No. 702,758. Patented June 17, 1902.

E. G. ACHESON.

METHOD OF GRAPHITIZING ELECTRODES.

(Application filed Dec. 18, 1900.)

(No Model.)

Fig. 1.

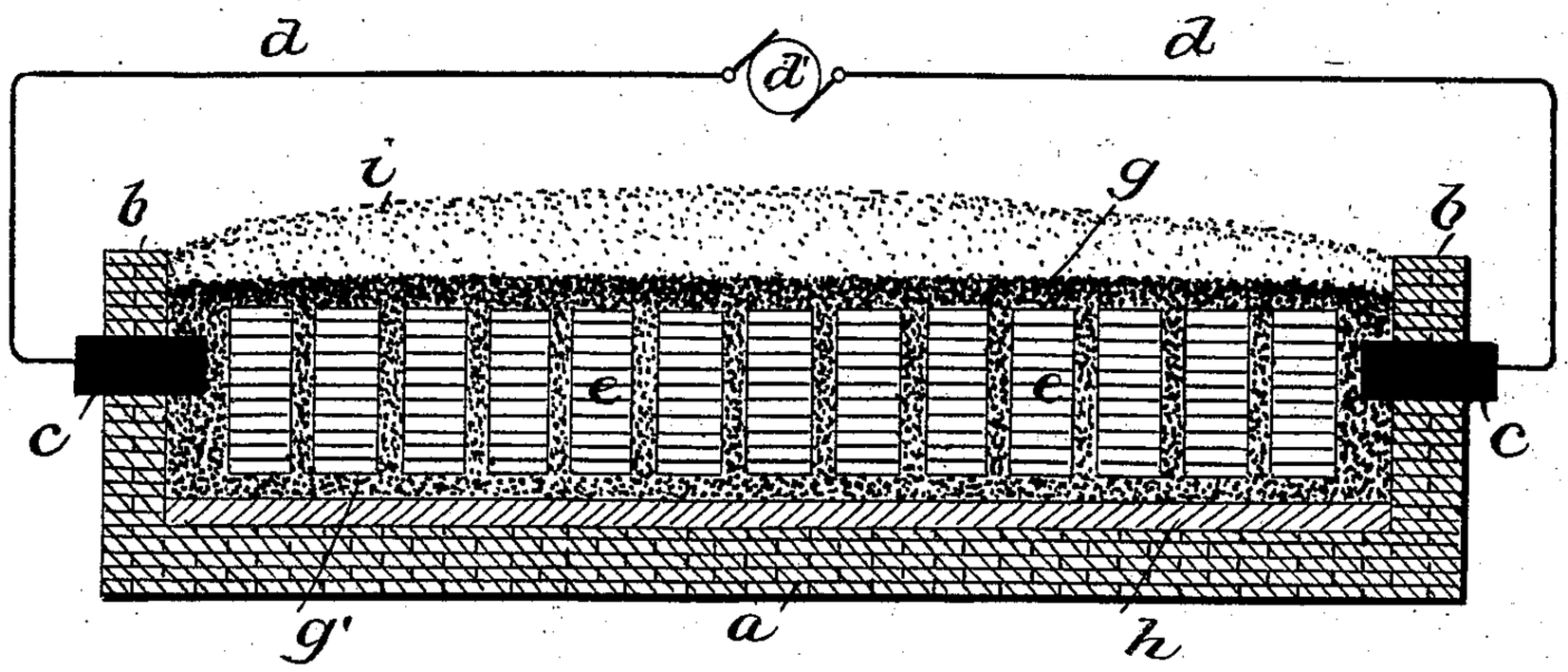


Fig. 2

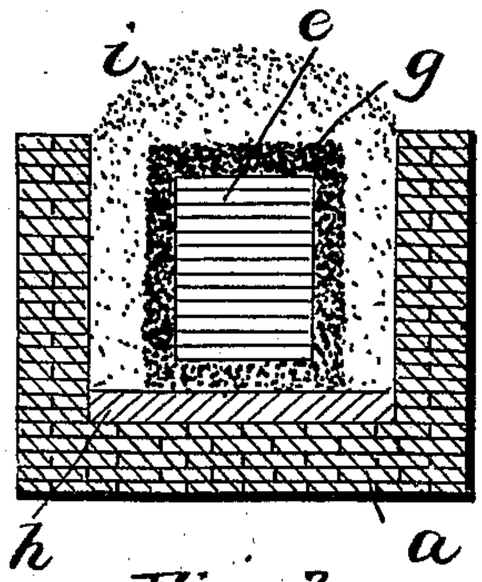
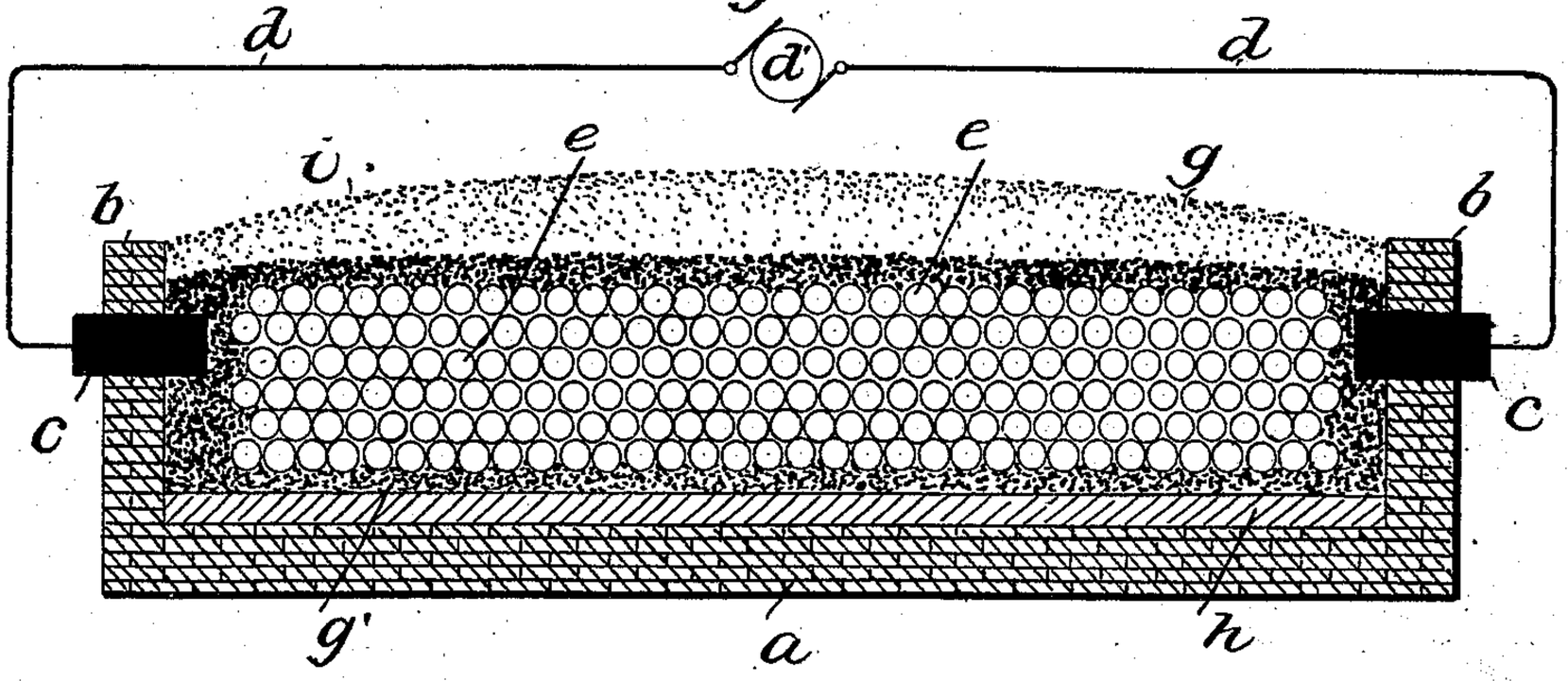


Fig. 3



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UNITED STATES PATENT OFFICE.

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METHOD OF GRAPHITIZING ELECTRODES.

SPECIFICATION forming part of Letters Patent No. 702,758, dated June 17, 1902.

Application filed December 13, 1900. Serial No. 39,742. (No specimens.)

To all whom it may concern:

Be it known that I, EDWARD G. ACHESON, a citizen of the United States, residing at Buffalo, in the county of Erie and State of New York, have invented certain new and useful Improvements in Methods of Graphitizing Electrodes, of which the following is a specification.

This invention relates to a new method of graphitizing electrodes and other articles composed, essentially, of carbonaceous materials.

Many carbon articles—such, for instance, as those generally known in the arts under the heads of "electrodes," "anodes," "motor and generator brushes," "battery-carbons," and the like—have been found to be materially improved for the purposes for which they are intended by subjecting them to such a treatment that more or less of the amorphous carbon of which they are formed is converted into graphitic carbon.

