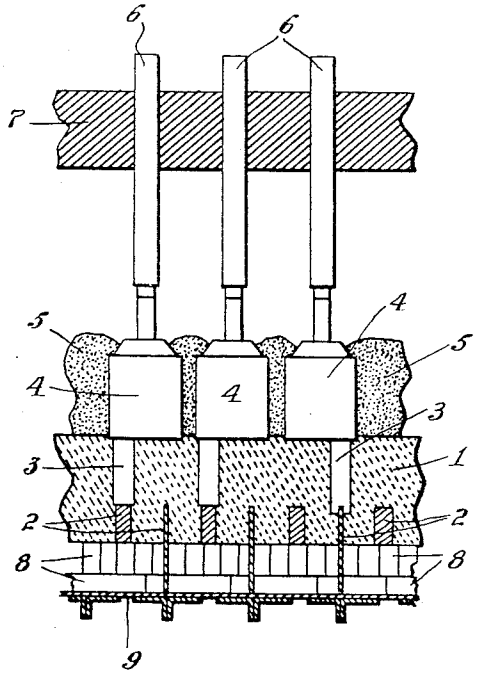
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METHOD FOR MAKING FURNACES FOR THE ELECTROLYTIC PRODUCTION OF ALUMINIUM

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METHOD FOR MAKING FURNACES FOR THE ELECTROLYTIC PRODUCTION OF ALUMINUM

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This invention relates to a new method for making furnaces for the electrolytic production of aluminum.

In the furnaces generally used for the electrolytic production of aluminum, the sole is made from a carbonaceous mass in which are disposed metallic conductors (usually iron conductors) which serve for the current supply.

The sole (or furnace bottom) is generally built up from baked carbon blocks or formed by ramming a raw carbonaceous mass and then baking it. The inner walls (lining of the walls) are made on a similar way, as far as they are composed of carbon or graphite. According to a recent method, one builds up the furnace bottom with a relatively small number of artificial carbon pieces having the desired shape, these artificial carbon pieces being obtained from a poured carbonaceous mass which has been submitted to mechanical vibrations of high frequency (several thousands a minute) before baking. According to this recent method, it is possible to make in a single piece a part of the wall together with a corresponding segment of the furnace bottom.

The baked carbon blocks (carbon compressed in a press or carbon obtained by pouring an artificial carbonaceous mass) must be joined together with a minimum of interspaces; this is difficult to realize and takes a long time. The method of leaving intentionally interspaces which one fills up afterwards by ramming is time-killing. On the other hand, the baked carbon blocks have the disadvantage that they expand with a different coefficient than that of the brickwork of the furnace shell at the starting of the furnace, so that inner tensions, which cause fissures and deformations, occur inevitably. The inner tensions which may be already present are suppressed during the heating and are then responsible for the formation of fissures and deformations.

The making of furnace soles and wall linings (inner walls) by ramming a carbonaceous mass needs also a great amount of work. If the ramming be not carried out in an appropriate manner, there may occur irregularities which cause troubles in the service of the furnaces. As the carbonaceous ramming mass becomes hardly pasty during the heating, it cannot fill the narrow interspaces of the brickwork when starting the furnace.

The mentioned disadvantages are avoided or at least greatly reduced when applying the method according to the invention.

The single figure of drawing shows diagrammatically in vertical section a short extent of the length of a furnace bottom and parts thereabove embodying the present invention. A prior instance of a furnace for electrolytic reduction of aluminum is shown in United States patent of Eigenheer No. 1,930,195 of October 10, 1933.

The invention is a method characterized by the fact that the furnace bottom (or furnace trough) is made, at least partly, by pouring a carbonaceous mass 1 into the furnace shell 8, 9 and then baking this mass. The artificial carbon mass used for this purpose is made from a mixture of a raw material composed substantially of carbon (for example ground coke) together with a binder (for instance coal-tar pitch) in such proportions that the mixture becomes sufficiently pasty for pouring when heated for instance to 140 to 200° C. By cooling it hardens again.

Applicant has found that it is advantageous to submit the artificial carbon mass to vibrations of high frequency (several thousands per minute, preferably over 6000 per minute) before baking. For vibrating the mass one uses most advantageously vibrating devices such as are utilised for the vibrating of cement concrete; one immerses the vibrating device into the artificial carbon mass. The vibrations are carried out preferably before pouring; it is however possible, although less easy, to execute the vibrating of the mass in the furnace itself during or after pouring (of course before solidification of the mass takes place).

It is generally preferable to make in this manner both the furnace bottom and the side walls of the furnace. In certain cases it may be suitable to form the sole and the walls partly from already baked carbon blocks and to pour round them a raw mass of artificial carbon.

