Sept. 15, 1942. J. R. FELLOWS ET AL 2,295,781

DOWN DRAFT FURNACE

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FIG. 1.

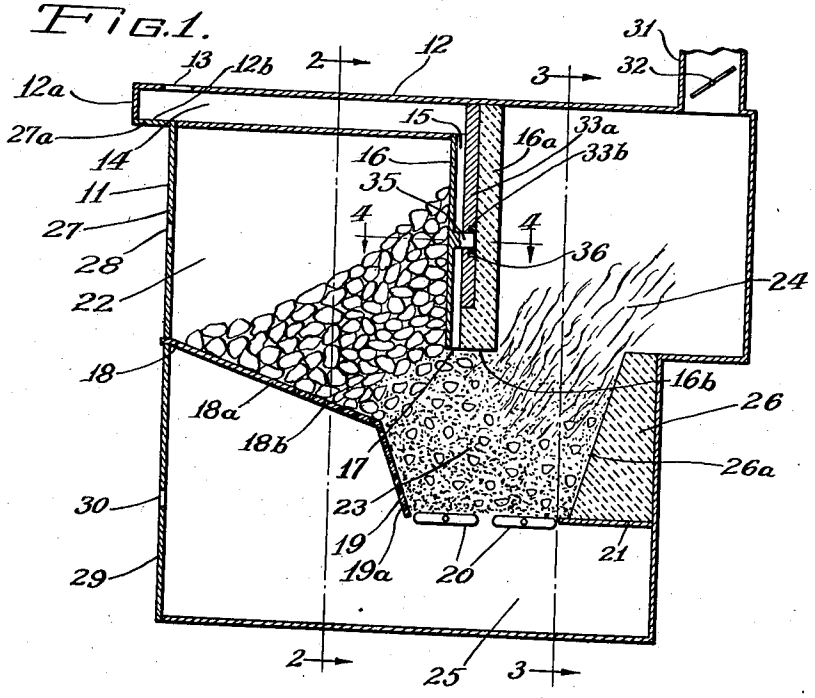


FIG. 2.

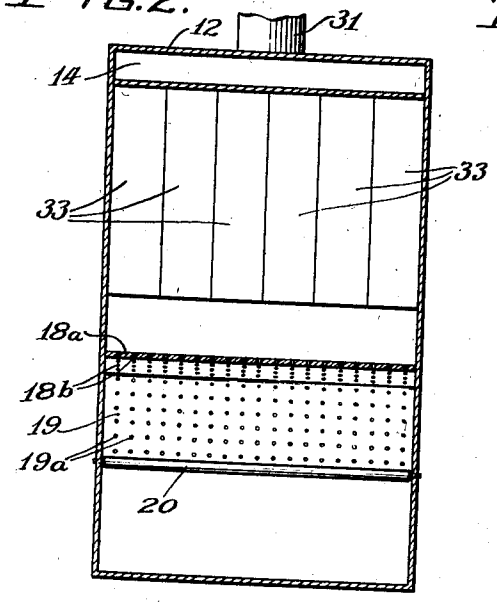
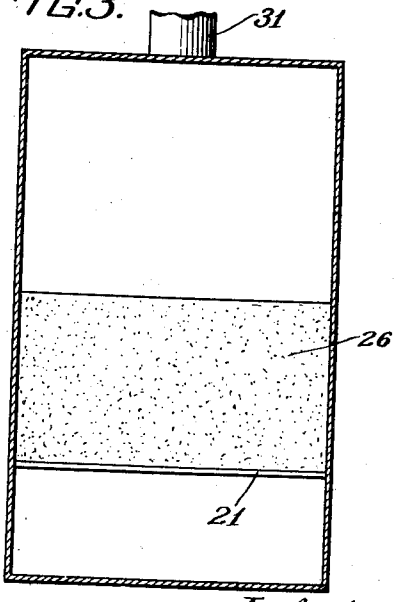


FIG. 3.



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Fig. 4.

