(No Model.) 2 Sheets—Sheet 1.

J. L. STEWART.

PROCESS OF AND APPARATUS FOR MANUFACTURING GAS.

No. 300,331. Patented June 10, 1884.

Fig. 1.

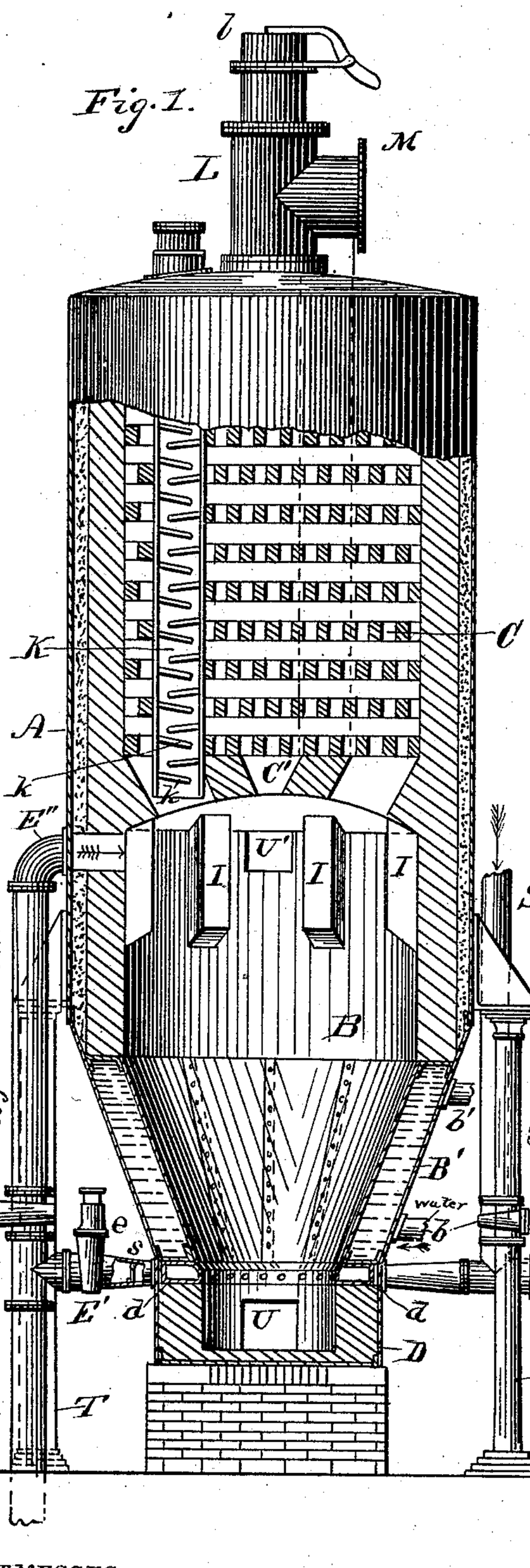


Fig. 2.

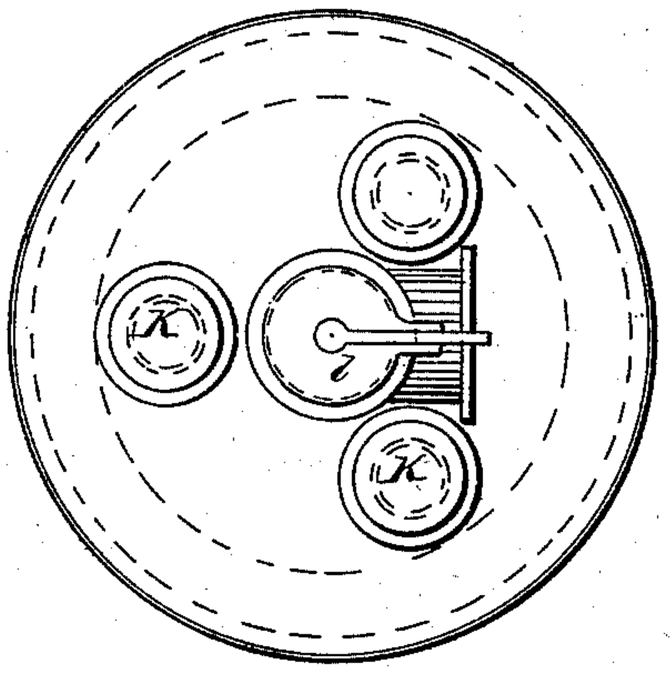


Fig. 3.

