Remarks on Edlund's Reply to Two Objections Against the Unitary Theory of Electricity

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Abstract

English translation of Wilhelm Weber's 1876 paper "Bermerkungen zu Edlund's Erwiderung auf zwei gegen die unitarische Theorie der Elektricität gemachte Einwürfe", [Web76], related to [Edl75].

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(Contribution made by letter.)[4]

To begin with, I must allow myself the observation that the first objection raised [by Edlund] against Neumann completely misses the mark.[5] In the "Postscript" to his essay in volume 155 of the *Annalen* (page 228) Neumann has *firstly* laid out the facts of the so-called *unipolar induction*, and *secondly* proved thereby, that (if it be at all true to ascribe the action of the electric current to any matter whatsoever, which flows through the conductor with a certain velocity) then at least *two* such types of matter must be supposed.[6]

Now Edlund has made no objection against the latter proof by Neumann. But, he also objected to Neumann's alleged (but in no way established or

[1] [Web76].

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[3] The Notes by Laurence Hecht are represented by [Note by LH:]; while the Notes by A. K. T. Assis are represented by [Note by AKTA:].

[4] [Note by AKTA:] Related to Edlund's 1875 paper, [Edl75].

[5] [Note by AKTA:] Edlund was criticizing C. Neummann's 1875 paper on unipolar induction, [Neu75].

[6] [Note by LH and AKTA:] That is, two electric fluids, positive and negative.

authenticated) fact, that a current ring of constant strength induces no electromotive force in an *unclosed* linear wire if both are fixed, but that an electromotive force of a certain value is induced if the ring be rotated around its geometric axis with constant velocity—and Edlund, in his second reply, has likewise stated explicitly that this is in correspondence with the general representation of the physical laws of *unipolar induction*. His doubt raised against the *correctness of the fact*, however, strikes Neumann, who has not established it, not at all.

Edlund sets out the facts of the unipolar induction (p. 592) in the following words:

> "Experience teaches that when a *closed* stationary conductor, b, is placed in the neighborhood of a magnet rotating about its own axis, no current is induced in the closed conductor.—The reason is, according to the usual model, that the rotating magnet actually induces a current in one part, b_1, of the closed conductor, but that an equally large current is induced in the other part, b_2, of the conductor; the two induced currents however flow in opposite directions and cancel one another. But if a portion of the path, b_1, be fixed to the magnet and the magnet set in rotation around its own axis, then the magnet does not act on this portion of the path. Now if the experiment be arranged such that b_1, notwithstanding the rotation, remains in continuous electrical contact with the other portion, b_2, then an induced current is produced in the conductor."

However, Edlund now denies the *correctness* of these facts, which he himself has set forth, namely that the rotation *itself* (be it of a current ring, or a magnet) produces a certain inducing action on the *stationary part* of a closed conductor located in the vicinity. Rather, he claims that the opposite is confirmed by experiment, and cites as proof of this assertion an experiment of Plücker (Vol. 87, p. 352 of this *Annalen*)[7] which he himself has repeated for this purpose.

According to Edlund's description of this experiment, a current is observed in a conductor which remains closed while a copper cylinder containing a part of the current path, b_1, is rotated around the axis of a magnet located

[7] [Note by AKTA:] [Plü52].

in the cylinder. *This current remains unvaried in direction and strength, whether the magnet remains stationary or rotates together with the cylinder.*

Edlund now thinks that this result must have been left out of consideration in the usual formulation of the physical laws of unipolar induction.—Namely, if the cylinder b_1 alone rotates and the magnet is at rest, one can consider the magnet as bound to the galvanometer wire b_2, which is also at rest, so that, according to that mode of representation, induction could take place only in b_1; however, when the magnet and the cylinder b_1 are rotated with equal velocity in the same direction, one can consider the magnet as bound to b_1, and then induction can take place only in b_2.

The induced current, Edlund continues, must therefore, *according to that representation*, alter its direction from one experiment to the other, and, as that does not occur, Edlund concludes that the hitherto accepted model of unipolar induction, must be incorrect *because it runs counter to experiment.*

The following remark will suffice to show Edlund's error in this deduction.

In the *first experiment*, the portion of the conductor, b_1, in which the current is induced rotates (forward), and the magnet stands still; in the *second* experiment, the magnet rotates (also forward) and the portion of the conductor, b_2, in which the current is induced stands still.

A direct comparison of the two experiments is not possible, but an indirect one can easily be made, if one observes that it is all the same whether the *wire rotates forward and the magnet stands still*, or *the wire stands still and the magnet rotates backward.*

In order to make the comparison of the *two experiments* possible, one must look at it as follows: the *backward rotating* magnet (in the first experiment) induces a current of *equal direction and strength* in the stationary portion of the conductor b_1, to that which the *forward rotating* magnet (in the second experiment) induces in the stationary portion of the conductor b_2, which stands in complete correspondence with the general representation of the physical laws of unipolar induction, as Edlund himself set it forth.—What has been overlooked by Edlund is that *oppositely directed currents* are only induced in the two portions, b_1 and b_2, of a permanently closed conductor, if the magnet *rotates in the same direction* relative to the wire, whether it induces it in b_1 or in b_2; on the contrary, *equally directed currents* will be induced in b_1 and in b_2 if, as in the above experiments, the magnet *rotates backwards* relative to the conductor b_1, while it rotates forwards relative to b_2.

Leipzig, 23. December 1875.

References

[Edl75] E. Edlund. Erwiderung auf zwei gegen die unitarische Theorie der Elektricität gemachte Einwürfe. *Annalen der Physik und Chemie*, 156:590–601, 1875.

[Neu75] C. Neumann. Ueber die gegen das Weber'schen Gesetz erhobenen Einwände. *Annalen der Physik und Chemie*, 155:211–230, 1875.

[Plü52] Plücker. Ueber die Reciprocität der elektro-magnetischen und magneto-elektrischen Erscheinungen. *Annalen der Physik und Chemie*, 87:352–386, 1852.

[Web76] W. Weber. Bemerkungen zu Edlund's Erwiderung auf zwei gegen die unitarische Theorie der Elektricität gemachte Einwürfe. *Annalen der Physik und Chemie*, 157:146–149, 1876. Reprinted in Wilhelm Weber's *Werke*, Vol. 4, H. Weber (ed.), (Springer, Berlin, 1894), pp. 358-360.