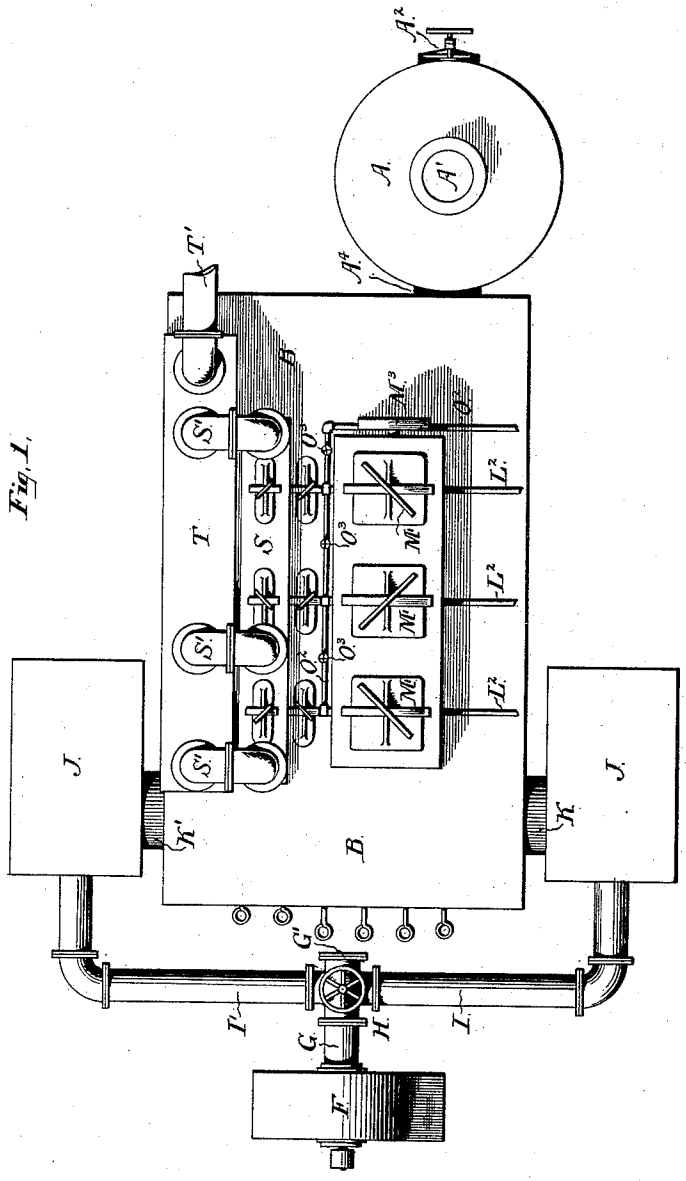

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Fig. 2.

