No. 725,646. PATENTED APR. 14, 1903.

R. S. MOSS.

COKING OVEN.

APPLICATION FILED DEC. 20, 1900. RENEWED SEPT. 26, 1902.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.

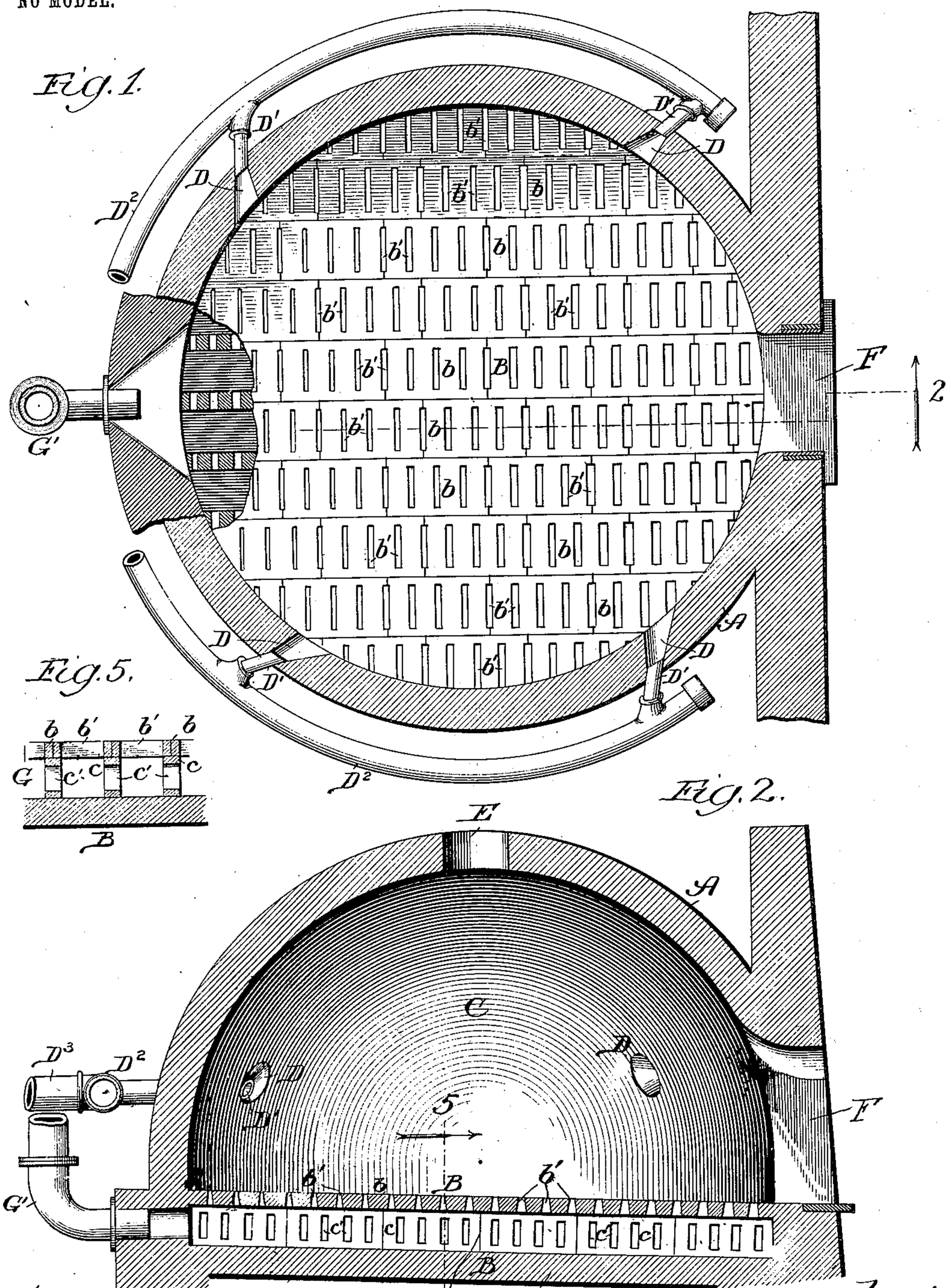

Fig. 5.

Fig. 2.

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NO MODEL. 2 SHEETS—SHEET 2.

