W. H. WILLIAMS.

MANUFACTURE OF GAS.

APPLICATION FILED OCT. 30, 1901. RENEWED OCT. 20, 1911.

1,027,681.

Patented May 28, 1912.

3 SHEETS—SHEET 1.

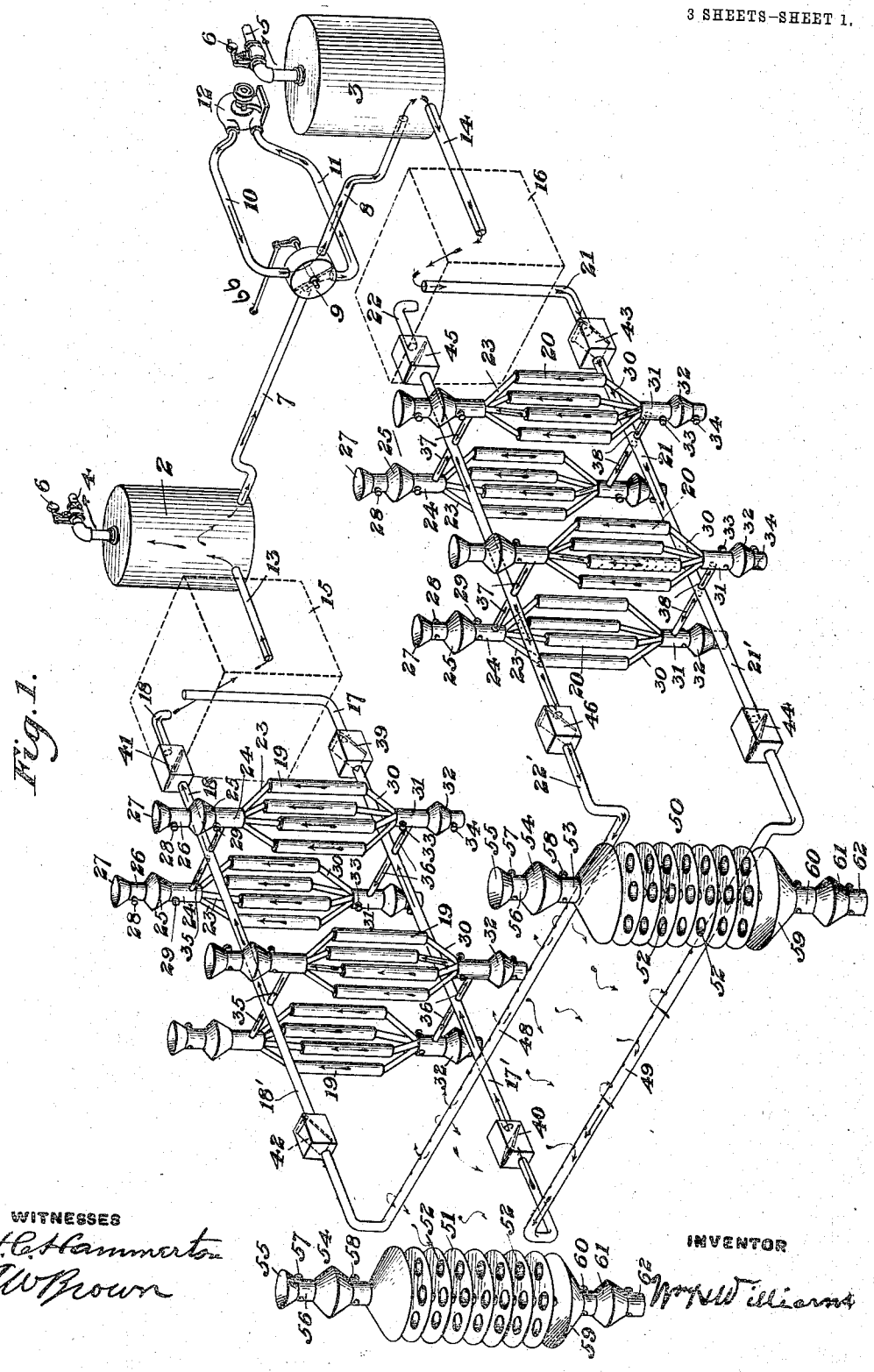

Fig. 1.