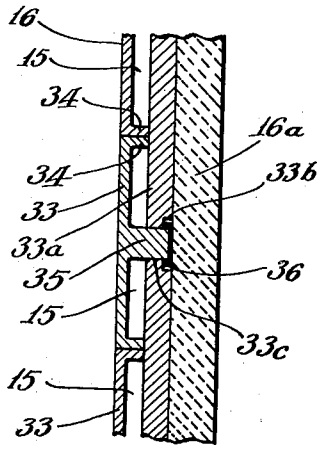


Fig. 5.

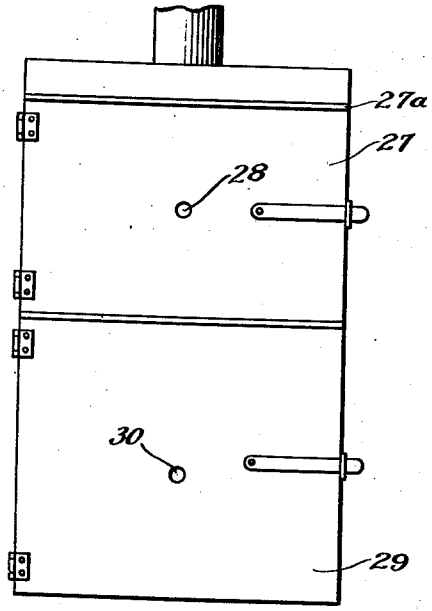


Fig. 6.

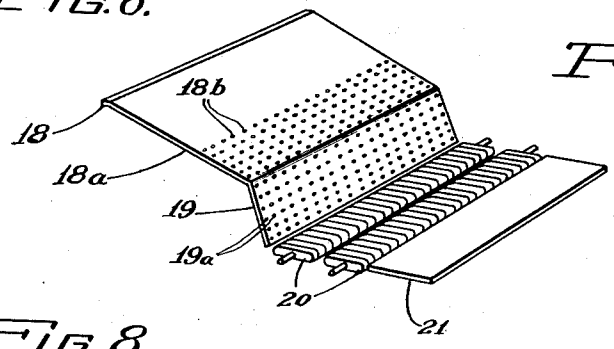


Fig. 7.

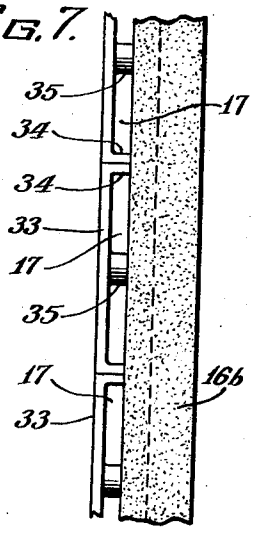


Fig. 8.

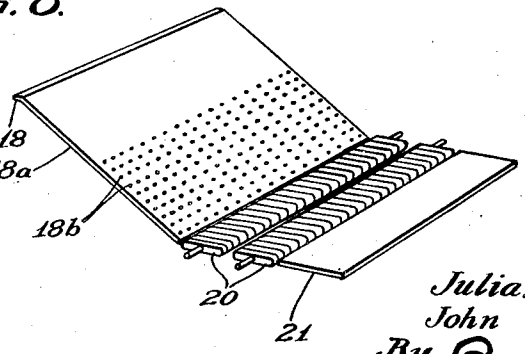
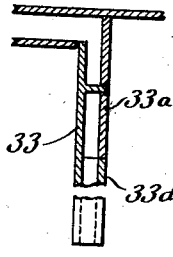


Fig. 9.



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UNITED STATES PATENT OFFICE

2,295,781

DOWNDRAFT FURNACE

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Application March 6, 1940, Serial No. 322,562

2 Claims. (Cl. 110—24)

This invention relates to down-draft furnaces, particularly to furnaces adapted to burn solid fuels, especialy bituminous coal and similar fuels, to the best advantage and without substantial smoke loss.

An object of this invention is to provide a down-draft furnace for burning bituminous coal and the like of such construction that the fresh or green coal is converted into coke by low temperature carbonization, the volatile matter distilling off and passing under a baffle wall and burned without substantial smoke, the temperature necessary for smokeless combustion being maintained from burning coke, and the oxygen and mixing essential to smokeless combustion being provided by an air stream entering adjacent or through said wall, and so arranged that when the furnace is recharged with fresh or green coal the coke may be forced down the inclined grate into a coke-burning chamber, the coke burning as a smokeless fuel while the new charge of coal is being coked.