Fig. 3.

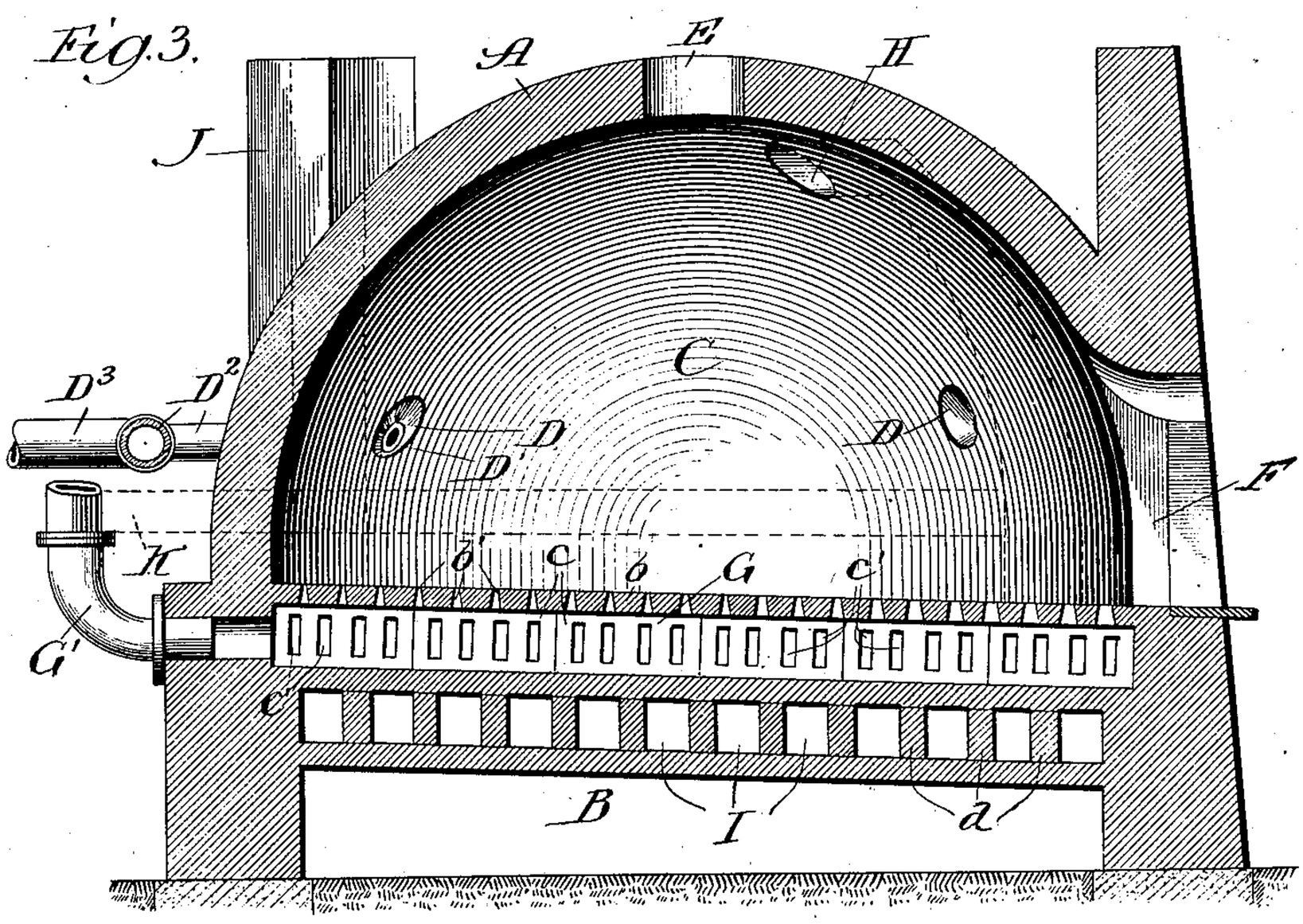
