

Aug. 24, 1926.

J. J. NAUGLE

1,597,208

ELECTRIC FURNACE FOR THE TREATMENT OF COMMUNUTED MATERIAL

Original Filed April 21, 1923 2 Sheets-Sheet 1

Fig. 1.

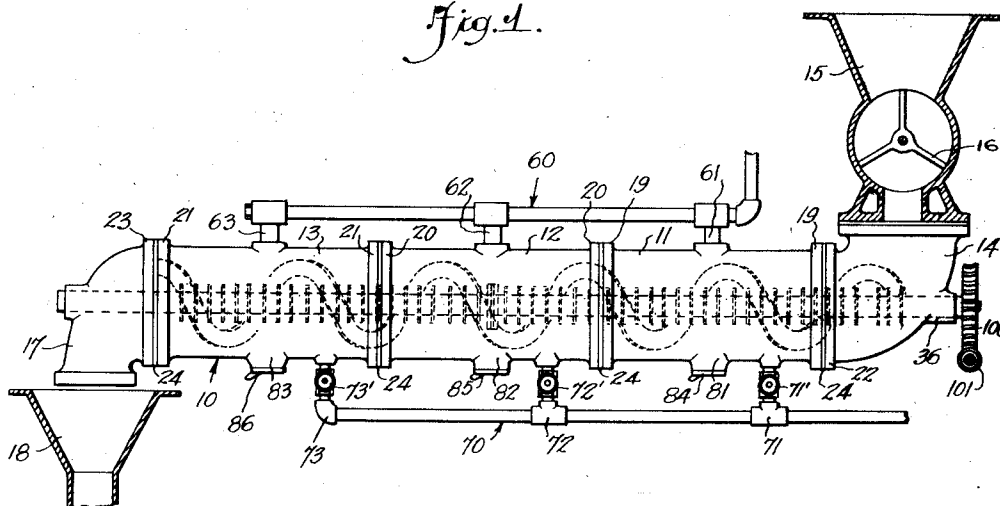


Fig. 2.

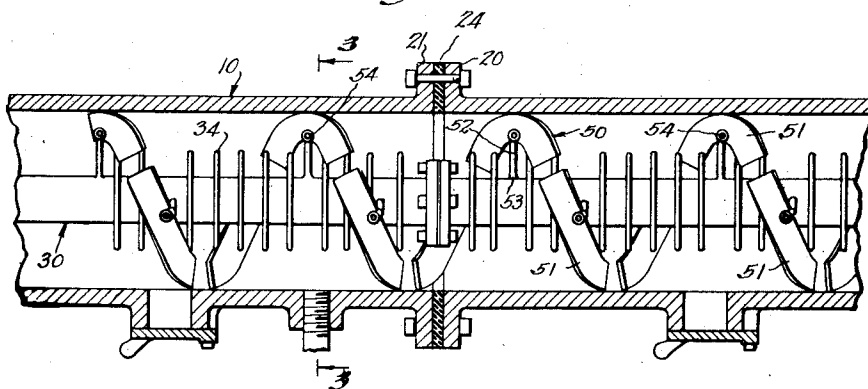
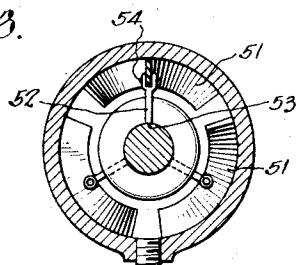


Fig. 3.



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Fig. 4.

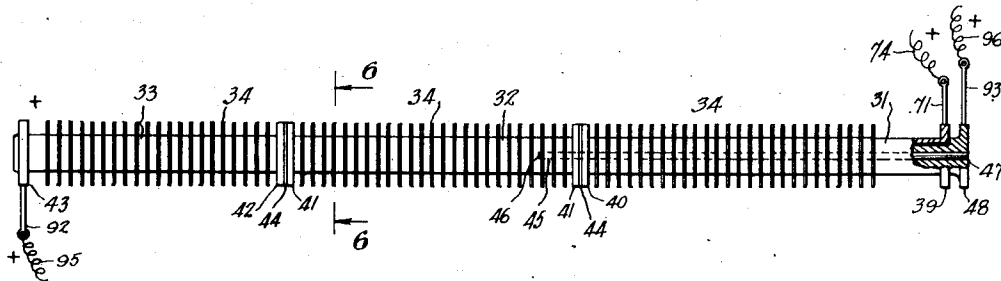


Fig. 5.

