No. 680,780. Patented Aug. 20, 1901.

W. J. KNOX.

PROCESS OF MANUFACTURING COKE.

(Application filed Apr. 21, 1900.)

(No Model.) 2 Sheets—Sheet 1.

FIG. 1.

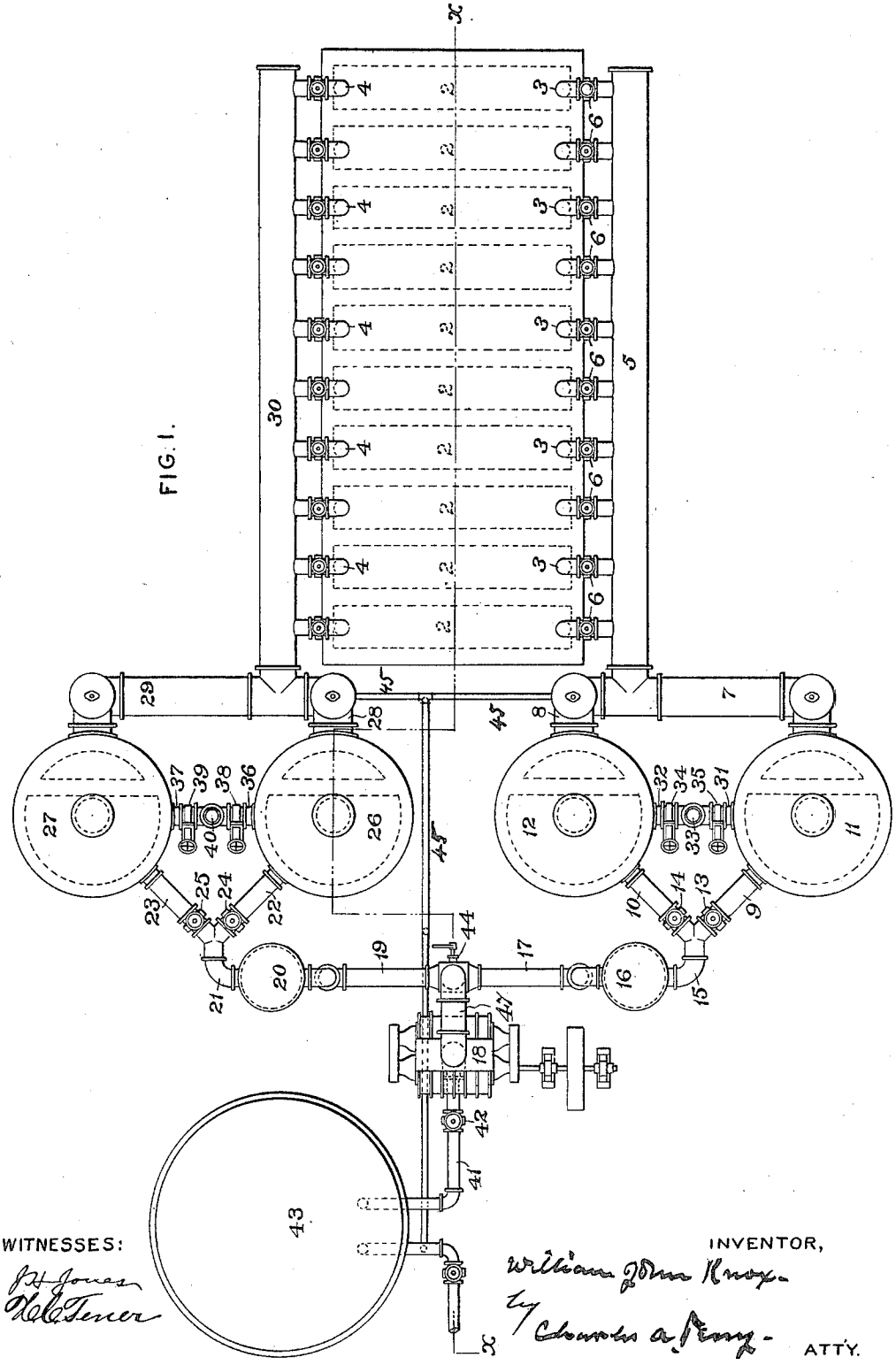

