No. 880,743.

PATENTED MAR. 3, 1908.

F. VON KÜGELGEN & G. O. SEWARD.

ELECTRIC FURNACE PROCESS.

APPLICATION FILED APR. 10, 1905.

2 SHEETS—SHEET 1.

FIG. 1.

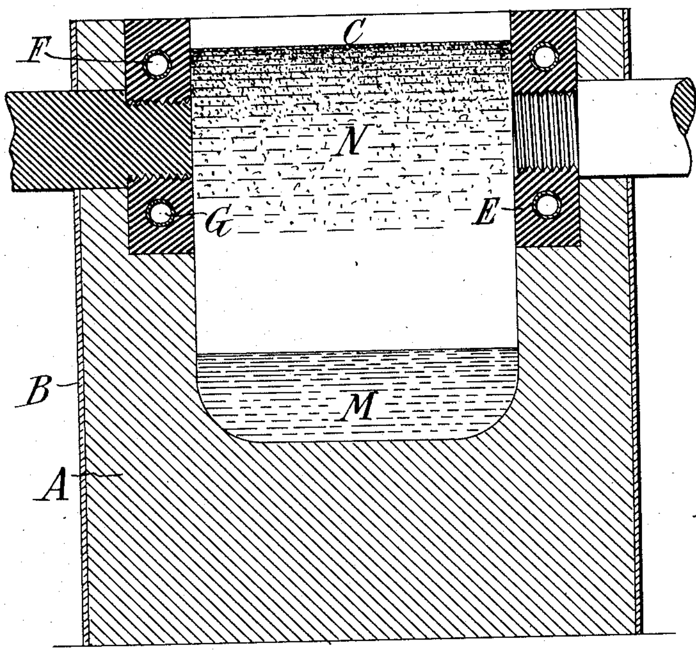


FIG. 3.

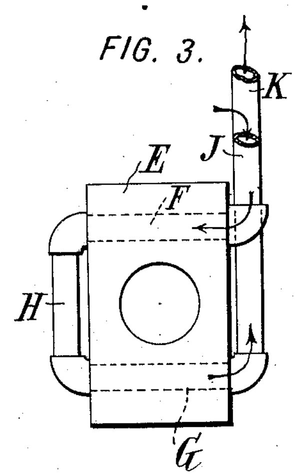
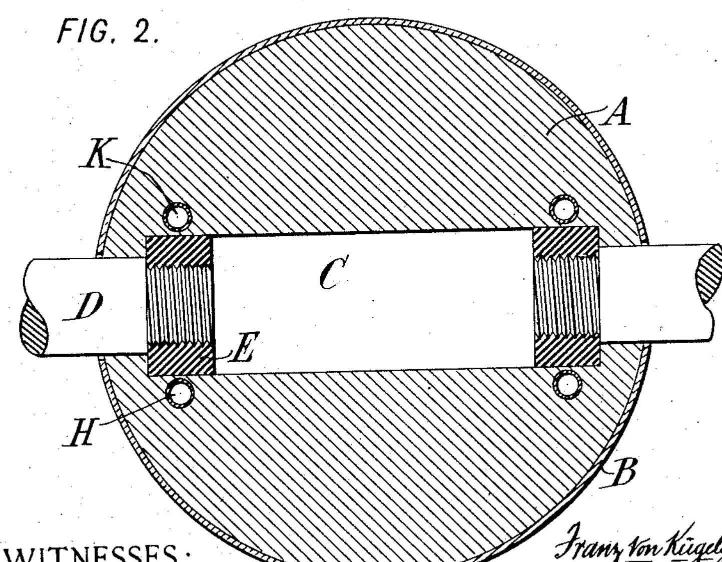


FIG. 2.



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2 SHEETS—SHEET 2.

FIG. 4.

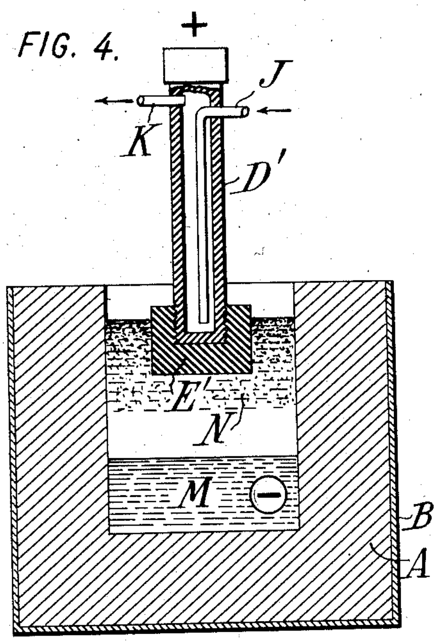


FIG. 5.