It is highly desirable and it is also an object of this invention to provide in such a furnace for the supply of a proper amount of air for each of the three stages of combustion, preferably from an independent source or opening, with stack-damper control or other suitable draft regulation.

Another object of the invention is to provide a coking chamber with a double roof comprising an air passage for the introduction of secondary air.

A further object of the invention is to provide a novel type of baffle wall separating the upper part of the coking chamber from the upper part of the combustion chamber and so constructed as to form a conduit uniting with that in the roof of the coking chamber for conducting secondary air to that portion of the furnace below the baffle wall.

It is also an object of the invention to provide a grate or grates of such form and arrangement as to permit proper combustion of the fuel but less than enough for complete consumption of the fuel thereon during the period required to coke an entire charge of fresh fuel in the coking chamber.

Other objects and advantages of the invention will readily appear from the following description.

Referring to the drawings:

Figure 1 is a longitudinal sectional view of a portion of a furnace embodying our invention, diagrammatically shown;

Fig. 2 is a vertical sectional view, taken as indicated at line 2 of Fig. 1;

Fig. 3 is a vertical sectional view, taken as indicated at line 3 of Fig. 1;

Fig. 4 is a horizontal sectional view, taken as indicated at line 4 of Fig. 1;

Fig. 5 is a front view;

Fig. 6 is a perspective view of grate 18;

Fig. 7 is a view of the lower end of baffle wall 16;

Fig. 8 is a view of another form of grate.

Fig. 9 is a partial sectional view of a modified form of baffle wall.

In the preferred form illustrated in Figs. 1–7, inclusive, the down-draft furnace 11 comprises a roof 12 having an opening 13 in the upper, front central portion thereof and an air conduit 14 extending horizontally and rearwardly to approximately the mid-portion of said roof and there connecting with a downwardly extending air conduit or conduits 15 in depending, transversely extending baffle wall 16 having an opening or openings 17 in its lower end, and refractory portion 16a, the lower end 16b thereof serving as an ignition surface. Suitably supported in said furnace is a grate 18 having an inclined front portion 18a, a second inclined portion 19 rearwardly of said first inclined portion, shaker-grate portions 20 and flat, rear portion 21, said rear portion supporting a transversely extending, refractory stop 26 having a face 26a, preferably inclined and positioned adjacent and to the rear of the shaker-grate portions 20; said grate, said baffle wall and said stop being so proportioned and disposed as substantially to divide said furnace into four compartments or chambers, namely, a coking chamber 22, a coke-burning chamber 23, a gas-combustion chamber 24, and an ash receiver 25, so proportioned with respect to each other and to the grate area as to conduce to substantially uniform and smokeless consumption of the fuel when air is admitted in suitable proportions.

The inclination of the portion 18a of said grate may be of any suitable angle but is preferably of such angle that the coking coal may be conveniently forced downwardly when the coking has sufficiently progressed and green fuel is added. We have obtained good results with an angle of approximately 20° from the horizontal. The inclination of the portion 19 of the grate is preferably sharper, of the order of 45° to 60° from the horizontal, so as to provide a chamber or pit 23 beneath the baffle wall 16 for the burning of the coke formed in the coking chamber 22, and the provision of a substantially continuous source of

heat suitable for igniting the green fuel in chamber 22 and the heating of the ignition surface 16b.

Baffle wall 16 consists of channel plates 33 supported by an intermediate plate 33a. Plates 33 have rearwardly extending flanged portions 34 and a suitably disposed anchoring portion 35 extending through an opening 33c provided in said intermediate plate 33a and secured thereto by welding a head 36 on the end of said anchoring portion in position as indicated in Figs. 1 and 4, the rear of said intermediate plate 33a having suitably disposed indented portions 33b to seat the heads 36. The plates 33 are preferably of special heat resisting material capable of withstanding a temperature of at least 1800° F. We have obtained satisfactory results with plates of 28% chromium and 8% nickel cast iron. A heat resisting alloy also is used in welding the head 36. The plates 33 may be of any suitable dimensions. We have obtained good results using plates of the material mentioned approximately 3" wide and ¼" thick, spaced a suitable distance, approximately 1/16" in the example referred to, to allow for expansion.