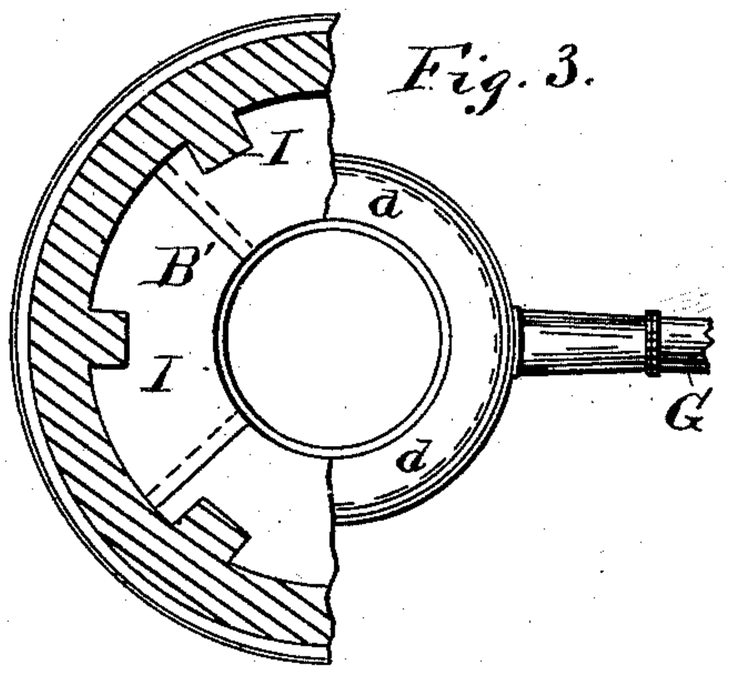
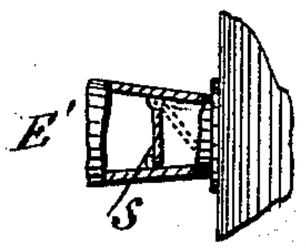


Fig. 6.



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(No Model.) 2 Sheets—Sheet 2.

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No. 300,331. Patented June 10, 1884.

Fig. 4.

