(No Model.) 4 Sheets—Sheet 1.

J. L. STEWART.

APPARATUS FOR MANUFACTURING GAS.

No. 584,714. Patented June 15, 1897.

Fig. 1.

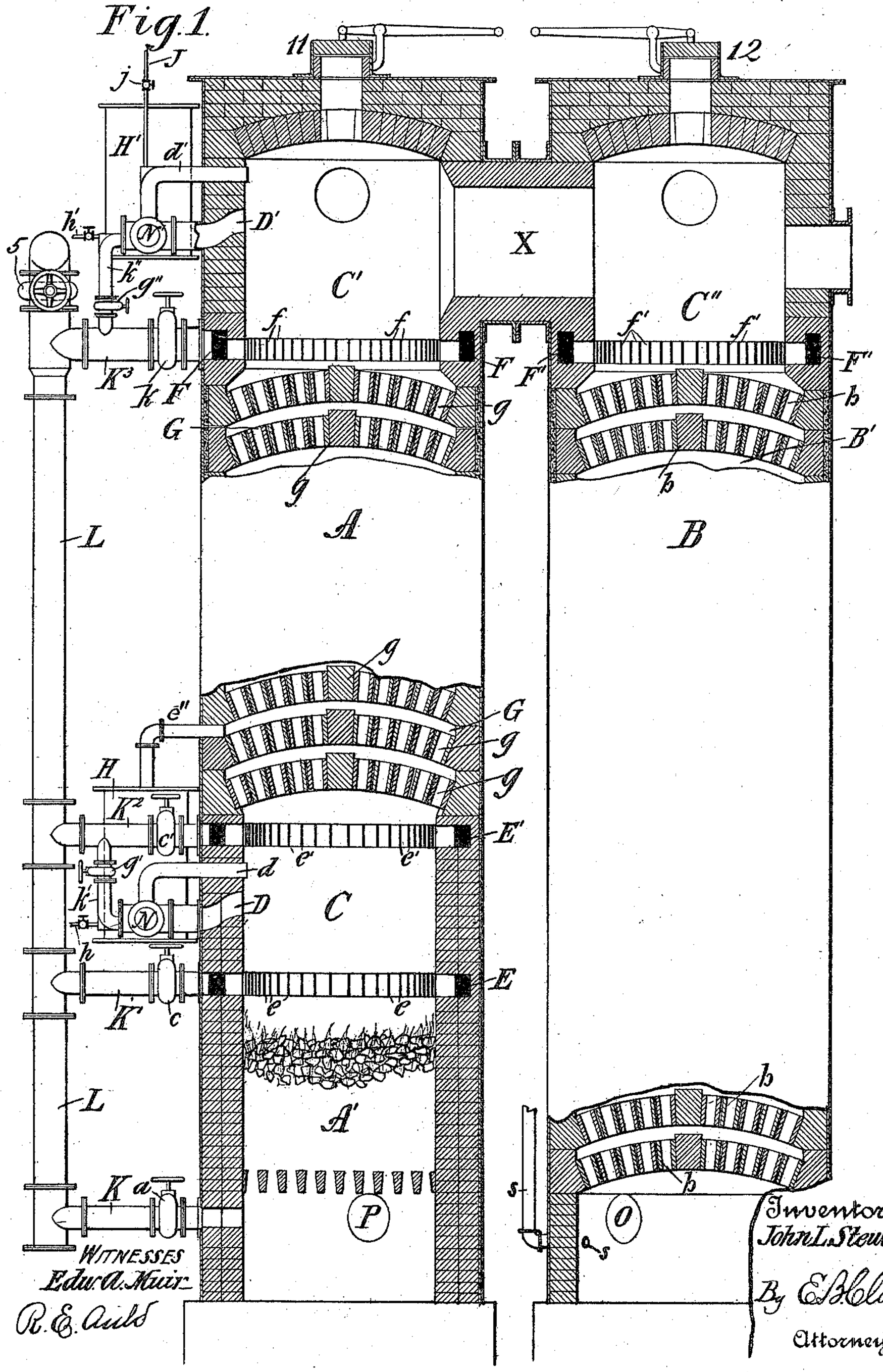

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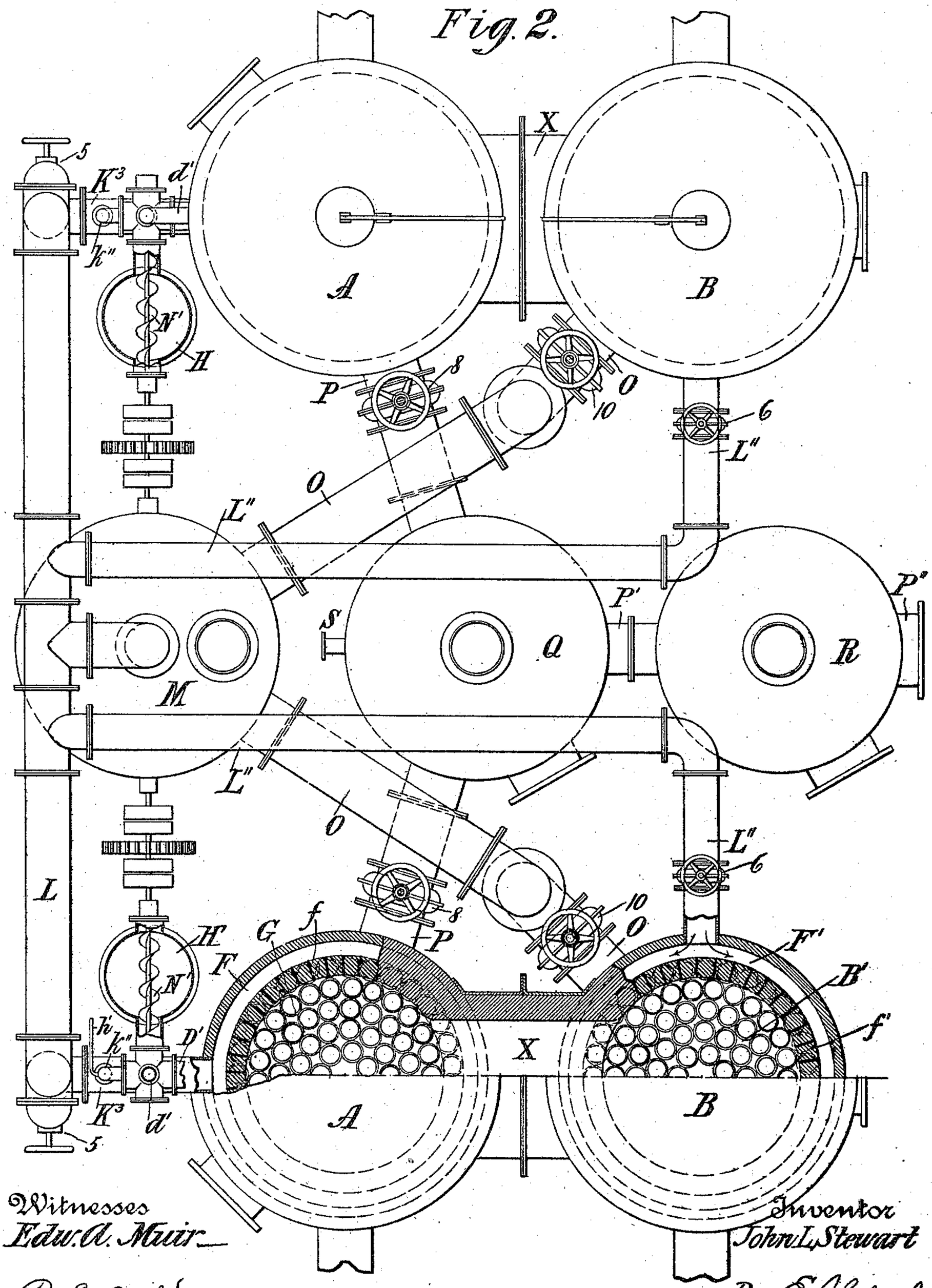
Fig. 2.



