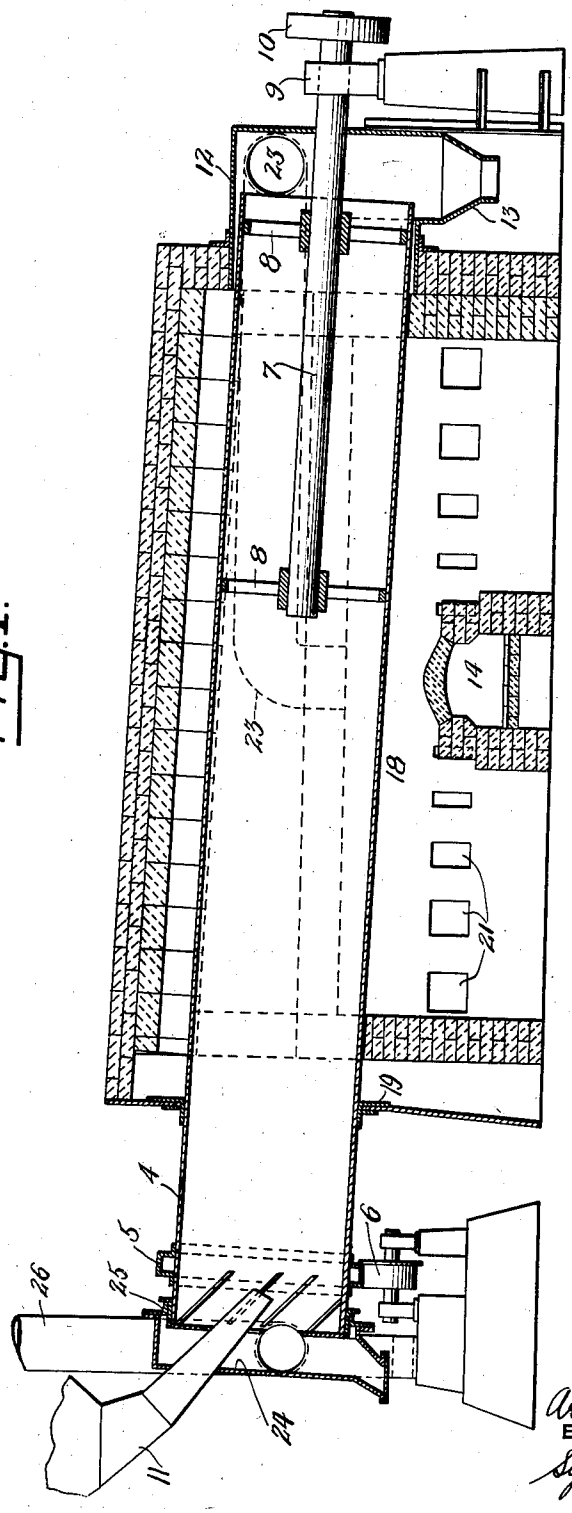
May 6, 1941. A. G. BUCK 2,240,757

APPARATUS FOR HEAT TREATING COAL

Filed March 2, 1937 3 Sheets-Sheet 1

Fig. 1.



