



# XIV. On a new voltaic battery, cheap in its construction and use, and more powerful than any battery yet made; and on a cheap substitute for the nitric acid of Grove's platina battery

Rev. N.J. Callan

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XIV. *On a new Voltaic Battery, cheap in its construction and use, and more powerful than any Battery yet made; and on a cheap substitute for the nitric acid of Grove's Platina Battery. By the Rev. N. J. CALLAN, Professor of Natural Philosophy in the Royal College, Maynooth\*.*

SOME time ago, whilst I was reflecting on the principle of action of Grove's and Bunsen's batteries, it occurred to me that lead might be substituted for the platina of the former and the carbon of the latter. I put into the porous cell of a Grove's battery a piece of lead about  $\frac{1}{8}$ th of an inch thick, two inches broad and six inches long. I found that the voltaic current produced by the lead excited by a mixture of concentrated nitric and sulphuric acid was very powerful. I afterwards compared the power of this leaden battery with that of a platina one of the same size, by sending through the helix of a galvanometer, at the same time, but in opposite directions, the currents produced by the two batteries. Both batteries were charged with the same acids; the lead and platina were excited by concentrated nitric and sulphuric acid, and the zinc by dilute sulphuric acid. The current from the platina battery destroyed the deflection produced by the leaden one, and caused an opposite deflection, which indicated that the former current was about twice as strong as the latter. The two batteries were left working for about three hours and a half. At the end of that time the current from the lead was about twice and a half as powerful as the current from the platina. The quantity of lead dissolved during these three hours and a half was very small.

It struck me that by diminishing the action of the acids on the lead, I might increase the power of the battery. I therefore covered a leaden plate with gold leaf, and coated another

\* Communicated by the Author.

of the same size with chloride of gold, in the same way in which sheet silver is platinized for Smee's battery. These plates and a platina one of the same size were put successively into the porous cell of a Grove's battery, and the voltaic current sent through the helix of our large electro-magnet, in which the iron bar is about thirteen feet long and two and a half inches thick; the copper wire is about 500 feet long and one-sixth of an inch diameter. The magnetic power given to the electro-magnet by the leaden plate coated with chloride of gold, appeared to be equal to that which was produced by the platina plate. The magnetic effect of the current from the leaden plate covered with gold leaf was not so great. A coating of chloride of platina was afterwards found to answer as well as one of chloride of gold.

Some days after a leaden and platina battery of the same size were left working for four hours and a half. At the end of that time the lead plate acted fully as well as the platina. When the nitric acid was so much exhausted that the lead was barely capable of magnetizing the large electro-magnet so as to make it sustain a certain weight, the leaden plate was taken out of the porous cell, and a platina plate of the same size put in its stead. The platina plate was not able to make the electro-magnet sustain the weight which the lead had caused it to sustain.

The magnetizing power of the platinized or gilded lead and platina batteries was compared several times in working an electro-magnetic machine. On these occasions the power of the leaden battery was evidently superior to that of the platina one. Sometimes the platina plate was taken out of the porous cell, and a platinized or gilded lead plate of the same size put in its place: the velocity of the machine was instantly and considerably increased. The same effect was produced when the platina plate was taken out of the cell and a platinized platina one put in its stead. Hence it appears that a leaden plate coated with chloride of platina or gold, or a platinized platina plate, produces a more powerful voltaic current than a platina plate does. On the 24th of last May, a small platinized lead battery and a Grove's battery of the same size, were exhibited before the Royal Irish Academy. The power of the former was obviously superior to that of the latter. By using double leads and single zincs instead of double zincs and single leads, the power of the battery appears to be increased. When the lead plates have been used for a long time, they require to be newly gilded or platinized. After being used they should be rinsed in water, and dipped into a weak solution of chloride of gold or platina.

Seeing that the concentrated acids, by dissolving the lead, removed the gold or platina powder, and that the nitric acid was very expensive, I endeavoured to find in its stead a cheap substitute which would not act on the lead. The first that occurred to me was common nitre. I dissolved about the eighth of an ounce of it in sulphuric acid, which I diluted with nearly an equal bulk of water. I poured the mixture into the porous cell of a Grove's battery, and put into it a platinized leaden plate. I then sent the voltaic current through the helix of our large electro-magnet: the magnetic power given to the magnet appeared to be greater than that which was given to it by a Grove's battery of the same size, in which the platina was excited by concentrated nitric and sulphuric acid. I afterwards compared the heating power of the two batteries, and found the power of the platinized lead battery to be evidently superior to that of the other. I charged a platinized leaden battery with a mixture consisting of about five parts of sulphuric acid, five of solution of nitre, and one of nitric acid, and a Grove's battery with equal parts of nitric and sulphuric acid. The former fused a piece of steel wire which the latter only raised to a white heat. When a platina plate is excited by a mixture of sulphuric acid and a solution of nitre, the voltaic current appears to be as powerful as that which is produced by the plate when excited by concentrated nitric and sulphuric acid. The cost of the nitre necessary for charging a battery is about the twentieth part of that of the nitric acid. The power of the former declines sooner than that of the latter: but from the results of several experiments, I have come to the conclusion that the expense of doing a given amount of work by a platina battery excited by concentrated nitric and sulphuric acid, would be three or four times as great as if the work were done by a platinized lead battery excited by a mixture of sulphuric acid and a solution of saltpetre. I have tried nitrate of soda, or cubic nitre, and nitrate of ammonia, as substitutes for nitric acid; but although they give great power, they do not answer as well as the common nitre. A solution of common nitre and cubic nitre along with sulphuric acid, forms a mixture scarcely inferior to the solution of common nitre and sulphuric acid. The most powerful mixture for the platina or platinized lead battery consists of about four parts of sulphuric acid, two of nitric acid, and two of a saturated solution of nitre. When no nitric acid is used, at least one half of the mixture should consist of sulphuric acid, and the remainder of nitre and water: the solution need not be saturated with nitre. Four parts of sulphuric acid, two of a solution of chromate of potash, and two

