(No Model.) 2 Sheets—Sheet 1.

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## METHOD OF AND APPARATUS FOR MANUFACTURING GAS.

No. 547,118. Patented Oct. 1, 1895.

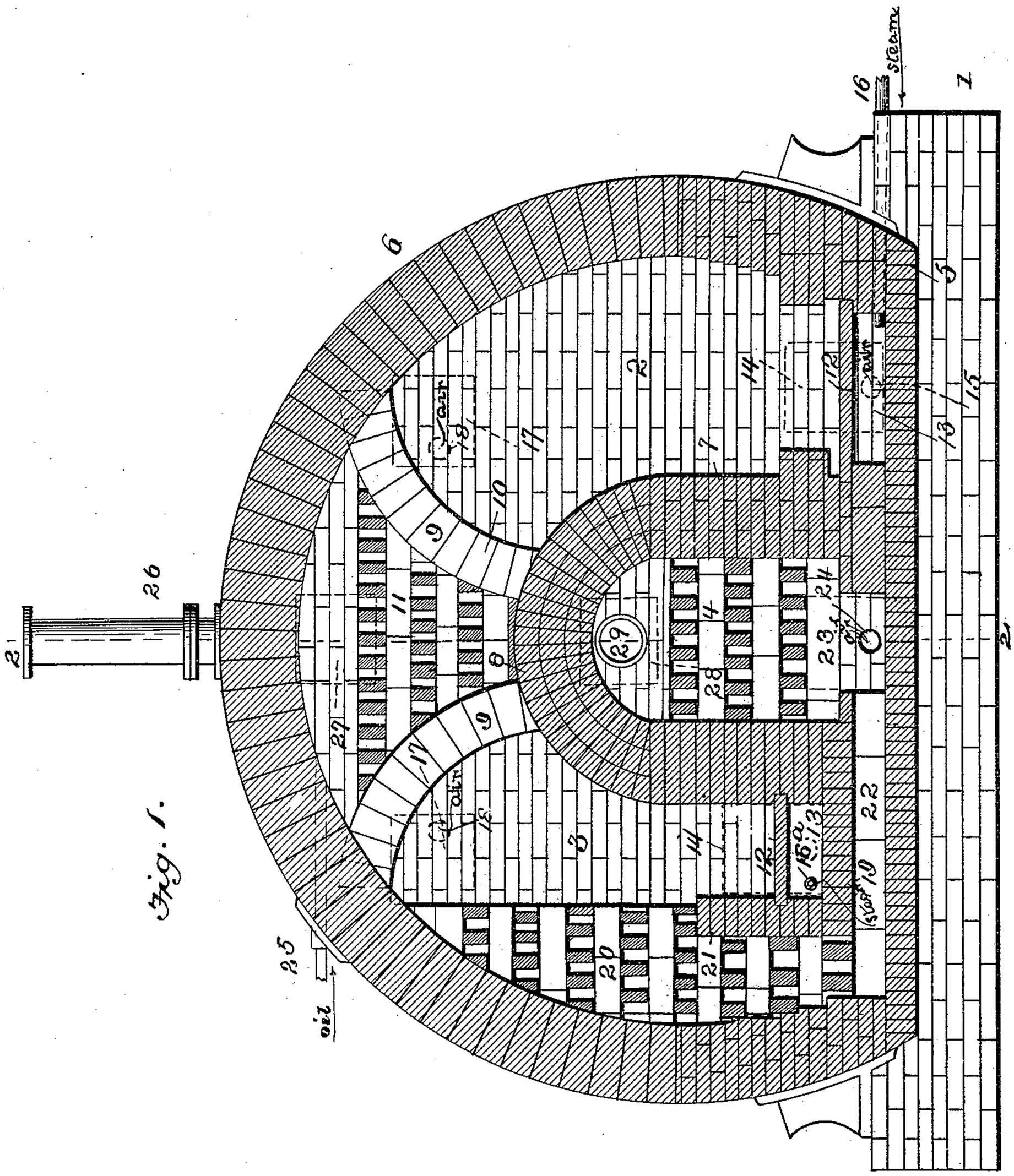


Fig. 1.