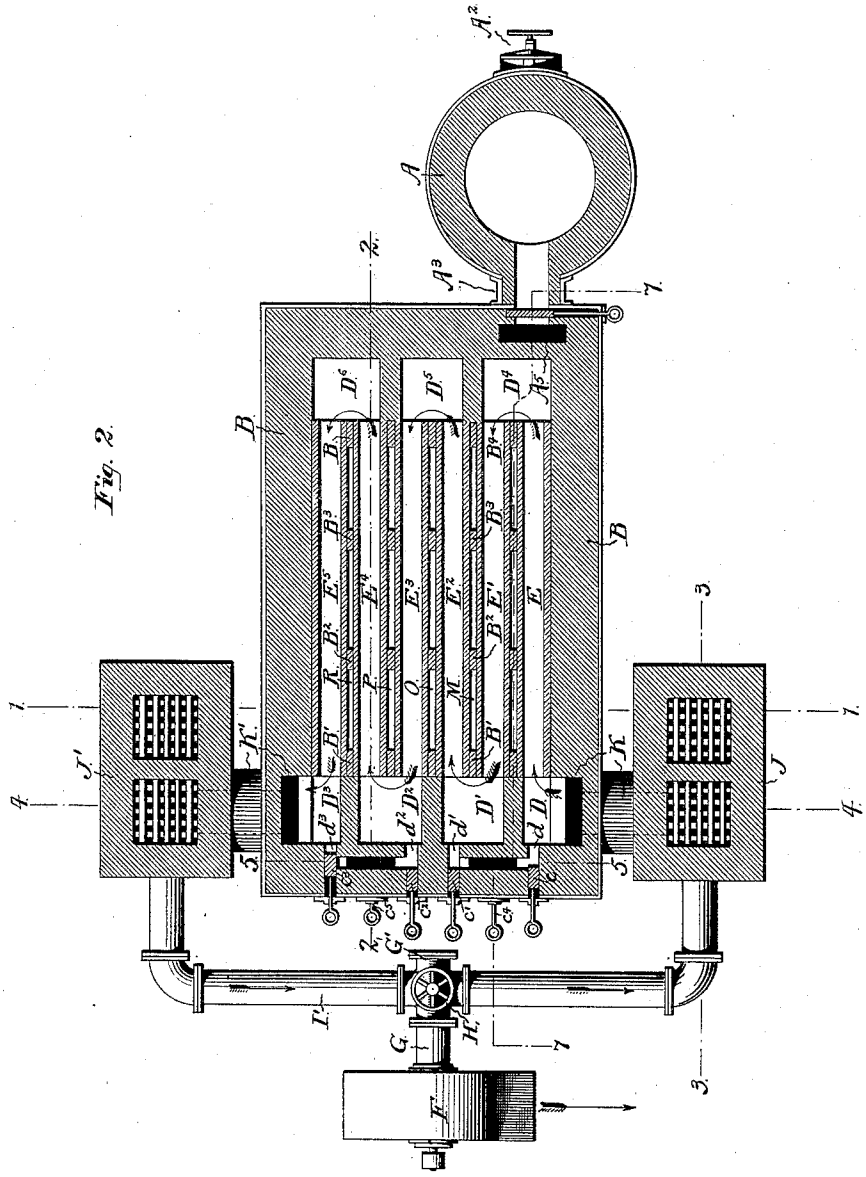
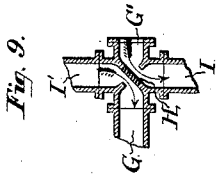


Fig. 9.



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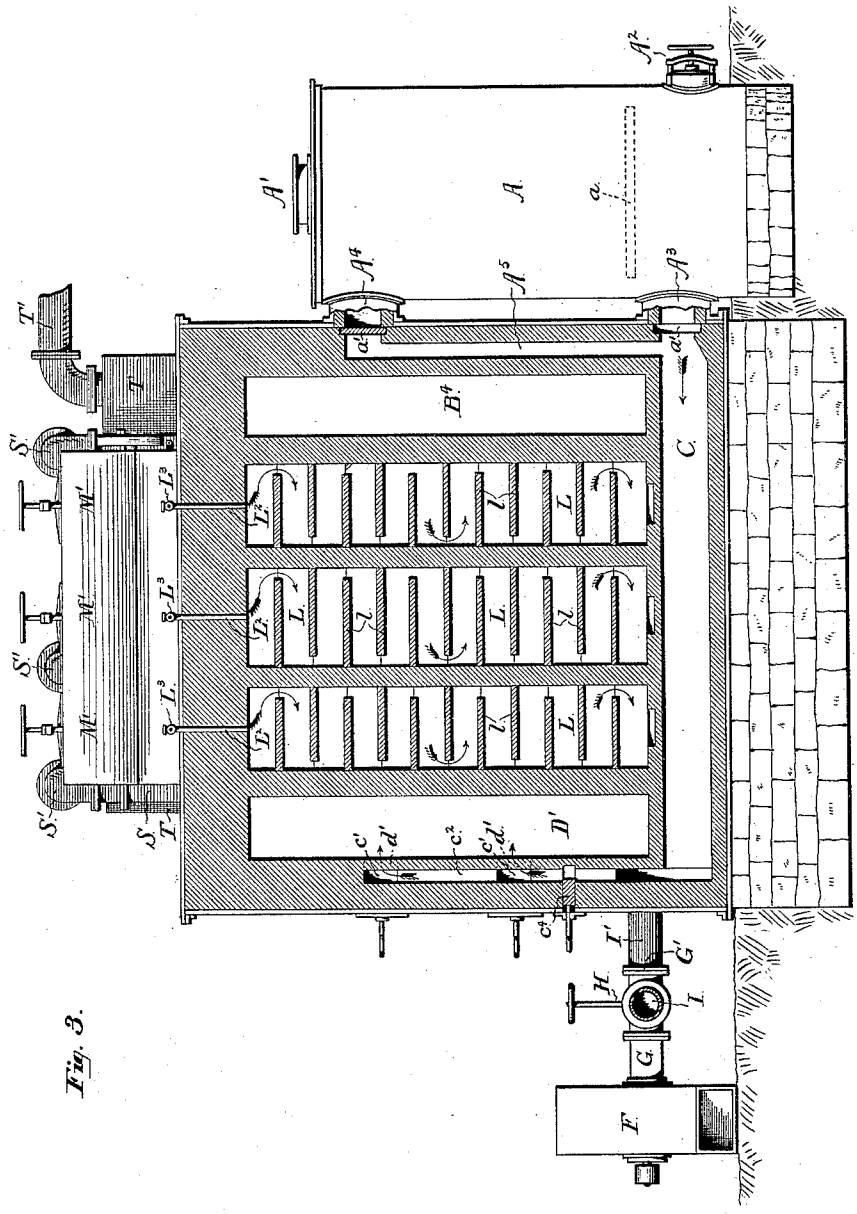