The baking is preferably carried out by means of an electric current sent through the mass. However the poured artificial carbon mass has only a very low electric conductivity before baking. On the other hand, it becomes again so pasty at the beginning of the baking operation that the carbon anodes 4 which are preferably used for the current supply may sink into the mass and deform the surface of the sole in an undesirable manner. The inventor takes account of both facts by disposing and embedding in the poured artificial carbon mass pieces or rods 3 of carbon already baked in order to obtain a good electric connection between the anodic current supply above and the cathodic current supply below and to allow the baking of the mass in an economic manner; these blocks of baked carbon ensuring on the other hand that the carbon anodes,

as far as they are used for the current supply during the baking, are maintained at the right distance from the iron or other metallic conductors 2 disposed in the furnace bottom. These baked carbon pieces may have any suitable shape; they may be for instance prisms or cylinders from baked carbon or from graphite. These baked carbon pieces are designated hereafter by the expression "conducting distance pieces." It is advantageous to have care that the upper ends of the pieces 3 are disposed a little lower than the height or top level of the surface of the sole or mass 1, in such a way that the carbon anodes may enter into contact also with the poured artificial carbon mass, which at the beginning does not conduct the electric current, but becomes gradually conductive during baking. After having disposed and positioned the conducting distance pieces 3 one pours the artificial carbon mass, heated for instance to 140–200° C., up to the desired height. One spreads it uniformly and allows it to cool down. One dresses then the surface of the sole in order to make it concave, the depth of the cavity being for instance 3 cm. It is also possible to obtain this shape of the surface by means of a template which is pressed into the still pasty mass. After having established the connections an electric current of such intensity is sent through the furnace that the conducting distance pieces 3 disposed in the mass become glowing, and that the totality of the artificial carbon mass 1 becomes baked gradually. One may for instance provide that the average increase of the temperature up to 500° C. be only 20 to 40° C. per day, this being extremely important for the durability of the furnace.

For the making of the walls of the carbon trough (formed by the bottom or sole and the surrounding inner walls) one uses a template or form to shape the poured material. It is advantageous to use for the making of the walls a carbonaceous mixture having a lower electric conductivity than the poured artificial carbon mass used for the bottom itself. In order to lower the electric conductivity one may for instance add to the carbonaceous mass alumina or residues of the carbon lining of old furnaces.

As has already been stated, one uses preferably for the upper current supply carbon anodes 4 which may be raised to serve afterwards for the electrolysis. For this purpose, after having prepared the surface of the sole 1, one disposes baked carbon anodes or Soederberg electrodes 4 and fills the free interspaces, for example up to the upper edges of the anodes or of the furnace, with a granular or powdery mass 5 able to protect the glowing part of the anodes against oxidation. One may use alumina powder; most advantageous is the use of coal powder or granular coal. The baking of the poured mass of artificial carbon which forms the trough of the furnace lasts generally several days. It is recommendable to avoid applying at the beginning the highest current intensity such as is applied in the electrolysis of the aluminum. One increases the current intensity in the course of the baking gradually up to the usual value for the electrolysis of aluminum. After the baking one removes the filling mass and pours into the furnace molten electrolyte or melts the electrolyte in the furnace itself lifting progressively the anodes; one can, thereafter, start the electrolysis.

The method according to the invention is not only applicable to the making of new furnaces, but also to the repairing of the furnaces which have been already in service. For the purpose of repairing a furnace, one empties it and cleans it down until sound carbon appears. If necessary one frees partly the iron conductors 2 disposed in the sole. One places then the conducting distance pieces in the same manner as when making a new furnace; the subsequent operations are also the same.

The drawing represents an example of carrying out the invention. It shows a part of a section through the furnace before the baking of the poured artificial carbon mass 1. The furnace wall may comprise wall brickwork 8 which may be a lining for the furnace outer shell 9, as of iron or steel. The iron conductors which must be disposed in the sole are designated by 2, the conducting distance pieces by 3, the carbon anodes by 4, and the carbon-powder or other filling by 5. The stems or rods 6 carrying the anodes 4 may depend from the upper support member 7, above the furnace, which may be the electrical conductor leading through the stems to the anodes. After current is established through the cathode elements 9, 2, 3 and 1 and thence through the anode elements 4, 6 and 7, the anodes may be lifted gradually away from elements 1 and 3 to cause electrolytic action within the furnace and reduction of aluminum as already indicated.

The new method presents great advantages with regard to the known processes. It needs much less manual labour for the making of the furnace trough than according to known processes. Moreover, the poured artificial carbon mass becomes again so pasty at the beginning of the baking that it fills up all the corrugations and cracks of the bottom and side walls and the interspaces which may occur in consequence of the thermal expansion of the brickwork and perhaps of the metallic conductors disposed in the sole. By submitting the poured mass of artificial carbon to vibrations of high frequency, it has a greater density (that is to say a lower porosity) after the baking, better mechanical properties, a greater durability, and a better electric conductivity than an artificial carbon mass which has not been submitted to vibrations. The usual ramming masses, as they are still often used for the making of furnace troughs, cannot, in consequence of their lack of pourability, be improved by means of vibrations of high frequency; their porous structure does not become more dense.

