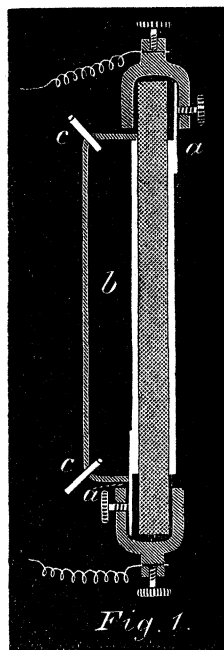


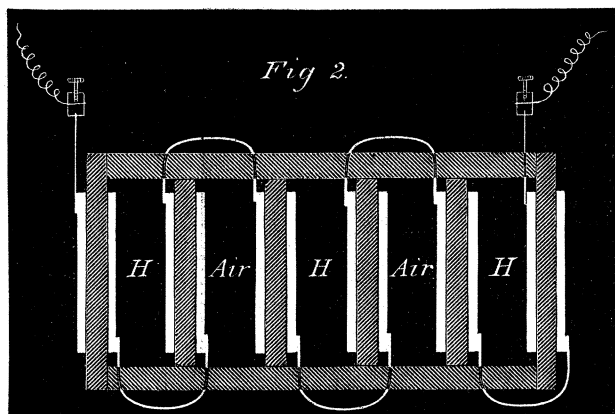
XVII. "Note on the Development of Voltaic Electricity by Atmospheric Oxidation of combustible Gases and other Substances." By C. R. ALDER WRIGHT, D.Sc., F.R.S., Lecturer on Chemistry and Physics, and C. THOMPSON, F.I.C., F.C.S., Demonstrator of Chemistry, in St. Mary's Hospital Medical School. Received June 20, 1889.

About fourteen months ago we had the honour of communicating to the Society ('Roy. Soc. Proc.,' vol. 44, p. 182) the results of a large number of experiments made with electromotor cells, of which a special feature was that one of the plates of the combination consisted of an "aeration plate," or layer of conducting material exposed to the atmosphere, and consequently superficially charged with a film of condensed air, which served as a means of indirectly effecting the oxidation of the other plate (when made of oxidisable metal), or of the fluid surrounding it (when the plate is of non-oxidisable material immersed in an oxidisable fluid). We showed that the E.M.F. of a given combination varies very considerably with the nature of the material of which the aeration plate is made, surfaces of platinum sponge, and especially platinum black, yielding the highest results when the electrolyte is dilute sulphuric acid; a convenient way of constructing the plates being to apply the spongy metal to the surface of unglazed earthenware, or other similar porous non-conducting material, so as to form a conducting film, the electrolytic fluid being absorbed in the porous material and so making contact. We also found that the substitution of pure oxygen for air only increased the E.M.F. by inconsiderable amounts, and that somewhat analogous cells are obtainable by employing combustible gases, *e.g.*, hydrogen, to surround the aeration plate, the opposed plate being either an incorrodible one immersed in a fluid capable of supplying oxygen (permanganate or chromic acid solution, nitric acid, &c.), or one itself capable of parting with oxygen (compressed lead peroxide, &c.). By employing two aeration plates, one in contact with the air and one with the oxidisable gas, a form of gas battery was obtained which, like all other gas batteries, furnished a current considerably less powerful than that due to the chemical action taking place, even under the most favourable conditions.

The most convenient form of simple cell of this class examined by us consisted of a thin plate of unglazed earthenware, such as that used for the porous pots of a Grove's battery, both sides of which were coated over with spongy platinum to within a short distance of the edges, contact being made by means of thin strips of platinum foil pressed against the coated earthenware by means of the clamping



portion of an ordinary binding screw (fig. 1, *aa*). One of the faces of the coated plate was boxed in by means of thin sheet gutta-percha, so as to form a shallow chamber, *b*, into which hydrogen or other gas could be led as required, by means of the inlet and outlet tubes, *c, c*; the other face was freely exposed to the air. By impregnating the porous earthenware with dilute sulphuric acid, caustic soda solution, or other electrolyte, and filling the chamber *b* with oxidisable gas (hydrogen, coal-gas, carbon oxide, &c.), maintaining a slow current through it to prevent material alteration of the internal atmosphere by diffusion and osmosis, a form of gas battery was obtained, capable of furnishing continuous currents of sufficient magnitude to effect very appreciable amounts of silver deposition in a silver voltameter. Obviously, by increasing the size of the plates and arranging a number of cells in series, the power might be greatly augmented; to effect this we arranged a series of coated plates in a covered trough or box of insulating material, so as to form partitions, and thus divide the trough into chambers alternately closed in and filled with hydrogen, &c., and open to the air (fig. 2), the connexions being made as indicated, the outer faces of each pair of plates thus being freely exposed to the air, and the inner faces in contact with a hydrogen atmosphere; obviously, to effect this disposition an odd number of chambers is requisite, including those open to the air as well as those