Fig. 3.

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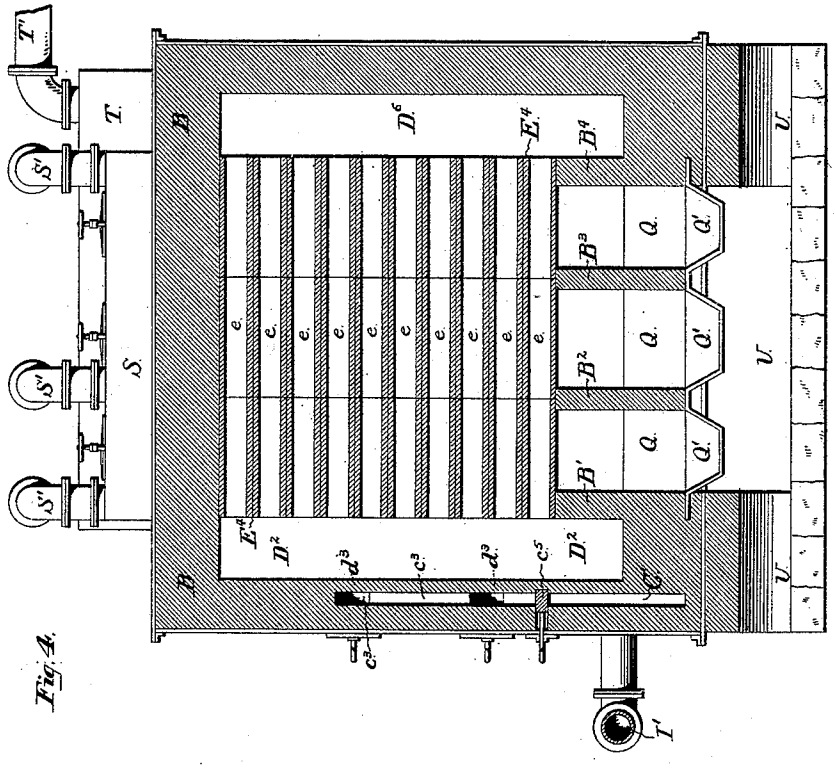

Fig. 4.

