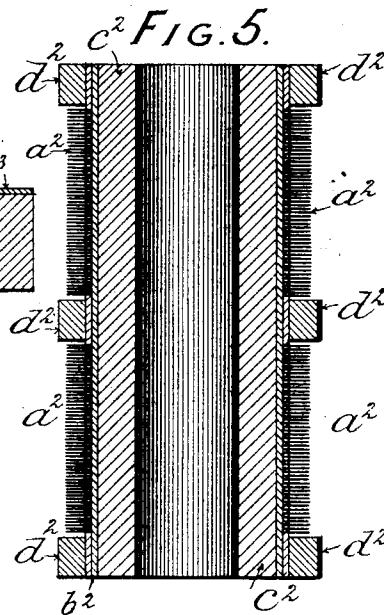
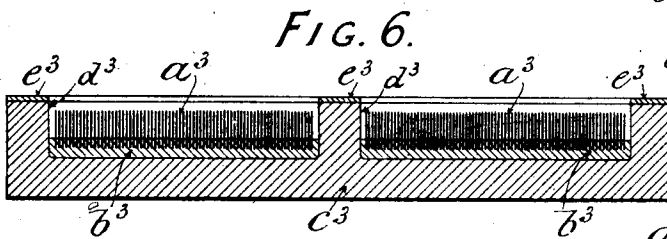
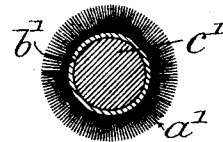
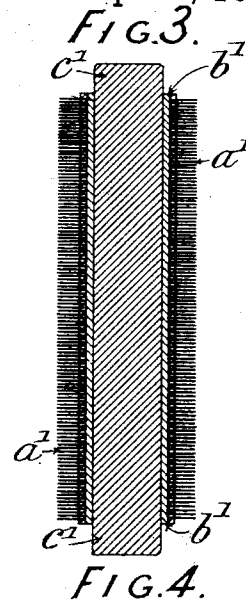
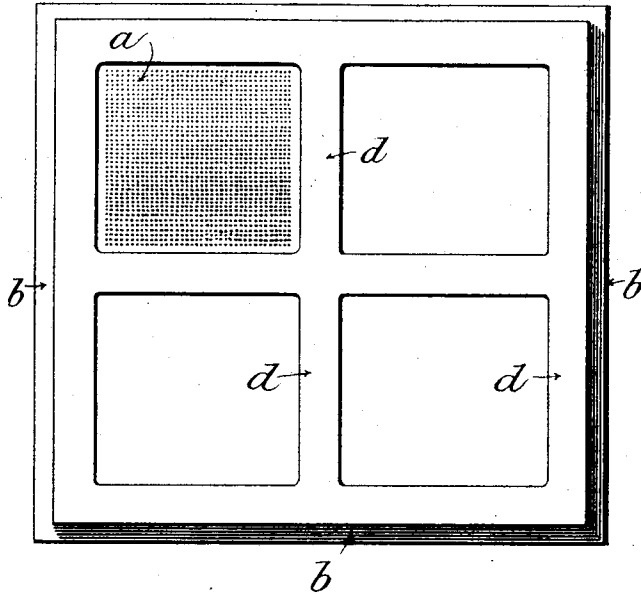
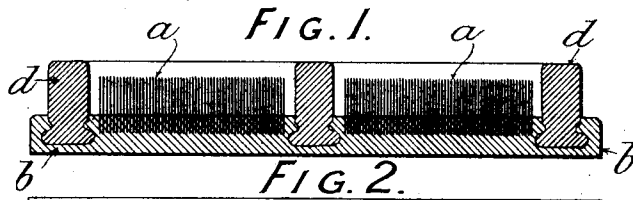


(No Model.)

H. T. BARNETT.
ELECTRODE.

No. 536,996.

Patented Apr. 9, 1895.



WITNESSES:

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UNITED STATES PATENT OFFICE.

HARRY THEODORE BARNETT, OF LONDON, ENGLAND.

ELECTRODE.

SPECIFICATION forming part of Letters Patent No. 536,996, dated April 9, 1895.

Application filed December 27, 1893. Serial No. 494,918. (No model.) Patented in England September 24, 1892, No. 17,099, and January 13, 1893, No. 758; in France November 2, 1893, No. 233,787, and in Germany November 16, 1893, No. 75,221.

To all whom it may concern:

Be it known that I, HARRY THEODORE BARNETT, a subject of the Queen of Great Britain, residing at London, England, have invented certain new and useful Improvements in Electrodes, (which have been patented in Great Britain by Letters Patent No. 17,099, dated September 24, 1892, and No. 758, dated January 13, 1893; in France by Letters Patent No. 233,787, dated November 2, 1893, and in Germany by Letters Patent No. 75,221, dated November 16, 1893,) of which the following is a full, clear, and exact specification.

