No. 637,255. Patented Nov. 21, 1899.

J. HEMINGWAY.

PROCESS OF MAKING COKE.

(Application filed Oct. 16, 1899.)

(No Model.) 2 Sheets—Sheet 1.

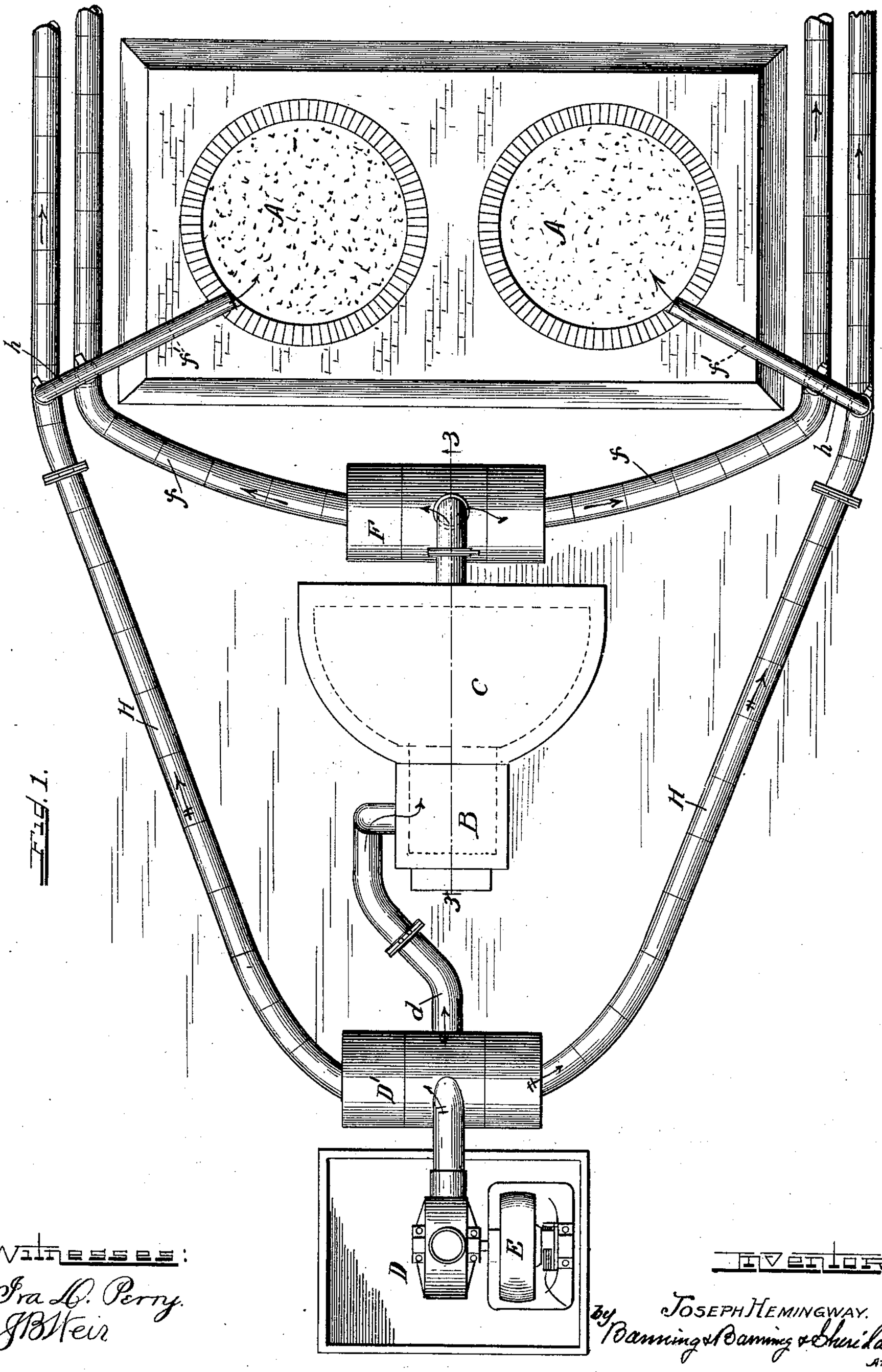

Fig. 1.

