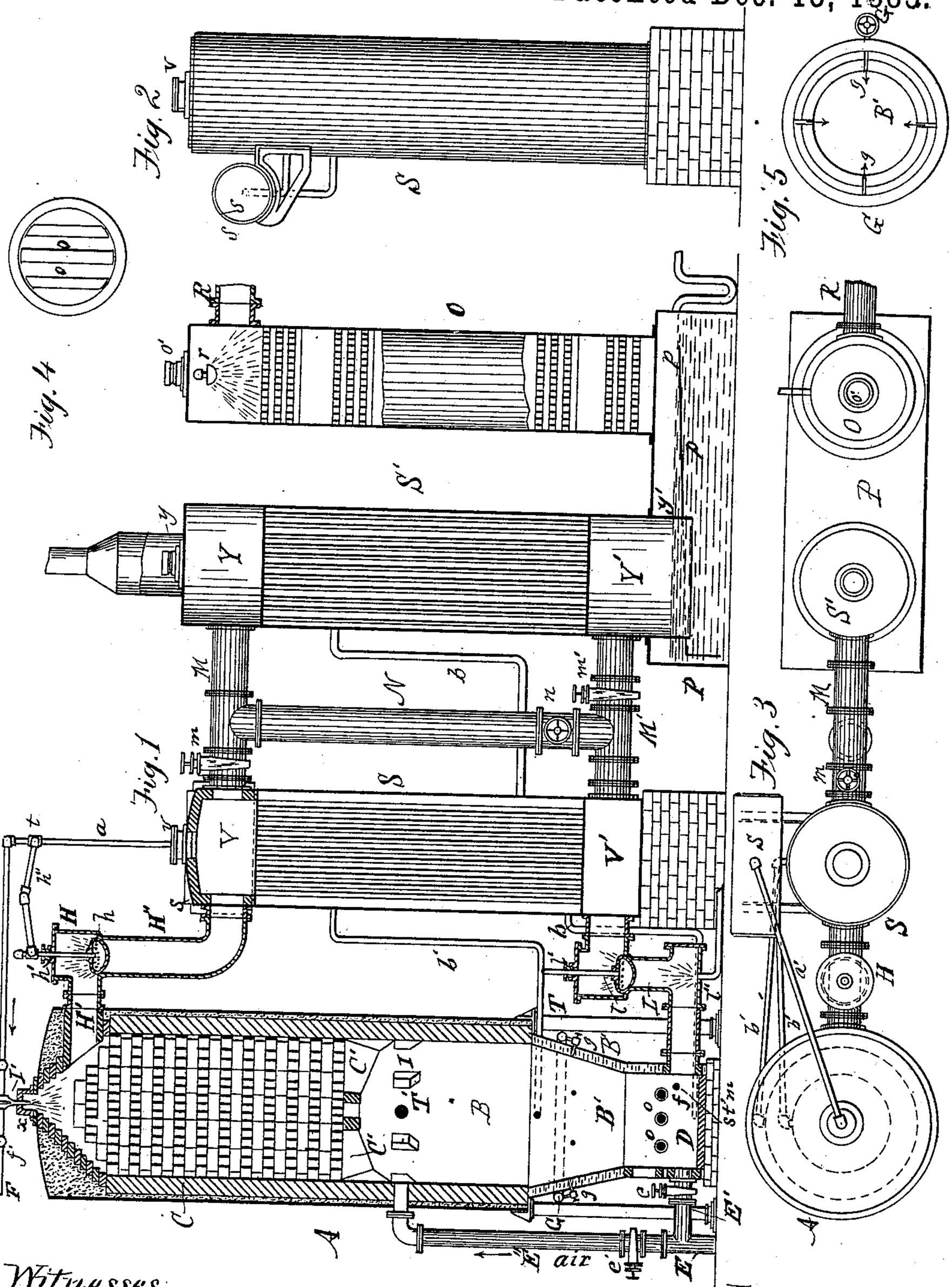
(No Model.)

2 Sheets—Sheet 1.

J. L. STEWART.

APPARATUS FOR MANUFACTURING GAS.

No. 332,569. Patented Dec. 15, 1885.



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(No Model.)

