Jan. 2, 1923. 1,441,037.

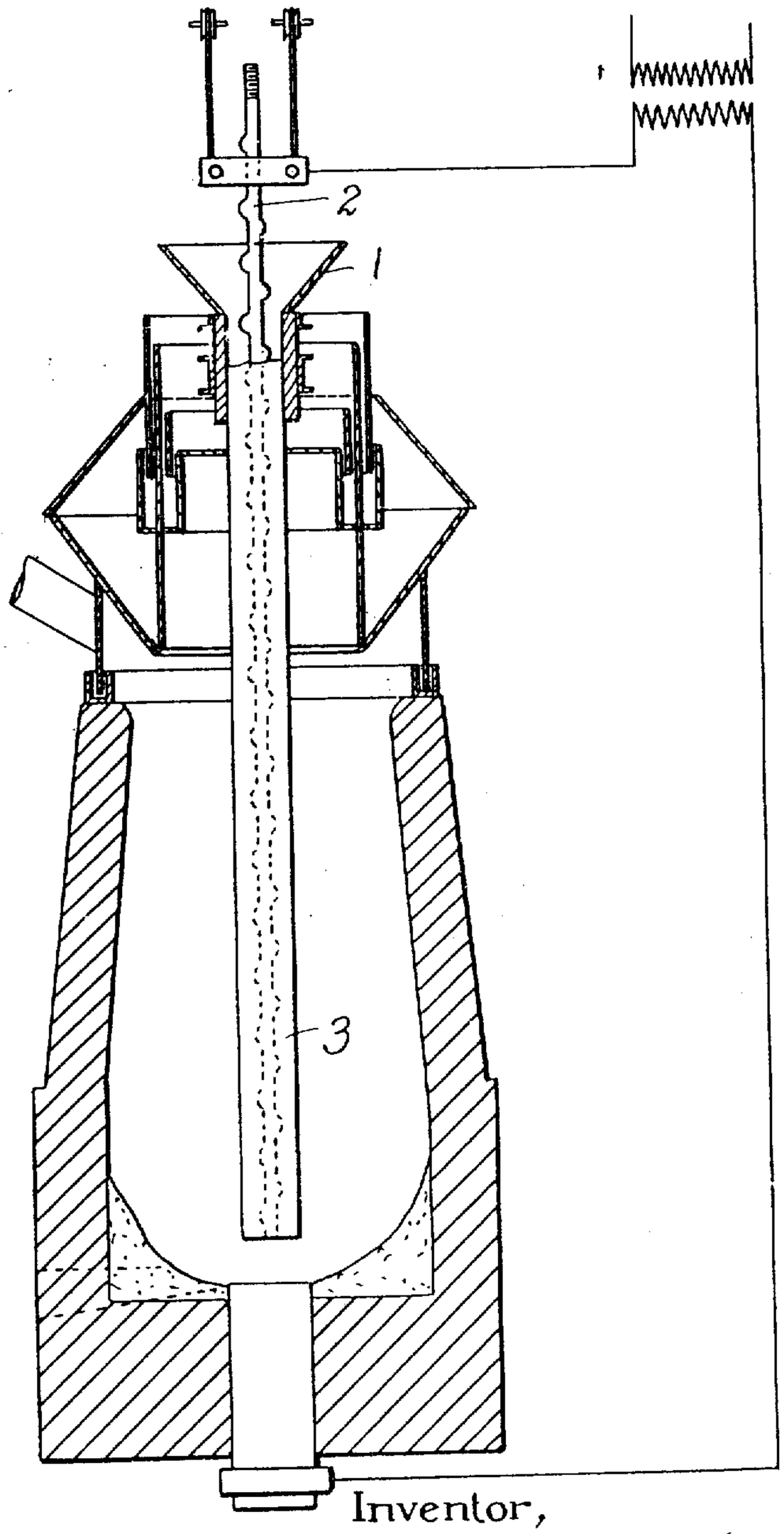
C. W. SÖDERBERG.

PROCESS OF BAKING CARBON ELECTRODES.

FILED DEC. 4, 1917.

2 SHEETS—SHEET 1.

Fig. 1.



Inventor,
Carl Wilhelm Söderberg

by Howson & Sole
Attorneys

Jan. 2, 1923.

1,441,037.