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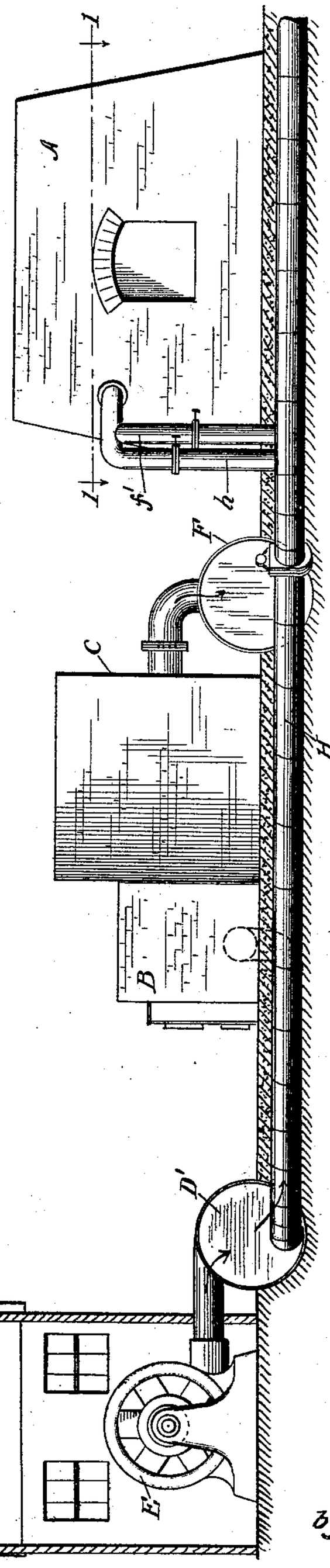

FIG. 2.

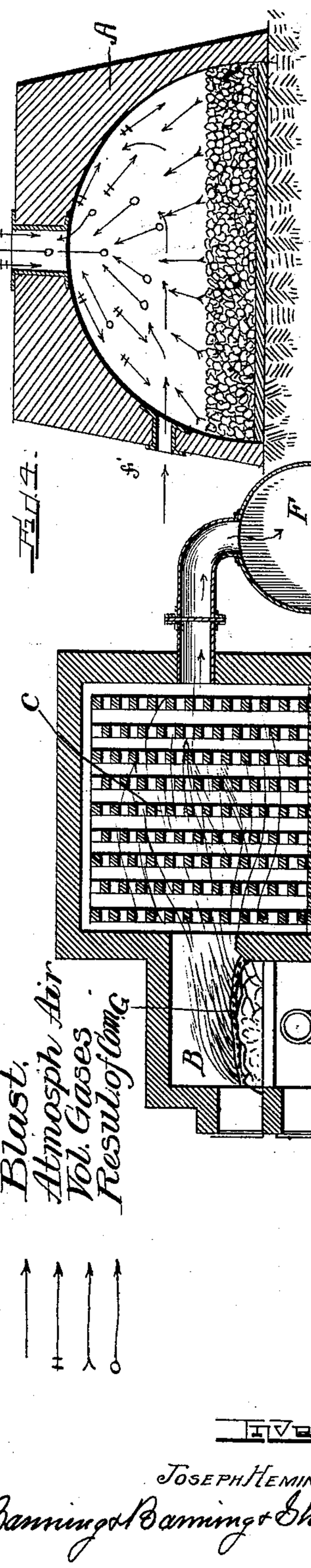

FIG. 3.

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UNITED STATES PATENT OFFICE.

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PROCESS OF MAKING COKE.

SPECIFICATION forming part of Letters Patent No. 637,255, dated November 21, 1899.

Application filed October 16, 1899. Serial No. 733,749. (No specimens.)

To all whom it may concern:

Be it known that I, JOSEPH HEMINGWAY, a citizen of the United States, residing at Spearfish, Lawrence county, South Dakota, have invented certain new and useful Improvements in Processes of Making Coke, of which the following is a specification.

The object of my invention is more particularly to devise a method of treating sulfurous coals and coals that have heretofore been regarded as non-cokable for commercial purposes, so that they can be coked in quantity and at a reasonable expense and so that the coke secured will be of a superior quality and applicable for all the uses to which good qualities of coke are now applied; and my invention also has for its object improving and expediting the coking of coals now coked by the ordinary processes; and my process consists in the operations and modes of procedure hereinafter described and claimed.