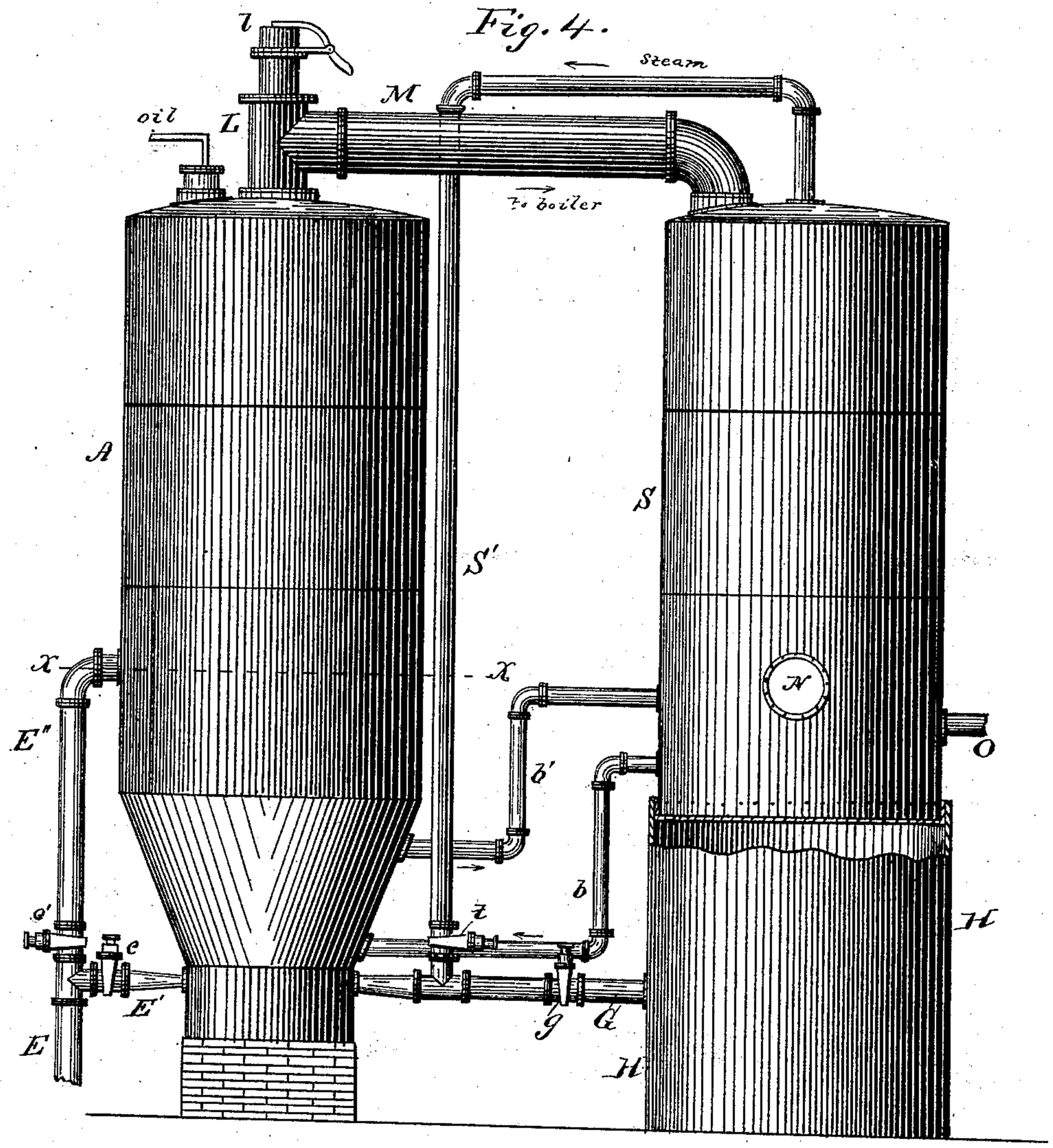
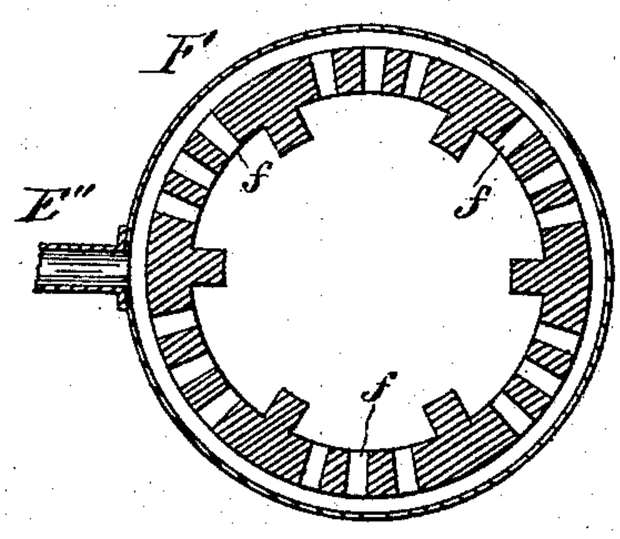


Fig. 5.



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UNITED STATES PATENT OFFICE.

JOHN L. STEWART, OF PHILADELPHIA, PENNSYLVANIA.

PROCESS OF AND APPARATUS FOR MANUFACTURING GAS.

SPECIFICATION forming part of Letters Patent No. 300,331, dated June 10, 1884.

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

To all whom it may concern:

Be it known that I, JOHN L. STEWART, of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Process of and Apparatus for Manufacture of Gas; 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 heating and illuminating gas in a cupola generating-furnace provided with a fixing-chamber, in which furnace and chamber steam is decomposed in contact with incandescent fuel, bituminous coal is distilled by the direct heat of the fuel and furnace-walls, oil is vaporized, and the resulting gases and vapors are combined and converted into a fixed gas.