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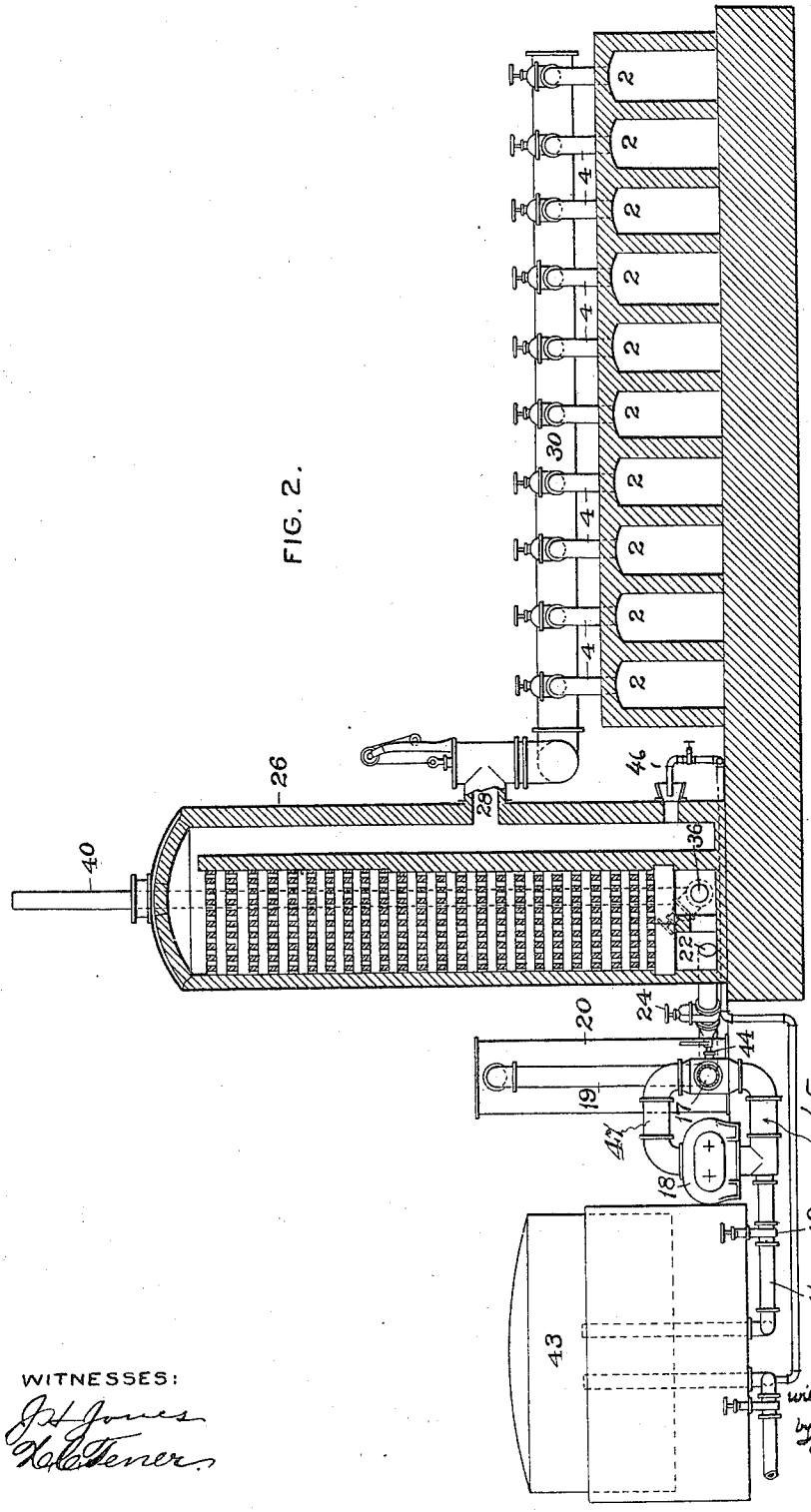
FIG. 2.



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UNITED STATES PATENT OFFICE.

