

(No Model.)

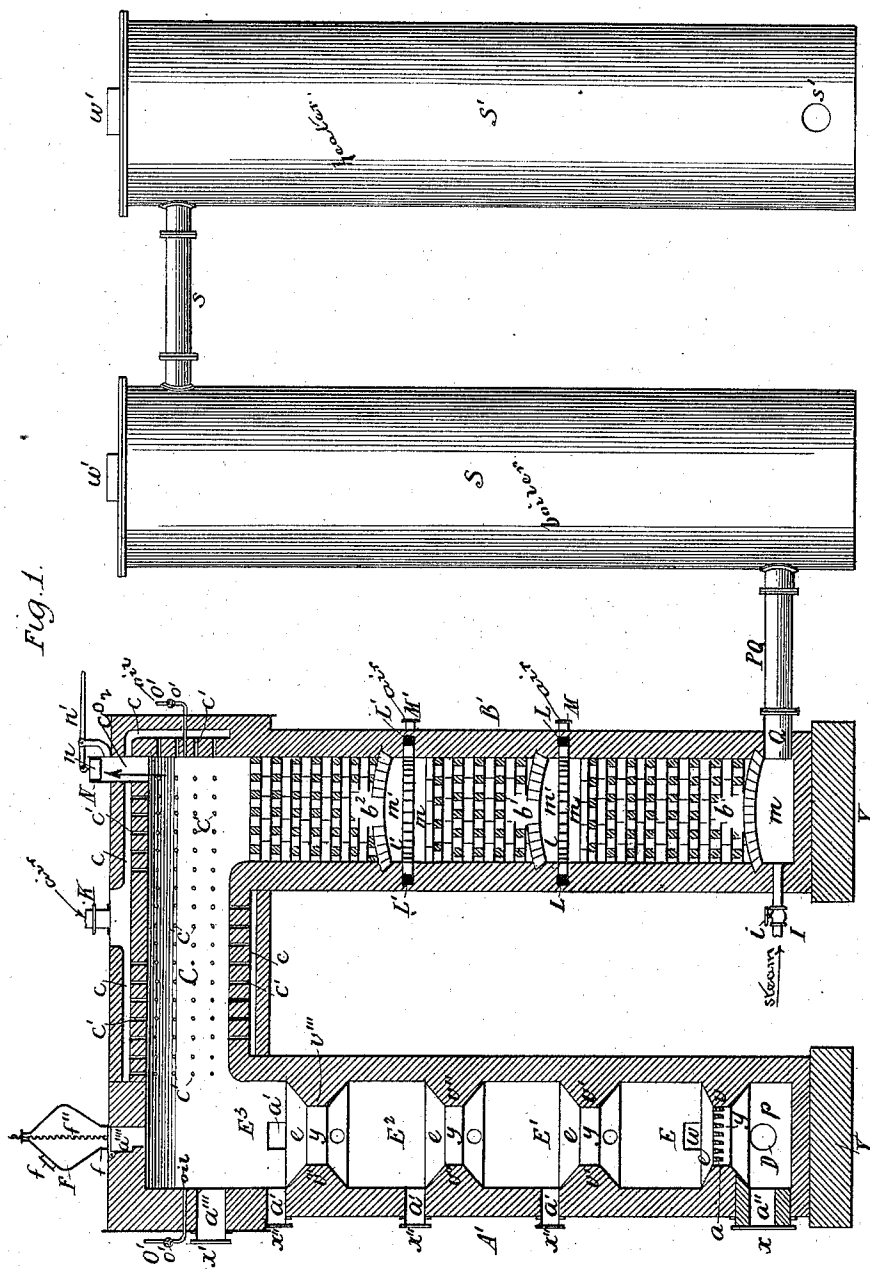
4 Sheets—Sheet 1.

J. L. STEWART.

APPARATUS FOR MANUFACTURING GAS.

No. 576,170.

Patented Feb. 2, 1897.



Witnesses

Will. Norton
Geo. H. Brown.

Inventor

John L. Stewart

By E. H. Clark
Attorney

(No Model.)

J. L. STEWART.

4 Sheets—Sheet 2.

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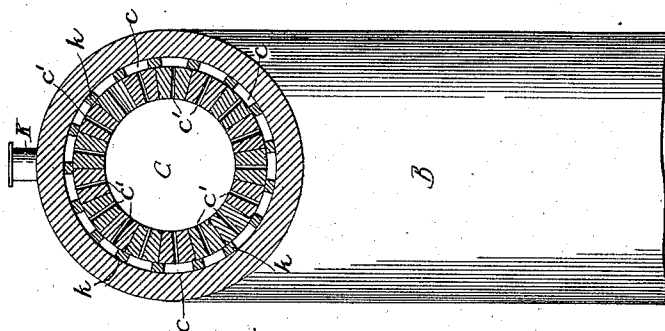


Fig. 3.