of the solution of nitre, make a most powerful exciting mixture for platina, but give comparatively little power to platinized lead. I endeavoured to find among the sulphates a substitute for sulphuric acid, but did not succeed. The voltaic current from a platinized lead battery, excited by two parts of sulphuric acid, three of sulphate of soda, and three of nitrate of potash, is very powerful, but considerably inferior to that which is produced by the concentrated acids.

On finding that platinized or gilded lead and platinized platina were superior to platina, I saw that the cause of the superiority was that, in the platinized or gilded lead, and in the platinized platina batteries, the acting metals were, not lead or platina and zinc, but gold or platina powder, and zinc; and that the gold or platina powder was more negative compared with zinc than platina is. Hence I inferred, first, that a leaden plate coated with any of those substances which are more negative and cheaper than platina or gold, would act as powerfully as platinized or gilded lead; and secondly, that any other metal to which the platina or gold powder would adhere might answer as well as lead. I therefore coated, by the galvanic process, leaden plates with antimony, arsenic, chromium, molybdenum and borax. The plates coated with arsenic and molybdenum were much inferior to platina: those that were coated with antimony and borax appeared fully equal to platinized lead, but they soon lost their power. The first plate which I chromed acted as well, and retained its power nearly as long as platinized or gilded lead. I afterwards coated a great number of plates with chromium; but all of them were far inferior to the first. The power of a leaden plate is greatly increased by being coated with mercury, or even with clay boiled in aqua regia, or with any other substance which I tried; but I have not found any substance to answer as well as the chloride of gold or platina.

I have compared with platinized lead, the other cheap metals coated with gold or platina, or chromium; and with the exception of cast iron, they were all inferior to it. Platinized or chromed cast iron answers as well as platinized lead; and without being chromed or platinized, cast iron appears to act as powerfully as platina. The power of a cast iron battery in magnetizing our large electro-magnet, and in driving an electro-magnetic machine, was compared with that of a Grove's battery of the same size. In the two batteries the exciting mixture was the same. The power of the former appeared to be fully equal to that of the latter.

From the results of several experiments which I have made on the relative power of platinized silver and platinized lead,

I feel confident that the latter may, without any diminution of power, be substituted for the former in Smee's battery. Cast iron does not take the coating of platina powder (at least until the hard surface is worn away) so well as lead or silver, and on that account it does not act as powerfully as either. But I have found zinc and cast iron excited by dilute sulphuric acid as constant in their action as zinc and platinized lead. A platinized lead, or cast iron plate six inches square, may be had for the twelfth part of the cost of a platinized sheet of silver of the same size.

From the experiments which have been described, I infer, first, that a battery superior in power to Professor Grove's nitric acid battery may be made by substituting platinized platina or lead for platina, and nitrosulphuric acid and nitrate of potash for nitric and sulphuric acid; and secondly, that a battery equal in power to the nitric acid battery may be constructed by the substitution of cast iron for platina.

The advantage of what I may call the nitre platina battery over the nitric acid one is, that the expense of working the former is, as has been already stated, considerably less than that of working the latter.

The advantage of the cast iron or platinized leaden batteries over Professor Grove's is, that they are far less expensive in their construction. A plate of cast iron or platinized lead may be had for a shilling, whilst a platina plate of the same size will cost nearly three pounds. Besides, a cast iron or platinized lead battery may be worked by a mixture of nitre and sulphuric acid for one hour for about the tenth part of the expense of working a Grove's battery for the same time.

The cheapness of cast iron and platinized lead will enable every one to procure a powerful voltaic battery. A platinized lead battery is about fifteen times as powerful as a common Wollaston battery of the same size. A cast iron battery is a little less powerful than the platinized lead one; but I prefer the former, because the cast iron does not require to be chromed or platinized. I am now preparing two large cast iron batteries for the College: one will contain about thirty-three square feet of zinc and sixty-six of cast iron, the other will contain eighty square feet of zinc and a hundred and sixty of cast iron. These batteries will be more powerful than any battery ever constructed. The expense will be very moderate; for the zinc plates and Wedgwood troughs of our former batteries will answer for the new ones.

Maynooth College, July 3, 1847.