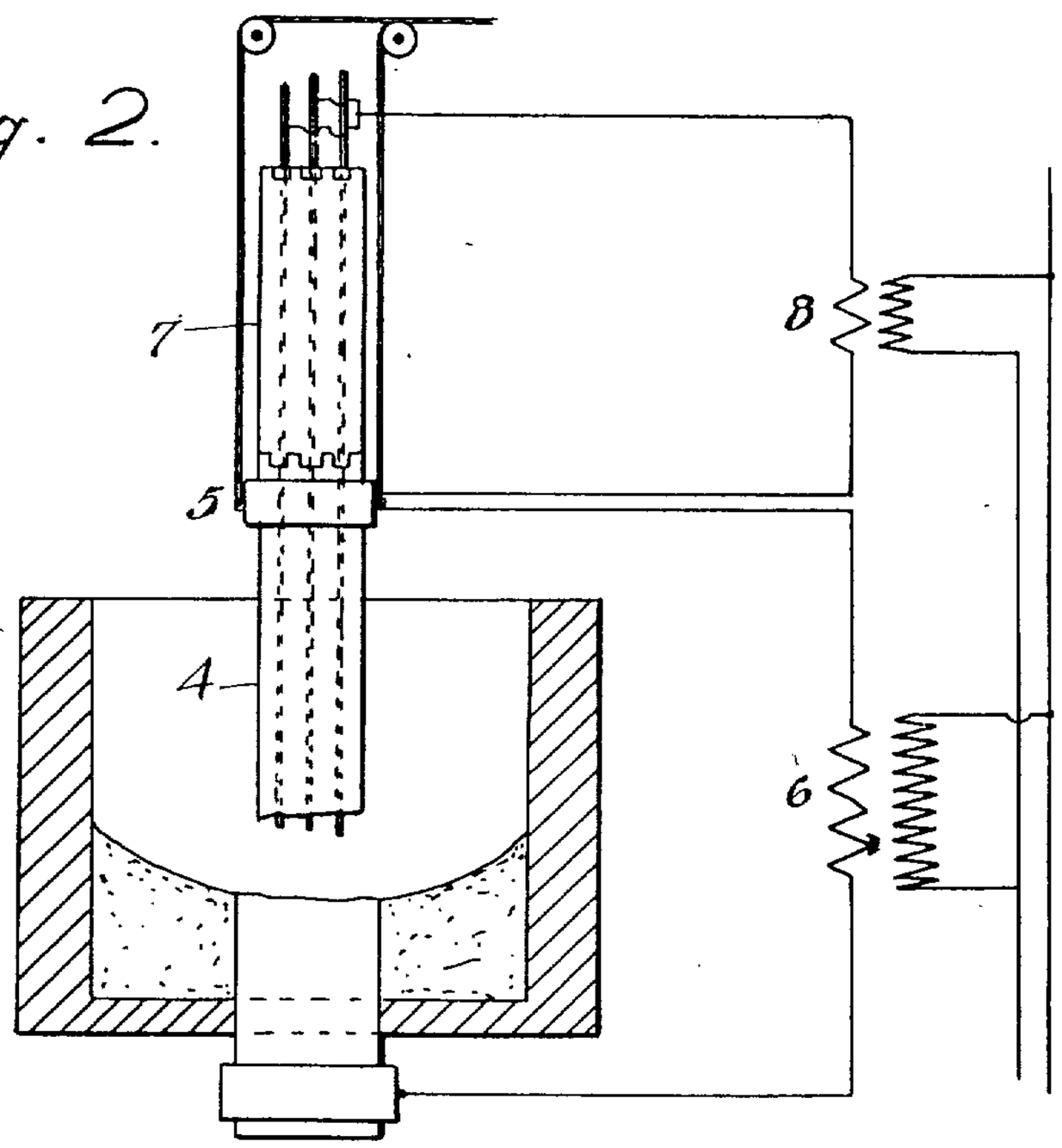
C. W. SÖDERBERG.

PROCESS OF BAKING CARBON ELECTRODES.

FILED DEC. 4, 1917.

2 SHEETS—SHEET 2.

Fig. 2.



Inventor,
Carl Wilhelm Söderberg

by Dorsey & Cole
Attorneys

Patented Jan. 2, 1923. 1,441,037

UNITED STATES PATENT OFFICE.

CARL WILHELM SÖDERBERG, OF CHRISTIANIA, NORWAY, ASSIGNOR TO DET NORSKE AKTIESELSKAB FOR ELEKTROKEMISK INDUSTRI OF NORWAY, OF CHRISTIANIA, NORWAY.

PROCESS OF BAKING CARBON ELECTRODES.

