(No Model.) 2 Sheets—Sheet 1.

T. G. SPRINGER.

PROCESS OF AND APPARATUS FOR MANUFACTURING GAS.

No. 361,191. Patented Apr. 12, 1887.

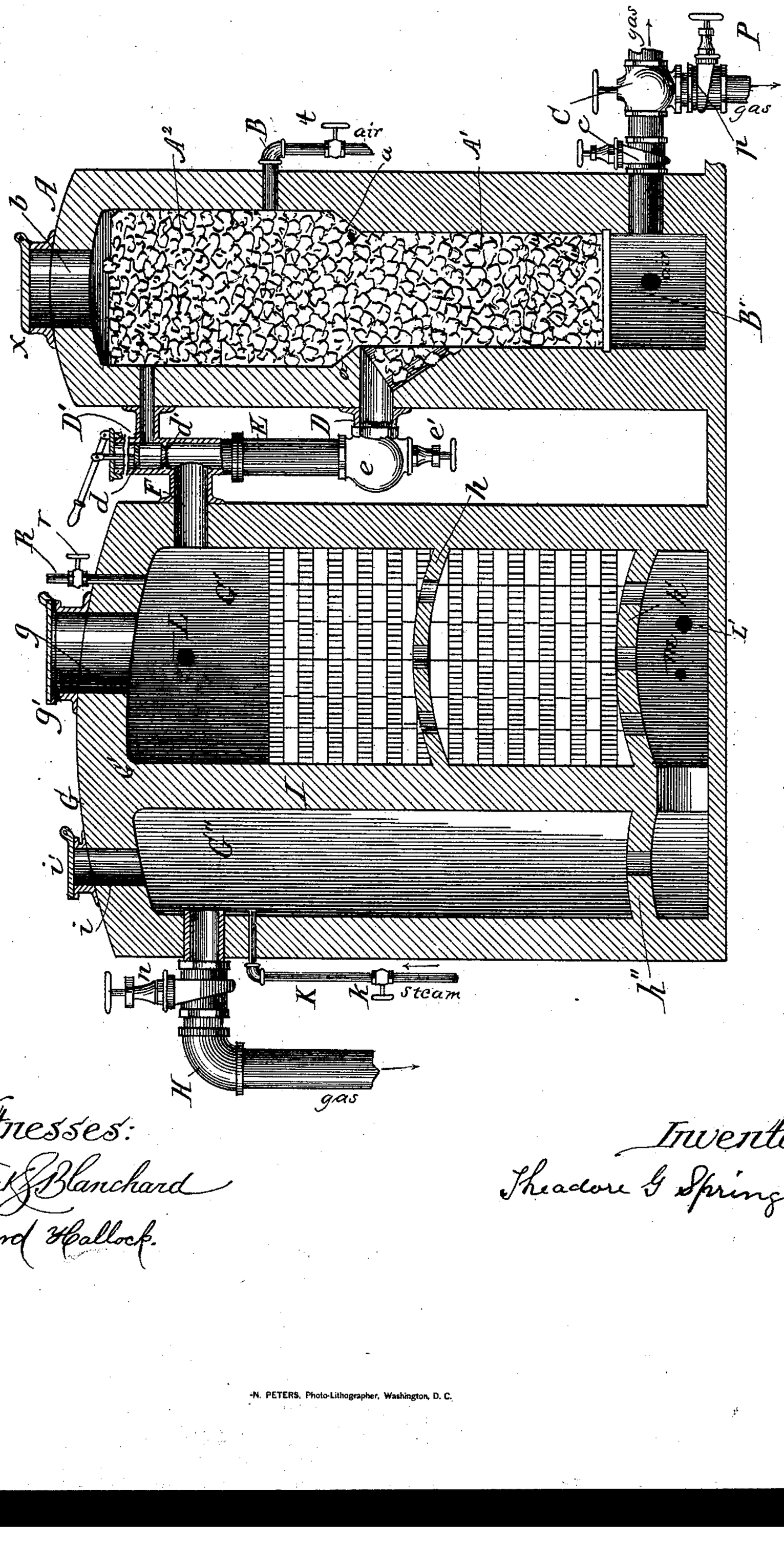

Fig. 1

Witnesses:
Frank L. Blanchard
Howard Hallock.

Inventor:
Theodore G. Springer

N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.) 2 Sheets—Sheet 2.

