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"Nec aranearum sane textus ideo melior quia ex se fila gignunt, nec noster vilior quia ex alienis libamus ut apes." JUST. LIPS. *Polit.* lib. i. cap. 1. Not.

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[THIRD SERIES.]

DECEMBER 1842.

LXXII. *On a Gaseous Voltaic Battery.* *By* W. R. GROVE, *Esq., M.A., F.R.S., Professor of Experimental Philosophy in the London Institution.*

To R. Phillips, Esq., F.R.S.

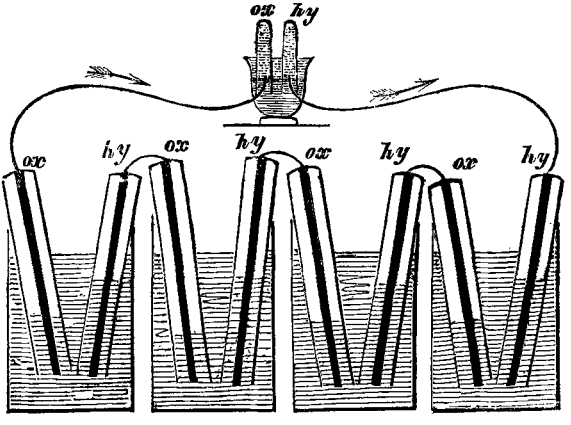
MY DEAR SIR,

IN the Philosophical Magazine for February 1839 I have given an account of an experiment in which a galvanometer was permanently deflected when connected with two strips of platina covered by tubes containing oxygen and hydrogen. At the conclusion of my notice, I say, "I hope, by repeating this experiment in series, to effect decomposition of water by means of its composition." The next paper of mine published in the same year contains an account of a battery to which the public has since attached my name, and which led me into a different field of research.

In reading over my papers lately for a purpose alluded to in my letter of last month, I was struck with the above sentence. My impression was, that I had expressed a hope not very likely to be realized; but after a few days' consideration I saw my way more clearly, and determined to try the experiment.

As the chemical or catalytic action in the experiment detailed in that paper, could only be supposed to take place, with ordinary platina foil, at the line or water-mark where the liquid, gas and platina met, the chief difficulty was to obtain anything like a notable surface of action. To effect this my first thought was to surround the platina foil with spongy platina precipitated in the usual way by muriate of ammonia. This was suggested to me by the known action of spongy platina on mixed gas, which would by its capillary attraction expose a considerable surface of metal and liquid to the action of the

gases. I still think this would be the best mode of effecting the object; but as it was very troublesome in manipulation, I determined to try the platina platinized by voltaic deposition from the chloride, as proposed for a different purpose by Mr. Smee. I therefore caused a series of fifty pairs to be constructed, the form and arrangement of which is given in the annexed figure, where *ox* denotes a tube filled with oxygen; *hy* one filled with hydrogen, and the dark line in the



axis of the tube platinized platina foil, which in the battery I constructed was about one-fourth of an inch wide. It is obvious that, by allowing the platina to touch the liquid, the latter would spread over its surface by capillary action and expose an extended superficies to the gaseous atmosphere. The battery was charged with dilute sulphuric acid, sp. gr. 1·2, and the following effects were produced:—

1st. A shock was given which could be felt by five persons joining hands, and which when taken by a single person was painful.

2nd. The needle of a galvanometer was whirled round and stood at about 60°; with one person interposed in the circuit it stood at 40°, and was slightly deflected when two were interposed.

3rd. A brilliant spark visible in broad daylight was given between charcoal points.

4th. Iodide of potassium, hydrochloric acid, and water acidulated with sulphuric acid were severally decomposed; the gas from the decomposed water was eliminated in sufficient quantity to be collected and detonated. The gases were evolved in the direction denoted in the figure, *i. e.* as the chemical theory and experience would indicate, the hydrogen travelling

in one direction throughout the circuit, and the oxygen in the reverse. It was found that 26 pairs were the smallest number which would decompose water, but that four pairs would decompose iodide of potassium.