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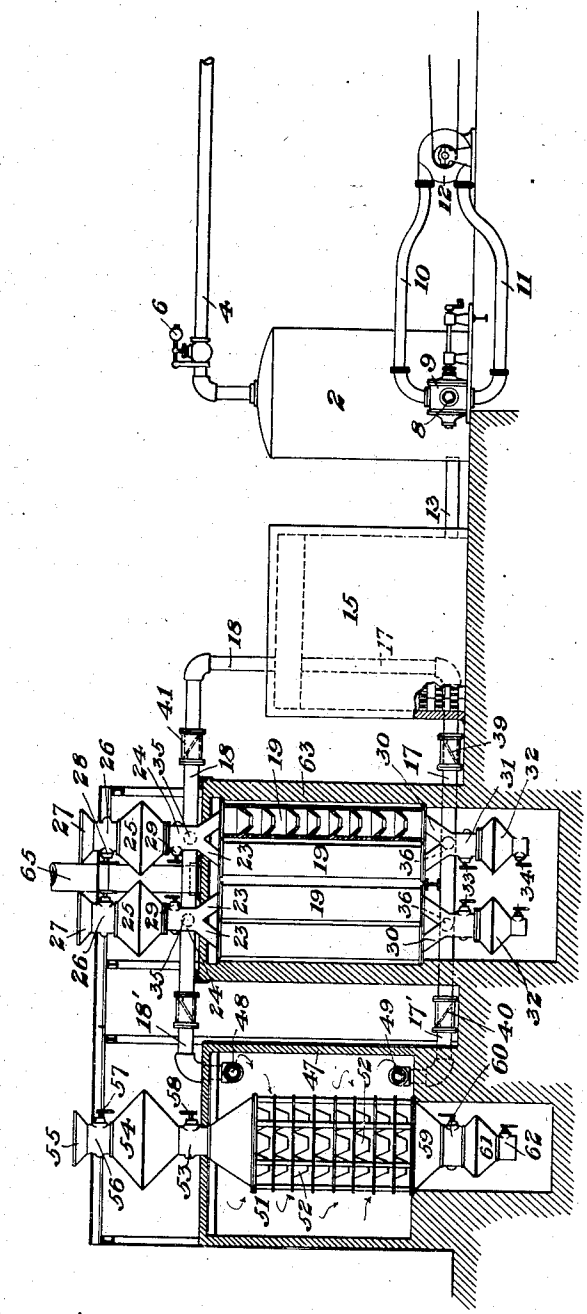
3 SHEETS—SHEET 2.

Fig. 2.



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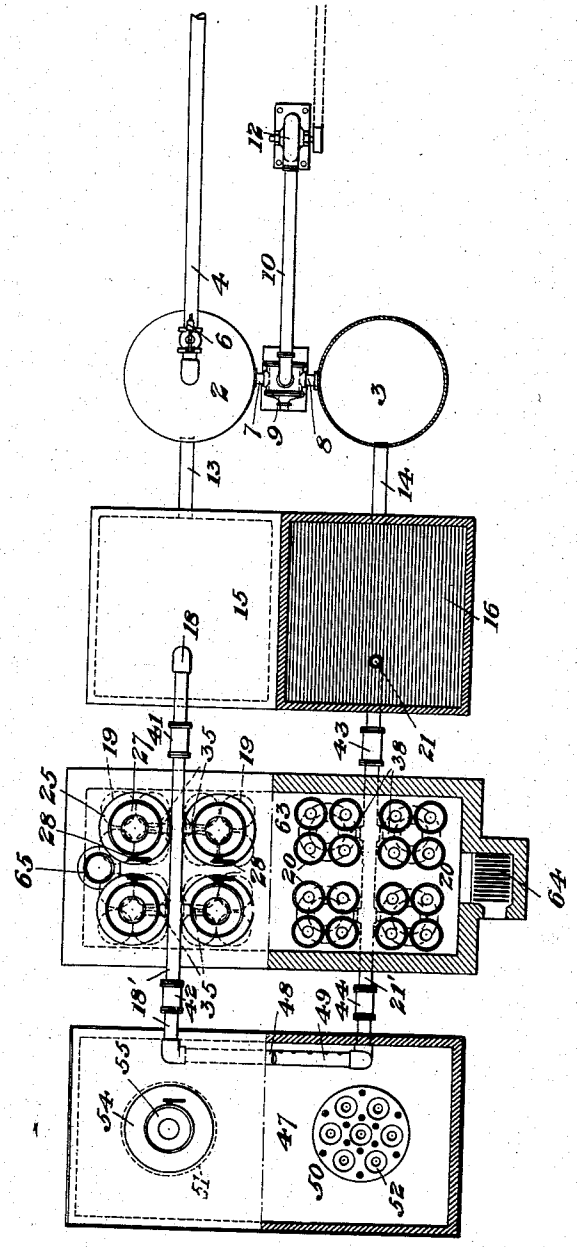
3 SHEETS—SHEET 3.