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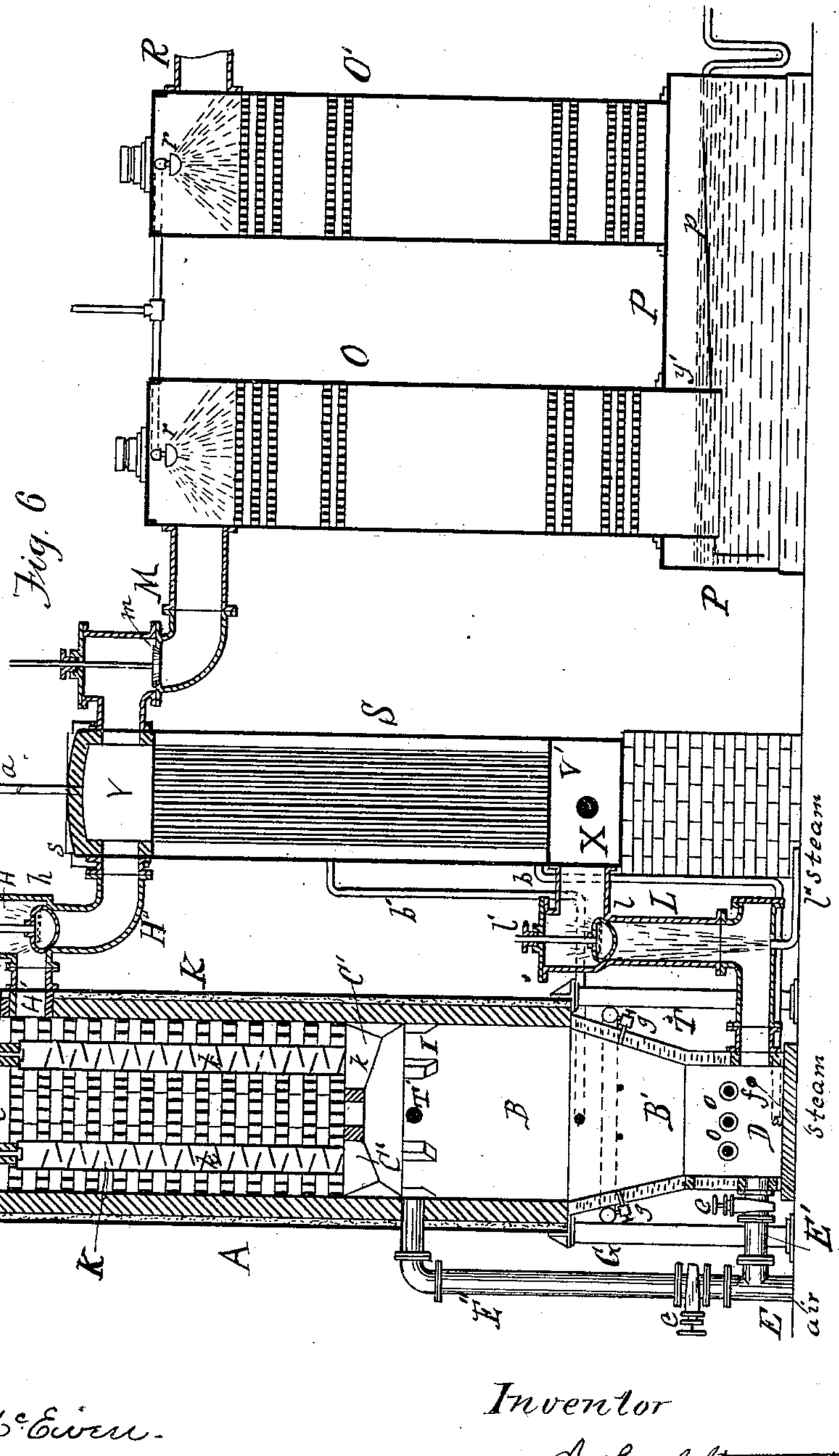

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APPARATUS FOR MANUFACTURING GAS.

SPECIFICATION forming part of Letters Patent No. 332,569, dated December 15, 1885.