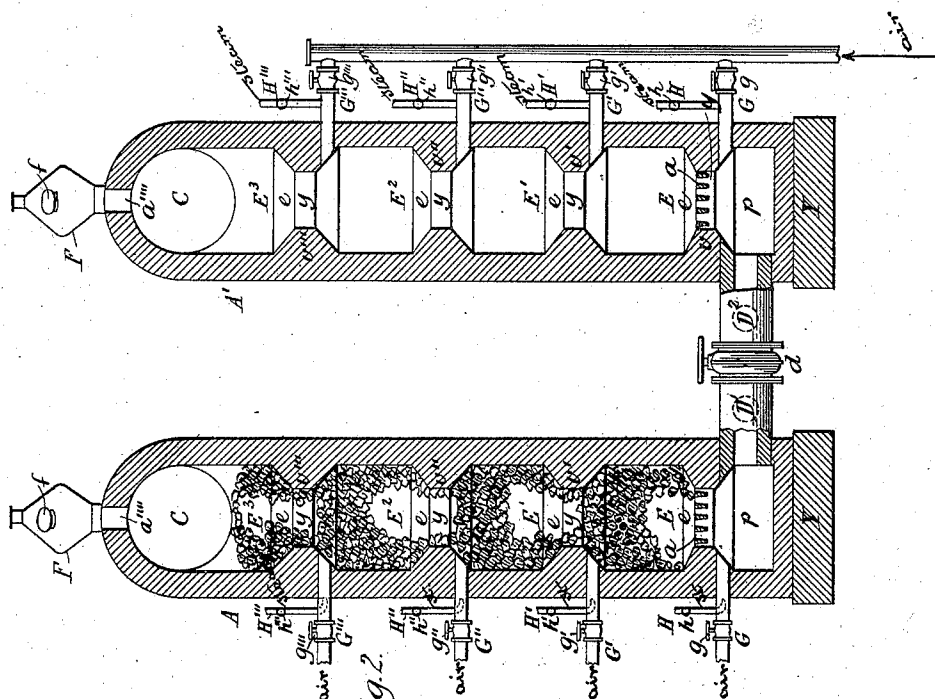


Fig. 2.

Witnesses
Wm. S. Norton
Geo. H. Brown

Inventor
John L. Stewart
By E. B. Clark
Attorney

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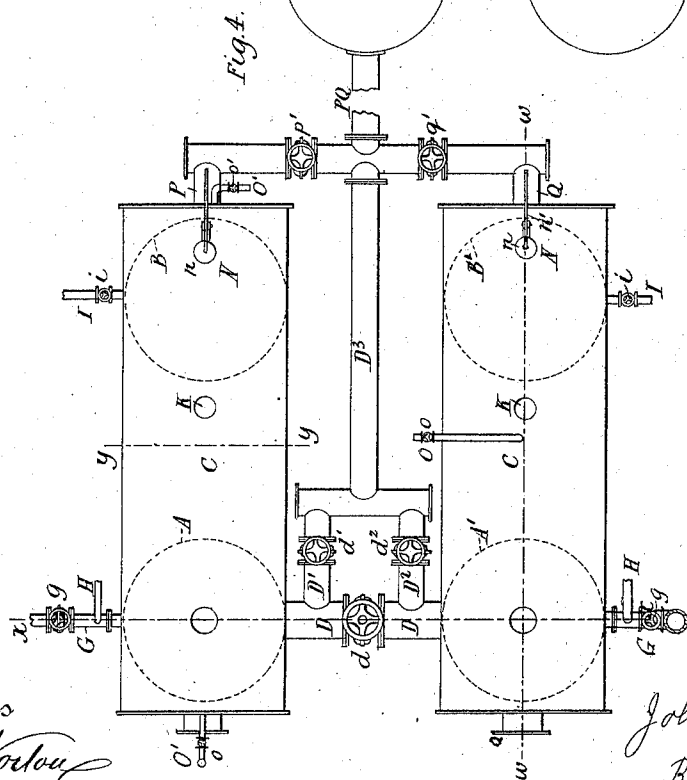
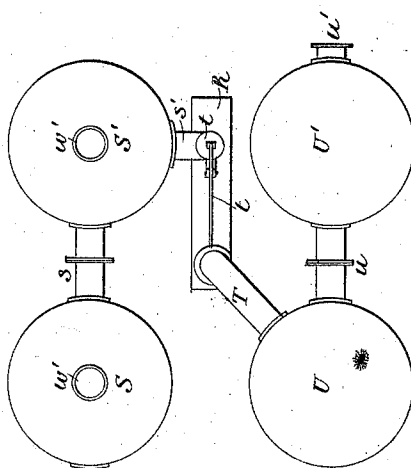
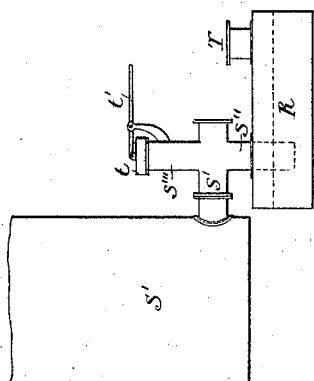
4 Sheets—Sheet 3.