Fig. 3.



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MANUFACTURE OF GAS.

1,027,681. Specification of Letters Patent. Patented May 28, 1912.

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To all whom it may concern:

Be it known that I, WILLIAM H. WILLIAMS, of East Liverpool, Columbiana county, Ohio, have invented a new and useful Improvement in the Manufacture of Gas, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is an isometric perspective view, showing apparatus arranged to carry out my new process, the proportions being changed somewhat for clearness of illustration. Fig. 2 is a sectional side elevation of the apparatus, and Fig. 3 is a top plan view of the same partly broken away.

My invention relates to the manufacture of gas for heating or other purposes, and its object is to provide a process whereby a gas of high calorific power can be cheaply and continuously manufactured; and it is especially designed to produce from carbonaceous matter and a reducible oxid, a substantially pure carbon monoxid gas.

To that end it consists in a new method of treating the carbonaceous matter, such as coal or wood, and a reducible oxid, such as oxid of iron, and continuously producing carbon monoxid and discharging it in an isolated condition substantially free from any gaseous mixture.

In the drawings, in which I show a preferred form of apparatus for carrying out my invention, 2 and 3 are gas tight receivers or tanks, from which lead off-take pipes 4 and 5 provided with pressure valves yieldingly held to their seats by weights 6. The gas in these receivers is thus prevented from flowing out through the pipes until a certain pressure is accumulated, and when this pressure is exceeded it forces back the yieldingly pressed valve and flows out to the general tank or gasometer. These receivers form parts of a closed circuit of chambers and have no direct connection with each other, but are connected by pipes 7 and 8 with two of the ports of a four-way rotary valve 9. The other two ports of this valve are connected by pipes 10 and 11 with a rotary blowing device 12 driven from any suitable source of power acting as a pump for the closed system. The receivers may be provided with thermometers, pressure gages, pet cocks, and sight drip cocks for drawing off the accumulated moisture and condensed carbon disulfid, these parts not being shown. The receivers 2 and 3 are also connected by pipes 13 and 14, respectively, with regenerators 15 and 16, the connecting pipes preferably entering the lower portions of such regenerators, which may be of any desirable form, and provided with the usual checker-work system. These pipes, as well as all connecting pipes or passages in the closed circuit proper are preferably of such size that the quantity of gas passing through them per minute will not exceed a speed of more than thirty-five feet per second; and the receivers 2 and 3 are each of such dimensions that the gas to be passed through either of them in one direction during any single phase of the reversing current in one direction, will not exceed the cubic contents of such receiver. The regenerators are of such size that the interstices of either of them is substantially equal to the capacity above designated for each receiver. The regenerators are not directly connected to each other, but constitute parts of the general closed circuit.

The regenerator 15 is connected by pipes 17 and 18 with a battery or system of coal retorts 19, the lower pipe 17 preferably leading upwardly to a point within the regenerator near its top; and the regenerator 16 is correspondingly connected with the battery of coal retorts 20 by similar pipes 21 and 22.

The coal retorts are arranged in four groups, four being shown in each group, though any desired number may be used. The upper ends of each group are connected by inclined converging feed channels 23 to the stem 24, of a hopper 25 which connects by a throat 26 with an upper hopper 27 open at its top. A valve 28 is provided in the upper throat and another valve 29 is located in the stem 24 below the intermediate hopper. The lower ends of each group of coal retorts connect by converging pipes 30 to a common outlet 31 leading to chamber 32; and valves 33 and 34 are provided above and below the receptacle 32. Each stem 24 for the series of retorts 19 is connected by branch pipe 35 with the pipe 18, and similarly each outlet channel 31 is connected by branch pipe 36 to the lower pipe 17; and similarly the series of retorts 20 are connected from stems 24 through branch pipes 37 to the upper pipe 22, while the

lower channels 31 are similarly connected by pipes 38 to the lower pipe 21.