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(No Model.)

4 Sheets—Sheet 3.

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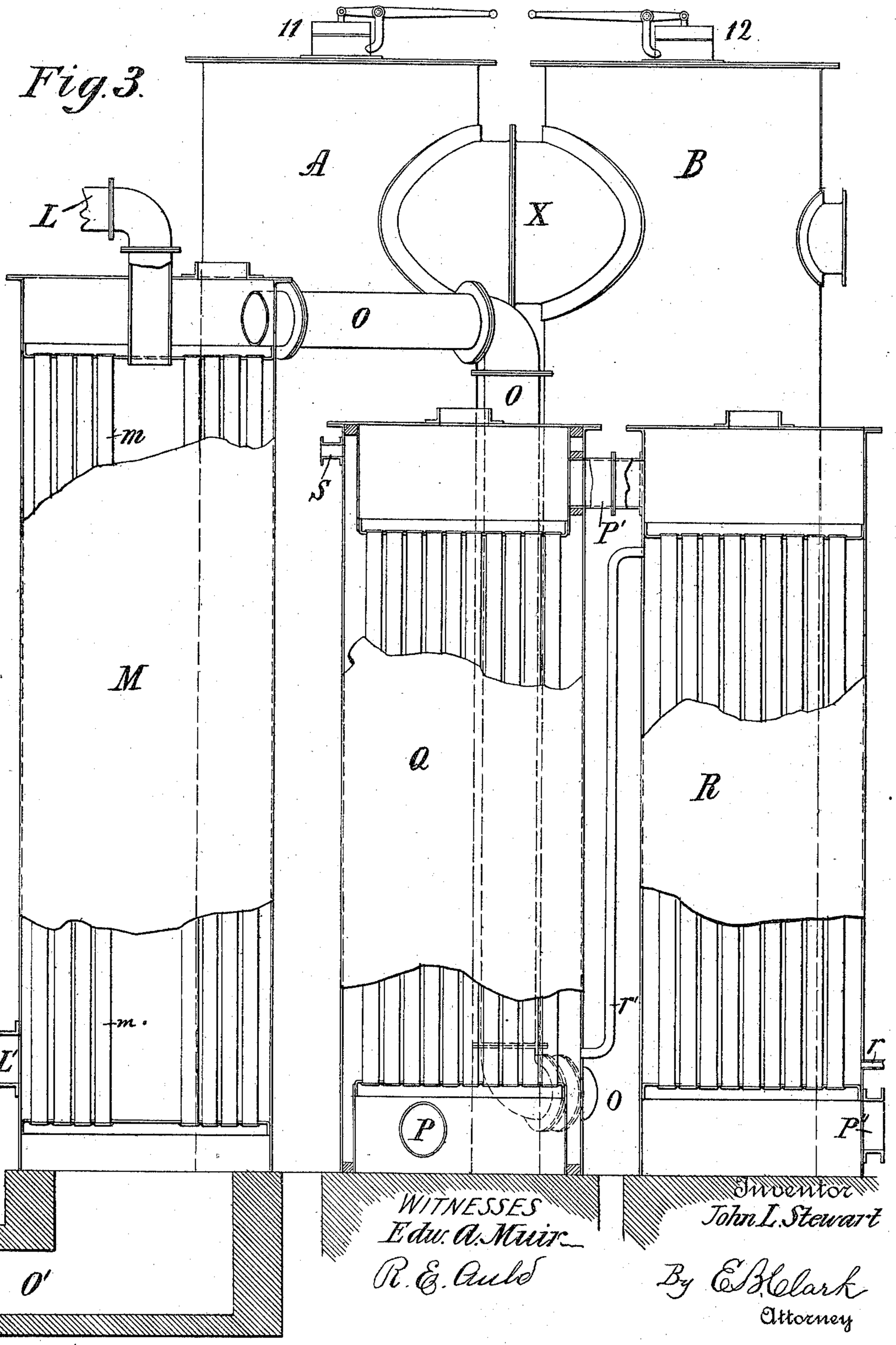
Fig. 3.