The invention also relates to the improved construction of furnace and the method of operating it, whereby the formation and adhesion of clinker to the walls is avoided, and whereby bituminous coal may be used for the production of gas and coke with greater advantage than heretofore attained in furnaces as they have been constructed and operated.

The invention includes the novel method of fracturing and breaking up the caked masses of partially or wholly coked coal by means of sudden puffs or blasts of highly-compressed gaseous fluid—such as air, steam, or any combustible or non-combustible gas, such as carbonic oxide, hydrogen, carbonic acid, or nitrogen or mixtures thereof—admitted to the fuel under pressure, in order that the ordinary air-blast admitted for raising the fuel to incandescence, and the succeeding steam-supply admitted for decomposition, may be brought or forced into intimate contact with numerous surfaces throughout the whole mass of fuel, and better results thereby secured.

It also includes the peculiar means both within the furnace and exterior thereto for accomplishing the improved results.

It also includes a tapering or flaring metallic water-jacket placed near the base of the generator, with the contracted end toward the ash-pit and the flaring end extending above, which jacket forms the walls of the furnace at that portion where the most intense combustion and greatest heat occur, and extends up to or above the point at which clinker is liable to form, in combination with fixed projections extending from the wall or top of the fuel-chamber.

It also includes certain combinations of parts hereinafter described, and pointed out in the claims.

Heretofore in the manufacture of gas the decomposition of steam has been almost entirely restricted to the use of anthracite coal or hard coke, in order that the air and steam might pass freely through every portion of the fuel. It is very desirable, however, to use bituminous coal in generating-furnaces on account of the large volume of rich carbureted-hydrogen gas evolved therefrom under the influence of heat in the furnace.

Where attempts have been made to use bituminous coal in generating-furnaces by introducing it on top of the fire or bed of hot fuel much trouble has arisen by reason of its tendency to run together in a solid mass or cake before parting with its volatile hydrocarbons, thereby preventing air and steam from passing through the same, excepting through one or more large openings, and causing a large proportion of the air and steam to pass up between the fuel and the wall of the furnace, where little or no useful effect is produced, but, on the contrary, injuring the walls. Even after the volatile matters are distilled off, the coke remains in the same compact condition—that is, in solid dark masses impervious to air or steam—causing waste of fuel and time.

By reason of the above obstacles the use of bituminous coal in furnaces for generating gas has not generally proved successful. In my improved process I overcome these difficulties by fracturing and breaking up the caked masses of coal or coke in an expeditious manner by means of sudden puffs or blasts of a compressed gaseous fluid—such as heretofore mentioned—admitted to any desired portion of the furnace under sufficient pressure to suddenly raise the mass of fuel and thrust it against projections extending from the furnace wall or arch at the top of the fuel-chamber, and thereby fracture the mass of coherent coke, producing a great number of

crevices and many small fragments of coke, and consequently a much greater extent of surface for the air and steam to act upon. By thus periodically breaking up the mass of caked coal and cohering masses of coke, I am enabled to secure the advantage of the rich hydrocarbon or carbureted-hydrogen gas evolved from the coal, and also to successfully use the coke directly while hot for decomposing steam. By constructing the fuel-chamber of tapering form from above down to the ash-pit, I provide for supporting the fuel while ashes, &c., are removed below, and secure a fuel-body of a form that is more readily raised and fractured by a sudden blast of compressed gaseous or aeriform fluid admitted from below than a body of equal diameter from top to bottom. On account of using bituminous coal in the generating-chamber, I obtain gases while raising the fuel to incandescence by an air-blast which yield by combustion much more heat than the ordinary mixture of carbonic oxide and nitrogen from anthracite coal or coke; and I therefore provide a larger fixing-chamber containing refractory material than usual for storing up the increased heat, to be afterward used for fixing carbureted gases.

The novel features of the process and apparatus constituting my invention in this application will be hereinafter specifically described, and particularly pointed out in the claims.