My invention relates to that class of electrodes, in which the active surface consists of numerous fine filaments projecting from a suitable conducting base.

My improvements have for their object, to combine increased efficiency, with facility of manufacture and durability.

In order to increase the efficiency, I employ carbon filaments produced from cotton, flax, jute, wood or other vegetable fibers or from celluloid or other suitable carbonizable material. They may be used in the form in which they originally occur, or after having been either sub-divided and separated or combined and agglomerated according to the thickness required for the resulting filament. They may each consist of one or more varieties of such carbonizable fiber, or they may be formed from some plastic substance or mixture, such as cellulose compounds. The said filaments may be carbonized before, after, or during their attachment to the conducting support. They may undergo any suitable mechanical, chemical, or other treatment either before or after carbonization for the purpose of increasing the toughness, conductivity, or selective gaseous affinity, or the porosity of the material.

The conducting support may consist of any convenient metal or of carbon. It may be solid, laminated, filamentary, or of any other suitable shape or structure.

The filaments or pile may be attached to the conducting support by various methods either before, after or during the carbonization of one or both of them. For instance, textile manufactures may be cemented to the base with a carbonizable cement; or a portion of

each filament may be incorporated within a metallic conducting support by casting or electrotyping, or within a carbonaceous conducting support, when in a plastic state before carbonization.

The conducting support of the filaments may (if deficient in strength, conductivity or bulk) itself be supported by some suitable material. For instance, if the filaments are formed by the "pile" of a velvet fabric, and the supporting base is the woven ground of the said fabric, the velvet or similar pile fabric may be attached to a block or rod of carbon or other conducting material by cementing before carbonization, or by other suitable means. The additional support may be of inert (non-conducting) material if desired and may be plain or perforated and situated upon either side of the pile.

In the accompanying drawings, Figure 1 is a section and Fig. 2 a plan of an electrode embodying my invention. Fig. 3 is a vertical and Fig. 4 a horizontal section of a modification. Figs. 5 and 6 represent other modifications.

a, a', a^2, a^3 indicate the filamentary projections; b, b', b^2, b^3 the supporting base, which in Fig. 1 is a flat plate, and in Fig. 3 the woven ground of a pile fabric, while a' represents the pile.

c' is a carbon rod, upon which the pile fabric a', b' is fixed by means of a suitable carbonaceous binding material, such as flour paste, (afterward carbonized) and which serves as an additional support for the base b' .

Carbon may be heat-reduced from a suitable hydrocarbon or other suitable carbonaceous fluid, upon the filaments or upon the conducting support or upon both at the same time. In the former case the deposited carbon may also serve as a binding substance for joining together the filaments and the conducting support.

If desired, the heat employed in the process of depositing the carbon, may be utilized also to effect the carbonization of some portion or portions of the complete electrode.

When the fine projections are so filamentary as to consist of single fibers of carbonized cotton or some such substance forming a close pile, they will stand a fair amount of hand-

ling owing to their resiliency, but when the projections are of agglomerated fibers or powder (afterward carbonized), they should be protected from shocks or rough handling, to prevent their being broken or rubbed away. This also applies to finer filaments, if they are to be subjected to more than the ordinary amount of handling during the manufacture or use of the electrodes. For this purpose I construct the electrodes with guarding portions (*d* Fig. 1) attached to or formed of the substance of the said conducting support, said guards being so disposed upon and so far outstanding from the same, as to prevent the fine projections being damaged under any ordinary treatment to which they might be subjected. I prefer to make the said guarding portions of some insulating substance or (in the case of their being of the same material as the conducting support or of other conducting material) to provide them with an insulating face (*e*³ Fig. 6), the said insulation serving to prevent accidental electric contact, when the said electrodes are in use.

In the case of rods or tubes of conducting material covered with velvet carbon, (Fig. 5,) they may have a number of india rubber rings *d*² placed upon them at intervals, there being a ring at each end of the pile-covered portion, and the depth of the rings being of course greater than the depth of the carbon pile.

In the case of flat carbons, (Fig. 6,) these may have ridges *d*³, bands, stubs or other projections of the required depth molded upon their surfaces during manufacture, cotton velvet *a*³, *b*³ being subsequently attached to the flat surfaces between such ridges, bands, or other projections and afterward carbonized.

In the case of carbon filaments cast into a lead backing (Fig. 1) portions of earthen or other non-conducting material *d* may be placed in the mold, before the lead is poured, so that, when the metal is cast, it shall incorporate a sufficient portion of the said guarding substances, as to insure their retention.

For many purposes it is necessary to cover the surface of the carbon, with a film of platinum, which owing to the high price of this metal is made very thin, and a spongy film of platinum deposited from a solution is usually preferred to the reguline form owing to its greater activity.

