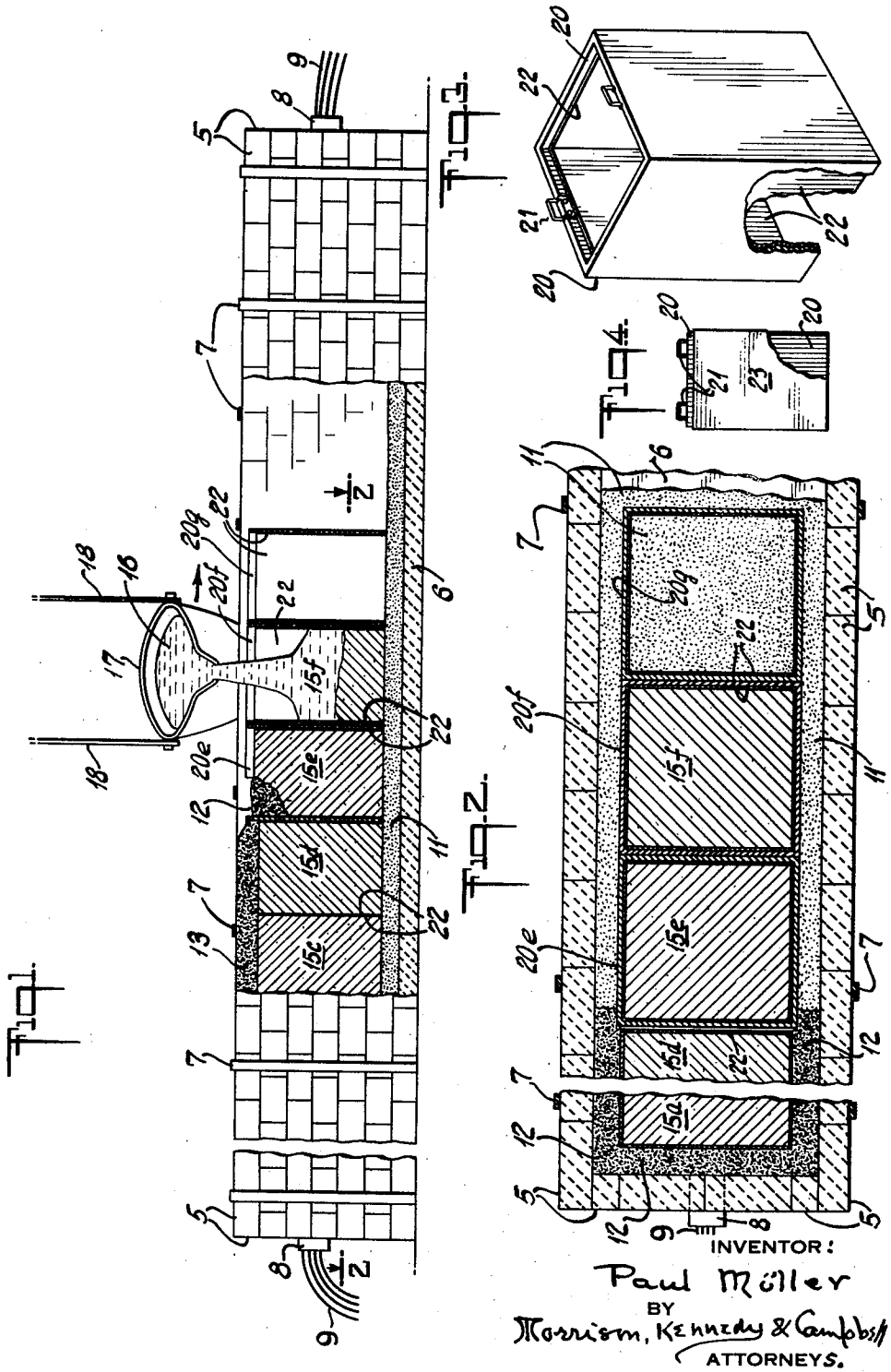
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METHOD OF ARTIFICIALLY PRODUCING CARBONACEOUS COMPOSITION PIECES

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METHOD OF ARTIFICIALLY PRODUCING CARBONACEOUS COMPOSITION PIECES

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1

This invention is a novel method of producing baked carbonaceous articles. Artificially produced carbonaceous composition pieces are used for various purposes, for example for electrodes of arc furnaces, as anodes for the electrolytic production of aluminium, as shaped blocks for the hearths of electrometallurgical furnaces, and like uses.

