(No Model.) 6 Sheets—Sheet 1.

H. C. REW.

PROCESS OF AND APPARATUS FOR MANUFACTURING FIXED GAS.

No. 290,930. Patented Dec. 25, 1883.

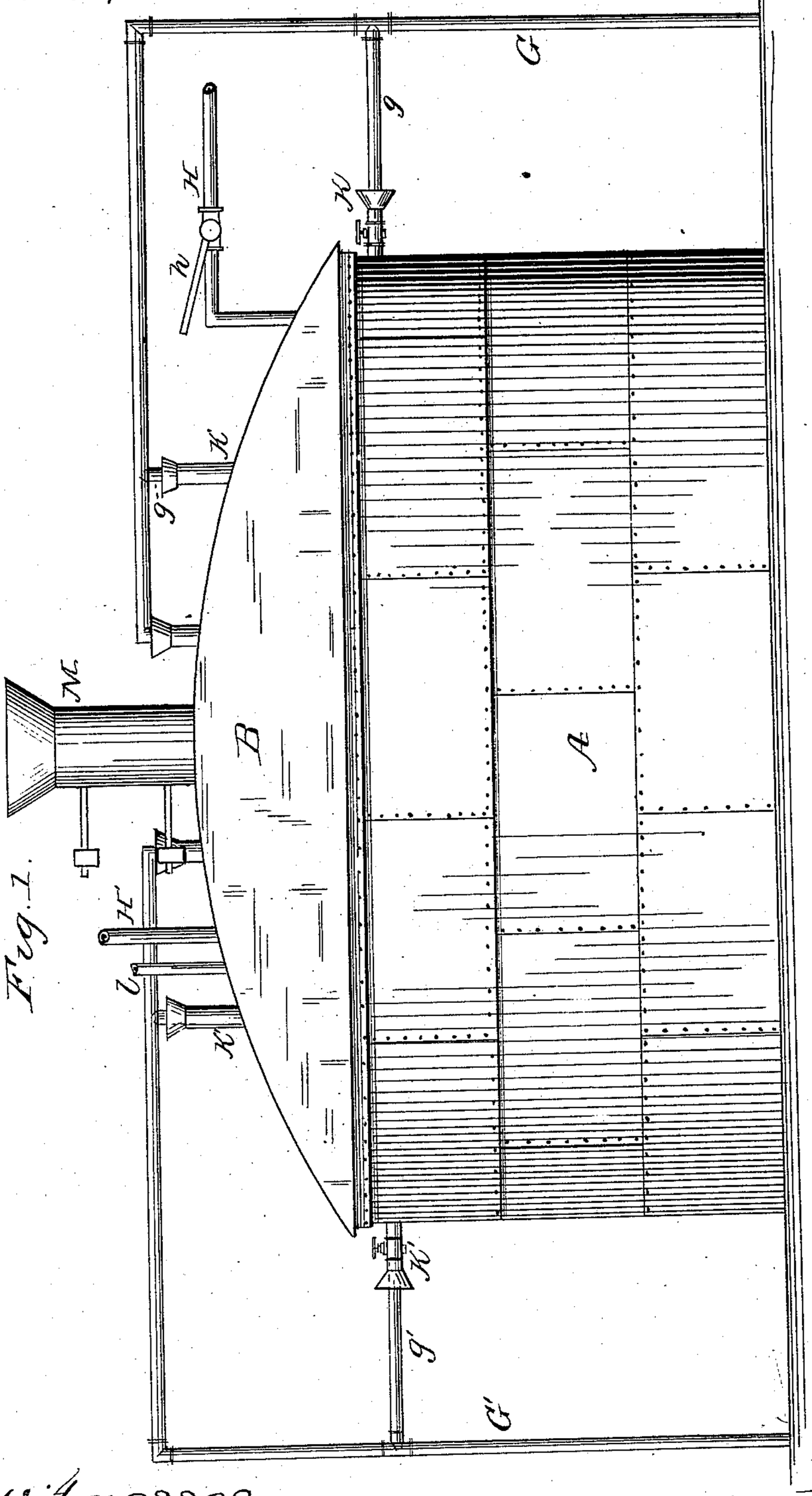

Fig. 1.

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Inventor
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(No Model.) 6 Sheets—Sheet 2.

