

(No Model.)

E. THOMSON.
PROCESS OF PRODUCING GAS.

No. 564,806.

Patented July 28, 1896.

FIG. 1.

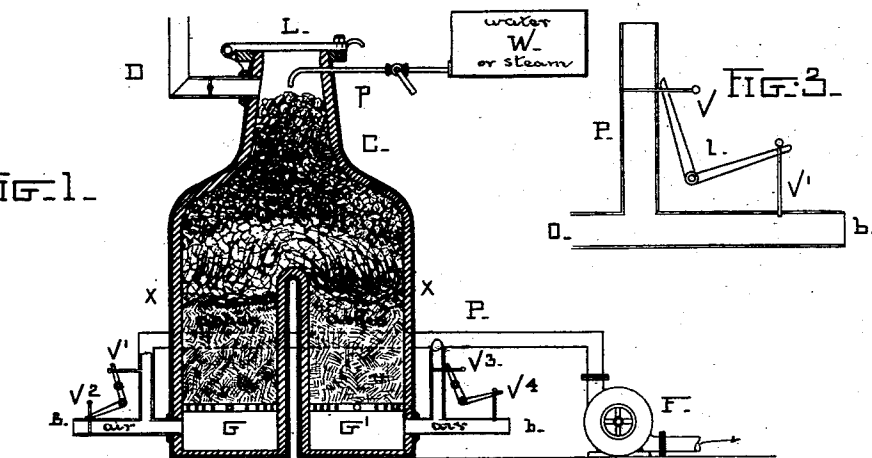


FIG. 2.

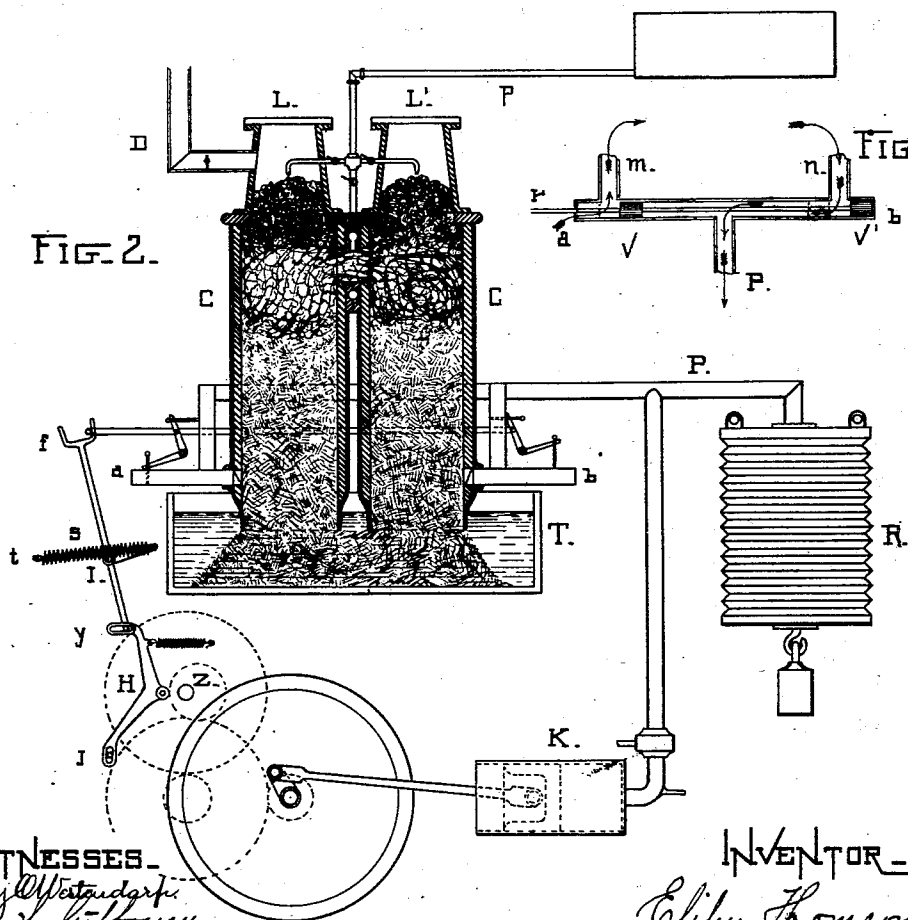
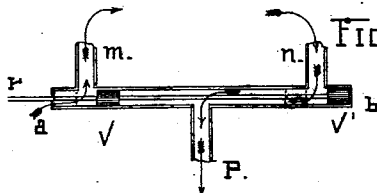


FIG. 4.



WITNESSES.

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PROCESS OF PRODUCING GAS.

SPECIFICATION forming part of Letters Patent No. 564,806, dated July 28, 1896.

Application filed June 14, 1895. Serial No. 552,802. (No specimens.)