The invention consists in such a method whereby such carbon articles are subjected to a high temperature and more or less of the contained carbon in such articles is converted into graphite in a manner that produces the most perfect and uniform results in the most economical manner. It is understood that the articles to be treated are composed of carbon and more or less impurities which are capable of determining the conversion of the carbon into graphite when subjected to a high temperature through the agency of electricity. In order to do this, use is made of an electric furnace, and the amorphous carbon articles are subjected to the action of a high temperature produced by a powerful electric current while the articles are embedded in or surrounded by carbonaceous materials, and it has been found that the successful carrying out of the operation in an economical manner depends largely upon the general character of the furnace, and more particularly upon the manner in which the heat is generated within the furnace and the arrangement of the articles in relation to the flow of the electric current through the furnace. It has been found important and necessary for the successful manufacture of such graphitized articles on a large scale to produce the heat, or a large part thereof, necessary for the graphitization in a relatively poor conducting material, in which the articles to be graphitized are embedded, and to so place the articles in this resistance material that their longest dimensions will be approximately at right angles to the flow of the electric current through the furnace, or so nearly so that the current in flowing through the furnace will traverse the articles in a direction transverse to their length.

In the accompanying drawings there is indicated generally the character of furnace adapted for the purpose, Figure 1 being a longitudinal vertical section of the furnace; Fig. 2, a transverse vertical section of the same with one form of the articles therein, and Fig. 3 a similar longitudinal section with another form of articles therein.

While the form and arrangement of the furnace may vary, the one illustrated is in practical use, and its general dimensions are thirty feet long between the inner ends of the electric terminals, and it is of a width depending upon the length of the electrodes or articles being graphitized, and when, for instance, these articles are thirty inches long the inner width of the furnace will be approximately fifty-two inches, more or less.

The base *a* of the furnace is made of firebrick or other suitable heat-resisting material, and the ends *b b* are of the same material. Supported in said ends are the terminals *c c* of the electric circuit, formed of amorphous carbon, and these terminals in a furnace of this general size are four hundred square inches in cross-section. To these terminals lead the conductors *d d* from the source of electric current *d'*. The amorphous carbon articles that are to be graphitized are represented at *e*, they being embedded in a packing *g*, of semiconducting material—such, for instance, as ground coke. The inner bottom surface of the furnace is covered with a floor or packing *h*, of highly-refractory material—such, for instance, as carbid of silicon—and there is a covering or jacket *i*, of re-

fractory material—such, for instance, as a mixture of ground coke and sand.

The mode of procedure in operating the furnace is as follows: The furnace-walls, the electrodes, and the floor *h*, of carbid of silicon, which in practice is made ten inches thick, having been properly prepared, a layer *g'* of granular carbon, such as ground coke, is spread upon the floor *h* to a depth of about two inches, and on this floor of carbon the articles to be graphitized are built up. Where, as in the present instance, they are composed of slabs or plates measuring, say, five inches in width, one inch in thickness, twenty-four inches in length, they are built up in a number of piles, the plates forming the individual piles being laid upon each other without any separating material and each separate pile being separated from its neighbor by a space of one inch. The piles are built to a height proper for the current density that it is intended to use, and in this particular instance it would be seventeen inches high, making the total cross-sectional area of articles to be treated four hundred and eight square inches. The several piles having been finished, the outer walls, which are composed of loose brick, are built up to a height slightly above that of the carbon articles, and running lengthwise with the furnace broad sheets or plates of thin iron are set up edgewise at a distance of one and a half inches from the ends of the carbon piles. Between these iron plates and the walls of the furnace is introduced the mixture *i* of sand and carbon, and between the iron plates in the space surrounding the piles of carbon articles is packed granular carbon, for which ground coke of a grain averaging about one-sixteenth of an inch in diameter is preferable. This carbon is introduced into all of the spaces about the terminals *c c* and between the several piles of carbon plates and between the ends of the plates and the sheets of iron, and it is continued up and above the top of the piles, so that the piles themselves are covered with a thickness of one and a half inches of carbon. The iron sheets are then removed and an additional quantity of the mixture *i* is placed over and above the entire furnace charge to a depth of about fifteen inches.

In the construction illustrated in Fig. 3 the parts are similarly lettered and the furnace is constructed similarly to that above described; but in this case I have shown the articles to be graphitized in the shape of carbon rods or cylinders *e*, arranged with their longest dimensions in the same general direction and with their surfaces in contact with each other without the interposition of any packing material between them. It will be seen that the surfaces of the carbon rods or cylinders which are in contact are relatively small, and I find that the desired temperature is attained under these conditions without the necessity of separating the rods or cylinders or groups of rods or cylinders as they are shown separated in Fig. 1.