The pipes 17, 18, 21 and 22 are extended on the side of the retorts opposite to the regenerators, and I have marked these extensions 17′, 18′, 21′, and 22′. The pipe 17 and its extension 17′ are provided with oppositely seating normally closed valves 39 and 40, which I have shown as in the form of flat valves held to their seats by gravity, though they may be made in many other forms, such as spring-pressed check valves. The pipes 18 and 18′ are similarly provided with valves 41 and 42, the pipes 21, 21′ with valves 43 and 44 and the pipe 22, 22′ with similar valves 45 and 46, each pair of valves in each pipe and its extension seating in opposite directions. These opposed check valves intercept communication between the batteries of coal retorts and the regenerators, and communication between a chamber 47 and the batteries of retorts respectively, according to the direction of the reversing current. The pipes 18′ and 22′ enter the chamber 47 near its top, while the pipes 17′ and 21′ enter the same chamber near its bottom; I have shown the pipes 18′ and 22′ as connected within this chamber by a perforated pipe 48, and the pipes 17′ and 21′ connected by similar perforated pipe 49, though these may or may not be used as desired. The pipes 17′, 18′, 21′ and 22′ may enter other parts of the chamber 47 without changing the character of the apparatus. The respective positions of the inwardly opening valves and the outwardly opening valves may be reversed without departing from my invention.

In the chamber 47 are placed vertical ore conduits 50 and 51. These conduits consist of a vertical series of hollow inverted frustums or hoppers 52 supported in vertical series at proper distances apart, such that exposed piles of pulverulent material passing through them will be formed in the intervening spaces, the piles shifting in proportion to the speed of descent of the material. The form and arrangement of these ore conduits may be varied widely, the object being to provide a shifting body of oxid, such as iron ore, which is freely exposed in the chamber 47. At the top of each ore conduit is provided a feed channel 53 leading downwardly from hopper 54, which is fed from an upper hopper 55 through the throat 56. Valves 57 and 58 are provided in the throat 56 and the channel 53; and at the bottom of these ore conduits is provided an outlet funnel or hopper 59, leading to valved channel 60, which communicates with receptacle 61 having valved outlet 62. The inlet and outlet systems for the ore conduits and the coal retorts lead respectively to points above and below the chambers in which they are inclosed. The size of the chamber 47 is such that the speed of the gas passing through it is slow enough to allow sufficient time for a complete reaction between the carbon monoxid carried into it and the reducible oxid exposed within it.

The batteries of coal retorts 19 and 20 respectively are inclosed in a heating chamber 63 which is heated by any suitable means such as the grate 64 at one end, with stack 65 leading from the opposite upper portion of the chamber. This chamber 63 is external to the closed gas system, and is designed to be used at the beginning of the operation of gas making.

The valved inlet and outlet systems for the coal retorts and the ore conduits are designed to prevent admission of air to the closed system; and in feeding the coal to the batteries 19 and 20, or an oxid such as iron ore, to the ore conduit, the material is fed into the upper hopper and the upper valve is opened to admit this material to the intermediate closed hopper. This upper valve is then closed, and sufficient carbon monoxid may be introduced from a gasometer or reservoir through pet cock not shown, into the upper part of the intermediate hopper, and the contained air is forced out through another pet cock, not shown, in its lower part. The valve below the middle hopper is then opened, thus allowing the hopper contents to descend into the coal retorts or the ore conduits, respectively. The delivery of the materials from the retorts or ore conduits is accomplished in a similar manner, except that the air is forced out from the intermediate lower receptacle or hopper, by admitting carbon monoxid, before filling them with the material from above. The ore and reduced iron discharged from the ore conduits into the open air may be elevated and again fed to the upper hopper, the reduced iron being reoxidized into magnetic oxid by contact with the air. This iron ore or other reducible oxid thus used serves simply as a carrier of oxygen, to provide the proper atmosphere in the chamber 47.