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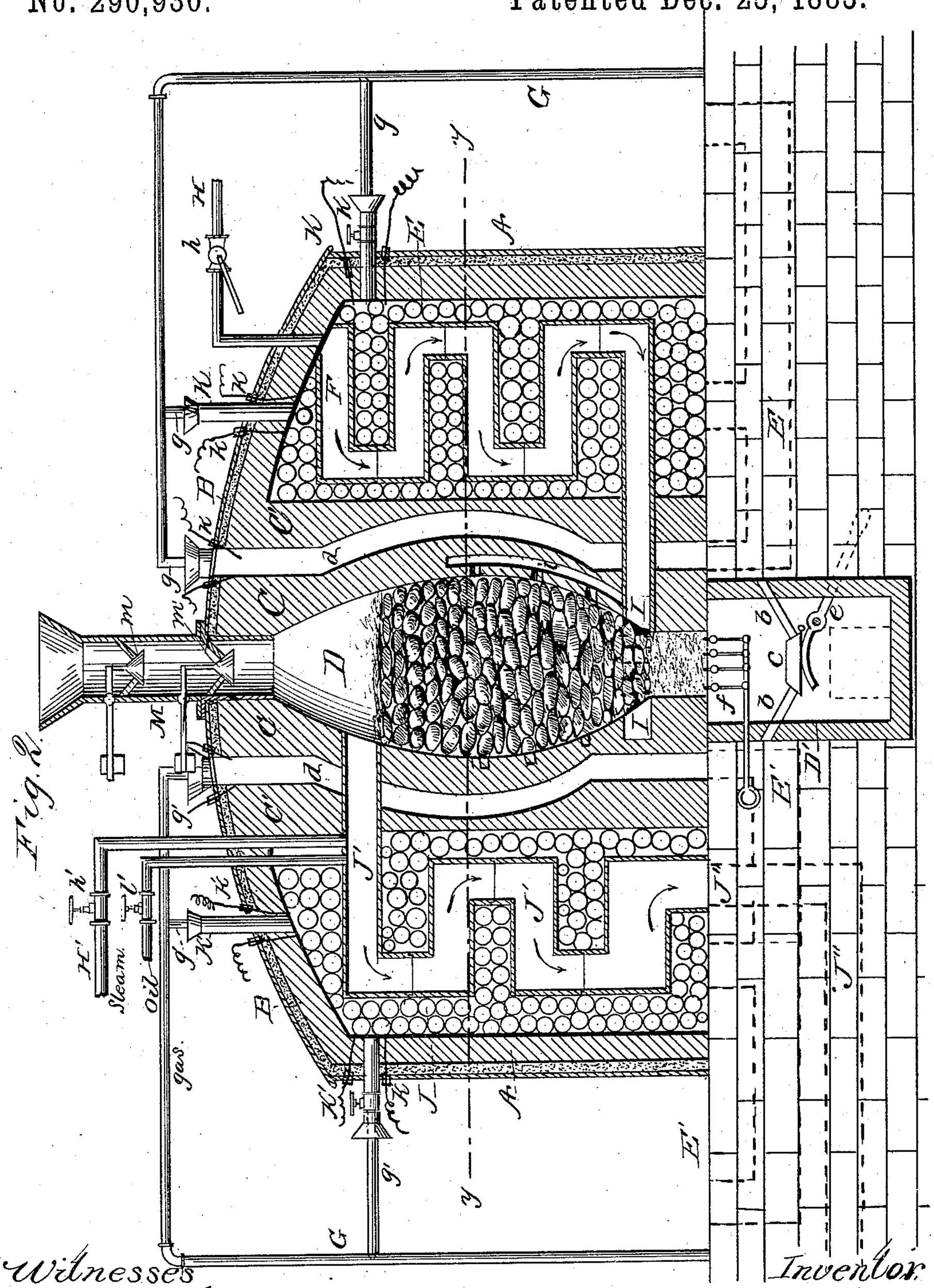

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H. C. REW.

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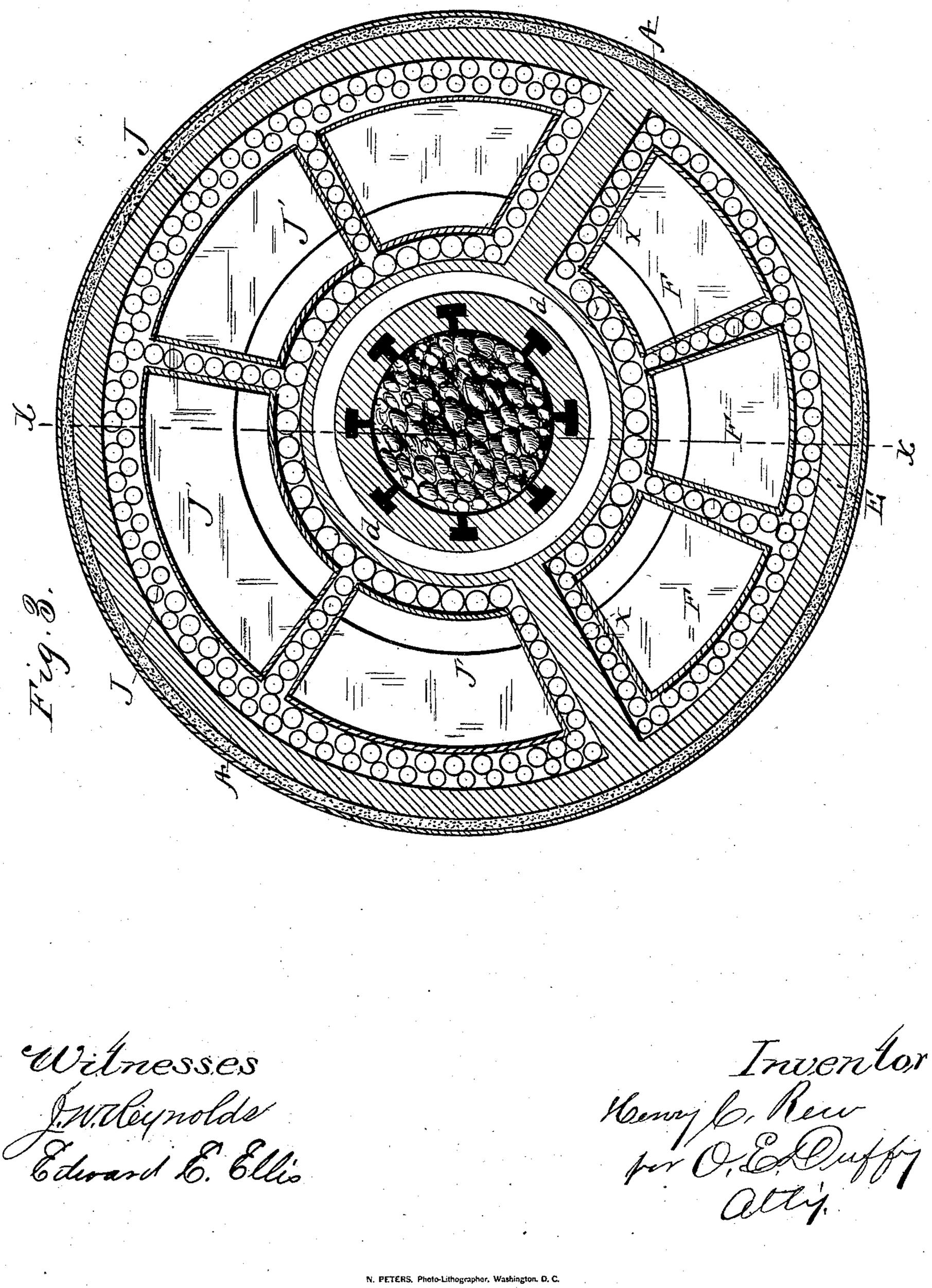