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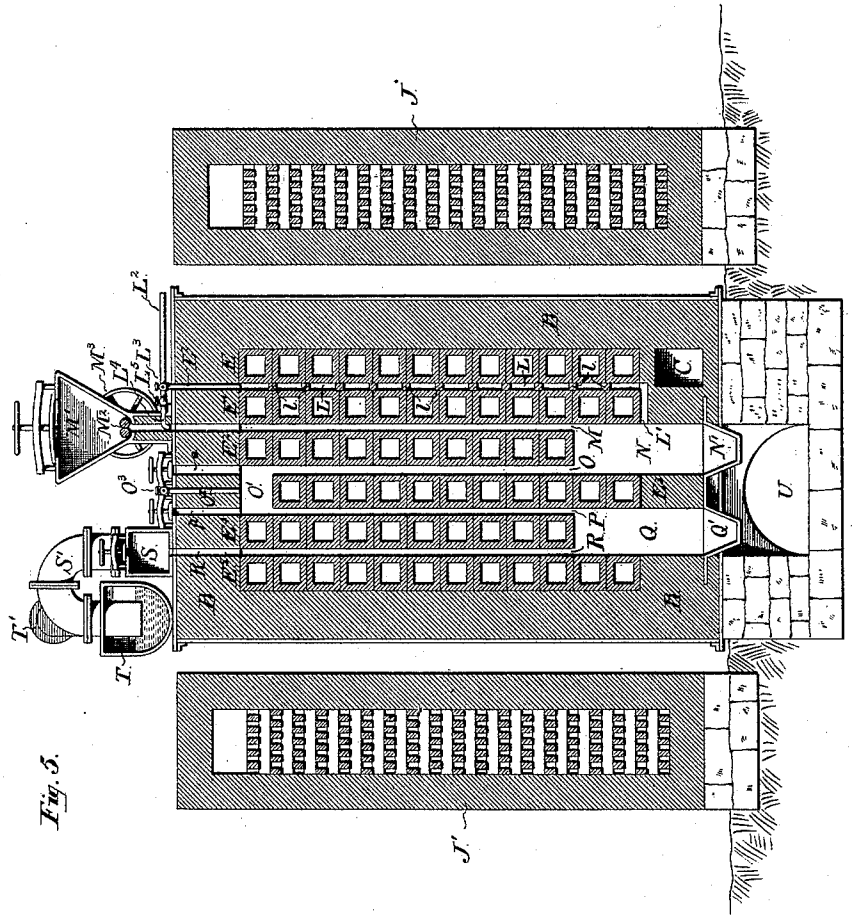

Fig. 5.

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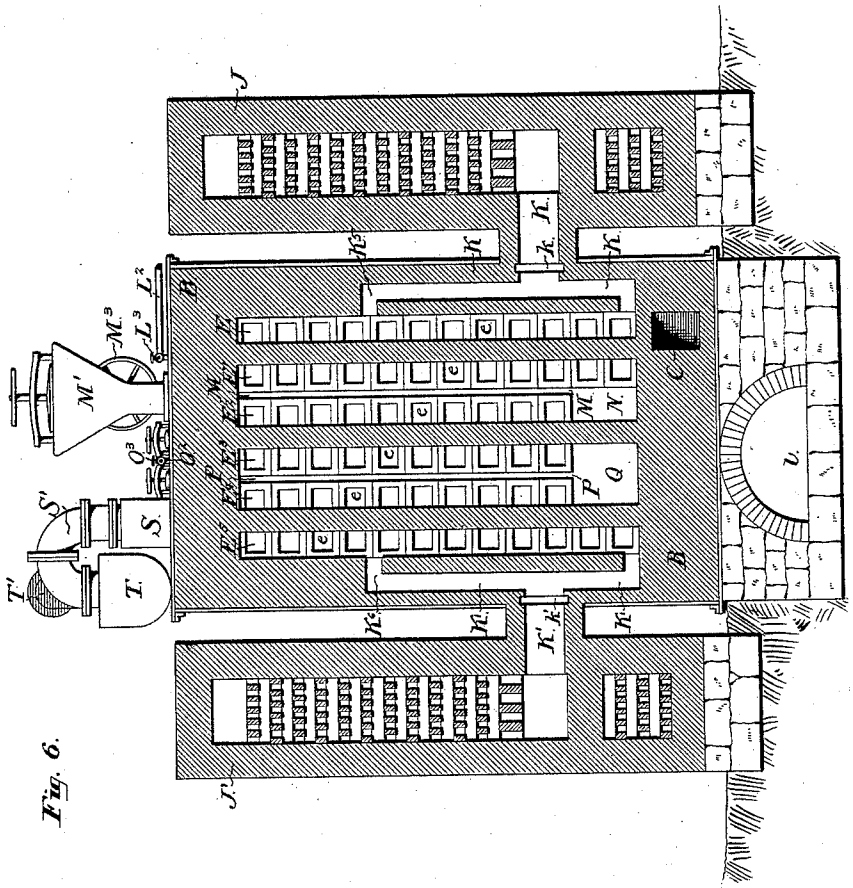

