Jan. 9, 1923. 1,442,033.

M. O. SEM ET AL.

METHOD OF OPERATING ELECTRIC FURNACES.

FILED OCT. 22, 1921. 2 SHEETS—SHEET 1.

Fig. 1.

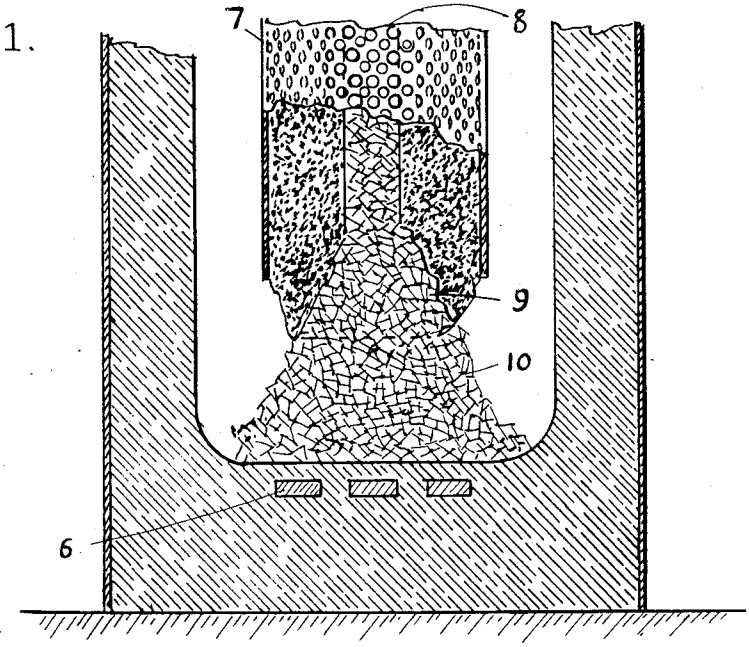
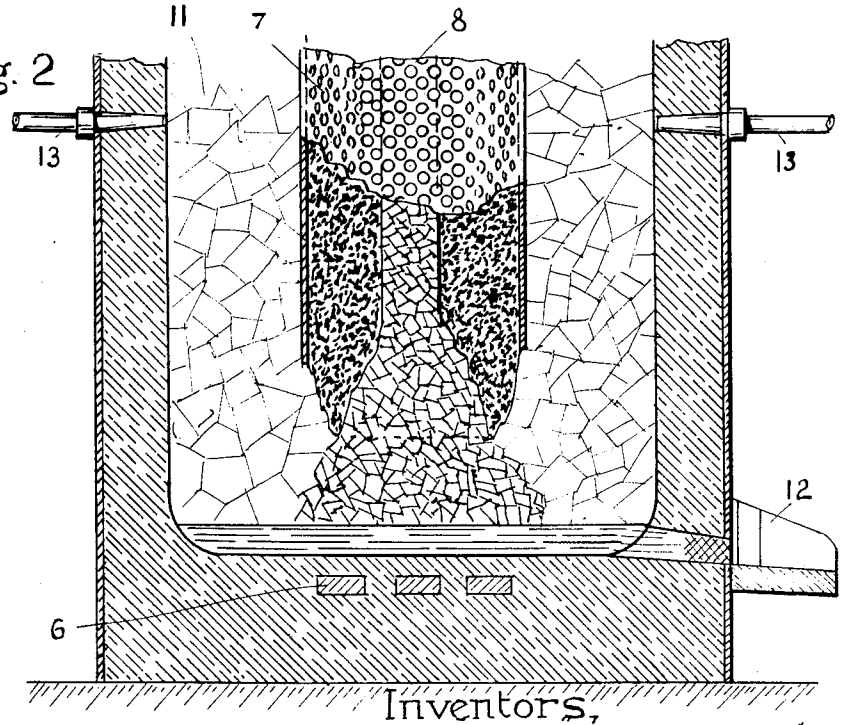


Fig. 2



Inventors,
Mathias Ovrom Sem,
Einar Lund,
By [illegible] Attorneys.

Jan. 9, 1923. 1,442,033.

M. O. SEM ET AL.

METHOD OF OPERATING ELECTRIC FURNACES.

