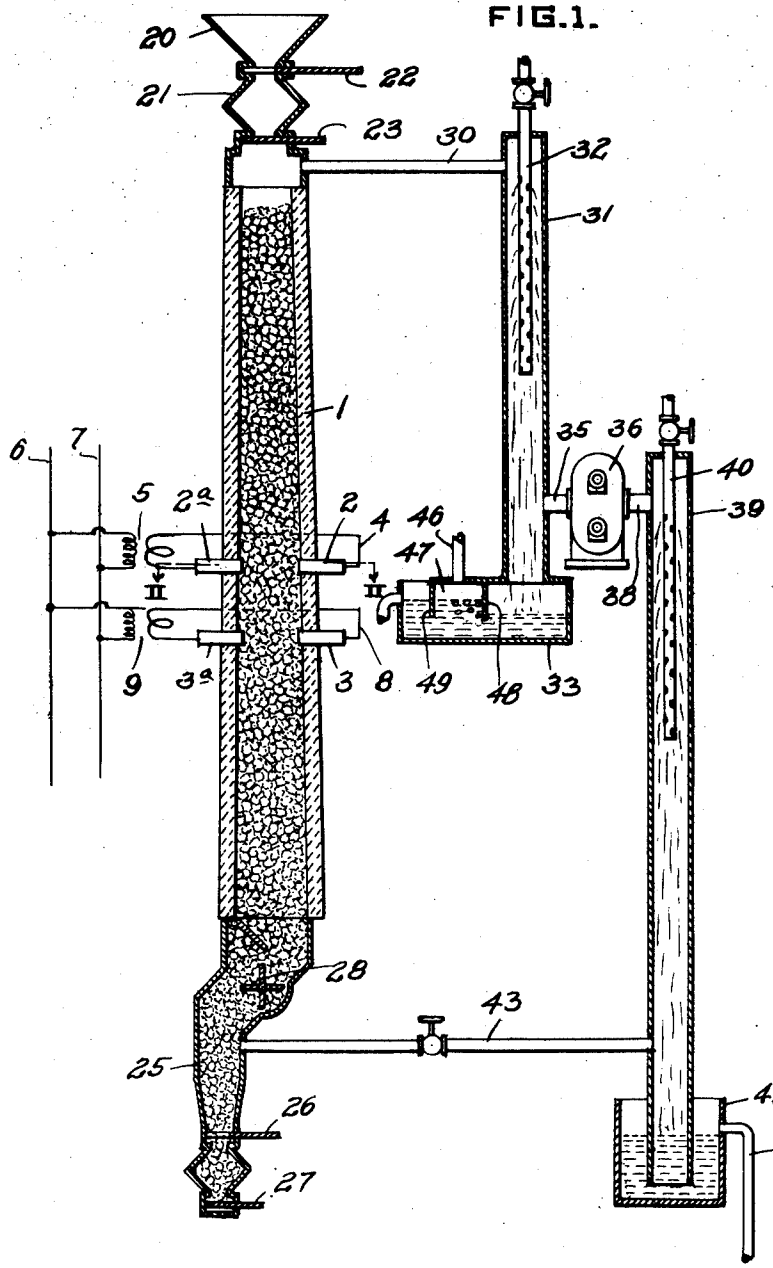
May 29, 1928. 1,671,673

V. C. DOERSCHUK ET AL

METHOD OF CALCINING COKE

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FIG. 1.



WITNESSES
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FIG. 2.

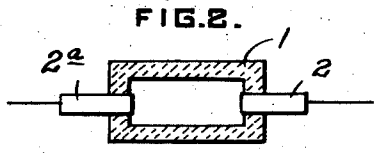


FIG 3.

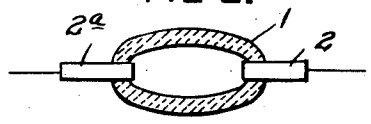


FIG. 4.

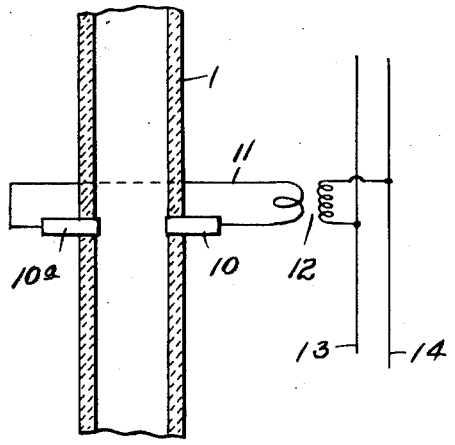
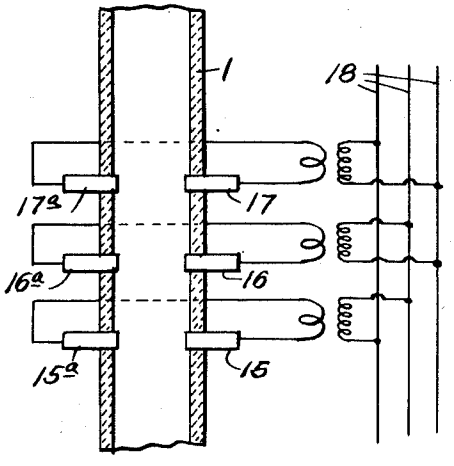