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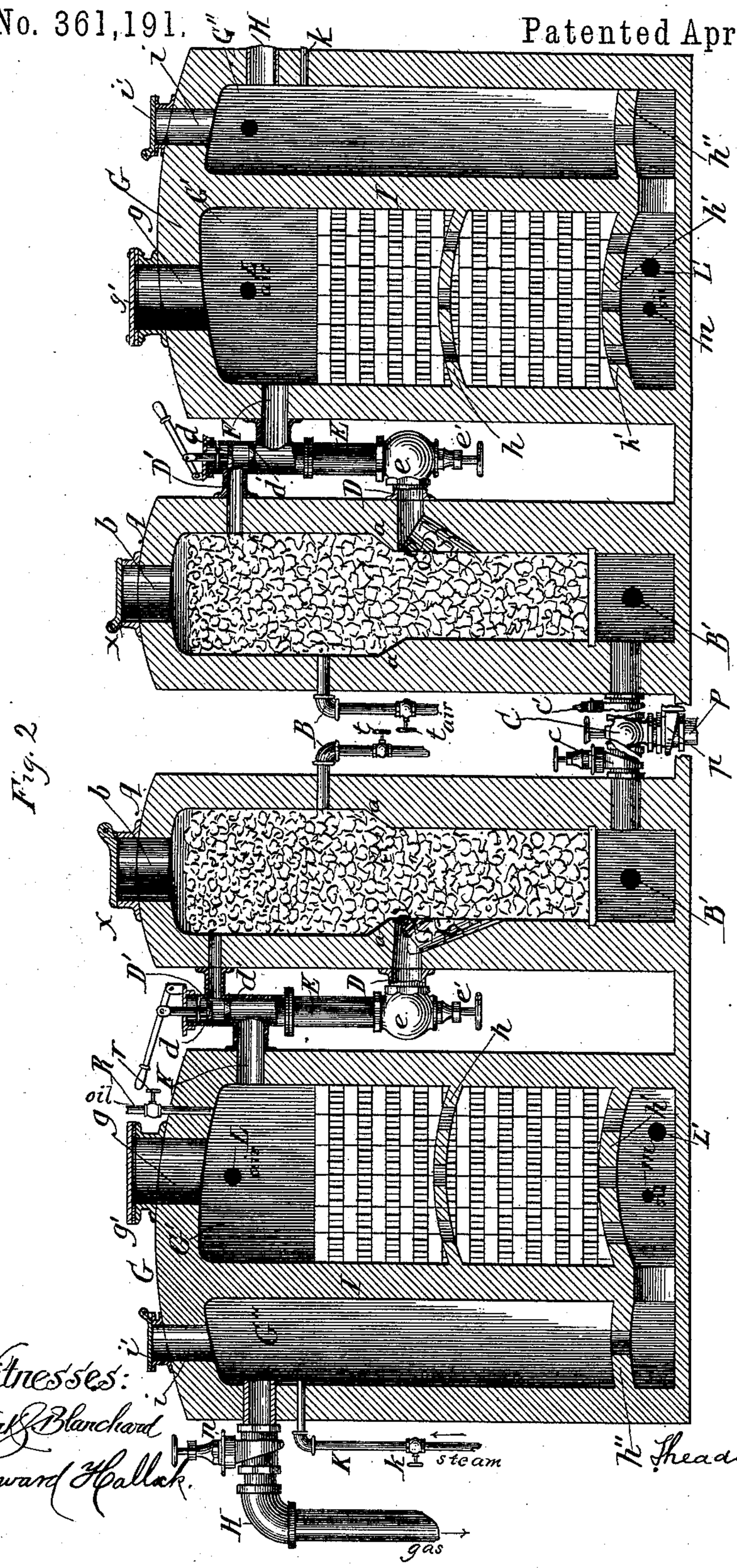

Fig. 2

Witnesses:
Frank L. Blanchard
Howard Hallock.

Inventor:
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UNITED STATES PATENT OFFICE.

THEODORE G. SPRINGER, OF NEW YORK, N. Y.

PROCESS OF AND APPARATUS FOR MANUFACTURING GAS.

SPECIFICATION forming part of Letters Patent No. 361,191, dated April 12, 1887.

Application filed November 29, 1886. Serial No. 220,198. (No model.)

To all whom it may concern:

Be it known that I, THEODORE G. SPRINGER, a citizen of the United States, residing at New York city, in the county of New York and State of New York, have invented a certain new and useful Improvement in Process of and Apparatus for Manufacturing Heating and Illuminating Gas; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to the process of and apparatus for manufacturing heating and illuminating gas; and the object of the invention is more particularly to utilize soft or bituminous coal in the manufacture of water-gas by first coking such coal, and thereby feeding or replenishing the body of incandescent coke in which steam is decomposed.

