No. 615,450. Patented Dec. 6, 1898.

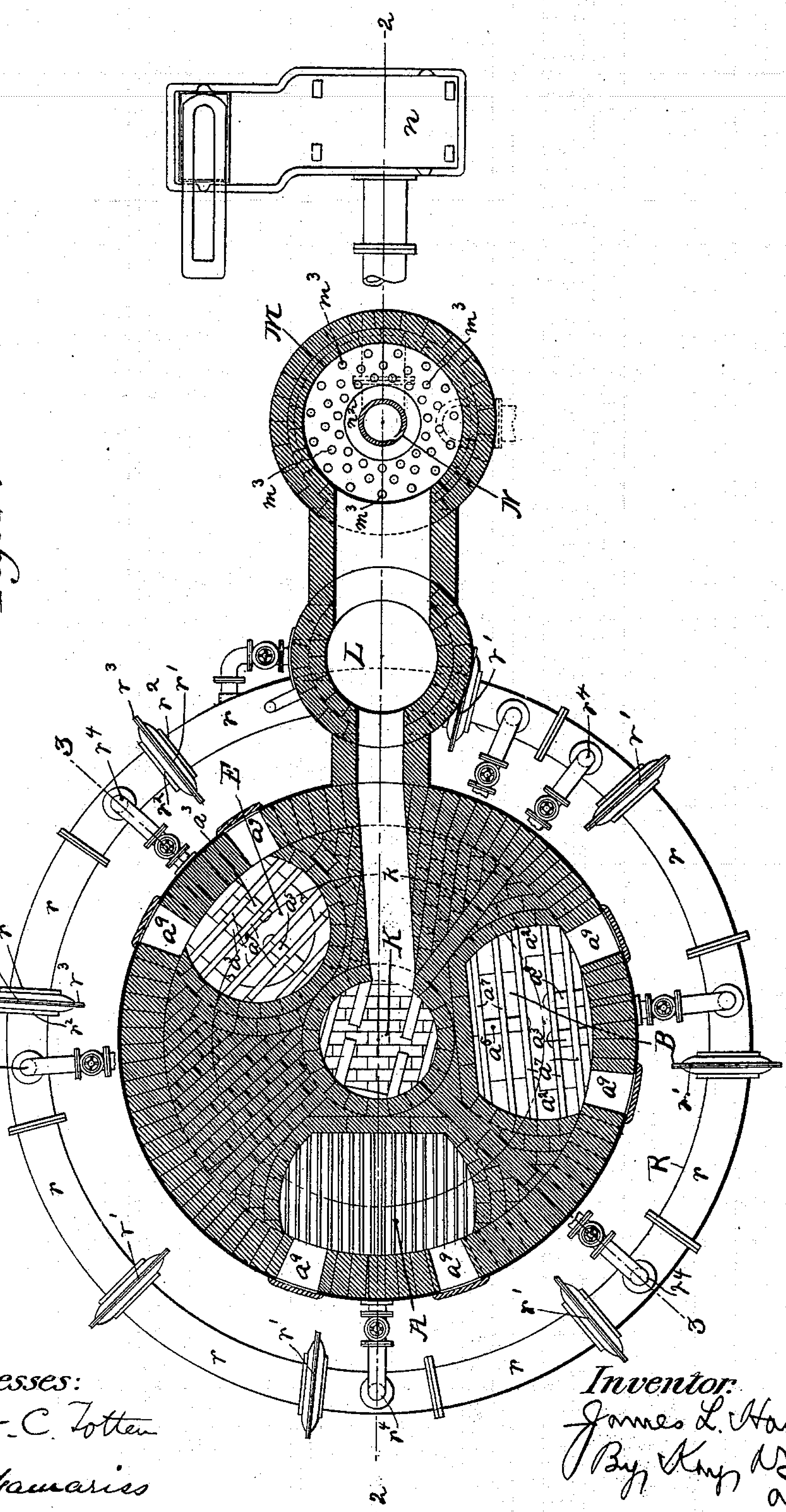
J. L. HASTINGS.

APPARATUS FOR MANUFACTURING GAS.

(Application filed June 11, 1897.)

(No Model.) 4 Sheets—Sheet I.

Fig. 1.



Witnesses:

Robert C. Totten

Walter Famariss

Inventor:

James L. Hastings

By Kay & Totten

attys

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(No Model.) 4 Sheets—Sheet 2.

Fig. 2.