Application filed May 31, 1884. Serial No. 133,292. (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, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to apparatus for manufacturing illuminating and heating gas, and embraces a number of special improvements whereby either illuminating or heating gas may be made at will in an economical manner in the same apparatus and in successive operations, and whereby the apparatus is more conveniently and successfully operated, and the heat of gases to be stored and of waste products is more perfectly utilized in the different operations concerned in the manufacture of gas.

The improvements are applied to my improved water-jacket furnace, in which the process of and apparatus for puffing with compressed aeriform fluid is used for breaking up clinker and caked coal, covered by my Patent No. 300,331, dated June 10, 1884.

The particular improvements in the apparatus constituting my invention herein will be pointed out in the claims.

The improved process of manufacturing gas described herein is made the subject of a separate application for patent, filed June 11, 1885, and bearing Serial No. 168,822.

The apparatus is illustrated in the accompanying drawings, in which Figure 1 represents a longitudinal vertical section of the apparatus. Fig. 2 is a side elevation of the first heater or boiler, showing the steam-drum. Fig. 3 is a top plan view of the apparatus. Fig. 4 is a horizontal section through the base of generator just above the water-bars. Fig. 5 is a horizontal section of generator through the water-jacket just above the puffing-pipes. Fig. 6 is a longitudinal vertical section of the apparatus, showing modifications in the arrangement and connections of parts.

The generating-cupola A is composed of the lower fuel and decomposing chamber, B, and the upper fixing-chamber, C, the two being separated by an arched partition, C′, of brickwork, provided with numerous passages. The lower portion of the fuel-chamber is constructed of a tapering form from above downward to or near the ash-pit D, which latter may have vertical walls resting upon a foundation of masonry. The tapering portion B′ and ash-pit D are formed of an iron water-jacket, or they may be constructed of brick and provided with an interior water-jacket lining of tapering form, as shown. An inlet water-pipe, *b*, connects with the base of the jacket, and an outlet water-pipe, *b′*, connects with the top of the jacket, and these circulating-pipes connect with the steam boilers or heaters S and S′, as shown.

E designates the air-blast pipe from the ordinary blower, and it connects by a branch, E′, having a valve, *e*, with the ash-pit, and by branch E″, having valve *e′*, with the top of the fuel-chamber just below the superheating and fixing chamber. Blast-pipe G, leading from a compression-chamber, (not shown,) connects by numerous short pipes *g* with the interior of the fuel-chamber near the top of the water-jacket. A steam-supply pipe, *f*, connects with the ash-pit and conducts steam from the drum of boiler S. Water-tubes *o*, connecting opposite sides of the water-jacket, form the supporting-grate. The cupola is supported circumferentially above the tapering portion of the water-jacket by columns T. Inwardly-projecting bricks I are secured in the fuel-chamber to form a resistance to the fuel when the puffing-blast is applied, as described in my patent above mentioned. The fixing and superheating chamber C is located directly above the decomposing-chamber, and is filled with refractory brick-work resting on arch C′, arranged to store the heat and present a large heating-surface for superheating steam, vaporizing oil, or fixing gas. A number of vertical oil-vaporizing retorts, K, having inclined shelves, may be arranged in the fixing-chamber, as shown in Fig. 6, and have oil-inlet pipes *k* connecting with their upper ends, while their lower ends are left open for discharging vapor at the base of the fixing-chamber. Independent of such retorts an injector, I′, opens directly into the top of chamber C, for supplying hydrocarbon oil, which is sprayed or atomized by a stream of

water-gas or steam under pressure. Oil-supply pipe *i*, with a tapering nozzle, projects into the injector, and back of the nozzle there connects a pipe, F, having valve *f'*, for supplying water-gas under pressure; also, a steam-supply pipe, *a'*, having valve *c*, which connects with the steam-drum by means of pipe *a*. Gas-eduction pipe H' leads from the top of chamber C and connects with valve-box H, which connects by pipe H'' with chamber V of steam-boiler S. A hollow perforated valve, *h*, is seated in chamber H, and has a hollow stem, *h'*, passing through a stuffing-box in the top of such chamber, and such pipe connects by a flexibly-jointed pipe, *h''*, with steam-pipe *a* at *t*, where a swivel-joint is provided. A water-supply pipe may also connect with the hollow valve-stem and valve. A gas-eduction pipe, L, having a valve-box, connects with the ash-pit and with chamber V' of heater S, and the valve-box of such pipe is fitted with a perforated hollow valve, *l*, and stem *l'*, as above described. A steam-pipe, *l''*, projects into pipe L below the valve, for supplying steam to protect the valve from the intensely-heated gases. A gas-outlet pipe, T', also leads from the top of the fuel-chamber. Suitable doors are provided in the fuel-chamber and ash-pit for supplying fuel and removing ashes.