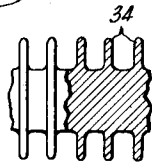


Fig. 6.

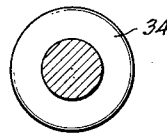
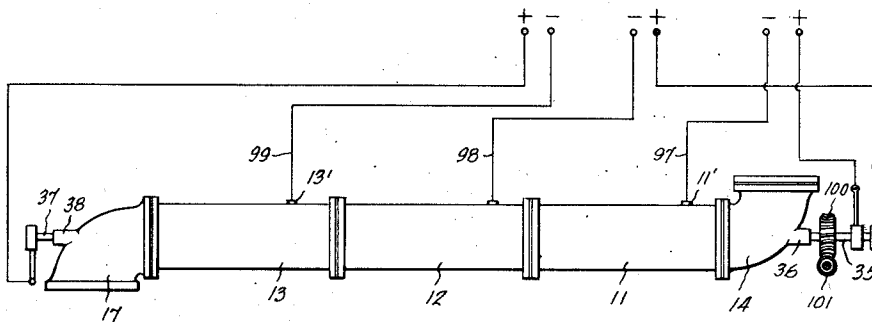


Fig. 7.



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ELECTRIC FURNACE FOR THE TREATMENT OF COMMINUTED MATERIAL.

Application filed April 21, 1923, Serial No. 633,642. Renewed November 7, 1925.

My present invention relates to electric furnaces, particularly, but not exclusively, such as are intended for the treatment of comminuted carbonaceous or other materials, and aims to devise structures of the general character designated above which shall be simple in construction, which shall have few parts, and which shall be admirably designed to effect a regulated heat treatment of the materials intended to be treated in the furnace, for producing a final product having certain predetermined characteristics. Another object of the present invention is to devise structures of the general character specified above, which shall be certain and dependable in operation, which shall require little power for mechanical and heat generating purposes; which shall make ample provision for the proper feeding of the material treated in said furnace and for the proper and efficient heating of such material during the time it is within the furnace; which shall make proper provision for current distribution in such a way as to most efficiently heat the material within the furnace; and which shall be capable of continuous, as distinguished from batch, operation.

A further object of the present invention is to devise furnaces of the general character specified above which shall permit the substantially continuous production of material of a high degree of purity. In particular, if comminuted carbonaceous material, such as comminuted carbonized lignin residues, suitable for the preparation of highly activated decolorizing carbons, is treated in a furnace constructed in accordance with the principles of the present invention, the result is a remarkably pure carbon of very high conductivity corresponding to a very high degree of activation and decolorizing power.

In the accompanying specification I shall describe, and in the annexed drawing show, an illustrative embodiment of the furnace of the present invention. It is, however, to be clearly understood that my invention is not limited to the specific embodiment thereof, herein shown and described for purposes of illustration only.

Referring to the drawing, wherein I have illustrated the aforesaid illustrative embodiment of the present invention:

Fig. 1 is a side view, partly broken away, showing the furnace comprising the afore-

said illustrative embodiment of the present invention;

Fig. 2 is a longitudinal sectional view of the same, partly in elevation;

Fig. 3 is a cross sectional view, partly in elevation, taken along line 3—3 of Fig. 2 of the drawing;

Fig. 4 is a side view of one form of central or inner electrode which may be used with the aforesaid illustrative embodiment of the present invention;

Figs. 5 and 6 are enlarged detail views of the electrode shown in Fig. 3 of the drawing; and

Fig. 7 is a side view, partly diagrammatic, indicating one form of wiring circuit that may be used in connection with the aforesaid illustrative embodiment of the present invention.

Referring now to the aforesaid illustrative embodiment of the present invention, and more particularly to the drawing illustrating the same, the furnace comprising the aforesaid illustrative embodiment includes a casing generally indicated by reference character 10 and being preferably of cylindrical form. The casing 10 comprises a plurality of, here shown as three, sections 11, 12 and 13, these sections being made of metallic material, such as cast iron or steel, and serving as the external electrodes of the device, as subsequently described in greater detail.