FILED OCT. 22, 1921. 2 SHEETS—SHEET 2.

Fig. 3.

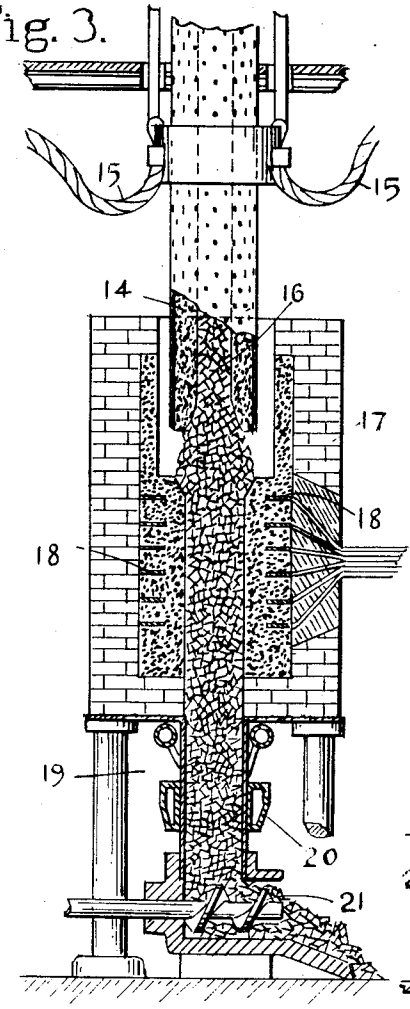


Fig. 4.

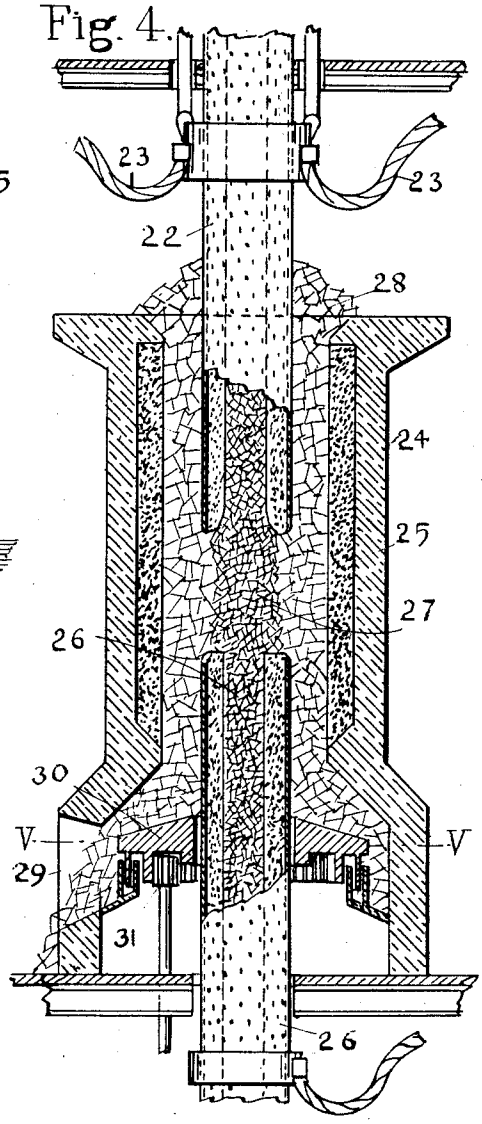
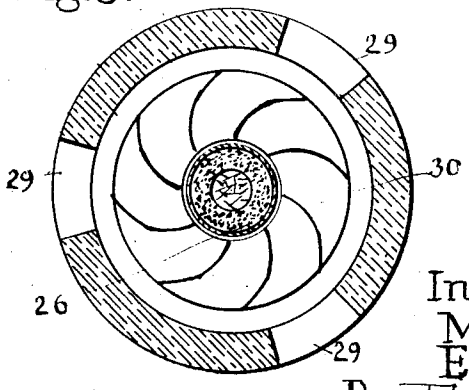


Fig. 5.



Inventors,
Mathias Ovrom Sem,
Einar Lund,
By Attorneys.

