

E. W. JUNGNER.
 METHOD OF MAKING ELECTRODES.
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917,875.

Patented Apr. 13, 1909.

Fig. 1.

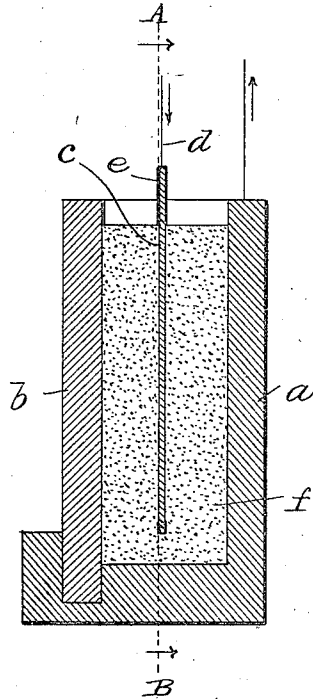
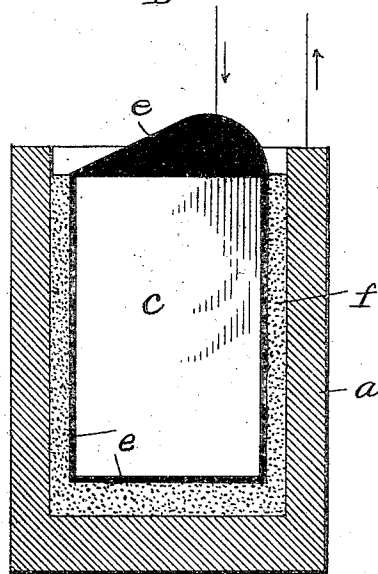


Fig. 2.



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UNITED STATES PATENT OFFICE

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METHOD OF MAKING ELECTRODES.

No. 917,875.

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To all whom it may concern:

Be it known that I, ERNST WALDEMAR JUNGNER, a subject of the King of Sweden, residing at Kneippbaden, Sweden, have invented certain new and useful Improvements in Methods of Making Electrodes; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The present invention relates to methods of electrolytically producing electrodes of magnetic metals, especially electrodes of nickel, designed and intended for the speedy storing and discharging of electrical energy.

If a nickel plate of 0.5 mm. thickness, after having been first treated or cleaned with emery, is immersed as an anode in a dilute solution of caustic potash (about 3 to 4 grams of KOH per liter of water) with or without traces or a small quantity of a suitable salt, for example sodium chlorid as indicated in United States Patent 731,308, a light greenish hydrate is formed at the commencement of the electrolysis. This hydrate does not however, adhere to the surface of the electrodes but is precipitated as a flocculent precipitate at the bottom of the vessel. If the electrolysis be continued the hydrate formed becomes heavier and at last adheres, although very loosely, to the electrode. After an electrolysis of from 4 to 7 hours according to the strength of the current the electrode is covered with a layer of nickel hydrate about one centimeter thick. If this precipitate be examined it will be found that the outermost layer consists of a more or less gelatinous-like, green hydrate but that the density of the hydrate as well as the firmness of the layer increases inward where the layer by degrees passes over from the greenish to the greenish-black and finally to the black hydrate. If such an electrode is used as anode in a stronger solution of alkali say 25%, only the innermost layer is oxidized to the higher electrolytically active hydrate that is bound to the nickel skeleton by molecular power while the rest of the mass will be peeled off by the gases and fall down. If this plate be now cleaned from hydrate by means of any suitable acid and weighed it will be found that it has lost from 50 to 75 per cent. of its weight according to the strength of the

current employed. It will also be seen that the plate is not evenly corroded and that in some places it is thicker than in others, the result being the same no matter what percentage or combination of salts be used in the electrolyte. Thus it will be seen that in the preparation of such electrodes crude material is lost and that on account of the unevenness of the skeleton, partly due to the long period of oxidation, the best economic results per unit of weight and price cannot be obtained.

Now the present invention has for its object to maintain the layer of hydrate in contact with the plate and when peeled off to replace it artificially and this is effected by surrounding the electrode during its formation by a porous substance moistened with the fluid required for the preparation of the plate. I thereby avoid the formation of any flaky, flocculent or gelatinous, as well as any loosely bound hydrate and after a few minutes of preparation a black even and closely adhering layer is formed on the plate. The advantages of such a formation in the dry way over those in the wet way are very important. By this method very thin plates may be used of 0.10 mm. or less and the electrodes produced will be very thin, and after a little more than half an hour will have an even and closely adhering layer of nickel hydrate without entailing any loss of crude material or electric current worth mentioning. Many different porous substances are more or less suited for this purpose but I prefer to use slaked lime which I have found to be the best. Lime is finely divided and mixed to a pasty or dough-like consistency with a suitable electrolyte. But this hydrate plays also a chemical role, the passage of the current causing a thinning of the electrolyte at the electrode and the hydrate of calcium which is somewhat soluble aids to keep the electrolyte at nearly constant concentration at the surfaces which are being prepared. Thus hydrates of the other alkaline earth metals may be used in place of calcium hydrate such as the hydrates of barium, magnesium and, generally all hydrates that are but slightly soluble in the electrolyte.

Referring to the drawings in which like parts are similarly designated, Figure 1 is a transverse section of the electrode and vessel ready to be subjected to electrolysis. Fig. 2 is a section taken on line A—B of Fig. 1.