At 14 I have shown an inlet provided with a suitable type of feeding means, such as the feed hopper generally indicated by reference character 15, and including the feeding member 16 rotatably operated from any suitable source of power not here deemed necessary to be shown. At the outlet end of the machine, I have provided discharge hopper 17 communicating with a discharge chute 18 leading to any suitable bin or other storage device in which the finished material may be stored.

Each of the sections 11, 12 and 13 is provided with flanged ends 19, 19; 20, 20; and 21, 21, respectively, while the inner ends of the inlet 14 and of the outlet 17 are provided with the flanged ends 22 and 23, respectively. Insulating gaskets 24 are inserted between the meeting faces of the flanged ends just referred to, so that the successive sections 11, 12 and 13 of the casing 10 will be insulated from each other and from the inlet 14 and the outlet 17.

Suitably mounted for rotation within the casing 10 is an inner electrode or shaft generally indicated by reference character 30. The shaft 30 is also divided into a series of, here shown as three, sections 31, 32 and 33, corresponding in number to the sections 11, 12 and 13 of the casing 10.

Each of the sections 31, 32 and 33 is provided with a series of conducting vanes or electrodes 34 which are preferably integral with the respective sections of the shaft 30.

One end 35 of the shaft 30 passes through a collar 36 forming an extension of the inlet 14 and preferably integral therewith. The other end 37 of the shaft 30 passes through a similar shaft 38 forming an extension of the outlet 17 and being preferably integral therewith. Preferably, the ends 35 and 37 of the shaft 30 are insulated from the collars or extensions 36 and 38, respectively, so that the shaft 30, and the sections 31, 32 and 33 of which the same is composed, including also the conducting vanes or electrodes 34, are insulated from the casing 10, including the sections 11, 12 and 13 of which the same is composed, and including, also, the inlet 14 and the outlet 17.

The section 31 has a plurality of flanged portions 39 and 40 at its ends, while the section 32 is provided with the flanged end portions 41, 41, the section 33 being provided with the flanged portions 42 and 43 at its ends. Gaskets 44 are inserted between the opposed flanged end portions of the sections 31, 32 and 33 of the shaft 30, so that the various sections of the shaft will be insulated from each other. The section 31 is preferably hollow so as to permit the passage therethrough of an auxiliary cable or conductor 45 which is insulated from the section 31 and also from the section 33, but which is in electrical connection at its inner end, as indicated at 46, with the intermediate section 32, and in electrical connection at its outer end, as indicated at 47, with a flanged sleeve or thimble 48 carried by the shaft 45 but insulated therefrom, all for a purpose subsequently to be described in greater detail.

Within the casing 10 are means generally indicated by reference character 50 for efficiently mixing and stirring the material treated in the furnace, and for continuously advancing the same from one heating zone to the next during the treatment. While various devices may be employed for this purpose, I prefer to employ the means shown in the drawing, preferably Fig. 2 of the same, said means comprising a plurality of spiral elements 51 carried by the successive sections 31, 32 and 33 of the shaft 30, as by means of the supporting arms or brackets 52. As shown in Fig. 3 of the drawing, the arms or brackets 52 are supported at their inner ends 53 by the respec-

tive sections 31, 32 and 33 of the shaft 30, and carry at their outer ends, indicated by reference character 54, the spiral elements 51 of the feeding means 50. It will also be noted that in the form illustrated herein by way of example, three spiral elements 51 are required for one complete turn of the spiral feeding means 50. Preferably, the spiral feeding means 50 and the arms or brackets 52 supporting the same, are of insulating material, or are covered with insulating material, so as not to serve as current carriers.

At 60 I have shown an exhaust pipe communicating, by means of the connection pipes 61, 62 and 63, with the successive sections 11, 12 and 13 of the casing 10. The exhaust pipe 60 leads to a condenser and a water seal and thus serves as an exhaust for the gaseous products of combustion or reaction, or for any other gas which may be present or which may be admitted to the charge within the furnace. At 70 I have indicated an inlet tube communicating by means of the sections 71, 72 and 73 with the successive sections 11, 12 and 13 of the casing 10. The gas inlet tube 70 may be connected with a source of supply of gas, preferably under pressure, intended to be admitted to the charge within the furnace. This gas may be either a neutral gas, to provide an inactive atmosphere within the furnace to lessen combustion, such as nitrogen gas, for example, or may be some other gas intended to take part in the reaction within the furnace, as to serve to eliminate in gaseous form certain undesirable impurities present in the charge of material present within the furnace.