In the drawings, Figure 1 represents a plan view of a convenient form of coking plant to carry out my process, with the coking-ovens shown in section taken on line 1 of Fig. 2. Fig. 2 is a side elevation. Fig. 3 is a longitudinal sectional elevation of the blast-heating furnace; and Fig. 4 is a vertical section of a coking-oven, showing the movement and circulation of the gases.

In describing the process or mode of procedure that I have found from months of actual work in coking sulfurous coals and coals that are generally regarded as non-cokable for commercial purposes and coals that are coked according to the present methods to be the best and the most successful I desire to say at the start that I do not intend in this application to attach special importance to the peculiarities of construction of the coking plant which I use, so long as it is adapted for carrying out my process.

The oven A—and when I say "oven" I mean to include as well a plurality of ovens—in which the coal is inclosed or confined may be and preferably is as to its interior of the ordinary beehive construction. It should, however, whatever the form of its construction, be built of materials capable of standing great intensities of heat. The most refractory or durable quality of fire-brick should therefore be employed for the interior lining of the coking-oven. This necessity grows out of the fact that in my process or mode of procedure I raise the temperature in the coking-oven to a point two or three thousand degrees above what is ordinarily employed in the coking operation as generally practiced at the present time. This temperature reaches, I should say, in many cases a point exceeding 4,000° Fahrenheit. Under the high temperature employed by me I secure not only rapid generation and evolution of the gases contained in the coal, but a breaking up and disintegration of their elements and a conversion of the volatile carbons into a fixed form, so that they are deposited upon the coke in large quantities and form constituents of and substantial additions to the coke product. This increase in the quantity of fixed carbon is not secured by the methods of coking in general use, where the temperature is insufficient to effect the separation of the constituents of the gases and the conversion of the volatile carbons into fixed form.

To secure the increased temperature employed by me, I have found it necessary to provide a blast heated outside of the coking-oven itself—an extraneously-heated blast. As a convenient means of heating the blast a furnace B may be employed, having an auxiliary arrangement of open brickwork C, preferably inclosed in the same wall that incloses the furnace. The open brickwork may be constructed of fire-brick and in the usual way. It operates to preserve equality in the temperature of the blast and is intended to be heated and maintained at as high a temperature as the blast driven through and in contact with the mass of burning fuel. In the heating-furnace I have represented a bed of coal, which may of course be as large and deep as the requirements of the case may seem to render expedient or desirable. The blast is furnished by any convenient fan or force blower D, driven by any suitable motor E, operated by electricity, steam, or other preferred means. The air furnished by the blower is, preferably, primarily conveyed into a reservoir or accumulator D′ and from thence through a pipe *d* to the furnace. After the air has passed through the burning fuel it is

of course, to a great extent at least, deprived of its free oxygen and may, therefore, not inappropriately and for convenience of designation be referred to as "deoxygenized." From the open-laid brickwork the deoxygenized blast is carried through a suitable pipe into, preferably, a reservoir or accumulator F, from which it may be carried in suitable pipes a desired distance and introduced into the oven above the mass of coal confined or inclosed and being coked therein. As shown in the drawings, I carry the blast from the reservoir through pipes *f* to the sides of the coking-ovens and carry it through branch pipes *f'* into the first of the ovens, where a plurality of ovens are employed. The pipes *f* may pass on to the next set of ovens and the blast be introduced into them through other branch pipes operating in the same way as the branch pipes *f* operate. The blast of extraneously-heated deoxygenized air is introduced above the mass of coal inclosed in the oven while the trunnel-hole in the top of the oven is left open. The blast supplying a volume of incoming extraneous air and gas, in addition to the gases evolved from the coal, creates a movement or circulation in the oven above the coal which facilitates the discharge or escape of the gases. This discharge naturally takes place in the direction of least resistance—the open trunnel-hole; but, as atmospheric air is heavier than heated air and always moves toward an area or spot of heated or rarified air, the atmospheric air, containing free oxygen, forces its way down and into the oven through the open trunnel-hole. Movement or circulation therefore in the dome of the oven while the trunnel-hole is open conduces to two important contributory results—the egress upward and out through the trunnel-hole of consumed or non-combustible or non-convertible gases and the ingress downward into the oven of a sufficient quantity of atmospheric air containing free oxygen to promote and support the necessary combustion to secure accelerated coking. I thus secure the great increase of temperature of which I have already pointed out the advantages and the movement or circulation in the gases conducive to their speedy combustion and discharge, and consequently the expedition of the coking operation.