Witnesses
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(No Model.) 6 Sheets—Sheet 4.

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PROCESS OF AND APPARATUS FOR MANUFACTURING FIXED GAS.

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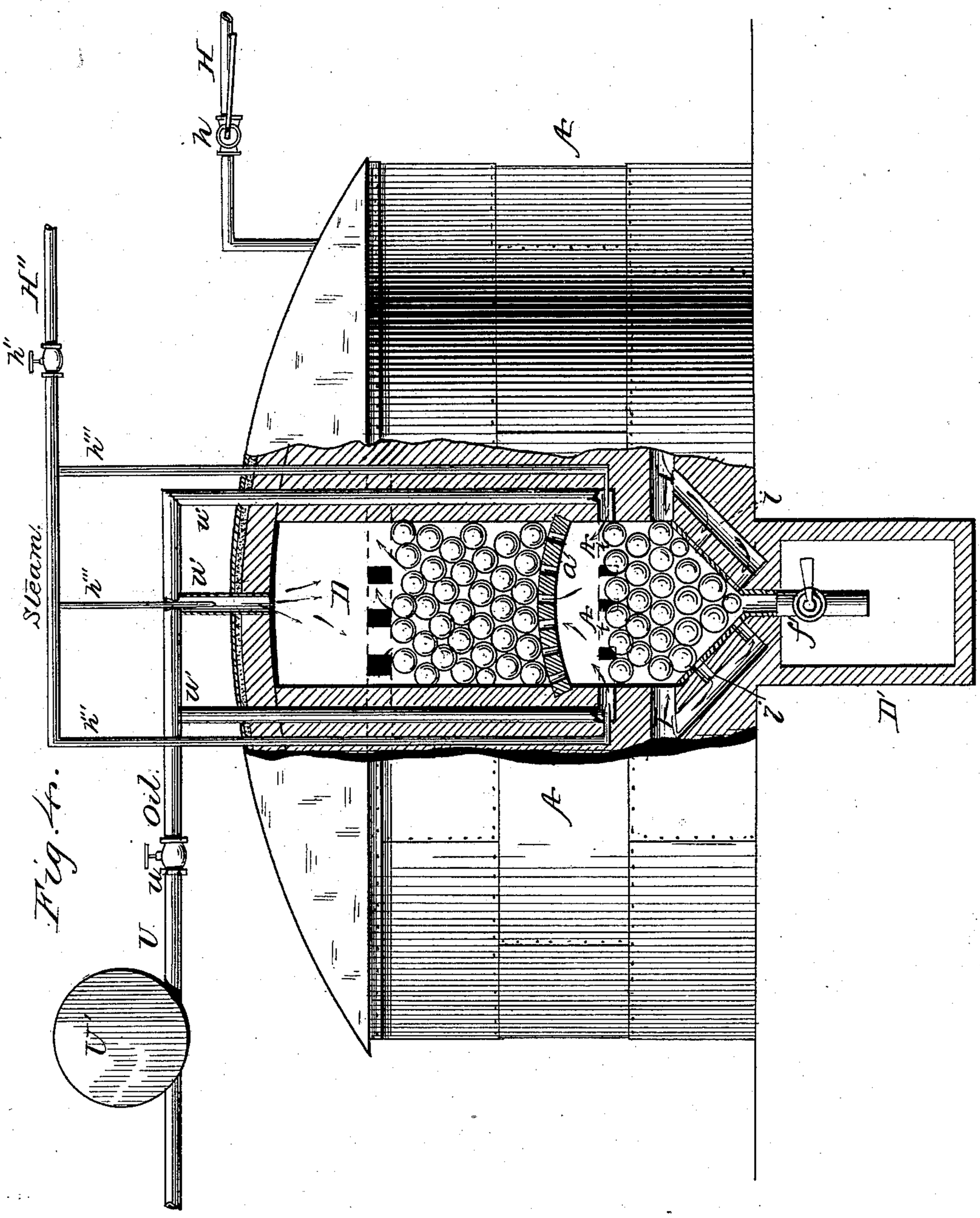

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(No Model.) 6 Sheets—Sheet 5.