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

Figure 1 represents a vertical section of the generator and fixing-chamber. Fig. 2 is a top plan view of the generator. Fig. 3 represents a horizontal section partially at the upper portion of the furnace, showing the projections, and partially at the base of the fuel-chamber, showing the annular air-chamber with which the blast-pipe connects. Fig. 4 represents an elevation of the generator, steam-boiler, and compression-chamber for aeriform or gaseous fluid. Fig. 5 represents a horizontal section of the generator on the line *x x*, Fig. 4, showing the upper air-supply passages. Fig. 6 is a detail view showing the check-valve in the air-blast pipe.

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, and 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 of fire-brick resting upon a foundation of masonry. The tapering portion B′ of the furnace is formed of an iron water-jacket, or it 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-boiler S, as shown in Fig. 4. At the top of the ash-pit, between it and the water-jacket, is placed the annular air-distributing box or chamber *d*, with which connect the supply-pipes for air and steam.

E designates the air-blast pipe from the ordinary blower, and it connects by a branch, E′, having a valve, *e*, with the distributer *d*, and by a branch, E″, having a valve, *e′*, with the annular distributer F at the top of fuel-chamber B. Blast-pipe E′ is provided with a hinged check-valve, *s*, to prevent back pressure and leakage of air or gas. Air-distributer F connects with the interior of the generator by numerous small passages *f*, opening at the top of the fuel-chamber, and just below the fixing-chamber, for supplying air to cause combustion of gaseous products of the fuel for heating the fixing-chamber. Air-distributer *d* is also provided with numerous holes leading into fuel-chamber. Blast-pipe G, having valve *g*, leading from the compression-chamber H, may also connect, as shown, with the distributing-box *d*, and there connects with pipe G the steam-pipe S′, having valve *t*, leading from the top of the boiler, so that steam to be decomposed is supplied through box *d*. Pipe G is to be provided with branches connecting with different portions of the furnace than the distributer *d*, as the distributer would diffuse the blast too moderately to be very effective in fracturing the fuel. For instance, a branch having a single large opening may connect with the ash-pit, and other branches may connect with different portions of the fuel-chamber, for admitting a sudden puff or blast of aeriform or gaseous fluid, as found most effective, and where most required, for breaking the masses of coke or caked coal. A metallic nozzle having a flexible connection with pipe G or the compression-chamber, for reaching different openings in the furnace at will, may be provided. The different openings provided in the furnace-wall may be ordinarily closed by fire-clay stopper having flanges, making a tight joint with the furnace-wall. The walls of the generator and superheater above the water-jacket are composed of fire-brick, and are covered by a tight iron jacket, between which and the brick wall is a filling of non-conducting material. The cupola is supported circumferentially above the tapering portion by the columns T, three or more of which may be used. The fuel-chamber is provided with the inwardly-projecting bricks I, located, as shown, near the top of the chamber, or at other desired portion thereof. These projections may be arranged at different heights and secured in the walls. They may also extend from the arch C′ downward over the surface of the fuel. The purpose of these projections is to form a resistance to portions of the body of fuel when it is raised by the sudden blasts of compressed gaseous or aeriform fluid admitted from the

compression-chamber. The fixing-chamber C is made, in proportion to the fuel-chamber, of larger size than usual for storing all the heat. It is filled with refractory brick-work or other material, arranged to store the heat and present a large heated surface to the gases to be fixed. A number of vertical oil-vaporizing retorts, K, are arranged in the fixing-chamber, passing from the top thereof down to arch C′, where their ends are open. The mouth-pieces of the retorts project through the top of the fixing-chamber, where they are closed by suitable caps, and have connecting with them oil-supply pipes. The interior of the vaporizing-retorts are provided with baffle-plates *k*, projecting alternately from opposite sides, to present a large heating-surface, and for causing the oil and vapor to take a tortuous course. At the top of the cupola there is a smoke-stack, L, having a tight-fitting cap, *l*, and with stack L connects the gas-outlet pipe M, which connects with the upper flue-chamber of the steam-boiler S. The flue-chambers and connecting-flues are not shown, but are of the ordinary kind, and the gas-outlet pipe N connects with the lower tube-chamber, and also at its other end with a hydraulic seal-box of the ordinary kind. Pipe N may have between the boiler and seal-box a short branch pipe with a removable lid, for the escape of products of combustion which have been passed through the boiler. A pipe, O, supplies water to the boiler. A door, U, is provided in the ash-pit for removal of ash, cinder, &c., and to give access to the interior of the furnace for kindling the fire, and a door, U′, is provided near the top of the generating-chamber to supply the fuel and coal to be distilled. The compression-chamber H is to be filled by a force-pump with air or gas—preferably a non-combustible gas, if gas is used—under high pressure.