The conventional method of producing such pieces consists essentially in mixing a raw material composed substantially of carbon (for example ground coke) together with a binder (for instance coal-pitch), thereafter compressing to shape the mixture, and then baking it at a high temperature. The raw materials are thoroughly mixed and at the same time usually also kneaded. According to the composition the mixture in consistency may vary from crumbly to viscous. Generally it is brought into the desired shape by pressing, ramming or pouring when heated to a temperature between 60 and 200° C. Thereupon the baking is carried out; continuing for several hours or days at temperatures attaining for instance 1200° C. During this treatment the binder becomes coked and the amorphous carbon may be transformed gradually into graphite, if the temperatures are sufficiently high, whereby the ash contents become lowered. If the mixture is shaped by pouring, it may be suitable to subject it to vibrations of a frequency of several thousands per minute before baking, according to the process described in the U. S. Patent of Richon No. 2,403,301.

One known method for the manufacture of shaped carbonaceous-composition pieces consists in compressing the mixture, then taking the compressed pieces out of the form and introducing them while still hot into a baking furnace. With this method it is suitable to coke the surface of the hot shaped pieces before introducing them into the baking furnace, this coking step being done by putting the pieces on glowing iron plates, after wrapping them in paper in order to avoid a direct contact with the glowing metal.

According to another known method comminuted mineral coal, still susceptible to baking, that is to say not coked, or only incompletely coked is poured into a receptacle in which it is heated until it is completely coked.

According to still another known method, the carbon pieces are produced in a mold under pressure and at dull red heat, whereupon they are unpacked and removed out of the mold and subjected to a further heating until substantially all the carbon is transformed into graphite.

2

Such a method is suitable principally for making artificial carbon pieces of relatively small size.

Also, gas heated annular kilns are used for baking the shaped carbon pieces. But electric resistance furnaces may also be used, which, like the gas heated ones, contain a filling powder in which the artificial carbon pieces are embedded; and metallic conductors, which serve as heating conductors, may be disposed in the filling powder.

The present invention relates to a method of artificially producing carbonaceous composition pieces, this new method involving improvements including, important simplifications or compared with the known processes, and being therefore more economical. According to the invention, each carbonaceous raw mass composed substantially of carbon (for example ground coke) with a binder (for instance coal-tar pitch) is introduced directly into the baking furnace, suitably in the warm and pasty state, in such a manner that it is surrounded by the filling powder after its introduction, and is then baked without any change of position, preferably until complete graphitization. In electric resistance furnaces in which the heat is produced in the interior of the carbonaceous mass or of the filling powder or of both, it is found most suitable that with several artificial carbon pieces they form a row without intervals.

If the artificial carbon pieces occupy a sufficient height in the furnace before baking, for example in the case of large electrodes, it is observable during the electric baking with heat generation in the interior, that the lower strata of the charge are hotter than the upper ones, because the latter are less compressed and present therefore a greater resistance to the electric current than the lowered strata, and because the heat losses are greater at the top, if the furnace is not provided with a well heat-insulated cover. Therefore each mass is baked gradually from the bottom to the top and a setting of the mass takes place during the baking; this setting being very advantageous because it increases the density of the baked pieces. If the height of the artificial carbon pieces is sufficiently low, this phenomenon does not take place as the temperature differences are vertically too small. With gas heated furnaces the heat is not produced in the interior of the carbonaceous mass or of the filling powder but is supplied from the exterior, so that the advantageous setting cannot take place; on the contrary, the baking proceeds at all sides from the exterior to the in-

terior and in some cases blow-holes are formed or inner tensions occur which lead to the bursting or rupturing of the pieces. According therefore to a further improvement of the invention the baking is carried out in electric resistance furnaces, and the height of the artificial carbon pieces in the furnace is chosen in such a manner that substantial temperature differences occur between the lower and the upper parts of the pieces and that the baking proceeds gradually from the bottom to the top.

It is possible to prepare and dispose the filling powder so that it is provided with the necessary mold spaces for the reception of the carbonaceous mass; in this case the filling powder answers the same purpose as the sand used in the casting of metals in sand molds.