WILLIAM JOHN KNOX, OF PITTSBURG, PENNSYLVANIA, ASSIGNOR TO GEORGE WESTINGHOUSE, OF SAME PLACE.

PROCESS OF MANUFACTURING COKE.

SPECIFICATION forming part of Letters Patent No. 680,780, dated August 20, 1901.

Application filed April 21, 1900. Serial No. 13,708. (No specimens.)

To all whom it may concern:

Be it known that I, WILLIAM JOHN KNOX, a citizen of the United States, and a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Processes of Manufacturing Coke, of which the following is a specification.

My invention relates to a process of manufacturing coke, the objects being to apply economically the heat energy necessary to carry on the coking operation and to secure as a product the gaseous hydrocarbons of the coal in an undiluted state.

The general plan of the invention is to pass the hydrocarbon vapors generated in the coke-ovens through suitable stoves, in which more or less of the heat carried by the vapors is conserved or stored, thence through cooling devices—such, for instance, as a steam-generator—thence into heating-stoves, where the temperature is raised to the degree required for effectively acting upon the coal to reduce it to coke. These heated vapors are then passed into the coking-ovens and usually across the top of the bed of coal or coke. This operation is continued until the stove which has been employed as the heat-absorbing stove has absorbed and stored a predetermined amount of sensible heat, whereupon the direction of circulation is reversed and this stove is utilized as the heating-stove and the former heating-stove as the heat-absorbing stove, and this operation of reversal is repeated continuously at suitable intervals as long as the temperature of the stoves is sufficiently high to conduct the coking operation. Additional stoves may be employed, so that any stove which has previously been used as described and its temperature reduced thereby may be cut out of the circuit and further heated by the consumption of fuel therein to restore its condition as a heating-stove.

The invention involves certain other features, all of which will be more particularly described in connection with the drawings.

Referring to the drawings, Figure 1 is a plan of a system for carrying out the invention; and Fig. 2 is an elevation, partly in section, of the same.

Referring to the figures, 2 2 2 represent coking-ovens of any suitable form. In the drawings they are shown as having pipes 3 and 4, respectively, connected with the upper portions at opposite ends. The pipes 3 terminate in a common pipe 5, suitable valves 6 being interposed in the pipes 3. The pipe 5 is shown as being connected with pipes 7 and 8, leading, respectively, to stoves or superheaters 11 and 12, respectively. The stoves 11 and 12 are respectively connected by pipes 9 and 10, containing suitable valves 13 and 14, with a pipe 15, leading to a steam generator or boiler of any suitable character 16. The boiler 16 is connected by a pipe 17 with one terminal of a suitable blower 18. This blower may be of any convenient character. In the drawings I have indicated a rotary blower, to the opposite sides of which are connected pipes 47 and 48, the pipe 48 being that one with which the pipe 17 is connected. The pipe 47 is connected with a pipe 19, leading to a boiler or steam-generator 20, which is similar to the boiler 16. The pipe 21 leads from the steam-generator 20 to two pipes 22 and 23, respectively, containing valves 24 and 25 and connected with stoves or superheaters 26 and 27. Pipes 28 and 29 connect these superheaters with a pipe 30, from which the pipes 4 lead to ovens 2. Suitable valves may be included in the pipes 4.

The stoves 11 and 12 may be connected through pipes 31 and 32 with a chimney 33, suitable valves 34 and 35 being provided for controlling these connections. Similar pipes 36 and 37 and valves 38 and 39 control the connections of the stoves 26 and 27 with a chimney 40. The blower 18 is provided with an offtake-pipe 41, provided with a valve 42.