At 81, 82 and 83 I have indicated sample test holes provided with the covers 84, 85 and 86, respectively, permitting the charge within each of the furnace sections 11, 12 and 13 to be tested from time to time, so as to determine the condition of the charge within the furnace at its different stages of treatment.

In order to provide proper electrical connections for the electrodes comprising the case sections 11, 12 and 13, and the sections 31, 32 and 33 of the shaft 30 carrying the conducting vanes or electrodes 34, I may employ the means shown more clearly in Figs. 4 and 7 of the drawing, and comprising the brushes 91, 92 and 93 contacting with the annular ends 39, 43 and 38 of the shaft sections 31 and 33, and the conducting thimble 47, respectively. The brushes 91, 92 and 93 are connected, by means of the wires 94, 95 and 96, with one of the poles, such as the positive pole, of a direct current generator of suitable capacity, this generator being preferably provided with a shunt wound field. The casing sections 11, 12 and 13 are connected, at

the points 11' 12' and 13', with the wires 97, 98 and 99 leading to the remaining pole, that is the negative pole, of the shunt wound generator referred to, which generator is not here deemed necessary to be shown. This system of electrical distribution is more particularly described and claimed in an application, soon to be filed.

In order to effect a relative movement, such as a relative rotation, of the cooperating sets of electrodes each comprising a casing section and a shaft section carrying the conducting vanes or electrodes 34, I employ any suitable means for effecting the desired relative movement, such as the spiral gear 100 cooperating with the worm 101 driven from any suitable source of power not here deemed necessary to be shown. By the operative engagement of the worm 101 with the spiral gear 100, the shaft 30, comprising the sections 31, 32 and 33 carrying the conducting vanes or electrodes 34, is rotated at any desired or suitable speed relatively to the casing 10 comprising the casing sections 11, 12 and 13. The feeding means 50, in the form of the plurality of spiral feeding elements 51 described above, being carried by the shaft 30, will likewise be rotated with the same, and will thus serve to feed or advance the material in the furnace during the treatment of the same and also to assist in thoroughly stirring and mixing such material.

The manner of assembling the above machine will be substantially clear from the foregoing description. The manner of operating the machine will also be substantially clear from the foregoing description and may be briefly summarized as follows: In commencing the operation of the furnace, the material to be treated, such as the comminuted carbonized lignin residues referred to, which residues are derived by carbonizing the cooking liquors from the treatment of wood by the alkali (soda) process for producing wood pulp, is fed into the feed hopper 15 and is thereupon continuously fed into the inlet 14 of the machine, by means of the rotating feeding element 16. From the inlet 14 the material to be treated is fed into the first of the heating zones or reaction chambers, in this case the heating zone or reaction chamber within the casing section 11. From the section 11 the material is fed into the successive heating zones or chambers within the successive casing sections 12 and 13, by means of the feeding means 50.

Taking, for example, the raw material specified above, or some other comminuted carbonaceous material, such as spent decolorizing carbon, for the purpose of preparing therefrom a decolorizing carbon characterized by a high degree of activation and decolorizing power, the former mate-

rial, that is, the carbonized lignin residues referred to, may have an average analysis as follows:

Analysis of comminuted carbonized lignin residues. 70

	Per cent.
Carbon-----	90
Ash-----	10

Analysis of ash. 75

Silicious matter-----	0.13	
Silica-----	0.75	
Ferric oxide-----	0.34	
Alumina-----	0.47	
Lime, CaO-----	0.23	80
Magnesia, MgO-----	0.11	
Chlorine as chlorides-----	0.47	
Sulphuric anhydride-----	2.65	
Carbon dioxide-----	1.00	
Alkalies (by diff.)-----	3.85	85
	10.00	

For the best treatment of this material for the intended purpose, the temperature in the first heating zone or reaction chamber within the casing section 11 should be from about 800° to about 1,500° C., corresponding to a particular current density; a temperature from about 600° to about 1,200° C., corresponding to a lower current density within the second heating zone or reaction chamber within the casing section 12; while a temperature of about 400° to about 600° C., corresponding to a still lower current density, should prevail within the last heating zone or reaction chamber within the remaining casing section 13. If the apparatus is used for the revivification of spent decolorizing carbon, the temperature in the successive heating zones or reaction chambers within the respective casing sections 11, 12 and 13, should be about 600° C., 500° C., and 400° C., respectively.