In carrying out my invention one portion of a body of fuel contained in a cupola—namely, the coke or other form of hard carbon—is blasted with air, causing its active combustion till it is heated to incandescence, and at the same time a body of bituminous or soft coal is subjected to direct contact with the body of highly-heated coke and to incomplete or smothered combustion, so as to distill off the volatile hydrocarbons, and thereby replenish the coke as fast as consumed by active combustion. The gaseous products resulting from the active combustion of the coke and from the distillation and incomplete or smothered combustion of the bituminous coal are burned in a regenerating-chamber and the heat stored in a body of refractory material. Steam is then highly superheated by passage through such heated refractory material and is then decomposed by passage through the incandescent coke only, or first through the partially-distilled and coked bituminous coal, and then on through the body of incandescent coke, forming water-gas. Steam in excess and a limited supply of hydrocarbon-oil in suitable proportions are also passed through the heated refractory material and therein converted by mutual decomposition into carbonic acid and hydrogen, and these mixed gases are passed into contact with the heated fuel, and thereby converted into carbonic oxide and light carbureted hydrogen. A second bed of coke or other form of hard carbon may be heated to incandescence, and a second body of bituminous or soft coal be reduced to coke, as in the first cupola, and the resulting gaseous products from both sources burned, and the heat stored in a second body of refractory material in a regenerator-chamber. The water-gas or mixture of carbonic oxide and light carbureted hydrogen passing from the fuel-chamber of the first cupola may then be passed through the fuel of the second cupola, and thence into the second body of refractory material, where it is carbureted and converted into a fixed illuminating-gas.

The matter constituting my invention will be defined in the claims.

In the drawings, Figure 1 represents a vertical longitudinal section of the single form of my apparatus; and Fig. 2 represents a vertical longitudinal section of the apparatus in connected or double form, adapted for making illuminating-gas.

The cupola A is built tall, and is partially divided by the ledge *a* into the lower combustion and decomposing fuel-chamber, A′, and the upper coking-chamber, A^2. It is constructed of fire-brick and surrounded and inclosed by a tight iron jacket in the usual manner. An air-blast pipe, B′, connects with the ash-pit for producing active combustion of the coke or other form of hard carbon in compartment A′, and a small air-blast pipe, B, having a controlling-valve, *t*, connects with the coking chamber or compartment A^2. Escape-pipes D D′ connect, respectively, with the tops of the compartments A′ and A^2, for conducting off the gaseous products from each, and these pipes connect with the vertical pipe E, which is connected by pipe F with the top of chamber G′ of the regenerator G. A conical valve, *d*, provided with a stem and operating-lever, is arranged to close upon a seat, *d′*, in pipe E, and thus close pipe D′ and communication between coking-chamber A^2 and the regenerator. A plug or stopper valve, *e*, having a stem, *e′*, is provided in the lower end of pipe E, for closing pipe D. A fuel-supply opening, *b*, having a tight-closing lid, *x*, is provided in the top cupola, A.

The regenerator G is divided into two vertical chambers, G′ and G″, by the vertical partition I, and chamber G′ is provided with two

perforated brick arches, *h h'*, dividing it into upper and lower compartments, and serving to support the brick checker-work placed in the chamber. A perforated arch, *h''*, is also arranged near the base of chamber G'', for supporting its brick checker-work. Chamber G' is provided at the top with passage *g*, and tightly-closing lid *g'*, and chamber G'' is provided at its top with passage *i* and tightly-closing lid *i'*. These passages or openings serve for the escape of products of combustion and for giving access to the chambers for cleaning or repairing the brick-work. An outlet gas-pipe, H, having valve *n*, connects with the top of chamber G'', for conducting gas which it is desired to save to a place of storage or use. Steam-supply pipe K, having valve *k*, connects with the top of chamber G''. An oil-supply pipe, *m*, connects with the base of chamber G', below arch *h'*. Air-blast pipes L L' connect with chamber G', the first at its top and the second just below arch *h'*, for supplying air to cause combustion of gaseous products from the cupola, and thereby heat the brick-work in chambers G' and G''. The take-off pipe C, for water-gas, or mixture of carbonic oxide and light carbureted hydrogen, connects with the ash-pit of cupola A and leads to the seal and wash-box. (Not here shown.)