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PROCESS OF AND APPARATUS FOR MANUFACTURING FIXED GAS.

No. 290,930. Patented Dec. 25, 1883.

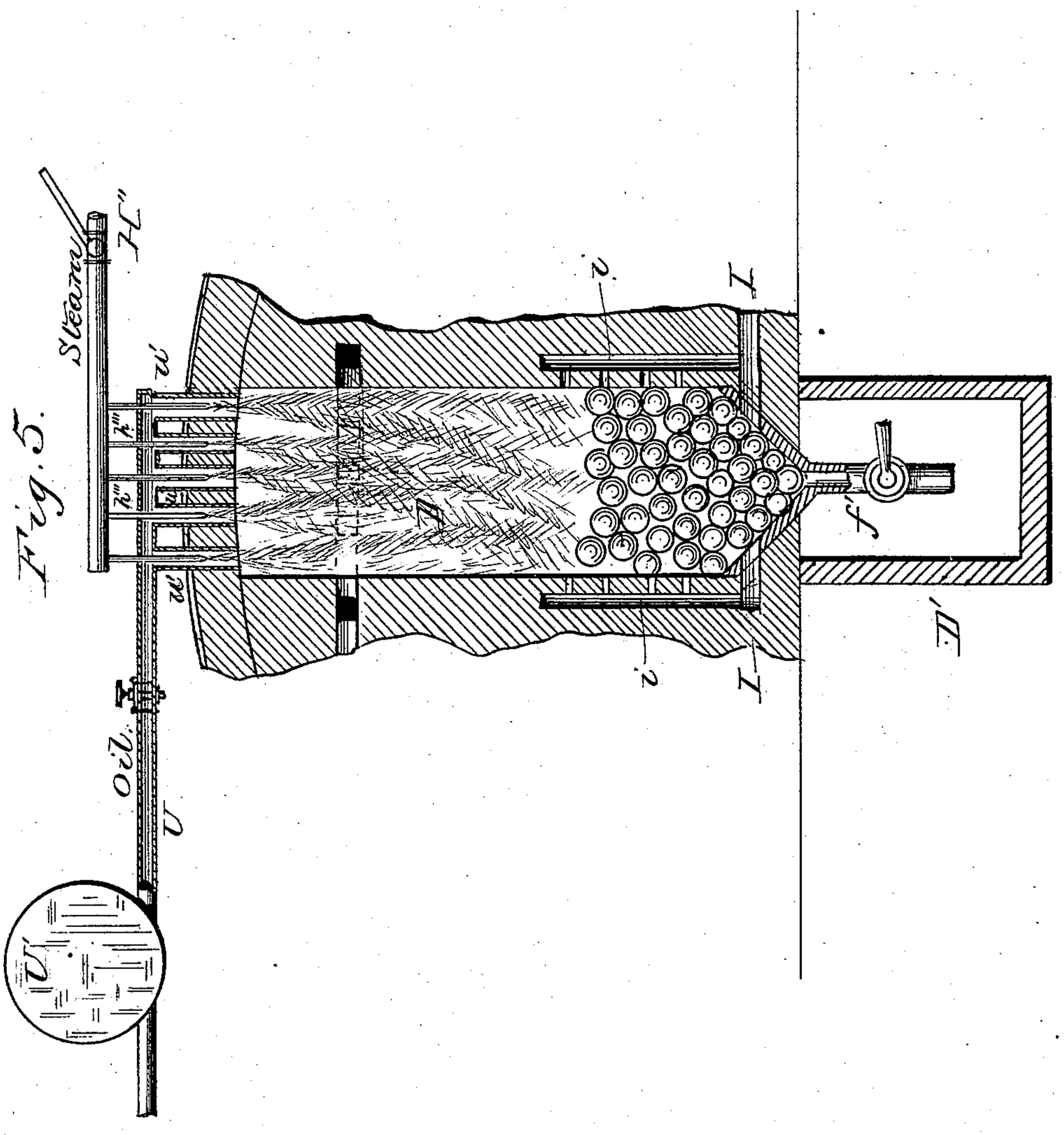

Fig. 5.

Witnesses:
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(No Model.) 6 Sheets—Sheet 6.

