(No Model.) 3 Sheets—Sheet 1.

T. G. HALL.

PROCESS OF AND APPARATUS FOR MANUFACTURING GAS.

No. 494,200. Patented Mar. 28, 1893.

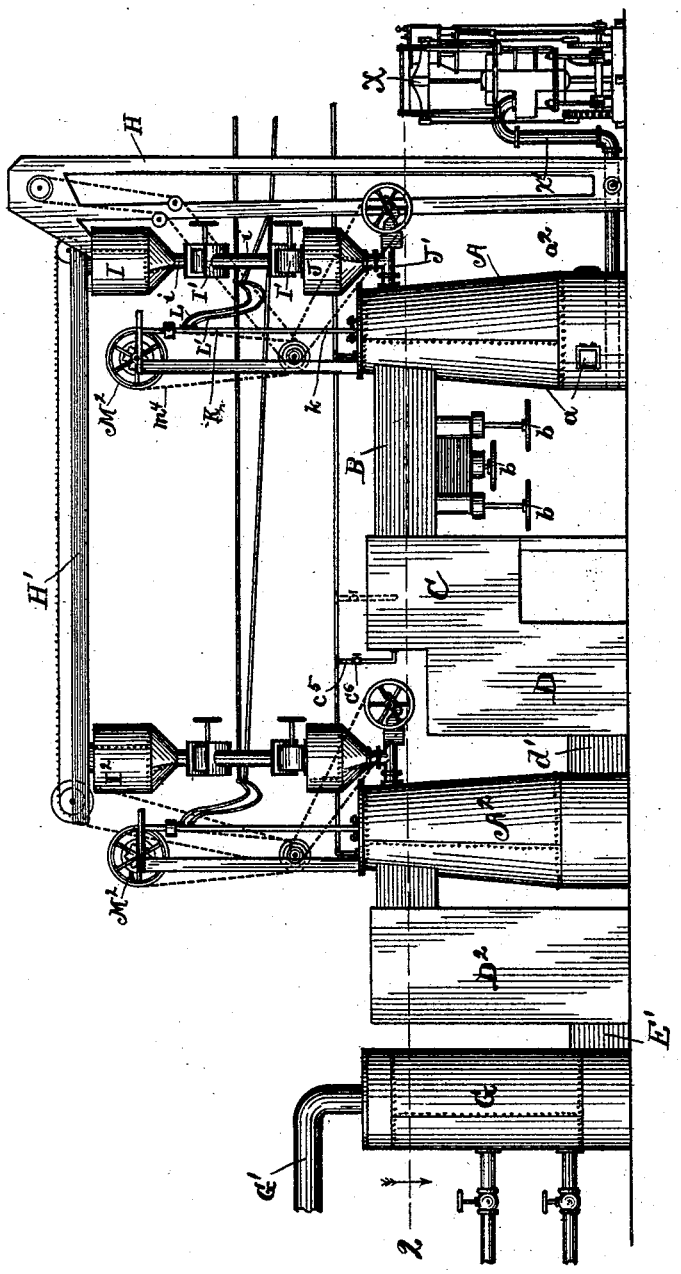

Fig. 1.

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(No Model.) 3 Sheets—Sheet 2.