A very practical and advantageous mode of operation with this invention consists in placing on the furnace sole, which has been covered with a layer of filling powder, sheet-metal boxes which have no bottom nor top walls and are therefore provided only with side walls, and filling the interspaces between boxes and walls with filling powder. The carbonaceous mixture is then poured into the sheet-metal boxes, the boxes are drawn away vertically and the whole assembly is covered with a layer of filling powder. The sheet-metal boxes are immediately ready for reuse. In order to avoid the artificial carbon pieces sticking together and to the filling powder the boxes may be lined with paper or wrapped in paper before pouring the carbonaceous mass. When the boxes are drawn away upwardly as above stated, being made bottomless for this purpose, the paper remains behind and forms a separating layer which is coked during the following baking, and thus prevents a sticking of the artificial carbon pieces, and moreover leaves on their surface a hard layer, with the effect that the filling powder can be very easily detached from the baked carbon pieces. The sheet-metal boxes are suitably made from sheet-iron, but can of course be made also from another metal. Each of the open-bottom boxes or molds is lifted out of the furnace after the pouring but before the baking of the mass, as already recited, to secure the advantages and results of the invention. This leaves no metal subject to melting, possibly to impair the product; this advantage prevailing even if the baking is continued until complete graphitization. The molds are salvaged unimpaired and ready for immediate reuse, reducing the operations. Also the costs are minimized both as to supplying many molds and storing them. These process factors may be summed up as charging the raw mass into the sheet-metal bottomless molds or boxes as the latter rest upon the filling layer which covers the furnace sole, with filling powder also surrounding the molds; and thereupon drawing away vertically the molds, and then completing the filling of the furnace with a layer of powder to cover the charges, all preparatory to the actual baking.

It is most suitable to bring the carbonaceous mass to the baking furnace and to pour it into the mold under avoidance of heat losses as far as possible (the mass already has been heated to 140–200° C. for the steps of mixing and kneading). In this manner waste of heat energy is avoided and the duration of baking is shortened.

In some cases it may be suitable to pour the warm, well mixed carbonaceous mass firstly into briquette forms and to introduce the solidified briquettes into the furnace after heating them again, or without reheating, as is done with self-baking electrodes. In these cases boxes made from thin wood or from cardboard can be used instead of sheet-metal boxes. The baking can be carried out in gas fired annular kilns. But the electric resistance furnaces are the most suitable; in these furnaces the carbonaceous mass to be baked provides the resistance. As the carbonaceous mass freshly filled in has only a very low electric conductivity at the beginning, heat may be produced in special heating conductors at the beginning of the baking. For this purpose it is suitable to use the filling powder at least partly as a heating conductor. In this case the filling powder answers three different purposes, namely: it maintains the artificial carbon pieces in the desired shape, it absorbs the volatile constituents which escape from the carbonaceous mass and it conducts the electric current. For this purpose the filling powder consists advantageously of coke such as is used in a known type of electric resistance furnace. Besides coke there can be used as filling powder for instance, mixtures of ground coke with bauxite powder, graphite, anthracite or alumina. After the burning the filling powder sticks generally together and must be broken. The detaching from the artificial carbon is very easy.

The carbonaceous mass may be subjected to high-frequency vibrations before or after pouring.

The method according to the invention is especially advantageous for the simultaneous production of several electrodes in one furnace. Of course it is also possible to manufacture artificial carbon pieces separately, such method being most suitable for the production of large electrodes, which may have any desired shape. It is even possible to provide the carbon pieces with grooves and mortises, for example by disposing wood pieces, the carbonised residues of which may be removed after the baking.

The method and principles hereinabove disclosed may be carried out in different forms of furnace, of which that shown in the drawings is a typical example. The furnace may be for example 1.5 meters wide and 1.7 meters high, and of extended length to permit charging the furnace with an extended row or series of molds so that a single baking can turn out a considerable number of products. Fig. 1 is a side elevation of an electrical resistance furnace suitable for the purpose; with its middle portion shown in longitudinal vertical section to disclose the characteristic molds and other elements; the furnace being in the process of being charged with a row of poured and molded articles, to be simultaneously baked into a number of products. Fig. 2, in top plan view on a larger scale than Fig. 1, is a horizontal section on the line 2—2 of Fig. 1. Fig. 3 is a perspective view of one of a series of the individual metal molds, containing sheets of lining material, such as paper, to serve as separators or septums between, and thus constitute wrappings for, a row of the articles to be baked. Fig. 4 is a side elevation of a modified arrangement wherein the septums or paper separators are placed outside the metal molds and thus constitute wrappings for the molds.

In the selected illustration the furnace is bounded by its side and end walls **5**, composed of refractory material such as firebricks, and at the bottom a similar wall **6** constituting the sole of the furnace, no rigid cover being necessary. Metallic frame parts may be embodied in the furnace, e. g. straps **7**, as of steel, which may sur-

round and bind the refractory walls at the sides and ends.