Patented Jan. 9, 1923. 1,442,033

UNITED STATES PATENT OFFICE.

MATHIAS OVROM SEM AND EINAR LUND, OF CHRISTIANIA, NORWAY, ASSIGNORS TO DET NORSKE AKTIESELSKAB FOR ELEKTROKEMISK INDUSTRI, OF CHRISTIANIA, NORWAY.

METHOD OF OPERATING ELECTRIC FURNACES.

Application filed October 22, 1921. Serial No. 509,460.

To all whom it may concern:

Be it known that we, MATHIAS OVROM SEM and EINAR LUND, subjects of the King of Norway, and residents of Christiania, respectively, in the Kingdom of Norway, have invented certain new and useful Improvements in Methods of Operating Electric Furnaces, of which the following is a specification.

This invention relates to electric furnaces especially those in which it is desired to attain very high temperatures, and the object of our invention is a process or method, in which the heating is effected by the use of hollow self-baking electrodes or self-baking electrodes provided with longitudinal channels.

Self-baking electrodes have been described in the co-pending applications of Carl W. Soderberg, Serial No. 205,416; Serial No. 322,480, and Serial No. 354,369. The hollow or channelled form of these electrodes which are employed in our present process open up a new field in electro-metallurgy, as they permit the use of large electrodes of any desired shape, and such electrodes can be made continuous, whereby economy is assured. On account of the large size of the electrodes, there is no dufficulty in providing them with a channel or channels of considerable cross-section through which the charge may be introduced, and processes are made possible which could not be carried out with ordinary hollow electrodes for the reason that the largest ordinary electrodes are only about twenty-eight inches in diameter, and that a channel would consequently be limited to about eight inches in diameter. A channel of this relatively small size would not be large enough for industrial processes.

Our process broadly consists in introducing an electrically conductive material into an electric furnace provided with a hollow electrode, the material being charged through the hollow or longitudinally channelled electrode. This material may be anthracite, coke or the like, or we may employ materials which are only rendered conductive at higher temperatures, as lime, magnesia or the like. When the furnace is started, the current will pass over from the electrode to the conductive material, and through this down into the furnace. The heat development is then partly due to the passage of the current from the electrode to the conductive material, and partly to the passage of the current through the material itself. Our heating method will therefore be a mixed arc—and resistance heating, as the passage of the current from the electrode to the conductive material takes place under formation of arcs. In this electric arc the electrode is consumed, and as the arc will burn concentrically towards the conductive material, the electrode gradually takes the shape of a shield covering the conductive material. If the furnace is made narrow, the electrode thus filling the greater part of the cross section of the furnace, the electrode will in this way form a kind of roof over that part of the furnace in which the heat development takes place. We may therefore raise the temperature as high as desired, as the furnace or the part of it, which is especially subjected to the heat, all through consists of the most refractory material known, that is carbon. The temperature in the furnace is consequently only limited by the melting point, respectively the point of evaporation of the material, which is introduced through the electrode. If this material consists of carbon, for example in the form of anthracite, we may heat it to the highest temperatures attainable, whereby firstly all contents of ashes may be completely reduced and evaporated, and secondly the amorphous carbon may be transformed to graphite.

When we use our process for the manufacture of graphite, it will of course be advantageous to follow the general practice of the graphite industry in employing such raw materials which contain substances acting as catalysts or by adding such substances.

At the high temperature of our furnace the conductive material is strongly calcined, and a column of calcined material is built up under the electrode. If desired we may continuously remove this column through the bottom of the furnace, whereby an altogether continuous process results. We may accomplish this by building the lower part of the furnace like a tube, for example of carbonaceous mass, through which the graphite gradually sinks down. The current supply may take place through the wall of the furnace.

When we employ this method of charg-

ing, it is obvious that every part of the conductive material must pass through the hottest point of the furnace, and a guarantee is thereby obtained that the material is subjected to a thorough heating to high temperatures. This is a great advantage for example in the manufacture of graphite, as it makes possible the production of a product of a far more uniform quantity than has hitherto been possible. At the same time we have succeeded in making the manufacture of graphite a continuous process which has not yet been attained in any other way.