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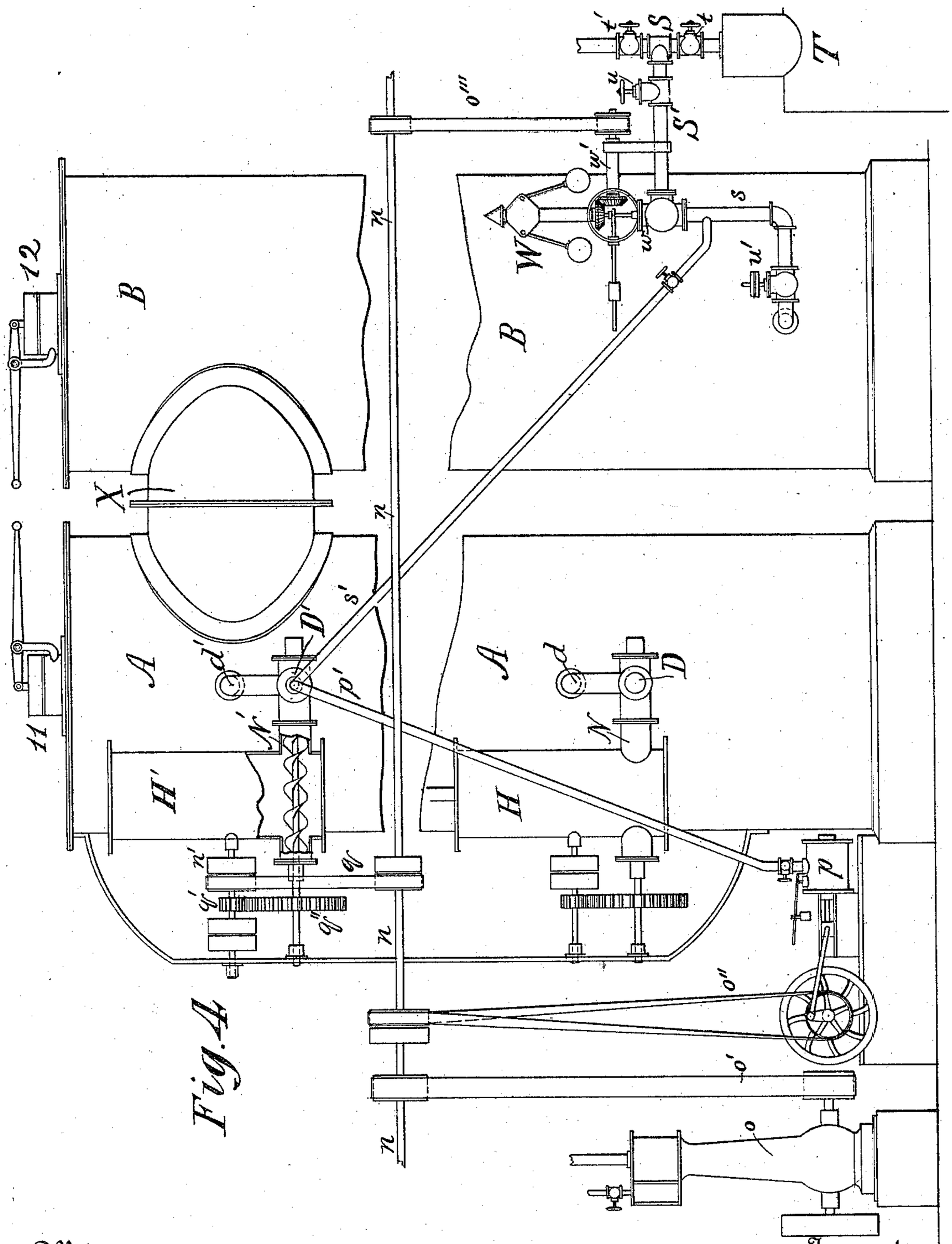

Fig. 4.