Application filed December 4, 1917. Serial No. 205,416.

To all whom it may concern:

Be it known that I, CARL WILHELM SÖDERBERG, a subject of Norway, and a resident of Christiania, Kingdom of Norway, have invented certain new and useful Improvements in the Processes of Baking Carbon Electrodes, of which the following is a specification.

This invention relates to the manufacture of electrodes for use in electric furnaces and as anodes or cathodes in various electrolytic processes. The object of the invention is an improved process for manufacturing the same and the electrode obtained thereby.

Electrodes for the purpose above mentioned are generally made from some carbonaceous material such as coal, coke, graphite, etc. The material or materials selected are reduced to the desired fineness and mixed with a suitable binder such as tar or pitch. The mixture is then moulded to the desired form and baked in a suitable furnace until the volatile products are driven off and the electrode has the desired density and conductivity.

The raw electrodes have a comparatively high resistance and are not conductive to any appreciable extent. The resistance, however, depends somewhat upon the materials employed in the manufacture; for instance, an electrode of course graphite will have a higher conductivity than one composed of other carbonaceous materials. In most cases the raw electrode will have a conductivity about 10000 times lower than it will have in the finished state.

Many attempts have been made to bake electrodes by means of the heat generated within the electrode itself when made a part of an electric circuit, but on account of the high resistance of the raw electrodes, this method has been found to be impractical.

According to my invention this difficulty is overcome by baking and rendering the electrode conductive in a part of its cross-section by means of heat electrically generated in a conductor connected in parallel with the electrode. This conductor may consist of metal or of a baked electrode. Preferably it is one or more iron bars inserted in the electrode itself.

As will be understood from the following examples my method is susceptible of many variations all of which embody the process above outlined. For instance, electrodes may be baked in a special electric furnace or the baking may be carried on simultaneously with the use of the electrode itself in the furnace in which it is mounted. In the latter case a portion of the baking is accomplished by the heat of the furnace in which the electrode is employed.

In either of the instances cited the raw electrode may be of the same construction and made in the same manner. A mould may be employed in this process in which is preferably mounted a core of conductive material, such as a rod of iron in diameter, for example, $\frac{3}{8}''$, or a small carbonaceous electrode. The raw materials for the electrode are tamped around the core in the usual manner and the mould removed as will be readily understood.

Where a separate furnace is to be employed for the baking of the electrode, the raw electrodes are placed therein and are series-connected in the secondary of a transformer furnishing sufficient current for the baking. With twenty electrodes, for example, a 400 kilowatt transformer of the voltage regulator type giving from 220 to 110 volts may be used. To this end electrode No. 1 may be placed on a carbon-block, that is connected to one terminal of the secondary. On the top-end of the same electrode is placed a short piece of carbon or graphite electrode of good conductivity that will take the current over to the top-end of electrode No. 2. The lower end of No. 2 rests on another piece of a carbon or graphite electrode. Electrode No. 3 is placed on the same piece of carbon or graphite, and so on, the last electrode of the series being connected to the other terminal of the secondary. The spaces between the electrodes are then filled with fine sand or finely ground charcoal. If the current is switched on with about 200 volts between the terminals, the ameter will immediately register about 800 amperes. The current drops slightly at the start and then gradually rises to about 2500 to 3000 amperes during a period of 24 to 36 hours as the baking of the electrodes proceeds. At the end of this time the baking is finished and the drop of potential will be about 6 volts per electrode if the current is 3000 am-

peres. It is possible to use a transformer without voltage regulation, but the baking will then proceed more slowly.

The electrodes baked as above are allowed to cool before removing from the furnace. This requires about 36 hours.

If an iron core has been employed its presence in the finished electrode would depend on the temperature obtained during baking. If it is dsired to bake at from 1500° to 1600° C. the iron will obviously melt and the baked portion alone of the electrode carry the current to complete the baking. Generally so high temperatures are not necessary and the iron-rod will be found in the electrode after the baking.

As a variation in the above method of baking in a separate furnace, it is readily possible if desired to make use of baked electrodes in place of an interior core. In that case the following arrangements of electrodes will be employed.

The raw electrodes and the ready baked electrodes are built up together, always one raw and one baked electrode close together and with top and bottom connected to the same conductor. At first the current will only pass through the baked electrode, but as the heat generated in this bakes the near side of the raw electrode this becomes slightly conductive and takes part in the transmission of current. The conductivity and the resulting heat development increase until the raw electrode is finally baked.