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(No Model.) 2 Sheets—Sheet 2.

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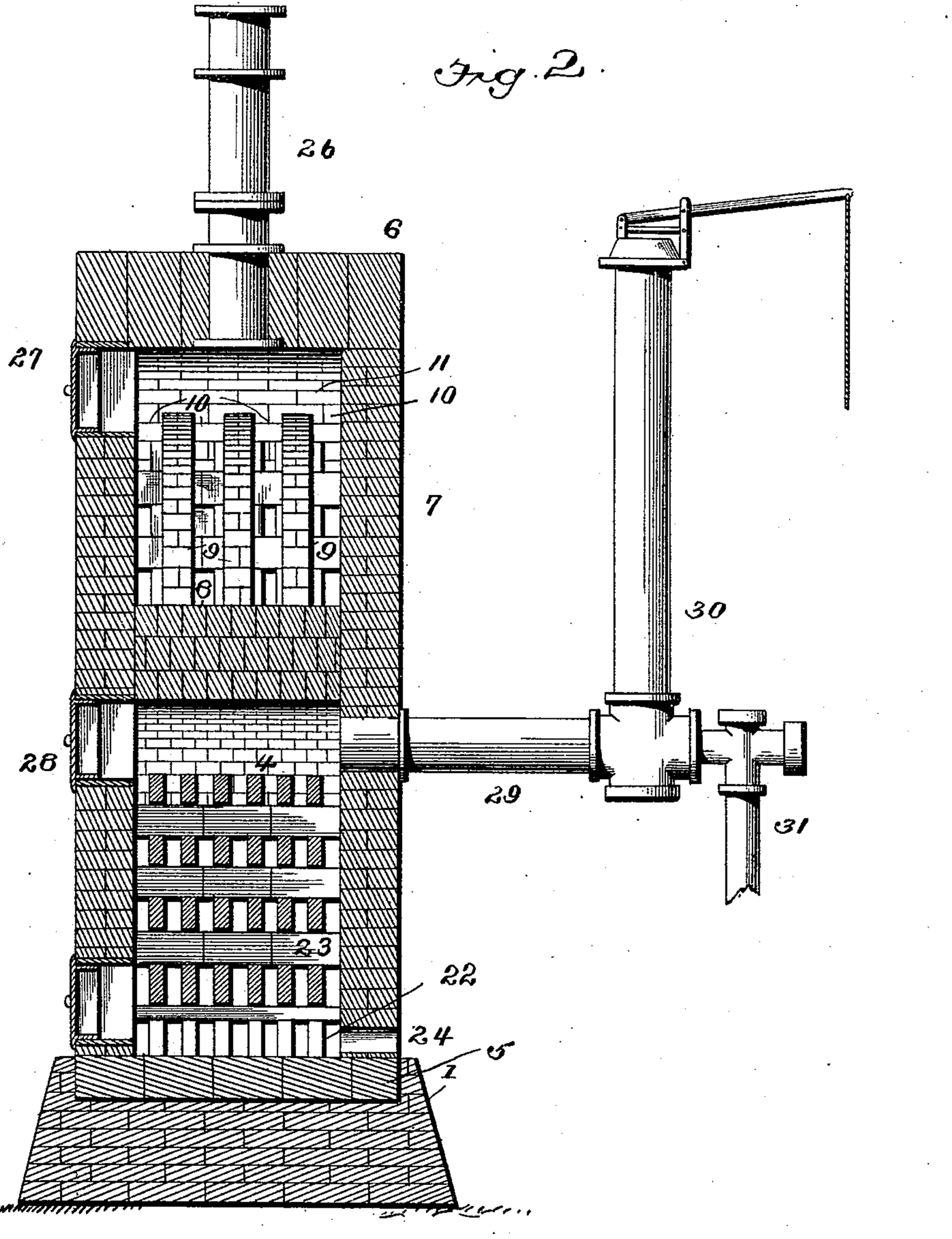
Fig. 2.