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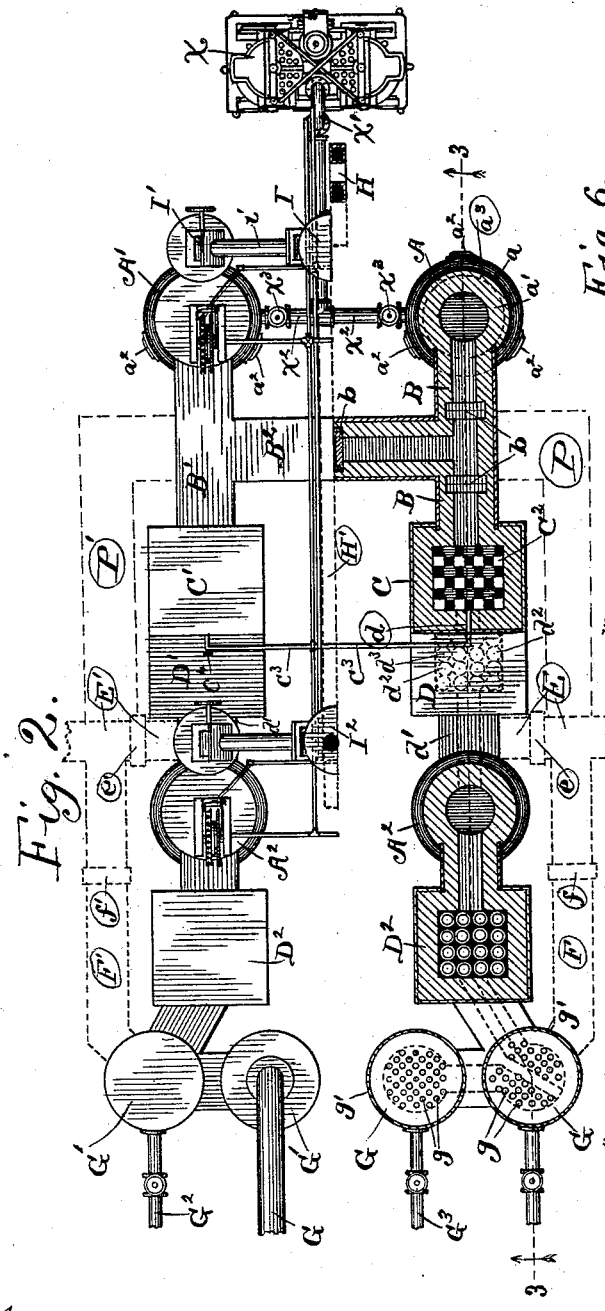

Fig. 2.

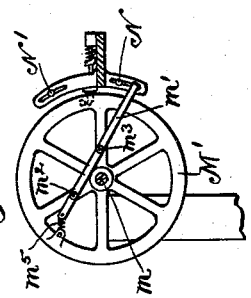

Fig. 6.

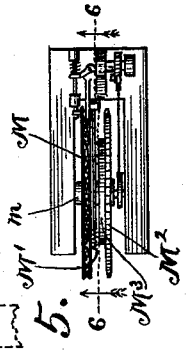

Fig. 5.

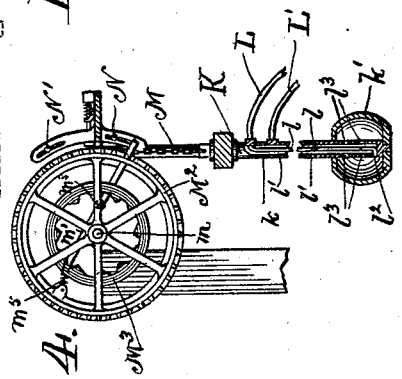

Fig. 4.

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(No Model.) 3 Sheets—Sheet 3.

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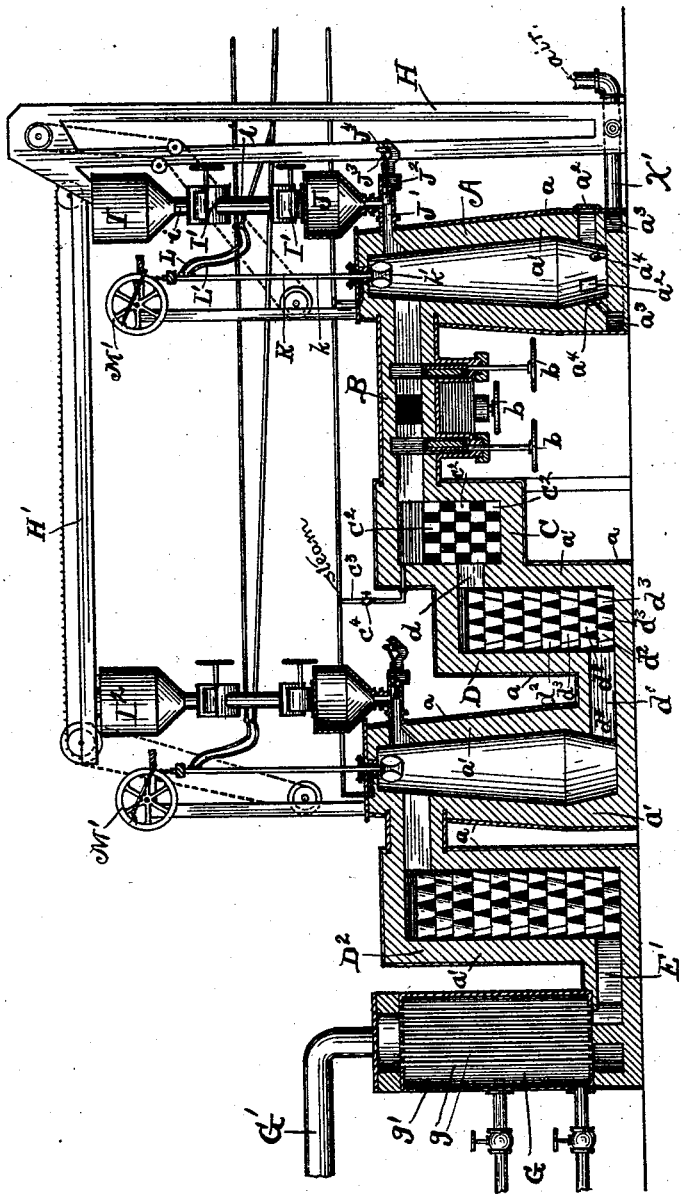
Fig. 3.