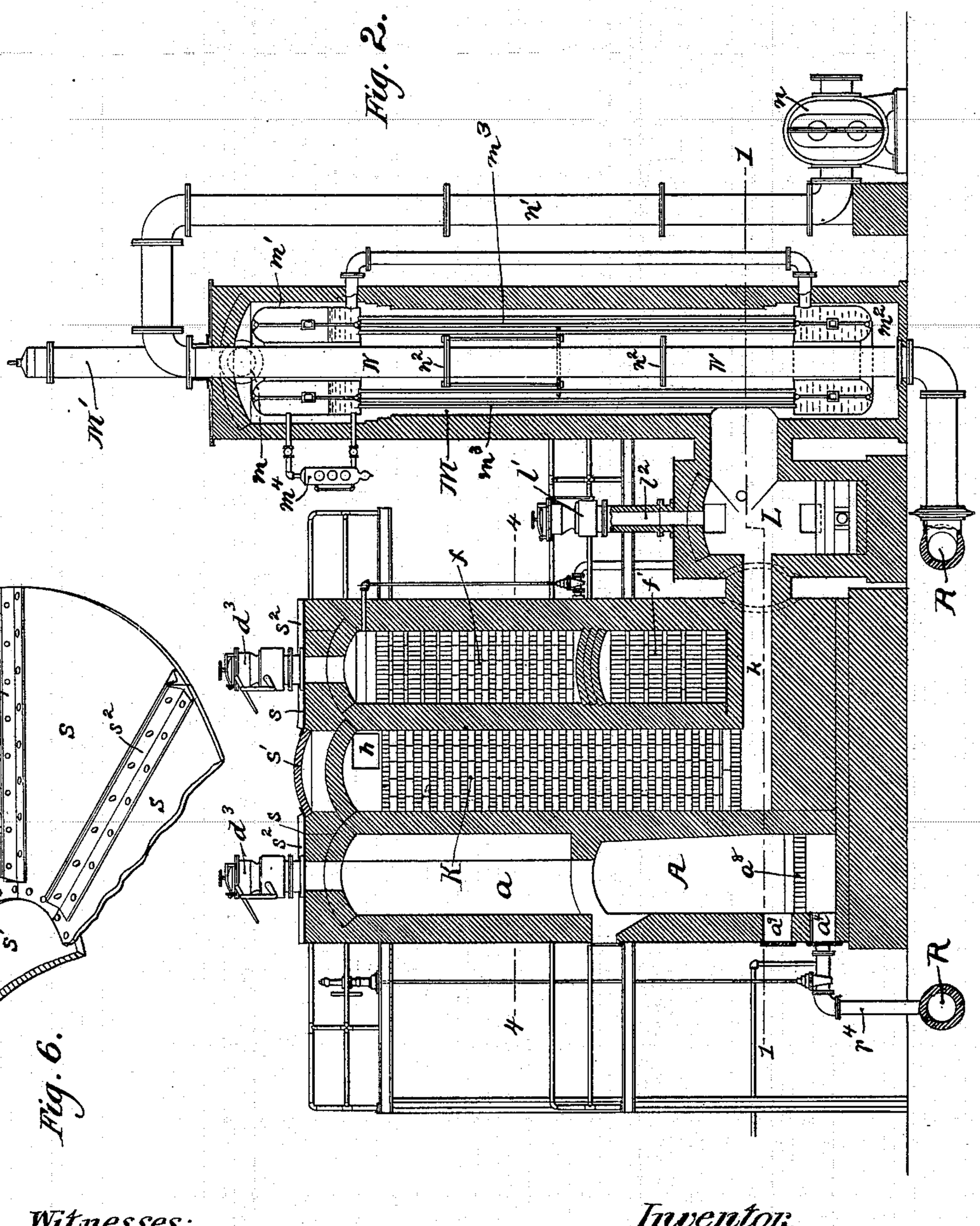

Fig. 6.

Witnesses:
Robert C. Totten
Wallace Famariss

Inventor:
James L. Hastings
By Kerr & Totten
Attys

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(No Model.) 4 Sheets—Sheet 3.