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UNITED STATES PATENT OFFICE.

JOHN L. STEWART, OF PHILADELPHIA, PENNSYLVANIA.

APPARATUS FOR MANUFACTURING GAS.

SPECIFICATION forming part of Letters Patent No. 584,714, dated June 15, 1897.

Application filed December 23, 1890. Serial No. 375,598. (No model.)

To all whom it may concern:

Be it known that I, JOHN L. STEWART, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, 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 gas-generating apparatus adapted for manufacturing gas by means of properly regulated and maintained proportions of carbon-dust and steam supplied in an intimate mixture and subjected to contact with highly-heated refractory material within the cupola.

The object of the invention is to provide for better superheating steam by passage upward through a heat-restorer and mixture therewith of carbon-dust, in connection with which it is decomposed by passage downward in contact with heated refractory material and heated fuel in a generating-chamber.

Another object is to provide an improved combination of devices for causing steam, air, and carbon-dust to be fed in properly regulated and maintained proportions to the generator during the manufacture of gas.

In case the generator was constructed in a single tall stack with the superheating-chamber at the top, as heretofore proposed, it would be difficult to force the superheated steam down to the middle portion of the generator where it is mixed with carbon-dust for the reason that the steam as superheated and expanded has a constant tendency to rise rather than to flow downward. I therefore arrange my superheater or heat-restorer in a separate chamber set alongside of the decomposing or generating chamber and admit the steam at the bottom of such heat-restorer. As it is superheated and expanded it readily passes upward and over into the top of the generator, where it is intimately mixed with carbon-dust, which increases its specific gravity to such an extent that it will then readily flow downward in contact with the heated brickwork and be decomposed.

My improved devices for feeding carbon-dust, steam, and air in properly regulated and maintained proportions will be specifically pointed out in the description of the apparatus by reference to the accompanying drawings, and the matter constituting my invention therein will be defined in the claims.

In the accompanying drawings, Figure 1 represents the generator and heat-restorer partly in vertical section. Fig. 2 represents a double set of apparatus partly in top plan view and partly in horizontal section. Fig. 3 represents a vertical section of the air-heater, steam-boiler, and water-heater. Fig. 4 represents a diagram of the generator and heat-restorer in elevation, with devices connecting therewith for regulating and maintaining proper proportions of carbon-dust, steam, and air fed to the generator for manufacturing gas.

Both the generator A and the heat-restorer B are constructed of brick, having linings of fire-brick and covered with tight iron jackets in the usual manner. The generator A is provided at the bottom with the usual fuel-chamber A′ and with the usual grate and ash-pit. A combustion-chamber C is formed above the fuel-chamber and has constructed within its walls two annular air-supply flues E E′, from which narrow slits or ports *e e′* open into the combustion-chamber. Above the combustion-chamber C, I construct the decomposing-chamber G, composed of arches of refractory material *g*, and above such decomposing-chamber G, I provide a second combustion-chamber C′, which has constructed in its wall an annular air-flue F, provided with ports *f*, opening into the chamber. A short flue X connects combustion-chamber C′ at the top of generator A with combustion-chamber C″ at the top of heat-restorer B.

Both the generator A and heat-restorer B are provided at the top with the usual openings for the escape of waste gaseous products, which openings are provided with tight-fitting lids 11 and 12. The combustion-chamber C″ at the top of heat-restorer B has constructed in its wall an annular air-flue F′, provided with ports *f′*, opening inward. The heat-restorer B is preferably filled with refractory brickwork B′, composed of separate arches *b*. The brickwork arches *g* and *b* in both the generator and heat restorer are preferably constructed of short fire-clay tubes, as

shown in Figs. 1 and 2, which present a great extent of heating-surface, since both their internal and external surfaces are exposed to the passing steam or gases.