Witnesses:
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UNITED STATES PATENT OFFICE.

THURSTON GORDON HALL, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE HALL CHEMICAL AND GAS COMPANY, OF SAME PLACE.

PROCESS OF AND APPARATUS FOR MANUFACTURING GAS.

SPECIFICATION forming part of Letters Patent No. 494,200, dated March 28, 1893.

Application filed November 30, 1892. Serial No. 453,573. (No model.)

To all whom it may concern:

Be it known that I, THURSTON GORDON HALL, of Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Process of and Apparatus for Manufacturing a Permanent Inflammable Gas, of which the following, in connection with the drawings accompanying and forming a part hereof, is a full, clear, and exact description, sufficient to enable those skilled in the art to which it appertains to carry on and use the same.

This invention relates to the continuous manufacture of a permanent inflammable gas, from coal or other carbonaceous material, and the invention consists in the herein described process and the apparatus used therein, as the same are set out and claimed.

The object of my invention is to obtain a continuous process of manufacturing a fixed, or permanent, inflammable gas, either a fuel gas or an illuminating gas, as desired, from carbonaceous fuel, air and steam, and to obtain an apparatus adapted to be used in the carrying on of such process, whereby all the carbonaceous material of the coal or other carbonaceous fuel introduced into the combustion chamber of the apparatus will be utilized.

In the drawings referred to and accompanying this specification, Figure 1, is a side elevation of the apparatus; Fig. 2, a top plan view of a portion of the apparatus and a horizontal sectional view of the remainder of the apparatus, on line 2—2 of Fig. 1, viewed in the direction indicated by the arrows; Fig. 3, a vertical sectional view on line 3—3 of Fig. 2, viewed in the direction indicated by the arrows; Fig. 4, a side elevation, on an enlarged scale, of that element or member of the apparatus hereinafter termed a stoker; and of the mechanism employed for hoisting and dropping the same; Fig. 5, a top plan view of the mechanism illustrated in Fig. 4; and Fig. 6, an elevation of a portion of such mechanism viewed on line 6—6 in the direction indicated by the arrows.

Similar letters of reference are used to indicate a given part where more than one view thereof is shown in the several figures of the drawings.

I will first describe that portion or part of the apparatus used in the manufacture, by this process, of a fixed or permanent fuel gas, and the manner of carrying on the process.

A, A′, are, respectively, duplicate combustion chambers. I construct the combustion chambers A, A′, respectively, (as well as the mixing chambers and the regenerating chambers hereinafter described,) with an outer wall or casing a, of sheet metal, preferably boiler iron, having therein a lining a', of fire-brick or other suitable refractory material.

a^2, a^2, a^2, are doors in combustion chambers A, A′, respectively, for cleaning purposes.

a^3, is a recess extending around the combustion chamber A, (and also around the combustion chamber A′,) in the lining a' thereof, forming an air conduit or way underneath the shell or casing a, and a^4, a^4, a^4, are passage-ways from air conduit a^3 into the combustion chambers, respectively. When fuel is burning in the combustion chambers, or either therof, the air necessary for combustion is supplied thereto through passage-ways a^4, a^4, a^4 by means of an air compresso - ing a pipe or conduit extending therefrom to the air conduit a^3 of the respective combustion chambers. X, is such air compressor or air blower; and X′, X^2, the pipes or conduits therefrom.