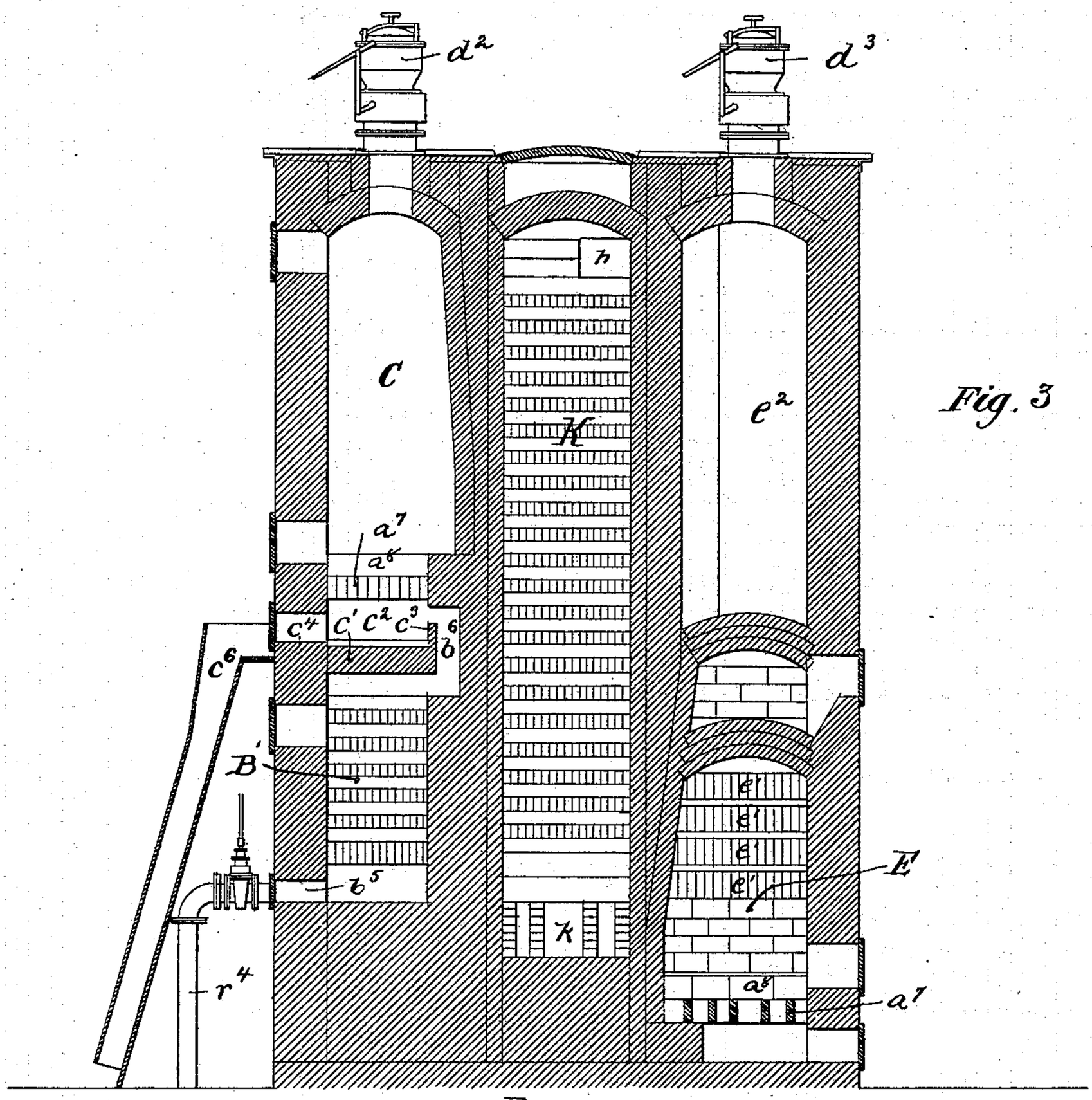

Fig. 3

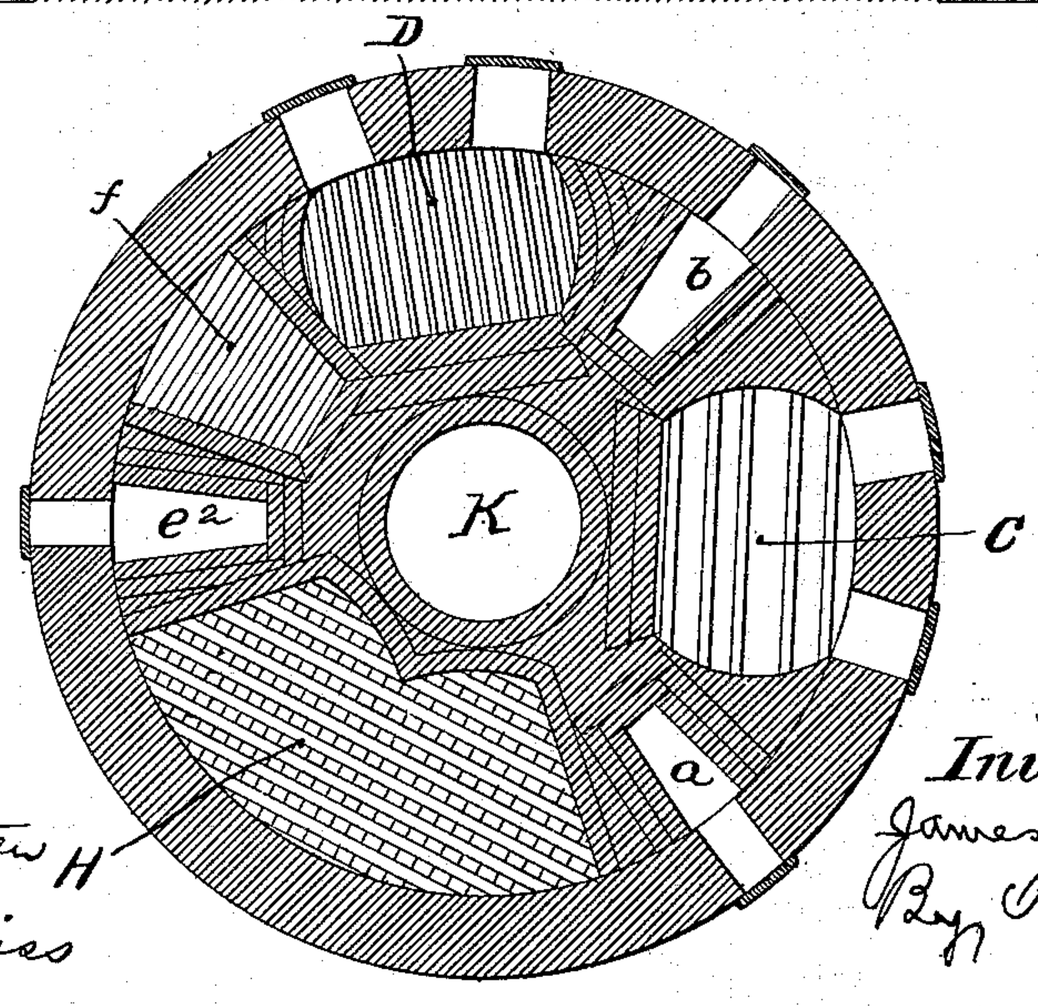

Fig. 4.

Witnesses:
Robt C Totten
Walter Samaries

Inventor:
James L. Hastings
By Kerr & Mattin
Attys

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J. L. HASTINGS.