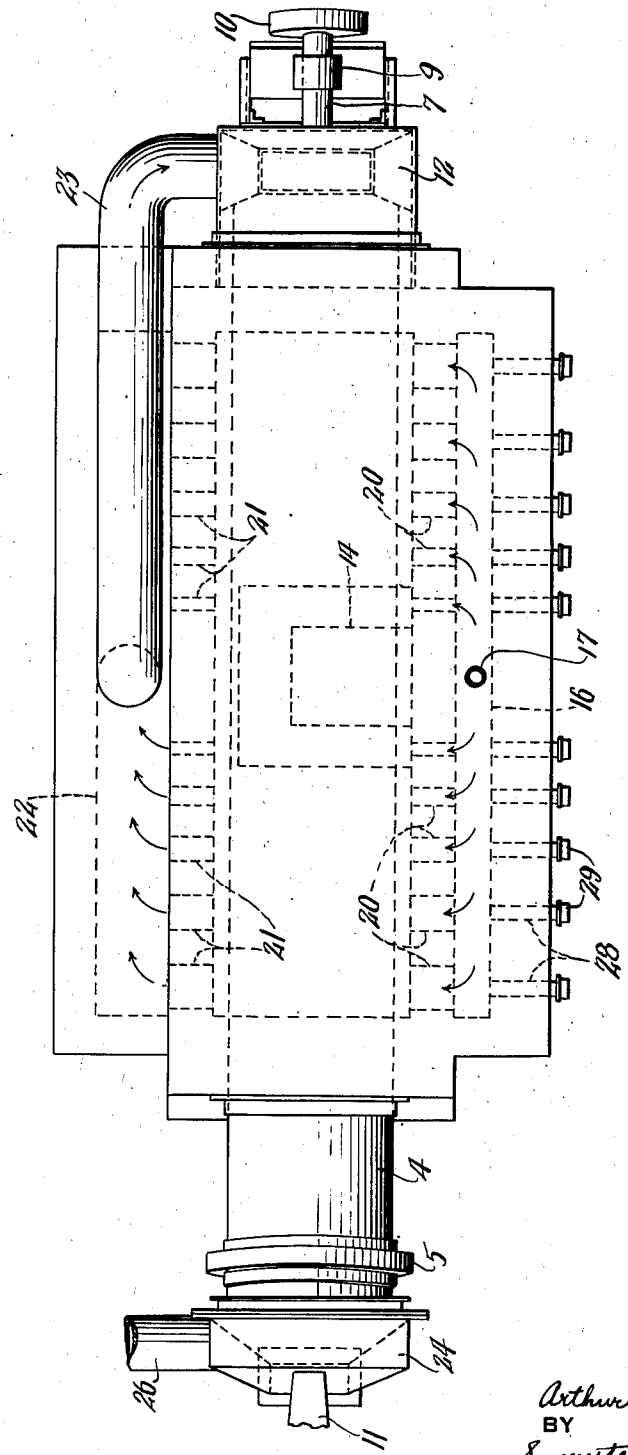
INVENTOR
Arthur Glasgow Buck
BY
Symmetwell & Lechner
ATTORNEYS

May 6, 1941. A. G. BUCK 2,240,757

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Fig. 2.



INVENTOR
Arthur Glasgow Buck
BY
Symmestvedt & Lechner
ATTORNEYS

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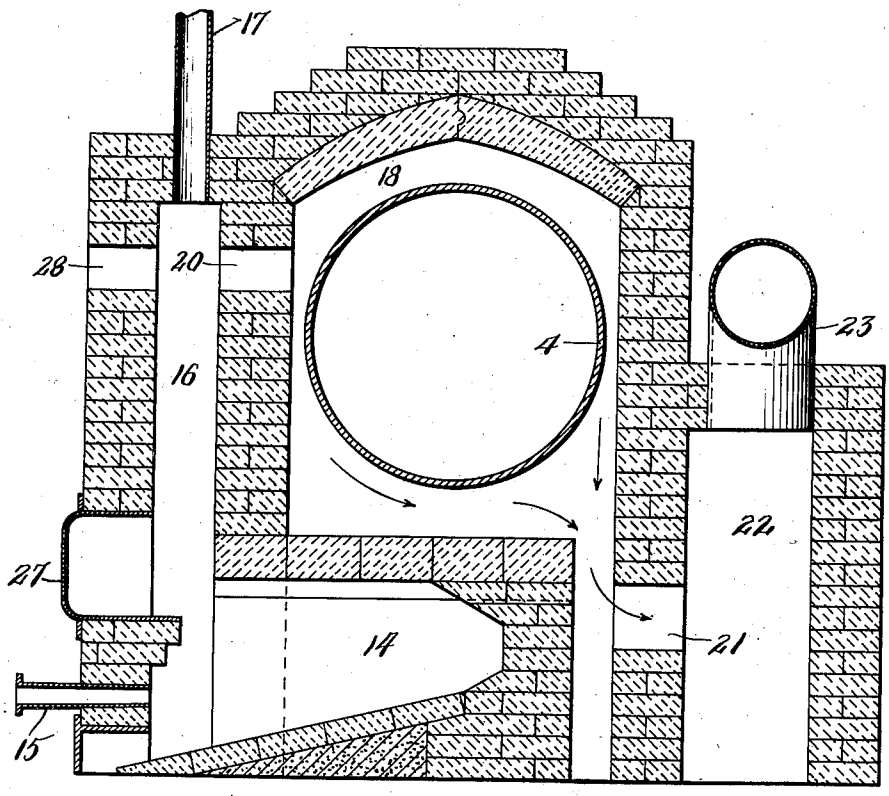


Fig. 3.