X^3, X^3, are valves in the respective pipes or conduits X^2, X^2, by which air is guided from the air compressor or blower into the one of the combustion chambers desired to be operated.

B, B′, are conduits or ways extending from the respective combustion chambers A, A′, to and into the respective mixing chambers C, C′.

B^2, is a conduit or way connecting conduit or way B with conduit or way B′.

b, b, b, respectively, are valves or gates in the respective conduits or ways B, B′, B^2, whereby the products of combustion, or partial combustion, in the respective combustion chambers are distributed into either one of the mixing chambers C, C′, as desired.

C^2, C^2, is a filling of refractory material, arranged in mixing chambers C, C′, respectively, so as to form series of gas passage - ways therethrough.

C^3, C^3, are conduits or pipes extending into the mixing chambers C, C′, respectively, by which steam is delivered into either one of such chambers; and C^4, C^4, are valves by which is controlled and determined the delivery of such steam.

D, D′, respectively, are regenerating chambers, and *d*, is an opening extending from the respective mixing chambers into the adjacent regenerating chambers.

d′, *d′* are passage-ways extending from the regenerating chambers D, D′, respectively.

d^2, d^3, respectively, are receptacles constructed of refractory material, as silica, containing metals or materials of opposite electric polarities, and arranged in the regenerating chambers so as to obtain series of conduits through the chambers by means of the interstices between such receptacles.

E, E′, respectively, are conduits or ways extending from the respective regenerating chambers D, D′, or from conduits or passage-ways *d′*, *d′*, respectively, through which the fuel gas is delivered from the apparatus when designed to be consumed in a heated condition; and F, F′, respectively, are conduits or ways extending from the respective regenerating chambers, D, D′, or from conduits or ways E, E′, respectively, to coolers G, G′, through which coolers the fuel gas is conducted when it is to be consumed in a cooled condition.

e, *e′*, *f*, *f′*, are valves or gates in the respective conduits or ways E, E′, F, F′.

Where, as is usually the case, in the manufacture of either fuel or illuminating gas by the process in which this apparatus is employed, the carbonaceous fuel used for combustion in combustion chambers A, A′, respectively is wholly or partially coal, elevator H may be employed for automatically raising the coal into hopper I.

i, *i*, are pipes or conduits extending from hopper I into hoppers J, J, respectively, one of such hoppers J, being attached to combustion chamber A, and one thereof being attached to combustion chamber A′.

I′, I′, are gates or valves in pipes *i*, *i*, respectively.

J′, J′, are pipes or ways into which the hoppers J, J, respectively, extend, and discharge one of such pipes or ways J′, extending into one of the respective combustion chambers A, A′, and the other into the other thereof; and J^2, is a piston adapted to travel back and forth in pipe or way J′, and thereby force the coal in front thereof contained in such pipe or way J′ into the combustion chamber into which such pipe extends.

When coal is to be introduced into a combustion chamber by elevator H, hopper I, conduit or pipe *i*, hopper J, conduit or pipe J′, and movable piston J^2, the lower one of the gates I′ (Fig. 3), is closed and the upper one thereof opened, so as to admit a charge of coal in the conduit or way *i* extending between such gates. The upper one of such gates is then closed and the lower one opened, when such coal will be discharged into the hopper J, it will be taken, as required, by piston J^2, and delivered through pipe or way J′ into the combustion chamber with which it is connected. Movement of piston J^2 is obtained by connecting rod J^3, extending therefrom to crank J^4, such crank being rotatable and driven by suitable pulleys or gear.