Fig. 6.

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Fig. 8.

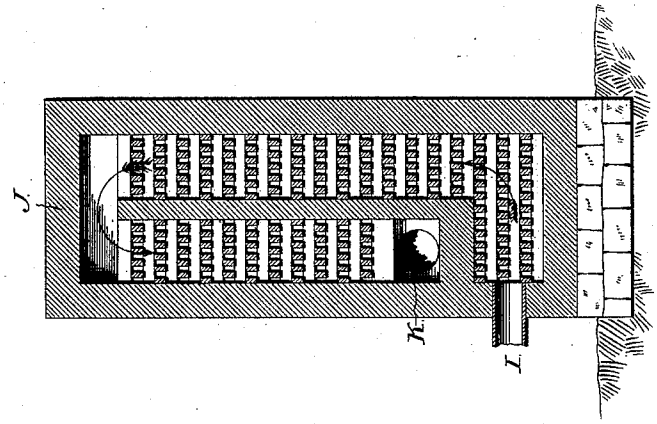
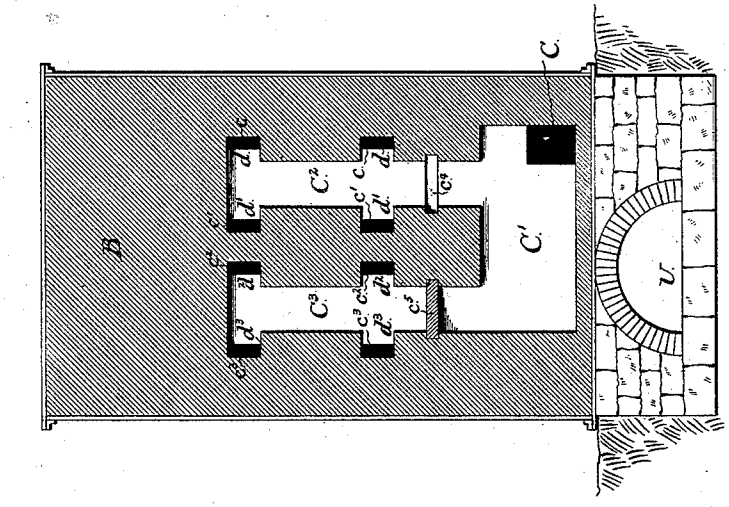


Fig. 7.



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UNITED STATES PATENT OFFICE.

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PROCESS OF MANUFACTURING GAS.

SPECIFICATION forming part of Letters Patent No. 463,139, dated November 17, 1891.

Application filed May 5, 1888. Serial No. 272,953. (No model.)

To all whom it may concern:

Be it known that we, JOSEPH H. COLLINS, Jr., of the city and county of Philadelphia, State of Pennsylvania, and ISAAC N. KNAPP, of Greenwich, county of Fairfield, State of Connecticut, have invented a new and useful Improved Process of Manufacturing Gas, of which the following is a true and exact description, reference being had to the accompanying drawings, which form a part of this specification.

Our invention relates to the manufacture of gas, and preferably to the manufacture of the mixed gas made up of ordinary coal-gas, water-gas, and the vapor of hydrocarbon oils, fixed and combined together to form a fixed gas.