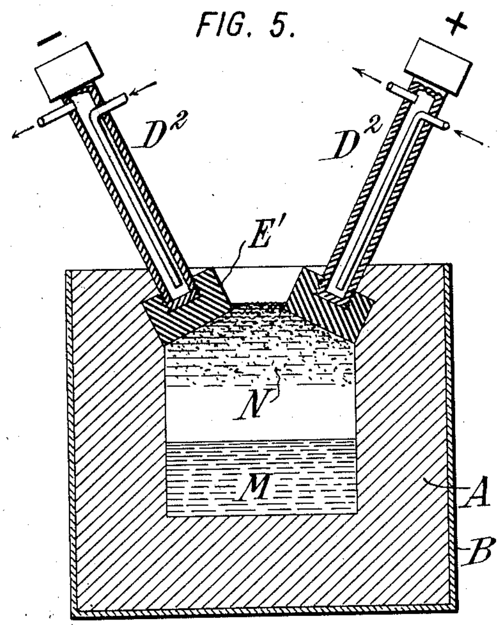


FIG. 6.

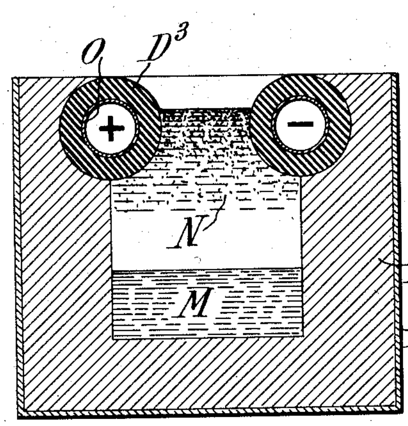
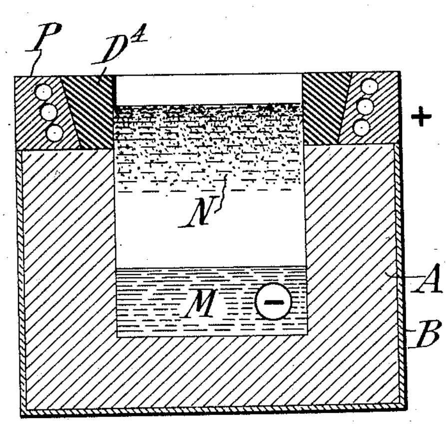


FIG. 7.



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UNITED STATES PATENT OFFICE.

FRANZ VON KÜGELGEN AND GEORGE O. SEWARD, OF HOLCOMBS ROCK, VIRGINIA, ASSIGNORS TO VIRGINIA LABORATORY COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

ELECTRIC-FURNACE PROCESS.

No. 880,743. **Specification of Letters Patent.** **Patented March 3, 1908.**

Application filed April 10, 1905. Serial No. 254,677.

To all whom it may concern:

Be it known that we, FRANZ VON KÜGELGEN, a subject of the German Emperor, and GEORGE O. SEWARD, a citizen of the United States, both residing at Holcombs Rock, in the county of Bedford and State of Virginia, have jointly invented certain new and useful Improvements in Electric-Furnace Processes, of which the following is a specification.

In our application No. 243,494, filed January 31, 1905, patented July 2, 1907, No. 858,400 we have described a resistance furnace or an electrolytic apparatus in which one or both of the electrodes is cooled by circulation of water therethrough, which cooling permits the substitution of metal for carbon electrodes with certain advantages specified therein in detail, and which cooling may also be used to advantage in connection with carbon electrodes.

The present application is in part taken from the previous application, and is based on the application of the process to carbon—usually graphite—electrodes; in which application there are certain peculiar advantages referred to hereinafter in detail.