I prefer to deposit the platinum from its solution by the same heating which effects the carbonization of the filamentary projections or of their supporting base if the latter consists of carbon. This is good for several reasons, but chiefly because of the very close union it engenders between the atoms of platinum and the filamentary carbon projections upon and into which they are deposited. The platinum might be reduced upon the said substances previous to their complete carbonization, as partial carbonization would be caused by a heat sufficient to reduce the platinum.

A convenient method of manufacture, in which the conducting support is a compound

solid cylindrical and textile mass, is as follows: Carbon rods suitable for electric arc lamps are pasted and dried and tightly bound with freshly pasted strips of cotton velvet that have been previously pasted upon the back and dried. Subsequently the rods are slowly dried in an air-current and then a solution of platinum chloride is sprayed on the filaments or pile, after which they are quickly dried in an oven, then packed in charcoal dust and carbonized in a gas muffle furnace or other highly heated chamber.

Before constructing electrodes in accordance with this invention it is advisable to consider the special purpose for which they are to be used. I will therefore explain the principal features or requirements and the points to be remembered in each case by means of a few examples.

First. A negative electrode for use in an electric battery of the "Smee" type. The current density being comparatively low, it is not necessary to aim at a specially high conductivity filament. It may however with advantage be treated with some substance which renders the liberation of hydrogen more rapid than it otherwise would be. To reap the full benefit of the surface in this case the pile should neither be very close nor very long, but should present a great number of points, the filaments being preferably inclined in an upward direction (from the vertical supporting base). Platinizing by the method described above is an advantage in this case.

Second. A negative electrode for use in a battery of the Bunsen type. The current density being higher than in the former case, the conductivity of the "pile" must be good and the contact between it and its conducting support must be more carefully studied, also there being in this battery but little liberation of gas a multiplicity of points is of less importance and the filaments may with advantage be thicker, longer and closer together, than in its former example, and may be unplatinized.

Third. An electrode for use as a negative element in a battery of the "chromic" type. In this case current density may assume its maximum. Therefore the conductivity everywhere should be the highest possible. The filaments may with advantage extend through a great portion of the space occupied by the depolarizing solution, as there being no liberation of gas, the said depolarizer does not of its own accord circulate freely.

Fourth. A positive or negative element for gas or gas metal batteries. Surface being of primary importance, the filaments may be of the greatest convenient length and fineness, that is, they should be as close in pile as is consistent with a ready permeability. The filaments should preferably be produced from such material or should undergo such treatment as shall insure their possessing the greatest possible selective affinity in the desired direction. If the whole of the filamen-

tary pile is to be immersed in the gas, the conducting support being the liquid contact, it is convenient to make the latter of woven, knitted or other filamentary textile fabric, thus being readily permeated by liquid and consequently of low electrical (diaphragm) resistance.

Fifth. As storage battery elements, the character of the electrodes must vary with the nature of the substance to be used upon or in conjunction with them, and also with the current density at which they are to be worked. Regarding the latter point the length, thickness, and closeness of the filaments may be decided upon the lines indicated in paragraphs first, second and third. Regarding the latter, as a rule the higher the electric resistance of the active matter, the finer and closer should be the filamentary pile.

Sixth. In electrolysis, the conditions may vary so much, that it is not possible for these remarks to cover the whole field, but as a negative element or cathode in the decomposition of water, the conditions being practically similar to those in paragraph first, the same class of carbon as therein mentioned may be used.

What I claim is—

1. In an electrode, the combination of carbon in the form of filaments, with a conducting support, from which the said filaments are projecting, and with which they are connected electrically and mechanically, the said conducting support being provided with guards extending beyond the free ends of the filaments, substantially as described and for the purposes specified.

2. In an electrode, the combination of carbon in the form of filaments, with a carbona-

ceous conducting support from which the said filaments are projecting and with which they are connected mechanically and electrically, the said conducting support being provided with guards extending beyond the free ends of the filaments, substantially as described and for the purposes specified.

3. The combination of an electrode consisting of numerous fine carbon projections situated upon and outstanding from a conducting support certain portions of which are raised above the general surface level for the purpose of protecting the fine carbon projections from injury, with a coat of electricity-insulating material applied to the outer surface or face of the said guarding portions, substantially as and for the purpose described.

4. In an electrode, the combination of a carbonized pile fabric, with a conducting support provided with guards extending beyond the ends of the pile and with which the pile fabric is connected mechanically and electrically, substantially as described and for purposes specified.

5. In a platinized carbon electrode, the combination of a conducting support, with numerous platinized carbon filaments projecting from the said supports and connected with the same mechanically and electrically, substantially as described and for the purposes specified.

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

HARRY THEODORE BARNETT.

Witnesses:

CHAS. ROCHE,
HARRY PETER VENN.