H. C. REW.

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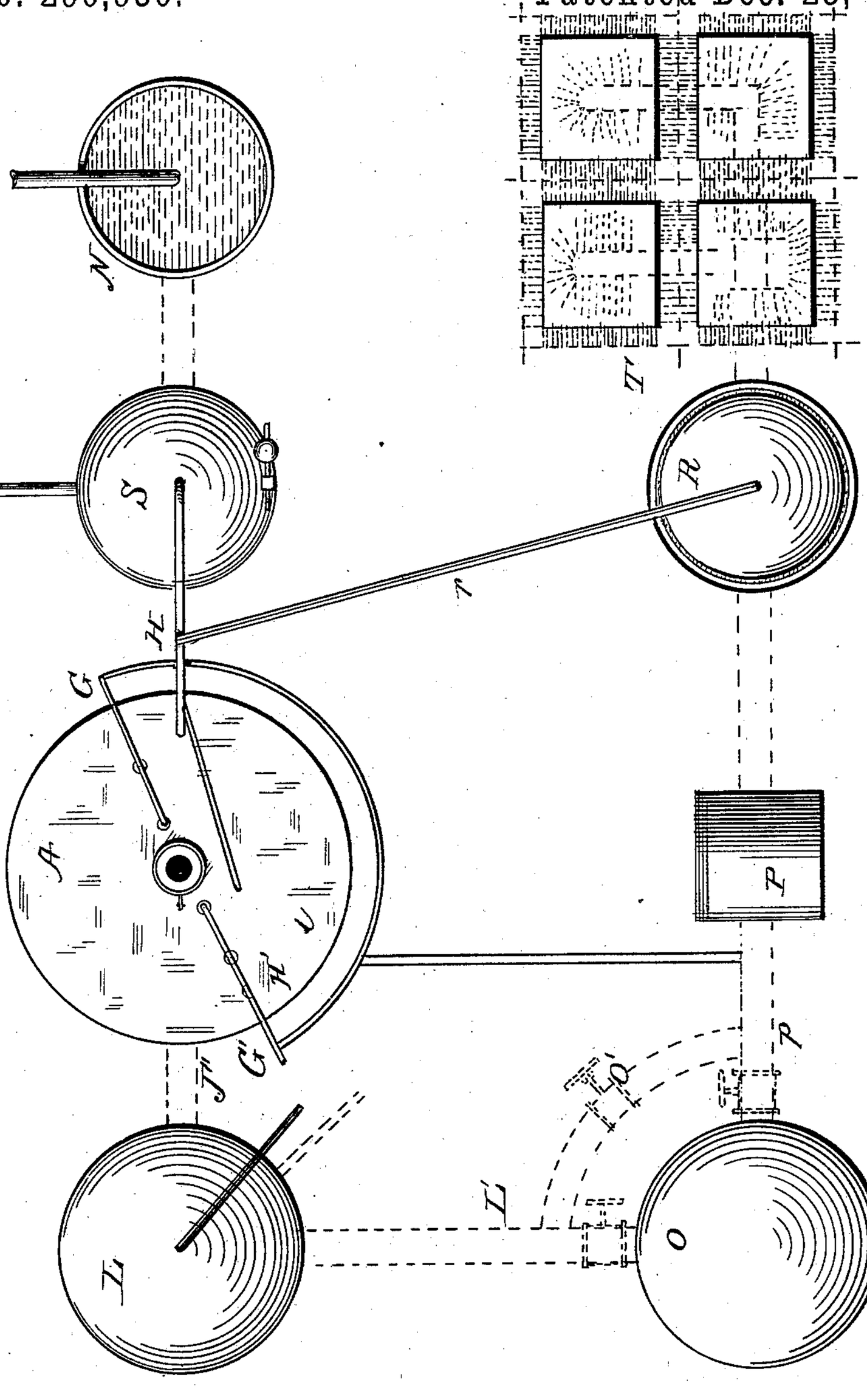

Witnesses:
J. W. Reynolds
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Attn.

UNITED STATES PATENT OFFICE.

HENRY C. REW, OF CHICAGO, ILLINOIS.

PROCESS OF AND APPARATUS FOR MANUFACTURING FIXED GAS.

SPECIFICATION forming part of Letters Patent No. 290,930, dated December 25, 1883.

Application filed May 9, 1883. (No model.)

To all whom it may concern:

Be it known that I, HENRY C. REW, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Process of and Apparatus for Manufacturing Fixed Gases for Fuel and Illuminating Purposes; and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form part of this specification.

This invention relates to the manufacture of fixed gases for fuel and illuminating purposes, and for running gas-motors, and more particularly concerns that kind of generators and the processes carried on therein in which gas is generated rapidly in a continuous manner by highly superheating steam to the temperature required for its decomposition in contact with carbonaceous fuel, solid or liquid, by passing the steam in continuous currents through a series of conduits, externally heated by the combustion of gas and air in a suitable chamber, then decomposing the highly-superheated steam by injecting it into and diffusing it through a body of carbonaceous fuel, solid or liquid, contained in an externally-heated chamber, at the same time distilling the carbureted hydrogen and other volatile matter from the coal, and then combining and fixing the resulting mixed gases in externally-heated conduits in a continuous manner. The mixed gases produced in the decomposing and distilling chamber may be enriched by liquid hydrocarbon mixed with them in the fixing-chamber, or if the gases from the distilling and decomposing-chamber are rich and the final product is desired for fuel or motive power, they may be diluted by steam mixed with them at their entrance to the fixing-chamber, and the steam decomposed with them in the fixing-chamber, the whole then being fixed, by their passage through the heated conduits, into a homogeneous gas.

The invention further embraces the automatic and continuous production and distribution of gas without a holder under a suitable continuous and uniform pressure extending from the feed-water tank through the boiler, generator, cooler, purifier, meter, regulating-governor, and mains to the place of use. The gas is distributed according to my improved system of mains and service-pipes, which form the subject of another application for patent, to which reference is hereinafter more particularly made.

