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XXIV. On voltaic series and the combination of gases by platinum

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It is no other than a leather strap, which connects two drums in a large worsted mill in the town of Keighley.

The dimensions and particulars of the strap are as follows:

It is in length	24 feet
Breadth	6 inches
Thickness	$\frac{1}{8}$ do.

It makes 100 revolutions in a minute.

The drums, over which it passes at both ends, are two feet in diameter, made of wood fastened to iron hoops and turning on iron axles; these drums are placed at 10 feet distance from each other, and the strap crosses in the middle between the drums, where there is some friction; the strap forming a figure of eight. There is no metal in connexion with the strap, but it is oiled. If you present your knuckle to the strap above the point of crossing, brushes of electrical light are given off in abundance, and when the points of a prime conductor are held near the strap, most pungent sparks are given off to a knuckle at about two inches; I charged a Leyden jar of considerable size in a few seconds by presenting it to the prime conductor. The gentleman who told me of this curious strap has frequently charged his electrical battery in a very short time from it, and he informed me that it is always the same, generating electricity from morning to night without any abatement or alteration. If this strap had the advantage of silk flaps and a little amalgam, it would rival the machine in the lecture room in Albemarle-street.

Pray excuse the earnestness of

Your most faithful Servant,

Keighley Rectory, Yorkshire,
Dec. 17, 1838.

THEODORE DRURY.

XXIV. *On Voltaic Series and the Combination of Gases by Platinum.* *By* W. R. GROVE, *Esq.* M.A.

GENTLEMEN, Swansea, Dec. 14, 1838.

IN a letter on an œconomical constant battery which you did me the honour to publish in your number for the present month, (Dec. 1838. vol. xiii. p. 430) I ventured to suggest the more extensive employment of the porous septum as an instrument of analysis for voltaic combinations. I am not unaware of the experiments of De la Rive, Porret, &c., and meant to allude less to its use in the decomposing cell, than in the trough itself, and to its practical application to the improvement of apparatus. The following experiments instituted with this view may not be uninteresting to your readers; they differ, it will

be seen, materially from those of Sir H. Davy on unimetal series. Having constructed two troughs in the manner described in my last letter, one of alternate plates of iron and unglazed porcelain, the other of plates of copper and porcelain, I poured into the alternate cells of the first a saturated solution of sulphate of iron and dilute sulphuric acid. With this arrangement, as was to have been expected, little electric action was manifest; equally trifling were the effects when sulphate of iron and dilute muriatic acid were the electrolytes; when however nitric acid was employed with sulphate of iron a tolerably active current was generated: with twelve plates acidulated water was decomposed and a slight shock felt in the moistened hands. I now tried the copper trough with sulphate of copper and the same three acids respectively: with the sulphuric and nitric the electric development was but slight; but with the muriatic, diluted with about twice its quantity of water, a most energetic series was formed. With twelve plates acidulated water was rapidly decomposed*: with a pair of copper plates each exposing about 36 square inches of surface, a Ritchie's rotating magnet was whirled rapidly round, exhibiting small but brilliant sparks; its revolution continued for several hours without the addition of fresh acid; in fact the energy was fully equal to that displayed by similarly sized arrangements of zinc and copper, excited by muriatic acid but without diaphragm: a strong solution of common salt, substituted for muriatic acid, produced effects not far inferior. On examining the batteries when exhausted, I found the sides of the copper which had been exposed to the sulphate of copper covered with a fine coating of that metal; the affinity between the chlorine and the copper had consequently (according to the principle of preponderating affinity established by Dr. Faraday,) been sufficiently powerful to cause the solution of copper to be de-oxidated by the transferred hydrogen and to produce vigorous electro-motive action without the presence of a dissimilar metal.

