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METHOD OF MAKING CATHODIC ELECTRODES FOR ELECTROLYSIS FURNACES

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Fig. 1

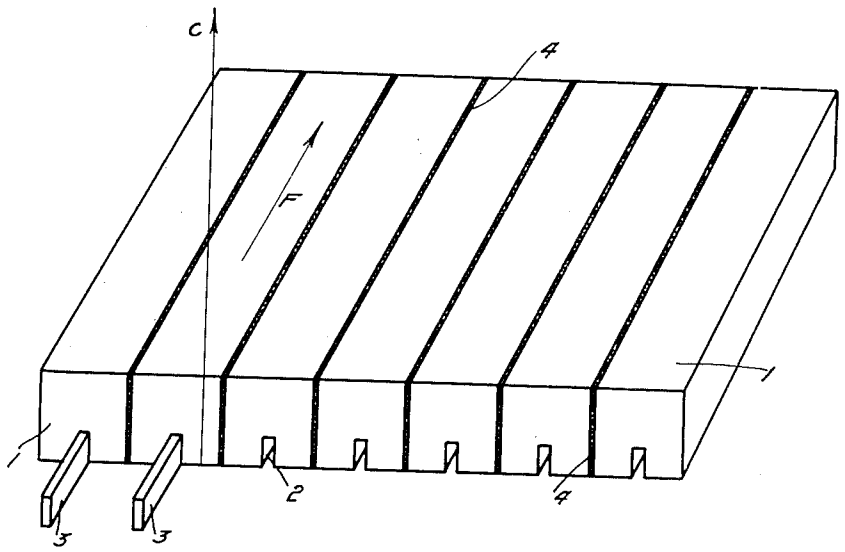
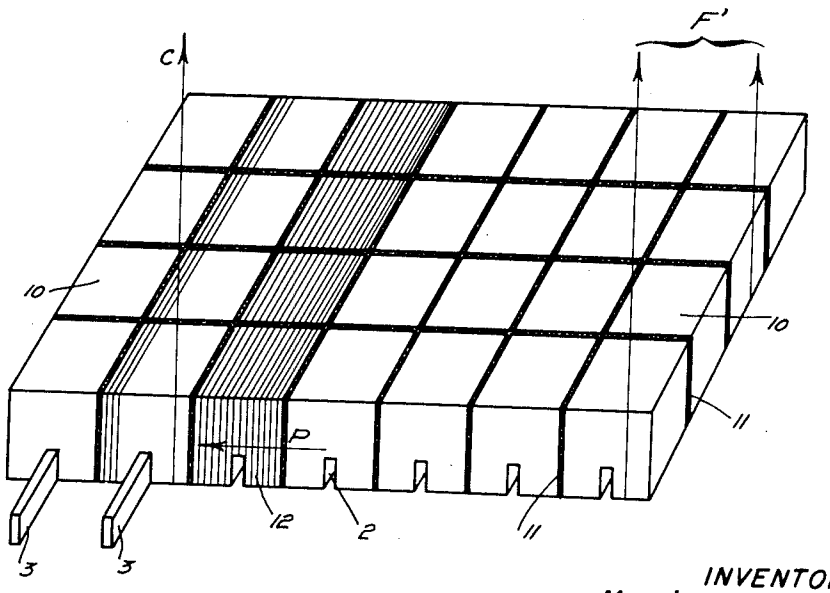


Fig. 2



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METHOD OF MAKING CATHODIC ELECTRODES FOR ELECTROLYSIS FURNACES

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3 Claims. (Cl. 18—54.7)

The present invention relates to cathodic electrodes for electrolysis furnaces.

One object of the present invention is to provide a method for the manufacture of one-piece cathodic electrodes for electrolysis furnaces, particularly for furnaces for the manufacturing of aluminum, from unfired or crude carbon blocks.

Another object of the invention is to provide cathodic electrodes having a low resistance to the flow of electric current.

Still another object of the invention is to facilitate and simplify the manufacturing operations for the construction of such electrodes.