However, our process also has many other possibilities of use. Thus the heat radiating from the above mentioned sintered column may be utilized by placing materials around it which are thereby heated to temperature of reaction. Thereby a type of furnace results, which we may employ for carrying out a series of chemical processes, for example manufacture of carborundum, nitrides, carbides, cyanides, burning of limestone, cement etc. In such cases for example in the manufacture of carborundum it will be advantageous to make the column forming under the electrode from conductive material very long, thus making the furnace look like a usual carborundum furnace in vertical position. This type of furnace possesses the great advantage that a continuous production is attained by gradually removing the finished carborundum together with the graphite core from the bottom of the furnace, and further it is made possible to transform all silicon carbide to the desired crystalline modification. We attain this by insulating the furnace externally. The great quantities of carbon monoxide which are formed during the process may be led out through the hollow electrode.

In such furnaces we have also found it advantageous to let the graphite core serving for the heating rest on a bottom electrode of the same type as the top electrode. Then the graphite core may remain in the furnace permanently, and need not be removed together with the material outside the graphite.

Further our heating method may be employed for carrying out smelting processes, whereby we obtain new advantages. In the reduction of oxidic ore, for example iron ore, we may thus introduce the reduction material through the hollow electrode, while we charge the ore mixture outside the electrode. We may then in the center of the furnace maintain a column of reduction material facilitating a complete recovery of the metal. We thus succeed in carrying out for instance iron smelting with use of the so-called "separate charging," which causes a saving in reduction material and utilization of the reduction gas by blowing air into the upper part of the ore-shaft, whereby the carbon monoxid will burn, transferring the heat developed direct to the charge which thereby becomes preheated.

Instead of only introducing a conductive material through the channel in the electrode, we may introduce a mixture of conductive and non-conductive materials, care being taken that the content of conductive materials is sufficiently high to secure passage of the current.

In the accompanying drawings forming part of this application:—

Figure 1 is a vertical sectional view through a furnace employed for the manufacture of graphite.

Figure 2 is a similar view of a furnace employed for iron-smelting with separate charging.

Figure 3 is a sectional view of a modified form of furnace, especially adapted for the continuous production of graphite.

Figure 4 is a similar view of a furnace employing hollow top and bottom electrodes, the conductive core being placed between them, and the material to be heated being continuously passed by outside the core.

Figure 5 is a horizontal sectional view on the line V—V of Figure 4.

Referring more particularly to the drawings, Fig. 1 shows an electric furnace with bottom contacts 6 and a top self-baking electrode 7 provided with an enclosing mantle and with a longitudinal channel 8. Through the channel crushed anthracite is introduced. When the current is turned on, electric arcs are formed between the electrode and the anthracite, and the lower end of the electrode will very soon form a funnel 9 acting as a kind of roof over the hottest part of the furnace. As the process proceeds the heated anthracite will sinter, forming a column 10 growing in height as the electrode is raised and more charge falls down through the channel 8. Instead of raising the electrode 7 the sintered column 10 may be lowered, and new charge will then gradually fall down through the channel 8.

In Fig. 2 a reduction material as coke or the like is introduced through the channel 8, while outside the self-baking electrode 7 iron ore 11 is charged. During the passage of the current the reduced iron will sink to the bottom, and may be removed in usual manner through the tapping hole 12. The furnace is provided with openings 13 through which air or another oxidizing gas is blown in, the carbon monoxide forming during the reduction of the iron burning to carbon dioxide and the heat developed thereby being utilized for preheating new charge.

In Fig. 3, 14 is a hollow continuous self-baking electrode provided with a metallic mantle. Electric current is supplied through the cables 15. Through the elec-

trode anthracite 16 is introduced which passes continuously through the electric furnace 17, which is internally lined with carbonaceous mass, and in the wall of which are placed annular contacts 18 for the electric current. During the passage through the furnace the anthracite will become graphitized, and the finished graphite will enter the room 19 below the furnace which is cooled by means of water 20. From this room the graphite is continuously removed by means of the endless screw 21.