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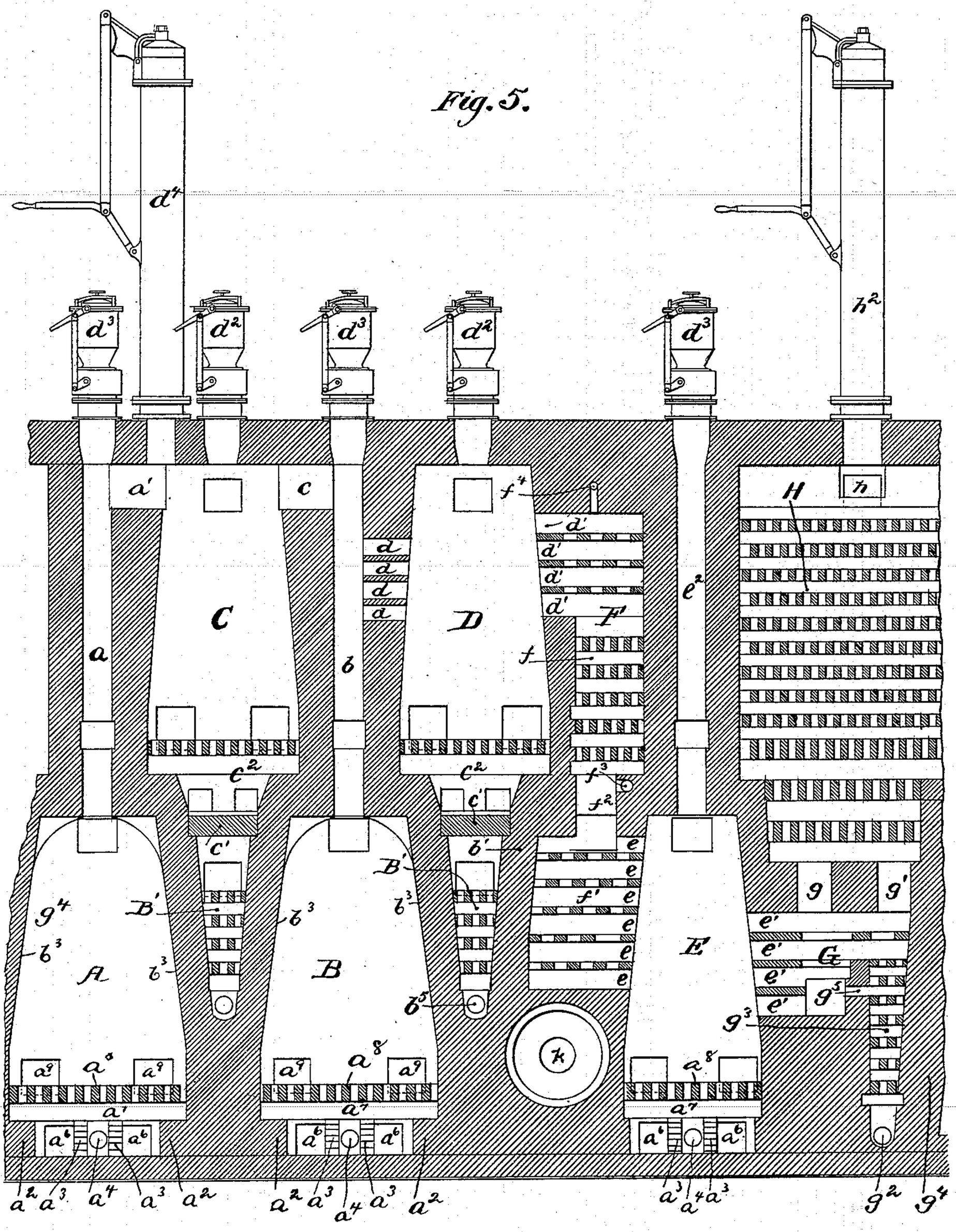
(No Model.) 4 Sheets—Sheet 4.

Fig. 5.



Witnesses:
Robert C. Totten
Walter Famaries

Inventor:
James L. Hastings
By Kay & Totten
Attys

UNITED STATES PATENT OFFICE.

JAMES L. HASTINGS, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO THE STANDARD GAS COMPANY OF AMERICA, OF SAME PLACE.

APPARATUS FOR MANUFACTURING GAS.

SPECIFICATION forming part of Letters Patent No. 615,450, dated December 6, 1898.

Application filed June 11, 1897. Serial No. 640,336. (No model.)

To all whom it may concern:

Be it known that I, JAMES L. HASTINGS, a resident of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a new and useful Improvement in the Manufacture of Gas; and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to the manufacture of gas, its object being to provide for the making of water-gas by a system in which in the same apparatus the amount of gas produced can be regulated according to the supply or demand by what I have termed a "cumulative" system, while the gases made in one part of the apparatus may be utilized to carry off the hydrocarbons in the bituminous coal contained in the other generators by the passage of the gases through the same, so providing for both the carbureting of such gases and the freeing of the hydrocarbons from the coal not only by the heating of the coal by ordinary means, but by the actual contact therewith of gases which are carbureted by contact with such coal in their course from the point of generation.

The further object of the invention is to form a compact gas apparatus which shall provide a large number of generator-chambers in proportion to the size of the apparatus, while sufficient checker-work for fixing the gases is provided, so that in proportion to the first cost of the apparatus a large daily output can be obtained.

The general construction of the apparatus desired to be covered consists in a series of generators arranged in zigzag course within the casing, there being a series of lower generators and a series of upper generators above the same, but each on a vertical plane between the lower generators or chambers, and beyond these generators there being suitable checker-work chambers providing the necessary heating-surface for the fixing of gases in connection with the hydrocarbons fed thereto. The apparatus is preferably arranged within a cylindrical casing, the several generators located in zigzag course, as above referred to, being arranged to communicate in succession in such way that the gases may be carried to the fixing-chambers, which are partly located in the same circle as the generators and partly formed by a central chamber within the circle formed of the generators and said outer fixing-chamber.