In preparing a nickel electrode I proceed as follows:—I take a vessel *a* made of a suitable conductor, preferably of wrought iron and having a removable wall *b* and place in it the metal plate *c* to be provided with oxygen compounds, say a nickel plate to be provided with an active mass of nickel hydrate, said plate having at its top a pole or contact extension *d* the edges of the plate being protected from chemical corrosion by being covered with a suitable insulating material *e* as shellac or paraffin. The iron vessel *a* forms the negative electrode and the plate *c* the positive electrode. The vessel is now filled with a substance *f* rendered semi-solid by a suitable electrolyte, preferably a hydrate of a metal of the alkaline earths or gelatin, rendered semi-solid by an alkaline electrolyte. This semi-solid substance is conveniently hydrate of calcium or slaked lime, which is kneaded to a stiff dough consisting of 100 parts of hydrate of calcium and 72 parts of a solution of caustic potash said solution containing 6 grams of potash to a liter of water, to which has been added a few cubic centimeters of ammonia of 0.85 specific gravity. An electric current of about 5 amperes per square centimeter is passed from the nickel plate to the vessel for about one hour. When the plate is taken out and the lime is removed, it will be found to be coated with an even well adhering layer of nickel hydrate principally NiOH_2 . After about 2 hours charging with a current of about one ampere per square centimeter in an electrolyte of 25 per cent. alkali the electrode is ready for use.

The addition of ammonia to the alkaline solution as well as the variation of the percent of alkali, is intended to compensate the effects of impurities of any kind which may be found in the lime. Some of these impurities facilitate the formation of the nickel hydrate and if they are found in sufficient or comparatively large quantities, the addition of ammonia is unnecessary. If on the contrary the impurities act to retard the oxidation by having a reducing effect it is advantageous to add ammonia in greater quantities. The ammonia acts as a solvent for the nickel hydrate and facilitates the reaction; some organic substances also act thus.

Instead of absorbing the electrolyte in a porous substance as lime, said electrolyte may be combined with a gelatin, for example by boiling with starch or both methods may be combined.

If the nickel hydrate be removed from an electrode made in this manner it will be found, if the formation has been carried far enough, that the plate at a loss of about 40 per cent. of its weight, has been uniformly perforated with fine close holes some of them microscopic and in reality the plate so perforated is very much like an exceedingly

porous nickel sponge, the pores of which are filled with active nickel hydrate, said hydrate being combined with the metal by a molecular adhesion *i. e.* the hydrate being formed in place or *in situ* adheres to a very great degree more strongly to the metal carrier on which it is formed than if it were first made and then forced into or on the carrier, even if done so under great pressure. The metal particles of the plate itself are hydrated and stick very tightly.

When the perforations are sufficiently large it is evident that two or more plates may be united to form a nickel electrode. Such compound electrodes may be readily assembled with any suitable negative electrodes to accumulators with unchangeable alkaline electrolyte, provided the mutual capacities of the electrodes by election of the number of combined nickel-plates be brought to correspond to one another. In like manner wire nets or nickel skeletons of any shape whatsoever may be prepared and the capacity of electrodes produced by means of the nickel hydrate cement according to the method described by me in a prior application may be considerably increased by being treated in the manner above described inasmuch as the nickel grains will thus be finally coated all over with a strongly adhesive electroactive hydrate. This method of producing electrodes is also applicable to other magnetic metals as iron and cobalt. An electrode produced in this manner can in 5 minutes store up to 90 per cent. of its normal capacity.

I claim:—

1. The method of making electrodes which comprises subjecting a carrier composed of a magnetic metal to electrolysis in a suitable electrolyte, while surrounded by a semi-solid substance in close contact with the surface of the carrier to be treated during the electrolysis, removing the semi-solid substance and then subjecting the plate to a charging current in a suitable electrolyte.

2. The method of making electrodes, which comprises subjecting a metallic carrier to electrolysis in a suitable electrolyte while surrounded by a substance that is but slightly soluble in the electrolyte and thus rendered semi-solid, removing said substance and subjecting the electrode to a charging current in a suitable electrolyte.

3. The method of making electrodes which comprises subjecting a metallic carrier to electrolysis while surrounded by a suitable substance rendered semi-solid by admixture with an alkaline electrolyte, said substance being slightly soluble in the electrolyte, removing said substance and subjecting the electrode to a charging current in an alkaline electrolyte.

4. The method of making electrodes which comprises subjecting a carrier composed of

magnetic metal to electrolysis while surrounded by a substance rendered semi-solid by an alkaline electrolyte containing an agent counteracting the reducing action of impurities in the semi-solid substance, said semi-solid substance slightly soluble in the electrolyte, removing the semi-solid substance and subjecting the electrode to a charging current in an alkaline electrolyte.

5 10 5. The method of making electrodes which comprises subjecting a carrier composed of a magnetic metal to electrolysis while surrounded by an alkaline earth metal hydrate rendered semi-solid by an alkaline electrolyte, thereby forming oxygen compounds of the magnetic metal on the carrier, removing the alkaline earth metal hydrate and subjecting the electrode so formed to a charging current in an alkaline electrolyte.

15 20 6. The method of making electrodes which comprises subjecting a carrier composed of a magnetic metal to electrolysis while sur-

rounded by an alkaline earth metal hydrate rendered semi-solid by an alkaline electrolyte containing ammonia, thereby forming oxygen compounds of the magnetic metal on the carrier, removing the alkaline earth metal and subjecting the electrode to a charging current in an alkaline electrolyte.

7. The method of making electrodes which comprises subjecting a carrier composed of a magnetic metal to electrolysis while surrounded by slaked lime rendered semi-solid by an electrolyte containing a hydrate of a metal of the alkalies and ammonia and removing the lime.

In testimony that I claim the foregoing as my invention, I have signed my name in presence of two subscribing witnesses.

ERNST WALDEMAR JUNGNER.

Witnesses:

E. RÅBERG,
K. E. WIBERG.