The second method of baking electrodes, to wit, by the use of the furnace in which they are employed as heating elements, is particularly advantageous where very long electrodes are desired, though obviously not limited thereto. The present type of electrode is about six feet long and to employ these in the furnaces referred to requires their being joined together and the present practice is to use a fragile carbon nipple for this purpose. The method now to be considered not only eliminates this difficulty but in making use of the electric furnace itself for baking makes possible the continuous supply of electrodes without shutting down the furnace for the installation of new electrodes.

This method is shown diagrammatically in the drawings which form a part hereof and which it is to be understood, are for illustrative purposes only.

In these drawings:—

Figure 1 is a diagrammatic vertical section of a simple electric shaft furnace for the manufacture of pig-iron; and

Fig. 2 is a diagrammatic cross-section of the usual type of metallurgical furnace.

The figures illustrate not only the different types of furnace to which the process is applicable but different methods of baking the electrodes themselves.

The electrode in the construction of Figure 1 is suspended at the top of the furnace and extends centrally down the shaft, when in use being surrounded by the ore and reducing material. The mixture of tar, coke, and anthracite used for making the electrode is filled in the funnel 1 and tamped around one or more iron bars 2. The current is led to the furnace through one or more of these iron bars which may also serve as a suspending means for the electrode. The iron bars may be corrugated or provided with small knots in order to prevent the electrode from sliding on them.

As the raw electrode mass is a poor conductor, the iron bars initially will alone carry the whole current above the shaft and in the upper and cool part of the shaft. Through the heat electrically generated in the bars and the heat from the smelting crucible the electrode is gradually baked and becomes conductive and will take part in the transmission of the current. Still nearer the zone of fusion—as at 3—the temperature of the electrode is so high, that the iron core melts out, the newly baked carbon electrode alone carrying the current.

The metal used for reinforcing the electrode need not be iron. Any metal can be used that has a melting point sufficiently high above the temperature at which the electrode mass becomes a good conductor, and which has sufficient mechanical strength. The reinforcing metal can thus be chosen according to the smelting process in question.

In the example just described, the entire smelting current was initially led to the furnace through the iron core and the cross-section of the core must therefore be large enough to carry the whole current. It is also possible to bake the electrode by a current that is only a fraction of the current used for the smelting operation. In this case the cross-section of the iron-bars can be much smaller. Fig. 2 illustrates the employment of such a method by the use of a separate transformer. In this figure the portion 4 of the electrode used for smelting is diagrammatically illustrated as already having been baked and as suspended from the electrode-holder 5 through which it is supplied with the working current, for example, 18000 amperes, from the secondary 6 of the lower transformer. The upper or raw portion of the electrode 7 formed by tamping the raw material around the iron bars, as is readily understood, is connected in series with the secondary 8 of the upper transformer and supplied with a baking current sufficient to cause slow baking; for example, about 2000 amperes. This transformer is preferably of low voltage and potential regulating type. As the lower portion 4 of the electrode is burned away, the electrode

holder 5 is shifted to the newly baked portion 7 of the electrode which is then used in the smelting operation.

The foregoing detailed description has been given for clearness of understanding 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 I claim as new and desire to secure by Letters Patent of the United States is:

1. The process of baking carbon electrodes which consists in connecting a conductor in parallel with a raw electrode and applying an electric current whereby a part of the raw electrode is baked and rendered conductive by heat electrically generated in the conductor and the baking continued by means of heat electrically generated in the conductor and in the electrode itself.

2. The process of baking carbon electrodes which consists in connecting a conductor in parallel with a raw electrode and applying an electric current whereby a part of the raw electrode is baked and rendered conductive by heat electrically generated in the conductor and the baking continued by means of heat electrically generated in the conductor and in the electrode itself, said conductor being incorporated with the raw electrode.

3. The process of baking carbon electrodes which consists in connecting a metal conductor in parallel with a raw electrode and applying an electric current whereby a part of the raw electrode is baked and rendered conductive by heat electrically generated in the metal conductor and the baking continued by means of heat electrically generated in the conductor and in the electrode itself.

4. The process of baking carbon electrodes which consists in connecting a metal conductor in parallel with a raw electrode and applying an electric current whereby a part of the raw electrode is baked and rendered conductive by heat electrically generated in the metal conductor and the baking continued by means of heat electrically generated in the metal conductor and in the electrode itself, said metal conductor being incorporated with the raw electrode.