FIG. 5.



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UNITED STATES PATENT OFFICE.

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METHOD OF CALCINING COKE.

Application filed April 22, 1926. Serial No. 103,791.

The carbon which is used in the manufacture of high grade electrodes, such as are employed in electric reduction processes, is customarily made from petroleum coke, a by-product in the refining of crude petroleum which in its raw state carries from about 6 to 12% of volatile matter. To render this coke suitable for the manufacture of these electrodes, this volatile matter must be driven off by calcining or equivalent processes.

In United States Patent No. 1,366,458 to Hoopes, there is disclosed a method of calcining this coke, according to which a body of coke is maintained in the form of a cylindrical column in a vertical shaft furnace and is heated by its resistance to the flow of an electric current passed longitudinally through a portion of the column intermediate of its ends. Provision is made for supplying raw coke to the top and for withdrawing calcined coke from the bottom of the column, and also for causing a current of gas to flow upwardly through the column to first cool the calcined coke in the bottom of the column, and, after the gas has become heated in the electric resistance zone, to then preliminarily heat the raw coke in the upper portion of the column.

In the practice of that method it is essential that the coke be uniformly calcined throughout to thoroughly remove its content of volatile matter, and to that end the coke must be uniformly heated by its resistance to the flow of an electric current. This is effectively and efficiently attained by the process of said patent when practiced with the use of apparatus constructed in all essential respects the same as that shown in the patent, but only in units of relatively small capacity. When attempted to be practiced in units of large capacity it has been found that the electric current does not flow uniformly through the entire body of coke between the upper and lower electrodes, but, on the contrary, finds localized paths of flow resulting in localized heating. The prejudicial effect of this is cumulative, because the electric resistance of the coke diminishes as its temperature increases. Therefore, when a localized path of flow is set up longitudinally through a portion of the column in the electric resistance heating zone, the flow becomes more and more localized as the operation proceeds, and the lack of uniformity in heating becomes correspondingly more and more pronounced.

The object of this invention is to provide a continuous method of and an efficient apparatus for uniformly calcining a large volume of coke to render it suitable for the manufacture of high grade carbon electrodes, and of other articles which must be made of highly and uniformly calcined carbon.

Our invention is predicated upon our discovery, made after the expenditure of much time and money in various unsuccessful attempts to increase the capacity of the process of said Hoopes patent, that uniformly and highly calcined coke can be continuously produced on a large scale by forming the coke in a column which is elongate in cross-section, and in passing an electric current transversely through the column intermediate of its ends in the direction of the longer dimension or major axis of the column. We have found that in so forming the column of coke and in so passing an electric current through it, the current distributes itself so uniformly throughout the entire cross-section of the column in the plane of the transverse flow of current that the coke becomes uniformly calcined as a result of its uniform heating. Stated differently, we have found that the effects of electric resistance heating, thermal conduction and gas convection throughout this relatively long and narrow section are such as to produce uniform heating of the coke, and to eliminate for all practical purposes the concentration of current flow along localized paths with resulting over-heating of some, and under-heating of other portions of the coke.

In the practice of the invention raw coke is supplied to the top of a column of substantially uniform elongate cross-section, and calcined coke is withdrawn from the bottom of the column. As to the form of the elongate cross-section of the column, its shorter or minor axis is preferably not greater than about half its longer or major axis. Intermediate of the ends of the column the coke is uniformly heated by passing an electric current transversely through it in the direction of the major axis of the column, and to increase as well as vary the extent and intensity of the heating zone a

plurality of currents may be passed through the coke at suitably spaced longitudinal intervals of the column. Also, the practice of this invention preferably includes the passing of an inert gas upwardly through the column to cool the heated calcined coke to a temperature at which it may be removed from the bottom of the column without becoming ignited when exposed to the atmosphere, and, after the gas has passed through the heating zone of the furnace, to heat the entering raw coke in the upper portion of the column for the purpose of lowering its resistance to the flow of an electric current through it.