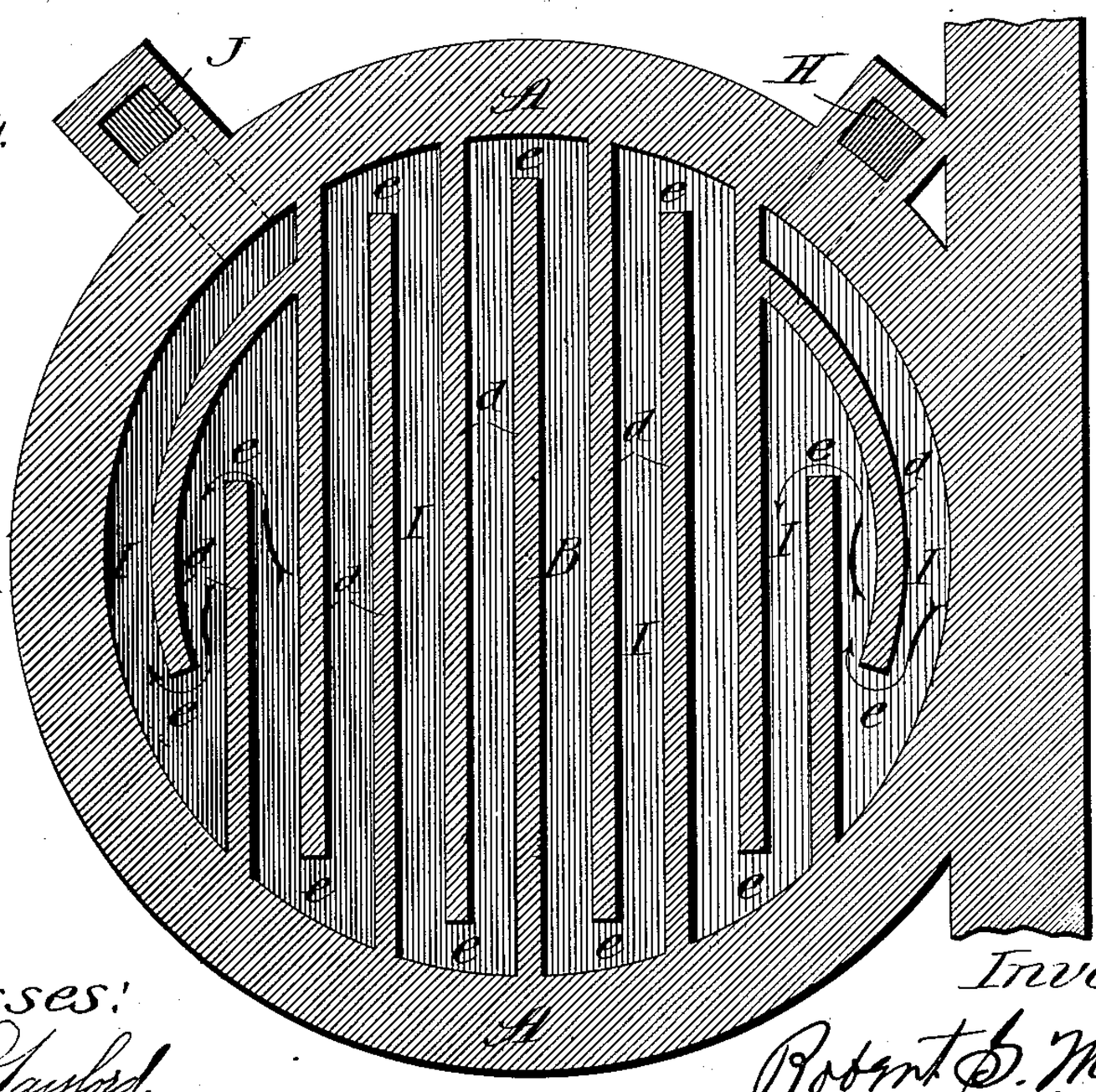