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, residing at Swampscott, in the county of Essex and Commonwealth of Massachusetts, have invented certain new and useful Improvements in the Production of Gas for Motive-Power Engines and other Purposes and in Apparatus Therefor, of which the following is a specification.

The object of my invention is to provide a supply of gas similar in some respects to water-gas, and for use in gas-engines or for general heating purposes.

My invention is based on the same principles as have been employed in the production of a fuel-gas, namely, the passage of steam over very hot carbonaceous fuel. In my invention also the combustion is kept up simultaneously by the passage of air over a portion of the combustible.

The chief advantage secured by my invention is the complete utilization of the heat of combustion, and the production, therefore, with the minimum expenditure of fuel for maintaining the heat in the producer, of the richest quality of gas compatible with the simultaneous combustion of the fuel.

In my invention I employ a gas-generator in which the regenerative principle of storing and returning heat is utilized.

Briefly, my invention consists in confining a body of fuel in a combustion-chamber situated above a portion of the apparatus in which material capable of absorbing and giving up heat accordingly as hot or cold gases are passed therethrough, supplying air which is heated by the passage through the regenerative material before reaching the combustion area, and in causing the products of combustion or the gas generated to heat the regenerative material in another portion of the apparatus, steam or water being fed into the apparatus in the vicinity of the combustion area for the purpose of converting it into gas. A reversal of the direction of the flow of gases is accomplished from time to time on the same general principle as in the application of regenerators to heating-furnaces.

Figure 1 is a vertical section of a gas-producer embodying the principles of my invention. Fig. 2 is a modification thereof. Figs.

3 and 4 are details showing the principle of the valve operations.

In Fig. 1, C is a chamber, preferably of gas-tight construction, lined with refractory material, at least so far as its upper portion is concerned. The lining is preferably a good non-conductor of heat. The chamber is divided into two portions at the lower part and has two grates G G' for supporting a mass of material above the grate. A cover or lid L is arranged so as to be approximately gas-tight, and is capable of being opened for the replenishment of the chamber with fuel. A draft-pipe D, with a valve or damper therein for closing it on occasion, is provided merely for starting the fire in the apparatus. Suitable means are provided for the removal of ashes from the portions below the grates, and for the clearing of the grates themselves as occasion requires, though this is not an essential portion of the invention, but one of the methods which I preferably employ and incorporate herein is shown in Fig. 2, to be hereinafter described.

Leading into the spaces below the grates G G' are openings a b, respectively, and also connected with such spaces are branches from an eduction-pipe P. This pipe P is attached to any means for withdrawing gas, such as a suction-fan F, though it is to be understood that the apparatus might be worked by a blast of air driven into the openings a b, in which case it would be worked under pressure superior to that of the external air. In the case shown in the figure, which is the preferable condition as avoiding the escape of gases, the pressure of the working is below atmospheric pressure. Governing the connections of the pipe P from each side, and also the openings of the apparatus to air a b, are suitable valves connected with means for changing their position, that is, opening and closing them. Thus in Fig. 3, b represents an opening to the air, while P is a branch of the eduction-pipe, and O would connect with the spaces under the grate, as G'. Suitable valves V V' are arranged, one to close the connection to the eduction-pipe P, and shown closed in the drawings, the other to close the connection from the external air b, shown open in the figure. A bell-crank lever L, suitably pivoted, is arranged so that by being thrown back or forth

these valves may be alternately opened and closed, V being opened when V' is closed and V' being opened when V is closed. At the same time, if a certain amount of lost motion of the lever be allowed between it and the valves, there will be in the intermediate position between opening and closing a closure of both valves $V V'$, which is desirable to prevent at any time a direct connection between the eduction-pipe P and the air-opening b . If in the apparatus Fig. 1 the valves on the left be marked V' and V^2 and those on the right be marked V^3 and V^4 , then when the valves $V^2 V^3$ are closed, as shown in the drawings, and $V' V^4$ open, the suction of the fan F will draw air in at b , which passes directly under grate G' , up through the mass of material resting thereon, out through valve V' , to eduction-pipe P . The part of the chamber above the grates $G G'$ is, however, filled with fuel, such as fine anthracite coal or coke, with sufficient kindlings to start combustion when lighted in the ordinary way. The bed of fuel extends downward into the two divisions above the grates $G G'$, such grates, however, supporting both the fuel and mass of material which is not combustible, but only capable of being heated and cooled. To this end the ashes of the fire left after the burning of a certain amount of fuel will be sufficient, or pieces of fire-brick or other resisting material might be placed upon the grates. However, when the operation of gas-production is continuous, the ashes themselves are allowed to accumulate in a bank of sufficient thickness, say eight to ten inches, in a small-size apparatus, and to a greater depth in larger apparatus. A line joining the letters $x x$ may indicate the lower edge of the zone of combustion or of unburned fuel, while below that position only the burned fuel or the ashes thereof would be found.