The operation of the apparatus is as follows: One or more of the stoves are first heated—as, for example, the stove 27—by burning therein fuel—such, for instance, as gas—admitted through an injector 46, which is connected by a pipe 45 with the holder 43, the injector being suitably placed in the base of the stove. The valve 39 in the pipe 37 is at this time open, so that the products of combustion may escape through the chimney 40. When the stove 27 has been heated to a sufficient temperature, the burning of gas in the

stove 27 is stopped and the blower 18 is operated in such direction as to cause a circulation of air through the pipes 47 and 19, boiler 20, pipes 21 and 23 (the valve 25 being opened and the valve 24 closed) to the stove 27, where the air is heated. The passage of the air through the boiler 20 at this stage is merely for convenience, the boiler forming a part of the circulating-path. The valve 39 being previously closed the heated air passes through the pipes 29 and 30 to the pipes 4, thence across the bed of fuel previously placed in the coke-ovens 2, and the volatile hydrocarbons generated pass out through the pipes 3 to the pipe 5, thence by way of the pipe 7 to and through one of the stoves, say 11, which is gradually heated by the hot gases thus passing from the coke-ovens. The valve 31 has been previously closed, and the gas from the stove 11 passes by way of the pipes 9 and 15 to the steam-generator 16, the valve 14 having been also closed. More or less heat is imparted to the steam-generator 16 by the circulating gas, and the gas passes thence through the pipe 17 to the blower 18, and a portion or all of this gas may be forced to repeat the circuit. As the process continues more hydrocarbon vapor is generated, and an amount approximately equal to that being generated may be drawn off through the pipe 41 to a suitable receptacle—such, for instance, as a holder 43. The proportion thus drawn off may be regulated by the valve 42. As the operation continues the stove 27 gradually cools by reason of the passage therethrough of the gas, which has delivered more or less of its heat to the stove 11 and the boilers 16 and 20. Meanwhile the stoves 12 and 26 may be heated by burning gas therein in the same manner that the stove 27 was heated. This is accomplished by supplying gas from the holder 43, through the pipe 45, to the injectors 46, (see Fig. 2,) each stove being provided with such an injector. The valves 34 and 38 are open during this heating process for permitting the products of combustion to escape through the respective chimneys 33 and 40, and the valves 14 and 24, as already stated, are closed during this operation. When the process has continued so long that the stove 27 has cooled to such a degree that it does not impart sufficient heat to the circulating gas to economically continue the coking process, the direction of circulation caused by the blower 18 may be reversed, either by reversing the direction of rotation of the blades or by means of any suitable controlling-valve 44, so that the circulation through the ovens will be in the opposite direction from that just considered. If desired, the stove 12 may have received a preliminary heating by the combustion of fuel not only during the time that the heat of the stove 27 was being imparted to the circulating gas, but also during the time that the stove 27 was originally heated. In practice it will be seen that by means of the four stoves each stove may be heated by the combustion of fuel during the time that two stoves are successively delivering their heat to the circulating gas. This usually affords a more economical method of heating than is obtained by attempting to heat more rapidly, as would be required if the gas were heated during only the period that one stove was delivering up its heat. The stove 12 is cut into circuit by opening the valve 14, and the stove 11 is cut out of circuit by closing the valve 13. The new path for the circulating gas, then, is as follows: from the blower 18 through the pipes 48 and 17, boiler 16, pipes 15 and 10, stove 12, pipes 8, 5, and 3, the coke-ovens, thence through the pipes 4, 30, and 29 to the stove 27, thence through the pipes 23 and 21 to the boiler 20, thence through the pipes 19 and 47 back to the blower 18. The stove 27 usually remains in circuit during this step in the process and receives some heat from the vapors or gases as they pass out from the ovens 2. The circulation is continued in this direction and through this path until the stove 12 has cooled to such a degree that it is desirable to substitute another stove—such, for instance, as the stove 26. When such substitution is made, the direction of circulation will be again reversed, and the path of circulation will be substantially the same as that originally described, except that the stoves 26 and 12 are in circuit instead of the stoves 27 and 11, respectively. Thus by successive heatings of the different stoves and successive reversals of the circulation a continuous operation of the coking process is maintained.

It will be observed that a large amount of the heat in the system is conserved by means of the boilers 16 and 20 and by causing the gas as it passes from the coking-ovens to enter one or the other of the stoves and deliver up more or less of its heat thereto. The steam generated in the boilers 16 and 20 may be used for any desired purpose.

When all the stoves of the system are in operative condition, the direction of circulation may be reversed back and forth with frequency between the two stoves on opposite sides of the system—as, for instance, stoves 11 and 27—until their temperature is no longer sufficient to carry on the coking operation with sufficient energy, whereupon those stoves are cut out to be reheated, and stoves 12 and 26, which have meanwhile been thoroughly heated, are cut into the circuit and operated with frequent reversals between them, as above described for the other pair of stoves 11 and 27.