Fig. 4.



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UNITED STATES PATENT OFFICE.

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COKING-OVEN.

SPECIFICATION forming part of Letters Patent No. 725,646, dated April 14, 1903.

Application filed December 20, 1900. Renewed September 26, 1902. Serial No. 124,955. (No model.)

To all whom it may concern:

Be it known that I, ROBERT S. MOSS, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Coking-Ovens, of which the following is a specification.

The object of the invention, primarily, is to construct an oven by the use of which coals of a sulfurous nature can be operated upon so as to practically desulfurize the coal and produce therefrom a high grade of coke having the sulfur as to all intents and purposes eliminated therefrom to an extent to make it practically free from sulfur, leaving a coke well adapted for use generally and possessing the qualities of the highest grade of coke made from non-sulfurous coal, and while the oven is more especially for the treatment of coals of sulfurous nature it is adapted for and can be used in the treatment of coal of non-sulfurous character and produce coke of a high grade.

The invention consists in the features of construction and combination of parts hereinafter described and claimed.

In the drawings illustrating the invention, Figure 1 is a horizontal sectional elevation of an oven embodying the features of the invention; Fig. 2, a vertical sectional elevation of the same; Fig. 3, a vertical sectional elevation of the oven of Figs. 1 and 2 with provision for heating the bottom thereof; Fig. 4, a horizontal sectional elevation on line 4 of Fig. 3, and Fig. 5 a detail showing the construction of the oven-bottom of the oven of Figs. 1 and 2.

For the purpose of illustrating the invention it is not deemed necessary to show but one oven, though it will be understood that the invention is adapted for use and can be used with a series of battery-ovens suitably connected together, as is the practice in the construction of coking-ovens arranged in series or battery form.

The invention is shown in connection with what is known as the "beehive" type or form of coking-oven, with which type or form of oven the invention is preferably used. The oven shown in Figs. 1 and 2 has a wall A and a bottom B with a coking-chamber C above the bottom and inclosed within the wall, in which chamber the coking of the coal is performed. The coking-chamber has external air supplied thereto for the support of combustion and to create an intense heat, which air is projected, preferably in the form of a blast, through openings D in the wall A, arranged, as shown, in alinement around the coking-chamber and having a formation that will cause the projected blast entered through each opening to have a circular travel within and around the coking-chamber, for which purpose the openings have an inclination in a lateral direction that will project the blast in such manner as to circle or travel around within the coking-chamber, and the openings also have an upward inclination by which the blast will be carried above and over the mass or charge of coal in the coking-chamber, so as to commingle with the evolved and expelled gases and volatile matter and cause a commingling of the air and the gases and volatile matter, from which complete and perfect combustion will be assured, by having the gases and volatile matter supplied with a sufficient quantity of air for complete and perfect combustion, giving an increased heat for operation on the coal in the oven in the production of coke. Each blast-opening D has entered thereinto a discharge pipe or nozzle D′, and the several pipes or nozzles are connected with a common supply-pipe D^2, which, as shown, encircles the exterior of the oven, and the common supply-pipe receives air under pressure from a pipe D^3, leading to a suitable source of supply. (Not shown.) The blast of air from the source of supply enters the pipe D^2 and through the discharging pipes or nozzles D′ is projected into the coking-chamber at the several apertures or openings D, so as to produce a circling blast within the coking-chamber. The oven at the upper end or top is provided with the usual trunnel-head E, having a charging-opening therein for feeding the mass or charge of coal into the coking-chamber, and the oven on one side has the usual opening F for the withdrawal of the coke.

The bottom B of the oven has a lower solid wall *a*, above which is an air-supply chamber

G, having a perforated flooring or covering *b*, which lies directly above the mass or charge of coal within the coking-chamber. The flooring or covering *b* of the air-supply chamber may be formed of tile or fire-brick provided with slits or perforations *b'*, so arranged as to have the slits or perforations with a narrow discharge or mouth at the side or point of admitting the air into the chamber, with the discharges or mouths gradually increasing in width in the direction of the opposite side of the oven to that on which the air is admitted or the side of the oven farthest removed from the admission of the air, as clearly shown in Figs. 1 and 2. The flooring or covering *b* in the construction shown is supported on vertical partitions *c*, which may be formed of tile or fire-brick and provided with cross-passages *c'*, so as to give free communication between the spaces of the partitions for the air-supply to be diffused or traveled over the full dimension to the entire surface of the bottom of the oven. The air for supplying the chamber G is admitted thereinto from a pipe G' and may be in the nature of an air-blast from a suitable source of supply.