A water-supply tank W or a steam-generator may be connected by a pipe p , having a regulating-valve for passing into the combustion-chamber either water which is to be vaporized in contact with the incandescent fuel or steam which is to be passed or drawn down through the fuel by the suction. In case of operating the apparatus under pressure the steam or water would be put under suitable pressure to cause it to enter. The vapor of water coming into the mass of fuel passes through a bed of said fuel in a highly-heated state and is decomposed in contact with the heated fuel into carbonic oxid and hydrogen.

The cycle of operation is as follows: Assuming the conditions such as have been described, the entrance of air at b and its passage up through the grate G' and the mass of material above it will cause such air to be highly heated, and upon reaching the fuel it will burn the fuel. The heat of combustion and production of carbonic acid and carbonic oxid will be fed to another mass of fuel, when the carbonic acid will be further converted

into carbonic oxid, and the carbonic oxid and nitrogen of the air will pass forward, being drawn down into the second space above the grate G , where the bed of ashes above the grate will rob the gases of their heat and the gases will be discharged into the eduction-pipe P as carbonic oxid and nitrogen, or if steam or water-vapor has been passed through the small pipe P and passed downward it will pass through a body of incandescent fuel, be there decomposed, and the original carbonic oxid and nitrogen will be mixed with an additional portion of carbonic oxid and hydrogen with, of course, some carbonic acid present. If this direction of flow be maintained for a time, the result will be to bring a considerable body of the incandescent fuel to a high temperature, as well as a portion of the material under the fuel and above the grate G , which then becomes a storer of heat. Now, if the reverse position of all the valves be made, so as to open valve V^2 , close valve V' , open valve V^3 , and close valve V^4 , the air entering at aperture a will pass up through grate G at once reaching a bed of incandescent ashes, be thereby heated to a high temperature before reaching the incandescent fuel, and the incandescent fuel will then be fed by a hot blast, will burn in part, and vaporized water or steam will mingle with the gases going forward, which will pass down through the material over the grate G' , and below the fuel will likewise be a heating of the ashes above G' , while that over the grate G will be cooled. By making the shifts of the valves at proper intervals there will be only a very slight escape of heat from the apparatus with the produced gases, or, in other words, the regenerative action will cool the gases which are produced, and the heat of combustion, being thus almost entirely retained, much less air for combustion will be required than if the gases escaped hot and had to be cooled before use or storage. This enables me to produce a richer gas than would be possible with a continuous combustion process.

In Fig. 2 I have shown how my apparatus may produce gas for use in a gas-engine for power, and I have also shown certain modifications in the disposition of the parts. In Fig. 2 practically two upright chambers, lined with refractory non-conductor for heat, are connected together near their upper portions by a short flue or passage, which may or may not be lined. Covers are provided at $L L'$ for introducing fuel into each of the receptacles. A draft-pipe D is provided in one of them, or might be applied to both, for starting the fire, the valve in this draft-pipe being closed after the heat has attained a sufficient development, it being understood that in starting the fire the air-openings at the bottom are kept open, the valve in the draft-pipe D open, and the covers $L L'$ kept closed. The fresh combustible occupies the upper part of each receptacle and is gradually con-

sumed in working its way down in burning, while the lower part of this receptacle is, as before, filled with the ashes or remains of combustion of the fuel, forming, as it were, a gas-sieve for the collection of the heat and its retention. The lower part of each receptacle dips into a tank containing water of sufficient depth to cover the lower edges of the receptacles, as shown at T. Into this tank also drop the ashes as they are formed, and they can be removed as often as is required by shoveling them out in the wet state. This gives a water-seal or gas-tight joint, while permitting the free removal of the ashes at any time. The tank T must be situated sufficiently low down and the receptacles extend toward the tank to a sufficient distance to prevent the capillary creeping of the liquid in the tank T to a height sufficient to interfere with the draft. The valve arrangements are similar to what they are in Fig. 1, and the operation is substantially the same as therein specified. A water-supply or steam-supply pipe may enter either between the two receptacles, may enter receptacle separately, or the supply may be divided between these three points—that is to say, a portion may be entered by suitable pipes at the top of each receptacle as two points of entrance, and also by a pipe leading to the neck between the two receptacles as the third point of entrance. I prefer, however, in most cases to have it enter in the neck connecting the two receptacles. I have shown the education-pipe P leading directly to a gas-engine cylinder K, the motions of which engine suffice to pump the supply of gas required for its own operation.