In order to utilize the heat of the waste products of combustion and hot gas passed off from the generator, I provide an air-heating chamber to be heated by the waste products and a steam-boiler and water-heater to be heated by the escaping hot gases.

A pipe O for products of combustion leads from the base of heat-restorer B to the top of air-heater M, and the gas take-off pipe P leads from the base or ash-pit of generator A to the bottom smoke-box of the tubular steam-boiler Q, Figs. 2 and 3. The pipe P′ connects the top smoke-boxes of boiler Q with the top smoke-boxes of water-heaters Q and R, and the pipe P″ for taking off water-gas leads from the bottom smoke-box of water-heater R.

As shown in Fig. 3, the air-heater M is provided with top and bottom smoke-boxes and with vertical iron tubes *m*, set in tube-sheets and connecting such smoke-boxes. Pipe O, conveying hot products of combustion, enters the top smoke-box and the products pass down through the tubes and escape from the lower smoke-box through chimney-flue O′.

An air-supply pipe L′ connects with the shell of the air-heater and opens into the space surrounding the vertical tubes *m*, so that air is circulated around and between such tubes and is heated and passed out through pipe L at the top. Hot air is supplied by pipe L and its various branches to the different parts of the generator, as described below. A main valve 5 is provided in pipe L for controlling the flow of air from the heater M to the generator. Pipe L is connected by branch pipe K, having valve *a*, with the ash-pit; by branch pipes K′ and K², having valves *c c′*, with the annular flues E E′, and by branch pipe K³, having valve *k*, with the annular flue F. A branch pipe L″, having valve 6, Fig. 2, leads from pipe L to annular flue F′ in the top of heat-restorer B.

Carbon-dust-supply boxes H and H′ are arranged in convenient position for supplying dust to the combustion-chambers C C′ of each generator and are provided with suitable connections for feeding the dust.

Spiral conveyers N N′ lead from the boxes H H′ into the injectors D D′, and the injectors open into the combustion-chambers C C′, as shown. The dust-conveyers are preferably of the kind shown in Figs. 2 and 4. The injectors are of any suitable known variety.

An air-blast pipe *k′*, having valve *g′*, leads from pipe K² into injector D, and a steam-pipe *h*, provided with a valve, also connects with injector D. An air-blast pipe *k″*, provided with a valve *g″* and a steam-pipe *h′*, connects with the injector D′.

Equalizing-pipes *d d′* lead from the interior of the generator into each injector for overcoming back pressure therein. An equalizing-pipe, such as shown at *e″*, is preferably used to connect the interior of the generator with each of the boxes H H′ to relieve them from back pressure. An oil-supply pipe J, provided with valve *j*, connects with the upper injector D′, and a similar pipe may connect with the injector D for supplying oil, when desired, for carbureting or enriching the water-gas.

A water-supply pipe *r* connects with the lower end of heater R, and a pipe *r′* connects the top of such heater with the bottom of boiler Q. A steam-outlet pipe S leads from the top of the boiler. Steam-supply pipe *s* connects with the base of heat-restorer and superheating-chamber B.

The apparatus for supplying properly-regulated and constantly-maintained proportions of carbon-dust, steam, and air to the generator during the gas-making operation is illustrated in Fig. 4. A steam-engine *o* is properly connected by belts to a main shaft and gearing with the spiral dust-conveyer, which feeds dust through an injector into the generator, and the same shaft which connects by gearing with the dust-feed conveyer also connects by a suitable belt and pulleys with a steam-governor for controlling the flow of steam into the dust-injector and into the heat-restorer or superheater B. A belt *o′* connects the pulley of the engine with pulley on the shaft *n*. A belt *o″* connects the pulley on shaft *n* with the belt-wheel of air-compressor *p*, and a belt *o‴* connects a pulley on shaft *n* with a pulley on the shaft *w′*, connecting by a bevel-gearing with the steam-governor W. A belt *q* connects the pulley on shaft *n* with fast and loose pulleys *n′*, mounted on a shaft above, which latter connects by gear-wheels *q′ q″* with the shaft of the dust-conveyer N′, leading into injector D′.