The object of our invention is to manufacture such gas by a practically continuous process, and one which we believe will be more economical than the processes now in use; and our invention consists, first, in the method of effecting a continuous destructive distillation of pulverized carbonaceous material by feeding pulverized fuel into a narrow vertical retort maintained at a high heat by external combustion; second, in the method of manufacturing gas, which consists of effecting a continuous destructive distillation of pulverized fuel, of feeding it into narrow vertical externally-heated retorts, and bringing highly-heated steam into contact with the hot carbonaceous residue of the distillation, so as to form a mixture of coal and water gas; third, in the continuous destructive distillation of pulverized carbonaceous material by feeding it into narrow, vertical, and externally-heated retorts, the formation of water-gas by introducing highly-heated steam into contact with the hot carbonaceous residue of the distillation, and the enrichment of the resultant gases by injecting into them hydrocarbon oils and maintaining the mixed gases and vapor at a high heat, so as to insure the formation of a fixed gas.

In the accompanying drawings, which form part of the specification, we have illustrated an apparatus for manufacturing gas in accordance with our improved process. Said apparatus, being also, we believe, original with us, will form the subject-matter of another application for Letters Patent to be filed simultaneously with the present application.

Referring now to the said drawings, Figure 1 is a plan view of the apparatus; Fig. 2, a plan view on the horizontal section indicated by the line 6 6 of Fig. 3. Fig. 3 is a vertical section on the broken line 7 7 of Fig. 2. Fig. 4 is a vertical section on line 2 2 of Fig. 2. Fig. 5 is a vertical section on line 1 1 of Fig. 2. Fig. 6 is a vertical section on line 4 4 of Fig. 2. Fig. 7 is a vertical section on line 5 5 of Fig. 2. Fig. 8 is a vertical section on line 3 3 of Fig. 2; and Fig. 9 is a horizontal sectional view of the four-way valve marked H in the drawings.

A is a producer-gas generator, *a* indicating the grate on which the fuel rests, A′ and A^2 openings or passages above and below the grate for the introduction of air to the generator.

A^3 and A^4 are openings or passages above and below the grate for the escape of the gas formed in the generator.

a′ and a^2 are valves by which the passages A^3 and A^4 are closed or opened.

C is a gas-conduit which, as shown, leads directly to the gas-passage A^3 and is provided with a supplemental conduit or flue A^5, leading to the gas-passage A^4. By this construction of the generator and the gas-conduit flues air is passed through the flue in the generator either upward or downward at will, and according to the position of the valves *a′* and a^2, the air-opening leading into the generator on the same side of the grate, with the opened gas-passage being of course closed and the air-passage on the other side of the grate opened.

B indicates the main structure of the apparatus containing the retorts, heating-flues, &c. It is preferably built of masonry and inclosed in an iron shell, as indicated in the drawings. The flue C, with its branch A^5, is formed in this structure, said flue C leading

from the generator A to a flue-chamber C′ in the front wall of structure B. (See Figs. 3 and 7).

C^2 and C^3 are upright flues or branches leading out of chamber C′, and having valves C^4 and C^5 by which they can each be closed or have their opening regulated.

D, D′, D^2, and D^3 indicate upright flue-chambers leading inside the upright flues C^2 and C^3 and connected with them by means of flue-passages *d d*, *d′ d′*, d^2 d^2, and d^3 d^3, the flues *d* leading from the branch C′ to chamber D, the flues *d′* from branch C′ to chamber D′, the flues d^2 from branch C^2 to chamber D^2, and the flues d^3 from branch C^2 to chamber D^3, and each of said flue-passages having regulating-valves, as indicated at *c*, *c′*, c^2, and c^3. The duplication of the said flue-passages is advisable, as it enables a better distribution of gas to be perfected in the flue-chambers D D′, &c.

E, E′, E^2, E^3, E^4, and E^5 each indicate a vertically-arranged row of combustion-flues marked *e e*, &c., said flues being preferably made square in section and each vertical row thereof being placed some little distance from the one adjoining it—say about three inches—so as to form narrow vertical spaces, as shown, and which spaces are hereinafter referred to as retorts.

