Dr. P. ZEEMAN. *Measurements concerning the Absorption of Electrical Vibrations in Electrolytes.*

On the occasion of our joint investigation, the results of which were communicated to the Academy last month [1]), Prof. COHN of Strassburg proposed me to verify MAXWELL's theory as to one of its consequences on the propagation of electrical oscillations in conductors, according to the following scheme:

The oscillations are absorbed in the conductor. The magnitude of the absorption is determined generally by the *conductivity* and the *specific inductive capacity* of the conductor, and by the *frequence* and the *logarithmic decrement* of the vibrator. If, the frequency being given, and the spec. induc. capacity being known approximatively, one chooses the conductivity high enough, it is possible to diminish indefinitely the influence of the specific inductive capacity. Now electrolytes of so high a conductivity were to be examined, that of their two electrical constants, only the easily measured conductivity was of importance. Frequency and logarithmic decrement of the oscillator were to be determined by BJERKNES's method. Further the diminution of the energy of the vibrations in the electrolyte was to be

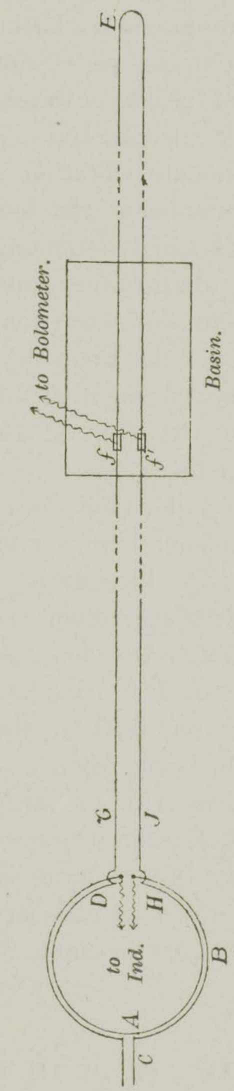
[1]) COHN and ZEEMAN. Verslagen Kon. Akad. Amsterdam. Zitting 28 Sept. 1895. Communications etc. n°. 21.

measured by moving along two parallel wires in the interior of the fluid little Leyden jars, transferring the energy to a bolometer. The general course of the absorption, determined in this manner, was to be compared with the one calculated according to MAXWELL's theory from the three mentioned data.

I have now commenced this investigation in the Physical Laboratory of Leiden. The favourable results obtained by the method as described in the above mentioned publication, led me to think that it would be suited immediately for the investigation of the absorption. In this respect however the result did not answer to my expectation.

Nevertheless I found it possible to maintain the following: 1°. measuring in separate experiments the wavelength and decrement of the vibrations in air, 2°. measuring the energy with *little Leyden jars in the fluid.* But for the rest I was obliged to modify the disposition of the experiments. The preliminary determination of the coefficient of absorption for Hertzian vibrations in an electrolyte seems to me to be of sufficient interest to communicate it already now.

2. *Method.* The disposition of the experiments is given in the subjoined figure. *B* is an oscillator of BLONDLOT, to which a RUHMKORFF was used as induction coil. The primary of the coil was interrupted by a rotating commutator. The interruptor had been fastened at the axis of an electromotor. The frequency was 2400 per minute. The regularity of the vibrations exceeds that which is obtained by means of the Foucault-interrupter. The double-wire circuit *A H J E G D*, along which the Hertzian waves are allowed to propagate, is



made of wires about 1 m.m. in diameter, the distance of the wires being 7 cm. According to BJERKNES's principle between A and the basin containing the electrolyte, are about 60 M. of the wires, and the double-wire circuit, being run through the basin, still continues for about 34 M. and is closed at *E*. *f* and *f'* are the little Leyden jars (6 turns of very fine wire), which are connected with the bolometer [1]) and by which the energy *in the electrolyte* is measured. They are attached to a frame work which is moved easily along the wires. The position of the tubes is to be read on a scale at the border of the basin.

The length of the wires was chosen in accordance with BJERKNES's principle. The wave train generated by the vibrator, being partially reflected from the surface of the electrolyte, returns to *A* only when the oscillations of the vibrator have died away. There is *no bridge* at the surface of the electrolyte, contrary to the experiments with pure

[1]) Communications l. c. pag. 6.

water [1]). In this manner the oscillations of the vibrator are undisturbed by the presence or absence of the basin.

That part of the train which is *not* reflected penetrates *into the basin.* By a suitable choice of the concentration of the electrolyte may be obtained, that at the end of the basin the energy of a determinate vibration is completely absorbed. That vibration, not being reflected, will pass only once by the little jars and no standing waves of the given period will occur. On the other hand the absence of a special stationary vibration shows that the energy, belonging to the vibration of this frequency, is really absorbed at the end. The measurement of the *wavelength* and the *decrement* of the vibrations *in air* I made according to BJERKNES's precepts. [2])

Of course the basin is then removed and a horizontal part of the circuit (10 M. in length in our case) serves for the displacement of the bridge; the little Leyden jars (6 turns) take the place of BJERKNES's electrometer.