INVENTOR
Arthur Glasgow Buck
BY
Symmetwedt & Lechner
ATTORNEYS

Patented May 6, 1941 2,240,757

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2,240,757

APPARATUS FOR HEAT TREATING COAL

Arthur Glasgow Buck, Somerville, N. J., assignor to Charles M. Buck, Brooklyn, N. Y.

Application March 2, 1937, Serial No. 128,579

7 Claims. (Cl. 202—137)

This invention relates to an improved apparatus for heat treating coal, and while many features of the invention are of use in connection with heat treatment of coal throughout a wide range of temperatures, the invention is especially advantageous in the heat treatment of coal at a temperature approximating the temperature of thermal decomposition of the coal under treatment.

One of the important objects which the invention has in view is to provide for improved heat treatment of coal such as to enable accurate subjection of the coal to a temperature of the desired value, thus avoiding the detrimental effects of over-heating and the inefficient results of under-heating.

The invention also has in view making possible the treatment of coal, for example in crushed or granulated form, in a manner to ensure a temperature rise throughout the entire body of each piece of coal to the temperature value desired, whereby to avoid mere surface heating of the particles or pieces which, in accordance with prior practice, frequently involves an undesired rise in temperature at the surface of the pieces and a temperature interiorly of the pieces lower than it should be.

As already indicated, the invention, and more especially the features thereof mentioned above, is especially useful in the treatment of coal at a temperature approximating the point of thermal decomposition, i. e. that point at which exothermic reactions begin to take place. This point, of course, varies with different types of coal. For example, the thermal decomposition point for lignite is in the neighborhood of about 400° F.; for some bituminous coals in the neighborhood of 480° F.; and for anthracite about 750° F. For any particular coal the point of thermal decomposition may be determined by tests now well known.

A number of changes of an endothermic character take place in coal when heat treated at temperatures ranging downwardly from the point of thermal decomposition, and more particularly in a range close to but just below that point.

For various reasons, some of which are disclosed in Buck Patent 1,925,132, issued September 5, 1933, it is of substantial advantage to subject coal to a temperature approximating but just below the point of thermal decomposition, prior to the time the coal is either pulverized or burnt. To effectively and fully bring about the reactions of the endothermic type mentioned above, it is desirable to raise the temperature of the coal to a point very close to the point of thermal decomposition and maintain that temperature for an interval providing time for the reactions to take place. In achieving the desired end, it is also of importance to ensure heating of the coal uniformly throughout its mass, and not merely at the surface of the particles.

The present invention provides a method and apparatus for accomplishing this critical and accurate type of heat treatment. Thus the invention is of especial use in the heat treatment of coal up to a temperature approximating its point of thermal decomposition, although the invention is also of advantage for heat treatment at lower temperatures, for example for drying purposes.

In the treatment of coal in accordance with this invention to a temperature approximating its point of thermal decomposition, certain occluded gases are liberated, and the invention provides, in effect, for the substitution of inert and non-flammable gases for those which are liberated, the liberated ones ordinarily being in large part flammable or even explosive.

How the foregoing, together with other objects and advantages are attained, will be apparent from a consideration of the following description, referring to the accompanying drawings, in which—

Figure 1 is a vertical longitudinal sectional view of coal treating apparatus constructed in accordance with this invention and suitable for carrying out the method of the invention;

Figure 2 is a top plan view of the equipment of Figure 1; and

Figure 3 is a transverse sectional view, on an enlarged scale, of the equipment shown in Figures 1 and 2.

In general, the equipment includes a rotating drum to which the coal is fed, and a surrounding heating chamber for applying heat to the drum wall. The drum is shown at **4**, one end of which is provided with a circumferential track **5** adapted to ride on wheels **6**, and the other end of which is equipped with a central shaft **7** mounted as by spiders **8**, the shaft being journalled as at **9** and provided with a driving pulley **10** or equivalent device.