As shown in the drawings, Fig. 2, a second cupola, A, and a second regenerator, G, constructed, arranged, and connected like those above described, are connected at the base through the medium of gas-pipe C. By this connection, water-gas, or the mixture of carbonic oxide and hydrogen, which is made in one set of chambers, (viz., a cupola and regenerator,) can be converted into illuminating-gas of any desired candle-power by passing it through the body of fuel in the second cupola and then into the second heated regenerator, where it is carbureted or enriched with hydrocarbons and converted into fixed gas by contact with the heated refractory material.

It has heretofore been proposed, and I have described in my Patents Nos. 257,100 and 263,612, the operation of supplying bituminous coal to the steam-decomposing chamber in a water-gas generator, and heating it to incandescence by active combustion with blasts of air for subsequently decomposing steam; but for reasons stated below such operation was not successful.

I have learned by experience that bituminous or soft coal cannot be successfully blasted and heated to incandescence and used for decomposing steam, for the reason that when highly heated in a deep body it runs together and cakes in large masses, so that steam cannot be advantageously passed through it for decomposition, and also for the reason that soot and lampblack are given off from it in such large quantities as to clog up the brick-work of the regenerator, and so render it inoperative. It is, however, very desirable to use such soft or bituminous coal in making water-gas, on account of its abundance and cheapness in many localities; and in order to use it and avoid the above-mentioned objections I apply the air-blast in large volumes directly to a body of coke, and cause its active combustion till it is heated to incandescence, and pass off the products of combustion below the body of bituminous coal, and at the same time subject such body of the bituminous coal to direct contact with the highly-heated coke and to a slow and incomplete or smothered combustion, with a limited and regulated air-supply, in order to gradually distill off the volatile matter and reduce it to coke, so as to thereby replenish the body of coke as it is consumed by the active combustion. The volatile and tarry matters are thus slowly driven off from the soft coal and consumed with the poor gaseous products from the coke without waste and without injury to the brick-work of the superheater, and such coal is reduced to coke, which is perfectly adapted to undergo active combustion and be raised to a high heat, and to subsequently be used for decomposing steam.

The operation is as follows: A fire is first kindled on the grate of the cupola, and coke or other hard carbon—such as anthracite coal—is fed in during the admission of the air-blast till compartment A' is nearly or quite filled with heated fuel. Then a deep body of bituminous coal is supplied to compartment A^2 on top of the body of hot fuel, and to such coal is admitted a limited and regulated supply of air through pipe B, just sufficient to cause a slow incomplete combustion, such as is best adapted for the coking operation. Valves *d* and *e* being open, the products of active combustion from the fuel in compartment A' pass off through pipe D, and the volatile matter and gases from the distilling coal in compartment A^2 pass out through pipe D', and both then flow into the top of the superheating regenerator-chamber G', where they are burned by the admission of air by pipe L. The products pass down and are given a second supply of air by pipe L', which causes their complete combustion. The hot products then pass down to the base of chamber G', and then up through chamber G'', from which they escape by passage *i*, thus highly heating the refractory brick-work in both chambers. When kindling the fire, the lid *x* should be open, then, after the air-blasts are admitted, lid *i'* is opened and lid *x* closed. The body of coke in compartment A' being heated to incandescence and the superheating-regenerator G G' G'' being heated to the desired temperature, the air-blasts are shut off, the lids *i'* and *g'* and *x* are tightly closed, and steam is admitted by pipe K into the top of chamber G'' and passed down through such chamber and up through chamber G' in contact with the heated brick-work, by which it is highly superheated, and is thence passed either directly through pipes E and D into the body of incandescent coke, where it is decomposed, or

it is passed by pipe D′ into compartment A², and thence down through the body of partially-coked bituminous coal, and thence on down through the incandescent body of fuel in compartment A′, where it is completely decomposed and converted into water-gas. The superheated steam, in passing down through the partially-distilled bituminous coal, carries some of the volatile and tarry matters down into the incandescent coke, where they are decomposed, together with the steam, resulting in the formation of carbureted hydrogen and water-gas. The steam having been passed down through chamber G″ and therein superheated, may be commingled with oil vapor resulting from the admission of a limited supply of oil through pipe *m* at the base of chamber G′, and the mixture of hydrocarbon oil with steam in excess is decomposed in contact with the heated brick-work in chamber G′, so as to form carbonic acid and hydrogen; and these gases, in a highly heated state, are conducted through the incandescent fuel, and thereby converted into carbonic oxide and light carbureted hydrogen. The mixture of carbonic acid and hydrogen may be passed through the incandescent coke only, or first through the partially-distilled coal and then through incandescent coke. The water-gas is finally passed off through pipes C and P, leading from the ash-pit.