Supporting plate 33a may be of any suitable material such as ⅝" locomotive firebox steel. The plate 33a is of the same width as the furnace but is preferably of substantially less depth than the baffle wall to avoid exposing its lower portion to intense heat. Plate 33a may be secured in any suitable manner, by screws, welding, or otherwise, to the sides or roof of the furnace.

The baffle wall may be supplemented by a refractory block or blocks 16a, which has a cutaway portion adapted to fit against the rear of plate 33a and beneath its lower portion as shown in Fig. 1. The block 16a may be of any suitable thickness. We have had satisfactory results with a block having a thickness of 3" at its lower end and 2⅜" at the narrower upper portion. Block 16a may be secured to plate 33a by bolts, screws or other suitable means, or may be supported from the roof or side walls of the furnace and merely abut against plate 33a. As previously stated, the lower refractory portion 16b of the baffle wall serves as an ignition arch, facilitating the combustion of the gases given off by the fuel.

When the plates 33 are not supplemented by a refractory block they are preferably of the form shown in Fig. 9, the part 33d being disposed beneath the bottom of the supporting plate 33a.

The refractory stop 26 serves to block the coke pushed down from the coking chamber and to form one side of the coke-burning chamber; its forward surface 26a, especially the upper portion thereof, also serves as a supplemental ignition surface for mixing and igniting the gas and air passing over it in a manner similar to the lower portion 16b of the refractory surface of the baffle wall 16. While it is preferable to use it, stop 26 may be omitted.

The roof 12 may be so formed as to provide a hood 12a over the door 27, said hood having a laterally extending opening 12b in its underside communicating with air passage 14 and adapted to admit smoke that may be emitted upon opening the door 27; said door 27 having an outwardly extending horizontal flange 27a across its upper edge adapted to close the opening 12b when the door is closed.

Air is admitted to the furnace through opening 28 in door 27 and opening 30 in door 29 provided in the front thereof and opening 13 previously referred to in such quantities as may be needed. These openings may be adjustable for various fuels but the adjustment having been determined for a given fuel it should remain unchanged to provide for the admission of relatively fixed quantities of air; whatever regulation is required being provided by damper 32 in stack 31 or other suitable draft regulating means.

The opening 28 is of such size and shape and so placed as to admit sufficient air to the coking chamber for coking the coal at a suitable rate but small enough to prevent excessive combustion of coke in the coking chamber and thus avoid overheating of the materials in the baffle wall. The opening 30 and the openings or perforations in the grates are of such configuration as to admit a quantity of air sufficient for maintaining an ignition temperature in the coke thereon at all times but insufficient for complete burning out of the coke on the grate during the period required fully to coke a charge of coal in the coking chamber. The opening 13, the conduit 14—15 and openings 17 thereof are of such form and proportions as to provide a stream of air suitable for substantially complete combustion of the gases passing beneath the baffle wall and into the gas combustion chamber. As shown the opening 13 is a round hole similar to openings 28 and 30, while the configuration of openings 17 is indicated in Fig. 7. The advantages of such an arrangement is readily apparent. Especially advantageous is the correct proportioning of the quantities of air admitted to the three stages or phases of combustion, namely, primary air to the coking chamber, primary air beneath the grate to facilitate the burning of the coke, and secondary air to mix with the combustible gases beneath the baffle wall and facilitate their further combustion; all being more or less directly related to the configuration of the several chambers and the grate and contributing to the substantially uniform and smokeless consumption of the fuel.

The rate of combustion is controlled by regulation of the draft (usually by means of a check door in the smoke pipe or stack). With such an arrangement it is possible, by proper apportionment of air, to time the several phases of combustion so that, for example, the coke-burning period will be approximately the same as the coking period, or longer, if desired.