We have discovered that, by cooling a carbon or graphite electrode, it may be used in resistance furnaces and still avoid the introduction of carbonaceous matter into the product; as for example in the process of refining a high carbon metal or alloy to a lower carbon metal or alloy and when reducing oxids by other agents than carbon (as in the Greene and Wahl process patented January 31, 1893, No. 490,961, and December 10, 1901, No. 688,510). Under such circumstances and in such processes, we may replace the water cooled metallic electrode specifically claimed in the above-entitled application by a water cooled carbon or graphite electrode, and often this substitution is of great benefit.

Whenever the expression "pyro-conductive charge" is used herein it means a charge of material which when cold is a non-conductor of electricity or substantially so, and which becomes an effective conductor only when heated to a high temperature, either to fusion or to an approach to the fusing point.

We have discovered that, by cooling a carbon or graphite electrode to a temperature considerably below that at which it would be otherwise maintained by the heat of the bath, the electrode is protected from attack by the material of the bath and of the charge, even though such material is of a very oxidizing nature such that it would rapidly consume the electrode if the latter were not so cooled. We have found that, by observing proper conditions in conducting the operation, it is possible to almost entirely and in some cases entirely preserve the carbon or graphite electrodes intact in a very oxidizing bath such as a mixture of metallic oxids. These discoveries are of value for the following reasons:—Though the idea of water-cooling a metallic electrode to a temperature such that it will not be attacked or melted by the bath of an electric resistance furnace or electrolytic furnace is of great value and enables us to successfully operate processes where, without the water-cooling, the material of the electrodes would inevitably contaminate the product, the substitution of water-cooled carbon or graphite electrodes for the cooled metallic electrodes, enables us to accomplish the same result with less loss by cooling and with greater immunity from possible damage to the electrode through temporary abnormal conditions in the furnace which may cause small arcing between the electrodes and the bath. Such substitution is found to be of special advantage in resistance furnaces where it is necessary to maintain a very high temperature to accomplish the desired reactions.

By water-cooling the carbon electrode we are enabled to immerse it in the most oxidizing slag or bath, such as molten mixtures of oxids suitable for refining high carbon metals, without danger of reactions between the electrode and bath and consequent carburization of the product.

We have maintained such a highly oxidizing bath as a molten mixture of chrome ore and lime at an intensely high temperature for days by the passage of an electric current therethrough between water-cooled graphite electrodes without appreciable effect on the electrodes.

Most oxids, mixtures of oxids, salts and slags are pyro-conductors, displaying a considerable conductivity only when heated to certain temperatures. It is important that the bath immediately in contact with the electrode, and therefore that portion of the electrode itself, shall be maintained at a temperature high enough for the bath to be suitably conductive, so that the current may be conducted from the electrode to the hotter "working portion of the bath".

By the "working portion of the bath" we mean that part of the bath remote enough from the cooling effect of the electrodes to be maintained, by its resistance to the current, at a temperature sufficiently high to bring about the desired reactions. This "working portion of the bath" will in all cases be higher in temperature than the portions surrounding the electrodes.

Depending on the nature of the charge and the temperature at which the bath becomes suitably conductive, that portion of the bath in contact with the electrode may be in some cases solid, in some cases molten, and in other cases passing through various degrees of pastiness.

Where the portion of the bath in contact with the electrode is reduced to a solid or pasty state by the cooling, it forms a conductive coating on the electrode and becomes practically the working electrode connecting the electrode proper to the working portion of the bath. In fact, it may be found desirable in some cases to lower the temperature sufficiently to form such a working electrode and thus perfectly protect the electrode proper.

The process is adapted also to the electrolysis of molten electrolytes.

The accompanying drawings illustrate suitable apparatus.

Figure 1 is a longitudinal section through a resistance furnace, and Fig. 2 is a horizontal section through the same. These figures show the method of applying the water cooling to rectangular blocks of graphite acting as electrodes. Fig. 3 is an elevation of one of the electrodes illustrating the method of arranging the water pipes. Figs. 4, 5, 6 and 7 are views similar to Fig. 1 illustrating more or less diagrammatically the application of the improvement to other arrangements of the electrodes.

Referring to the furnace illustrated, A is the body or wall of the furnace or "lining", which may be made of chrome ore or other suitable material, depending on the nature of the charge. The wall is held in shape by an iron shell B. The bath in Figs. 1 and 2 occupies the oblong space or chamber C between the two electrodes which, in the present embodiment of the invention are composed of pencils D and blocks E. A sufficient quantity of the bath is maintained to be always in contact with the exposed ends of the electrodes.