By the operation of the gears 100 and 101, the shaft 30, comprising the shaft sections 31, 32 and 33 carrying the conducting vanes or electrodes 34, is caused to rotate with respect to the sections 11, 12 and 13 of the casing. At the same time, the feeding means 50, also carried by the shaft 30 and the sections thereof, is caused to rotate, thus causing the rotation and operation of the spiral feeding elements 51, which, together with their supporting arms 52, are insulated from the shaft 30 and the sections 31, 32 and 33 of the same, and also from the conducting vanes or electrodes 34, as well as from the casing 10 and the casing sections 11, 12 and 13 of the casing 10. This relative rotation causes the material being treated, here designated by reference character M, to be continuously fed from one heating zone or reaction chamber into the next, and to be thus subjected to electrical currents

of varying densities and correspondingly varying degrees of heat. In the present instance, for the particular purpose in view, the current density, and thus the degree of heat, diminishes from one heating zone or reaction chamber to the next in the direction of the feed of the material being treated.

The time of treatment may vary, but is usually from about 15 to 60 minutes. The treatment should be continued long enough to expel substantially all of the volatile matters contained in the raw material, and to fuse the fusible mineral substances present therein to the condition of small aggregates or clinkers. These will be found to adhere to the sections 31, 32 and 33 of the shaft 30, and to the conducting vanes or electrodes 34 carried thereby, as well as to the spiral feeding elements 51, and occasionally to the inner walls of the sections 11, 12 and 13 of the casing 10.

The following is an average analysis of the final product resulting from the treatment of the raw material specified above in the above described form of furnace in accordance with the method outlined above.

Analysis of treated product.

Carbon	97.60
Ash	2.40

Analysis of ash.

Calcium	0.16
Sodium, Na ₂ O	0.35
Magnesium, MgO	0.16
Chlorides, (Cl ₂)	0.06
Sulphates (SO ₃)	0.78
Silica, SiO ₂	0.50
Iron and alumina (Fe ₂ O ₃ , Al ₂ O ₃)	0.39
	2.40

The method is described and claimed in detail in one of my copending applications filed of even date herewith, and the resulting product is likewise described and claimed in another of my copending applications filed of even date herewith.

The products of combustion are drawn off through the gas outlet 60 by means of the connecting tubes 61, 62 and 63 communicating with the respective casing sections 11, 12 and 13. The products of combustion or other gases of reaction are led to a condenser and a water seal. By means of the pipe 70 having the connecting tubes 71, 72 and 73 communicating with the respective sections 11, 12 and 13 of the casing 10, I may admit a suitable gas or gases to the various reaction chambers, such as nitrogen gas, if it is desired to minimize combustion and to carry on the reaction in a neutral or inactive atmosphere, or some other gas or gases which it may be desired to add and which will take part in the reaction, such as a gas calculated to remove in gaseous form

some of the impurities present in the raw material being treated.

By means of the sample test holes 81, 82 and 83, provided with the respective covers 84, 85 and 86, I may withdraw samples from each of the heating zones or reaction chambers from time to time to determine the condition of the material being treated at each of its stages. In this way I am enabled to regulate the speed of feeding the material into the machine, the rate at which the material should be fed through the machine, the rate at which the material should be mixed and stirred, and also the current densities which should best be employed with the particular material being treated in the machine. The finished product passes out of the machine through the outlet 17 into the discharge hopper 18, leading to a bin or other suitable storage receptacle.