The special points desired to be covered will be hereinafter more fully set forth and claimed.

To enable others skilled in the art to employ my invention, I will describe the same more fully, referring to the accompanying drawings, in which—

Figure 1 is a horizontal section on the line 1 1, Fig. 2. Fig. 2 is a vertical section on the line 2 2, Fig. 1. Fig. 3 is a vertical section on the line 3 3, Fig. 1. Fig. 4 is a cross-section on the line 4 4, Fig. 2. Fig. 5 is an opened-out section showing the different chambers arranged around the apparatus, and Fig. 6 is a detail view showing the construction of the roof of the casing.

Like letters of reference indicate like parts in all the drawings.

I will first describe the preferred arrangement of generators and treating-chambers, so as to give an idea of the general system, this being best shown in the opened-out section Fig. 5. The system is called a "cumulative" system on account of the number of generators employed, there being in the plant illustrated three lower generators A, B, and E and two upper generators C and D. The generators A B C D are the main generators for forming gas, and, as shown in the drawings, they are located two on the lower tier and two on the upper tier, the upper ones being staggered with relation to the lower ones—that is, being placed on vertical planes between the planes of the lower ones. The first of the lower generators A has the uptake-passage a, leading to the upper end of the generator C and communicating therewith at a', and the second generator B has the uptake-passage b, with which the upper end of the generator C communicates at c, these generators opening by the ports d, of which several are preferably employed, into the generator D at a point below the top thereof, the lower port d being about midway of the height of the generator D, while on the opposite side of the generator D are the ports d' on about the same horizontal plane as the ports d, which open into

the carbureting-chamber F, the ports d and d' providing a horizontal course for the gases from the generators A, B, and C horizontally across the upper part of the generator D. To follow the general course of the gases, I would state that they pass into the upper section f of the carbureting-chamber F and thence into the lower section f' of said carbureting-chamber, which has a series of ports e similar to the ports d, which open into the coal-chamber or generator E, while the said coal-chamber has on the opposite side thereof the ports e', located on practically the same plane as the ports e, and so providing a practically horizontal course for the gases from the carbureting-chambers through the generator or coal-chamber E. The course provided for the gases from the ports e' is into the chamber G and by different passages g g' up into the checker-work fixing-chamber H, from which they pass through the port h into the central checker-work fixing-chamber K, passing downwardly through the same to the outlet-passage k, Fig. 1, which leads under the chamber f' into the supplemental coal-chamber L, Fig. 1, and thence into the steam-generator and air-heater M, Fig. 1, from which the gases lead through the outlet-port m to the scrubbers on the way to the storage-tank.

Having given thus a general outline of the different parts and of the course of the gases, I would state that so far as the apparatus is concerned it is considered most desirable to build the plant within one main plate-metal cylinder, in which the several cupola-generators, the carbureting-chamber F, and the first fixing-chamber H are arranged in a circle, the central part of the apparatus being occupied by the final fixing-chamber K. The other parts may be included in supplemental casings if necessary.

In order that the details of the apparatus may be clearly understood, I will now proceed to describe the parts thereof. As it is desired to use highly-heated air, as hereinafter described, for maintaining the combustion in blowing up the apparatus or in fuel-gas making, it is impracticable to employ in the cupola-generators the ordinary cast-iron grate-bars, and in the several cupola-generators I prefer to employ the construction illustrated for supporting the tile forming the base of the chamber. This construction consists, generally stated, of side abutments a^2 and central piers a^3 on each side of the air-entrance a^4 and the central pier a^5 opposite but between the piers a^4, space being left between these piers and side abutments to give clear access for the removal of the ash through the doors a^6. Supported on these several piers and abutments are the subtiles a^7, which form the support for the tile grate a^8, the tile grate being formed of a series of tiles resting on the subtiles and supported at numerous points, giving space for the dropping of the ash through the same, while a practically smooth tile surface is provided, over which the operator can work through the doors a^9 for removal of clinker or ash from the upper surface of the grate. As thus constructed access is given for the cleaning of the grate above or below the same at all points except between the two piers a^3; but as the steam and air pipe b^2 enters through this space the current of air will keep this free from ash, so that the ash can be removed from all points under the grate. This same grate is employed in the different cupola-generators. As the lower cupola-generators have the converging side walls b^3, it will be evident that space will be left between said walls, and these spaces form air-heating chambers B', through which the air passes and which serve to heat the air for the upper cupola-generators by contact with the highly-heated walls of the lower cupola-generators or of the wall b^4 between the second air-heating chamber B' and the lower section F' of the carbureting-chamber. The steam and air pipes b^5 communicate with the base of this chamber B', the chambers themselves being preferably filled with checker-work, so as to distribute the air and throw it into contact with the side walls of the lower generators, the air rising until it reaches the top of such chamber B'. It then enters a by-pass b^6, which carries it past the solid floor c', forming the bottom of the ash-pit c^2 of the cupola-generator C or D, as the case may be. By means of this solid ash-pit floor c' and the by-passage b^6 I am enabled to provide a solid floor to collect the ash from the upper cupola-generator, while at the same time heating the air in the chamber B' and conducting the air so heated by induction through the walls of the lower cupola-generators into the upper generator. At the back of the floor c' is the upwardly-projecting wall c^3, which prevents ash from entering into the by-pass b^6. The upper generators have the doors c^4 communicating with the ash-pit c^5 on the level of the grate, so as to provide for the clinkering and removal of the ashes from the generators. The clinker and ash are drawn through these doors into the ash-chute c^6, which extends from about the level of the lower door c^4 to the ground. Coal is fed to the several cupola-generators through hoppers on the top floor of the casing, the hoppers d^2 communicating directly with the upper cupola-generators C and D, while the hoppers d^3 communicate with the uptakes from the lower tier of cupola-generators—that is, the uptakes a b above referred to and the uptake e^2, leading up from the coal-chamber E. For the purpose of heating up the apparatus I also provide the stand-pipe d^4, arranged above the cupola-generator C, which gives outlet in the primary blowing up of the apparatus to the several cupola-generators in that part of the apparatus before the gases are sufficiently hot to burn within the checker-work chambers.