In operating my apparatus for the manufacture of gas, I proceed as follows: A fire is kindled in the generating-chamber, natural draft being at first used till a bed of glowing coals is formed; then the fire is urged by an air-blast admitted through pipe E from an ordinary blower, while anthracite coal or coke is gradually fed in till a bed of incandescent or highly-heated fuel several feet thick is formed. After the bed is partially formed, however, bituminous coal may be fed in till the bed is formed of sufficient depth. As soon as combustible gaseous products containing carbonic oxide are given off at the top of the fuel, the air-blast is admitted by pipe E″, distributing-chamber F, and passages *f* at the top of chamber B, for causing complete combustion of the gas, and thereby heating the refractory material in the fixing-chamber. The products of combustion, after passing through the fixing-chamber, may be allowed to escape by way of the smoke-stack by opening its lid *l;* or they may be passed, as is preferred, through the boiler S and by pipe N, out of its escape branch pipe, above described, for the purpose of generating steam in the boiler. After the feeding of bituminous coal is commenced the rich hydrocarbon gases and vapors evolved while the air-blast is on yield by combustion a large volume of heat at a high degree, and in order to store this heat an extra large fixing-chamber filled with refractory material is provided. After the apparatus is properly heated up and a bed of incandescent fuel obtained, and steam raised in the boiler, the air-blasts are shut off and the outlet-cap, where the waste products of combustion escape, is closed. Just before or after the air-blast is shut off a small charge of bituminous coal is deposited upon the hot fuel in the generator. The blast having been shut off and the escape-pipe for products of combustion closed, steam is admitted to the fuel through distributing-box *d*, and is decomposed into hydrogen and carbonic oxide in contact with the incandescent carbon. These gases, rising through the distilling coal above, combine with and carry off the rich carbureted hydrogen being evolved therefrom, and the mixture passes into the fixing-chamber, where a fixed gas is formed. The hydrogen resulting from the decomposed steam envelops and protects the hydrocarbons from the coal, and thus preserves them from destructive decomposition or reduction to lamp-black by the high heat of the fixing-chamber. After the decomposition of steam has proceeded for a short time and the rich gas been mostly distilled from the bituminous coal, and the high heat of the fixing-chamber suitably reduced, then liquid hydrocarbon is admitted to and vaporized in the retorts K, and the vapors thereof escape at the lower ends of the retorts and mingle with the water-gas rising from the fuel-chamber, highly enriching or carbureting it, and the mixture is converted into a fixed illuminating-gas in the fixing-chamber. If, however, only heating-gas is desired, then no liquid hydrocarbon is admitted. The gas, after leaving the fixing-chamber, is passed down through the steam-boiler, and thence to the main or hydraulic-seal box, from which it is passed to the purifiers and holder. The manufacture of gas by the operations above described is continued till the temperature of the fuel and the fixing-chamber is reduced so low as to become inoperative. Then the steam is shut off, and oil, if used, is also shut off. At this time the sudden puff or blast of compressed gas or air or steam may be admitted, preferably, at or near the base of the body of fuel, for raising it and breaking the caked coal or large masses of coke. The body of fuel being in a conical form, with the smaller end downward, it is readily raised by the blast admitted at the ash-pit and thrown against the projections from the walls or arch, and thereby fractured and reduced to fragments. This breaking up, however, may be performed at any time while the ordinary blast is being applied in raising the fuel and superheater to the proper temperature, in order to provide for the free passage of the steam through the

fuel. In order to reheat the fuel and the fixing-chamber the air-blasts from the ordinary blower are admitted, as before described, till the fuel and chamber are raised to the proper temperature. A charge of bituminous coal or other fuel may be deposited upon the bed of fuel before the air-blast is admitted, or at any time when required, to maintain the fuel at a proper height. After heating up, the manufacture of gas is proceeded with, as previously described.