The air admitted into the supply-chamber beneath the perforated flooring or covering passes up through the perforations of the flooring or covering and is projected into the mass or charge of coal over the entire bottom surface thereof, so as to thoroughly permeate and enter such mass or charge from the bottom and insure a perfect operation in supplying air to the bottom of the mass or charge of coal for the operation of desulfurizing and coking the coal. The discharge of the air-supply will naturally be the strongest adjacent to the immediate point of admission, and with perforations having the discharge or mouth of each perforation of an equal width the result would be that the air-supply adjacent to the point of entrance of the air into the supply-chamber would be too great, while the air-supply at the side farthest removed from the point of admission would be too weak, so that as a result the coking-oven operation would be carried on under conditions of an unequal air-supply that would result in an imperfect production of coke. The gradual increase in width of the mouth or discharge-openings from the air-supply chamber gives a regular and uniform distribution of air throughout the entire bottom of the oven, as the narrow discharge or mouth of the slits or openings adjacent to the point of admission of the air into the air-supply chamber will not pass as much air as the wider discharges or mouths of the openings on the side farthest removed from the point of admission of the air. The ratio of increase should be a proportionate one, so as to give a capacity for the perforations at the side farthest removed from the point of admission of the air, an equality corresponding to the admitted air through the perforations adjacent to the point of air-supply to the chamber, thus equalizing the air-supply admitted beneath the mass or charge of coal over the entire bottom thereof for the admitted air to operate equally throughout the entire lower portion of the mass or charge of coal.

The supplying of air directly to the lower portion or bottom of the mass or charge of coal results in producing an increased evolving and expelling of the gases and volatile matter to pass upward through the mass or charge, thereby giving an increased supply of gases and volatile matter to commingle with the air-supply in the coking-chamber above the mass or charge of coal, producing an increased heat for the coking operation. The air-supply admitted evenly and uniformly throughout the bottom of the oven directly into the mass or charge of coal at the lower portion thereof and over the entire surface results in great beneficial effects, as the air will act directly on the mass or charge of coal, producing a regular, uniform, and complete coking of the mass or charge as a whole with the operation practically even and at the same rate throughout the entire mass or charge of coal. It will be understood that the volume of air supplied to the chamber in the bottom of the oven can be determined from the nature and properties of the coal under treatment and should be regulated according to the work required.

The sulfur is to be eliminated by the employment of a salt having an affinity or liking for the sulfur, according to the nature in which the sulfur exists in the coal, and the salt preferred is ammonium chlorid; but for use with some kinds of coal containing sulfur sodium chlorid or even lime or limestone may be employed. The salt, ammonium, or sodium chlorid is to be mixed either in a dry state or in the form of a solution evenly throughout the mass or charge of coal, which can be done either at the time or before the charging of the oven with the coal, and in some cases it is practicable to spread a layer of the salt on the bottom of the oven. The coking operation acts to decompose the salt, which at the time of decomposition creates an interchemical reaction, with the result of eliminating the sulfur which passes ordinarily in the form of sulfur dioxid and sulfureted hydrogen by the chlorin ejecting the sulfur and assuming its place.

The oven of the present invention having the capability of supplying the air in regular proportionate quantities throughout the entire surface of the bottom of the oven will be found practical and successful not only in the treatment of sulfurous coal for the elimination of the sulfur, but also for the treatment of non-sulfurous coal, as the air-supply which is projected into the lower portion of the mass or charge of coal insures the evolving and expelling of the gases and volatile matter from the lower portion or bottom of the mass or charge to pass upward and commingle with the air admitted into the coking-

chamber above the coal, causing an increased combustion and producing a higher temperature for the coking operation.

The treatment of some kinds of coal requires, in addition to the air-supply at the bottom or lower portion of the mass or charge, that the bottom of the oven shall be brought to a high degree of heat for the purpose of transmitting heat to the bottom or lower portion of the mass or charge and evolving and expelling the gases and volatile matter therefrom coincident with the evolving and expelling of the gases and volatile matter from the upper portion of the mass or charge, and thereby furnish a uniform degree of heat throughout the entire mass or charge for the better and more rapid evolving and expelling of the gases and volatile matter. An oven having this capability in addition to the feature of an air-supply delivered into the bottom or lower portion of the mass or charge is illustrated in Figs. 3 and 4. This oven is constructed with the containing-wall and the bottom having an air-supply chamber and a perforated flooring or covering over the air-supply chamber the same as the oven of Figs. 1 and 2.