One end of the drum (the left end when viewed as in Figure 1) is raised above the other end so that upon rotation of the drum, the coal is caused to move longitudinally therethrough. At the upper end, a feed chute **11** serves to deliver coal, preferably in crushed form, into the drum, and at the delivery end a casing **12** is ar-

ranged, providing a discharge chamber having an outlet spout 13.

The heating means for the drum includes a furnace chamber 14 fed by the fuel admission means 15, in which chamber the fuel is burned to produce a heating gas which passes from the chamber 14 proper into the inlet distribution chamber 16. As seen in Figure 2, this chamber 16 is extended lengthwise throughout an appreciable length of the drum. A flue or off-take 17 may be provided at the top of chamber 16.

Chamber 16, and also the remaining chambers hereinafter described, as well as the furnace chamber 14, are all preferably formed by built-up refractory walls, many details of which need not be considered herein since they form no part of the present invention per se. In the brickwork, a heating chamber 18 is provided around the drum 4, this chamber having its walls spaced from the drum walls on all sides thereof, and being substantially closed toward the inlet end of the drum, as by the sealing ring 19 (at the left in Figure 1) so as to avoid escape of any substantial quantity of gas from the heating chamber. The seal of chamber 18 around the other end of the drum need not be as complete, since leakage of gas at this point would result in inflow thereof into the interior of the drum, to which the heating gas is ultimately delivered, as more fully brought out herebelow.

The heating gas flows through ports 20 from the inlet distribution chamber into the heating chamber 18 around the drum, and it is especially to be noted that these ports are located adjacent the top of the heating chamber, and further that the ports (see Figure 2) are graduated in size from the ends of the heating chamber toward the middle, the ports of larger cross-sectional area being located adjacent said ends.

Heating gas is withdrawn from the heating chamber through the outlet ports 21 which communicate with the heating chamber in a lower portion thereof, preferably below the drum, and deliver into an outlet collecting chamber 22 which, as seen in Figure 2, is also extended lengthwise of the drum throughout a substantial portion of its length. The ports 21 are also graduated in size in a manner similar to the inlet ports 20.

Withdrawal of gases from the outlet collecting chamber 22 is effected by means of a conduit 23 which communicates with this chamber at a point approximately midway of its length and which is extended to deliver the discharged gas to the casing 12 to flow therefrom through the interior of the drum 4. At the coal feeding end, the drum is also provided with a casing 24 forming a gas receiving chamber having a seal 25 around the drum, and further provided with an outlet or stack 26.

A removable element 27 serves as a closure for a clean-out opening adjacent to the combustion chamber 14. Clean-out openings 28 are also preferably provided in the front wall of the brickwork in alignment with the apertures 20 and 21 (see Figure 2), these openings being provided with removable closures 29.

In operation, fuel is preferably burned in the combustion chamber 14 to produce an inert gas, which gas is delivered to distribution chamber 16 from which it flows through inlet ports 20 into the upper portion of the heating chamber. The gases then flow around the drum in contact with the surface thereof, and thence downwardly and out through the outlet ports 21 into the outlet collecting chamber 22. From here the gases are withdrawn through conduit 23 and delivered to the coal delivery end of the drum 4, and finally, after passing the drum, the gases pass out the stack 26.

Several important features of the foregoing should be noted. In the first place, it will be observed that the inlet and outlet ports are located substantially opposite to each other diametrically of the drum and are distributed throughout an extended length of the chambers associated with the drum, whereby to distribute the gas around both sides of the drum and also lengthwise thereof in spite of the fact that the source of supply of inert heating gas is in communication with the distribution chamber 16 only in the central region thereof. While the distribution may be accomplished by the use of inlet ports or portage of a variety of types, I prefer to employ graduated ports, with those of largest cross-sectional area positioned adjacent the ends of the chamber and diminishing in size as the center is approached.

Similarly, the outlet ports 21 are arranged to aid in maintaining the distribution of the flow of gases over different portions of the drum lengthwise thereof. To accomplish this, these outlet ports are also graduated in size, and because of the provision of inlet and outlet ports of the character mentioned, withdrawing of gases, as by means of draft action or the like, through conduit 23, results in substantially uniform flow of gases over the drum throughout the length thereof.