I claim:

1. Method for making furnaces for the electrolytic production of aluminum provided with a sole or trough made from carbon, characterised by taking an artificial carbon mass made substantially from a mixture of ground coke with coal-tar-pitch, this mixture being hard at room temperature and pasty at elevated temperature, placing cathodic conducting distance pieces at predetermined positions within the furnace shell with the anodes in contact thereupon, and then heating the carbon mass and pouring it in the pasty heated state and in a vibration-homogenized condition into the furnace shell, to embed the distance pieces and line the shell, and there baking it to hardness.

2. Method for making furnaces for the electrolytic production of aluminum provided with a sole or trough made from carbon, characterised by taking an artificial carbon mass made substantially from a mixture of ground coke with coal-tar pitch, this mixture being hard at room temperature and pasty at elevated temperature, placing cathodic conducting distance pieces at

predetermined positions within the furnace shell with the anodes in contact thereupon, and then pouring the carbon mass in the pasty heated state, say 140–200° C., into the furnace shell, to embed the distance pieces and line the shell, and there baking it to hardness.

3. Method for making furnaces for the electrolytic production of aluminum provided with a sole or trough made from carbon, characterised by taking an artificial carbon mass made substantially from a mixture of ground coke with a binder such as coal-tar pitch, this mixture being hard at room temperature and pasty at elevated temperature, pouring this artificial carbon mass in the heated state, say 140–200° C.. into the furnace shell, in which are disposed metallic conductors for the cathodic current supply as well as already baked carbon pieces in contact with them, sending an electric current of such intensity through these baked carbon pieces that they become glowing, and baking in this way the artificial carbon mass.

4. Method according to claim 3, characterised by the fact that the current intensity be increased gradually during the baking.

5. Method according to claim 3, characterised by the fact that during the baking the carbon anodes used afterwards for the electrolysis of the aluminum ensure the electric connection between the anodic current supply and the baked carbon pieces.

6. Method according to claim 3, characterized (*a*) by the fact that during the baking the carbon anodes which are to be used afterwards for the electrolysis of the aluminum function to ensure the electric connection between the anodic current supply and the baked carbon pieces; and (*b*) by the fact that the interspaces between such carbon anodes are filled up with a ground or powdery mass which at least lowers in a high degree the oxidation of the carbon anodes.

7. Method according to claim 3, characterized (*a*) by the fact that during the baking the carbon anodes which are to be used afterwards for the electrolysis of the aluminum function to ensure the electric connection between the anodic current supply and the baked carbon pieces; and (*b*) by the fact that the interspaces between such carbon anodes are filled up with a ground or powdery mass which at least lowers in a high degree the oxidation of the carbon anodes; such powdery mass consists of finely ground coal.

8. The method of making an electrolytic furnace or cell adapted for aluminum production of the kind having an outer shell, as of brick and/or metal, with a trough or lining, and metallic conductors extended through the shell for introducing the electrolyzing current, and conducting pieces between such conductors and the anodes or molten electrolyte; such method comprising the steps of preparing a mixture of a carbon material (such as ground coke) with a binder (such as coal-tar pitch) the mixture being in proportions to become pasty or plastic at an elevated temperature (such as 140 to 200° C.), but hard at room temperature, heating a mass of such mixture to such pasty condition and thus applying or pouring it into and spreading or shaping it as a lining within the furnace shell to embed such previously positioned conducting pieces and fill all irregularities of the shell bottom and side walls, and then baking such applied lining into a hard condition, at yet higher temperature (as by passing a current through the conducting pieces, of prebaked carbon or graphite, via the anodes and conductors and of an intensity to raise the conducting pieces to a glowing heat, the conducting pieces being rigid and serving as distance pieces to space the anodes in position while the lining mass is soft during the beginning of baking).

9. The method as in claim 8 and wherein after the shaping the lining is cooled to hardness and then reheated for baking.

10. The method as in claim 8 and wherein during baking the current intensity and temperature are gradually increased, as for example by about 20° to 40° C. per day for several days to a baking temperature of the order of 500° C.

11. The method as in claim 8 and wherein before baking the anodes are placed in lowered position and the interspaces between anodes are temporarily filled with powdery filling material, as ground coal or alumina, to protect the anodes from undue oxidation during baking, such filling material being removed after baking.

12. The method as in claim 8 and wherein the pasty lining mass before baking is subjected to high speed vibration to increase density and improve conductivity.

13. An electrolytic furnace or cell adapted for aluminum production having a shell with a lining of plastically applied carbon material baked to hardness and embedding conducting pieces extending between the entering metallic conductors and the anode positions, and made by the method set forth in claim 8.

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