It is well known that with perfect and complete combustion consumed gases having a high degree of heat rise to the upper portion of the coking-chamber, and these highly-heated gases with the construction of oven shown in Figs. 3 and 4 are withdaawn from the upper part of the coking-chamber and conducted throughout the bottom of the oven beneath the air-supply chamber. This result is accomplished by a flue H, formed with or attached to the wall A of the oven. The mouth of this flue opens into the coking-chamber at the top thereof, and the flue descends and at its lower end communicates with a channel or passage I, formed in the bottom of the oven below the air-supply chamber. This channel or passage I is formed by a series of vertical partitions *d*, with an opening *e* at the end of alternate partitions and with the initial partition and the final partition curved to conform to the curvature of the wall of the oven. This arrangement of partitions and openings forms a sinuous or zigzag channel or passage in the bottom of the oven through which the highly-heated gases at the top of the coking-chamber are conducted in a sinuous or zigzag manner, so as to impart a high degree of heat to the entire surface of the oven-bottom. The highly-heated gases drawn into the eduction-flue and conducted through the sinuous or zigzag channel or passage discharge through an eduction-flue J, formed with or located adjacent to the wall of the oven. This construction of flues and sinuous or zigzag channel or passage takes the highly-heated gases from the upper portion of the coking-chamber and discharges such gases to pass throughout the entire surface of the bottom of the oven and out therefrom, imparting the high heat of the gases to the entire surface of the oven-bottom for such heat to act in conjunction with the bottom air-supply and evolve and expel the gases and volatile matter from the lower portion of the mass or charge coincident, or nearly so, with the evolving and expelling of the gases and volatile matter from the upper portion of the mass or charge, producing an increased supply of gases and volatile matter to commingle with the air, requiring more air for complete combustion of the gases and volatile matter, and thereby create an increased heat for the coking operation through a more perfect and uniform combustion.

It may be necessary in order to obtain the best results under some conditions to retard the action of the air-supply projected into the bottom or lower portion of the mass or charge of coal through the perforated bottom—as, for instance, where the evolving and expelling of the gases and volatile matter might be so rapid as to consume the carbon of the coal, destroying the coke. This retarding of the action of the supplied air can be secured, with the construction of oven-bottom shown in Figs. 3 and 4, by providing a pipe K, connected at one end with the eduction-flue H and entered at the other end into the pipe G′, through which air is conducted into the air-supply chamber and providing such pipe at the juncture with the eduction-flue with a valve, by means of which the highly-heated gases can be shut off, in whole or in part, from descending the flue to enter the sinuous or zigzag channel or passage and deflected to pass through the pipe K and be carried into the air-supply chamber to pass upward with the air through the slits or perforations and enter the mass or charge of coal at the bottom. These hot gases, added to the air, will give an increase in the volume of air without any increase in the amount of oxygen contained therein. The hot gases being non-combustible and wholly lacking in oxygen when mixed with the air necessarily dilute the supply of oxygen contained in the air, and as a result the combustible quality of the air is lessened and the heating qualities decreased, so that the heat will be reduced in intensity, and such reduction will be to a sufficient degree to evolve and expel the gases and volatile matter from the lower portion of the mass or charge of coal without any injurious effects as regards the future coking of the mass or charge.

The operation is as follows: Coal, preferably in the form of fine even powder or in a reduced state, is fed into the coking-chamber through the charging-opening of the trunnel-head, and after the oven is charged and the coal ignited in the usual manner a supply of air is projected through the apertures or openings D from the nozzles D′ to produce a circular travel or motion of the air around and within the coking-chamber above the mass or charge of coal. The heat from the ignition of the coal evolves and expels the gas and

volatile matter therefrom to commingle with the admitted air and create a perfect and complete combustion and an intense heat, and the air-supply from the chamber in the bottom of the oven projected into the lower portion or bottom of the mass or charge causes the evolving and expelling of the gases and volatile matter to extend from the top to the bottom of the mass or charge, producing a uniform heat, which in conjunction with the salt employed for the desulfurizing purposes reduces the coal to the condition of coke, with the sulfur eliminated therefrom. The operation is the same with non-sulfurous coals, except the omission of the desulfurizing salt. The operation is conducted under conditions by which it will be impossible to produce an excess of heat at one point over another that will consume the fixed carbon in the coal, and it will be understood that the amount of air employed at the top and bottom of the mass or charge of coal and the length of time the air can be safely supplied without injury to the coke is to be determined from the nature and property of the coal used, the amount of volatile matter therein, and the rapidity with which this volatile matter is evolved and expelled.