The generation of heat is on the electrical resistance principle; for which there is shown an electrical terminal member 8 at each end operating to carry the power into the furnace interior, to operate upon the charged contents of the furnace, the molded masses and filling powder, to develop the necessary high baking temperatures. For each lead-in terminal 8 there is shown an exterior conductor or cable 9 energized from a convenient power source at appropriate potential and current.

For the purpose of isolating and supporting the articles to be produced these are, during the baking period, surrounded by a filler or powder 11 consisting preferably of a body of ground coke, which thereby acts like a sand or similar mold, confining and maintaining the shape of the masses until baked. Thus, first, within the bottom of the furnace, is a layer 11 of the filling powder, overlying the sole to a substantial depth and serving initially as a support for the metal molds and shaped products within the furnace. This layer 11 appears in Fig. 1 also in Fig. 2, while Fig. 2 shows similar upright deposits or layers 12, inserted progressively between the introduced molds and the side and end walls of the furnace; so that, when fully charged, the complete row of articles, ready for the baking step, is surrounded and enclosed at bottom and sides. By way of completing the enclosing of the mold series and products there is preferably added a top layer 13, overlying the articles to a substantial depth as seen in Fig. 1.

The lengthwise row of products 15, whether electrodes for arc furnaces or other articles to be more or less graphitized, may extend substantially from end to end; the first molded mass 15^a being shown at the left in Fig. 2, the adjacent gap indicating one or more articles 15^b, 15^c, the latter showing in Fig. 1, followed by product 15^d seen in Figs. 1 and 2. Down to this point in the charging operation the molds have been extracted, relying upon interposed septums to maintain separation between products. Product 15^e has been completely cast, but its mold not yet lifted out, while the next product 15^f is shown being poured, into the next mold 20^f. Other spaces beyond are yet to be provided with molds 20^g etc. and poured to complete the charging of the furnace.

In Fig. 1 the molten and flowable carbonaceous mass is shown being poured from a supply mass 16 contained in a ladle 17, which is tiltably supported, as by rods 18, and can be shifted along from mold to mold, during charging, in the direction of the arrow.

Of the molds 20, three or four may suffice for charging a long furnace, having capacity for six or more molds, namely, by reason of each mold upon extraction being advanced to and applied at a new position . The molds may be like boxes, of sheet iron, of various sectional shapes, as round, but square being shown. The sides of each mold are closed but the top and bottom are open. When set in, each mold rests on the previously laid filler layer 11 over the sole 6.

The oldest mold that appears in Figs. 1 and 2 is mold 20^e, containing product 15^e, the previous molds having been withdrawn. After the initial or partial setting of the mass 15^e its mold will be lifted out, away from the mass. The mold 20^f is seen having the mass for the next product 20^f poured into it. An empty mold 20^g has been placed, ready for the next pouring thereafter, from the advanced ladle. As the setting down into place of the molds proceeds, the filling powder 12 may be placed between the mold row and the end and side walls, with compacting if desired; and as the removal of molds progresses the supplying of filling powder for the top layer 13 may be carried along, so that finally the row of products, about to be backed, becomes wholly embedded in and isolated by the filler material, which serves also as a resistance heat source, and a conductor adapted to transmit heat to the articles to be baked. By allowing an appreciable space between each two molds, these spaces, upon the extraction of the molds may be filled or stuffed with filler before baking, affording more complete heat penetration. Lifting eyes or handles 21 on the molds, Fig. 3, help in depositing and withdrawing them.

It is of important advantage to provide, for each mold and product, a septum or separating liner 22 of thin sheet material, preferably paper, arranged in tight sheet contact within the mold. As shown, the liner or other septum 22 may be slightly less tall than the mold, reaching almost to the top, and providing a guide in the pouring of the warm pasty material into the mold, as well seen in Fig. 1; the additional height of the mold assisting in its extraction, aided by the eyes 21. The paper septum prevents both the sticking of the poured article to the mold and the sticking of adjoining articles to each other. The paper during baking may become coked or incinerated under the high temperature, but nevertheless retains its function of maintaining separate the baked products.

A lining or interior septum 22 is generally satisfactory, but in some instances a wrapping septum has advantages, and Fig. 4 shows such, the septum 23 surrounding the metal mold 20. The mold, when lifted out between the poured mass and the exterior seutum, leaves the mass wholly separated from the next adjacent masses, preventing sticking.