Pipe M, having valve *m*, connects chamber V with chamber Y at the tops of the heaters, and pipe M', having valve *m'*, connects chambers V' and Y' at the base of the heaters, and pipe N, having valve *n*, connects with the two pipes M M'. Valve *m* is placed between chamber V and pipe N, and valve *m'* is placed between pipe N and chamber Y', for properly controlling the flow of gases, as hereinafter more fully explained.

Boiler or heater S is mounted on a masonry foundation, and is provided with chambers V V' and the usual tubes for the passage of hot products of combustion and gases, and has a safety-valve, *v*, fitted to an opening in its top. The steam-drum *s* is supported on a bracket near the top of the boiler, and is connected therewith by suitable pipes. The second heater, S', is mounted on the hydraulic seal and wash-box P, and has an open extension, *y'*, dipping down into the water of the box. It is provided with chambers Y Y' and tubes, like heater S, and has a safety valve or cap, *y*, fitted to an opening in the top, which valve is opened when desired for the escape of the waste products of combustion, which are conducted up the hood or stack above. The extension *y*, dipping into the water of box P, forms a sufficient seal to prevent the return of gas from the box to the heater, and also, when cap *y* is open, to prevent the flow of products of combustion into the box. An inclined plate, *p*, is provided in the box, just above the end of extension *y*, for causing gas to be washed to travel a longer distance through the water. A scrubber, O, is mounted on the box P and opens into it at the bottom. Such scrubber has the usual perforated or grated shelves and a rose-spray head at the top, and is also provided at the top with a safety-valve or cap, *o'*, fitted to an opening, and a gas-outlet pipe, R. A trap overflow-pipe is properly connected with the wash-box. Valves *h* and *l* in the pipes next to the generator, being hollow and perforated, and having hollow stems for the supply of steam, are kept comparatively cool by the flow of steam into them and out through their perforations. The escaping steam also protects the pipes from the intense heat of the gases, whereby warping and uneven expansion of the valves and seats are prevented and tight joints are maintained. A small leak through valve *l*, however, when it is closed, would not be objectionable, as at that time the air-blast is admitted to the ash-pit and the escape of a small quantity of air into chamber V' would complete the combustion of gaseous products descending through the boiler, or would simply escape with the products of combustion at the top of heater S'. A small leak also through valve *h*, when it is closed and during the gas-manufacture, would only let a small quantity of steam into chamber V, where it would mingle with the gas and fine ash, and finally be condensed in the wash-box and scrubber and aid in removing the ash and soot from the gas.

The construction and arrangement of the apparatus just described may be somewhat modified without departing from my invention. For instance, connecting-pipe N may be omitted, and simply the straight pipe M M' with slide-valves be used for connecting the tops and bottoms of the heaters, or pipes M M' may be fitted with boxes having valve-seats and provided with hollow perforated valve and stems connecting with steam-pipes, like those shown in pipes H' and L. The apparatus may also be modified, as shown in Fig. 6, in which but one heater S is used, which is connected to the generator by pipes with valves, as above described, and is provided with an escape pipe or stack, X, for products of combustion, leading from chamber V', and extending to about the top of the heater, where it is provided with a safety cap or valve opening into a funnel. The top chamber, V, of the boiler S is connected directly to the top of scrubber O by pipe M, having valve *m*, and the scrubber is mounted upon the washer and seal-box P, the scrubber having an open-ended extension, *y'*, dipping into the water of the box and forming a seal with the liquid, as previously described. Scrubber O' is mounted on the opposite end of the box and has gas-outlet pipe R at the top. The scrubbers are provided with safety-valves *o' o''* and rose-spray heads *r*, connecting with supply-pipe *r'*.