It is usually desirable that the periods of reversal shall be so frequent that the temperature at the cold ends of the stoves 11, 12, 26, and 27 shall not have time to become unduly heated, for it is desirable that the heat produced by the consumption of the fuel in the stoves shall be very largely absorbed by the stoves, and to do this it is necessary that the cold ends of the stoves—that is to say, the ends with which the chimneys are connect-

ed—shall be at a comparatively low temperature.

If the runs were continued too long, the heat would be distributed throughout the stoves, and thus the cold ends would attain too high a temperature. By inserting the steam-generators 16 and 20 in the circuit between the stoves the vapors and gases passing from one stove to the other become cooled in passing, so that they enter the cold end of any given stove at a relatively low temperature and receive the temperature evenly as they pass through the heating-stove. The steam produced in the generators 16 and 20 may be utilized for any desired purpose—such, for instance, as operating the blower, charging and discharging apparatus, coal-crushing machinery, &c.

The rate at which the circulation is maintained may be regulated by means of the controlling-valve 44, which when entirely closed causes all of the gases or vapors to pass through the blower, and when it is open a direct connection is made between the pipes 17 and 19, and between these limits any desired gradation may be obtained.

The amount of steam raised may be regulated from a certain minimum up to any amount desired, depending upon the length of time between the reversals, for it is apparent that the longer a run in a given direction the hotter will become the cold end of the stove, and therefore the greater will be the amount of heat passed to the steam-generators.

I have found it advantageous in manufacturing coke to pass the heated gases across the top of the bed of coal or coke, thus gradually coking downward. This produces a firm pure quality of coke, especially useful in metallurgical processes. I desire to have it understood, however, that in some cases the general process may be applied to the manufacture of coke in which the heated gases are passed through the body of coke.

In another application filed by me on March 9, 1901, Serial No. 50,416, claims are made to the apparatus described herein.

I claim as my invention—

1. The hereinbefore-described process of manufacturing coke, which consists in circulating heated gases through the coking-ovens, cooling the gases as they come from the coking-ovens, reheating the gases, or a portion thereof, and continuing the operation.

2. The hereinbefore-described process of manufacturing coke, which consists in passing heated gases across a bed of coal to be coked, thereby generating additional gases, then cooling the gases, thereafter reheating a portion of the same, and continuing the process.

3. The hereinbefore-described process of manufacturing coke, which consists in subjecting coal to the action of heated gases, thereafter cooling the gases, then reheating the gases, or a portion thereof, repeating the operation, and periodically reversing the direction of circulation of the gases.

4. The hereinbefore-described process of manufacturing coke which consists in passing heated gases across the coal to be coked, vaporizing hydrocarbons thereby and gradually reducing the coal to coke, cooling the gases, generating steam by the heat extracted therefrom, and utilizing the steam for forcing a circulation of the gases, substantially as described.

5. The hereinbefore-described process of manufacturing coke, which consists in passing heated gases across the material to be coked, generating gaseous hydrocarbons thereby, cooling the gases, reheating a portion thereof, and passing them again across the material to be coked, utilizing a portion of the excess gases for imparting heat to the heating devices by combustion.

6. The hereinbefore-described method of manufacturing coke, which consists in heating a portion of the hydrocarbons developed during the process of coking, passing such heated hydrocarbons across the material being coked, thereby generating additional hydrocarbons, extracting heat from the hydrocarbons as they pass from the coking-ovens and storing such heat, and subsequently utilizing the heat so stored in reheating the gases to be passed through the coking-ovens.

7. The hereinbefore-described process of utilizing the hydrocarbons developed in the process of coking coal, which consists in passing more or less of the hydrocarbons through a continuous circuit alternately heating and cooling the same, substantially as described.

Signed at Pittsburg, in the county of Allegheny and State of Pennsylvania, this 17th day of April, A. D. 1900.

WILLIAM JOHN KNOX.

Witnesses:
J. A. ADAMS,
CHAS. F. MILLER.