As above shown, the carbureting-chamber F is formed in two parts, the primary part f being at the side of the cupola-generator D and

the secondary part f' being at the side of the cupola-generator E, the two sections communicating through the passage f^2, with which the air-inlet f^3 communicates. The oil-inlet pipe f^4 enters above the primary section f and feeds the oil to the gases passing from the cupola-generator D. The carbureting-chamber may be filled either with tile or checker-work, as desired, it being preferred that tile shall be used in the parts so illustrated to receive the gas as it is broken up into streams in passing through the upper generator D and to divide the same after carbureting into streams to pass through the lower generator or coal-chamber E. The main portion of the fixing-chamber H is in the upper tier of the apparatus, though below the same is the chamber G, which forms practically part thereof, the gases passing from the chamber E into this chamber G and meeting therein a current of air entering through the pipe g^2 and passing upwardly through the air-heating chamber g^3, which is close to the outer wall g^4 of the cupola-generator A, and provides for the heating of the air by induction. A small portion of air passes into the gases entering from the chamber E by the side port g^5; but the main body of air rises through the ports g and g' and intermingles with the gases in the base of the fixing-chamber H, burning in the mass of checker-work therein and distributing the heat more evenly through the mass instead of heating a special combustion-chamber to such a high heat as will break up the hydrocarbons instead of fixing them. The gases thence rise to the port h, which leads into the central checker-work fixing-chamber K through the cylindrical wall h', surrounding the same. To assist in the blowing up of the apparatus, I provide a stand-pipe H^2 above the checker-work chamber H, so that the gases can be permitted to escape through the same in order to evenly distribute the heat in the apparatus and before sufficient heat is obtained to carry through the checker-work chamber K. As this central portion of the cylindrical casing is occupied as a treating-chamber and no bracing means can well be employed therein, I brace the casing by the roof thereof, as shown more clearly in detail, Fig. 6. The roof is formed in sections s of plate metal, the inner ends of which are lapped over and bolted to the heavy rigid center plate s', preferably made of cast-iron, because it must be rigid, this center plate resisting the collapsing strain to which the casing is necessarily subjected at times under the changes of temperature incident to heating and cooling. To brace the sectional plates and carry the strain to the center plate, angle-bars s^2 are swetted to the plates at their meeting edges and are bolted to each other, so forming radial braces extending from the center plate to the outer walls of the casing. The port k leads, as shown in Fig. 1, under the lower section f' of the carbureting-chamber and through the side wall of the main casing into the coal-chamber L, which is built within a separate casing, the purpose of which is to provide for the heating up of the steam-generator and air-heater when necessary. This coal-chamber is provided with the necessary grate and air and steam entrances, above referred to, and has the coal-hopper l' to feed the coal through the chute l^2 into the chamber as needed without permitting escape of gases. From this chamber the port l leads to the steam-generator M and air-heater N.

The steam-generator is built within a long vertical casing, being more particularly shown in Figs. 1 and 2, and providing for generating the steam and heating the air when the generating apparatus is in operation mainly, if not entirely, by the heat of the waste products or outgoing gas, though, as above stated, the coal-chamber L is provided for the heating up of the steam-generator in starting the apparatus when a sufficient amount of heat for generating and superheating the steam is not obtained from the outgoing products or gases. The generator M has the upper annular drum m' and the lower annular drum m^2, these drums being connected by a series of water-tubes m^3, the water being maintained in the upper drum m', with which the indicator m^4 communicates. The air-heater is formed of a large pipe N, which passes centrally through the chamber, air being forced by means of the blower n by a steam or gas engine, as desired, upwardly through the pipe n' to the top of the combined steam-generator and air-heater and thence downwardly through the pipe as it passes centrally through the chamber, the pipe N then communicating by an underground connection with the hot-air-distributing pipe R, Figs. 1 and 2. In order to deflect the heated products and gases into contact with the tubes of the boiler in their upward passage through the steam-generator, I provide the annular baffle-plates n^2 at intervals around the air-pipe N, so that the flame, heated products, or gases are compelled to pass at intervals out among the tubes of the steam-generator instead of hugging around the pipe N, as would be their natural course. These products escape through the stand-pipe M', while the gases pass through the outlet-port m to the scrubbers on their way to the holder.

As shown in the drawings, the heated air is distributed by means of an annular sectional pipe placed below the working floor and extending entirely around the main casing. As this pipe is subject to different changes of temperature, it is made in sections connected by disk expansion-joints, so that each section can be anchored within the brickwork of the foundation and yet leakage be prevented, while such expansion-joints provide for the expansion and contraction of the pipe or main. As shown more particularly in Fig. 1, this hot-air pipe or main R is formed of the sections r, connected at suitable inter-

vals by the disk expansion-joints r', the main being preferably formed of curved cast-metal pipe having flanges r^2 at the ends, to which the disks r^3 are bolted, two such disks being bolted together at their outer edges and forming the disk expansion-joints r'. By such construction the uptake-pipes r^4, leading from the hot-air main to the different points at which air is to enter the apparatus, require no special attention, as they are relieved from any great strain arising from contraction or expansion. Suitable pipes of course lead from the steam-generator to the different chambers in the apparatus into which steam is to be injected; but it is not considered necessary to illustrate this in detail.

