



## XXXVII. On some experiments with alternating currents

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XXXVII. *On some Experiments with Alternating Currents.*  
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*To the Editors of the Philosophical Magazine.*

GENTLEMEN,

IN No. 238 (vol. xxxix. 1895) of your valuable Magazine Mr. Griffiths has published a paper on "Some Experiments with Alternating Currents," in which he describes some experiments with Lenard's bismuth spiral. I was investigating the same subject in 1892-1893, and obtained the following results, agreeing well with those of Mr. Griffiths.

(1) With the bismuth spiral in a strong field absolute silence in the telephone is never obtained, but only a minimum of sound.

(2) The superficial distribution of alternating currents is without influence on the resistance.

(3) The resistance of bismuth depends on the phase of the current.

The following results are similar to those of Mr. Griffiths, but do not coincide with them in every respect:—

(1) The bismuth spirals have something like the self-induction, *but not equivalent* to it; I have tried the hypothesis

$$r = r_0 \left( 1 + \frac{\lambda}{i} \frac{di}{dt} \right),$$

where  $r_0$  is the resistance for a constant current,

$i$  the current,

$\lambda$  a constant positive coefficient, and

$r$  apparent resistance (measured with a Wheatstone bridge and telephone).

Under this hypothesis  $r$  must be always  $> r_0$ , which does not agree with the experiments of Lenard, Zahn, and myself.

(2) I have observed the difference of resistance with frequency 500 without field to be as stated by Messrs. Lenard and Zahn; the resistance with a constant current was greater (0.1 per cent.).

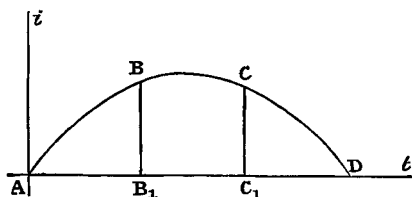
In addition to the above, I have found the following:—

(1) M. Lenard's statement that the difference of resistance is due to the currents of great frequency, *i. e.* 10,000, is erroneous. Let ordinates of the curve A B C D represent the

\* Abstract of a paper published in the Journal of the Russian Physico-Chemical Society, vol. xxvi. pp. 81-156 (1894).

current and abscissæ the time. If we divide the curve in three parts AB, BC, CD, such that  $AB_1 = B_1C_1 = C_1D$  (approximately), and measure the resistance with the currents

Fig. 1.



AB, BC, CD; then denoting the measured resistance by  $\rho_1, \rho_2, \rho_3$ , I have obtained experimentally:—

(a) Without magnetic field, with frequency 4-6:

$$\rho_1 = \rho_2 = \rho_3.$$

(b) With intense magnetic field, with the same frequency, 4-6:

$$\rho_1 > \rho_2 > \rho_3.$$

Taking  $\rho_2$  as unity, the following figures are obtained for four spirals:—

$\rho_1$	$\rho_3$
1.0045	0.9927
1.0037	0.9938
1.0030	0.9940
1.0036	0.9943

If we take the currents represented by the curves figs. 2 and 3 and measure the same  $\rho_1, \rho_2, \rho_3$ , we obtain as above,

$$\rho_1 > \rho_2 > \rho_3;$$

but the differences  $\rho_1 - \rho_2$  and  $\rho_2 - \rho_3$  are much smaller than with the current ABCD.

My method of experimenting for obtaining the data for  $\rho_1, \rho_2$ , and  $\rho_3$  was similar to that of Mr. Griffiths. The alternating current was supplied by a small magneto-electric machine set in motion by an electromotor. This current was sent through a Wheatstone bridge, in one branch of which was placed a bismuth spiral. The galvanometer branch contained an automatic double intermittent contact (rotated by the magneto-electric machine supplying the alternating

current), by which it was possible to complete the circuit of the galvanometer for the parts of the current AB or BC, and BC or CD, and thus to compare immediately  $\rho_1$  with  $\rho_2$ , and  $\rho_2$  with  $\rho_3$ .

In the first part of my investigation I measured without field the resistance of a bismuth spiral with a telephone, and

Fig. 2.

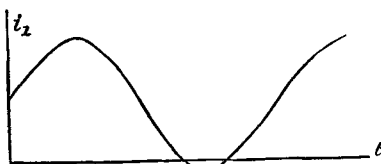
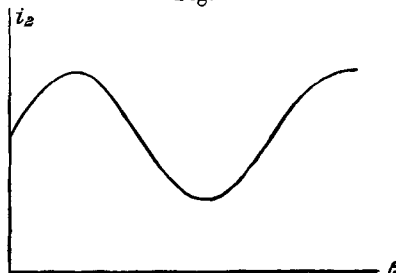


Fig. 3.



an alternating current obtained from a Kohlrausch inductorium. As interrupter I took a toothed wheel turned by an electromotor; the frequency of interruption varied between 92 and 2088, the difference of resistance varied with the frequency between 0.12 and 0.27 per cent.

March 18, 1895.

### XXXVIII. Notices respecting New Books.

*The Great Ice Age and its Relation to the Antiquity of Man.* By JAMES GEIKIE, D.C.L., LL.D., F.R.S., &c. Third Edition. Pages i-xxviii; and 1-450; with 18 maps and 78 illustrations. 8vo. Stanford: London, 1894.

THIS new edition of an important geological work has been "largely rewritten" by the Author, and contains two new chapters on the "Glacial Phenomena of North America," by Professor T. C. Chamberlin.

As a systematic account of the visible results of ice-action on a large scale in this part of the World, and of the probable history of the origin, progress, and end of this period of glaciation, we have here a valuable repertory of facts and opinions recorded by many geological enquirers and grouped by one who has studied the subject for almost a life-time. Formerly one of the members of the Geological Survey engaged in mapping the geology of Scotland, and now holding the Chair of Geology at Edinburgh, Professor James Geikie has naturally taken up one of the most interesting groups of geological features in that country as a