The exposed parts of the apparatus with the exception of the receivers 2 and 3, the coking apparatus and their immediate connections are preferably made as nonconducting as possible to retain the heat in the system.

The apparatus thus comprises a closed circuit from which there is no outlet for the gases, except the pressure valves controlling the outlet from the receivers; and in which circuit a hot reversing current can be maintained and supplied with carbon and reducible oxid, as desired, without exposure or intrusion of outside air; and consequently the operation of forming carbon monoxid is carried on free from nitrogen or any other

gases after the pressure of confined gas becomes sufficient to overcome the pressure of the outlet valves.

In carrying out the operation according to my new process, the coal retorts are supplied with small coal or slack in the manner above described, and the ore conduits are supplied with finely divided dry iron ore or other reducible oxid. The coal retorts are then heated by means of the grate 64 to start combustion of the coal in the retorts, the valves to the hoppers are closed, and the pumping apparatus started, operating slowly until the chamber 63 and the ore retort chamber is heated to preferably about 500° F. by the heated gas current from the coal retorts. The speed of the pumping apparatus may then be increased until the temperature in the coal retort chamber and the ore chamber 47 is raised to preferably about 600° F. During this time the temperature in the coal retort chamber should be carefully watched, and when the temperature begins to go above 750° F. the external fire in the grate should be dampened and kept under control. A gas burner may be provided to replace the fire in the grate, as this burner can be easily controlled by a thermostatic device, though this is not essential. The oscillations of the gas currents are produced by reversing the position of the four-way rotary valve by a suitable lever connection 66 by which the position of this valve is reversed at certain intervals to change it from the position shown in Fig. 1 to that in which the pipe 7 is connected to the pipe 10, and the pipe 8 is connected to pipe 11. By heating the carbon in the retorts to about 580° F. there is produced, under the conditions which obtain therein, comparatively pure monoxid. When the carbon is heated above 580° F. considerable carbon dioxid is produced. The action of reversing the gas current when the temperature is about 750° F. is to develop carbon monoxid from the carbon dioxid, which began developing when the temperature was about 580° F. Each oscillation of the current carries carbon monoxid over the hot coal in the retort and forward into the upper part of the ore chamber, where it comes in contact with the heated iron oxid and takes up oxygen from this oxid to form carbon dioxid again, which is carried on to one or the other of the set of coal retorts 19 and 20 from the lower part of the chamber 47, according to the direction of the gases. As the heated carbon dioxid returning from the ore chamber comes in contact with the heated carbon in the coal retort, it takes up carbon and is converted into carbon monoxid. If no oxygen were added to the carbon in the retorts, the production of carbon monoxid or carbon monoxid and carbon dioxid would very soon cease for want of oxygen. If the oxygen were supplied from the atmosphere, a large volume of nitrogen would be introduced. To avoid both of these conditions, I obtain the oxygen for the production of the carbon oxid or oxids in the retort from the oxygen contained in the iron oxid in the ore in the ore-conduit chamber 47. The gas produced in the retorts is principally carbon monoxid, which, upon coming in contact with heated iron oxid in the ore chamber, is transformed into carbon dioxid by the absorption of oxygen from the iron oxid. When this carbon dioxid is brought into contact with the heated carbon in the retorts, it is reduced to carbon monoxid, and the oxygen thus liberated combines with the heated carbon to form carbon monoxid. It will thus be seen that the oxygen necessary for the formation of the carbon monoxid is supplied by the oxygen from the iron oxid in the ore chamber, and as this is free from nitrogen, the gas produced is free from the latter element. The volume of the closed circuit being constant, the increasing volume of gas formed in it by successive development of carbon monoxid soon raises the pressure to a point above that of the outlet pressure valves of the receivers, and the isolated carbon monoxid gas is then discharged as it is formed. If the direction of the current is reversed before a greater quantity of gas is forced through the closed circuit than one of the receivers can supply, no carbon dioxid will be present in either receiver, and only carbon monoxid will be passed off from the receivers. The feeding of materials to and from the retorts and the oxid conduits being carried out in the manner before described, air is prevented from entering the system to mix with the heated gas currents therein. The heat generated by the reactions is largely returned by the regenerators, and the temperature is thus maintained, while the conductive surface of the receivers and connections is sufficient to dissipate the surplus heat forming during the reaction. The direction of the current in the closed circuit in one direction is illustrated by the arrows in Fig. 1, and the direction during the opposite period of oscillation will be the opposite of this. The current passing through its proper channels in each direction by reason of the automatically acting valves in the pipes 17, 17′, 18, 18′, 21, 21′, 22 and 22′.