In addition, while the supply of gas to the inlet distribution chamber 16, and the exhaust from the chamber 22 may be effected toward either or both ends of these chambers (in which case a different graduation of ports would be employed), I prefer to employ the central location illustrated since this latter provides the most effective gas distribution.

A still more important advantage flows from the use of inlet ports above or adjacent the top of the drum and outlet ports below or adjacent the bottom of the drum. During feed of coal through the drum, this coal, of course, is tumbled as it progresses from the inlet end to the delivery end, and during the tumbling action the pieces of coal are periodically brought into contact with the drum surface and then thrown out of such contact. The surface contact of the coal with the drum wall takes place only in a lower portion of the drum and a little up one side, depending upon the direction of rotation. The heat transfer from the drum wall to the coal, being by conduction, is relatively rapid in its effect. For this reason the present invention provides for the contacting of the heating gases first with the upper portion of the drum (with which the coal is not in contact) and serially thereafter with the lower portion of the drum surface (in the region in which the coal comes in contact with the drum wall). Tests show that a temperature drop of from about 800° F. to about 500° F. takes place from the time the gases contact with the drum in the upper portion thereof to the time the gases reach the lower portion of the drum wall. This is of substantial advantage in avoiding over-heating at the times when the coal particles come in direct contact with the drum wall.

Upon withdrawal of the gases through the discharge conduit 23, their temperature is still further reduced so that at the time of admission into the interior of the drum, such gases may

have a temperature in the neighborhood of about 450° F. The arrangement is of advantage also in providing for flow of the discharged gases through the drum, the advantages, in general, being two-fold—first, heating of the coal by convection, and second, the surrounding of the coal particles with a substantially inert atmosphere, which latter is important in replacing the formerly occluded gases which are being liberated by the treatment. The inert atmosphere further insures against initiation of exothermic combustion, even though the temperature of the coal is being carried up to a point very close to the point of thermal decomposition.

Although temperature figures are mentioned above, it should be noted that they are given only by way of example, since different coals and different treatments would require other temperatures.

From the foregoing it will be seen that very accurate control of the heat treatment of coal is provided in accordance with this invention. The method of applying the heat to the coal is applicable to treatment of the coal for various purposes, as for instance for the purpose of replacing occluded gases by inert gas or for drying purposes, and thus the equipment is useful over a wide range of treatments. The degree of control, and the uniformity of heating throughout the mass of the individual pieces of the coal treated, is of especial importance where the treatment involves carrying the temperature of the coal up to a point close to the point where active reactions commence.

The distribution of the gas inlet and gas outlet openings lengthwise of the heating chamber, and the graduation in size of these openings, is of importance not only to provide for gas distribution lengthwise of the drum, but also in avoiding the over-heating which would occur in the central region of the drum, were the inlet area concentrated in the central region.

Finally, it may be noted that the passing of the inert gas lengthwise through the drum (especially in a direction opposite to the movement of the coal therein) is of importance in setting up a novel type of heat transfer to the coal under treatment. It will be noted that heat is transferred from the gases surrounding the drum to the drum wall. From the drum wall (interiorly thereof) heat transfer takes place to the inert gas flowing through the drum, and, in turn, this heat is given up to the coal. This system of heat transfer provides maximum uniformity of temperature in the coal being treated.

I claim:

1. Coal treating equipment including a rotatable drum adapted to the feed of coal therethrough, and mechanism for heat treating the coal fed through the drum including a chamber surrounding the drum, a source of supply of a heating gas, an inlet manifold at one side of one chamber, an outlet manifold at another side of said chamber, inlet means in an upper portion of the chamber for delivering gas from the inlet manifold to the chamber, and outlet means for discharging gas from a lower portion of said chamber, generally diametrically opposite the inlet means into the outlet manifold, the inlet and outlet means being distributed lengthwise of the drum throughout an extended length thereof.