The apparatus constructed and arranged as described is adapted for the manufacture of gas from either bituminous or anthracite coal, and for making either illuminating or heating gas at will and in successive operations. It may be operated in a variety of ways for producing the exact quality of gas desired and

from the material found most economical or convenient in any particular locality.

First. For the manufacture of pure water-gas for heating or motive-power purposes the apparatus is operated as follows: The steam-boiler S and heater S′ are supplied with water till it rises to about one-half the height in the steam-drum *s*, and all the valves being closed, I then open valve or cap *x* on top of the generator, which is arranged so it can be moved one side, and start a fire in chamber B′ of the generator, air being supplied by leaving the ash-pit door open, causing a natural draft, or an air-blast may be supplied through blast-pipe E′ by means of a blower run by a gas-engine or a steam-engine supplied from an auxiliary steam-boiler, until sufficient steam is generated by means of the jacket and heaters S and S′. Air is also admitted above the fuel for causing combustion of the carbonic oxide or other gaseous products rising from the fuel, and thereby heating the body of refractory brick-work in superheating and fixing chamber C. After the generator and chamber C have been dried and heated, the valve *x* and ash-pit door are closed and valves *h*, *m′*, and *y* are opened and the hot products of combustion passed down through boiler S and up through heater S′ into the chimney. When a body of incandescent or highly-heated fuel (anthracite coal) several feet thick is formed in the generator and chamber C is heated to the proper temperature, the air-blast is shut off, valves *h*, *m′*, and *y* closed and valves *l* and *m* opened, and steam is admitted into the top of superheater C through the injector by opening valve *c*. The steam passing down through the brick-work is highly superheated, and is then passed into the incandescent fuel, where it is decomposed into free hydrogen and carbonic-oxide gases, which, escaping at the base of the decomposing-chamber, pass up through boiler S, down through heater S′, through the washer and scrubber to the place of storage or use. The decomposition of steam is continued till the temperature of the fuel and superheater is reduced too low, when the apparatus is reheated and the manufacture of water-gas is resumed, as above described.

Second. In the manufacture of illuminating-gas the operation is as follows: The temperature having been raised to the proper degree in the same way as for making water-gas, all the valves being shut, valves *l* and *m* are opened, steam admitted through injector I at the top of superheater C and water-gas made till the temperature in the generator becomes reduced to the required degree for vaporizing hydrocarbon liquid and converting the vapors into a fixed gas. Hydrocarbon oil is then admitted through pipe *i* and sprayed with compressed water-gas or steam (preferably the former) admitted into injector I, the oil being in suitable proportion to produce gas of the desired candle-power. The hydrocarbon vapor being thus mixed with water gas, is protected from destructive decomposition while passing through the heated fuel in the generator. The illuminating-gas, if passed through the fuel, is passed off through pipe L, and through the water-heaters and scrubber. In case the fuel is too hot for safely passing illuminating-gas through it, such gas may be passed off through pipe T, connecting between the surface of the fuel and the bottom of the superheater, and then conducted through the water-heaters and scrubber. It is evident that at the commencement of the operation the fuel and superheater need not be so highly heated as to require the preliminary passage of steam through them to reduce the temperature to the proper degree for making illuminating-gas, though by the second method of conducting the operation water-gas and illuminating-gas are economically made in the apparatus in successive operations, which under some circumstances is quite advantageous.

Third. Illuminating-gas can also be made in this samer generator by heating to the proper temperature; then, all the valves being shut, valves *h* and *n* are opened and oil is admitted over the surface of the heated fuel, or directly into vaporizing-retorts K, set in the superheater, as shown in Fig. 6, in which case the oil vapors will pass out over the fuel in the generator, and at the same time steam is admitted at *f*, which in passing up through the incandescent carbon is decomposed in the usual way, the resulting gases as they escape from the surface of the fuel commingling with the hydrocarbon vapors. The mixed gases and vapors are then converted into a fixed gas by passage through fixing-chamber C, which gas is passed through pipe H′ down through boiler S through pipe N, down through heater S′, and out through the washer and scrubber. During all these operations steam in small quantities is kept passing through the valve-stem and valves *h h′* and *l l′*, so as to prevent their becoming overheated, and when gas is being generated and discharged from the bottom of the generator steam is also turned on through pipe *l″*, so as to keep the pipe and valve-seat from getting overheated, and also to thoroughly saturate the gas and dust with steam, so that when they reach a cool place, as the washer or scrubber, the steam will condense and carry the dust or ashes with it into the wash-box. After discharging gas from the bottom of the generator, and before turning on the air-blast to again raise the heat in the generator, I turn on steam at *f* for a few moments, so as to drive out all the gas and prevent any explosion of the gas and air. Steam can also be used in the same way and for the same purpose in any part of the apparatus where explosions are liable to take place. The ash-pit at the bottom of the generator can be made any desired depth for the reception and storage of the ashes that fall through the water-tube grate-bars, and such deep ash-pit may be divided by a horizontal partition having a damper or valve and