It is known that aluminum is generally manufactured by electrolysis of alumina, dissolved in a melt of cryolite. This electrolysis is carried out in special furnaces in which electric current is supplied through carbon electrodes, one of which, the upper electrode, plays the part of an anode, the lower electrode playing the parts both of a cathode and of a refractory container for the electrolysis melt.

The anode is frequently obtained from a mixture of carbon grains and dust with a hydrocarbon binder, said mixture being shaped by extrusion, compression or any other method and then fired in special furnaces before being placed in the electrolysis tank. It is also known, however, to use so-called "self firing" anodes, consisting of a casing, generally made of aluminum sheet, filled with an unfired or crude paste of carbon grains and dust mixed with a hydrocarbon binder; such anodes, placed in working position when crude, are fired in the very furnace in which they are used. This method leads, among other advantages, to the saving of the preliminary firing of the paste forming the anode.

Along the same line it could be conceived to save also the preliminary firing of the cathode and to place crude cathodes in the electrolysis tank. However, considering that the cathode plays also the part of a refractory container for the electrolysis melt, said cathode must be absolutely tight and, particularly, must offer no crack which could lead to the penetration of the electrolysis melt therein. Thus a cathode may be quite pervious to melted metal and, generally, to the electrolysis melt, even when the permeability of the individual blocks which form it is low, if the blocks are poorly bonded together. The penetration of the melt inside the cathode causes, among other drawbacks, a poor quality of the metal produced and a rapid destruction of the cathode which makes it necessary to interrupt production prematurely.

When setting a tank into operation, the voltage drop in the cathode, which is difficult to measure with any accuracy, is of the order of 200 to 250 millivolts. This voltage drop begins to increase after a few months of operation, it then increases rapidly and at the time when it is found necessary to put the tank out of working, the said voltage drop generally reaches from 500 to 1000 millivolts, as an average 600 to 700 millivolts. The

difficulty of obtaining tight cathodes caused the unburnt cathodes to be abandoned long ago. Consequently, cathodes are generally made out of previously fired carbon blocks, separated from one another by joints of small dimensions filled with a crude brasque consisting of a mixture of carbon grains and dust with a hydrocarbon binder generally having a low melting point. It is therefore always necessary to perform a previous firing of the individual blocks.

It is also known to manufacture cathodes by tamping crude brasque over their whole area and thickness, the firing being carried out in the proper furnace in which they are to be used. Such a method, however, involves some difficulties and drawbacks, the main four of which are detailed hereafter.

Generally, no powerful hydraulic equipment is available on the spot for shaping the brasque or paste; for this operation, low power pneumatic or electric tampers have to be used, which are unable to compress the paste on a large thickness as must be the case for a cathode (400 to 500 mm.). Therefore, the paste must be tamped in successive applications, i. e. in fairly thin layers not exceeding 5 cm. in thickness, which are tamped one after the other. This method of shaping causes a tendency to laminating, with the consequence of a separating of the various layers from one another, and of a penetration of the bath inside the cathode, leading to its premature destruction.

During the tamping operation, the paste delivered from the mixers is actually at a temperature much higher than that of the melting point of the binder; but it has to be spread in thin layers, over a large area (that of the tank), in a medium which is at room temperature (much below the melting point of the binder). Such operative conditions are favourable to a rapid cooling of the paste. Now, the viscosity of hydrocarbon binders usually employed in the electrode industry doubles when the temperature drops by 7 degrees centigrade. The result is that the viscosity of the paste during the tamping varies from one moment to the next and may become such that the shaping of said paste be practically impossible. Particularly, pastes usually employed for electrodes, and in which the binders are dry pitches having high melting points (70° C. and above) cannot be used in such conditions; pastes must be used which contain binders with low melting points (40–45° C.). Such binders however have the drawback of having a lower, fixed carbon content (coking residue), and, consequently less favourable agglomerating properties.