It would appear from this that the diaphragm is of more practical importance in voltaic combinations than as a mere

* It is more expensive but much more satisfactory, if, in these experiments, series, as in the text, be employed instead of single combinations. I have frequently imagined I had obtained results from a single pair with the galvanometer, but have found them entirely negatived when the same combination was used in series. This was most probably owing to the many interfering circumstances to which the magnetic galvanoscope is liable, or perhaps to superficial differences in the two plates of metal.

preventer of cross precipitation; for instance, if zinc and copper be employed with muriatic acid but without diaphragm, putting out of the question the precipitation of the zinc on the copper, the power would be only as the excess of the affinity of chlorine for zinc over its affinity for copper; with the diaphragm we have no opposing current, the affinity of chlorine for copper, assisted by that of hydrogen for oxygen, is able readily to cause decomposition of the sulphate of copper and give rise to a strong current. In the first or common arrangement, this current opposes, and consequently, in estimating the resulting power, must be deducted from that produced by the superior affinity of chlorine for zinc; in the last arrangement, the thus evidently inferior obstacle, the resistance to decomposition of the sulphate, is the only one to be overcome*.

It would seem then that the best form of combination would be one with two metals and two electrolytes, the generating metal being one which has the strongest affinity for the anion of the electrolyte in contact with it, while the other solution is most readily decomposable by its cation and does not cause a precipitate upon which its own anion would readily react; zinc with muriatic acid and copper with sulphate of copper fulfil these conditions to a great degree; if these principles be correct, very superior combinations may be discovered. I cannot refrain from expressing, with much diffidence, a hope that these experiments may be thought worthy of verification and extension by those "older in practice, abler than myself."

I remain, Gentlemen, yours, &c.,

W. R. Grove.

P.S. Jan. 1839. I should have pursued these experiments further, and with other metals, but was led aside by some experiments with different solutions separated by a diaphragm and connected by platinum plates; in many of these I have been anticipated.

I will however mention one which goes a step further than any hitherto recorded; and affords, I think, an important illustration of the combination of gases by platinum.

Two strips of platinum 2 inches long and three-eighths of an inch wide, standing erect at a short distance from each

* The reason why iron with sulphate of iron and muriatic acid is inferior to the copper combination here described, may be that the difference of affinities is not so great, but more probably proceeds from the minute currents on the surface of the iron weakening the efficacy of the chemical action to produce a general current; copper being more homogeneous evolves no hydrogen and the whole action is utilized. Copper with sulphuret of potassium and sulphate of copper is a most powerful unimetal combination, if unimetal it may be called.

other, passed, hermetically sealed, through the bottom of a bell glass; the projecting ends were made to communicate with a delicate galvanometer; the glass was filled with water acidulated with sulphuric acid, and both the platina strips made the positive electrodes of a voltaic battery until perfectly clean, &c.; contact with the battery having been broken, over each piece of platinum was inverted a tube of gas, four-tenths of an inch in diameter, one of oxygen, the other of hydrogen, acidulated water reaching a certain mark on the glass, so that about half of the platina was exposed to the gas, and half to the water. The instant the tubes were lowered so as to expose part of the surfaces of platinum to the gases, the galvanometer needle was deflected so strongly as to turn more than half round: it remained stationary at 15°, the platinum in the hydrogen being similar to the zinc element of the pile. When the tubes were raised so as to cover the plates with water, the needle returned slowly to zero; but the instant that the tubes were lowered again, it was again deflected; if the tubes were changed with regard to the platina, the deflection was to the contrary side.

The action lowered considerably after the first few minutes, but was in some degree restored every time the tubes were raised so as to wash the surface of the platina, and again lowered. After 24 hours, the water had risen half an inch in the tube containing hydrogen, and three eighths of an inch in that containing oxygen. In two other tubes, without platina, but with the same gases and immersed in acidulated water for the same time, the water had scarcely perceptibly risen, the effect therefore could not have been due to solution; the same sheets of platinum were exposed to atmospheres of common air and of similar gases, i. e. both to oxygen or both to hydrogen, &c., but without affecting the galvanometer. The platinum in the hydrogen was made the positive, and that in the oxygen the negative electrode of a *single* voltaic pair; the water now rose at the rate of three-eighths of an inch per hour in the hydrogen tube and proportionally in the oxygen; when the platina was not assisted by a pair of metals the oxygen was absorbed in more than its relative proportion. I hope, by repeating this experiment in series, to effect decomposition of water by means of its composition.