The progress of the charging of the furnace, from the viewpoint of each rigid mold 20 and the article formed therein, may be described beginning with the empty mold 20^g, provided with its septum in the form of wrapper or liner. Next, the mass for each mold is poured and the mold substantially filled in the manner shown at the mold 20^f, the product 15^f being built up to the desired shape. When filled, and until initial hardening, the condition is shown by the mold 20^e containing the product 15^e. Then the mold is lifted out, leaving the products each surrounded by its septum or liner, as shown by the products 15^d, 15^c, 15^b and 15^a. When the entire row or series of products has thus been molded and the molds removed, further filling powder may be placed within all of the furnace spaces not theretofore filled and up to the level of the tops of the side and end walls, as shown in Fig. 1, the top layer 13 serving as a cover, no other cover to the furnace being necessary. When all of these charging steps are attended to the furnace is ready for the baking operation. A conventional switch, not shown, is thrown to apply the current through the cables 9 and terminals 8 to and through the filling powder layers and the embedded products; whereupon the necessary interior temperatures are progressively developed and transmitted to the products, the process requiring no further attention other than awaiting the necessary baking interval.

I claim:

1. The method of producing baked carbonaceous articles, such as electrodes for metallurgical furnaces, carried out with the aid of molds open at top and bottom in an electric-resistance baking furnace in which heat is generated by electric current passing through an interior body of carbonaceous filling powder which is of high-resistance conductivity; said method comprising placing a bottom layer of the filling powder on the sole of such a furnace, and, for each article to be produced, setting upright such a mold upon such bottom layer; then filling the interspaces between each mold and the furnace lateral walls with the filling powder; then charging into the mold a raw carbonaceous mass, composed substantially of a finely divided carbon material premixed with a binder material, adapted when warm to become pasty and take the required form in the mold; then extracting upwardly the mold leaving the unbaked molded mass or article supported below and laterally by the filling powder, then completing the surrounding of the molded article by applying upon the article an enclosing protective top covering, and then, while retaining the formed and embedded article in its unchanged molding position in the furnace, subjecting it to an elevated baking temperature at least until the hardening of the article by passing an electric current through the filling powder within the furnace, such current passing progressively also through the hot carbonaceous article itself in the course of the baking.

2. The method as recited in claim 1 and wherein the carbonaceous mass to be baked is composed of a finely ground coke mixed with a coaltar pitch; and wherein the mass is prewarmed and charged by pouring in pasty condition into the mold.

3. The method as recited in claim 1 and wherein the carbonaceous mass is in the form of small solid briquettes adapted to be charged as such and to become warmed, softened and molded by the starting of the baking stage.

4. The method of producing baked carbonaceous articles of a form determined by thin-walled box molds open at top and bottom and carried out in an electric-resistance baking furnace in which heat is internally generated by electric current passing through a high resistance carbonaceous filling powder; said method comprising placing a bottom layer of the filling powder on the furnace sole and positioning upright thereon a series of the molds while associating with each thereof a thin septum of paper-like material by placing it to serve as a separator between articles during baking; filling the interspaces between each mold and the furnace lateral walls with the filling powder; charging a carbonaceous mass, composed substantially of a finely divided carbon material premixed with a binder material, directly into each box mold to take the required form of the article; extracting upwardly each mold while leaving each unbaked molded mass or article supported below and laterally by the filling powder, and also leaving the separating sheet in position between the formed articles; applying over the molded articles an enclosing protective top covering of high-resistance filler within the furnace; and then, while retaining the formed and embedded articles in their unchanging molding positions in the furnace, subjecting them simultaneously to an elevated-temperature baking operation at least until the hardening of the article by passing an electric current through the filling powder within the furnace, during which baking operation the paper-like septum sheet functions to protect each article from adhering to filling powder and to adjacent articles, both before and after the disintegration by coking of the septum.

5. In the art of molding a carbonaceous mass to the form of a desired product or article and baking it to hardness in an electric furnace, with the aid of a loose mold open at top and bottom, and wherein the mass is a premixture of a finely divided carbon material and a binder material and is adapted under heat to soften to moldable consistency but with prolonged subjection to high temperature to become baked to permanent hardness; the method of charging such furnace consisting in, first, laying upon the furnace sole a substantial bottom layer of a suitable filling powder possessing high-resistance conductivity; then introducing into the furnace a loose mold for each article to be formed and positioning it to stand upright to rest removably upon such bottom layer; adding filling powder to fill the interspaces between the loose molds and the furnace walls, and at the same stage warming the mass to pasty consistency and charging it into each such loose mold to take the desired form of the article; extracting bodily upwardly each such mold leaving the molded mass supported underneath and laterally by the filling powder acting as an enclosing mold, and then placing in the furnace further filling powder including a substantial top layer covering and completing the embedding of the formed article in readiness for the application of electric power to generate baking heat in the filling powder and molded masses.

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