Feb. 23, 1932. L. I. YEOMANS 1,846,982

METHOD OF CONVERTING COAL

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Fig. 1

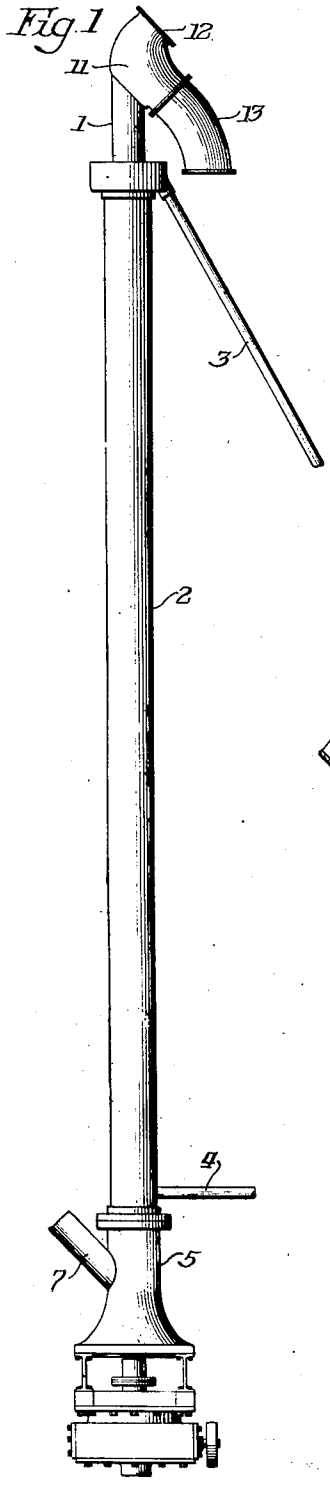
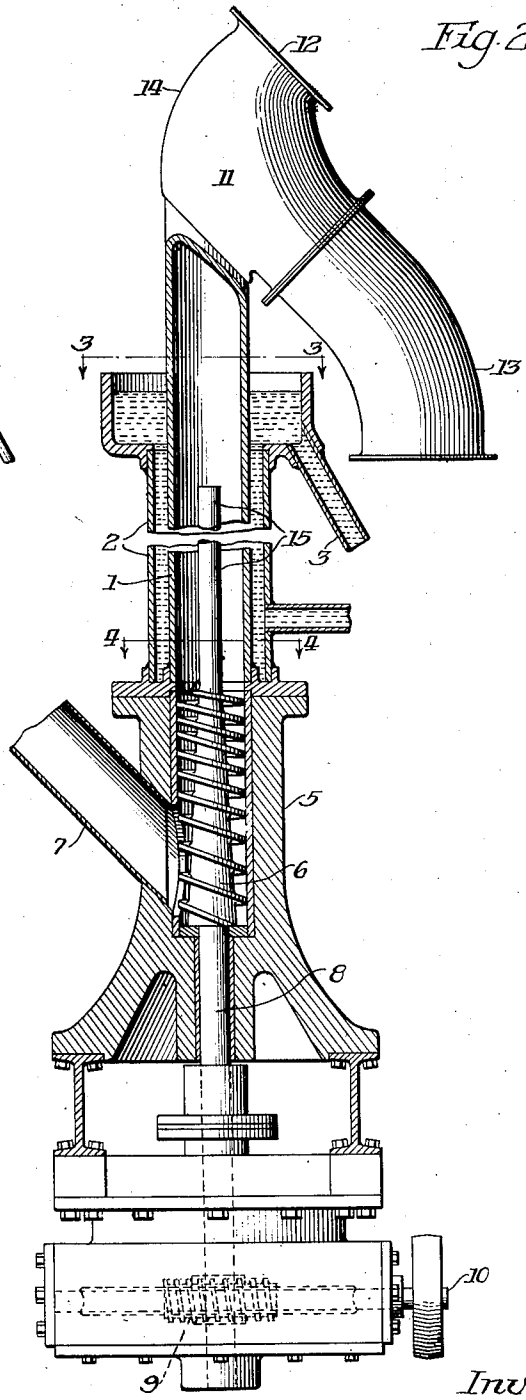


Fig. 2



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Fig. 3.