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Will^d. Norton
Geo. H. Brown Jr.

Inventor.

John L. Stewart

By E. H. Clark
Attorney

UNITED STATES PATENT OFFICE.

JOHN L. STEWART, OF SAN FRANCISCO, CALIFORNIA, ASSIGNOR TO THOMAS A. MCINTYRE, OF NEW YORK, N. Y.

APPARATUS FOR MANUFACTURING GAS.

SPECIFICATION forming part of Letters Patent No. 576,170, dated February 2, 1897.

Application filed January 13, 1893. Serial No. 458,304. (No model.)

To all whom it may concern:

Be it known that I, JOHN L. STEWART, a citizen of the United States, residing at San Francisco, in the county of San Francisco and State of California, have invented certain new and useful Improvements in Apparatus for Manufacturing 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 a cupola generating apparatus provided with a superheater and with special and novel features of construction adapting it for coking bituminous coal and generating gas.

The object of my invention is to provide an improved apparatus for coking bituminous coal without producing injurious cakes or crusts and for utilizing the resulting incandescent coke for decomposing steam in the production of fuel or water gas.

In the manufacture of water-gas from bituminous coal a much deeper body of fuel (coke and coal) is required for decomposing steam than where hard coal is used, and heretofore much difficulty has been experienced in producing a sufficiently deep body of coke without caking to completely decompose steam and produce a good quality of water-gas. By means of my improved construction I overcome the difficulty heretofore encountered and produce a deep body of good hard coke which may be readily heated to incandescence, and I also overcome the difficulty which heretofore arose in the production of hard cakes or crusts of carbon, which were almost impervious to the passage of steam or gas and caused much annoyance or failure in the production of a uniform quality of water-gas. In order to attain my improved results, I provide a series of communicating coking-chambers, one above the other, and provided with suitable supply-pipes for air and steam and with stoking-holes, whereby a deep body of porous hard coke may be readily produced and heated to incandescence and by means of which steam may be completely decomposed into hydrogen and carbonic oxid, practically free from carbonic

acid and other deleterious impurities. I also provide improved means for causing complete combustion of the large volume of hydrocarbons—gases and vapors—given off from the bituminous coal at the time of heating up the apparatus, so as to free the superheater from lampblack and also to better heat the refractory brickwork therein.

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

I will now particularly describe the details of construction and the method of operating my apparatus by reference to the accompanying drawings, in which—

Figure 1 represents a vertical longitudinal section on lines *ww*, Fig. 4, of a single generator and an elevation of the boiler and water-heater. Fig. 2 represents a vertical transverse section on line *xx*, Fig. 4, of a pair of connected generators. Fig. 3 represents a transverse section on line *yy*, Fig. 4, through the combustion flue or chamber and an elevation of the superheater. Fig. 4 represents a top plan view of a double generating apparatus. Fig. 5 represents a detail view in elevation showing the gas-take-off pipe and hydraulic seal-box. Fig. 6 represents a plan of a modified arrangement of apparatus.

I preferably construct my apparatus double or with duplicate generators and superheaters, as shown in plan view, Fig. 4, though a single generator composed of a coking and decomposing chamber and a fixing-chamber may be advantageously used for generating a comparatively small amount of gas.

I will first describe a single generating apparatus, as shown in Fig. 1.