My invention has particularly for its object the construction and operation of gas-generators and their adjuncts operating in connection therewith on an entirely new, novel, and practical plan, in such a manner that they may be located in the centers of densely-populated districts with perfect safety, not only without not depreciating the value of adjacent property, as has been the case heretofore in the construction of gas-works and their dangerous holders for the storage of gas, but, on the contrary, greatly increasing the value of surrounding property, by reason of abundantly furnishing manufactured gaseous fuel of the finest quality at comparatively low prices, and superseding the use of raw fuel with all the accompanying discomforts and inconveniences arising from storage, dust, ashes, waste, expense, and labor of handling the same.

Having stated the nature and objects of my invention, I will now proceed to describe it more particularly with reference to the accompanying drawings, in which—

Figure 1 represents my generator in elevation. Fig. 2 represents a vertical section of the same through the steam-superheating chamber, the decomposing and generating chamber, and the fixing-chamber on the line *x x* of Fig. 3. Fig. 3 represents a horizontal section through the same chambers on the line *y y* in Fig. 2, showing the relative area or size of the steam-superheating chamber and the gas-fixing chamber. Figs. 4 and 5 represent vertical sections of the generating-chamber of modified form adapted for the use of liquid hydrocarbons. Fig. 6 represents a plan view of the various parts of my plant or apparatus for producing gas by an automatic continuous process, and the system of mains for distributing the same by my new and improved method, also illustrating the great advantages gained thereby in comparison with the old system, owing to the greatly-reduced length of piping and excavating required.

The outer walls, A, of the generator and its

chambers are built of the best fire-brick, and preferably in circular form, and are covered by tightly-riveted plates of boiler-iron, and the arched cover B rests upon the outer walls and upon the interior walls, C C′, of the decomposing and generating chamber D. The annular chamber, between the outer wall, A, and the inner wall, C′, of the fuel-chamber is divided by radial partition-walls X, into two chambers of unequal size, the smaller one, E, being the steam-superheating chamber, and the larger one, J, being the gas-fixing chamber, as shown in Fig. 3. The steam-superheating chamber E is provided with two or more fire-clay conduits, F, in zigzag form, extending from the top to the bottom thereof. They are connected at the top with steam-pipes H, having valves *h*, extending from the boiler S. (Shown in Fig. 6.) At the bottom the conduits connect by branch pipes I *i*, passing through walls C C′, with and into the fuel-chamber D. The conduits are surrounded with loosely-laid refractory material, preferably in the form of spheres, filling chamber E, for the purpose of absorbing and holding a uniform heat in the chamber. Said refractory material and conduits are heated by the combustion of gas and air delivered into the chambers by Bunsen burners, as shown by letter K, the same being ignited in the chamber by electrical currents conducted by wires *k*. The gas-supply pipe G, having branches *g* and controlling-valves, connects with the burner-tubes K, projecting into them a short distance to form Bunsen burners, and the flaring outer ends of the tubes K are to be provided with registers for admitting the desired supply of air. Electrical wires *k*, properly insulated, pass through the wall and have their extremities properly arranged in proximity to the inner openings of the Bunsen burners for igniting the stream of gas and air when admitted.

The gas-fixing chamber J is made of larger capacity than chamber E, and is provided with a greater number of conduits, J′, for the passage of gas to be combined and fixed. Said conduits connect at the top with the decomposing and generating chamber D, and at the bottom with the eduction-flue J″ leading to the cooler L. The conduits J′ are surrounded with the refractory fire-clay spheres filling the remaining space in chamber J, and the Bunsen-burner tubes K, having flaring outer ends and air-registers, extend through the walls. The branch gas-pipes *g′* of the supply-pipe G′ connect with the tubes, as before explained. Electrical-lighting wires *k′* are also provided for igniting the current of gas and air. A steam-pipe, H′, having valve *h′*, and an oil-supply pipe, *l*, having valve *l′*, pass through the arch B and open into the conduit J′ for diluting or enriching the gas from chamber D, as desired.

The walls C C′ of the chamber D are made double, having between them an annular combustion-chamber, *d*, which has entering it at the top gas and air inlets in the form of Bunsen burners and electric-lighting wires, as previously described. A flue, E′, for conducting away products of combustion, connects with the lower ends of chambers *d*, E, and J. The top of the generator D is provided with a coal-magazine, M, and cup and cone feeding devices *m m′*, and at the base of chamber D is constructed a double ash-pit, D′, having a conical division-diaphragm, *b*, and tight-fitting valve *c*, operated by a cam-lever, *e*, and having in its upper chamber the shaking-grate *f*. An outer tight-fitting door, as shown by dotted lines, is provided in the wall of the lower chamber for removal of the ashes.

The steam-boiler S, Fig. 6, is supplied with water from an elevated tank so constructed and arranged as to supply water to the boiler at any required pressure, as fully described in another application. The boiler S is to be of peculiar construction, as shown and described in another of my applications for a patent. The gas passes from the generator through a cooler, L, in which a circulation of water is maintained, and the gas is thereby cooled, while the heat is absorbed and carried off by the water and utilized for heating buildings, as shown and claimed in another application for patent. The cooled gas passes from cooler L by pipe L′ into and through the lime-purifier O, thence through the meter P into the small governing-holder R, from which it is passed into and through my peculiarly-arranged distributing system of mains and service-pipes shown in the plan T, for which a separate application has been made. A by-pass pipe, O′, connects pipe L′ with pipe *p* for conducting gas from cooler L to the mains without passage through purifier O, when purification by lime is not required.