An air-pipe *p′* leads from compressor *p* into injector D′, and steam is also supplied to such injector through pipe *s′*.

Steam for supplying the heat restorer and generator may be taken from any suitable boiler, such as Q. (Shown in Fig. 2.) For the purpose of illustration I have shown in Fig. 4 an ordinary boiler T, from which leads a steam-pipe S, having globe-valves *t t′*. A steam-pipe S′ leads from pipe S to the regulating-valve *w*, which is controlled by the governor W. A steam-pipe *s* leads from the regulating-valve *w* into the base of heat-restorer and superheater B. A branch pipe *s′* leads from pipe *s* into injector D′.

For the purpose of maintaining a uniform pressure upon the governor-valve *w* I apply a pressure-regulating valve *u* to steam-supply pipe S′. A similar pressure-regulating valve *u* may be applied to steam-valve *u′*, connecting with heat-restorer B. The pressure of steam flowing from the boiler is regulated by valve *u*, while the volume or quantity of steam flowing into the generator and heat-restorer is controlled by the governor W and its valve *w*.

The steam-governor and its valve are so

constructed and connected that as the engine which connects therewith runs faster the valve will be opened wider, admitting a larger supply of steam, and so that as the engine is run slower the valve will be partially closed, reducing the supply of steam.

It will be seen that since the dust-conveyer and the steam-supply valve and governor are connected by belts and pulleys to the same engine-shaft the proportions of dust and steam will be maintained substantially the same whether the engine be run fast or slow.

It will also be seen that since the air-compressor is likewise connected by a belt and pulleys to the same main shaft from which the dust-conveyer is operated the proportions of dust and air supplied to the generator will be maintained uniform.

The carbon-dust is blown into the generator either by steam or air alone, or by any suitable mixture of the two, according to the quality of the gas which it is desired to generate.

In order to operate the apparatus for the manufacture of gas, it is first heated up as follows: The lid 11 at the top of generator A being open a fire is kindled on the grate and fuel is gradually supplied till a sufficient body is well ignited. After the fuel is well ignited the lid 11 is closed and valve 10 opened and the gaseous products are conducted down through heat-restorer B, thence through pipe O into the air-heater M, from which they escape through the flue at the bottom. After the bed of fuel has become sufficiently ignited the carbon-dust is blown into combustion-chamber C and a suitable supply of air is admitted through annular flues E E′ and their ports *e e′* for causing combustion of the dust. The carbon-dust supplied is burned until the brickwork in the decomposing-chamber G is well heated. The gaseous products arising from the carbon-dust and passed over into the heat-restorer are fully burned by air admitted through flue F′ and its ports *f′*, and the hot products of combustion are passed off through air-heater M.

The tubular brickwork arches in the decomposing-chamber G of generator A, having been heated to the proper temperature, preferably a lively red, and it being desired to still further heat the brickwork in heat-restorer B, then the carbon-dust and air-blasts are preferably shut off from combustion-chamber C and are admitted into chamber C′ at the top of generator A. The spiral dust-conveyer N′ is started and valve *g″* is opened, supplying air to the injector D′. Valve *k* is also opened, admitting air through flue F and ports *f*, which causes combustion of the dust spread in above. The resulting gaseous products are passed over through the connecting-flue X into the combustion-chamber C″ at the top of heat-restorer B and are completely consumed by admission of air through flue F′ and ports *f′*, and the resulting gaseous products are passed down through heat-restorer B, highly heating the brickwork thereof, and finally pass off at the bottom by pipe O, through valve 10, into the top of air-heater M, through the tubes *m*, and off through chimney-flue O′ at the bottom, as before explained, the combustion of carbon-dust in chamber C′ and the combustion of gases resulting therefrom in chamber C″, by means of numerous jets supplied through the flues and ports, as before explained, being continued until all the brickwork in heat-restorer B is heated to the proper temperature for highly superheating steam, which in a subsequent operation is to be decomposed in generator A for the manufacture of gas.