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# UNITED STATES PATENT OFFICE.

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## METHOD OF AND APPARATUS FOR MANUFACTURING GAS.

SPECIFICATION forming part of Letters Patent No. 547,118, dated October 1, 1895.

Application filed May 21, 1894. Serial No. 512,007. (No model.)

*To all whom it may concern:*

Be it known that I, JOHN W. HAYES, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented new and useful Improvements in Methods of and Apparatus for Manufacturing Gas, of which the following is a specification.

My invention relates to the manufacture of carbureted and uncarbureted water-gas; and it consists in the method of making gas and in the features of construction and novel combinations of parts in a gas-making apparatus, as hereinafter described and claimed.

In the annexed drawings, illustrating the invention, Figure 1 is a vertical longitudinal section of my improved apparatus for the manufacture of gas. Fig. 2 is a transverse sectional elevation of the same on the line 2 2 of Fig. 1, with the checker-work of the carbureting-chamber removed to show the spaced-apart construction of the arches at the ends of said chamber.

Referring to the drawings, the numeral 1 designates a brickwork or masonry base on which the two fuel-chambers 2 and 3 and an intermediately-located gas-superheating chamber 4 are built.

The gas-making apparatus is preferably provided with a horizontal fire-brick floor 5 laid in the masonry base 1, and the casing or walls and roof of the apparatus are formed by a large outer fire-brick arch 6, closed on each side by perpendicular walls.

The central gas-superheating chamber 4 is separated from direct communication with the two fuel-chambers 2 and 3 by means of fire-brick end walls 7 and a closed arch 8, that springs from the tops of said walls and forms the roof of the superheater. Springing outwardly and in opposite directions from the crown of the arch 8 are sectional arches 9, that are extended across the tops of the fuel-chambers 2 and 3 and connect with the main outer arch 6 of the apparatus. These sectional arches 9 are constructed of fire-bricks, spaced apart to form openings or passages 10, Fig. 2, through which the two fuel-chambers communicate with the carbureting-chamber 11, that occupies the space between said sectional arches. A portion of the outer arch 6 forms the top of the carbureting-chamber, and the crown of the inner arch 8 forms its bottom. The gas-superheating chamber 4 and the carbureting-chamber 11 may each be partly or wholly filled with checker-work of fire-brick or similar refractory material. In the lower portion of each fuel-chamber 2 and 3 are a grate 12 and an ash-pit 13, and doors 14 are provided to afford access to the grate-bars and ash-pits. Air-inlets 15 are provided in the ash-pit walls at suitable points for introducing air beneath the grate-bars to support combustion of the fuel placed on the grates in starting the apparatus to work. If desired, these air-inlets may be connected with a blower. Beneath the grate of the first fuel-chamber or gas-generator 2 is inserted a steam-inlet pipe 16, leading from a boiler or steam-generator placed at any convenient point. The second fuel-chamber 3 may have a similar steam-inlet pipe $16^a$ inserted beneath its grate. In an upper part of each fuel-chamber 2 and 3 is a charging-door 17 and an inlet 18 for air. The second fuel-chamber 3 may be of somewhat less capacity than the first fuel-chamber 2 and has a smaller grate. This diminution in the size of the fuel-chamber 3 results from its being provided with a raised floor 19, at the outer end of which is built a vertical checker-work 20, that is extended into and occupies a large portion of the fuel-chamber. The lower portion of the fuel-chamber 3 is divided by a vertical partition-wall 21, that assists in supporting the checker-work structure 20, which may extend upward to about the level of the charging-door 17 at or near the top of the chamber. On referring to Fig. 1, it will be observed that by reason of its raised floor 19 the grate and ash-pit of the second fuel-chamber 3 are located at a somewhat higher level than the corresponding parts of the first fuel-chamber.

Between the raised floor 19 of the second fuel-chamber 3 and the main horizontal floor 5 of the gas-making apparatus is formed a horizontal conduit or gasway 22, leading direct from the lower end of checker-work 20 to an air-chamber 23, located below and communicating with the central gas-superheater. In one side of this chamber 23 is an air-inlet

24, and the other side may be provided with a suitable door to afford access to the interior for cleaning or other purposes.