The advantages of the foregoing construction are numerous and of great practical importance. The furnace is simple in construction and has comparatively few parts, so that it may be readily built, set up and repaired if necessary. The furnace is so constructed as to effect an accurately regulated heat treatment of the materials intended to be treated in the same, for producing a final product having the desired characteristics. The furnace is also very certain and dependable in operation and requires comparatively little power for mechanical and heat generating purposes. The furnace also makes ample provision for the proper feeding and stirring of the material into, through and out of the same, and for the proper and graduated heating of the material during its treatment within the furnace. Provision is also made for accurate control and regulation of the feeding of the material into the machine through the machine, and out of the same, and for the proper distribution of current through the material being treated. Furthermore, the furnace is capable of continuous, as distinguished from batch, operation. The resulting product is characterized by a high degree of purity, and, in the case where the raw material is either carbonized lignin residues or spent decolorizing carbon, such product is a remarkably pure and highly conductive decolorizing carbon characterized by a remarkably high degree of activation.

It may here be stated that the carbonized lignin residues referred to herein are the residues remaining after leaching the residues obtained by carbonizing the spent or used cooking liquors derived in the treatment of wood by the alkali (soda) process in the production of wood pulp; and that the terms "activation" and "decolorizing", or their equivalents, as used in the specification and claims, include also deodorization, purification and filtration.

It may also be stated that the heat treatment to which the raw material, such as the carbonized lignin residues referred to, is subjected, serves also to volatilize a part, at least, of the more readily volatile mineral constituents of the material being treated to produce the product of the present invention. The product is thus of an unusually high degree of purity and of comparatively low specific gravity, weighing as low as about six, and up to about nine, pounds per cubic foot, whereas the raw material weighs from about eighteen down to about ten pounds per cubic foot. The product is also remarkably porous, of very uniform quality, and of very high efficiency.

Since I prefer, also, that the carbon of the present invention shall, in the course of its preparation, or otherwise, be deprived of a substantial part of the "fines" or finer particles, the presence of which would tend to make the product unstable, to render it more combustible and to diminish its efficiency, which "fines" usually comprise from about twenty, to about thirty, per cent of the weight of the material treated for the production of the product of the present invention, I obtain a product which may be made with a high yield, which is remarkably stable, which is less combustible than other products of a similar nature, which shows a very low percentage of loss during its manufacture, and during its use for filtration and subsequent revivification, and which tends to yield a product of constantly increasing efficiency during successive revivifications.

This reduction in the percentage of "fines", or finer particles, may be effected by admitting air in regulated quantities through the inlet pipe 70 and the branches 71, 72 and 73 of the same leading to the casing sections 11, 12 and 13, respectively. The amount of air, or other oxidizing or oxygen-containing gases, admitted to the heating or reaction chambers within the casing sections 11, 12 and 13 may be regulated by the respective valves 71', 72' and 73'. This amount of air, or its equivalent, may vary for the different chambers, since a greater degree of combustion will generally be desired in the first reaction chamber 11 than in the subsequent reaction chambers 12 and 13. It may here be stated that the heat of combustion resulting from the burning of the "fines" referred to, assists in the treatment of the carbon and reduces the amount of electric current which would otherwise be required to generate the desired degree of heat in each of the reaction chambers. The addition of air, or its equivalent, in regulated quantities, as above set forth, is found to have a very beneficial action upon the product, accelerating the reaction and acting, in some way, to produce

a product of greater purity, apparently by the elimination of some of the more volatile mineral constituents of the raw material being treated for the production of the final product.

Instead of air, or, sometimes, together with air, or in place thereof, as by subjecting the material being treated to alternate treatments with air and steam, steam in regulated quantities may likewise be admitted to the respective reaction chambers within the casing sections 11, 12 and 13, through the inlet pipe 70 and the branches 71, 72 and 73 of the same controlled by the respective valves 71', 72' and 73'. Steam in some way acts to accelerate the reaction, as by breaking down the mineral substances present in the raw material being treated, in this way yielding a product of increased porosity and purity. I may also add to the charge within the furnace an addition agent, such as a fluoride, as sodium fluoride, for example, which would tend to combine with a part or all of the mineral impurities present in the charge within the furnace, particularly silicious mineral impurities, such as silica and silicates, to produce volatile compounds which would thus be eliminated from the final product. Where the mineral impurity desired to be eliminated is silica, and the addition agent sodium fluoride, silicon fluoride is eliminated, with the production of a soluble byproduct which may be eliminated by washing the product. It may also be pointed out that the casing sections 11, 12 and 13 may be of different lengths, thus permitting the raw material to be subjected to treatment for different lengths of time in the respective reaction chambers, depending upon the particular treatment desired to be given such material in the particular chambers and under the particular atmospheric conditions, as to air, steam and products of combustion or other reaction, or otherwise, prevailing in the particular reaction chambers.