In Fig. 4 22 is a hollow continuous self-baking electrode, provided with a metallic mantle, the current being supplied through the cable 23. The electrode is placed in an electric furnace 24 lined with carbonaceous mass 25. In the furnace is also placed a continuous hollow bottom self-baking electrode 26 provided with a metallic mantle. The channels of both electrodes are filled with a conductive material as coke or the like, and when the current is turned on, a sintered column 27 will form between both electrodes, and will serve as a resistance heater. The material to be heated is introduced from above through the opening 28, passes through the furnace and is continuously removed at the bottom of the furnace through the openings 29 by means of the rotating disc 30, which is driven by the gear 31.

Fig. 5 shows a horizontal section through the line V—V in Fig. 4.

The foregoing detailed description of our process has been given for clearness of understanding only, and no undue limitation should be deduced therefrom, but the appended claims should be construed as broadly as permissible in view of the prior art.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. The method of operating an electric furnace comprising the baking therein during the operation of the furnace of a channelled electrode and the introduction of a conductive material through the electrode.

2. The method of operating an electric furnace comprising the baking therein during the operation of the furnace of a channelled electrode provided with an enclosing metallic mantle, and the introduction of a conductive material through the electrode.

3. The method of operating an electric furnace comprising the introduction of a conductive material through a channelled electrode composed in part of incompletely baked material and being baked in the furnace during the operation thereof, and passing a current through the electrode to and through the conductive material.

4. The method of operating an electric furnace comprising the baking therein of a channelled electrode composed of a baked portion and a partially baked portion, introducing a conductive material through the electrode, and developing heat by the passage of current from the electrode to the conductive material inside of it and by passage of the current through the material itself.

5. The method of operating an electric furnace comprising the introduction of conductive material through a centrally channelled current carrying electrode composed in part of unbaked material, developing heat by passage of the current through the electrode and the conductive material, whereby the electrode is consumed into a funnel-shaped formation at its working end, and continuing the development of heat by passage of current from the said funnel-shaped working end to the conductive material.

6. The method of operating an electric furnace comprising the baking therein of a channelled electrode consisting in part of unbaked material, the introduction of a conductive material through the electrode during the baking thereof and the formation from the conductive material of a column of calcined material under the electrode.

7. The method of operating an electric furnace comprising the introduction of carbon through a channelled electrode being baked in the furnace and consisting in part of unbaked material and supplying electric current thereto until the said carbon is transformed to graphite.

8. The method of operating an electric furnace comprising the introduction of carbon through a channelled electrode being baked in the furnace in which it is used, supplying electric current thereto until the said carbon is transformed to graphite, and continuously removing the graphite.

9. The method of operating an electric furnace comprising the introduction of a conductive material through a channelled electrode being baked in the furnace in which it is used, supplying electric current thereto whereby the said conductive material becomes heated forming a column of calcined material under the electrode, lowering the said column and removing the calcined material from the furnace, and introducing fresh conductive material through the channelled electrode as the calcined material is removed.

10. The method of operating an electric furnace which comprises the introduction of conductive material through a channelled electrode, supplying electric current thereto whereby the said conductive material becomes heated forming a column of calcined material under the electrode, raising the electrode, as the said column is formed, and supplying fresh conductive material through the electrode.

11. The method of operating an electric furnace comprising the baking therein of a channelled electrode consisting in part of incompletely baked material, introducing a

conductive material through the electrode, and charging another material outside the electrode.

12. The method of operating an electric furnace comprising the baking therein of a channelled electrode consisting in part of incompletely baked material, introducing a conductive material through the electrode, and charging the furnace, outside the electrode, with another material with which the conductive material will react chemically.

13. The method of operating an electric furnace comprising the introduction of a conductive material through a channelled electrode baked in the furnace and consisting in part of incompletely baked material, supplying electric current thereto, whereby the said conductive material becomes heated forming a column of calcined material under the electrode, supporting the said column of calcined material on a bottom electrode, and charging another material outside the said channelled electrode.

14. The method of operating an electric furnace comprising the arranging therein of an upper and a lower channelled electrode, the electrodes being arranged in opposed relation, introducing a conductive material through one of the electrodes and into the other, forming between the electrodes a column of calcined material from the conductive material by passage of current therethrough and charging another material outside the electrodes.