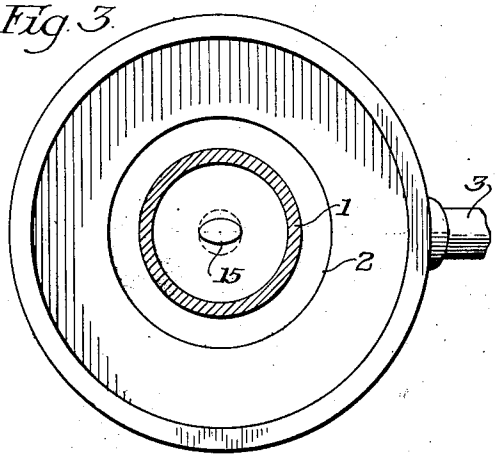


Fig. 4.

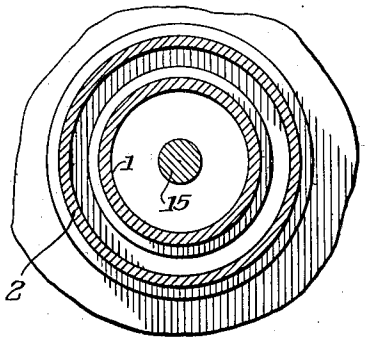


Fig. 5.

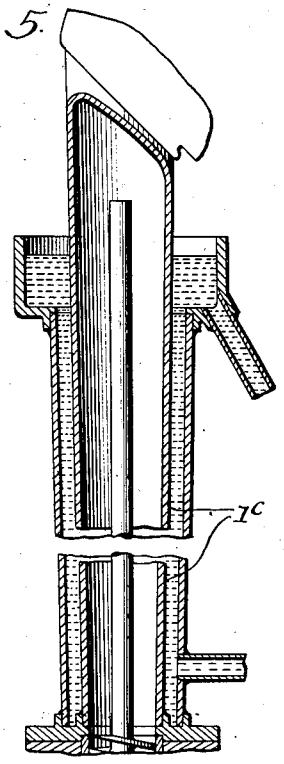
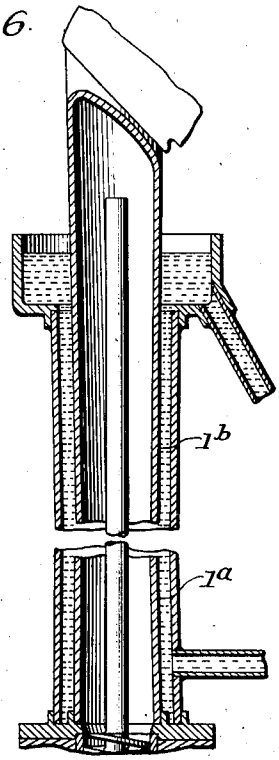


Fig. 6.



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UNITED STATES PATENT OFFICE

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METHOD OF CONVERTING COAL

Application filed March 23, 1927. Serial No. 177,562.

It is probable that grades of bituminous coal which are particularly distinguished by a low volatile content and high fixed carbon, such as Pocahontas, were formed in nature from high volatile coal by suitable conditions of slight pressure, moderate temperature and undisturbed conditions during ensuing exothermic reactions; and I have found that coal of high volatile content can be converted into coal of comparatively low volatile by simulating the conditions above noted.

The commercial value of such conversion is evident. Large quantities of readily gasified constituents cause coals of that nature to burn with resultant smoke, except under extremely favorable conditions, and it is usual to pay considerably higher prices for coal of lower volatile content which may be fired more or less carelessly in ordinary furnaces without a resultant smoke nuisance.