For cooling the exposed end of the graphite electrode, water is conducted through the blocks E by means of inlet pipes F and outlet pipes G. Pipes F and G are inserted through blocks E by first boring holes of the proper size, and these pipes are then connected to each other by a pipe H, and to the supply and discharge pipes J and K, the pipes H, J and K being beyond the sides of the block as illustrated. The block with its several pipes attached is then molded in place in the chrome ore lining. The water circulating through the pipes E and G at the desired rate, reduces the temperature to a point depending on the conditions and nature of the bath.

An example of the application of the invention is the refining of ferro-chrome, and in this case the bath consists of a refining slag of chrome ore and lime, and the charge is the metal to be refined or a mixture of same with ore or ore and lime. The bath is maintained at about the level indicated, and the product (low carbon ferro-chrome) collects in the bottom of the crucible. The resistance of the bath N to the electric current is in this case the only source of heat. The same principle may be applied to practically all types of electric resistance furnaces. For example Fig. 4 is a diagram of a furnace in which only one pole, the carbon electrode D′, is cooled, the other pole being the metallic product M itself. The cooling in this case is accomplished by passing water through admission and discharge pipes J and K, entering the hollow stem of the electrode so as to maintain this stem always full of water. A larger graphite or carbon block E′ is used for the contact end of the electrode. This is the type of furnace commonly known as "single pole." It can, of course, be varied by using a number of electrodes of the same polarity in place of the electrodes D′ E′.

Fig. 5 illustrates the application of the invention to a common form of "double pole" furnace. In this furnace the current enters the bath by one of the electrodes D^2 and leaves it by the other, instead of leaving it by a metallic connection with the product at the bottom as in Fig. 4. In this construction the current passes in part directly through the bath and in part through the bath from one electrode to the product and thence to the other electrode, the division of current following Ohm's law. This type of furnace might also have two or more electrodes of each polarity, forming the type known as "double pole multiple electrode". The electrodes are shown inclined, but otherwise they do not differ from the carbon electrode of Fig. 4.

Fig. 6 is a diagram of a double pole furnace in which the electrodes are of hollow carbon, preferably graphite, and are cooled by a circulation of water through the metallic cores O which also form the electrical connections. As indicated the electrodes are of opposite polarity, and the current goes in part directly through the bath from electrode to electrode and in part by way of the metallic product. The same construction might be used, only making both electrodes of the same polarity and connecting the metal at the bottom with the opposite pole of the circuit. The advantage of this construction is that the electrodes may be rotated when it is necessary to expose a fresh surface to the bath, and this feature makes it one of the best types of furnace for the purpose.

Fig. 7 shows a cored metal ring P through which a circulation of water is maintained and a graphite ring D^4 constituting the electrode and fitting accurately the metal ring which serves both to cool the graphite ring and convey the current to it. This is a single pole furnace, the metal at the bottom of the bath constituting the other pole, and is a very practical form of furnace. These variations will suffice to show that the invention is applicable to all types of electric resistance furnaces where the resistance is a fluid oxid bath, or other fluid bath.

Though we have described with great particularity of detail certain embodiments of the invention, yet it is not to be understood that the invention is limited to the particular embodiments disclosed. Various modifications thereof may be made by those skilled in the art without departure from the invention.

What we claim is:—

1. The method which consists in treating in an electric furnace a pyro-conductive charge by passing through it from a carbon electrode in contact with it a current sufficient to maintain the charge molten, and cooling said electrode sufficiently to protect it from attack by the portion of the charge in contact with it.

2. The method which consists in treating in an electric furnace a pyroconductive charge by passing through it from a carbon electrode in contact with it a current sufficient to maintain the charge molten, and cooling said electrode sufficiently to cause a portion of the charge to be chilled in a protective but conducting coating thereon, whereby such chilled portion forms in effect a new working electrode.

In witness whereof, we have hereunto signed our names in the presence of two subscribing witnesses.

FRANZ VON KÜGELGEN.
GEORGE O. SEWARD.

Witnesses:
GEO. T. LANCASTER,
FRIEDR. VON KIDDER.