In the making of water-gas with the above apparatus the preferred process is practically as follows: When the apparatus is entirely cold, fire is started in the coal-chamber L to generate steam to operate the blower n, though where it is operated by a gas-engine the blast may be turned on before steam is generated in the boiler. Fire is kindled in the different coal-chambers or cupola-generators, and when commencing to heat up the apparatus all the stand-pipes d^4, h^2, and M′ are opened, and the products from the different coal-chambers escape through one or the other in the natural course for the same. As soon as the main cupola-generators are sufficiently heated the stand-pipe d^4 is closed, the gases passing over into the carbureting-chamber F and are met by an air-blast therein, burning and passing through the coal-chamber e and with the gases therefrom being burned in the combustion-chamber G and rising thence through the checker-work chamber H and escaping through the stand-pipe h^2. As soon as these parts are sufficiently heated this stand-pipe is also closed and the heated products pass downwardly through the central checker-work chamber K and over through the chamber L to the steam-generator and air-heater, rising through the same and escaping through the stand-pipe M′.

As soon as the apparatus is brought to the proper heat for gas-making where all of the different coal-chambers are to be utilized for gas-making—that is, the full product of the apparatus is to be made—by means of jets of steam the fixing-chambers are cleared from worthless gases, such as carbonic acid and nitrogen, which are blown out of the apparatus through the stand-pipes and the air-heater. Steam is then turned first into the lower cupola-generator A the greatest distance from the carbureting-chamber, and the water-gas formed therein passes up through the passage a to the upper end of the cupola-generator C. The heat of this gas in passing above the coal in the upper part of this chamber meets with and carries off the lighter hydrocarbons, coal being fed to this generator just before starting to make gas. The lighter hydrocarbons are freed by the heat of the mass of coal therein and by the gases passing through the chamber. Steam is then admitted to this cupola-generator C, and the gas formed therein mingles with that from the generator A and passes over into the passage b and thence across and through the generator D. The gases from these chambers, as well as from the chamber B, are carried across the cupola-generator D about midway of the body of coal therein at a point above the zone of highest heat therein, such gases from the other chambers serving to carry off any hydrocarbons contained in the coal in the upper part of the generator D, while in case any carbonic acid has passed from the other cupola-generators A, B, or C such carbonic acid will be converted into carbonic oxid in passing through such chamber. The gases then pass downwardly through the carbureting-chamber, where if they are to be carbureted the oil for enriching the gases is sprayed into the same and the gases and hydrocarbons then passing downwardly and about midway across the coal-chamber or generator E, which serves to give the primary fixing to the gases formed and to still further reduce any carbonic acid present. Its main value, however, is that as the upper part of the same is not too highly heated it forms a red mass of carbon, in which the hydrocarbons can mingle and unite with the water-gas, and the primary fixing takes place. As the gases pass in their course through the fixing-chambers H and K they are subjected to still higher heat by their contact with the checker-work, and all final fixing necessary is accomplished. At the proper time during the making of the gas steam can also be admitted to the cupola-generator D, forming water-gas in the lower part thereof, which mingles with the gases passing across such generator, and steam may also be admitted to the lower part of the coal-chamber E for the same purpose, if considered desirable. It is not expected, however, that much gas will be obtained from the chamber E, its main usefulness being as a mixing and fixing chamber, as above stated. It will be noticed that the gases in passing across the cupola-generator D and the coal-chamber E are divided by the series of ports into streams and distributed throughout the mass of heated coal or carbon in such chambers. This gives better results than if small ports were used, because it provides a more positive distribution of the gases and prevents too rapid cooling down of the bodies of coal through which the gases are carried. All the water-gas so formed passes in its course through the coal-chamber L and upwardly through the steam-generator and air-heater, so providing for the absorption of a large portion of the heat of the outgoing gases by the water or the incoming air, the carrying back of such heat into such gas-generator, and the cooling of the gases, the gases then escaping through the outlet-port m and being treated in the usual way in the scrubbers.

When the apparatus becomes too cool for gas-making, air can be admitted at different points therein for raising the bodies of coal to the proper temperature and for burning the generator-gas to heat the bodies of checker-work and the incoming air. The air entering the chambers B′ and g^3 is still further heated by contact with the hot walls of the apparatus, and the highly-heated air, which is raised to a temperature of about 500° Fahrenheit, provides for the quick raising of the bodies of coal to the necessary heat for gas generation, while, as a large number of bodies of coal are provided, sufficient generator-gas is formed to quickly heat up the other chambers, air being admitted for a short time between the two sections of the carbureting-chamber, a proper amount of air being admitted to the combustion-chamber G to heat up the checker-work fixing-chambers. When the apparatus is running full, the heated products or such gases as still remain and which may be burned in the steam-generator are sufficient, in connection with the outgoing gases above referred to, to maintain the air at a high heat and give a full supply of steam for gas generation, making a corresponding saving in cost of production.