When it is desired to use liquid hydrocarbon—such as crude petroleum or naphtha—instead of solid fuel for generating gas and decomposing steam, the decomposing and generating chamber D is constructed as shown in Fig. 4, or according to the modification shown in Fig. 5. Fire-clay spheres are filled into the bottom of the chamber up to the nozzles *t* of the oil-inlet pipes, and the superheated-steam-inlet pipes I and tuyeres *i* enter around the circumference and through the inclined bottom of the chamber. Just above the oil-inlet nozzles a perforated arch, *d′*, is constructed, above which another body of fire-clay spheres is placed. The oil-supply pipe U is connected by branch pipes *u′* extending down through the walls of chamber D, and opening into the interior of such chamber at the nozzles *t*, and one oil-pipe, *u′*, may connect directly with the top of chamber D. Steam-pipes *h‴ h‴*, extending from the main supply-pipe H″, project into the nozzles of the oil-pipes *u′* for blowing the oil into the generating-chamber among the spheres in position to be taken up and converted into gas by the highly-superheated steam entering from below. The spheres

serve to break up the oil and intimately mix it with the steam, and by their heat assist in decomposing the steam and oil. The gases and vapors produced in chamber D are completely combined and fixed in the fixing-conduits. Should any tarry matter collect in the bottom of chamber D it is drawn off through pipe and valve f' into a suitable receptacle. In Fig. 5 the oil-delivery pipes u', and the steam-jet pipes h''' projecting into them, discharge directly into the top of chamber D, and the oil is sprayed down upon the spheres. The superheated steam, entering from below through passages I and tuyeres i, passes up and mingles with the oil-spray, converting it into gas and carrying it into the fixing chamber where a fixed gas is produced.

A meter, U′, is connected with the oil-pipe U for measuring the oil supplied to the generator.

Having described the construction and arrangement of my apparatus, I will now describe its operation, as follows: A fire is kindled on the grate of chamber D and maintained by natural draft till a large body of fuel, which is gradually fed in, is raised to an incandescent state, and at the same time the superheating-chamber E and fixing-chamber J are heated to the required temperature by the combustion of gas and air admitted by the Bunsen burners. The steam-superheating chamber should be heated to much the highest temperature, in order to superheat the steam up to or above the temperature at which it is readily decomposed in contact with carbonaceous fuel. The fuel having been heated to incandescence and the superheating and fixing chambers properly heated, the decomposing-chamber is closed above and below, and the steam is admitted to the conduits F by opening valve h of pipe H, and in passing down through the conduits is highly superheated, and is conducted into the fuel through passages I and the tuyeres i. By passage through the fuel the steam is rapidly decomposed into hydrogen and carbonic oxide, and at the same time the charges of fresh coal, which are periodically dropped into chamber D, are distilled, the rich gases evolved therefrom being carried off by the continuous currents of gas resulting from the steam decomposed below. As the coal is distilled it is changed to coke and fitted for decomposing steam, and as the fuel is consumed and reduced to ash it is renewed by fresh charges from above, and the ashes are periodically shaken down and removed through the double ash-pit. The mixed gases arising from the fuel are conducted into the conduit J′ of the fixing-chamber, where, if they are too rich for fuel-gas, they are diluted by steam admitted by pipe H′, and where, on the contrary, if they are not sufficiently rich for illuminating-gas, they are enriched by liquid hydrocarbon admitted through pipe l. The gases in passing through the conduits J′ are combined and converted into a homogeneous fixed gas. The operation of producing gas having been started, it is continuously maintained by keeping up the combustion of gas in the steam-superheating and the fixing-chambers and constantly supplying the highly-heated steam to the fuel. The proper temperature of the fuel is also maintained by the combustion of gas in the annular chamber d. The gas on leaving the fixing-chamber is cooled in tank L, and if for illuminating purposes is purified in the lime-vessel O, and thence delivered through the meter and governing-holder to the distributing-mains.

The supply of steam from the boiler S to the superheating-chamber is automatically controlled by means of the governing-holder and the lever r connecting therewith, and with the valve in supply-pipe H, the lever being properly pivoted at a point between the holder and valve.

The advantages gained by my system for the manufacture and distribution of gas for fuel and illuminating purposes, by a continuous process, are obvious and important, and may be stated as follows:

First. The process for the manufacture of gas being to a large extent automatic and continuous, and gaseous fuel alone being used to create the necessary heats, there is a marked saving in the labor required to be employed to attend the operation of the generators, boilers, and other parts of the apparatus.

Second. The compactness of the works is such that they may be built entirely under cover on a comparatively small plot of ground in the heart of a city, and add to the value of surrounding property, instead of detracting therefrom, as is now the case with works requiring holders and tanks for the storage of gas.

Third. By having a continuous forward flow of gas, and no backward pressure from a holder, I am enabled to dispense entirely with the usual water-seals now employed in all gas-works, which require boilers, engines, pumps, tanks, and the necessary care, labor, and expense to construct, operate, and maintain the same in order to furnish a constant supply of cool water to the water-seal.