As already suggested, one of the applications of my process is in the coking of sulfurous coals. In the case of such coals I specially treat the extraneously-heated blast before its introduction into the oven, so as to impart to it in the act of heating an additional property or capacity adapting it to effect to a greater or less extent the desulfurizing of the coal being treated. In order to give the blast this desulfurizing property in a convenient and efficient manner, I drive it through a layer of, preferably, lime G, spread or arranged on the bed of coal or fuel through which the air is driven to heat it. In passing through the layer of lime or similar material the blast is changed or has imparted to it the property or capacity of removing sulfur from the coal under heat. In this way I have been able to successfully coke sulfurous coals and produce coke adapted to use for metallurgical purposes which have heretofore been regarded as practically non-cokable for such purposes. By thus specially preparing the blast and imparting to it a desulfurizing property there is avoided that physical application to or intermixture with the coal of desulfurizing agents that may remain as impurities or objectionable ingredients in the coke product. I have also found that after creating a condition of temperature in the coking-oven favorable to the rapid generation of the volatile gases in the coal—a condition, as already pointed out, of great intensity of heat—great acceleration of the coking operation may be obtained by shutting off the extraneously-heated deoxygenized blast and following it up with a supply of live air containing free oxygen. I have shown in the drawings a convenient arrangement of pipes for supplying this live air. As illustrated, I employ pipes H, which run from the reservoir or accumulator D' to a desired proximity to the sides of the coking-ovens and connect with the branch pipes *f'* by branch pipes *h* entering them. It will of course be understood that all these pipes are provided with suitable valves or shut-offs, so that the air may be carried through such of them as may be desired and shut off from the others. This arrangement of pipes and valves will be readily understood from an inspection of Fig. 1 without further detailed description. I will simply say that when it is desired to shut off the deoxygenized blast and to admit a supply or volume of live air containing free oxygen the proper valves are operated to shut off the one and admit the other. This supply of live air coming into the oven after the necessary and desired conditions of heat have been secured causes a rapid combustion of the combustible gases thrown off or evolved from the coal, so that the coking operation is greatly accelerated. The rapid evolution and rapid consumption of gases enable me in many cases to complete the coking of a charge in one-half or even one-third the time ordinarily required as the art of coking is now practiced. The supply or volume of live air should, however, be shut off as soon as the combustible gases cease to be evolved from the coal, as otherwise the oxygen would attack and cause a combustion to take place in the fixed carbon of the coal, thus consuming and reducing its quantity, which should of course be avoided.

In carrying out my process I have, as will appear from an inspection of the drawings, which illustrate a convenient arrangement of plant, and from the description of such plant, made provision for introducing into the coking-oven a supply of live air along with the heated deoxygenized blast, as well as for the

admission of either separately. The advantage of admitting both together grows out of the fact that there is thereby induced in the oven at one and the same time the two conditions conducive to the rapid prosecution of the coking operation—the great intensity of heat required for the rapid evolution of the volatile constituents of the coal and the immediate presence of the requisite supply of free oxygen for the consumption of such of them as are combustible. Moreover, when thus admitted, either together or alternately at the will of the operator, the two kinds of blast may readily be graduated or regulated with reference to their respective effects, so that the rapidity of consumption will bear the desired relation to the quantity of generation of the gases evolved and the coking operation properly governed and controlled. Provision of some kind for the separate and alternate, as well as simultaneous, admission of a supply of live air and of a deoxygenized blast will also be found advantageous in many cases where, owing to existing conditions, it may be desirable to employ the one or the other at different stages of the operation. For example, if the coking-oven be cold or practically so and it be necessary to begin the coking operation in effect *ab initio* or where the extraneously-heated deoxygenized blast has not yet been brought to the requisite temperature to rapidly heat the coking-oven a supply of live air may be introduced immediately upon firing the coal to promote and support combustion in the oven during the initial stages of the operation. The deoxygenized blast can then be employed to contribute its heat to the production of the high temperature desired in the oven, after which the operation may be conducted as already described.