The two sets of fuel and regenerator chambers may be conveniently operated at the same time, but independently of each other, for making heating-gas, as above described, and when it is desired to make illuminating-gas they are connected at their bases through the medium of pipes C, by opening the valves *c c′* and closing valve *p*. (Shown in Fig. 2.)

Before commencing the generation of illuminating-gas both valves of pipe C are closed and both bodies of fuel in the two cupolas are blasted and heated at the same time, and both regenerator-superheaters are also heated, as above described with reference to one of them. Then, when all are heated up, valves *c c′* are opened and valve *p* closed. Then water-gas, or the mixture of carbonic-oxide and light carbureted hydrogen gas, is made, as heretofore described, preferably in the right-hand side superheater, G, and cupola A, and such gas is passed through connecting-pipe C and up through the hot coke in compartment A′, and thence directly into chamber G′, to be carbureted and fixed, or through the hot coke and on through the partially-distilled bituminous coal, and then into chamber G′. As the gas passes into chamber G′ through pipe F hydrocarbon oil is admitted by pipe R, having valve *r*, into the top of such chamber in suitable quantity to carburet the gas to the desired candle-power. The oil is quickly vaporized and mixed with the water-gas, and the mixture is combined and converted into a fixed gas by passage through the heated brick-work in chambers G′ G″, and the resulting illuminating-gas is finally passed off by pipe H, the valve *n* of which is open. In case the two cupolas are connected together at the base by pipe C and it is desired to make water-gas in each, then steam, or steam and oil, is preferably decomposed in one set while the other set is being blasted with air and heated up. For instance, valve *c′* may be closed and the right-hand cupola and regenerator blasted with air and heated up, while valves *c* and *p* are opened and water-gas is generated in the left-hand regenerator and cupola, and such gas passed off through pipes C and P. Then, of course, the left-hand set may be heated up, while gas is generated in the right-hand set by closing valve *c* and opening valve *c′*. In this manner two sets of generators can be conveniently and economically used for generating water-gas, or for generating illuminating-gas, as desired.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In the manufacture of gas, the process of raising one portion of a body of fuel to incandescence and coking simultaneously a body of bituminous coal preparatory to decomposing steam, which consists in blasting the coke with air and causing active combustion till it is heated to incandescence, and at the same time subjecting a body of bituminous coal to direct contact with the highly-heated coke and to incomplete or smothered combustion, (by admitting a limited supply of air,) thereby distilling off the volatile hydrocarbons and forming coke to replenish the body of coke below as consumed by the active combustion, and at the same time burning the gaseous products resulting from the coke and bituminous coal and storing the heat in a body of refractory material.

2. The process of manufacturing gas, which consists in raising a body of coke to incandescence by active combustion with an air-blast, and at the same time subjecting a body of bituminous coal to direct contact with the highly-heated coke and to incomplete or smothered combustion by admitting a limited supply of air, so as to distill off the volatile hydrocarbons and replenish the coke as consumed by active combustion, and at the same time burning the gaseous products resulting from the coke and bituminous coal and storing the heat in a body of refractory material, then superheating steam in the refractory material and decomposing it by passing it through the heated fuel.

3. The process of manufacturing gas, which consists in raising two bodies of coke to incandescence by active combustion with air-blasts, and at the same time subjecting two bodies of bituminous coal to direct contact with the highly-heated coke and to incomplete or smothered combustion by admitting a limited supply of air, so as to distill off the volatile hydrocarbons and replenish the coke as consumed by active combustion, and at the same time burning the gaseous products resulting from the

coke and bituminous coal and storing the heat in two bodies of refractory material, then superheating steam in one of the bodies of the refractory material and decomposing it by passing it through the bodies of fuel, and, finally, carbureting the resulting gas and fixing it by passing it through the second body of refractory material to form illuminating-gas.

4. A cupola gas-generator having a lower compartment for decomposing steam and an upper compartment for coking coal, each compartment being provided with an air-blast pipe, in combination with a regenerating-chamber containing refractory material, and a gas-eduction pipe having a controlling-valve leading from each compartment of the fuel-chamber and connecting with such regenerating-chamber.

In testimony whereof I affix my signature in presence of two witnesses.

THEODORE G. SPRINGER.

Witnesses:

A. P. HUNSHAUP,

J. W. P. MYERS.