Aug. 6, 1929. F. C. GREENE ET AL 1,723,932

APPARATUS FOR CARBONIZING COAL AND THE LIKE

Filed Oct. 24, 1925

Fig. 1.

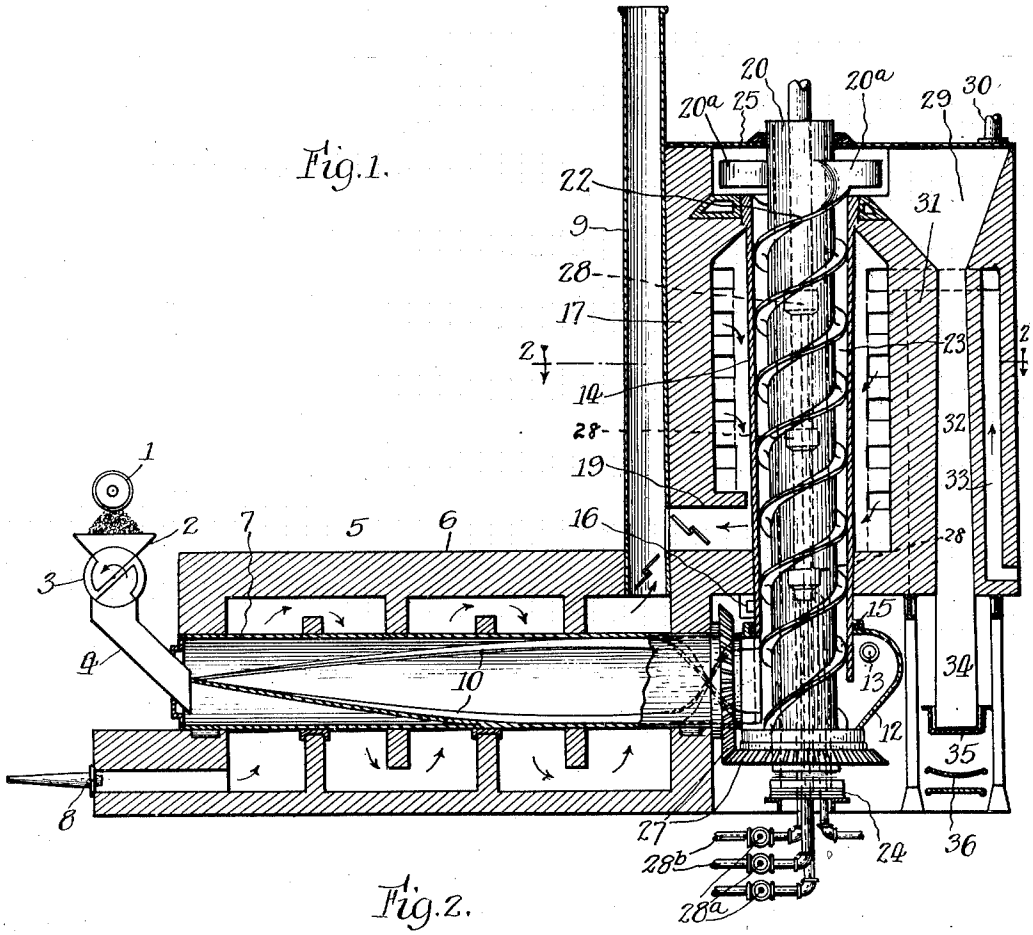
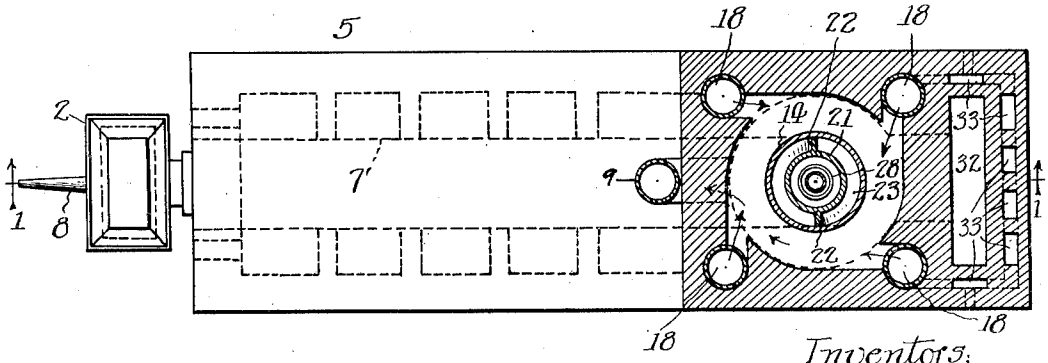


Fig. 2.