The flue rows E E′, &c., are connected with the flue-chambers D D′, &c., and with similar flue-chambers D^4, D^5, and D^6 at the back of structure B, so as to form a continuous tortuous passage for the gases, as indicated by the arrows in Fig. 2. We will hereinafter refer to the system of upright flue-chambers indicated by the letters D D′, &c., as "connecting-chambers"—a name which correctly describes their function.

F is an exhauster; G, a pipe-section connected with the exhauster; G′, a pipe-section opening to the air, and I and I′, pipes leading from pipe-sections G and G′.

H is a four-way valve, by moving which pipe I is connected with the pipe G, and the exhauster F and pipe I′ opened to the air through pipe-section G′, or the reverse connections made at will.

Pipes I and I′ lead, respectively, into regenerators, (indicated at J and J′,) the regenerator J being connected through flue or conduit K and the chamber D, and the regenerator J′ by flue or conduit K′ with connecting-chamber D^3.

k and *k′* indicate valves by which the openings of flues K and K′ can be regulated at will.

L is a narrow vertical retort formed between the walls of flue-rows E and E′ and opening at its bottom into an enlarged chamber N through an elbow L′.

L^2 is a steam-pipe entering the top of retort L. L^3 is a valve to control the admission of steam. *l l*, &c., are baffle-tiles secured in said retort, as shown in Fig. 3. The use of this retort in the apparatus is to superheat steam.

M is a narrow vertical retort formed between the walls of flue-rows E′ and E^2. At the top of this retort M is placed a hopper M′, having a feeding device M^2 at its bottom, by means of which a regulated supply of pulverized carbonaceous material can be continuously fed into the top of the retort, M^3 being a pulley-wheel for actuating the feeders M^2.

L^4 is a branch steam-pipe leading from the steam-pipe L^2 into retort M. M^5 is a valve for regulating the passage of steam through pipe L^4.

N is a chamber placed directly beneath the bottom of the retort M. It is of an area considerably greater than that of said retort, and has at its bottom an ash-pan N′.

O is a narrow vertical retort formed by the walls of flue-rows E^2 and E^3. The bottom of this retort opens into the chamber N.

P is a narrow vertical retort formed between the flue-rows E^3 and E^4. The top of this retort is connected with the top of retort O by means of a passage O′, into which passage opens an oil-injecting pipe O^2, the supply of oil being regulated by the valve O^3 in said pipe.

o and *p* indicate passages formed through the structure B from the top of the retorts O and P to the top of the inclosing structure. These passages are to enable the retort-chambers into which they lead to be cleaned, and when the apparatus is at work they are closed by some convenient covers—such, for instance, as is shown in the drawings.

Q is an enlarged chamber formed on the bottom of the retort P′ and provided with an ash-pan Q′.

R is a narrow vertical retort formed between flue-rows E^4 and E^5 and leading vertically upward through structure B into a conduit S, from which siphon-pipes S′ lead into a hydraulic main T, T′ being a gas-conduit leading from the said hydraulic main.

The operation of this apparatus is as follows: Fuel is introduced in the producer-gas generator A, the openings A′, A^2, A^4, and A^5 being adjusted so that the combustion will be either upward or downward, as may be desired. The exhauster F is then set in operation and the four-way valve H adjusted so as to connect the exhauster with either one of the pipes I or I′, the one of said pipes disconnected with exhauster being opened to the air through pipe-section G′. For the purpose of following the gases through the machine, I have in Fig. 2 indicated by arrows the course of the gases when the exhauster is connected with the pipe I′. As can be easily seen, the exhauster will draw in two currents of air, the first entering the generator A and passing into the flue or conduit C as producer-gas, which is led to flue-chamber C′, and the valve C^4 being opened, the flue C^2 from which it is admitted to chamber D through flue-passages *d*. The second current of air is drawn through pipe-section G′ and passes through pipe I, regenerator J, and pipe or conduit K into the