For the purpose of comparing the specific resistivity, or conductivity, as desired, of the raw material and of the final product, it may be stated that the total resistance of a mass of the raw material (in this case the carbonized lignin residues referred to) within a tube one inch long and one and seven-sixteenth inches in diameter, under a total pressure of one kilogram, was found to be about 167 ohms, corresponding to a resistance of about 6.28 ohms per cubic centimeter. The total resistance of a mass of the final product within a tube of the same dimensions and under a similar total pressure, was found to be about 33.5 ohms, corresponding to a resistance of about 1.26 ohms per cubic centimeter.

Another very valuable characteristic of the product of the present invention is that

it is almost absolutely neutral, being neutral to phenolphthalein. This is probably the result of the manner in which the carbon is preferably produced, which consists in initially subjecting the raw material to a comparatively high temperature, which apparently converts the sulphates present in the raw material being treated, principally calcium and sodium sulphates, into sulphides, by the reducing action of the carbon, the sulphides, at a comparatively low temperature, being converted into the normal carbonates of calcium and sodium, respectively, to yield a neutral carbon. If the temperature is again raised so as to be comparatively high, the carbonates are apparently calcined and converted into the highly alkaline oxides. This is to be avoided since the neutralization of such an alkaline carbon by the addition of acid will tend to yield an acid carbon, which is highly undesirable, since acid carbons tend to invert sugar, where the carbons are used for the purification or filtration of sugar solutions, while alkaline carbons tend to form slimes which retard the rate of filtration or purification; while the carbon of the present invention, being, as it is, absolutely neutral, no slimes tend to be formed and thus a high rate of filtration or purification is possible, while the absence of acid in the carbon avoids the inversion of sugar if sugar solutions are purified or filtered through the product of the present invention.

What I claim as my invention is:

1. In an electric furnace for the treatment of comminuted, carbonaceous or other material, a substantially continuous cylindrical heating chamber having an inlet and an outlet and a plurality of heating zones of different heat intensities therein, electrodes mounted for rotation within said chamber, means secured to said electrodes for forcing material through said chamber, and means for separately regulating and controlling the heat intensities of said heating zones.

2. In an electric furnace for the treatment of comminuted carbonaceous or other material, a heating chamber comprising a plurality of heating zones of different heat intensities, electrodes mounted for rotation within said chamber, means for charging comminuted material to said chamber, means operable by and upon rotation of said electrodes for feeding said material from one heating zone to another, and means for regulating the relative heat intensities of said heating zones.

3. In an electric furnace for the treatment of comminuted carbonaceous material, a cylinder providing a plurality of communicating heating zones, and separate means for heating each of said heating zones so as to provide heating zones of different heat intensities, and means secured to said heating

means for forcing material through said cylinder.

4. An electric furnace for the treatment of comminuted carbonaceous material and the like, comprising a heating chamber having a plurality of zones of relatively varying intensity the inner wall of which chamber serves as one electrode, and a rotatable electrode within said heating chamber, said electrode being so formed as to serve to advance said comminuted material during the relative rotation of said heating chamber and contained electrode.

5. An electric furnace for the treatment of comminuted carbonaceous material and the like, comprising a chamber having a plurality of communicating heating zones, said chamber having an inner wall serving as one electrode, an electrode within each of said heating zones, and means for effecting relative rotation of the last mentioned electrodes with respect to the chamber.

6. An electric furnace for the treatment of comminuted carbonaceous material and the like, comprising a chamber having a plurality of communicating heating zones, said heating chamber having an inner wall serving as one electrode, an electrode within each of said heating zones, and means for effecting relative rotation of said inner electrodes with respect to the chamber, each of said electrodes being so formed as to serve to feed comminuted material during the relative rotation of the electrode with respect to the chamber from one of said heating zones to another.