15. The method of operating an electric furnace comprising the baking therein of an upper and a lower electrode arranged in opposed relation and consisting in part of incompletely baked material, introducing a conductive material through one of the electrodes and into the other, forming between the electrodes a column of calcined material from the conductive material by passage of current therethrough and charging another material outside the electrodes.

16. The method of operating an electric furnace comprising the arrangement therein of an upper and a lower channelled electrode, the electrodes being arranged in opposed relation, introducing a conductive material through one of the electrodes and into the other, forming between the electrodes a column of calcined material from the conductive material by passage of current therethrough, and continuously passing another material around the column of calcined material.

17. The method of operating an electric furnace comprising the arrangement therein of opposed channelled electrodes, introducing a conductive material through one of the electrodes and into the other, and forming a column of calcined material from the conductive material between the electrodes by the passage of current therethrough, said calcined material constituting a resistance heater.

18. The method of operating an electric furnace comprising the introduction of carbon through a channelled electrode baked in the furnace and consisting in part of incompletely baked material, supplying electric current thereto and charging a metal oxid outside of the electrode, whereby the said oxid is reduced.

19. The method of operating an electric furnace comprising the introduction of carbon through a channelled electrode baked in the furnace and consisting in part of incompletely baked material, supplying electric current thereto and charging iron oxid ore outside of the electrode, whereby the said iron oxid is reduced.

20. The method of operating an electric furnace comprising the introduction of carbon through a channelled electrode baked in the furnace and consisting in part of incompletely baked material, supplying electric current therethrough and charging iron oxid ore outside of the electrode, whereby the iron oxid is reduced, blowing an oxidizing gas into the outer charge above the working end of the electrode, whereby the carbon monoxid formed during the reduction process is oxidized to carbon dioxid, the heat thus liberated serving to preheat the outer charge.

21. As a new and useful article of manufacture, an electrode comprising a carbonaceous portion and an enclosing metallic mantle, the carbonaceous portion of the electrode being provided with a feeding channel and being baked in the furnace in which it is used and comprising when in use a baked portion and a partially baked portion.

22. As a new and useful article of manufacture, an electrode comprising a carbonaceous portion and enclosing metallic mantle, the carbonaceous portion of the electrode being provided with a feeding channel and being composed when in use of a portion which is baked and a portion which is unbaked.

23. As a new and useful article of manufacture, an electrode for use in an electric furnace comprising a carbonaceous portion and an enclosing metallic mantle, the carbonaceous portion being provided with a channel and being structurally different at its two ends, the conductivity of the carbonaceous portion being permanently greater at the working end thereof.

24. In an electric furnace the combination of oppositely placed longitudinally channelled electrodes, one of the said electrodes comprising a feeding means for the furnace and the other comprising a discharge means therefor.

25. The method of operating an electric furnace equipped with a channelled electrode which comprises compensating for the

wasting away of the electrode at its operating end within the furnace by adding raw electrode material to the opposite end of the electrode and baking said raw electrode material after its addition thereto, and introducing a conductive material through the electrode.

26. The method of operating an electric furnace equipped with a channelled electrode which comprises compensating for the wasting away of the electrode at its operating end within the furnace by adding raw electrode material to the opposite end of the electrode and baking said raw electrode material after its addition thereto, introducing a conductive material through the said electrode and supplying electric current thereto, whereby the said conductive material becomes heated forming a column of calcined material under the electrode.

27. The method of operating an electric furnace equipped with a channelled electrode which comprises compensating for the wasting away of the electrode at its operating end within the furnace by adding raw electrode material to the opposite end of the electrode and baking said raw electrode material after its addition thereto, introducing a conductive material through the electrode, and charging another material outside the electrode.

28. The method of operating an electric furnace equipped with opposed channelled electrodes which comprises compensating for the wasting away of one of said electrodes at its operating end within the furnace by supplying raw electrode material to the opposite end of that electrode, and baking said raw material after its addition thereto, introducing a conductive material through one of the electrodes and into the other, and forming a column of calcined material from the said conductive material between the electrodes by the passage of current therethrough, said calcined material constituting a resistance heater.

Signed at Christiania, Norway, this 3 day of October, 1921.

MATHIAS OVROM SEM.
EINAR LUND.