By way of example, the specifications of a furnace according to our invention may be substantially as follows: Given a heat demand of 100,000 B. t. u. per hour and a fuel having a heating value of 10,000 B. t. u. per pound, and a minimum firing period of 4 hours, the volume of the coking chamber 22 should be such as to accommodate 40 pounds of green coal, taking into account the slope of the coal when piled into the coking chamber and the waste space resulting, or approximately 2 cubic feet; the volume of the coke-burning chamber 23 would be approximately 1 cubic foot; the volume of the combustion chamber 24, depending on the design and arrangement of the heating surface, would be not less than approximately 2 cubic feet. For combustion of such a charge of fuel, using Illinois bituminous coal, to the best advantage and without substantial smoke loss the openings for the admission of air to the furnace should be approximately as follows: opening 13, one and three-quarters inches in diameter; 28 and 30, each one inch in diameter. Draft available should be approximately 0.12" of water. Openings 18b and 19a in inclined portions 18a and 19 of grate 18 may be of the order of ⅛" diameter on 1" cen-

ters, the area of each such portion being approximately 0.5 square foot; shaker portions 20 may be of conventional construction of approximately 0.7 square foot total area and approximately 50% free area. In such a furnace the baffle wall 16 may have a depth of approximately 14" and its lower end may be spaced about 6" from the nearest point of the inclined portion of the grate and approximately 12" from and preferably directly above the front portion of the horizontal shaker grate portion 20.

Instead of the arrangement of grates shown in Fig. 6, an arrangement such as that shown in Fig. 8, in which the forward grate has a single inclined portion may be employed. The openings 18b and 19a of grate portions 19a and 19 may be omitted, in which case the free area in the grate 20 should be enlarged accordingly.

While not shown in the drawings, the side walls of the furnace would ordinarily be suitably lined with refractory material from the level of the grate to a height approximately even with the lower end of the baffle wall 16.

We have used the words coke and coking in describing our invention, not in the limited sense of the terms as applied to the commodity known as coke or making or forming that commodity strictly but in the sense of the product resulting when heat is applied to solid fuel and the volatile matter driven off therefrom, and the process of making or forming such product.

Our invention is to be understood as residing in the method of controlling the combustion of fuel as herein set forth as well as in the combination, construction and arrangement of parts illustrated in the accompanying drawings, and while we have shown therein a preferred embodiment we wish it further understood that the same is susceptible of modification and change without departing from the spirit of our invention.

Having now described our invention, we claim:

1. A down-draft furnace comprising a coking chamber having an inclined forward grate, means for supplying air to the upper portion of said coking chamber, a coke-burning chamber, a combustion chamber, a baffle wall between said coking chamber and said combustion chamber, the lower portion of said baffle wall forming an ignition surface above the forward portion of said coke-burning chamber, a vertically extending conduit through said baffle wall having an outlet in the lower portion thereof for introducing secondary air into said furnace downwardly near the forward portion of said coke-burning chamber to mix with and facilitate the combustion of gases emanating primarily from said coking chamber and secondarily from said coke-burning chamber, said coke-burning chamber being disposed adjacent to the lower portion of said coking chamber so that coke burning in said coke-burning chamber will provided an ignition surface for gases emanating from the coking chamber, and means for admitting air into said furnace beneath the coke-burning chamber so as to pass upwardly into the bed of coke burning therein, the parts having such relative dimensions and being so arranged as to enable the flow of air to the coking chamber and to and beneath the coke-burning chamber in predetermined proportions and to provide regulable, progressive, substantially smokeless combustion of successive charges of fuel, proceeding sequentially through the coking of one charge concurrently with the burning of coke derived from a preceding charge.

2. A down-draft furnace as set forth in claim 1, in which the outlet of the secondary air conduit is disposed above the rearward portion of the inclined forward grate, the conformation of the structure being such as to provide a stricture between the lower portion of the coking chamber and the adjacent portion of the coke-burning chamber whereby the fuel charge is retained in the coking chamber until coke burning in the coke-burning chamber is substantially consumed, and the coking of the fuel in the coking chamber progresses regulably, forwardly and upwardly from said stricture.

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