March 2, 1937. E. RAHM 2,072,721

LOW TEMPERATURE CARBONIZATION

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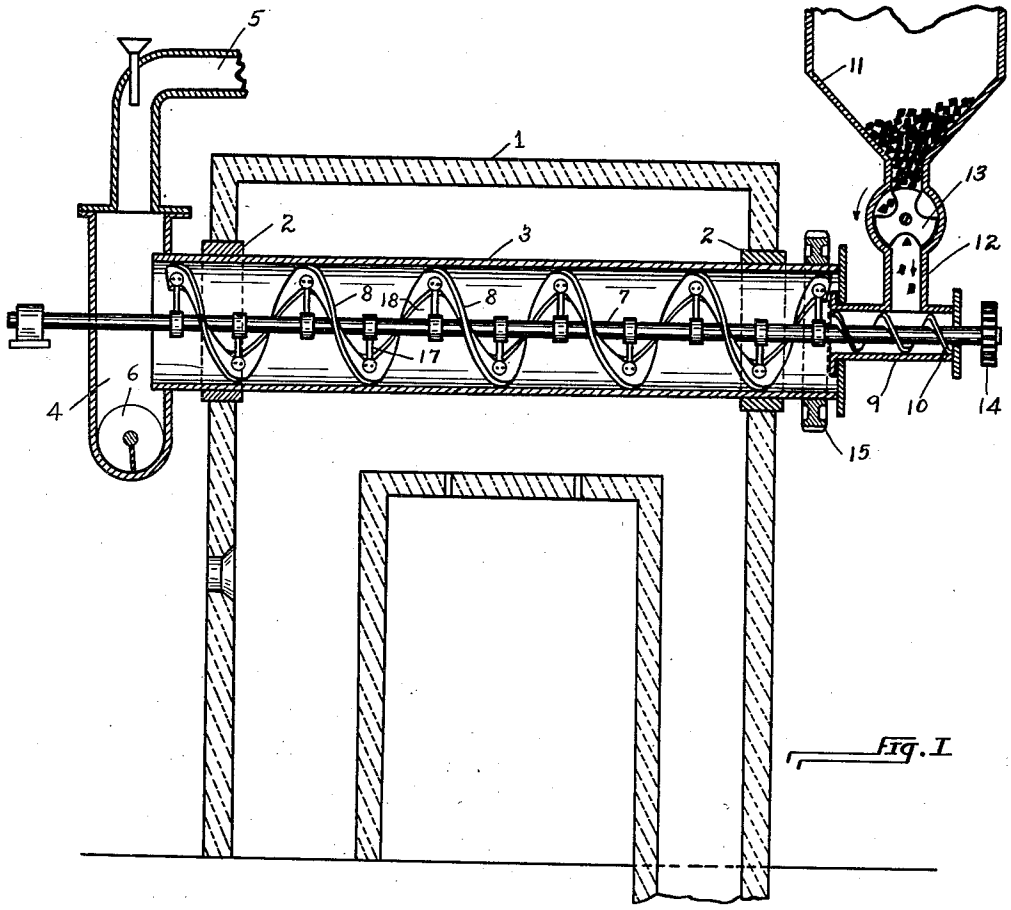


Fig. I

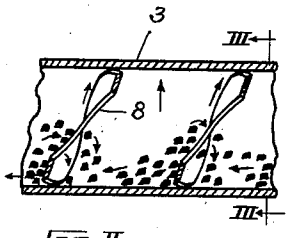


Fig. II

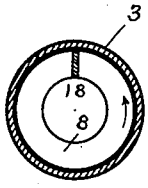


Fig. III

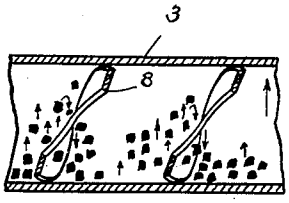


Fig. IV



Fig. V

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LOW TEMPERATURE CARBONIZATION