My generator is composed of the fuel and decomposing chamber or cupola *A'*, the superheating and fixing chamber *B'*, and the connecting combustion chamber or flue *C*, and such chambers are constructed of brick, having a lining of fire-brick, and are covered with tight iron jackets in the usual manner. The fuel and decomposing chamber *A'* is provided at the bottom with the usual grate *a* and ash-pit *p*, having an opening *a''*, closed by a lid or door *x* for the removal of ashes. The ash-pit *p* is partly arched over or covered by an

inwardly-projecting brickwork *v*, forming at the top a contracted throat or passage *y*, into which is set the grate *a*. The brickwork *v* will project circumferentially from the outer wall of the chamber *A'*, being either circular or rectangular, according to the shape of said chamber. Chamber *A'* is preferably cylindrical, and the brickwork *v* will, therefore, be made circular. The upper part of this brickwork *v* is constructed to form an inclined annular floor or hearth *e* from the wall of the chamber to the grate *a*. Above the grate I construct a series of coking-chambers *E*, *E'*, *E''*, and *E'''*, one above the other in vertical series, as shown in Fig. 1, said chambers being partially separated or partitioned one from the other by means of the inwardly-projecting rings of brickwork *v'*, *v''*, and *v'''*, formed with inclined upper sides forming annular floors or hearths *e* at the bottoms of the coking-chambers *E*, *E'*, &c. Central openings or throats *y y* are formed in the brickwork and serve to connect the coking-chambers *E* to *E'''* one with the other.

The inwardly-projecting brickwork *v v'*, &c., and the annular floors or hearths *e e* serve the important function of supporting the coke in separate bodies and overcomes the difficulty which would be caused by a single deep body of coke and coal, which on account of the superincumbent weight would settle into a dense mass and prevent the free and effective passage of air, steam, gas, and vaporthrough it. The projections also serve the important purpose of deflecting currents of air and steam away from the side walls—where they are apt to pass along in channels—and into the central portion of the body of carbon, where thorough decomposition is insured.

In manufacturing gas with bituminous coal currents of air and steam are apt to pass up along the side walls, where they are not exposed to proper contact with the fuel and thus escape without decomposition or with only partial decomposition, so that a large percentage of carbonic acid and other deleterious gases are thus formed. By deflecting the current at different heights in the generating-chamber from the side walls I overcome this defective operation and secure greatly-improved results in the quality of gas produced and am also enabled to use bituminous coal in the manufacture of water-gas. The central openings *y y* permit the descent of the coke from chamber to chamber, and the passage of the coke is aided by means of stoking-bars inserted just above the annular floors *e*.

For the purpose of breaking up the coke and working it down from chamber to chamber I provide a series of openings *a'* in the side walls just above the floors *e* and in practice close such openings with the lids *x''*, as shown in Fig. 1. Just above the grate in the wall of chamber *E* an opening or door *w* is provided for the removal of cinder, clinker, &c., when it is desired to clean the generator.

In the wall of the top chamber *E'''* there is constructed a manhole-opening *a'''*, which is closed by a lid *x'*, and in the top of such chamber is formed a fuel-supply opening *a''''*, at the top of which is connected a coal-hopper *F*, having at the top a supply-opening *f'* and at the bottom a valve *f''*, which may be pivotally connected at one side and held up by means of a chain *f'''*, passing up through the hopper. The drop-valve *f'* being raised to close the hopper, as shown in Fig. 1, the hopper is filled with coal through the opening *f'*, after which such opening is closed, and then at any time desired valve *f'* is dropped down, permitting the charge of coal to fall into the coking-chamber below.

An air-blast pipe *G*, Fig. 2, having valve *g*, connects with the ash-pit. A steam-supply pipe *H*, having a valve *h*, also connects and may be tapped into the air-pipe *G*, or may pass separately through the side wall.

With the tops of the coking-chambers *E E'*, &c., there connects the air-pipes *G'*, *G''*, and *G'''*, provided with valves *g'*, *g''*, and *g'''*, and with said air-pipes there may be connected the steam-supply pipes *H'*, *H''*, and *H'''*, provided with valves *h'*, *h''*, and *h'''*. The steam-supply pipes, however, may be passed separately through the walls of the chambers, but I prefer that the air and steam be admitted just below the contracted openings *y*. Air may be thus supplied at the base of each coking-chamber in regulated quantity, either for aiding in coking the coal or for heating the coke to incandescence. When the air is admitted to aid in coking the comparatively fresh coal, it is preferably supplied only in small quantity, so as to produce a slow or smothered combustion favorable to the coking operation. Steam may also be admitted in suitably-regulated proportions, so as to control the temperature and assist in desulfurizing the coal during the coking operation. When the heat is high, steam may also be admitted into the different coking-chambers and be decomposed for the production of gas.