The carburetor or carbureting-chamber 11 is provided with an inlet-pipe 25 for introducing crude petroleum or other suitable hydrocarbon material. In the top of the carbureting-chamber 11 is a combustion relief-valve 26, and, if desired, access to the chamber may be afforded through a door 27 in one side.

One side of the upper portion of the gas-superheater 4 may be provided with a door 28, and from the other side leads a gas-outlet pipe 29, that communicates on one hand with a valved combustion relief-pipe 30 and on the other hand with a gas-pipe 31, Fig. 2, that may communicate with a gas main or holder or with any suitable apparatus for cleaning or purifying the gas, if required.

In starting the gas-making apparatus to work, wood fires are ignited on the grates of both fuel-chambers 2 and 3, while air is admitted below the grate-bars to support combustion. During this time the relief-valve 26 is open and the valve of the relief-pipe 30 is closed. After the fires are well started coal is fed to them gradually through the charging-doors 17, and as the fuel heats up the supply is further increased until the top of the coal-bed is about up to the level of the charging-doors or near the tops of the fuel-chambers. For this fuel I prefer to use bituminous nut coal or slack. When the two fuel-chambers 2 and 3 are thus filled up to the charging-doors 17 and the coal is well ignited, the relief-valve 26 is closed and the valve of the relief-pipe 30 is opened. The air-inlet below the second fuel-chamber 3 may now be closed off and the air-pressure at the inlet below the first fuel-chamber or gas-generator 2 may be increased by running the blower faster. The products of combustion from the first fuel-chamber 2 will now pass up into and through the chamber 11 to the top of the second fuel-chamber 3 and unite with the products of combustion generated therein. It will be observed that in the chamber 3 one side of the body of fuel will rest against the vertical body of checker-work 20 above the partition 21 and will ordinarily permit the passage of products of combustion downward and outward through the fuel and to the said checker-work. Products of combustion will also pass directly to the top of the checker-work 20 from the upper part of the fuel-chamber. It will thus be obvious that even should the body of fuel in the chamber 3 become "bridged" by an accumulation of baked coal, the checker-work 20, being extended above the level of the fuel, will afford ample opportunity for a full and free passage of the gases and products of combustion to the gasway or conduit 22 that leads to the chamber 23 beneath the superheater. The checker-work 20 is thoroughly heated up by the hot gases and products of combustion passing through it. Air is admitted to the chamber 23 through the inlet 24, to burn the gases and thus heat up the checker-work in the superheater, the products of combustion being passed up through the same to the relief-pipe 30, the valve of which is still open. This operation is continued until both bodies of coal are raised to the proper temperature for making gas. The valved relief-pipe 30 is then closed, thus leaving open no outlet from the apparatus except through the gas-pipe 31, leading to a purifying apparatus or to a gas-holder or directly to the place of consumption, as may be preferred. Now in order to make gas the air-inlets below the grate-bars are shut off, or the blower stopped, and steam is admitted through the steam-pipe 16 and allowed to pass up through the body of incandescent coal and coke in the gas-generating chamber 2, whereby the steam is decomposed and converted into water-gas, which is commingled at the top of the apparatus with coal-gas distilled from the fuel. These commingled gases pass through the openings 10 of the sectional arches 9 and across and through the checker-work in the carbureting-chamber 11, where they may be mingled with hydrocarbon material, preferably oil, forced in a jet or spray through the pipe 25, that discharges into said carburetor. By contact with the heated checker-work of the carburetor the oil or other carbureting material is rapidly broken up and combined with the surrounding hot gases through a mutual reaction of the hydrogen, oxygen, and carbon elements in the water-gas, coal-gas, and oil-gas. The hot gas compound thus produced passes into the upper part of the fuel-chamber 3 and thence to the checker-work 20 in one side of said chamber. The gas will pass directly to the checker-work 20 by reason of its upper end being above the bed of fuel. In the meantime steam may be admitted through the pipe $16^a$ to the space below the grate of the second fuel-chamber 3 to pass up through the body of incandescent fuel in said chamber, from which mingled water-gas and coal-gas will pass over the wall 21 into the checker-work 20 and there become mixed with the gases passed over from the first fuel-chamber. The extensive and highly-heated surfaces of the checker-work 20, into and through which the gas must pass, will assist materially in fixing the gas, besides facilitating its flow to the superheater 4, where the fixing is completed.