The invention may be further explained with reference to the accompanying drawings which somewhat diagrammatically show the preferred form of apparatus which we have provided for the practice of the invention. In the drawings Fig. 1 is a vertical central sectional view through the several units of the apparatus; Fig. 2 a transverse sectional view of the calcining furnace showing the cross-section of the column, the plane of view being indicated by the line II—II, Fig. 1; Fig. 3 a view corresponding to Fig. 2 showing a modification in form of column cross-section; and Figs. 4 and 5 longitudinal central sectional views through the heating zone portion of the furnace showing modifications in the number and arrangement of electrodes.

Having reference first to Fig. 1, a vertical shaft 1, which may be formed of suitable refractory material, is provided at its upper end with means for feeding raw coke to the top of a column of coke in the shaft, and at its bottom with means for discharging calcined coke from the bottom of the column, both of which means will presently be explained. As previously stated, the shaft is elongate in cross-section. It may, as shown in Fig. 2 be of rectangular form, or of general elliptical form as shown in Fig. 3, or of various other forms to afford space for a column of coke which is elongate in cross-section. Intermediate the ends of the shaft electrodes extend through its end or narrower walls and into the interior of the shaft in positions to cause an electric current to pass transversely through the portion of the column of coke lying between the electrodes. The number and arrangement of these pairs of electrodes may be varied to meet different requirements. For example, in Fig. 1, there are shown two pairs of electrodes 2, 2^a and 3, 3^a, the electrodes 2, 2^a being connected to each other by a conductor 4 to which current is supplied through a transformer 5 from main line conductors 6 and 7. In a similar manner electrodes 3, 3^a are connected to each other by a conductor 8 to which current is supplied through a transformer 9 from the same main line conductors. These pairs of electrodes are spaced from each other vertically of the shaft at an interval sufficient to prevent flow of current longitudinally of the shaft between the pairs, or in other words, at such intervals as will necessarily cause the current to flow between the elements of each pair.

If desired, the shaft may be provided with but a single pair of electrodes 10, 10^a, as shown in Fig. 4, these being connected to each other by a conductor 11 to which current may be supplied through a transformer 12 from main line conductors 13 and 14. A still further arrangement of electrodes is illustrated in Fig. 5 which shows the furnace shaft as being provided with three pairs 15, 15^a,—16, 16^a and 17, 17^a, to each pair of which electric current may be supplied from a three-phase main line 18 in the manner clearly illustrated in this figure. In all cases current passes through the column of coke in a direction substantially at right angles to that of its passage through the furnace shaft, and it is manifest from the foregoing that the intensity of the heating may be varied between or among several pairs of electrodes, and that the extent of the heating zone may also be varied.

For supplying raw coke to the top of the furnace shaft, the shaft may be provided with various forms of feeding mechanism. As generally illustrated in Fig. 1 such mechanism may consist of an upper hopper 20, a lower hopper 21, a suitable valve 22 for controlling the passage of coke from the upper to the lower hopper, and a suitable valve 23 for controlling the passage of coke from the lower hopper into the furnace. By suitably controlling these valves the raw coke may be introduced into the furnace without permitting the escape from the furnace of volatile matter driven from the coke while it is being calcined.

The calcined coke may be discharged from the lower end of the column by a suitable apparatus such as a casing 25 provided with a pair of valves 26 and 27 which also may be controlled to prevent the escape of gas from the furnace while coke is being discharged from it. To uniformly feed the calcined coke downwardly from the lower end of the column toward its discharge outlet of casing 25, and to thereby effect a uniform downward movement of the column of coke through the shaft, a rotary vaned propeller 28 may be provided in the upper part of casing 25, as illustrated.

While inert gas from various sources may be variously supplied to the furnace for first cooling the calcined coke and for preliminarily heating the raw coke, it is preferred to utilize a portion of the gases distilled or driven from the coke in the furnace, and to make provision for causing them to flow in a continuous cycle in which the heated gases

taken from the top of the shaft are cooled for entry at the bottom of the shaft and for the removal of the heavier hydrocarbons distilled from the coke. For this purpose one or more gas washers may be used. In the illustrative embodiment of the invention the volatile matter driven from the coke is removed from the top of shaft 1 through a pipe 30 and carried to a washer comprising a vertical tower 31 into the upper end of which water or other cooling fluid is sprayed from a pipe 32. This cooling of the gas serves the double purpose of condensing the tar and other heavier volatile vapors, and also of cooling the more or less fixed gases. At the lower end of tower 31 there is a vessel 33 for receiving the water sprayed into the tower, as well as for receiving the condensate formed in the tower.