The apparatus is cumulative in that it provides for the making of any desired amount of gas, according to the demand and without the necessity of banking up and holding bodies of coal in readiness for a quick demand, as only the upper tier of cupola-generators need be employed or only the lower tier, or both, so varying the supply, as found desirable. In like manner a good quality of fuel-gas can also be provided by feeding the heated air to any one or more of the cupola-generators while steam is being fed to the other cupola-generator, the generator-gas and water-gas so produced being intermingled in their passage through the different generators or through the coal-chamber, and such gases being carbureted or not, as desired, according to the purpose for which they are to be employed. On account of the numerous coal-chambers employed all carbonic acid produced in one or the other generator is reduced to carbonic oxid, and the employment of a comparatively short generator, which might be liable to produce carbonic acid, is not therefore objectionable. The air can also be fed to the different chambers at such high heat as to quickly bring the apparatus to the proper temperature for gas-making after a "run."

One of the important advantages of the process and apparatus is that on account of the passage of the gases through the bodies of coal a very large proportion of the hydrocarbons contained in the bituminous coal can be utilized for the carbureting of the gas, there being no waste of such hydrocarbons, except possibly in the blowing up, while by feeding the fresh coal to the generators at the time of gas-making the greater proportion of such hydrocarbons can be saved and utilized in the resultant gas.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. A gas apparatus having a series of cupola-generators inclosed within a casing and arranged in tiers the one above the other, the generators in the upper tier being on vertical planes between those on the lower tier, and outlet-passages leading from the generators, substantially as set forth.

2. A gas apparatus having a series of cupola-generators inclosed within a casing and arranged in tiers the one above the other, the generators in the upper tier being on vertical planes between those on the lower tier, the generators of the lower tiers having uptake-passages adjoining and leading to the generators of the upper tier, substantially as set forth.

3. A gas-making apparatus having two cupola-generators or chambers having converging walls and an air-heating chamber arranged between the walls of said generators and having an air-inlet pipe at the base, and an outlet-port at the top thereof and a cupola-generator above said two generators with which said outlet-port communicates, substantially as set forth.

4. A gas apparatus having two sets of cupola-generators, one arranged above the other, the generators of the upper set being on vertical planes between those on the lower set, the generators of the lower set having converging walls, and the spaces between such walls forming air-heating chambers having air-inlets and communicating with the bases of the upper generators, substantially as set forth.

5. A gas-generating apparatus having a cupola-generator, an air-heating chamber directly under the same, a solid ash-pit floor below the generator and a by-pass in the walls leading around the same and forming communication between the air-heating chamber and generator, substantially as set forth.

6. A gas-generating apparatus contained within a casing and having a cupola-generator with passages in the side walls about midway of the height thereof, a carbureting-chamber at one side of said cupola-generator and extending below the same and another cupola-generator on a lower level than the first one and with which said carbureting-chamber communicates, having passages in its side walls about midway of the height thereof, substantially as set forth.

7. A gas-generating apparatus built within a cylindrical casing and having a series of cupola-generators on different levels communicating with each other arranged around the same and a checker-work chamber with which the last cupola-generator communicates arranged on the same circular plane and a checker-work chamber in the center of

the apparatus with which said first-mentioned checker-work chamber communicates, substantially as set forth.

8. A gas-generating apparatus built within a cylindrical casing and having a series of cupola-generators on different levels communicating with each other arranged around the same and a checker-work chamber with which the last cupola-generator communicates arranged on the same circular plane and a checker-work chamber in the center of the apparatus with which said first-mentioned checker-work chamber communicates, and an outlet-passage leading from the lower end of said central checker-work chamber, substantially as set forth.

9. A gas-generating apparatus formed of a main cylindrical casing containing a number of generators and of treating-chambers and having beyond said casing a generator or fire-chamber in the course of the outlet-passage therefrom and beyond the same a steam-generator, substantially as set forth.

10. A gas-generating apparatus formed of a main cylindrical casing containing a number of generators and of treating-chambers and having beyond said casing a generator or fire-chamber in a separate casing in the course of the outlet-passage therefrom and beyond the same and in another casing a steam-generator, substantially as set forth.

11. A gas-generating apparatus formed of a main cylindrical casing containing a number of generators and of treating-chambers and having a generator or fire-chamber in a separate casing in the course of the outlet-passage therefrom and beyond the same and in another casing a steam-generator, and said steam-generator having an air-heating pipe extending centrally and vertically through the same, substantially as set forth.

12. A gas-generating apparatus built within a cylindrical casing and containing generating and treating chambers in combination with an air-heating apparatus and a circular air-supply pipe extending around the main casing and having pipes leading therefrom to the different chambers, said circular pipe being formed of sections connected by expansion-joints, substantially as and for the purposes set forth.

13. A gas-generating apparatus having a coal-chamber, the checker-work fixing-chamber H, the connecting-chamber G between them, an air-inlet having the side port g^5 communicating with the chamber G and the port g' leading into the chamber H, substantially as set forth.

14. A gas-generating apparatus having a cylindrical plate-metal casing having a roof formed of a heavy rigid center plate and radial plates connected thereto and extending to the cylindrical casing, substantially as set forth.

15. A gas-generating apparatus having a cylindrical plate-metal casing having a roof formed of a heavy rigid center plate and radial plates connected thereto and extending to the cylindrical casing, and radial braces connected to the sectional plates at their meeting edges, substantially as set forth.

In testimony whereof I, the said JAMES L. HASTINGS, have hereunto set my hand.

JAMES L. HASTINGS.

Witnesses:
JAMES I. KAY,
ROBERT C. TOTTEN.