The horizontally arranged and direct gasway or conduit 22 is preferably extended the entire width of the lower part of the apparatus from the lower end of the gas-fixing checker-work 20 to the chamber 23 below the superheater, and thus provides an ample, free, and unobstructed passage for the gas. From the checker-work 20 and conduit 22 the gas enters the closed chamber 23 and passes thence upward into and through the superheater 4 to the gas-outlet 29 near its top. In passing

through the centrally-located superheater the gas is subjected to a high temperature, whereby it becomes thoroughly fixed and may then be conducted to a purifier or to a gas-holder.

In Letters Patent No. 507,003, granted to me October 17, 1893, is shown a gas-making apparatus comprising two fuel-chambers, a gas-superheater located between the two fuel-chambers, a carbureting-chamber arranged above the superheater and communicating with the tops of both fuel-chambers for transit of gases from one fuel-chamber, in which water-gas is generated, to the other fuel-chamber, in which the fixing of the gas is commenced, a fender located in the upper part of said last-named fuel-chamber, a gas-heating air-chamber below the superheater and communicating therewith, a descending conduit leading from the bottom of the gas-fixing fuel-chamber to the said gas-burning air-chamber, and a gas-outlet leading from the superheater. This construction I do not broadly claim herein.

The location of a checker-work structure in one side of the second fuel-chamber, in which the fixing of gases is commenced, the said checker-work having its top extended above the bed of fuel and its bottom connected directly with a broad horizontally-arranged gas-way leading to the bottom of the superheater, presents the great advantage of providing a much more extensive and highly-heated surface for commencing the fixing of the gases and affords a more ample and free passage for the unobstructed flow of gas to the superheater. This construction also wholly obviates the difficulties heretofore experienced in attempts to get the gases through a second body of coal that has become bridged over and obstructed. Besides providing more room for the fixing of the gases the checker-work structure, extended from top to bottom of the second fuel-chamber in one side thereof, will also permit a large increase in the rate of speed at which the gas can flow and adds materially to the economical operation of the gas-making apparatus. An illuminating-gas cannot pass through incandescent carbon without great loss of illuminants, thus requiring more oil to bring up the candle-power. The passage of gas through red-hot brick in contact with carbon does not have this injurious effect upon the gas. The high heat of incandescent carbon, which changes the illuminants of the gas to lampblack, reduces the light in quality. Therefore, instead of fixing the gases, incandescent carbon goes to the other extreme and destroys the richer hydrocarbons, resulting in lampblack and the breaking up into non-illuminants and into marsh-gas. I further find that a hydrocarbon gas containing a percentage of carbonic acid will have the same reduced in quantity by passing the said hydrocarbon gas through a long body of checker-brick or other refractory materials that have been heated to redness in the presence of heated carbon and in contact therewith, the extra atom of oxygen taking up with the heated carbon to form carbonic oxide. It is not necessary that these gases should pass through a body of heated carbon, but if they pass through a body of highly-heated refractory material, such as the checker-work 20, in contact with heated carbon and in such manner that the carbonic gas will come into contact with the highly-heated carbon, but without passing through the same, the reduction of the carbonic acid will be secured without injury to the illuminants of the gas and without requiring any further carbureting to restore candle-power. The tarry matter is arrested by this body of heated refractory material in contact with carbon and broken up into gases, and this tarry matter, so arrested, will also aid in the reduction of carbonic acid.