It is difficult to tamp the paste inside a mould having large horizontal dimensions. Now the aluminum tank, before it is lined, actually forms such a mould. Under the action of the tamping tool, the paste, which is not held by adjacent vertical walls, is pushed horizontally around the tamping tool, which is also a favourable condition for laminating. By partitioning the tank and tamping the fractions thus constituted one after the other, this phenomenon is only restricted.

Any shaping process such as extrusion, compression, vibration, tamping, ramming, and the like, creates an orientation of the paste layers or strands, and of the particles which form said paste; the result is that products intended to lead electric current, and manufactured by means of such processes have, a resistance to the flow of current, which is a minimum in the plane of the layers or in the direction of the strands and a maximum in the perpendicular direction. Now it is well known that the method of manufacturing of cathodes by tamping of brasque leads to a horizontal orientation of the paste layers, and of the particles which form said paste. A cathode manufactured by such a method, therefore opposes a maximum resistance to the flow of current which cir-

culates vertically between the anode and cathode, through the bath, which among other drawbacks, increases the voltage drop in the cathode.

It was already known, further, in other industries, to use initially crude refractories. Thus the hearth, base block and even boshes in blast furnaces are sometimes made of a tamped, crude carbon brasque or mass. In open-hearth furnaces also, crude magnesia bricks and, in some other furnaces, crude prefabricated blocks of refractory chamotte and melted cement have been used.

It has heretofore been impossible, due to the above mentioned difficulties and drawbacks, to prepare crude carbon cathodes for electrolysis furnaces, such as those used for aluminum, presenting lasting qualities and, at the same time good working conditions.

Now, it has been found that, when starting from crude carbon blocks, excellent cathodes may be obtained, which obviate the drawbacks met heretofore.

The improved method according to the present invention comprises forming crude blocks of carbon by shaping, for instance moulding or extruding under pressure, a crude paste consisting of carbon and a hydrocarbon binder while keeping said paste at a uniform degree of viscosity, assembling said blocks to the shape desired for the cathode, binding them together by means of crude brasque joints, and firing the so obtained cathode in the electrolysis furnace proper.

For the preparation of individual blocks, all usual hydrocarbon binders may be used, including those having a high melting point, a high fixed carbon content and consequently a maximum of agglomerating properties.

The carbon which is used is not different from that generally used for the manufacturing of electrodes.

The blocks are shaped in temperature controlled capacities (moulds, dies, or the like), which are adapted to keep the paste, during the entire shaping operation, at a temperature and consequently at a viscosity which are uniform throughout the mass. Furthermore, the shaping may take place under a very high pressure, which may also be controlled.

The blocks or bars thus obtained may be cut and, generally speaking, machined in such a manner that they can always be arranged with the desired orientation of the layers or strands of paste and of the particles which form said paste, and particularly with such an orientation that the said layers and particles are parallel with the direction of the flow of current through the electrolysis tank, in order that the cathode offers a minimum resistance to the flow of such current.

By operating according to the present invention, a series of advantages are obtained, either from the point of view of production or from the standpoint of the properties imparted to the manufactured electrodes. The cost of unburnt blocks is generally lower than that of pre-fired blocks and the positioning of a cathode according to the invention requires less labour than that of a cathode made entirely of brasque.

In addition, in view of the fact that the physical condition of the carbon blocks and the brasque paste forming the joints is the same, an excellent bonding is thus obtained between the blocks and consequently the cathode is truly a one piece member. The carbon blocks themselves, made in one piece, for instance by extrusion in powerful hydraulic presses, do not have the above mentioned lack of homogeneity and, in particular, are not laminated. These combined factors impart to the cathodes according to the invention a substantially longer life than that of known cathodes.

Furthermore, all the above recalled difficulties and complications resulting from a premature cooling of the paste under working, are avoided and it is possible to use, for agglomerating, dry pitches with high melting points, having the highest agglomerating power.

Finally, at the time when the furnace is started, the blocks of crude carbon, passing through a plastic condition, are in a better condition for withstanding deformations due to possible outside stresses (expansion stresses for instance), than prefired blocks which have been already subjected to inner stresses resulting from their firing.