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2 Claims. (Cl. 202—12)

This invention relates to apparatus for carbonizing coal and for leading off to recovery the volatile products of the carbonization. In the carbonization of coal for the recovery of the volatiles and the production of coke, it is important, since the temperatures employed are not high, that the treatment be of relatively great duration. The length of a retort in which carbonization is conducted is limited not only by the increased expense of constructing an extremely elongate vessel of such nature, but is also limited by practical operating conditions, for the reason that an unduly long retort tends to sag, or become waved or twisted. Further, extreme length of a retort in itself renders difficult an even heat distribution throughout the length of the retort.

With this problem in mind there have been devised various forms of apparatus, and associated methods, looking to the subjection of coal in a retort to heat treatment through a treating period of relatively great duration without unduly extending the length of the retort. In all such structures and methods it is the purpose to so conduct the coal along a heated retort that it is for an extended period of time in contact with the heated surface of the retort.

It should be explained that coal undergoing carbonization passes through a stage in which it tends to form a tacky mass, and that during the treatment this mass must be continually broken up by agitation, or prevented from forming, in order that the interior of the retort may be kept adequately clean and a thorough carbonizing treatment effected in the retort. An other object of agitating coal in the retort is to facilitate positively the release of volatiles by exposing each coal particle adequately to the heated wall of the retort.

Assuming the existence in the art of retorts suitable for coal carbonization generally considered, and which provide an extended period of heat treatment and an agitation of the coal in a retort of moderate length, and assuming further that in the art there have been used retorts of circular cross section having therein screw conveyors for conducting coal through the retort and for agitating it therein, I have invented in connection with apparatus and method of that general nature certain improvements which are of great practical importance.

It is the object of my invention to obtain by means of simple apparatus an improved agitation, and a definite rabbling of the coal particles in the retort, both to facilitate driving off the volatiles from the coal, and to improve the qualities of the coke remaining as a residue after the removal of the volatiles.

In the accompanying drawing, which is illustrative of my improved form of apparatus, and exemplary of apparatus suitable for conducting my method, Fig. I shows in vertical longitudinal section a furnace, a retort, and elements directly associated with the retort.

Fig. II is a fragmentary longitudinal section through the retort, illustrating conditions within a region of the retort during one phase of its operation.

Fig. III is a cross-sectional view taken on the line III—III of Fig. II, and indicating the direction of revolution of the retort and the propeller therein.

Fig. IV is a fragmentary view in longitudinal section through the retort, illustrating another phase of its operation.

Fig. V is a diagram illustrating progress of coal through the retort.

Referring to the drawing, reference numeral 1 designates a furnace, having in opposite vertical walls thereof bearings 2 in which there is revolubly mounted a cylindrical metallic retort 3. At its discharge terminal retort 3 leads into a discharge receptacle 4, such as is well-known in the gas industry. A discharge pipe 5 leads from the upper terminal of the discharge receptacle 4 and a screw conveyor 6 is mounted in the lower region of the receptacle for the removal of solid material which is carried into the receptacle.

Arranged concentrically of the retort is a shaft 7 carrying a propeller which is of the general screw conveyor type, and which will be hereinafter specifically described and discussed. At the entering end of the retort, shaft 7 passes through a feed cylinder 9, and carries a screw conveyor 10 for conducting material for treatment to the retort. Coal for treatment is shown as fed to the supply conveyor 10 from a hopper 11 by way of a duct 12, containing a star-wheel feeder 13. Shaft 7 is revolved through suitable connections such as the gear 14 mounted terminally thereon at the entering end of the retort; and the retort 3 itself is revolved by suitable connections such as the gear 15 mounted thereon exteriorly of the furnace wall.