7. An apparatus for obtaining a highly activated decolorizing carbon from comminuted carbonaceous and like material, comprising an electric furnace having a plurality of communicating heating zones each including a plurality of cooperating electrodes, and means for passing electric currents of regulated different densities between the cooperating electrodes in the respective heating zones to provide a series of heating zones of different heat intensities.

8. An electric furnace for the treatment of comminuted carbonaceous and like material, comprising a plurality of communicating heating zones each including a plurality of cooperating electrodes, means for effecting the advance of comminuted material from one heating zone to another, and means for passing electric currents of regulated different densities between the cooperating electrodes in the respective heating zones whereby a series of heating zones of different heat intensities are provided.

9. An electric furnace for the treatment of comminuted carbonaceous and like material, comprising a plurality of communicating heating zones, each including a plurality of cooperating electrodes, means for effecting relative rotation of certain of said

electrodes with respect to certain others of said electrodes, certain of said electrodes being so formed as to serve to advance comminuted material from one heating chamber to another, and means for passing electric currents of regulated densities between the cooperating electrodes in the respective heating zones to provide a series of heating zones of different heat intensities.

series of heating zones of different heat intensities, in combination with means for permitting the withdrawal of comminuted material from each of said heating zones for testing purposes.

15. In an electric furnace for the treatment of comminuted carbonaceous material or the like, a chamber for receiving such material, and a plurality of cooperating electrodes forming a plurality of heating zones of different heat intensities, certain of said electrodes serving to advance the material through said chamber, in combination with means for admitting a gaseous reagent to each of said heating zones.

16. In an electric furnace for the treatment of comminuted carbonaceous material or the like, a plurality of communicating heating zones and means comprising a plurality of independently regulatable cooperating electrodes in each of said heating zones for varying the heat in each of said zones relative to the other zones, certain of said electrodes serving to advance the material through said heating zones, in combination with means for admitting and controlling the admission of a gaseous oxidizing reagent to each of said heating zones.

17. An electric furnace for the treatment of comminuted carbonaceous material and the like, comprising a plurality of communicating heating zones, each of said heating zones having an inner wall serving as one electrode, an electrode within each of said heating zones, and means for effecting relative rotation of said last named electrodes with respect to the heating zones, in combination with means for admitting and controlling the admission of a gaseous oxidizing agent and steam to each of said heating zones.

18. An apparatus for obtaining a highly activated decolorizing carbon from comminuted carbonaceous and like material, comprising a cylinder having an electric furnace having a plurality of communicating heating zones, each including a plurality of cooperating electrodes, and means for passing electric currents of regulated different densities between the cooperating electrodes in the respective heating zones to provide a series of heating zones of different heat intensities, in combination with means for admitting air and steam, alternately, to said heating zones.

In testimony, whereof, I have signed my name to this specification this 30th day of March, 1923.

JOHN J. NAUGLE.

10 10. In an electric furnace for the treatment of comminuted carbonaceous or other material, a substantially continuous heating chamber having a plurality of heating zones of different heat intensities therein, means for regulating the heat in each zone relative to other zones, and means for permitting the withdrawal of comminuted material from each of said heating zones for testing purposes.

20 11. In an electric furnace for the treatment of comminuted carbonaceous or other material, a heating chamber comprising a plurality of heating zones of different heat intensities, and means for feeding comminuted material from one heating zone to another, in combination with means for permitting the withdrawal of comminuted material from each of said heating zones for testing purposes.

30 12. In an electric furnace for the treatment of comminuted carbonaceous material, a substantially continuous heating chamber, and means for heating said heating chamber so as to provide heating zones of different heat intensities, in combination with means for permitting the withdrawal of comminuted material from each of said heating chambers for testing purposes.

40 13. An electric furnace for the treatment of comminuted carbonaceous material and the like, comprising a plurality of communicating heating zones, each of said heating zones having a wall serving as one electrode, an electrode within each of said heating zones, and means for effecting relative rotation of said inner electrodes with respect to the heating zones, in combination with means for permitting the withdrawal of comminuted material from each of said heating zones for testing purposes.

50 14. An electric furnace for the treatment of comminuted carbonaceous and like material, comprising a plurality of communicating heating zones each including a plurality of cooperating electrodes, and means for passing electric currents of regulated densities between the cooperating electrodes in the respective heating zones to provide a