The supplying of a blast of air to penetrate throughout the lower portion or bottom of the mass or charge of coal and pass upward therethrough insures the evolving and expelling of the gases and volatile matter from the lower portion or bottom of the mass or charge to pass upward and commingle with the air admitted into the coking-chamber above the coal, increasing the combustion and producing a higher temperature for the coking operation, and where a high temperature is needed in addition to the air-supply at the bottom such temperature can be secured by admitting the highly-heated gases at the top of the coking-chamber into the eduction-flue H to pass into the sinuous or zigzag channel or passage in the oven-bottom and transmit heat to the bottom and the lower portion of the mass or charge of coal, likewise heating the air admitted into the supply-chamber, which adds to the rapidity of the operation in evolving and expelling the gases and volatile matter.

The feature of supplying air to penetrate throughout the bottom or lower portion of the mass or charge will increase the evolving and expelling of the gases and volatile matter from the entire mass or charge of coal, with the result of a higher and more rapid combustion and an increased heat, thereby reducing the period of time required for the coking operation. The desulfurizing of coal, which is accomplished readily and quickly by the oven, makes the resultant product a high grade of coke. The retarding of combustion by the admission of the highly-heated consumed gases prevents the carbon from being consumed and destroying the coke, and at the same time such retardation does not materially affect the rapidity and efficiency of the coking operation.

As an example of the working of the oven in daily practice in a given case take coal containing thirty-six per cent. of volatile matter. Six tons of this coal is charged in a finely-powdered condition through the trunnel-head, the mass of coal is leveled off and the door in front of the oven bricked and clayed, the coal is ignited, and when ignited the volatile matter will be thrown off very readily in large volume. Air is now blown into the oven-chamber through the perforated bottom and passes up through the mass or charge of coal, increasing the rapidity of evolution of the volatile matter, causing the oven to smoke excessively, emitting from the trunnel-head thick heavy volumes of volatile matter, which is evolved to pass out into the atmosphere. Air is now supplied through the four openings above the mass of coal in just sufficient quantity to prevent smoke and insure complete combustion inside the oven and above the mass of coal. When complete combustion has been secured, the trunnel-head is closed and the valve of the flue, which connects with the zigzag passage below the perforated bottom, is opened, allowing the consumed hot gases to escape from the top of the oven-chamber and travel down through the side flue and through and underneath the bottom of the oven, imparting heat to the bottom, and thereby increasing the evolution of the volatile matter in the coal. This increase in evolved gases requires proportionately more air to be supplied in order to maintain perfect combustion, and this additional air is supplied by gradually opening the air-valve which controls the admission of air through the four openings above the mass of coal. This increased combustion produces an increase of temperature, and as a consequence the volume of hot waste gases which travel under the bottom will be increased. Under these conditions the coking will proceed from above downward with great rapidity, so that at the expiration of about twenty hours, with coal of the character specified, the greater portion of the volatile matter is expelled, and when this step is reached it becomes necessary to dilute the air passing up through the mass of coal from the bottom, so as to prevent combustion of fixed carbon, and thereby reducing the yield of coke. This dilution of the air is easily accomplished by passing a portion of the consumed hot gases up through the bottom, mixing the same with the air at a junction-point just outside of the oven. As the volatile matter in the coal becomes less and less the air-valves, both top and bottom, are gradually closed, reducing the combustion until at the expiration of about thirty hours, with coal of the character named, practically all the volatile matter has been expelled, and when this condition is reached the air-valves are wholly closed, stopping combustion, and the coke allowed

to remain in the oven for some six hours longer to obtain fusion and regular cell structure, and at the end of this period of time the oven is drawn in the usual manner, after which the process is repeated. It will thus be seen that in thirty-six hours the total heat produced has been equal to the heat which would have been produced in seventy-two hours under the old process, by reason of the added heat from the consumed hot gases projected through the oven-bottom. The amount of air supplied varies with different kinds of coal, but depends in all cases upon prevention of smoke, or, in other words, obtaining a perfect combustion. The greater the volume of volatile matter expelled in a given time the greater the volume of air required to obtain perfect combustion. This is easily determined from the nature of the flame, which can be noted through the usual sight-hole in the oven-front. As an illustration, if twenty pounds of hydrocarbon are evolved in five minutes such evolving will require double the amount of air which is required by an oven evolving only twenty pounds in ten minutes, from which it is readily seen that the amount of air depends entirely upon the amount of volatile matter expelled.