placed a short distance below the grate and the lower chamber be provided with an outer door.

The processes for making gas may be carried out in the modified apparatus illustrated in Fig. 6 in about the same manner as above described, the slight changes in the apparatus requiring only such slight changes in the manipulation of valves, &c., as will be readily understood by any gas-engineer.

The water-tubes connecting opposite sides of the water-jacket and forming the supporting-grate are not claimed in combination with the generator in this application, as such matter is claimed in my application filed April 30, 1885.

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

1. The combination of the fuel-chamber having a steam-inlet pipe at the base, a chamber containing refractory material located above it, an oil-injecting pipe connected with the top of such chamber, and a gas-discharge pipe leading from the fuel or generating chamber, for the purpose described.

2. The combination of the fuel-chamber, a chamber located above and provided at its top with an injector having connecting-pipes for oil and steam, and a gas-outlet pipe having a valve connecting with the base of the fuel-chamber, for the purpose described.

3. The combination of the fuel-chamber, a chamber containing refractory brick-work directly above, provided with an oil-injecting pipe at the top and a gas-outlet pipe leading from the generating-chamber, for the purpose described.

4. The combination of the fuel-chamber, a chamber containing refractory brick-work located above and provided at its top with an injector having connecting-pipes for oil and water-gas, and a gas-outlet pipe connecting with the base of the fuel-chamber.

5. The fuel and decomposing chamber and the superheating-chamber containing refractory brick-work, arranged in relation to each other, as described, in combination with the steam-inlet pipe at the top of the superheater, and the gas-outlet pipe connecting with the base of the fuel-chamber and with a boiler or water-heater, and having a steam-jet nozzle and a valve, for the purpose described.

6. The decomposing-chamber and fixing-chamber constructed, as described, in combination with a boiler or heater, a pipe provided with a controlling-valve connecting them at the top, and a pipe provided with a controlling-valve connecting them at the bottom, and a gas-outlet pipe leading from the heater.

7. The generator and boiler or heater, in combination with a connecting-pipe, a hollow valve therein having a hollow stem, and a flexible pipe connecting the latter with the steam-drum or other source of steam-supply, for the purpose described.

8. In combination with a gas-connecting pipe of a gas apparatus, a hollow perforated valve having a hollow stem, and a flexible pipe connecting such stem with a steam-chamber, for the purpose described.

9. In combination with the pipe connecting the generator and boiler or heater, a hollow valve having a hollow stem connecting with a steam-chamber, and a steam-pipe connecting with the gas-pipe and adapted to spray steam against the valve, and also exhaust gas from the generator.

10. The combination of the generator, a steam boiler or heater, and a second heater or scrubber, pipes having controlling-valves connecting the generator and boiler at top and bottom, and a pipe having a controlling-valve connecting the boiler and second heater or scrubber at top, for the purpose described.

11. The combination of the generator, a steam boiler or heater, pipes having valves connecting the two at top and bottom, a second heater connected with the wash-box at the base, and having a safety and escape valve at the top, pipe M M′, having valve *m m′*, connecting the heaters at top and bottom, and pipe N, having valve *n*, connecting the two pipes, as and for the purpose described.

12. In combination with the generator, the puffing-blast pipe G and inlet-pipes *g*, connecting with the middle portion of the fuel-chamber, and the usual air-blast and steam-supply pipe connecting with the base of the generator.

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

JOHN L. STEWART.

Witnesses:
CHAS. W. WILLIAMS,
CHAS. F. VAN HORN.