2. Coal treating equipment including a rotatable drum adapted to the feed of coal therethrough, and mechanism for heat treating the coal fed through the drum including a source of supply of a heating gas, a heating chamber surrounding the drum, an inlet distribution chamber and an outlet collecting chamber, all of said chambers being extended throughout a major portion of the length of the drum, means delivering gas from said source to the inlet chamber at a point intermediate the ends thereof, gas inlet ports interconnecting the inlet chamber and an upper portion of the heating chamber and distributed lengthwise of said chambers throughout an appreciable length thereof, gas outlet ports generally diametrically opposite the inlet ports and interconnecting a lower portion of the heating chamber and the outlet chamber and distributed lengthwise of said chambers throughout an appreciable length thereof, and an exhaust conduit for discharging the gases from the outlet chamber, the exhaust conduit being connected with the outlet chamber at a point intermediate the ends thereof.

3. Coal treating equipment including a rotatable drum adapted to the feed of coal therethrough, and mechanism for heat treating the coal fed through the drum including a source of supply of a heating gas, a heating chamber surrounding the drum, an inlet distribution chamber and an outlet collecting chamber, all of said chambers being extended throughout a major portion of the length of the drum, means delivering gas from said source to the inlet chamber at a point intermediate the ends thereof, gas inlet ports interconnecting the inlet chamber and the heating chamber and distributed lengthwise of said chambers throughout an appreciable length thereof, gas outlet ports interconnecting the heating chamber and the outlet chamber and distributed lengthwise of said chambers throughout an appreciable length thereof, and an exhaust conduit for discharging the gases from the outlet chamber, the exhaust conduit being connected with the outlet chamber at a point intermediate the ends thereof, the gas inlet ports being of greater cross-sectional area adjacent the ends of the chambers than toward the central region thereof.

4. Coal treating equipment including a rotatable drum adapted to the feed of coal therethrough, and mechanism for heat treating the coal fed through the drum including a source of supply of a heating gas, a heating chamber surrounding the drum, an inlet distribution chamber, both of said chambers being extended throughout a major portion of the length of the drum, means delivering gas from said source to the inlet chamber at a point intermediate the ends thereof, gas inlet ports interconnecting the inlet chamber and the heating chamber and distributed lengthwise of said chambers throughout an appreciable length thereof, and means for withdrawing gases from the heating chamber, the said inlet ports being of graduated size from each end toward the central region of the chambers, with the larger ports disposed toward the ends of the chambers.

5. Coal treating equipment including a rotatable drum adapted to the feed of coal therethrough, and mechanism for heat treating the coal fed through the drum including a source of supply of a heating gas, a heating chamber surrounding the drum, an inlet distribution chamber, both of said chambers being extended throughout a major portion of the length of the drum, means delivering gas from said source to the inlet chamber at a point intermediate the ends thereof, gas inlet ports interconnecting the

inlet chamber and the heating chamber in an upper region of the latter and distributed lengthwise of said chambers throughout an appreciable length thereof, and means for withdrawing gases from a lower portion of the heating chamber, the said inlet ports being of graduated size from each end toward the central region of the chambers, with the larger ports disposed toward the ends of the chambers.

6. Equipment for heat treating coal including an elongated drum rotatively mounted to provide for continuous feed of coal therethrough along the bottom of the drum, and means for applying heat to the exterior surface of the drum including a chamber surrounding the drum throughout an extended length thereof, and means for circulating a heating gas through the chamber in a direction from the upper portion of the chamber to the generally diametrically opposite lower portion thereof, the path of gas flow being substantially parallel to a plane perpendicular to the axis of the drum substantially throughout the length of the heating chamber, to provide contact of the surface of the drum at the top with the heating gas at a higher temperature than at the bottom at all points cross sectionally of the drum throughout the length of the heating chamber.

7. Equipment for heat treating coal including a rotatively mounted drum through which coal is adapted to be fed lengthwise thereof for treatment, a heating chamber surrounding said drum, inlet and outlet ports providing for circulating a heating medium through the chamber around the drum in a path generally transverse the axis of the drum throughout an extended length thereof and in a direction from the upper side of the drum to the lower side thereof, the outlet ports being offset to one side of the longitudinal vertical mid plane of the drum, and the direction of drum rotation being such as to tumble the coal up in the drum at said side of said plane.

ARTHUR GLASGOW BUCK.