To stoke, or break down the crust or coal arch which I have found in the working of plants heretofore constructed by me for the carrying on of this process in a commercial way, is produced in the combustion of coal or carbonaceous fuel in the combustion chamber, particularly, when bituminous coal is employed, I construct a plunger or stoker arranged so that the same can be elevated in the combustion chamber and dropped automatically, or automatically allowed to fall, on such crust or arch therein. K, is such plunger or stoker, and preferably consists of the hollow rod *k*, and hollow head *k′*. *l*, *l′*, respectively, are ways or conduits in hollow rod *k*; both of such ways *l*, *l′*, having openings therefrom into the hollow head *k′*.

l^2, l^2, are the openings from way *l′*. Way *l* extends to and communicates with flexible pipe L, and way *l′* extends to and communicates with flexible pipe L′. Pipes L, L′, respectively, extend to a suitable water supply and water discharge to secure circulation of water through the rod *k* and head *k′*, whereby stoker K is maintained at the desired temperature.

To hoist stoker K chain M is connected thereto and extended therefrom to and partially around the periphery of wheel M′ mounted on rotatable shaft *m*.

m′, is a lever fulcrumed to wheel M′, by pivot m^2.

m^3, is a roller mounted on lever *m′*, such roller forming a dog adapted to be engaged with or disengaged from the teeth of ratchet wheel M^3, such ratchet wheel consisting of a ring secured to sprocket wheel M^2 and having teeth on the inside thereof. Sprocket wheel M^2 is loosely mounted on shaft *m*.

m^4, is a sprocket chain by which movement is given to sprocket wheel M^2.

m^5, is a spring abutting at one end against the periphery of wheel M′ and at the other end against lever *m′*, and yieldingly holding such lever in either one of its two positions, so that dog, or roller m^3 is in or out of engagement with the teeth of ratchet wheel M^3, as desired; the position of such lever *m′* being automatically determined by pins or abutments N, N′, respectively.

The working of the hoisting devices just described is as follows:—The lever *m′* being in the position illustrated in Figs. 4, 5, and 6 (and roller or dog m^3 thereon being out of engagement with ratchet wheel M^3, and there held by spring m^5), rotation of the sprocket wheel to the left by sprocket chain m^4, will not cause rotation in wheel M′, or prevent such wheel

from turning in the opposite direction and the weight of stoker or plunger K will cause rotation in wheel M′, by chain M, to the right. In Figs. 4 and 6, wheel M′ is illustrated in the position it is in when having been turned to the left sufficiently to raise the stoker K to its highest position, and when in such position lever m' has been actuated on its fulcrum m^2 to release dog m^3 from ratchet wheel M^3 by contact with the pin N, so that further movement to the left of wheel M′ is prevented. By such releasing of roller or dog m^3 from engagement with the teeth of ratchet wheel M^3, the stoker K will be allowed to fall. In the fall of the stoker, chain M will be drawn downward and wheel M′ will be thereby turned to the right. The wheel M′ will continue to turn to the right until lever m' strikes pin N′, when such lever will be again turned on its fulcrum m^2, so that the roller or dog m^3 is again brought into engagement with the teeth of the ratchet wheel M^3, when the wheel M′ will again be turned to the left and the stoker thereby again elevated.

Coolers G, G′, are, constructed in the ordinary way, so that the gas passing therethrough will extend through pipes g, g, g, such pipes being surrounded with cool water contained in the space lettered g'.

P, P′, respectively, are conduits or ways, indicated by dotted lines in Fig. 2, extending, respectively, from the passage-ways B, B′, to passage-ways E, E′.

Conduits or ways P, P′, may be employed for conveying the products of combustion in the combustion chambers D^2, D^2, respectively, directly into carbureting chambers A^2, A^2, respectively.