The top of the fuel and decomposing chamber or cupola *A'* is connected to the top of the superheater *B'* by means of the cylindrical cross-flue *C*, as shown in Fig. 1, and this flue *C* is constructed with double walls, forming an interior annular air-space *c*, which connects with the interior of the flue by numerous perforations *c'*. The inner lining or wall is constructed of special arch fire brick or blocks, each having a central orifice or hole *c'* for the passage of air to the internal flue. The inner fire-clay blocks are supported and spaced apart from the outer lining by means of the spacing-brick *k*, as shown in Fig. 3, thus forming the annular air-flue *c*, by means of which air may be distributed entirely around the circumference of the inner flue and also at the end adjacent to the superheater, as shown in Fig. 1. An air-blast pipe *K* connects with the annular air-space *c* at

the top of flue C. A manhole-opening or smoke-flue N is formed in the top arch of connecting-flue C over the top of the superheater B, and is provided with a tight-fitting lid or valve *n*, having an operating-lever *n'*. The annular air-space *c* and the numerous perforations *c'*, leading therefrom to the interior of flue C, supply the requisite quantity of air in numerous small streams for producing complete combustion of the large volume of hydrocarbon gases and vapors given off from the body of coke and coal in chamber A' during the operation of heating up, and prevent the accumulation of soot and fine carbon in the superheater, and also serve to highly heat the brickwork of such superheater, so that steam in passing through it will be highly superheated, or carburated gases in passing through it will be fixed.

The superheater B' is constructed of brick, having a lining of fire-brick and the usual tight iron jacket, and is supported upon a suitable brick or stone foundation Y. Within the superheater B are constructed at different heights a number of arches *b*, *b'*, and *b''* for supporting bodies of brick checker-work. Below the lower arch *b* is formed a chamber *m*, with which connects the main outlet-pipe Q, through which is passed at different times the products of combustion and gas. A steam-supply pipe I, having a valve *i*, also connects with chamber *m*. Below the arches *b'* *b''* are formed the combustion-chambers *m'*, which are supplied with air by the annular flues L L', having ports *l''* leading into the chambers *m'*. Air is supplied to the annular flues L and L' by blast-pipes M M', which preferably connect with a separate blower; that is, a blower distinct from the blower used for supplying air to the fuel and decomposing chamber A'. At the top of either chamber A' or B' or at the top of both there connects an oil-supply pipe O', having a valve *o'* for supplying hydrocarbon oil to carburet the water-gas when it is desired to make illuminating-gas. The oil-supply pipe may connect at any convenient point with the flue C, so as to admit the hydrocarbon oil or vapor into the water-gas passing from the chamber A' to the fixing-chamber B'. The gas-take-off pipe Q, leading from the base of the superheater, is provided with a valve *q'*, Fig. 4, and connects by means of a pipe P Q with the base of the vertical boiler S, which is constructed with the usual tube-sheets and smoke-boxes at the top and bottom, but which are not here shown. A pipe *s* connects the boiler S with a tubular water-heater S', constructed substantially like the boiler S, and a pipe *s'*, Fig. 5, leads from the bottom of heater S' and connects by a pipe *s''* with the hydraulic seal-box R, which is partially filled with water or other liquid in the usual manner. A short pipe *s'''* extends upward from the pipe *s'* and is provided with a tight-fitting lid or valve *t*, having an operating-lever *t'* for the escape of waste products of combustion.

The hydraulic seal-box R connects by a pipe T with scrubber U, which in turn connects by a pipe *u* with a second scrubber U'. A pipe *u'* leads from scrubber U' for conducting the gas to the purifier or to a storage holder, and it may connect with pipes leading to a furnace where the gas is burned.

The boiler S and water-heater S' are provided at the top with the usual manholes and lids *w'*.

The description above given applies more particularly to a single generating apparatus, but such apparatus may be duplicated, forming a double generator, and I prefer to construct a double generating apparatus, as shown in Figs. 2 and 4, for the reason that such a form of apparatus may be operated to produce a much larger volume of gas than a single apparatus and may also be operated in a greater variety of ways with greater economy for the production of either fuel-gas or illuminating-gas. Even though a comparatively small quantity of gas be required, such as might be produced by a single generator, I preferably construct a double apparatus, so that in case one set or generator becomes impaired by becoming broken or by becoming choked and clogged with cinder and clinker, such generator may be thrown out of use and the other generator put in operation for the manufacture of gas. The two single generators are connected by a cross-pipe D, provided with a valve *d*, and connecting the ash-pits *p* at the base of the fuel and decomposing chambers A and A', as shown in Figs. 2 and 4. The two generators are constructed alike and are both provided with steam and air pipes, like those above described. Gas-take-off pipes P and Q lead from the bases of the superheaters and are provided with valves *p'* and *q'*, and connect with the pipe P Q, which leads to the steam-boiler. Gas-escape pipes D' and D², having valves *d'* and *d''*, connect with the cross-pipe D on each side of the valve *d*, and also with the pipe D³, which connects with the pipe P Q. The two fuel and decomposing chambers A A' and the two superheaters B B' are thus each connected by a separate valved pipe, leading from its base, to the steam-boiler. Products of combustion and hot gas are both conducted off by means of these pipes into and through the steam-boiler and water-heater for generating steam, and the waste products are discharged through the pipes *s'''* by opening the lid *t*, while the gas to be stored is passed off through the seal-box by closing the lid *t*.