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UNITED STATES PATENT OFFICE.

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APPARATUS FOR CARBONIZING COAL AND THE LIKE.

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In Patent No. 1,713,840 granted May 21, 1929, to Irving F. Laucks, there is disclosed an apparatus for carbonizing coal at a relatively low temperature, which apparatus comprises a screw retort which is internally and externally heated. The functions of the screw retort are, first, to produce agitation, circulation or kneading of the particles of coal from a period commencing previous to the softening point and lasting through the plastic stage; and, second, to raise the temperature of the material being treated, means being provided in practice for regulating the temperature to effect the desired results.

Certain operations or reactions occurring prior to the softening point and after the plastic mass has set may be better accomplished by other apparatus than a screw retort. For example, drying of the coal and preheating almost up to the softening point may be effectively done in less expensive apparatus than a screw retort. Likewise, the coke may be annealed more economically and to better advantage in a retort apart from the screw retort, as the screw tends to abrade the coke and produce breeze or fines. The object of the present invention, therefore, is to provide, in connection with an improved form of screw retort, improved means for treating the coal prior to its introduction into the screw retort and for treating the coke after it has been discharged from said retort. Certain improvements in the screw retort also will be pointed out hereinafter.

In the accompanying drawings, Figure 1 is a view, more or less diagrammatic, illustrating an apparatus embodying the features of our invention, the view being taken in the plane of line 1—1 of Fig. 2.

Fig. 2 is a sectional view taken in the plane of line 2—2 of Fig. 1.

In the drawings, 1 denotes a conveyor by means of which coal is discharged into a hopper 2. The lumps of coal are preferably, although not necessarily, under one inch in size. The outlet from the hopper 2 is controlled by means of a rotary feed gate 3 of well known construction, in order that air may be excluded from the apparatus. The coal passing through the feed gage 3 enters an enclined spout 4 which directs the coal to a drier or preheater 5 of any preferred construction. In the construction herein shown the preheater 5 comprises a furnace 6 containing a relatively long rotatory drum 7 into one end of which the spout 4 extends. The inlet end of the preheater drum 7 is slidably supported to accommodate expansion and contraction of the drum. The furnace 6 is preferably heated by means of a gas burner 8 supplied with gas produced in the carbonizing process, the products of combustion being discharged through a stack 9. Within the drum 7 is fixed a device for agitating and advancing the material toward the outlet end of the drum. While the agitating and advancing means may be of any desired character, we have herein shown two spiral blades 10 fixedly mounted in diametrically opposite positions within the drum. The major portions of the blades 10 are curved to conform to a helix of relatively great pitch so that the blades act to lift and shower the coal slightly ahead on each revolution of the drum. At the discharge end of the drum the blades 10 are given a smaller pitch so as to be more efficient as conveying elements. The drum is sealed at each end against admission of air.

The discharge end of the drum 7 communicates with a chamber 12 from which the steam generated in the drying of the coal is conducted through a steam outlet pipe 13. The steam is preferably withdrawn under a slight vacuum.

The screw retort comprises a tubular casing or retort wall 14 supported in vertical position. The casing 14 is preferably suspended from its upper end, its lower end projecting slidably through a gland 15 into the chamber 12, thus accommodating changes in the diameter and length of the retort wall 14 due to temperature changes. The portion of the retort wall 14 that extends through the gland 15 is cylindrical, but the remainder of the casing 14 tapers slightly outward upwardly. Any desired means may be provided to prevent the casing 14 from turning, as, for example, straps 16 at the lower end thereof.

The retort 14 is externally heated by a furnace 17 which may be of any preferred construction. As herein shown, it comprises

four combustion chambers 18 which deliver hot gases spirally around the retort at any desired elevation. The hot gases pass downwardly around the retort and pass to the stack 9 through a flue 19.