filled with hydrogen, and an even number of doubly-coated porous partitions. We found that the difficulty in avoiding leakage of gases from one chamber to another and various other causes usually prevented the E.M.F. of a battery of  $n$  doubly-coated plates from reaching quite as high as  $n$  times the E.M.F. obtainable from a single cell; in no case did we obtain as high an E.M.F. as 1 volt per cell, even with only infinitesimal currents, whilst 0.6 to 0.7 volt per cell was about the highest value obtained with currents of magnitude sufficient to measure readily with the silver voltameter. Still our results were sufficiently good to convince us that if the expense of construction were no object, so that large coated plates could be employed, enabling currents of moderate magnitude to be obtained with but small current density, there would be no particular difficulty in constructing "double aeration plate cells" of this kind, competent to yield currents comparable with those derived from ordinary small laboratory batteries; although we concluded that the economical production of powerful currents for commercial purposes by the direct oxidation of combustible gases did not seem to be a problem likely to be readily solved, chiefly on account of the cost of the large appliances that would be requisite.

Precisely the same remark applies to all other forms of cell in which oxidation is effected by means of atmospheric air applied as an "aeration plate," at least, so far as our observations have extended. Given sufficiently large aeration plates, there is no difficulty in setting up aeration cells capable of producing moderately powerful currents, the energy being due either to the oxidation of a metal (*e.g.*, zinc or aluminium, &c.), or to the oxidation of an oxidisable fluid, such as solution of sodium hydrosulphite (Schützenberger's), ammoniacal cuprous oxide, and such like liquids. As yet we have not succeeded in effecting the direct oxidation in this way of alcohol, petroleum,

coal, and such like forms of comparatively cheap sources of energy, but we are far from being convinced that such actions are impracticable.

Our reason for bringing this note before the Society is that at the *Conversazione* of the Society last night (June 19th) there was exhibited by Mr. Ludwig Mond and Dr. Carl Langer an elegant and compact "dry gas battery," said to have been invented by them, but substantially identical in principle with one of those experimented with by ourselves some two years ago, chiefly differing in being far larger and more neatly finished, and in consequence capable of producing much more current than any arrangement constructed by us. It consisted of a battery of fourteen double aeration plates of films of platinum leaf and platinum black, supported by porous material impregnated with dilute sulphuric acid; when fed with hydrogen and air, as the gases introduced into the compartments formed by the parallel plates arranged in a trough or box, it furnished a current powerful enough to keep alight for a long time a small incandescent lamp, and was stated to be capable of giving a current of 2 ampères per element, with an E.M.F. of about 0·7 volt, the total effective surface of each element being 774 square centimetres.

[*Note*.—Since the above was written, we have had the opportunity of seeing an uncorrected proof of a paper by Mr. Mond and Dr. Langer entitled "On a New Form of Gas Battery" (read before the Society on June 20th, 1889) in which the dry gas battery above referred to is described, as well as various experiments on aeration cells; and the causes discussed which prevent the E.M.F. of such combinations from being as large in practice as it theoretically ought to be, calculating from the heat developed during the chemical actions taking place. From the internal evidence of this paper, as well as from Mr. Mond's assurances to us, we are convinced that the form of gas battery described by Mr. Mond and Dr. Langer was not, as might perhaps be supposed, in any way suggested to them by our previous work (with which indeed they appear to have been entirely unacquainted), but was arrived at by them quite independently. In this paper the authors have repeated unknowingly various of our former experiments on aeration cells, with substantially the same results, as the following figures indicate, obtained with cells where the aeration plates were layers of platinum sponge and black resting on porous plates moistened with dilute sulphuric acid, and opposed to various metals immersed in the acid.

The theoretical values being Zinc = 2·281 : Cadmium = 1·924 : Copper = 1·203.