The apparatus may be effectively and economically operated in a variety of ways for the production of either fuel-gas or illuminating-gas. A mixture of water-gas and illuminating-gas may be made for use as a fuel, so that it may have the necessary odor to make it safe in use and also have a greater calorific value for heating purposes.

In operating a double apparatus a positive blower is preferably used for each generator,

so that a definite and ascertained amount of air may be supplied to it. For secondary combustion a single Sturtevant blower will answer for supplying air to the combustion-chambers and superheaters of a double set of generators.

In starting a single generator it is first fired up by kindling a fire on the grate of chamber A' and gradually filling it up with coke, allowing it first to burn by natural draft and the products of combustion to escape through the short flue or stack N at the top of the fixing-chamber. After the fuel is well ignited valve *n* may be closed and the air-blast admitted to ash-pit *p*, then valve *q'* opened and the products of combustion passed down through the superheater and out through the steam-boiler and water-heater, and finally permitted to escape through the pipe *s'''*, the valve or cover *t* of which is open. After admission of the air-blast to the ash-pit air may be admitted through one or more of the pipes G G' to the chambers E E' for assisting combustion and quickly heating the coke to incandescence. Air is also admitted by pipe K into the annular air-space *c*, from which it escapes through the perforations *c'* into the combustion-flue C, causing combustion of the gaseous products, and the resulting hot products pass thence down through the superheater, where air may be again admitted by means of the flues L L' and ports *l l'* for completing combustion of any particles of carbon or unburned gases. After starting the generator with coke, as above described, bituminous coal is subsequently supplied to the upper coking-chamber E³, and as the coal is partially coked it is worked down by means of stoking-bars into the coking-chamber E² next below, and the coking operation thus proceeds from chamber to chamber until the volatile matter is all driven off from the coal. As soon as the coal is coked it may be subjected to a strong air-blast and heated to incandescence without danger of being melted or formed into cakes and crusts of hard carbon. Stoking-bars are inserted through the holes *a'* and are operated to break up the coke and to push it down into and through the openings *γ* from one chamber to another. Small streams of air may be admitted into the coking-chambers for producing a smothered combustion of the gases and thereby aiding the coking operation, but care must be taken not to raise the heat too high in the upper coking-chambers where the coal is comparatively fresh.

The above-described construction of the coking-chambers and method of operating them is important, for if the coke and coal were in one straight cylindrical body it would be thoroughly impracticable for generating gas, for the reason that the pressure from top to bottom would be so great as to compact the whole mass into a solid body, so that neither steam nor air could pass through it. Though

it is impracticable to manufacture gas with only a deep body of soft coal and coke, yet a much greater depth and bulk of such fuel is required than is the case with hard coal.

In case a double apparatus is used the valve *d* in cross-pipe D at the base of the generators is closed, the valves *p' q'* are opened, and the generators are fired and the air-blast admitted to both of them, as above explained with reference to one of them. The hot products of combustion now pass off through both superheaters and thence through pipes P and Q to and through the steam-boiler and water-heater and finally escape by the pipes *s'''*, the valve *t* of which is open for that purpose. After shutting off the air and turning on the steam at the base of the gas-generators the valve *t* over the seal-box is left open until all of the products of combustion remaining in the gas-generators and superheaters, steam-boiler, and water-heater is expelled by the current of steam and the resulting water-gas. Valve *t* is then closed, causing the gas to pass down into the hydraulic seal-box and thence pass through the scrubbers, from which it is passed to the purifier or relief-holder.