The process of making gas by the hereinbefore described apparatus is as follows:—Carbonaceous fuel, as say, coal, is supplied to one of the combustion chambers A, A′. The coal is ignited, doors a^2, a^2, firmly closed, and air supplied to the combustion chamber through ways a^4, a^4, a^4, in sufficient quantity to support combustion in the combustion chamber, and to produce enough pressure in the combustion chamber to force the products of combustion, or partial combustion, therefrom through the mixing chamber, with which such combustion chamber is placed in communication by adjustment of gates b, b, b, and through the regenerating chamber adjacent thereto. As the products obtained in the combustion chamber enter the mixing chamber, after it has been heated to 500° Fahrenheit or more steam from pipe C^4 is mechanically mixed therewith, and the mechanically mixed steam and products from the combustion chamber pass through the series of passage-ways formed by the interstices between the several receptacles d^2 and d^3, in the regenerating chamber, and from the regenerating chamber the fuel gas, (which in such passage will have become a permanent inflammable gas,) will pass in or through the passage-ways E, F, or E′, F′, respectively, according to whether the process of making gas is carried on with the mixing chamber C and regenerating chamber D or the mixing chamber C′ and the regenerating chamber D′, duplicates thereof, to the place of consumption of such gas. I have found by experiment and by the working of plants adapted to carry on this process on a commercial scale that where the materials contained in the receptacles d^2, d^3, are of opposite electric polarities, as say, copper and iron, arranged so that materials of opposite electric polarities will not come in contact with each other, the elements of the mechanically mixed steam and products of the combustion chamber will separate or become separated into a nascent condition, and will then immediately recombine into a permanent inflammable compound gas, containing the elements hereinbefore described, and as the same extend through the regenerating chamber, while so recombining, that sufficient heat will be generated in such regenerating chambers, so as to enable me to continuously maintain the operation of the plant and the carrying on of the process. I have also found that where the number of receptacles d^2, d^3, containing, as stated, materials of opposite electric polarities, arranged as described, is in excess of the number required to enable me to continuously carry on the process of making a permanent inflammable gas, as described, the heat in such regenerating chamber (or chambers, if more than one be used), will continuously become greater until such heat is so intense as to necessitate diversion of the products of the combustion chamber into the other one of the duplicate mixing and regenerating chambers, illustrated and described, to allow the overheated regenerating chamber or chambers to cool down sufficiently to be again used. I have also found that where, as may readily be done, the material of opposite electric polarity, arranged so that material of one polarity will not come in contact with material of opposite polarity, and so as to obtain a series of gas passages therethrough, is placed in the regenerating chamber in suitable quantity or number, so that in the operation of the process, the heat of such chamber can be maintained at a sufficiently low temperature not to endanger the stability of the plant, the making of a permanent or fixed gas by this process is continuous through one set of mixing and regenerating chambers, and in such case, the combustion chambers A, A′, may, and properly should be alternately used, so that one thereof may be cleaned of the slag, ashes or other refuse, resulting from the combustion therein: it being understood that coke is not formed in such combustion chambers, or either of them, and the stopping of the combustion in such chambers, or either of them, is for the purpose of cleaning the same and not for the purpose of removing by-products of any kind or character, there being none necessarily produced by this process. And

the purpose of providing in the apparatus herein described the duplicate set of combustion chambers and mixing and regenerating chambers with means for diverting products of combustion or partial combustion, in either combustion chamber, into either set of mixing and regenerating chambers is to enable me, when necessary, to divert the products of combustion or partial combustion from either combustion chamber into either one of the mixing and regenerating chambers, as desired; and also to divert the products of combustion, in either one of the combustion chambers, continuously through either set of mixing and regenerating chambers: it being understood, that I have heretofore constructed a plant adapted to make a permanent inflammable gas on a commercial scale, wherein the products of combustion, or partial combustion in a furnace, assay, furnace A, are continuously convexed through a mixing and regenerating chamber, as say, C and D, such regenerating chambers containing therein materials of opposite electric polarities, arranged so that materials of opposite electric polarities will not come in contact with each other and so as to form a series of passage-ways through the chambers, for an indefinite time, as say in practice amounting to days and weeks, but as stated, I prefer in practice to have more than one combustion chamber from which the products can be continuously turned into a set of mixing and regenerating chambers.

In the continuous carrying on of the process fuel is supplied intermittently, as described, and the stoker described is intermittently used to break down the arch or crust which is continuously forming.

Where illuminating gas is desired to be obtained by this process, the fuel gas obtained as described, while in its heated condition, is conducted through passage-way d' into a second chamber, A^2, termed by me a carbureting chamber, and carbonaceous material, as coal, oil or the like, is supplied thereto. If such carbonaceous material be coal it is supplied to the carbureting chamber A^2 in substantially the same manner as to combustion chambers A, A', respectively, (no additional air or steam being supplied however,) and the heated fuel gas passing through the body of carbonaceous material takes up an additional amount of carbon and the mixture is then conducted to and through an additional regenerating chamber, as D^2, constructed substantially the same as the hereinbefore described regenerating chambers.

