W. A. GOODYEAR.

Process and Apparatus for Manufacturing Water-Gas.

No. 207,413. Patented Aug. 27, 1878.

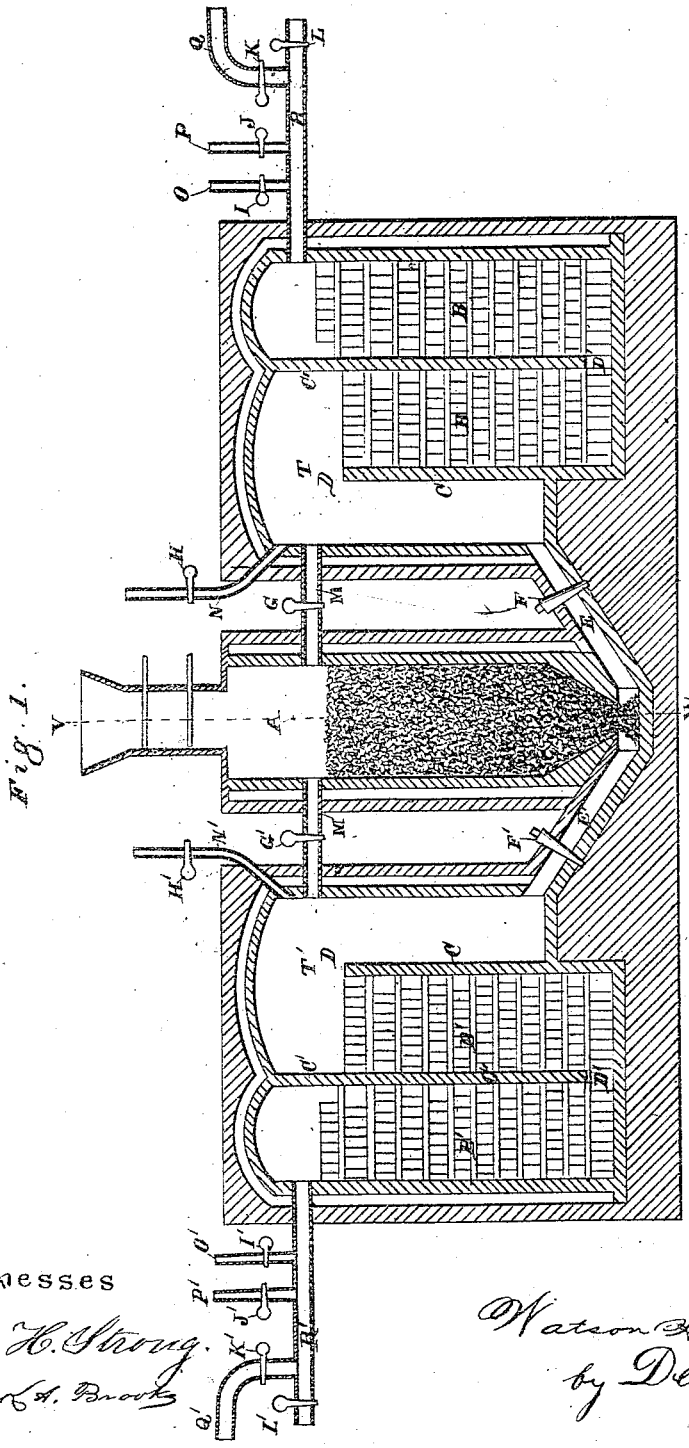

Fig. 1.

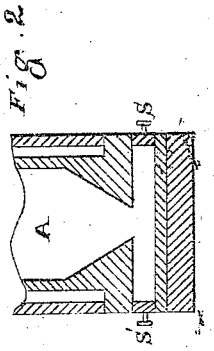

Fig. 2.

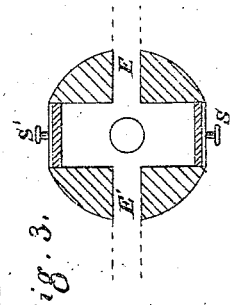

Fig. 3.