Assuming that the process conducted in the apparatus described is a carbonization process conducted on coal for the production of coke and the recovery of volatiles, coal in relatively finely divided form is fed at a controlled and relatively

slow rate to the retort, in which it is agitated, and through which it is slowly passed. It has been noted that the retort 3 is revoluble, revolution of the retort being of importance both to preserve the retort from the effects of localized heating, and to maintain the coal particles within the retort under a continuous and uniform heating effect. Desirably the rate of revolution of the retort is slow, from one to two revolutions per minute having been found suitable. The rate of revolution of discharge propeller 8 is relatively rapid with respect to that of the retort. I have found suitable, and prefer, to revolve shaft 7 which carries the propeller 8 at approximately ten times the angular speed at which the retort is revolved, and have found it important that the direction of revolution of the retort and the propeller shaft be the same in sense.

Figs. II to V inclusive of the drawing show, from the position in which the apparatus is viewed, a counterclockwise revolution of both the retort and the conveyor.

In order to obtain an extended retention of the individual solid particles within the retort, I have found that it is adequate in conjunction with a relatively short retort to have an intermittent actuation of the propeller, while permitting a continuous revolution of the retort. In itself such arrangement is desirable, in that it avoids the complexity and expense incident to a reversing mechanism for intermittently changing the direction of revolution, either of the retort or the propeller. A mere intermission of screw revolution also does not subject the screw and its operating connections to the shock attendant upon a reversal in its direction of revolution.

To describe the conduct of a low temperature carbonization process in the equipment illustrated, the retort 3 is slowly rotated, the speed of revolution as noted above being desirably from one to two revolutions per minute. The coal is fed in gradually to the retort in which the screw propeller 8 is revolved at an angular speed substantially higher than the speed of revolution of the retort, and, as noted above, desirably at a relatively high speed as compared with the speed of revolution of the retort. After each single revolution of the propeller screw, or after each few revolutions of the propeller screw, in accordance with the lead of the screw and the conditions of the process, the screw is stopped so that there is an interval in the propulsion of coal from the entering end of the retort to its discharge end. Desirably the propeller screw remains idle throughout a single complete revolution of the retort, when it is again driven through one or more revolutions.

The desired intermission in revolving the propeller screw 10 may be effected by any one of a number of well known mechanical expedients for that purpose. For example, intermittent revolution of the screw may be effected by the use of an interrupted gear, or by the use of an automatic, cam operated, clutch.

I have found that at the moderate temperature of low temperature carbonization, namely, a temperature of from 1000° F. to 1200° F., frequent intermission in the revolution of the screw conveyor is effective to subject the coal to the heating effect necessary to drive off substantially its entire volatile content during passage into the retort. This is due in part to the interruption in the revolution of the screw only, but may more definitely be attributed to the combined effect of such intermitted action with a form of screw adapted to promote agitation under such condition.

The screw propeller 8, shown in the drawing, is a ribbon propeller, which has the turns of its blade supported from central shaft 7 by suitable means, such as the arms 17. Being a ribbon propeller, it provides a longitudinally extending passage 18 throughout the length of the retort, and interconnecting spaces between the spiral turns of the screw blade. Aside from the function of providing a continuous duct 18 for the passage of gases longitudinally of the retort, the ribbon form of the propeller is of advantage in producing a rabbling effect on the coal particles undergoing carbonization, under the conditions of revolution of the retort and the screw.

Fig. II of the drawing illustrates the forward propulsion of the solid particles of coal in the entering zone of the retort under the influence of the ribbon propeller 8, with the retort and propeller revolved in the same direction of revolution; and illustrates the rabbling effect on the coal occurring under such conditions. The agitation effected by the revolution of the retort alone is greatly intensified by the action of the propeller 8, which churns the coal, tending to detach it from the wall of the retort, and to propel it longitudinally forward through the retort. Due, however, to the continuous lifting and falling of the coal, and to the churning action of the propeller, there is a substantial vertical movement of the coal particles as well as a horizontal movement of the particles. The action of the conveyor, or propeller, also tends to scrape the wall of the retort, detaching coal particles which would otherwise adhere to the wall.