In the passage of the fuel gas carbureted as described, through the regenerating chamber D^2, a similar condition will obtain as in the regenerating chambers D, D', respectively, and thereby a permanent gas or a permanent carbureted fuel gas is produced. Where sufficient carbon is not added to the fuel gas by the passage thereof, as described, through a single carburetor to produce the candle power desired, particularly, where the carbonaceous material contained therein is coal, additional carburetors may be used. The gas thus becomes carbureted and from the regenerating chamber D^2 extends to and through the coolers G, G'.

The process of manufacturing illuminating gas is continuous, as in the case of the manufacture of fuel gas by this process; such fuel gas being first obtained as described, and then passed through the additional chamber A^2, and together with the products arising in such chamber, extending through the regenerating chamber D^2.

Where coal and a hydro-carbon, or coal sufficiently rich in volatile matter is employed for fuel in combustion chambers A, A', respectively, the fuel gas produced by the hereinbefore described process may be used for illuminating purposes, as well as for those certain fuel purposes requiring a gas rich in carbon, as in the working of certain metals; but a preferable process of making such a permanent inflammable gas is furnished by this apparatus by means of the conduits or passage-ways P, P', respectively, whereby the products of combustion in the combustion chambers can be conducted or conveyed directly into the carburetors A^2, A^2, respectively. In such case, the outlets of pipes E, E', respectively, are closed, valves f, f', respectively, are closed, and valves e, e', respectively, are opened. In such case the mixed products are conveyed from the carbureting chambers A^2, A^2, respectively, into and through regenerating chambers D^2, D^2, respectively, or, if required, into and through a series of such regenerating chambers.

I have found in practice where the materials of opposite electric polarities employed as filling in the regenerating chambers are not contained in receptacles, as herein described, and not otherwise separated, that in the operation of the machine, a coating of carbon will form or be formed upon such materials sufficient to insulate such materials of opposite electric polarity, from each other. I have also found that the materials of opposite electric polarities may be contained in receptacles, arranged in the following manner: that is, one of such materials contained in a receptacle, as a porous cup of refractory material with a second porous cup of refractory material embedded therein, such second cup containing the material of opposite electric polarity. I therefore, do not confine myself in this apparatus to any particular receptacle, or any particular way of insulating materials of opposite electric polarity from each other.

Where the walls of the mixing chamber are sufficiently heavy and constructed as hereinbefore described, of fire-brick, or like material, I have found reasonably good results obtainable when the filling C^2 and the series of gas passages thereby formed through such mixing chamber are omitted.

Having thus described my invention, what

I claim as new, and desire to secure by Letters Patent, is—

1. The continuous process of making gas, which consists in burning carbonaceous fuel, supplying air under pressure to said fuel, forcing steam into the products of combustion, mixing the steam and products of combustion, and then conducting the mixture through a heated regenerator filled with materials of opposite electric polarities, such filling being so disposed as to leave passages for the gas therethrough; substantially as described.

2. The continuous process of making gas, which consists in burning carbonaceous fuel, supplying air under pressure to said fuel, mechanically breaking down the arch or crust which forms in the combustion of such fuel, forcing steam into the products of combustion, mixing the steam and products of combustion, and then conducting the mixture through a heated regenerator filled with materials of opposite electric polarities, such filling being so disposed as to leave passages for the gas therethrough; substantially as described.

3. The continuous process of making gas, which consists in burning carbonaceous fuel, supplying air under pressure to said fuel, forcing steam into the products of combustion, mixing the steam and products of combustion, carbureting the mixture, and then conducting the mixture through a heated regenerator filled with materials of opposite electric polarities, such filling being so disposed as to leave passages for the gas therethrough; substantially as described.

4. The continuous process of making gas, which consists in burning carbonaceous fuel, supplying air under pressure to said fuel, forcing steam into the products of combustion, mixing the steam and products of combustion, conducting the mixture through a heated regenerator filled with materials of opposite electric polarities, such filling being so disposed as to leave passages for the gas therethrough, in carbureting the heated compound gas thus obtained and then conducting the mixture through an additional regenerator having filling of opposite electric polarities so disposed as to leave passages for the gas therethrough; substantially as described.

