L. The effect of great current-strength on the conductivity of electrolytes

Theodore William Richards & John Trowbridge

To cite this article: Theodore William Richards & John Trowbridge (1897) L. The effect of great current-strength on the conductivity of electrolytes , Philosophical Magazine Series 5, 43:264, 376-378, DOI: [10.1080/14786449708621006](https://doi.org/10.1080/14786449708621006)

To link to this article: <http://dx.doi.org/10.1080/14786449708621006>

Published online: 08 May 2009.

Submit your article to this journal [↗](#)

Article views: 2

View related articles [↗](#)

Sometimes the mercury gets into a lethargic condition; but it can always be roused by mechanical agitation of the surface. Now let the current be kept on for a few seconds; the negative globule sends forth a tentacle towards the positive globule, the length of the tentacle depending upon the current and the distance between the globules. Under favourable circumstances it may extend from corner to corner, and thus establish contact; or *fissure* may occur, the tentacle breaking into spheroids; and these spheroids may cross over between the globules. This is the order of things usually to be observed, but the action is sometimes erratic.

Let us now bring back the scattered globules of mercury to their respective corners, and distribute a few isolated spheroids in the interspace. In addition to the effects previously noticed at the terminal globules, we now see that, when the current is applied, each intermediate spheroid extends a "finger" towards the positive globule. This is the process of mobile coherence; the short "fingers," or long "tentacles," form links between consecutive spheroids, and finally a complete conducting circuit is established.

By successive applications of the current, any elongated bodies of mercury between the terminal globules can be made to creep along like caterpillars; the successive forward motions of the tentacle, or tail, cause a corresponding retrogression of the globule as a whole.

Any small spheroids scattered about the dish may be urged in a direction depending upon the direction of the successive current impulses; and a "finger" will always appear on the side towards the positive electrode. So that by choosing a convenient stray spheroid, and operating a battery-reverser as a transmitting-key, a telegraphic receiver is improvised from no other apparatus than a drop of mercury and a little oil. By some such means the awakening genius of primitive man may have contrived all the subtle machinery of a telegraph-instrument upon the smooth surface of an oyster-shell.

L. *The Effect of Great Current-Strength on the Conductivity of Electrolytes.* By THEODORE WILLIAM RICHARDS and JOHN TROWBRIDGE*.

IN our paper on the temperature and ohmic resistance of gases during the oscillatory electric discharge†, we have described a method of determining resistance by

* Communicated by the Authors.

† Page 349, *suprà*.

measuring its damping effect upon electric oscillations. The method is obviously one which will apply to electrolytes also, provided that the resistance to be measured is less than twenty ohms; and it seemed to be very well worth while to determine if the intense current involved in the discharge of a large condenser is capable of causing any change in the condition of an electrolyte.

In our first experiment, two copper plates of sixteen square centimetres area were clamped at a distance of three centimetres apart by means of vulcanite. Upon being immersed in a saturated solution of pure cupric sulphate at 15°C ., the plates allowed about ten oscillations from one of our large leyden-jars, nine from two jars, and eight from three jars to pass through it. According to the scale of standards, given in our last paper (see fig. 2, p. 355), each of these results corresponds to a little less than four ohms' resistance. By means of Kohlrausch's method, using a very small inductorium, this cell gave an extremely poor minimum at a point corresponding to a resistance of about ten ohms. The plates, which had purposely been left very dirty, in order to test the efficiency of the method, were now scrupulously cleaned with alkali and acid, and were then both carefully plated with pure copper. With Kohlrausch's method the cell now gave an excellent minimum at exactly four ohms' resistance, and further cleaning and plating caused no further change. New photographs of the sparks from the two jars sent through the cell showed again about nine half-oscillations, corresponding to about 3.8 ohms. It is evident, then, that the resistance of concentrated cupric sulphate is not essentially altered by great alterations in the strength of the current.

Experiments with zincic sulphate gave similar results, and a solution of cadmic sulphate between cadmium electrodes which possessed a resistance of 4.7 ohms according to Kohlrausch's method, gave nine, seven, and six half-oscillations with one, two, and three jars respectively, corresponding to about 5 ohms in each case.

Undoubtedly the reason why the strong instantaneous current, which alters so much the resistance of gases, has so little effect upon solutions, is because of the great mass and specific heat of the material which must be warmed in the latter case. The average temperature of the solution rose during our experiments only at the rate of about 1° in three minutes.

A similar, although smaller, heat-capacity prevents the wire resistances which are used as standards from becoming seriously altered in resistance by the heat. We had used

manganin wire in our tests ; but in order to be sure that our fine short wires had not been overheated, we constructed a five-ohm resistance of four strands of coarse manganin wire about 0.25 millim. diameter and 3.5 metres long. This was stretched upon each side of a thin vulcanite plate to avoid self-induction, but it allowed essentially the same number of oscillations to pass as did the short fine wire. A short german-silver wire, with a very high temperature-coefficient, showed a conductivity only a very little less ; thus the error from the heating of the wire may be neglected.

In order to show that common electrolytic polarization does not interfere with the accuracy of our method, we measured with the help of our 20,000 volt storage-battery and condensers the resistance between two bright platinum plates similar in size to the copper ones described above in a cupric sulphate solution. This was found to be four ohms, and after plating the electrodes with copper the resistance remained unchanged. Kohlrausch's method gave no satisfactory result with both electrodes free from copper, but when both were plated it indicated a resistance of 3.9 ohms.

Our method may therefore be a useful one for the approximate determination of conductivities in cases where impurities or polarization render Kohlrausch's method unsatisfactory. For accuracy, of course pains must be taken to develop all the photographs in the same fashion, and in general to arrange the conditions of the exposure alike in all cases.

Our conclusion that the conductivity of electrolytes is *not* greatly affected by great changes in current-strength only emphasizes all the more strongly the conclusion of our last paper, that the conductivity of gases is very much affected by changes in the current-strength.

Harvard University,
March 8, 1897.

LI. *The Electrical Conductivity of the Æther.*

By JOHN TROWBRIDGE*.

THE electrical conductivity of the æther has been maintained by Edlund and has been apparently disproved by various recent investigations—notably those of Prof. J. J. Thomson†. The latter writer, in his treatise entitled ‘Recent Researches in Electricity and Magnetism,’ also remarks, p. 98 :—“Again, if we accept Maxwell's Electromagnetic

* Communicated by the Author.

† Roy. Soc. Proc. vol. xlv. 1888, p. 290.