Within the retort casing 14 is a rotor 20 comprising a tubular shaft 21 (Fig. 2) having upon its periphery two spiral screw threads or fins 22. The outer diameter of the threads 22 increases upwardly from the bottom for ease of withdrawal, such taper also affording increasing clearance to the material being treated in the retort. It will be understood that the taper of the retort bore corresponds with that of the screw. The width of the screw thread is such that a comparatively narrow spiral space 23 is left between the shaft of the screw and the inside surface of the retort. A proportion of at least three inches between adjacent thread-convolutions per inch of width of thread is considered desirable. The helical thread fits inside the cylindrical retort with only a small clearance.

The lower end of the rotor 20 is supported in a step bearing 24. Its upper end passes through a head casting 25, a stuffing box 26 preventing entrance of air.

The preheater drum 7 and the rotor 20 may be driven in any preferred manner, as, for example, by means of two intermeshing miter gears 27, one of said gears being driven through any desired source of power (not herein shown). The discharge ends of the blades 10 extend into the chamber 12 and sufficiently close to the rotor 20 to feed coal to the last-mentioned rotor, the casing 12 being of such shape as to return the upmounded coal to the screw. We believe that the plastic mass with which the rotor 20 almost solely deals, moves at a rate slower than either moist or dry coal, hence the rotor should not be completely filled at the bottom.

The rotor 20 is internally heated by means of a heater of any preferred type. In the present instance, we have shown a heater comprising a plurality of spaced gas burners 28 connected respectively to gas supply pipes 28^b. 28^a are valves in the pipe 28^b for regulating the intensity and points of application of the heat.

Within the head casting 25 the rotor 20 is provided with ejecting blades 20^a which push successive portions of the coke ribbon brought up by the screw thread 22 into a dust box 29. The gases and vapors driven off from the material in the screw-retort are withdrawn through a conduit 30 connected to said dust box. Any preferred means (none being herein shown) may be employed to divert dust from the vapor outlet 30.

The dust box 29 is located above and communicates with an annealing furnace 31. The annealing chamber 32 of said furnace is amply tapered outwardly and downwardly. The annealing furnace 31 comprises flues 33 which are adapted to receive hot products of combustion from a suitable heating means (not shown), and which may be connected to the adjacent combustion chambers 18 and thus vented to the heating chamber surrounding the screw retort, the hot gases flowing eventually to the stack 9 by way of the flue 19.

The lower part 34 of the annealing chamber is preferably of metal construction terminating in a discharge gate 35 of any desired character, said gate being operated to discharge coke from the lower end of the annealer at the same rate as the annealer is filled. 36 denotes a conveyor onto which the char is discharged. Any preferred means (none being herein shown) may be provided for gradually cooling the coke prior to or after its discharge onto the conveyor.

The operation is as follows: The preheater or drier is externally heated to about 350° centigrade or less. The lower end of the retort wall 14 and the rotor 20 receive heat from the upper hotter parts and thus impart heat to the coal entering the screw retort. The screw retort, being internally and externally heated, raises the temperature of each particle of coal at substantially the same rate. As the coal is elevated by the screw it is subjected to a gradually increasing degree of heat, as a short distance above the point where the coal enters it meets the parts of the retort and screw which are directly heated by the furnace 17 and the internal burner 28. The temperature of the coal mass soon reaches the softening point. The particles now commence to stick together. The plasticity of the mass increases for a distance and finally the particles of coal become fused to a homogeneous mass. The fused mass soon reaches its state of maximum fluidity and then becomes increasingly stiffer and more viscous, until it finally sets to a rigid mass. This stage from the softening point to the setting point we call the plastic stage or zone. To prevent clogging of the rotor, the application of heat throughout the plastic zone is so controlled that the rotor wall is at least as hot as, or better, somewhat hotter than the opposite portion of the retort wall; in order that there shall be a greater tendency of the material to adhere to the retort wall than to the rotor wall. The plastic zone may take up the entire upper portion of the retort above the softening point, or it may end a short distance below the top, depending on circumstances. The points of beginning and ending of the plastic zone depend on the rate of increase of temperature, rate of feed, rate of revolution of the screw, amount of moisture in the feed, and on other factors.

In the granular condition the mass of coal, of course, lies on the upper surface of

the screw threads, and is contained between the inner surface of the retort and the shaft of the screw. It is important, however, that the coal mass shall not completely fill this space, some vacant space being left above the coal for the escape of the gas and vapors. The shape of the coal mass may be described as a spiral ribbon, conforming to the helix of the screw, and several inches thick and nearly as deep as the space between the threads. The ribbon thus has a free upper surface from which the gas and vapors are continuously withdrawn upwardly. By reason of such upward withdrawal, there is no condensation of vapors in or upon the cooler material lower down.