Another advantage obtained from passing the gases through the body of heated refractory material is that when bituminous coal is used in contact with the refractory material the distillation of coal-gases is hastened by the heated refractory material that is in contact with the coal and also by the highly-heated gases passing over it on the way to the fixing-chamber or superheater. This is is not all, but it is easier to force gas through checker-brick in contact with carbon than to force it through carbon, and consequently the wear and tear on the apparatus is less, while the other advantages are equal.

What I claim as my invention is—

1. In an apparatus for making gas, the combination of a single casing containing two fuel chambers having grates and air inlets, a checkerwork structure located in one side of the second fuel chamber and extended from the bottom of said chamber to or above the top of the bed of fuel, a carbureting chamber through which the upper ends of the two fuel chambers communicate, a gas superheating chamber located between the fuel chambers and below the said carbureting chamber and provided with a gas outlet, and a conduit or gas-way through which the bottom of the checkerwork in the second fuel chamber communicates with the gas superheating chamber, substantially as described.

2. In an apparatus for making gas, the combination of an arched casing located on a horizontal base, two fuel chambers inclosed by said arched casing and provided with grates and air inlets, the second one of said fuel chambers having its floor and grate at a higher elevation than the floor and grate of the first fuel chamber, a checkerwork structure located in one side of the second or elevated fuel chamber and extended from the raised floor of said chamber to the top of the bed of fuel, a carbureting chamber through which the upper ends of the two fuel chambers communicate, a gas superheating chamber located between the fuel chambers and below said carbureting chamber and provided with a gas

outlet, and a broad horizontal gas-way or conduit through which the bottom of the checkerwork in the elevated fuel chamber communicates with the gas superheating chamber, substantially as described.

3. In an apparatus for making gas, the combination of a single casing containing two fuel chambers having grates and both provided with inlets for steam and air below said grates, a checkerwork structure located in one side of the second one of said fuel chambers and extended from the bottom of said fuel chamber to the top of the bed of fuel, a carbureting chamber through which the upper ends of the two fuel chambers communicate, a gas superheating chamber located between the two fuel chambers and below the said carbureting chamber and provided with a gas outlet, and a gas-way or conduit leading from the bottom of the checkerwork in the side of the second fuel chamber to the lower portion of the gas superheating chamber, substantially as described.

4. The herein described process of making gas, which consists in bringing two separate bodies of coal to a state of incandescence, admitting a limited supply of air over the heated coal to burn part of the gases and heat up a body of refractory material intermediate the two bodies of coal, then carrying the heated products of combustion and unburned gases from one body of coal through said heated body of refractory material to a second body of incandescent coal in contact with a second body of refractory material, then admitting a current or currents of air to consume the unburned gases and heat the said second body of refractory material, then excluding all air and admitting steam to each body of incandescent coal to generate water gas, then passing said gas from the first body of coal through the first named body of refractory material and at the same time mingling oil or like hydrocarbon with the gas, then carrying the combined gases and vapors from the first body of coal and first body of refractory material, together with the gases from the second body of coal, through the second body of highly heated refractory material and in contact with the carbon of the second body of coal, and subsequently carrying all the gases and vapors through another body of highly heated refractory material, substantially as and for the purposes specified.

5. The herein described process of making gas, consisting in bringing two separate bodies of bituminous coal to a state of incandescence, burning part of the gaseous products and thereby heating up a body of refractory material intermediate the upper portions of the two bodies of coal and also heating up a second body of refractory material in immediate juxtaposition to the second body of coal and a third body of refractory material intermediate the lower portions of the two bodies of coal, then excluding all air and admitting steam to both bodies of incandescent coal to generate water gas, then passing said gas from the first body of coal through said first named body of refractory material and therein mingling oil or like hydrocarbon with the gas, then carrying the combined gases and vapors from the first body of coal and first body of refractory material, together with the gases from the second body of coal, through the second body of refractory material and in contact with the carbon of the said second body of coal, and finally conducting the combined gases through the third body of highly heated refractory material, substantially as and for the purposes set forth.

In testimony whereof I have hereunto set my hand and affixed my seal in presence of two subscribing witnesses.

JOHN W. HAYES. [L. S.]

Witnesses:
D. J. HAYES,
JAMES GALLAHER.