5th. A gold leaf electroscope was notably affected.

6th. The battery was charged with distilled water; the electroscope was affected, and iodide of potassium decomposed.

7th. Although the phænomena were too marked to render it in the least probable that accidental circumstances could have produced the current, still counter experiments were carefully gone through; thus the gases were repeatedly changed, oxygen being placed in the tubes which had contained hydrogen, and *vice versâ*. The effects were equally powerful, and the direction of the current was reversed.

8th. All the tubes were charged with atmospheric air; no effect was produced.

9th. The battery was charged with carbonic acid and nitrogen in the alternate tubes; not the slightest effect observable.

10th. It was charged with oxygen and nitrogen; not any effect.

11th. With hydrogen and nitrogen, slight effects. The difference between this and the last experiment at first struck me as extraordinary, but upon consideration was easily explicable. The liquid being exposed to the air would necessarily absorb some oxygen, and this with hydrogen would give rise to a current. This was proved by the liquid rising in the hydrogen tubes, but not in those containing nitrogen; and, as a further proof, one set of tubes was charged with hydrogen, and the alternate set with acidulated water without gas; a slight current was perceptible: with oxygen and the liquid in alternate tubes there were no effects produced.

12th. As the oxygen and hydrogen were procured in the first instance by electrolysis, and as Dr. Schœnbein in his careful experiments on polarized electrodes supposed the peculiar substance which he has named Ozone to be a principal agent, I caused the tubes to be charged with oxygen evolved from chlorate of potash and oxide of manganese, and hydrogen from zinc and sulphuric acid; the effects were the same.

The tubes were not all of equal size, nor were they graduated; the exact proportional diminution of gas in each tube could not be ascertained with perfect accuracy; both gases did diminish, and the hydrogen so much more rapidly than the oxygen, that my assistant, who was unacquainted with the rationale of the battery, observed that the hydrogen was absorbed twice as fast as the oxygen. Mr. Gassiot is now preparing a graduated battery of this sort, by which the point will be accurately

determined; supposing the gases at the electrodes and at the plates exposed to uniform facilities of solution, the quantity evolved should be equal to that absorbed.

Several curious points are suggested by this novel battery.

α. How is its action explicable on the contact theory? I am by no means wedded to any theory, and have constantly endeavoured to look with the eye of a contact theorist upon the facts of voltaic electricity, but I cannot see them in that light; if there be any truth in the contact theory, I either misunderstand it, or my mind is unconsciously biassed. Where is the contact in this experiment, if not everywhere? Is it at the points of junction of the liquid, gas, and platina? If so it is there that the chemical action takes place; and as contact is always necessary for chemical action, all chemistry may be referred to contact, or upon the theory of an universal plenum, all natural phænomena may be referred to it. Contact may be necessary, but how can it stand in the relation of a cause, or of a force?

β. Its phænomena present to my mind a resolution of catalysis into voltaic force, in other words, the action of this battery bears the same relation to the phænomena of catalysis as that of the ordinary batteries does to those of ordinary chemistry. Whether these effects could be produced by other inoxidable metals (such as gold or silver) is an experiment worth trying. The more we examine chemical and voltaic actions, the more closely do we assimilate them. For some mysterious reason three elements seem necessary for very many if not for all chemical actions.

γ. This battery is peculiar in having the current generated by gases, and by synthesis of an equal but opposite kind at both anode and cathode; it is therefore, theoretically, more perfect than any other form, as the batteries at present known, act by one affinity at the anode, and have to overcome another at the cathode.

δ. This battery establishes that gases in combining and acquiring a liquid form evolve sufficient force to decompose a similar liquid and cause it to acquire a gaseous form. This is to my mind the most interesting effect of the battery; it exhibits such a beautiful instance of the correlation of natural forces.

Many other notions crowd upon my mind, but I have occupied sufficient space and must leave them for the present, hoping that other experimenters will think the subject worth pursuing. I remain, my dear Sir, yours very sincerely,

London Institution, Oct. 29, 1842. W. R. Grove.