The advantages of my invention result from the formation of the carbon monoxid gas of high calorific power in a continuous manner, and at comparatively small expense.

Wood, sawdust, or other carbonaceous materials may be used in place of coal, other reducible oxids may be used in place of iron oxids, and the form of the apparatus may

be widely varied without departing from my invention.

In connection with the reversing of the direction of flow of the gas, it will be explained that when the gas is flowing in any one direction, oxygen is taken off from the carbonaceous material in one set of retorts, while little or no oxygen is taken off from the carbonaceous material in the other retorts, because of the oxygen supplied thereto from the metallic oxid in the chamber 47. Under these conditions, if the flow of the gas be in one direction only, one of the retorts would cease to act after a time, and then the other would cease to act when its carbonaceous material had given off all of the oxygen. In order that the generation of gas may be continuous, the direction of flow of the gas is reversed periodically in order that the retort which is about to become inactive may be rendered active by the supply of oxygen thereto from the metallic oxid.

I claim:

1. The herein described process of making gas, which consists in subjecting carbonaceous material to heat in a closed circuit to produce a gas containing carbon monoxid, causing said carbon monoxid to take up oxygen by subjecting it to the action of a heated metallic oxid in a closed circuit to form carbon dioxid, then reducing all of the carbon dioxid in the gas to carbon monoxid by subjecting the same to the action of heated carbonaceous material in the closed circuit and finally taking off the carbon monoxid, substantially as described.

2. A process of producing carbon monoxid gas, which consists in oxidizing carbon monoxid in a closed circuit by forcing the carbon monoxid through the circuit in one direction over a heated metallic oxid, then reducing the gas thus produced by forcing the same in the same direction over heated carbonaceous material, periodically reversing the direction of flow of current, and finally withdrawing the carbon monoxid from the system, substantially as described.

3. A process of producing carbon monoxid, which consists in heating carbonaceous material in a retort to produce carbon monoxid, subjecting said carbon monoxid to the action of heated metallic oxid in another retort to produce carbon dioxid, then subjecting the carbon dioxid to heated carbonaceous material in another retort to produce carbon-monoxid, continuing the operation until the oxygen in the carbonaceous material of the first retort is substantially exhausted, then reversing the order of the steps, whereby the oxygen in the first-mentioned retort is restored by the oxygen from the metallic oxid, and taking off the excess monoxid, substantially as described.

4. The process of producing carbon monoxid which consists in heating carbonaceous material in a retort to produce carbon monoxid, subjecting said carbon monoxid to the action of heated metallic oxid in another retort to produce carbon dioxid, subjecting the carbon dioxid to heated carbonaceous material in another retort to produce carbon monoxid, then carrying the carbon monoxid to the first-mentioned retort, continuing the operation in the same order in a closed circuit, periodically reversing the flow of the gas, and taking off the excess carbon monoxid, substantially as described.

5. The herein described process which consists in heating carbonaceous material to produce carbon monoxid in a closed circuit, passing the gas thus produced around the circuit and into contact successively with heated metallic oxid and heated carbonaceous material and back to the starting point, continuing the flow of gas around the circuit, periodically reversing the direction of the flow of the gas and taking off the excess carbon monoxid, substantially as described.

6. In the production of carbon monoxid gas, the steps comprising the heating of carbonaceous material in a retort to produce carbon monoxid, subjecting the carbon monoxid to the action of heated metallic oxid in a retort, and feeding in fresh metallic oxid to the latter retort while excluding air therefrom, substantially as described.

7. In the production of carbon monoxid gas, the steps comprising the heating of carbonaceous material in a retort to produce carbon monoxid, subjecting the carbon monoxid to the action of heated metallic oxid in the retort, and feeding in and taking out carbonaceous material and metallic oxid to and from the retorts while excluding air therefrom, substantially as described.

In testimony whereof, I have hereunto set my hand.

WM. H. WILLIAMS.

Witnesses:
A. W. BROWN,
H. H. C. HAMMERTON.