It is common practice to convert such coals into coke by driving off the volatile constituents in whole or in large part by the application of high temperatures, leaving a resultant product composed largely of fixed carbon and ash. It has also been proposed, by the application of lower temperatures, to produce what is sometimes called low-temperature coke, in the resultant of which processes some part of the volatile is still retained. Low-temperature processes, however, have not been commercially successful on any large scale, due to a failure to observe the essentials for the conversion of a coal of high volatile into a low-volatile product partaking of the characteristics of coal rather than simulating those of coke.

The essentials necessary for the conversion of high volatile coal into low volatile coal are as follows:

1. Heat must be applied throughout a mass of the coal to be treated until a condition of semi-fluidity is reached, but the ignition point of the coal must not be attained. In the treatment of certain Illinois coals, for example, the mass should be heated to 390° C.

2. After the mass of coal has reached this temperature, exothermic reactions occur, gases and vapors being liberated. During this period the mass must be relatively quiescent, in order to avoid crumbling of the char, and a slight pressure must be maintained upon the mass to minimize the production of pores in the char, and thus insure a product having a density approximately that of coal.

3. Ample opportunity for the free escape of volatile constituents must be provided, before the coal mass becomes semi-fluid, during that stage, and afterward, all with the least restriction and necessity for travel of gases through the mass.

The object of the present invention is to provide a method adapted for the continuous conversion of carbonaceous material, as, for example, high-volatile coal, into low-volatile high-fixed-carbon coal, and arranged to produce the essential conditions hereinbefore mentioned.

In the accompanying drawings, Figure 1 is an elevation of one form of apparatus which may be used in carrying out my invention.

Fig. 2 is a fragmental vertical sectional view of the form of apparatus shown in Fig. 1.

Fig. 3 is a horizontal sectional view in the plane of line 3—3 of Fig. 2.

Fig. 4 is a section on line 4—4 of Fig. 2.

Figs. 5 and 6 are fragmental vertical sectional views showing modifications of the apparatus illustrated in Fig. 2.

The apparatus shown in Figs. 1 and 2 comprises an elongated cylindrical retort 1 preferably arranged in vertical position. The length of the retort 1 is determined, in part, by the rate at which it is desired to move material through the retort, by the time required to initiate and complete the exothermic reaction and to permit setting of the product resulting from such reaction, and by the pressure to be produced by the weight of the column of material. In order that the material under treatment shall be heated as uniformly as practicable, it is desirable that the retort be of relatively small diameter, thus minimizing the distance through which heat must penetrate from the retort wall to the inner portion of the charge.

Any suitable means may be provided for

heating the retort throughout all or a portion of its length. Herein is shown a casing 2 surrounding the retort 1 and connected at its upper and lower ends to pipes 3 and 4 which extend to a suitable source of supply of liquid or molten material for maintaining the retort 1 at the desired temperature. The bath of molten material surrounding the retort prevents the retort from being excessively heated at any point. In practice, a plurality of retorts 1 would preferably be enclosed within a furnace of any desired character.

Means is provided at the lower end of the retort for forcing coal up through the retort. Preferably the coal-moving means is of such character as to produce continuous or substantially continuous movement of the mass under treatment. Herein is shown a casing 5 containing a screw conveyor 6 alined with and of the same diameter as the retort. 7 is a conduit leading from a suitable source of supply of crushed coal to the lower portion of the chamber containing the screw conveyor. If desired, the screw conveyor 6 may be of such form as to compress the coal as the latter is advanced to the retort. Herein the shaft of the screw is shown as decreasing regularly in diameter, and the spiral of the screw as gradually decreasing in pitch, from the inlet to the discharge end of the conveyor.

The screw conveyor 6 is shown as driven by means including a shaft 8, reduction gearing 9 and a drive shaft 10, although it will be understood that any desired means may be provided for this purpose.

The upper end of the retort communicates with a casing 11 which provides a connection 12 for a conduit through which gas and vapor are exhausted, and an outlet 13 for the converted coal. The wall 14 of the casing 11 is curved or inclined so as to extend across the path of movement of the solid product emerging from the retort, whereby the upper end of the column of material is fractured, the pieces broken off being discharged by gravity through the outlet 13.