It will be further noted in Fig. II of the drawing that, because of the central opening 18 throughout the blade of the propeller 8, the rabbling effect is such that some coal particles, which are lifted, and which fall within the pitch of a turn of the screw, actually fall rearwardly through the screw so that their movement is not in a definite forward direction.

Fig. IV of the drawing illustrates the condition existing in the entering zone within the retort in intervals during which revolution of the propeller screw 8 is arrested while the retort continues to revolve. The propeller screw being stationary, there is no tendency present causing propulsion of the coal particles along the retort. In this stationary condition of the propeller screw there is present an increased tendency to move the coal particles vertically. In this action, also, there is a tendency for some of the lifted coal particles to fall rearwardly through the central opening of the screw propeller into the adjacent space defined by the spiral of the screw.

In the intermediate zone of the retort, in which the coal tends to become particularly tacky, there is naturally less of a tumbling action in the coal. There is, however, a tendency in that direction which is more efficient in keeping the retort clear than is the backward and forward movement obtained by reversing the action of a screw propeller intermittently.

It may be stated generally that by utilizing the screw propeller of the ribbon blade rather than of the solid blade type, an overall time period of treatment equal to that incident to the use of a solid screw frequently reversed is obtained by a mere intermittence in the revolution of the screw, and that a superior agitation of the coal,

preventing adhesion of the coal to the wall of the retort, is obtained.

It is thus possible by rotating the ribbon propeller in the same direction of rotation as the retort, but at a much higher speed, and frequently intermitting the revolution of the propeller throughout a revolution of the retort, to obtain a treatment of the coal in a 20 foot retort equal to that obtainable by a continuous propulsion of the coal through a 200 foot retort. Coincidentally, the interior surface of the retort wall is kept relatively clean, and a thorough agitation of the coal is obtained.

The diagram of Fig. V illustrates this effect, showing a portion of a treating period, indicating generally the movement of the coal during its treatment. It is to be noted in the diagram that there are intervals during which the coal moves substantially in parallelism with the axis of the retort and intervening periods during which the movement of the coal is approximately perpendicular to the axis of the retort. As has been explained, these latter periods not only prolong the total period of treatment, but also give that distinctive rabbling effect which has been described.

To continue the general description of the process, coke from which the volatiles have been driven off during passage through the retort is delivered at the discharge end of the retort into the discharge receptacle 4. There the coke is taken up by a discharge conveyor 6, and is carried to a point of delivery. Desirably, conveyor 6 lies in a body of cooling water, which does not extend upwardly in the receptacle as high as the lowermost region of the retort.

It should be understood that in the economical conduct of the process a plurality of identical retorts may be mounted in a single furnace, and that the discharge receptacle 4 may be continued along the retorts to serve as a discharge header for all the retorts of the battery.

The volatiles driven off from the coal during carbonization constitute, of course, a valuable product of the process. While some of these volatiles may be liberated adjacent the discharge end of the retort, a relatively great proportion of the volatiles are liberated from the coal in the longitudinally intermediate region of the retort and adjacent its entering end. While a treatment of coal at a temperature of from 1000° F. to 1200° F. is considered as a low temperature carbonization process, it should be understood that such temperature range constitutes a cracking temperature for a large proportion of the volatiles driven off from the coal.

It will be observed that volatiles driven off from the coal in any region of the retort have a clear and unobstructed passage through the central opening 18 in the propeller to the discharge receptacle 4, from which they may pass by way of pipe 5 to condensation and collection. Desirably, a lowered pressure is permitted to exist at, or adjacent, the condenser, so that the volatiles are carried rapidly through, and from, the retort. I thus remove the volatile products of carbonization from the retort so rapidly that they are not subject to elevated temperature for a length of time sufficient to produce in them any substantial degree of cracking. The volatile products of the process are, therefore, recovered in the form in which they are driven off, and I am able to obtain from these volatiles materials representing unchanged all but the heaviest end of the volatile content of the coal.