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

1. In a coking-oven, the combination with the coking-chamber, of a series of air-discharging apertures or openings in the wall of the oven each aperture or opening having a lateral inclination tangential to the horizontal plane of the side wall of the oven for projecting air into the coking-chamber at a lateral angle and giving a circulation thereto circumferentially around and within the coking-chamber, substantially as described.

2. In a coking-oven, the combination with a coking-chamber, of a series of air-discharging apertures or openings located in the wall of the oven in the same horizontal plane in relation one to the other, a discharge pipe or nozzle entered into each aperture or opening and having a lateral inclination tangential to the horizontal plane of the side wall of the oven for projecting air into the coking-chamber at a lateral angle and giving a circulation thereto circumferentially around within the coking-chamber, and an air-supply pipe common to all the discharge pipes or nozzles for supplying air under pressure to the discharge pipes or nozzles, substantially as described.

3. In a coking-oven, the combination with the coking-chamber, of a bottom therefor, an air-supply chamber throughout the bottom, a flooring or covering for the air-supply chamber having perforations or slits therein gradually increasing in width from the point of admission to the side farthest removed from the admission of the air, for discharging air throughout the surface of the bottom of the oven in proportionate ratio of quantity and supply into the coking-chamber, substantially as described.

4. In a coking-oven, the combination with the coking-chamber, of a series of air-discharging apertures or openings in the wall of the oven, each aperture or opening having a lateral inclination for projecting air into the coking-chamber at an angle and giving a circulation thereto around and within the coking-chamber, a bottom for the coking-chamber, an air-supply chamber in the bottom, and a flooring or covering for the air-supply chamber having perforations or slits therein gradually increasing in width from the point of admission to the side farthest removed from the admission of air, substantially as described.

5. In a coking-oven, the combination with the coking-chamber, of a bottom therefor having heat imparted thereto from highly-heated gases drawn from the upper portion of the chamber and conducted through and in direct contact with the surface of the bottom, an air-supply chamber in the bottom, and a flooring or covering for the air-supply chamber, extending throughout the bottom and having perforations or slits therein for projecting air into the lower portion of the coking-chamber, substantially as described.

6. In a coking-oven, the combination with the coking-chamber, of an eduction-flue opening into the coking-chamber at the upper portion thereof, a bottom for the coking-chamber, a passage or channel extending throughout the bottom and having communication with the eduction-flue, an air-supply chamber throughout the bottom above the heat-conducting passage or channel, and a covering or flooring for the air-supply chamber extending throughout the surface of the bottom and having perforations or slits therein for supplying heat to the bottom and projecting air into the lower portion of the coking-chamber, substantially as described.

7. In a coking-oven, the combination with the coking-chamber of an eduction-flue opening into the coking-chamber at the upper portion thereof, a bottom for the coking-chamber, a sinuous or zigzag passage or channel extending throughout the bottom and having communication with the eduction-flue, an air-supply chamber in the bottom above the sinuous or zigzag passage or channel, and a covering or flooring for the air-supply chamber throughout the surface of the bottom and having perforations or slits therein for supplying heat to the bottom and projecting air into the lower portion of the coking-chamber, substantially as described.

8. In a coking-oven, the combination with the coking-chamber, of an eduction-flue opening into the coking-chamber at the upper portion thereof, a bottom for the coking-chamber, a sinuous or zigzag passage or channel extending throughout the bottom and having communication with the eduction-flue, an air-supply chamber in the bottom above

the sinuous or zigzag passage or channel, and a covering or flooring for the chamber throughout the surface of the bottom and having perforations or slits of a gradually-increasing width from the point of admission to the side farthest removed from the admission of air, for supplying heat to the bottom and projecting air into and throughout the surface of the lower portion of the coking-chamber, substantially as described.

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