Mond and Langer. Nature of aeration plate surface, platinum black. Strength of acid, not stated.		Alder Wright and Thompson.		
		Platinum black.	Platinum sponge.	
		$10\text{H}_2\text{SO}_4, 100\text{H}_2\text{O}.$	$10\text{H}_2\text{SO}_4, 100\text{H}_2\text{O}.$	$2.5\text{H}_2\text{SO}_4, 100\text{H}_2\text{O}.$
Zinc . . .	1.77 volt.	1.750 volt.	1.628 volt.	1.681 volt.
Cadmium	1.425 „	1.505 „	1.383 „	1.356 „
Copper ..	0.70 „	0.780 „	0.658 „	0.636 „

Similarly, in attributing the diminution of the E.M.F. of gas batteries below the calculated amount to the circumstance that heat is evolved during the condensation of gases on surfaces like spongy metals, the authors appear to have been unacquainted with numerous previous papers by one of us, and more especially with one published in 1881, in which this and various allied matters were pretty fully discussed,\* and the conclusion arrived at (*inter alia*), that “the heats of condensation of oxygen and hydrogen by platinum, &c., may jointly amount to almost as large a quantity as that developed by their union to form liquid water.”—July 30th, 1889.]

XVIII. “On certain Geometrical Theorems. No. 4.” By  
W. H. L. RUSSELL, A.B., F.R.S. Received May 25, 1889.

[Publication deferred.]

XIX. “An Experimental Verification of the Sine Law of  
Malus.” By E. J. SPITTA. Communicated by W. DE W.  
ABNEY, Capt. R.E., F.R.S. Received May 29, 1889.

XX. “Observations on the Spark Discharge.” By J. JOLY.  
Communicated by Professor G. F. FITZGERALD, F.R.S.  
Received June 15, 1889.

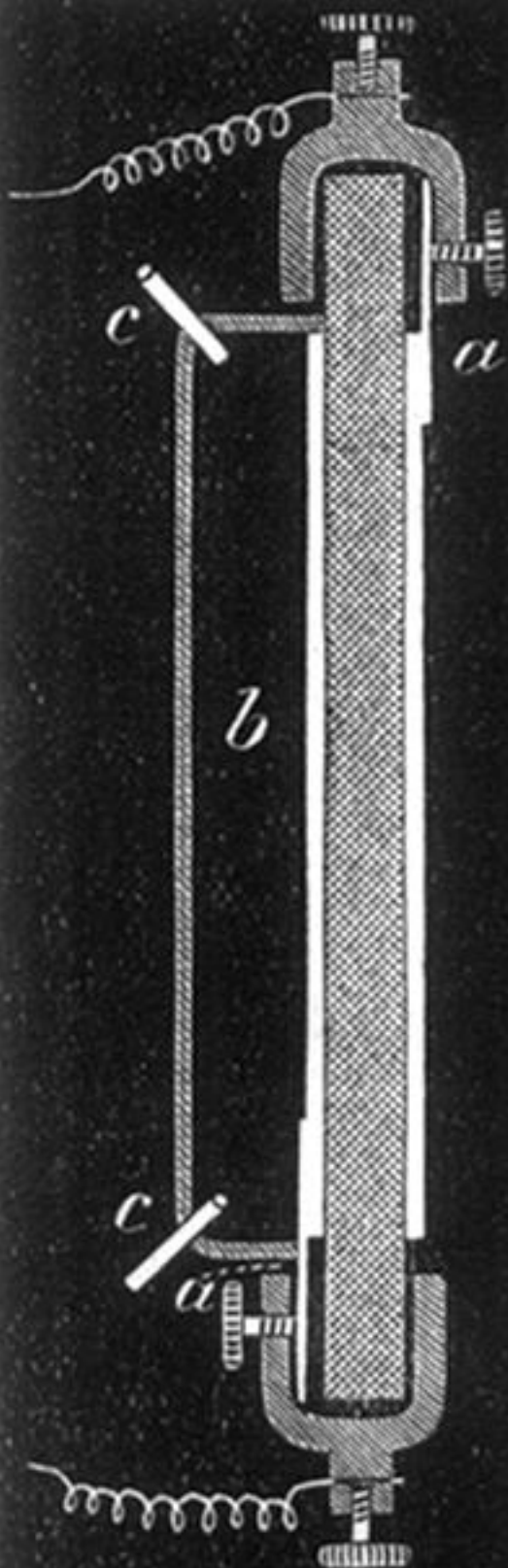
[Publication deferred.]

*Presents, June 20, 1889.*

Transactions.

Baltimore :—Johns Hopkins University. Circular. Vol. VIII.  
No. 73. 4to. *Baltimore* 1889. The University.

\* No. III of a series of nine Memoirs on the “Determination of Chemical Affinity in terms of Electromotive Force.” ‘Proceedings of the Physical Society,’ vol. 4, p. 101; also ‘Phil. Mag.,’ March, 1881 (Series 5, vol. 77, p. 169).



*Fig. 1.*