5. The process of baking carbon electrodes which consists in connecting an iron conductor in parallel with a raw electrode and applying an electric current whereby a part of the raw electrode is baked and rendered conductive by heat electrically generated in the iron conductor and the baking continued by means of heat electrically generated in the iron conductor and in the electrode itself.

6. The process of baking carbon electrodes which consists in connecting an iron conductor in parallel with a raw electrode and applying an electric current whereby a part of the raw electrode is baked and rendered conductive by heat electrically generated in the iron conductor and the baking continued by means of heat electrically generated in the iron conductor and in the electrode itself, said iron conductor being incorporated with the raw electrode.

7. The process of baking carbon electrodes which consists in connecting a conductor in parallel with a raw electrode and applying an electric current whereby a part of the raw electrode is baked and rendered conductive by heat electrically generated in the conductor and the baking continued by means of heat electrically generated in the conductor and in the electrode itself, said conductor and electrode being connected in series with another conductor and electrode, which is baked simultaneously.

8. The process of compensating for the wasting away of an electric furnace electrode at its operating end within a furnace, which comprises adding raw electrode material to the opposite end of the electrode and baking said raw material after its addition thereto.

9. The process of compensating for the wasting away of an electric furnace electrode at its operating end within a furnace, which comprises adding raw electrode material to its opposite end and baking said raw material partly by passing an electric current through the electrode and partly by the heat generated at the operating end of the electrode when in use.

10. The process of producing carbon electrodes continuously in the furnace in which they are employed, which comprises supplying in electrode form raw electrode material together with a conductor in parallel connection therewith and applying current whereby the raw electrode is baked and rendered conductive in part by the heat electrically generated in the electrode itself and in part by the heat generated at the operating end of the electrode when in use.

11. The process of baking carbon electrodes for electric furnaces which consists in connecting a conductor in parallel with a raw electrode and applying an electric current whereby a part of the raw electrode is baked and rendered conductive by heat electrically generated in the conductor and the baking continued by means of heat electrically generated in the conductor and in the electrode itself, said electrode being the electrode of an electric furnace.

12. The process of baking carbon electrodes for electric furnaces which consists in connecting a conductor in parallel with a raw electrode and applying an electric current whereby a part of the raw electrode is baked and rendered conductive by heat electrically generated in the conductor and the baking continued by means of heat electri-

cally generated in the conductor and in the electrode itself, said electrode being the electrode of an electric furnace, and the baking of the electrode being accelerated by heat generated in said electric furnace.

13. The process of baking carbon electrodes for electric furnaces which consists in connecting a conductor in parallel with a raw electrode and applying an electric current whereby a part of the raw electrode is baked and rendered conductive by heat electrically generated in the conductor and the baking continued by means of heat electrically generated in the conductor and in the electrode itself, said electrode being the electrode of an electric furnace, the electrode being continuously formed in said furnace.

14. The process of baking carbon electrodes for electric furnaces which consists in connecting a conductor in parallel with a raw electrode and applying an electric current whereby a part of the raw electrode is baked and rendered conductive by heat electrically generated in the conductor and the baking continued by means of heat electrically generated in the conductor and in the electrode itself, said electrode being the electrode of an electric furnace, and said conductor being able to carry the total electric current led to the electric furnace.

15. The process of baking carbon electrodes for electric furnaces which consists in connecting a conductor in parallel with a raw electrode and applying an electric current whereby a part of the raw electrode is baked and rendered conductive by heat electrically generated in the conductor and the baking continued by means of heat electrically generated in the conductor and in the electrode itself, said electrode being the electrode of an electric furnace, and said conductor being able to carry only part of the total electric current led to the furnace.

16. As a new and useful article of manufacture, an electrode comprising an initial conductor and a carbonaceous unbaked portion.

17. As a new and useful article of manufacture, an electrode comprising an initial conductor and a carbonaceous unbaked portion connected in parallel with each other.

18. As a new and useful article of manufacture, an electrode baked in the furnace in which it is used and comprising when in use a baked portion and a partially baked portion.

19. As a new and useful article of manufacture, an electrode baked in the furnace in which it is used and comprising when in use a body portion, a part of which is baked and a part of which is unbaked, and a reinforcing member of conductive material in parallel electrical relation therewith.

20. As a new and useful article of manufacture, an electrode for use in an electric furnace comprising a body portion structurally differing at its two ends and a reinforcing member of conductive material in parallel relation therewith, the conductivity of the body portion being permanently greater at the working end thereof.

CARL WILHELM SÖDERBERG.