In order that the char shall be relatively dense, it is important that the escape of gas and vapor during the period when the coal is plastic and is setting be facilitated as much as possible. To attain this result I provide a shaft 15 disposed axially of the retort 1 and rotated by any preferred means, as, for example, by being attached to the discharge end of the screw conveyor 6. The length of the shaft 15 may vary in accordance with the conditions met in practice; with some coals it may terminate a short distance after it enters the mass; with other coals it should preferably extend through the region in which the char is setting. That portion of the shaft which extends upwardly from the region where gases and vapors are liberated in considerable quantities is preferably of non-circular cross-section, as indicated in Fig. 3, so as to provide in its rotation a passage or vent for the gases and vapors.

In use the carbonaceous material to be treated, as, for example, coal of high volatile content preferably crushed to comparative fineness, is conducted through the conduit 7 to the screw conveyor 6. As it is carried along by the screw it is packed or somewhat compressed. After leaving the screw the material is forced upwardly through the retort by the thrust of the screw propelling succeeding masses of raw coal against it. By the rotation of the screw conveyor and the extended shaft 15 a space in the center of the moving column of raw coal is kept free from coal, and when the portion of the shaft 15 which is round in cross-section has been passed, this space constitutes a passage for the escape of vapors and gases and thus provides for their egress from the apparatus with the shortest possible travel through the mass being treated. As hereinbefore stated, the retort 1 is of relatively small diameter in order that the gases and vapors shall be obliged to pass through only a thin layer of material to reach the central gas passage.

The weight of the mass and the friction against the retort walls may be relied upon to cause resistance to the travel of the mass, resulting in the establishment of slight pressure which is most effective in the plastic zone, thus preventing the liberation of the gases and vapors from imparting porosity to the char.

If in treating certain varieties of coal it should be desirable to increase the pressure beyond that resulting from the weight of the column and the friction upon the retort walls, the retort may be made to taper inwardly slightly from its lower end as far as the need for such increased pressure exists, as indicated at 1^a in Fig. 6. If desired, the remainder of the retort may taper outwardly toward its upper end, as indicated at 1^b in Fig. 6.

If the coal to be treated swells considerably during carbonization, it may be desirable to construct the retort so that it increases in diameter from its lower to its upper end, as indicated at 1^c in Fig. 5.

Although the mass is moving continuously through the retort, no substantial agitation occurs, the particles of the mass being practically at rest with relation to each other. Hence practically no breeze is produced.

By my improved method herein disclosed, coal containing approximately 35% volatile from the deposits of southern Illinois may be converted into a coal product with a specific gravity, volatile content and fixed carbon resembling that in such coals as Pocahontas.

While I have described the method as adapted for the carbonization of coal, it may

be useful in the treatment of other materials.

In the following claim, the term "continuous" is intended to include intermittent movement consisting of steps which are so short and frequent that the motion, for all practical purposes, is continuous.

I claim as my invention:

A continuous method of converting crushed bituminous coal having a specific gravity less than that of Pocahontas coal into a fuel having a specific gravity and volatile content approximating that of Pocahontas coal, which consists in forcing a quantity of said crushed bituminous coal arranged in the form of a hollow cylinder upwardly through a retort by pressure exerted only at the lower portion of the column, the axis of the cylinder being along the direction of movement of the material, uniformly heating the retort only to the degree necessary to initiate exothermic reaction in the coal, the path of travel of the material being of sufficient length so that fusion and setting occur prior to discharge from the retort, and so that the weight of the column of material after setting shall produce sufficient continuous pressure upon the plastic material to make the char of a density approximating that of Pocahontas coal and greater than that of the coal being treated, withdrawing the vapors and gases upwardly within the cylinder of material, and discharging the char from the retort immediately after the recited heating and setting.

In testimony whereof I have hereunto affixed my signature.

LUCIEN I. YEOMANS.