Two embodiments of cathodes manufactured according to the invention are described hereafter, reference being had to the appended drawings, in which:

Fig. 1 is a perspective view of a plane cathode formed of juxtaposed bars;

Fig. 2 is a view similar to Figure 1 of a modified construction made out of smaller elements.

The cathode shown in Figure 1 is formed of bars 1 having a square section and arranged side by side. Said bars comprise grooves 2 for housing current input rods 3. They are united together longitudinally by brasque joints 4.

The cathode shown in Figure 2 consists of substantially cubical blocks 10 arranged checker board fashion and connected together by brasque joints 11.

In both cases, the cathode assembly is in a crude condition. Vertical arrows C show the direction of the current flow.

The first type of embodiment which corresponds to Figure 1 calls for square section bars 1, for instance 500 by 500 mm. having a length of 2,400 meters.

Said bars were obtained as follows:

A mixture containing 82% of strongly calcined anthracite grains and dust, and 18% of coal tar pitch having a "Kramer" melting point of 85° C. was kneaded to a paste. Said paste was placed at a temperature of 105° C. in a 6.000 metric tons extrusion press and extruded thereby through a die having a square opening of the size required for the bar. The extruded bars were cut to the desired length of 2.400 meters and machined by planing to form the grooves 2 for the rods 3. After having been fitted with said rods, the bars were arranged horizontally on the bottom of the tank, parallel to one another (the direction of their extrusion F is horizontal), said bars being separated laterally from one another by joints 25 mm. wide. Then a brasque was kneaded, consisting of 84% of strongly calcined anthracite fine grains and dust and 16% of a coal tar pitch having a "Kramer" melting point of 45° C.; this brasque was then introduced into the joints at a temperature of 60 to 70° C., by an exhaustive tamping by means of pneumatic tampers. A one piece, crude cathode was thus obtained, offering little resistance to the current flow.

The "Kramer" melting point may be defined as being the temperature at which a drop of mercury, placed on top of a plug of solid pitch, arranged at the bottom of a tube dipping into a liquid which is being heated, goes through said pitch plug when the latter melts due to the heating of the liquid. This test is delicate and the prescribed operating method must be followed very strictly to obtain results capable of duplication.

As a modification of this first embodiment, bars prepared in the same conditions as above were cut, on their issuing from the die, into cubes 10, with sides of 500 mm. These cubes were machines, as above mentioned, and positioned in horizontal rows provided with a continuous groove 2, each block being oriented so that the direction of extrusion F' (Figure 2) be vertical. The cubes were separated from one another in all directions, by joints 25 mm. wide which were filled with crude brasque obtained and introduced according to the above described method.

In another embodiment, a paste having the same composition as above described was shaped, in a compression press, under a pressure of 600 kg./sq. cm., into cubes 10 with 500 mm. sides. After machining said cubes for providing grooves 2, these blocks were arranged on the bottom of the tank so that the direction of compression P was horizontal (Figure 2) (the planes of orientation of the paste then being vertical, as shown at 12), said blocks

being separated from one another, in all directions, by 25 mm. joints which were filled with crude brasque according to the above mentioned method.

What I claim is:

1. A method for the manufacture of a one-piece cathode for an electrolysis furnace, comprising the steps of preparing unfired carbon blocks by shaping under pressure a paste consisting of comminuted carbon and a hydrocarbon binder while keeping said paste at a uniform degree of viscosity, assembling in said furnace said blocks in the shape desired for the cathode and to constitute substantially the whole area desired for the cathode except for relatively narrow joints between the blocks, uniting said blocks together by tamping in the joints unfired carbon brasque having substantially the same composition as said blocks and firing the obtained cathode in said electrolysis furnace.

2. A method according to claim 1, wherein the unfired carbon blocks are prepared by compressing the paste in molds under high pressure at such a temperature that a uniform viscosity is preserved throughout the mass during the whole compressing operation.

3. A method according to claim 1, wherein the unfired carbon blocks are prepared by extruding the paste under a high pressure at such a temperature that a uniform viscosity is preserved throughout the mass during the whole extruding operation.

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