In the above connection, the intermittent operation of the screw, with consequent tendency to break up masses of tacky coal, is adequate to prevent such balling of the coal at the interior of the screw as materially to obstruct the eduction of volatiles.

I have above given a temperature of 1000° F. to 1200° F. as typical of the temperature employed in a low temperature carbonization process. It is to be understood, however, that I do not intend by this to limit myself to that temperature range for a coal carbonization process, since the nature of the material acted upon, and the nature of the products desired, may cause substantial variation above or below that range. It should be understood that with the apparatus shown, relatively accurate control of the process conditions is obtainable. For example, by either increasing the speed of revolution of the propeller, or by decreasing the duration or frequency of the rest periods of the propeller, a decreased treatment is obtainable. By establishing a converse set of conditions, the treatment of the coal is increased. It is thus possible to conduct the process either to produce coke having therein a relatively high percentage of the higher boiling constituents, thus giving a relatively leaner volatile recovery; or to produce a coke having but a small remaining percentage of volatiles, and thereby to produce a recovery of volatiles richer in the heavier volatile constituents of the coal. In such regulation, temperature, as well as the time period of treatment, is also a controlling factor.

It is to be understood that the apparatus herein disclosed may be utilized for the heat treatment of various substances other than coal; my invention is, therefore, susceptible of uses other than that to which it primarily relates.

I claim as my invention:

1. The herein described method of effecting the low temperature carbonization of coal to produce therefrom coke and volatiles in a tubular retort of short length which comprises feeding the coal in particulate condition to an exteriorly heated tubular retort containing with slight clearance a centrally open spiral propeller, slowly revolving the retort in that angular direction in which the spiral propeller by virtue of the direction of its spiralling must revolve in moving coal from the receiving end of the retort to the delivery end of the retort, propelling the coal through the retort in a series of frequently recurrent propulsion periods of substantially uniform duration by recurrently revolving the centrally open spiral propeller in the retort in the direction of revolution of the retort at an angular speed substantially exceeding the angular speed at which the retort revolves, recurrently agitating the coal transversely to the axis of the retort without advancement of the coal and with passage of coal rearwardly through the blades of the ribbon propeller by stopping the revolution of the ribbon propeller throughout agitating periods of substantial and approximately uniform duration while continuing revolution of the retort, and throughout the continuance of the process maintaining such uniform periodicity that the recurrent agitation periods exceed the recurrent propulsion periods adequately to effect approximate devolatilization of the coal in passage of the coal through the retort.

2. The herein described method of effecting low temperature carbonization to produce in a

tubular retort of short length coke and volatiles from carbonaceous material having the property of coking and of giving off volatiles during coking, which comprises feeding the carbonaceous material in particulate form to an exteriorly heated tubular retort containing with slight clearance a centrally open spiral propeller, slowly revolving the retort in that angular direction in which the spiral propeller by virtue of the direction of its spiralling must revolve in moving the carbonaceous material from the receiving end of the retort to the delivery end of the retort, propelling the carbonaceous material through the retort in a series of frequently recurrent propulsion periods of substantially uniform duration by recurrently revolving the centrally open spiral propeller in the retort in the direction of revolution of the retort at an angular speed substantially exceeding the angular speed at which the retort revolves, recurrently agitating the material transversely to the axis of the retort without advancement of the material and with passage of particles thereof rearwardly through the blades of the ribbon propeller by stopping the revolution of the ribbon propeller throughout periods of substantially uniform duration while continuing revolution of the retort, and throughout the continuance of the process maintaining such uniform periodicity that the recurrent agitation periods exceed the recurrent propulsion periods adequately to effect approximate devolatilization of the carbonaceous material in its passage through the retort.

EDWARD RAHM.