chamber D, where it meets the producer-gas and supplies oxygen for its combustion. The burning gases are drawn from chamber D through the flues *e* of the vertical flue-row E, thence through chamber D^4 and flue-row E′ to chamber D′, and so on through the flues and connecting chambers, as indicated by the arrows, until from chamber D^3 the gases pass through conduit K′ to the regenerator J′, which they raise to a high temperature, and after leaving it they pass through pipe I and pipe-section G to the exhauster F, and thence escape. The combustion in the flues E E′, &c., is regulated by means of the valves shown and before referred to, producer-gas being introduced in any or all of the connecting chambers D, D′, D^2, and D^3, if desired. At intervals the cock H is turned, with the result of reversing the course of the burning gas and air through the flues E E′, &c., and the additional result of causing the air which supports combustion to pass through the regenerator heated by the products of combustion, while the other regenerator is heated up by the escaping products of combustion. By this system the narrow vertical retorts formed between the two rows E E′, &c., can be raised to very high temperature and great uniformity of temperature be preserved throughout the whole series, as the combustion is, through the valve system described, under perfect control, and any retort showing an undue fall of temperature can, without stopping the apparatus, be soon raised to the proper heat. When the retort-chambers have been heated to a sufficiently-high temperature, pulverized fuel is fed into the top of the retort M, and falling between its hot walls a destructive distillation takes place, so that at the bottom of the retort the pulverized fuel fed into the top thereof issues into the chamber M as coal-gas and intensely hot and very finely-divided coke. The gases will of course pass from the chamber M into the retort O, and thence through the retort-chamber shown, the hydraulic main, &c., to a proper storage-tank, while the hot particles of coke will continue their downward course toward the ash-pan M′. By introducing steam, however, into the chamber M′ the vapor of water will come in contact with the hot particles of coke as they fall from retort M, and a decomposition of the water will ensue with the formation of water-gas, (carbonic oxide and hydrogen,) which will mix with the coal-gas issuing from retort M and pass with it into the retort O. We prefer to introduce the steam into the top of the vertical retort L and pass it through said retort and among the baffle-tiles *l*, placed therein, so that it will be superheated to a high degree and pass through elbow L′ into chamber M in the best possible condition to unite with the hot particles of coke. As the coke issuing from retort M will seldom be free from impurity, the ash will remain after the union of the steam and coke, which ash will fall through chamber M into the ash-pan M′ and can be removed from time to time.

If it is desired to enrich the gases passing out of chamber M, we do so by injecting oil through the pipe O^3. Said oil will of course be vaporized by the high heat of the gases and of the retorts into which it is injected, and by passing the mixed gases through the retort-chambers E and R they are fixed or made permanent before their delivery into the hydraulic main T. The function of the chamber Q, which connects the retorts P and R, is to furnish an additional settling-chamber for ash in case, as is not unlikely, some is carried over with the gases issuing from chamber M.

We will here call attention to the division of the various narrow vertical retorts by the partition-walls B′, B^2, B^3, and B^4, (see Fig. 3,) and to the fact, as illustrated in the drawings, that each of these divisions is made independent of the others, so that if it becomes necessary to stop the manufacture of gas in any one of them there need be no interference with the action of the others.

Having now described our invention and the construction and operation of our preferred apparatus for carrying into effect our improved process, what we claim as our invention, and desire to secure by Letters Patent, is—

1. The method of manufacturing gas from pulverized carbonaceous materials, which consists in feeding the pulverized fuel in regulated quantity into the top of an externally-heated retort to effect a destructive distillation thereof and injecting highly-heated steam into the products of the destructive distillation at or near the bottom of the said retort so as to effect a decomposition of the steam and the formation of carbonic oxide and hydrogen gas by the union of its oxygen with the hot particles of carbon.

2. The method of manufacturing gas from pulverized carbonaceous materials, which consists in feeding the pulverized fuel in regulated quantity into the top of an externally-heated retort to effect a destructive distillation thereof, injecting highly-heated steam into the products of the destructive distillation at or near the bottom of the said retort so as to effect a decomposition of the steam and the formation of carbonic oxide and hydrogen gas by the union of its oxygen with the hot particles of carbon, and separating the solid and gaseous products of the said treatment by subsidence in one or more enlarged chambers.

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