In operating a single generating apparatus any desired quality of gas can be made. All water-gas may be made at one run and all illuminating-gas at the next run; or illuminating-gas may be made only in from ten to twenty runs, so as to impart to the fuel-gas a strong odor of hydrocarbons and also increase its heat-units per cubic foot. All the valves being closed, valve *p'* in pipe P is opened and the air-blast admitted at the bottom of generator A, and air is also admitted to the combustion-flue C and at the necessary points in the superheater B, causing combustion of the fuel and of the resulting gaseous products until the fuel is heated to incandescence and the superheater is also heated to the desired temperature. The air-blast is now shut off, and in order to make fuel-gas valve *p'* is closed and valve *d'* is opened. Steam is then admitted at the base of superheater B and superheated by passage up through such superheater and then passed into the top of fuel-chamber A, where it aids in coking the fresh bituminous coal and carries downward part of the volatile hydrocarbon vapors therefrom into the incandescent coke below, where decomposition of the steam and vapors is effected, and the resulting water-gas passes off by way of pipes D', D³, and P Q through the steam-boilers and thence to and through the scrubbers.

When the apparatus requires reheating, valve *d'* is closed and valve *p'* opened and the apparatus is heated up as before described. Now in order to make illuminating-gas valve *p'* is left open and steam is admitted at the base of the fuel and decomposing chamber A and is decomposed by passage up through the body of incandescent fuel. Oil is sprayed into combustion-flue C or into the top of

chamber A by means of pipe O, thereby carbureting the water-gas as it passes to the superheater B.

The carbureted gas is combined and fixed in superheater B, and is thence discharged through pipe P through the boiler and scrubbers to the holder. Two single sets of apparatus may be operated at the same time, one making fuel-gas and the other making illuminating-gas, and the two gases thoroughly mixed by passing them both at the same time through pipe P Q, and thence through the boiler and water-heater and scrubber.

The double-set apparatus may be operated all together as a single apparatus for the manufacture of gas, as follows: The two fuel-chambers and the two superheaters are heated up to the proper temperature, as heretofore explained. Then all the valves being closed valves d and p' are opened and steam is admitted into the base of superheater B' and passed up through such superheater and thence in a superheated condition into the body of fuel in chamber A', in passing down through which it is partially or wholly decomposed. A small additional quantity of steam may be admitted into one or more of the coking-chambers, in either chamber A or A', and passed along with the water-gas. The whole product of water-gas and partially-decomposed steam is then passed through the cross-pipe D up into and through the body of fuel in chamber A, where decomposition of steam into water-gas is completed. The resulting water-gas then passes down through superheater B and finally passes off through pipe P Q, the steam-boiler and water-heater and the scrubbers to a place of storage or use.

The water-gas on passing from the top of chamber A may be carbureted by the admission of hydrocarbon oil through pipe O or through a similar pipe connecting with the cross-flue C, and the carbureted gas fixed by passage down through the superheater B.

The direction of the flow of steam and gas may be reversed at the next run by opening valve q' and closing valve p' , valve d being left open. Steam is now admitted first into the base of the superheater B and passed in the opposite direction through the apparatus, and the resulting gas is passed off through pipe Q and its valve q' .

By operating the double set of generators as a single apparatus steam may be decomposed very rapidly, forming gas which is practically free from carbonic-acid and other gases and deleterious vapors, and the water-gas may also be effectively carbureted, producing a superior quality of illuminating-gas.

In Fig. 6 I have illustrated in plan view a modified arrangement or setting embracing two sets of gas-generating apparatus, together with connecting air-blowers, and a gas-exhauster and an exhauster for waste products of combustion and a relief gas-holder. In each set of apparatus there is a fuel and

decomposing chamber or generator A and fixing-chamber B, (or generator A' and fixing-chamber B'), a steam-boiler S, and a water-heater S', while the two scrubbers U U' serve for scrubbing the gas from both sets of apparatus. Pipes s' , having valve t , connect the two water-heaters S' S' with the exhauster T², having an escape s''' for drawing off the waste products of combustion and discharging them into the air. The two water-heaters S' S' also connect by pipes T' T', having valve t'' t''' , with scrubber U, which connects by pipe u with scrubber U', which latter connects by pipe u' with the gas-exhauster V, which discharges the purified gas into the hydraulic main R, from which the gas escapes by pipe u'' to the relief-holder W. The two fuel and decomposing chambers A A' are supplied with air through pipes G, having valves g , leading from the positive blower Y, and the superheaters B B' are supplied with air through the pipes K, having valves k' , leading from the fan-blower X. Two single sets of generating apparatus are thus arranged and connected in convenient form for effectively and economically manufacturing gas.

Only combustible gas will pass through the scrubbers, while both the hot gas and hot products of combustion will pass through the steam-boiler and water-heater.