But as this ribbon of coal moves upward, it does not move as a simple spiral, when the motion of the individual particles is considered. A particle, for example, which happened to be adjacent to the thread of the screw on the bottom convolution, will not be found in the corresponding position when it has reached the next convolution. We have found that there is a continual circulation of the particles of coal. Take a particle, for example, which is in contact with the inner surface of the screw thread. This particle as soon as the screw commences to rotate, moves inward on the upper surface of the thread until it meets the shaft of the screw. It then moves upward along the vertical surface of the shaft until it emerges on the top surface of the ribbon of coal. Here it is again thrown outward to the inner surface of the retort. After riding along for a short distance on the top of the coal bed, it is turned under and eventually is overtaken by the upper surface of the screw thread. It has therefore made a complete revolution as far as the coal bed is concerned.

The whole ribbon is thus twisting, as it were, as it climbs, the paths of individual particles being helices whose axes are also helices, the latter helices having substantially the same pitch as the helix of the thread. The effect of this twisting or turning over and over, is to bring practically each particle in contact with the heated surfaces of the retort 14 and the screw 20. Thus the temperature of each particle rises at about the same rate, and all arrive at their softening point at practically the same time. Each particle is in close contact with its neighbors, and when the softening point is reached they can readily amalgamate to form a plastic mass. In fact, there is considerable pressure tending to compact the particles. This pressure is not only due to the height of the coal bed, but also is generated by the friction against the walls of the retort.

After the mass melts or softens this turning over and over is still continued as long as the mass is plastic enough to be readily deformed by the forces acting on it, but the circulation ceases as soon as the mass stiffens sufficiently.

It will be understood that definite temperatures can not be set down, as these will vary with different coals, depending on their composition. But a typical case may be described as follows: The coal is raised to its melting or softening point of 400° C., the method of heating being such that substantially each particle is uniformly heated, and the whole mass melts or softens at about the same time. The temperature is then raised gradually to about 450° C. at which approximate temperature setting takes place. The coke is then held at this temperature or one somewhat higher in the annealing chamber 32 for a further period to improve its strength. The duration of this period depends upon the character of the coal or other carbonaceous material being treated. With some coals or mixtures a period of about one-half hour gives good results; with others a period of one to two hours may be necessary.

By dividing the process into three stages as herein described, the capacity of the plant per dollar of investment is increased, as the preheater and the annealer are much less expensive than the screw retort. Moreover, the annealer 32 is more efficient than the screw retort would be for that particular purpose, since the annealer is adapted to handle the coke with a minimum amount of friction.

We claim as our invention:

1. An apparatus for carbonizing coal comprising a screw retort consisting of a tubular casing suspended in vertical position from its upper end and free to expand downwardly, an enlarged casing into which the lower end of the tubular casing extends, said last mentioned casing having a steam outlet, a rotary screw extending from said last mentioned casing upwardly through said tubular casing, said tubular casing and screw tapering slightly out upwardly, the width of the screw thread being approximately one-third of the distance between adjacent thread-convolutions, the screw fitting the tubular casing closely whereby to form a narrow spiral path for the material, and a preheater arranged to discharge heated coal into said last mentioned casing.

2. An apparatus for carbonizing coal comprising a screw retort consisting of a vertical tubular casing, an enlarged casing into which the lower end of the tubular casing extends, said last mentioned casing having a steam outlet, a rotary screw extending from said last mentioned casing upwardly through said tubular casing, the width of the screw thread being approximately one-third of the distance between adjacent thread-convolutions. the screw fitting the tubular casing closely whereby to form a

narrow spiral path for the material, and a preheater arranged to discharge heated coal into said last mentioned casing.

3. An apparatus for carbonizing coal comprising a screw retort consisting of a vertical tubular casing, an enlarged casing into which the lower end of the tubular casing extends, said last mentioned casing having a steam outlet, a rotary screw extending from said last mentioned casing upwardly through said tubular casing, the screw fitting the tubular casing closely whereby to form a spiral path for the material, a preheater arranged to discharge heated coal into said last mentioned casing, and means for externally heating the tubular casing and for internally heating the screw.