From the lower end of tower 31 the gas is drawn through a pipe 35 by a suitable blower 36 which keeps the gas in continuous circulation, and the gas then flows from the outlet of the blower through a pipe 38 into the upper end of a second cooling and condensing tower 39, into the upper end of which water may be sprayed from a pipe 40. This water and the condensate formed by further cooling the gases and vapors is caught in a receptacle 41 which forms a liquid seal for the lower end of the tower, and from which the water-and condensate mixture may flow through a pipe 42. From tower 39 the cooled gas is conducted through a pipe 43 to discharge casing 25 at the bottom of furnace shaft 1.

The gas thus cooled in towers 31 and 39, and kept in circulation by blower 36, cools the column of calcined coke in the lower portion of the furnace shaft, and, after it becomes heated by passing through the coke in the calcining zone of the shaft, it preliminarily heats the raw coke forming the top of the column so that the resistance of the coke to the flow of electric current is diminished. The surplus gas continuously evolved in the furnace may be removed from the system through a pipe 46 extending from a liquid sealed pocket 47 in vessel 33, such pocket being formed by baffles 48 and 49 extending downwardly from the top of this vessel as shown in Fig. 1.

In the operation of this apparatus raw coke is supplied to the upper end of shaft 1 in quantities sufficient to maintain the shaft substantially filled with coke. The column of coke descends through the shaft at a uniform rate by the continuous rotation of vaned member 28 in casing 25 at the lower end of the shaft, and to facilitate the downward movement of the coke the shaft preferably tapers slightly outwardly from its top to its bottom as indicated. In the heating zone of the shaft an electric current or currents are caused to flow transversely of the shaft in the direction of its major axis, and in the planes of the passage of these current or currents the coke is uniformly heated throughout the entire cross-section of its column. By way of example, and not of limitation, we have found that by the use of a column the minor axis of which is 21 and the major axis 58 inches, coke may be completely and uniformly calcined at the rate of about 800 pounds per hour.

According to the provisions of the patent statutes we have described the principle and mode of operation of our invention, have given specific examples of how it may be practiced, and have illustrated and described what we now consider to be the best form of our improved apparatus. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically shown and described.

We claim:

1. The continuous method of uniformly calcining a large volume of coke, comprising forming a vertical column of coke having an elongate cross-section, supplying raw coke to the top of said column, withdrawing calcined coke from the bottom of the column, and intermediate of the ends of the column passing an electric current transversely through the column in the direction of its major axis.

2. The continuous method of uniformly calcining a large volume of coke, comprising forming a vertical column of coke of elongate cross-section having its minor axis not greater than about one-half its major axis, supplying raw coke to the top of said column, withdrawing calcined coke from the bottom of the column, and intermediate of the ends of the column passing an electric current transversely through the column in the direction of its major axis.

3. The continuous method of uniformly calcining a large volume of coke, comprising forming a vertical column of coke having an elongate cross-section, supplying raw coke to the top of said column, withdrawing calcined coke from the bottom of the column, and at a plurality of points intermediate of its ends passing electric currents transversely through the column in the direction of its major axis.

4. The continuous method of uniformly calcining a large volume of coke, comprising forming a vertical column of coke having an elongate cross-section, supplying raw coke to the top of said column, withdrawing calcined coke from the bottom of the column, passing intermediate of the ends of the column an electric current transversely through the column in the direction of its major axis, and passing upwardly through the column a current of inert gas to cool the calcined coke in the lower portion and to preliminarily

heat the raw coke in the upper portion of the column.

5. The continuous method of uniformly calcining a large volume of coke, comprising forming a vertical column of coke of elongate cross-section having its minor axis not greater than about one-half its major axis, supplying raw coke to the top of said column, withdrawing calcined coke from the bottom of the column, passing intermediate of the ends of the column an electric current transversely through the column in the direction of its major axis, and passing upwardly through the column a current of inert gas to cool the calcined coke in the lower portion and to preliminarily heat the raw coke in the upper portion of the column.

6. The continuous method of uniformly calcining a large volume of coke, comprising forming a vertical column of coke having an elongate cross section supplying raw coke to the top of said column, withdrawing calcined coke from the bottom of the column, passing at a plurality of points intermediate of its ends electric currents transversely through the column in the direction of its major axis, and passing upwardly through the column a current of inert gas to cool the calcined coke in the lower portion and to preliminarily heat the raw coke in the upper portion of the column.

In testimony whereof, we hereunto sign our names.

VICTOR C. DOERSCHUK.
FRANCIS C. FRARY.