In order to operate a single set of apparatus, as A B, the fuel having been ignited therein, the exhauster T² is started, valves p' and t are opened, and air-blasts are admitted through pipes G and K. The positive blower Y supplies air to the generator A, and the fan-blower X supplies air to the superheater. The apparatus having been heated up, air is shut off, the valves p' and t closed, and the valves q' and t'' opened, and steam is admitted to the base of the superheater B. Then the gas-exhauster R is started, thereby drawing gas off through the boiler, water-heater, and scrubbers, and forcing it through the water seal and thence into the relief-holder W. When both sets of apparatus are being operated at the same time, one set will be manufacturing gas while the other set is being heated up, and then both exhausters and both blowers will be run at the same time.

This apparatus is peculiarly adapted for manufacturing gas for all kinds of metallurgical furnaces and all kinds of metallurgical work, or for other furnaces and industries.

Heretofore it has been proposed to construct the walls of a roasting-furnace with "a series of conical contractions and enlargements, like a series of concave truncated cones placed base to base and apex to apex," and also arrange "centrally within the same a corresponding series of convex cones of smaller diameter, leaving an annular zigzag conical space between the two." The central series of convex cones were secured to a

central rod. The series of conical contractions and enlargements, forming the interior surface of the shaft-furnace, do not form chambers with circumferential hearths adapted to support coal or coke, as in my gas-generating furnace, and the series of interior convex cones in the roasting-furnace would be a serious obstruction in my coking-chamber and, in fact, would render my furnace inoperative for distilling and coking bituminous coal and generating gas therefrom. It has also been proposed to construct an ore-roasting furnace with inwardly-projecting inclined offsets, one above another, and with a central hollow shaft having secured to it a series of disks arranged between the offsets. This furnace would also be inoperative for coking coal and for manufacturing gas. The ore-roasting furnaces above mentioned are also open at top and bottom, and no provision is made in them for conducting off and saving combustible gas. The interior central obstructions would prevent coal and coke from being fed down from chamber to chamber, as in my gas-generator, and I make no claim to such construction of furnace.

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

30 1. A closed cupola gas-generator having a gas-escape pipe and constructed with a vertical series of connecting coking-chambers having intermediate circumferential solid hearths or ledges, provided with central openings for the passage of coke, said chambers being free from internal obstructions, and the walls of said chambers having stoking-openings, provided with tight-fitting lids above said hearths, for the insertion of bars to break up the coke and work it down through the central openings, whereby the coal, as coked, may be worked down into the chambers below and blasted with air, and the gaseous products directed from the side walls into the central portion of the body or bodies of fuel for better conversion into fixed combustible gas, substantially as described.

2. A cupola gas-generator constructed with a vertical series of connected coking-chambers having solid circumferential hearths or ledges between them, provided with central openings for the passage of coke, the side walls of said chambers having stoking-openings for the insertion of bars to break up the coke and also having air-supply pipes opening into the chambers below said inwardly-

projecting hearths, substantially as and for the purpose described.

3. A cupola gas-generator constructed with a series of circumferential brickwork hearths as v, v', v'', v''' , projecting inward from the walls of the cupola and provided with central openings y , and forming a vertical series of connected coking-chambers, E, E', E'', E''' , said chambers being provided with stoking-openings as a' , having tight-fitting lids, and with pipes for supplying them with air and steam, substantially as and for the purpose described.

4. In a gas-generating apparatus, the combination with the fuel and decomposing chamber and the fixing-chamber containing refractory material, of a combustion-flue, C , connecting them at the top and constructed with double walls forming an annular air-space, c , the interior wall being formed of perforated brick and spaced apart from the outer wall by means of spacing-brick, k , and an air-pipe connecting with space c , substantially as and for the purpose described.

5. In a gas-generating apparatus, two fuel and decomposing chambers, each constructed with a vertical series of coking chambers or apartments, having intermediate circumferential solid hearths, the walls of said chambers having stoking-openings, and a valved pipe, D , connecting the chambers at the bottom, in combination with two fixing-chambers, the combustion-flues, C , connecting such fixing-chambers with the fuel-chambers at the top and constructed with double walls forming an annular air-space, c , and the interior wall being perforated, and the gas-take-off pipes, P and Q , provided respectively with valves, p' and q' , leading from the fixing-chambers, substantially as described.

6. In combination with the two fuel and decomposing chambers and their connected fixing-chambers, a pipe D , having a valve, d , connecting the fuel-chambers at the bottom, gas-take-off pipes P and Q having valves, p' and q' , and leading from the fixing-chambers and the gas-take-off pipes D', D'' , having valves, d', d'' , connecting with the cross-pipe D , substantially as and for the purpose set forth.

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

JOHN L. STEWART.

Witnesses:

DANIEL HANLON,
LOUIS A. SOUC.