In manufacturing gas for storage it is preferred to decompose steam and pass the resulting gases and those from the coal for some moments through the fixing chamber till the latter is cooled to the proper temperature for admitting the oil to the vaporizing-retorts, in order that the rich hydrocarbon vapors of the oil may not be burned or destructively decomposed by the high heat. Gas of low illuminating-power is thus for a time, sent to the holder; but in order to make up the deficiency gas very rich in hydrcarbon or illuminants, and consequently of high candle-power, is afterward sent to the holder, and there mixed with the poorer gas. By this process of manufacturing gas, as above described, a large amount of the richest hydrocarbons in the fuel is saved and utilized in either the heating or illuminating gas. A large saving is also effected by admitting the rich hydrocarbons at the proper temperature, thereby preventing their destructive decomposition and securing a greater number of the units of light than when the rich hydrocarbons are admitted when the furnace and superheater are at too great a degree of heat. Water-gas made by this process by the use of bituminous coal is of much greater value than that generated by the use of anthracite coal or coke on account of its containing a much greater percentage of carbon obtained from the distillation of bituminous coal while gas is being produced by the decomposition of steam.

I do not claim in this case the method of fracturing the coking coal in the process of generating gas by forcing blasts of air at certain intervals or intermittently into the fuel, said blasts being of greater pressure than the regular blasts, as such method is claimed in a separate pending application filed by me March 23, 1883.

Having thus described my invention, what I claim is—

1. The process of manufacturing gas, which consists in raising a body of fuel to incandescence by combustion thereof with air and decomposing steam in contact with the incandescent fuel by intermittent operations, and periodically raising and breaking up the body of fuel by sudden puffs or blasts of a gaseous or aeriform fluid under high pressure greater than the ordinary air-blast, for the purpose described.

2. The process of generating gas, which consists in distilling bituminous coal by direct contact with incandescent or highly-heated fuel in a furnace, decomposing steam by passage through the heated fuel, and periodically fracturing and disintegrating the caked masses of coal or coke by the admission of sudden puffs or blasts of highly-compressed gaseous or aeriform fluid.

3. In the manufacture of gas with bituminous coal in furnaces, the method of fracturing and disintegrating the caked masses of coal or coke, which consists in admitting to the fuel periodically sudden puffs or blasts of highly-compressed gaseous or aeriform fluid.

4. In the manufacture of gas by the distillation of bituminous or soft coal in a furnace, the method of fracturing and disintegrating the caked masses of coal or coke, which consists in periodically forcing the fuel by sudden puffs or blasts of gaseous or aeriform fluid under high pressure against rigid projections in the furnace whereby the air to promote combustion and steam for decomposing may be passed freely through the fuel and in contact with a much greater number of carbon surfaces.

5. In combination with a gas-generating furnace, the ordinary blast-pipe connecting with a blower, and a blast-pipe for gaseous or aeriform fluid connecting the generator with a compression-chamber for such fluid.

6. A gas-generating furnace having a fuel-chamber which tapers from above downward toward the ash-pit, and having projecting brick or other rigid obstructions extending into the fuel-chamber, for the purpose described.

7. In combination with the fuel-chamber of a gas-generating cupola, the fixed projections extending into the fuel-chamber from the sides or top, and a connecting blast-pipe for admitting compressed gaseous or aeriform fluid in sudden puffs, for the purpose described.

8. The fuel-chamber of a gas-generator, provided with rigid projections extending into it from the walls or top, in combination with a storage-chamber for compressed gaseous or aeriform fluid, and a connecting blast or puffing pipe, for the purpose described.

9. The fuel-chamber of a gas-generating cupola, having a tapering form toward the ash-pit, and provided with rigid projections extending into it from the walls, in combination with a compression-chamber and a connecting blast-pipe, for the purpose described.

10. A gas-generating furnace having a water-jacket of tapering form downward and forming the inner wall, and also having fixed projections extending from the walls or top into the fuel-chamber, for the purpose described.

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

JOHN L. STEWART.

Witnesses:
B. F. MORSELL,
EDWARD E. ELLIS.