The generator A and heat-restorer B having both been heated to the proper temperature for commencing the gas-generating operation all the dust and air supply pipes are closed, valve 10 in pipe O is closed, and valve 8 in pipe P, leading from the bottom of the generator, is opened for directing the water-gas which is to be made into the base of steam-boiler Q.

The engine *o* for operating the steam-governor W and dust-conveyers and its valve *w* is started. Steam flows by a pipe *s* into the base of heat-restorer B and through pipe *s′* into the upper injector D′. Dust is conveyed to injector D′ by the conveyer N′ and is blown into the upper chamber C′ of the generator. The main supply of steam admitted by pipe *s* to the base of heat-restorer is superheated by passage up through and in contact with the heated brickwork in such restorer, and as it passes at the top over into chamber C′ of the generator it meets the supply of carbon-dust blown through injector D′. The two are intimately mingled and passed down through the decomposing-chamber G, where the steam, through the action of the finely-divided carbon in contact with the heated brickwork, is rapidly and completely decomposed, resulting in the production of hydrogen and carbonic oxid, with perhaps a small percentage of carbonic acid. This gas is passed down through the bed of fuel, where any carbonic acid present is converted into carbonic oxid. The resulting products, known as "water-gas," pass off through pipe P and valve 8 into the base of the steam-boiler Q, thence up through the tubes of such boiler and down through the tubes in the water-heater R, and are finally conducted off through pipe P″ to the usual scrubber and purifier. The generation of water-gas, as above described, is conducted so long as the heat restorer and generator remain at the proper temperature for superheating and decomposing steam, after which the apparatus is reheated by the combustion of dust and air, as before explained.

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

1. A cupola gas-generator having a fuel-chamber at the bottom and a dust-burning

chamber above such fuel-chamber, in combination with means for supplying such combustion-chamber with carbon-dust, steam and jets of air, a heat-restorer containing refractory brickwork connecting with the top of the cupola generator, such restorer having a combustion-chamber at the top provided with an annular air-flue and ports in its wall, and a steam-pipe connecting with the base of the heat-restorer, substantially as described.

2. A cupola gas-generator having a fuel-chamber at the bottom, a carbon-dust-burning chamber above, a decomposing-chamber containing refractory material above the dust-chamber and a carbon-dust chamber at the top for mixing dust with superheated steam, in combination with suitable conveyers and injectors for supplying dust, steam and air to the chambers, a heat-restorer and steam-superheater having a combustion-chamber at its top, provided with an air-supply flue and ports, a flue connecting the top of the generator with the top of the heat-restorer and a steam-supply pipe connecting with the bottom of the restorer, substantially as described.

3. In combination with a cupola gas-generator and a heat-restorer connected at the top, a carbon-dust feed-box, conveyer and steam-injector connecting with the upper part of the generator, suitable gearing for operating the dust-conveyer connecting with a main driving-shaft, an engine connecting with such shaft, a steam governor and valve applied to a steam-supply pipe and connecting by suitable gearing with said main shaft, and steam-pipes leading from the governor-valve into the heat-restorer and dust-injector for supplying carbon-dust and steam in properly regulated and maintained proportions to the generator, substantially as described.

4. In combination with a gas-generating cupola, the carbon-dust-feeding devices, the air-supply compressor, the steam-supply governor and valve, and an engine all connected by gearing with the same main driving-shaft for supplying carbon-dust, air and steam in proper proportions to the generator, substantially as described.

5. In combination with a gas-generating cupola the carbon-dust-feeding devices and a steam-supply governor and valve both connecting by means of suitable gearing with the same main shaft, and an engine also connecting with such shaft for supplying carbon-dust and steam in suitable proportions for manufacturing gas.

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

JOHN L. STEWART.

Witnesses:

JOHN CARSON,

GEO. W. CARSON.