In explaining, as above, the great acceleration secured in the coking process I desire to call attention to an important contribution to this result referable to the employment of an extraneously and highly heated deoxygenized blast. After a charge of coal has been coked and wetted down, so as to cool it and the interior of the oven sufficiently to permit the charge of coke to be drawn from the oven and a new charge, comprising several tons, introduced, the oven, as is well known, will have become "cooled" or "chilled," relatively speaking, though its walls, particularly in the dome, are expected to still retain sufficient latent heat to fire the new charge through the reflection or reverberation of the heat from the converging walls of the dome. This result, however, requires considerable time, so that often two or three hours may elapse before the reduced heat effects the generation and ignition of combustible gases from the coal; but by the use of my extraneously highly-heated blast projected into the oven above the coal a temperature is secured sufficient to cause the evolution and flaming of the gases often within five minutes from the time of the introduction of the blast. This of course is an important factor in the acceleration of the coking operation.

It will of course be understood that all or only a part of the various steps or operations above described may be employed, according to the requirements of circumstances. For example, where I am coking coal that is free from sulfur it will be unnecessary to use a specially-prepared desulfurizing blast. Nor, as already intimated, do I attach special importance to the constructional features of my plant so long as it is capable of embodying or carrying out my process or method of operation. I do not therefore desire to be understood as limiting myself further or more closely than as pointed out in the claims.

What I regard as new, and desire to secure by Letters Patent, is—

1. The process of coking coal, which consists in confining the coal in an oven, firing the coal, and then subjecting the coal to a temperature sufficiently high to cause not only the generation of gases but also the disintegration of their elements and the conversion of volatile carbons into fixed form and their disposition as constituent appreciable integral additions to the coke product, substantially as described.

2. The process of coking coal, which consists in confining the coal in an oven, firing the coal, and then introducing into the oven, above the coal, an extraneously-heated deoxygenized blast to accelerate the generation of and induce circulation or movement in the volatile gases, in the oven, while the trunnel-hole in the top of the oven is open, thus causing the ingress into the oven of atmospheric air to support combustion and the egress through the same hole of non-combustible or consumed gases, substantially as described.

3. The process of coking coal, which consists in confining the coal in an oven, firing the coal, and then introducing into the oven, above the coal, an extraneously specially prepared highly-heated blast, having imparted to it, during the act of heating it, as an additional quality, the property of desulfurizing coal under heat, substantially as described.

4. The process of coking coal, which consists in confining the coal in an oven, firing the coal, then introducing into the oven, above the coal, an extraneously-heated deoxygenized blast of a temperature, before its introduction, greater than that usually employed in the coking operation, to increase the heat in the oven above the temperature produced by the combustion therein of the gases generated from the coal and to accelerate the generation of such gases, and then permitting the deoxygenized blast and that portion of the evolved gases not converted into fixed carbon to escape through an opening at the top of the oven, substantially as described.

5. The process of coking coal, which consists in confining the coal in an oven, firing the coal, then introducing into the oven, above

the coal, an extraneously-heated deoxygenized blast of a temperature, before its introduction, greater than that usually employed in the coking operation, to increase the heat in the oven above the temperature produced by the combustion therein of the gases generated from the coal and to induce a condition favorable to the rapid generation of such gases, then introducing a sufficient volume of live air into the oven to cause the combustion of the combustible gases being evolved, and then shutting off the supply of live air with the cessation of the generation of combustible gases to prevent the combustion of fixed carbon, substantially as described.

6. The process of coking coal, which consists in confining the coal in an oven, firing the coal, then introducing into the oven, above the coal, a blast comprising extraneously-heated deoxygenized air, of high temperature, and live air containing free oxygen, to induce in the oven, a temperature and quality of heat favorable to the simultaneous generation and combustion of volatile combustible gases and thus accelerate the coking operation, substantially as described.

7. The process of coking coal, which consists in confining the coal in an oven, firing the coal, and then introducing into the oven, above the coal, alternately and in the order preferred, extraneously highly heated deoxygenized blasts and supplies of live air, to regulate and control the coking operation by adjusting and balancing the temperature and quality of the heat in the oven, at the will of the operator, to secure the proper relative rates of the generation and combustion of the volatile gases, substantially as described.

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