Fourth. In dispensing with holders I overcome one of the most serious difficulties and items of expense connected with gas-works, with all the attending disadvantages of being compelled to locate works in outlying districts far removed from where the gas is required to be used. I also avoid the cost of laying large mains through outside territory, where but little gas is used or required, in order to reach and supply the desired gas-consuming territory.

Fifth. A most important advantage is gained in locating gas-generators in the centers of blocks and distributing the gas therefrom to the rear of the buildings and structures surrounding the works, owing to the comparatively small amount of piping required to be

laid, and but little or no paving required to be taken up and relaid.

Sixth. The cost of the whole plant, and the ground occupied by the same, is reduced to the minimum, and a very large amount of money is saved in construction and piping as compared with the cost of works built on previous plans, by which I am enabled to economize, to a marked degree, in the manufacture of gas, and thus supply any demand both for fuel and illuminating purposes at very moderate prices to the consumer.

Seventh. As by the use of my process and apparatus the fuel employed is entirely converted into its constituent gases with the exception of the ash, the best results attainable with any gas-producing material can be fully realized and the largest possible amount of gas obtained from it. When it is considered that in the combustion of raw fuel as ordinarily burned in stoves, ranges, grates, furnaces, and under boilers, not more than fifteen to twenty per cent. of the latent heat and force of the fuel is actually utilized and saved, (the rest escaping in the form of smoke, unconsumed vapors, and gases,) the importance of my system, which saves the full value of the fuel by converting it, without waste, into its constituent gases, and delivers the gas to consumers free from the annoyances, labor, and expense attending the use of raw fuel, and at a reduced cost, will readily be seen and appreciated by those skilled in the art of the manufacture and distribution of gas.

Eighth. The boiler and also the steam-superheating and gas-fixing chambers being heated by a continuous supply of gaseous fuel of the finest quality, and the heat and products of combustion being carried downward against the natural tendency to rise, the heats required are supplied with the greatest economy, convenience, and uniformity, and the best results attainable are fully reached. The steam-heating and gas-fixing chambers in the generating apparatus are also kept free from dust and ashes, by which a great improvement is made upon chambers and regenerators of the same character in other cupola processes, which are heated by burning the products of combustion of raw fuel driven into them from fires urged by blasts of air, thus bringing in dust and ashes, and gradually clogging up the passages in the loosely-laid refractory material placed therein.

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

1. The process of generating gas, which consists, first, in passing steam in a continuous current through a highly and continuously heated conduit, and thereby superheating it to or above its decomposing temperature, then decomposing such steam by passing it in a continuous current, into contact with carbonaceous material, solid or liquid, and thereby distilling the rich gases from such material, as distinguished from an intermittent operation, then conducting the gases from the steam and the carbonaceous material into a separate heated chamber or conduit, and therein carbureting them with volatile hydrocarbon, and finally combining the gases and vapors and converting them into a fixed gas by passing them through the heated conduit, as described.

2. In the manufacture of gas, the method of maintaining the heat of the fuel of the steam-superheating conduits and the gas-fixing conduits, which consists in burning jets of gaseous fuel around the fuel-chamber and in the chambers surrounding the conduits, then in highly superheating steam by passage through one set of conduits and conducting it into the fuel.

3. The decomposing and generating chamber D, in combination with the steam-superheating conduit F, connected therewith at the bottom and by side passages or tuyeres, and the combustion-chamber surrounding the conduit and having gas and air inlet pipes, as shown, and an outlet-flue for products of combustion.

4. The decomposing and generating chamber D, in combination with the surrounding heating-chamber, having gas and air inlet pipes, the steam-superheating conduits and their surrounding combustion-chamber, the gas-fixing conduits and their surrounding combustion-chamber, the gas and air and inlet pipes connecting with the combustion-chambers, and an eduction-flue for products of combustion.

5. The decomposing and generating chamber D, having double walls and an interposed combustion-chamber, *d*, in combination with the outer surrounding wall, A, inclosing an annular chamber between it and the double wall of chamber D, the radial partition-walls X dividing the annular chamber into a smaller chamber, E, and a larger chamber, J, as and for the purpose described.

6. The process of generating gas and delivering it under the pressure desired, which consists in supplying water to the steam-boiler from an elevated tank under a pressure regulated to the degree desired, and thereby delivering steam at a regulated pressure from the boiler to the gas-generator and therein producing gas under the pressure of steam exerted from the boiler and discharging it therefrom to the mains.

7. The process of generating gas, which consists in spraying liquid hydrocarbon into a body of heated refractory material, and at the same time forcing superheated steam into the refractory material below the hydrocarbon spray, thereby converting it into gas, then subjecting the hydrocarbon gas and steam to a sufficiently high heat to convert them into a fixed gas by passing them through a fixing-chamber.

8. The generating and decomposing chamber D, having therein a body of refractory spheres, in combination with the inlet-pipes

and tuyeres, and the oil and steam inlet pipes passing down through the walls and opening by nozzles *t* into chamber D, and outlet-flues at the top connecting with the fixing-chamber, as and for the purpose described.

9. The combination, in a gas-generating apparatus, and with its steam, gas, and air supply conduits, and with its combustion-chamber, of the electrical-igniting wires suitably insulated, for the purpose specified.

In testimony that I claim the foregoing as my own I affix my signature in presence of two witnesses.

HENRY C. REW.

Witnesses:
B. F. MORSELL,
O. E. DUFFY.