5. The continuous process of making gas, which consists in burning carbonaceous fuel, supplying air under pressure to said fuel; forcing steam into the products of combustion, mixing the steam and products of combustion, and then alternately conducting the mixture through one or the other of a series of heated regenerators filled with materials of opposite electric polarities, such filling being so disposed as to leave passages for the gas therethrough, substantially as described.

6. In a gas machine a mixing chamber having series of gas passages therethrough, formed by a filling of refractory material in combination with a regenerator consisting of a chamber having an inlet and an outlet, and a filling contained therein composed of materials of opposite electric polarities, the materials of opposite polarities not coming in electrical contact with each other, and so arranged as to form series of gas passages through the chamber; substantially as described.

7. A gas generating apparatus consisting of a combustion chamber, a mixing chamber into which the heated products from the combustion chamber may be delivered, a filling of a refractory material in such mixing chamber arranged to form series of gas passages therethrough, a regenerating chamber having a passage-way extending thereinto from the mixing chamber, a filling of material of opposite electric polarities, arranged in the regenerating chamber so that material of one polarity will not come in contact with material of opposite polarity, and to form series of gas passage-ways therethrough, an air supply extending into the combustion chamber at the base thereof, and a steam supply extending through the walls of the apparatus, and adapted to discharge steam into the heated products obtained from the combustion of the carbonaceous fuel; substantially as described.

8. A gas generating apparatus consisting of a combustion chamber, a mixing chamber into which the heated products from the combustion chamber may be delivered, a regenerating chamber having a passage-way extending thereinto from the mixing chamber, a filling of material of opposite electric polarities, arranged in the regenerating chamber so that material of one polarity will not come in contact with material of opposite polarity, and to form series of gas passage-ways therethrough, an air supply extending into the combustion chamber at the base thereof, and a steam supply extending through the walls of the apparatus, and adapted to discharge steam into the heated products obtained from the combustion of the carbonaceous fuel; substantially as described.

9. A gas generating apparatus consisting of more than one combustion chamber and more than one mixing chamber into which the products of the combustion chambers can be delivered, passage ways connecting the several mixing and combustion chambers a filling of a refractory material in such mixing chambers arranged to form series of gas passages therethrough, regenerating chambers, connected, respectively, with the respective mixing chambers, and a filling of material of opposite electric polarities arranged in the regenerating chambers, respectively, so that material of one polarity will not come in contact with material of opposite polarity, and to form series of gas passage-ways therethrough; substantially as described.

10. A gas generating apparatus consisting of more than one combustion chamber and more than one mixing chamber into which

the products of the combustion chambers can be delivered, passage ways connecting the several mixing and combustion chambers, regenerating chambers, connected respectively with the respective mixing chambers, and a filling of material of opposite electric polarities arranged in the regenerating chambers, respectively, so that material of one polarity will not come in contact with material of opposite polarity, and to form series of gas passage-ways therethrough; substantially as described.

11. A gas generating apparatus consisting of a combustion chamber, an air supply extending into the combustion chamber, at the base thereof, and a steam supply extending through the walls of the apparatus and adapted to discharge steam into the heated products obtained from the combustion of the carbonaceous fuel, a carbureting chamber adapted to contain carbonaceous material, a passage or way extending from the combustion chamber into the carbureting chamber, and a regenerating chamber having a passage-way extending thereinto from the carbureting chamber, and a series of gas passages in the regenerating chamber obtained by filling of material of opposite electric polarities, arranged so that material of one polarity will not come in contact with material of opposite polarity; substantially as described.

12. In a gas apparatus, the combination of a closed receptacle forming a combustion chamber with a stoker, such stoker consisting of a rod extending through the top of the closed receptacle, a circular head on the lower end of the rod, and within the combustion chamber, the top of the head extending downward and outward from the rod to the periphery of such head, and means for hoisting and letting fall such rod and head; substantially as described.

THURSTON GORDON HALL.

In presence of—
CHARLES TURNER BROWN,
JAMES W. CHISHOLM.