Witnesses

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IMPROVEMENT IN PROCESSES AND APPARATUS FOR MANUFACTURING WATER-GAS.

Specification forming part of Letters Patent No. **207,413**, dated August 27, 1878; application filed May 28, 1878.

To all whom it may concern:

Be it known that I, WATSON A. GOODYEAR, of the city and county of San Francisco, and State of California, have invented an Improved Process and Apparatus for Manufacturing Water-Gas; and I do hereby declare the following to be a full, clear, and exact description thereof, reference being had to the accompanying drawings.

My invention relates to an improved method of manufacturing water-gas, the object being to produce at a minimum of cost, through the decomposition of the vapor of water by means of carbonaceous matter, a gas of great heating-power.

The apparatus used for the purpose is a suitable furnace, which I call the "generator," having one or more regenerative chambers suitably connected with it. These chambers are loosely filled with fire-brick or other refractory materials, so as to allow a free passage of gases through the chamber, for the purpose of retaining and utilizing as much as possible of the heat that is produced in the various stages of the process. The necessary pipes and valves for introducing, discharging, and controlling blasts or currents of air, steam, or gas which are employed or produced are properly placed for the purpose, all as hereinafter described.

The apparatus is so arranged as to be continuous in its operation, the currents of air, steam, or gas moving through the chambers and furnace first in one direction and then in the other, suitable arrangement being made for controlling them at the proper time.

The great result obtained by the arrangement hereinafter described is the saving of by far the greatest portion of the heat generated by the combustion of the air-gas during the passage of the air-blast, which heat is subsequently taken up by the steam-blast, and by it returned to the generator, and thus utilized in the generation of the desired product—the water-gas—which possesses a far higher degree of heating-power than the air-gas does.

The essence of my invention consists in utilizing the greatest amount of available heat in the manufacture of water-gas by means of the alternate passage of blasts or drafts of air and steam through ignited carbonaceous material, the heat generated by the combustion of the air-gas produced during the passage of the blast or draft of air in one direction being intercepted and temporarily stored up in a set of regenerative chambers, from which it is afterward taken up by the counter-blast or draft of steam in one direction and returned to the generator, where it is utilized in the production of the water-gas, while the surplus heat contained in the water-gas itself, as it issues from the mass of incandescent fuel in the generator, is also intercepted and temporarily stored up in another set of regenerative chambers, where it is first augmented by the heat generated by the combustion of the air-gas produced during the passage of the next succeeding blast or draft of air, and from whence it is then taken by the next succeeding blast or draft of steam and returned to the generator, where it is utilized, and so on alternately, in such a way that all the gaseous products of the process—viz., the water-gas itself as well as the waste gases—are finally discharged from the apparatus in a comparatively cool condition, and the greatest portion of all the heat generated in the process is retained within the apparatus, and there utilized in the decomposition of the steam and the production of the water-gas.

My invention further consists in a generator, in combination with two regenerative or superheating chambers and proper pipe-connections to carry out my process.

In the accompanying drawings, Figure 1 is a vertical longitudinal section of the apparatus, showing the generator with two sets of regenerative chambers and the necessary pipes, valves, &c. Fig. 2 is a vertical section through the generator, on the line V W of Fig. 1, on a plane at right angles to that of Fig. 1. Fig. 3 is a horizontal section through the bottom of the generator, showing ash-boxes, &c.

A represents the generator, which is lined with fire-brick and filled with fuel which is ignited. This fuel may consist of coal, coke, or other suitable carbonaceous material.

B and B′ are the two sets of regenerative chambers, lined throughout with fire-brick. The separate regenerative chambers are filled with loosely-piled fire-brick, as shown. The partition-walls C C′ between these chambers are constructed of fire-brick, and are made as

nearly as possible air-tight. Passages D D′ are formed alternately at the bottom of one partition and top of the next one, in order to compel the gases in traversing the set to pass down one chamber and up the next throughout the set without reference to the number of separate chambers used.