4. An apparatus for carbonizing coal comprising a screw retort consisting of a vertical tubular casing, a rotary screw within said tubular casing, the screw thread being relatively narrow and fitting the tubular casing closely whereby to form a narrow spiral path for the material, means for feeding coal to the lower end of said screw retort, and an annealing furnace consisting of a chamber connected to the upper end of the screw retort to receive coke discharged therefrom, and means for externally heating said chamber.

5. An apparatus for carbonizing coal comprising a vertical internally and externally heated screw retort, a preheater arranged to discharge dried and heated coal to the lower end of the screw retort, an annealing chamber connected to the upper end of the screw retort to receive coke therefrom, and means for externally heating said chamber.

6. An apparatus for carbonizing coal comprising, in combination, a screw retort consisting of a vertical casing, an enlarged casing into which the lower end of said first mentioned casing extends, said enlarged casing having a vapor outlet, a rotary screw extending from said enlarged casing upwardly through said first mentioned casing, a preheater arranged to discharge coal into said enlarged casing, and means for heating said retort.

7. An apparatus for carbonizing coal comprising, in combination, a screw retort consisting of a vertical casing, an enlarged casing into which the lower end of said first mentioned casing extends, a rotary screw extending from said enlarged casing upwardly through said first mentioned casing, a rotary preheater drum arranged to receive coal at one end and to discharge coal from the other end into said enlarged casing, said drum having a plurality of generally longitudinal helical blades on its inner periphery to propel the coal longitudinally thereof, and means for heating said retort and said drum.

8. An apparatus for carbonizing coal comprising, in combination, a screw retort consisting of a vertical casing, an enlarged casing into which the lower end of said first mentioned casing extends, a rotary screw extending from said enlarged casing upwardly through said first mentioned casing, and an elongated rotary preheater arranged to receive coal at one end and to discharge same from the other end into said enlarged casing, said preheater having a helical blade on its inner periphery, the receiving end of said blade having a relatively large pitch, and the discharge end of said blade having a relatively small pitch and extending substantially to said screw.

9. An apparatus for carbonizing coal comprising, in combination, a retort consisting of a vertical casing, an enlarged casing into which the lower end of said first mentioned casing extends, a rotary screw extending from said enlarged casing upwardly through said first mentioned casing, and a preheater consisting of a furnace chamber having a plurality of staggered transverse baffle members, and an elongated rotary drum journaled in said baffles, one end of said drum being adapted to receive coal and being slidably disposed in said furnace and the other end of said drum being adapted to discharge coal into said enlarged chamber, and being anchored against endwise movement.

10. An apparatus for carbonizing coal comprising a vertical screw retort, a preheater arranged to discharge dried and heated coal into the lower end of said retort, a dust chamber connected to the upper end of said retort to receive coke therefrom, a vertical annealing chamber opening to the bottom of said dust chamber to receive coke therefrom, and means for externally heating said retort and said annealing chamber.

11. An apparatus for carbonizing coal comprising, in combination, a vertical screw retort, a dust chamber connected to the upper end of said screw retort to receive coke therefrom, an annealing chamber arranged below said dust chamber, an opening thereto to receive coke therefrom, and means for externally heating said retort and said annealing chamber.

12. An apparatus for carbonizing coal comprising a vertical screw retort, an enlarged downwardly tapering chamber communicating with the upper end of said retort to receive the material discharged therefrom, a vapor outlet for said chamber, an upwardly tapering vertical annealing chamber opening to the bottom of said first mentioned chamber, and means for externally heating said annealing chamber.

13. An apparatus for carbonizing coal comprising a furnace structure having a heating space, a vertical screw retort dis-

posed in said heating space, means for internally heating said retort, and a vertical annealing chamber disposed in said heating space adjacent said retort, the upper end of said chamber being connected to the upper end of said retort to receive coke therefrom.

14. An apparatus for carbonizing coal comprising a furnace structure having a heating space, a vertical screw retort extending through said heating space, means for internally heating said retort, a preheater having its discharge end opening to the lower end of said retort to discharge dried and heated coal thereto, and a vertical annealing chamber extending through said heating space adjacent said retort, the upper end of said chamber being connected to the upper end of said retort to receive coke therefrom.

In testimony whereof we have hereunto affixed our signatures.

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