The furnace being thus constructed, the current is started with a voltage of two hundred and ten, the amperes registering fourteen hundred. A more or less rapid increase of amperes occurs until after about five hours, when the amperage will register three thousand six hundred with the voltage unaltered, after which the volts by means of regulation are gradually lowered as the amperes continue to increase, until at the end of the operation (which is ordinarily about twenty-four hours) the instruments show a voltage of eighty and an amperage of nine thousand. After a sufficient interval of time has passed to permit proper cooling of the furnace charge and articles contained therein the outer coverings are removed and the articles taken from the furnace, when they will be found to be converted more or less completely into soft graphitic carbon.

While the amount of packing material or granular carbon may vary with the character of the articles and its fineness may be regulated to suit the conditions of furnace charge, &c., it has been found from experience that the successful and economical manufacture of graphite articles is largely controlled by the amount and character of the packing material. As an economical rule the articles to be treated are separated to such an extent that sixteen per cent. of the total distance between the faces of the furnace-terminals is occupied with packing material, and the amount of packing material that is placed at the bottom, top, and ends of the piles is as small as possible and only sufficient to protect the articles from the action of the vapors that are produced from the mixture of sand and carbon during the operation.

It of course is evident that where carbons of irregular forms are used it will not be possible to so place them that their longest dimensions will be exactly at right angles to the length of the furnace, and it also sometimes occurs that an article is of too great a length to place at right angles across the furnace. Under these conditions it is convenient to arrange them at such an angle as to permit them to enter the furnace and at the same time hold a position as nearly as may be possible at right angles to the direction of the flow of the current.

By this method of treatment it is possible to graphitize at one time a large volume of carbon while using electric currents of such units of voltage and amperage as is found most practical in electrometallurgical operations. Thus a mass of carbon whose area of cross-section in the furnace is, as above shown, larger than the area of cross-section of the terminals of the furnace employed can be efficiently graphitized. This condition is made possible solely by reason of the fact

that the larger part of the heat being produced by the current and utilized in the conversion of the carbon articles is not produced within the carbon article itself, but in and by the granular packing material, and from it imparted to the carbon articles. To obtain the highest efficiency, the articles should, as above stated, be placed with their longest dimensions as nearly at right angles to the flow of the current as possible, because, owing to their density, they have a comparatively high conductivity, and this is more particularly true during the process of their graphitization, due to increased conductivity of the graphitic carbon.

When it is desirable to graphitize carbon rods or cylinders, it can be efficiently performed by packing them into the furnace in such manner that the rods are in contact with each other throughout their length and without placing any packing or other separating material between them. The necessary temperature is attained under this condition by reason of the small surfaces of contact that occur between adjoining rods, and to successfully operate in this manner the articles should be placed so that the current in passing through the furnace will pass through the articles in a direction transverse to their length. When rods or cylinders are graphitized in this manner, the furnace is constructed in the same manner as above described and the articles and granular carbon are surrounded by the mixture of sand and carbon, as is done when graphitizing rectangular or other forms of carbon in the manner above described.

What I claim is—

1. The herein-described method of subjecting electrodes and other articles, composed of carbon and impurities capable of determining the conversion of the carbon into graphite, to a high temperature through the agency of electricity, which consists in arranging said electrodes or other articles with their longest dimensions in the same general direction, and then passing a current of electricity through the same in a direction approximately transverse to the direction of their longest demensions.

2. The herein-described method of graphitizing electrodes and other articles, composed of carbon and impurities capable of determining the conversion of the carbon into graphite when subjected to a high temperature through the agency of electricity, which consists in embedding said electrodes or other articles, with their longest dimensions in the same general direction, in a mass of material having a lower coefficient of electrical conductivity than said articles, and then passing an electric current through the electrodes or other articles in a direction approximately transverse to the direction of their longest dimensions.

3. The herein-described method of graphitizing electrodes and other articles, composed of carbon and impurities capable of determining the conversion of the carbon into graphite when subjected to a high temperature through the agency of electricity, which consists in arranging the electrodes and other articles in separate piles with the longest dimensions of said electrodes or other articles in each pile in the same general direction, surrounding the piles with a mass of material having a lower coefficient of electrical conductivity than the articles themselves, and then passing an electric current through said electrodes or other articles in a direction approximately transverse to the direction of their longest dimensions.

4. The herein-described method of graphitizing electrodes and other articles composed of carbons and impurities capable of determining the conversion of carbons into graphite when subjected to a high temperature which consists in arranging said electrodes or other articles in piles separated by a mass of material having a lower coefficient of electrical conductivity than said articles, and then subjecting the electrodes or other articles to a temperature sufficiently high and for a sufficient length of time to convert a greater or less proportion of the amorphous carbon into graphite.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EDWARD G. ACHESON.

Witnesses:

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