The two flues E E′ lead from the bottom of the nearest regenerators on either side into the bottom of the generator A. Through these flues the blast of air or steam reaches the fuel. F F′ are valves in these flues, which may be opened or closed, so as to control the blast from either direction at will. G G′ are valves in the pipes M M′. H H′ are valves in the pipes N N′. I I′ are valves in the pipes O O′. J J′ are valves in the pipes P P′. K K′ are valves in the pipes Q Q′. L L′ are valves in the pipes R R′, all of which can be opened or closed at will, and the use of which will be more clearly explained hereinafter.

The generator A is provided with a charging-funnel at the top, provided with dampers, as shown. S S′ are ash-pit doors closing the apertures, through which the ashes, &c., may be raked out.

The process of manufacture is as follows: The valve L in the pipe R, valve K in pipe Q, and valve J in pipe P being all closed, and the valve I in pipe O being open, the valve G in pipe M and valve H in pipe N being closed, and the valve F in the flue E being open, the valve F′ in the flue E′ is closed, and the valve G′ in the pipe M′ and valve H′ in the pipe N′ open, and the valve I′ in the pipe O′, valve J′ in pipe P′, and valve K′ in pipe Q′ being closed, and the valve L′ in the pipe R′ being open, a blast of air from a blowing-engine or other apparatus is introduced through the pipe O. The air so introduced passes on through the regenerators B, and under and over the partitions C and into the chamber T, and then enters the generator A through the flue E.

In passing up through the mass of incandescent fuel in the generator its oxygen takes up an equivalent of carbon and forms carbonic oxide, and the gas issuing from the top of the fuel consists, essentially, of nitrogen and carbonic oxide, together with such volatile hydrocarbons as the fuel may have yielded. This gas, being formed by the action of air upon the fuel, I shall denominate "air-gas," in order to distinguish it from the water-gas, which is formed in the second stage of the process.

The air-gas, issuing from the generator through the pipe M′ into the room or chamber T′, is there met by a second blast of air introduced through the pipe N′, the valve H′ being open, whereby it is burned, producing a high degree of heat. The intensely-heated products of this combustion pass on through the regenerative chambers B′, yielding up on the way most of their heat to the fire-brick with which these regenerative chambers are filled, and, issuing at last in a comparatively cool condition, are conveyed through the pipe R′ to a chimney, where they are discharged.

When this operation has been continued for a sufficient length of time, so that the fire-bricks in the regenerative chambers B′ nearest the generator have attained an intense heat, the valve I in the pipe O is closed, thus shutting off the blast of air, and the valve K in the pipe Q is opened, the valve F in the flue E is closed, and the valve G in the pipe M is opened, the valve G′ in the pipe M′ and valve H′ in the pipe N′ are closed, and the valve F′ in the flue E′ is opened, and valve L′ in the pipe R′ is closed. The valve J′ in the pipe P′ is then opened, and a jet of steam is introduced through the pipe P′. This steam, passing through the regenerative chambers B′, becomes intensely superheated, and in that condition enters the bottom of the generator through the flue E′. In passing up through the incandescent fuel in the generator it is decomposed, with the formation of carbonic oxide and free hydrogen, and the mixture of these two gases with such volatile hydrocarbons as the fuel may furnish, which now issues from the top of the fuel in the generator constitutes the water-gas which it is the object of the process to produce. The water-gas thus formed, issuing from the generator through the pipe M, passes on through the chambers B B, where it leaves most of its heat, and, entering the pipe R, is conducted thence by the pipe Q to the purifying apparatus, if such be employed, and thence to the gas-holder, where it is stored for use.