The curve of interference resulting from the measurements was a fine damped sinuscurve. The complete wavelength of the incident vibrations was 6.40 M., the logarithmic decrement, γ of BJERKNES, being 0,34.

The measurements in the electrolyte with the little jars were taken for successive positions, the distances between them being 2.5 cM. At every turn 2 series of these observations were taken; in the one the little jars were moved away from the oscillator, in the other up to it.

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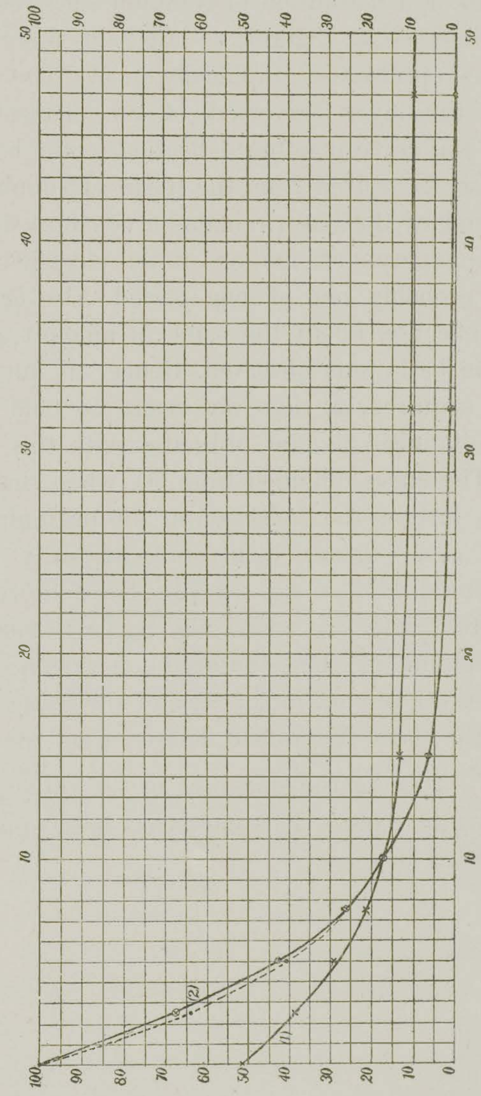
[1]) Communications l. c. pag. 6.

[2]) BJERKNES, Bihang till K. Sv. Vet. Akad. Bd. 20. Afd. I. n°. 5. p. 7. 1895.



3. *Result.* For a solution of common salt, the conductivity being $\lambda = 3200.10^{-10}$ that of mercury, the results are represented graphically in (1). The abscissae represent the layer traversed of the electrolyte, the ordinates the corresponding deflection of the bolometer.

The latter is derived from the mean of 3 double-series. At the end of the basin remains a constant deflection, due to a superponed motion of the electricity in the vibrator, probably one of long period. Also *behind* the basin a deflection about the same in amount as at the end of the basin was observed. Hence, till further evidence is acquired, it does not seem too bold a procedure, to diminish all the ordinates with this constant amount. The curve obtained from (1), when this is done and when further the deflection at the beginning is put 100, the other values being proportionally reduced, is represented in the fig. by (2). The following table contains the data on which the curve is founded. In the first column has been entered the thickness of the traversed layer in cm., in the second the reduced deflections, in the third the values derived from the formula $100.\ e^{-2pz}$, z being the thickness of the traversed layer and p being $= 0.0884$. This curve has been represented by the dotted line.

Traversed layer.	Observed deflection.	Calcul. deflection.
0	100	100
2.5	67	64
5	42	41
7.5	26	27
10	17	17
12.5	11	11
15	7	7
31	1	0
47	0	0

Hence it would follow: 1°. that the intensity of the vibrations, travelling through an electrolyte, decreases within the limits of the errors of measurements, in the logarithmic ratio; 2°. that the vibrations now used decrease to $^1/e$ their initial intensity, when they travel through a layer of 5,7 cm. of a solution of common salt, the coductivity of which is $\lambda = 3200.10^{-10}$. This, I believe, is the first measurement of a coefficient of absorption for electrical vibrations. It is hardly necessary to mention that the above demonstration is far from complete and especially that the supposition concerning the constant deflection requires further investigation. However I intend soon to investigate the subject more closely, and to consider at the same time the agreement between the value of p, deduced from theoretical considerations, with the observed one.