No details of the engine itself are shown or the valve mechanism employed, it being understood that it is such an engine as will, by its own motions, draw in a mixed charge of gas and air and explode them by suitable means on compression. A reservoir with flexible sides, as at R, is preferably provided for damping the impulses of the engine and containing a supply of gas which can be drawn upon suddenly by the engine. This constitutes the draft for the gas-producer itself. The reservoir R might, of course, be replaced by a closed tank of suitable dimensions without any flexibility, the elasticity of the gas itself being sufficient, or a suitable weighted gas-holder arranged to draw the gas might be employed to maintain a continuous suction on the pipe P.

I have indicated also in Fig. 2 how the motions of the engine may cause the sudden shifting of the valves, or alternating their position at intervals of a greater or less length of time. To this end it is only necessary to connect to the shaft of the engine a reducing-gear, so as to cause the final motions for working the valves to take place only after a considerable interval. Thus, if the shaft Z carries upon it an eccentric or

cam and makes only one revolution in several minutes during the action of the engine, it will reciprocate the lever H back and forth, said lever being pivoted to a fixed support at J and held against the cam by a spring, as shown. A slotted opening in the upper part of H engages with a pin in the lower part of a second lever, pivoted at I, the upper extremity of which is forked at *f*. A spring S is carried, on the motion to and fro of this second lever, above and below the pivot I, said spring being strained in the direction of its fixed extremity *t*. The spring S in such case will cause the fork *f* to snap back and forth. When the lever H has caused the spring to pass over the center or fulcrum I in either direction, the spring S will at once continue the motion rapidly in the same direction, a slotted opening Y in the lever H permitting the free play. The result is that the fork *f* will, if adjusted in the opening between its prongs, act intermittently to work the valves governing the entrance or exit of gas during the operation of the engine, which is supplied with the gas. The nature of the valve motion required is readily exemplified by Fig. 4, where P would represent the connection to the education-pipe, where the open ends *a b* would represent the connections to the external air, and the portions *m n* the connections to the receptacle or chamber containing the combustible. Here the valves V V' are connected together by a valve-stem *r*, which is reciprocated. In the position of the valves shown air enters at *a* and passes freely to *m*, while gas passes downward from *n* to P. By throwing the valves from the position shown over to the left air may be made to enter at *b* and pass through *n*, and gas be drawn from *m* to P, the motion being the same practically as that used in a steam-engine in reversing the direction of flow of steam.

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

1. The process of producing and delivering cold gas, consisting in first passing air through a mass of incombustible, inert material in which heat has been stored, then passing the air so heated directly through a body of fuel for combustion, mixing the products of combustion while on their passage through the fuel mass with water-vapor or its equivalent whereby hydrogen is furnished as a constituent gas, continuing the passage of the mixture of combustion products and water-vapor through incandescent fuel, and, finally, robbing the gaseous products of their heat by passing the same through heat-absorbing and heat-storing, inert and incombustible material, and reversing or interchanging at intervals the inflow of air and outflow of gas so that the hot gases leaving the incandescent fuel shall give up their heat to the heat-storing material, which heat shall, after reversal,

be taken up by the entering air to heat said air, while the heat-storing material which has been cooled by the entering air is, after reversal, heated by the passage through it of the gaseous products leaving the incandescent fuel; whereby the produced gases are delivered in a cooled state and the heat of combustion is preserved for effecting the chemical reactions, substantially as described in the foregoing specification.

2. The process of manufacturing a combustible gas similar to water-gas or producer-gas and intermediate between them, consisting in passing air over inert material which has been heated to a high temperature by hot gases passed therethrough, whereby the said air is superheated, then passing said air through solid carbonaceous fuel, such as anthracite or coke, whereby combustion is carried on, mixing the products of combustion with water-vapor or its equivalent, continuing the passage of the mixture produced through the incandescent fuel or body of combustible, and further passing the mixed products, still highly heated, through heat-receiving and heat-storing material incombustible in character; whereby the gaseous products are cooled as they leave the apparatus; reversing the flow of air and gaseous products at intervals through the heat-storing material and

body of combustible, substantially as and for the purpose described.

3. The process of manufacturing a combustible hydrocarbon gas, consisting in passing air through a body of heat-absorbing and heat-communicating material, which is incombustible and inert, whereby said air is heated, then passing said air through a body of combustible material, such as coal, coke or charcoal, so as to produce therefrom a gas consisting mainly of carbon oxids, mixing with said heated gas, water-vapor or its equivalent, continuing the passage of the mixed gaseous product through combustible material at high temperature whereby the resultant gas produced is mainly carbonic oxid containing hydrogen with nitrogen, finally passing said heated gases through a second body of heat-absorbing material similar in character to the first, and reversing the direction of flow of said air and gases at such intervals as to deliver the gaseous product in a cooled state and to superheat the air supplied before it reaches the combustible material, substantially as and for the purpose described.

Lynn, Massachusetts, June 12, 1895.

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Witnesses:

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ROBERT SHAND.