As the production of water-gas involves the absorption of a large amount of sensible heat, it is accompanied by a rapid decrease of temperature in the chambers B′, and eventually also in the generator A, while at the same time the chambers B are only moderately heated by the sensible heat of the current of gas produced. As soon as this cooling process has proceeded so far that the temperature in the generator A is no longer sufficiently high to enable the fuel to decompose the steam with facility, the valve J′ in the pipe P′ is closed, shutting off the steam, and the valves L in pipe R and H in pipe N are opened, and the valve K in the pipe Q is closed. Then the valve I′ is opened, and a blast of air is introduced through the pipe O′. This air, traversing the chambers B′ and the room T′, becomes considerably heated on the way by the heat which still remains in those chambers, and, thus heated, it enters through the flue E′ into the bottom of the generator. The air-gas, which now issues from the pipe M into the room T, is here met by another blast of air from the pipe N, and so burned. The resulting products of this combustion pass on through the chambers B, and through the pipe R to the chimney, where they are discharged. The temperature now rapidly falls in the chambers B′ and rapidly rises in the generator A, while the chambers B speedily become heated to the same intense

degree which was at first produced in the chambers B′. As soon as the desired temperature is reached in the generator A and the chambers B, the valve I′ in the pipe O′ is closed, shutting off the blast of air, the valve F′ in flue E′ is closed and valve G′ in pipe M′ is opened, the valve F in flue E is opened, and the valve G in pipe M, valve H in pipe N, and valve L in pipe R are closed, and the valves J in pipe P and K′ in pipe Q′ are opened. A blast of steam then enters the apparatus through the pipe P, and, passing through the chambers B, enters the generator through the flue E. The resulting gas, passing out of the generator through the pipe M′, chambers T′ and B′, and pipe R′, is conducted by the pipe Q′ to the gas-holder, where it is stored.

When the chambers B and the generator A have again become cooled so far that the fuel no longer decomposes the steam with facility, the valves are again changed, so as to shut off the steam and send a blast of air through the apparatus in the same direction last followed by the steam, which rapidly raises the temperature in the generator A, while at the same time the combustion of the air-gas produced speedily reheats the chambers B′, the cooled products of this combustion being discharged by the chimney, as before. Then the valves are again changed, so as to send a blast of steam through the apparatus in a contrary direction to that last followed by the air, and again produce water-gas, which is sent to the gas-holder, as before. Thus the process of manufacture is continued without intermission, each blast of air following the same direction through the apparatus—from right to left, or left to right, as the case may be—as the last preceding blast of steam, while each blast of steam follows a contrary direction to that of the last preceding blast of air.

The regenerative chambers may be more or less in number; and I do not claim any particular details of size or shape in the construction of either the generator or regenerative chambers; nor do I claim, broadly, the use of regenerative chambers in connection with a generator for the production of water-gas, as I am aware that this, in certain phases of its application, is not new.

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

1. In the manufacture of water-gas by means of the alternate passing of blasts or drafts of air and steam through ignited carbonaceous material, the process of utilizing the heat of the decomposed steam and of a succeeding blast of air for superheating a subsequent blast of steam, which consists in passing the decomposed steam or water-gas through a regenerative chamber and storing up its heat in heat-absorbent material, and then passing the waste gases resulting from the admission of air to the generator into the same regenerative chamber, and thereby causing their complete combustion, and storing the heat produced in the same absorbent material, from which it is afterward taken by the counter-blast of steam to superheat it before reaching the generator.

2. The apparatus consisting of the generator A, with its regenerative chambers B and B′, connecting-flues E E′ and M M′, with their valves, and the passages O P Q R and O′ P′ Q′ R′, with their valves, and the passages N N′, with their valves, whereby blasts of air follow blasts of steam through the apparatus from right to left and from left to right alternately, and the heat generated by the combustion of the products of the decomposition of the air is taken up by the subsequent counter-blast of steam, and by it returned to the generator, where it is utilized in the production of the water-gas, substantially as shown, and for the purpose herein described.

In witness whereof I hereunto set my hand and seal.

WATSON A. GOODYEAR. [L. S.]

Witnesses:

GEO. H. STRONG,

CHAS. G. YALE.