Oersted Confirmed Frog's Leg Convulsions by Thermoelectric Effect in 1830

Submitted by Keith P Walsh on Thu, 2016-05-19 12:32

Dear Members,

I was in a second-hand bookshop in Edinburgh just recently and I came across a copy of "Selected Scientific Works of Hans Christian Oersted". (Translated and edited by Karen Jelved, Andrew D. Jackson and Ole Knudsen, Princeton University Press, 1997.) After only a quick flick through it I was able to judge that the marked price of 15GBP (approximately 21USD) represented an absolute bargain, and along with an illustrated copy of Kenneth Grahame's "The Wind in the Willows", I snapped it up there and then.

I already knew that not only had Oersted shown a great deal of interest in Thomas Johann Seebeck's earliest reports of what came to be known as the Thermoelectric Effect, but also that he was instrumental in the accurate interpretation of what this effect was.

Oersted had been conducting his own experiments observing the deflections of compass needles in the vicinity of a current-carrying electric circuit, but he had only ever used electrolytic (Voltaic) piles as the source of the electrical potential for his circuits. However, because the effect that Seebeck had demonstrated by the application of only a temperature difference to his bi-metallic circuits appeared identical to that observed by Oersted, it appears that it was in fact Oersted who first correctly deduced that the deflection of the needle produced by Seebeck's experiments was also the result of an electrical current being induced in his circuits.

This was Oersted's reaction to the discovery, which he published in the paper, "On Some New Experiments in Thermoelectricity Performed by Baron Fourier and Mr Oersted", in 1823:

"I have had the honor of demonstrating to this illustrious assembly the remarkable experiments by which Mr Seebeck has proved that an electric current may be produced in a circuit formed of solid conductors only by disturbing the equilibrium of the temperature. We are therefore in possession of a new class of electric circuits, which may be called thermoelectric circuits, thus distinguishing them from galvanic circuits, which from now on may conveniently be called hydroelectric."

Well, the term "hydroelectric circuit", which Oersted had proposed for distinguishing those circuits relying on electrolysis for their source of electrical potential, obviously did not catch on, but I think that here was Oersted's own assertion of the fundamental principle that a thermoelectric circuit is capable of producing an electrical current without any electrolysis being involved.

In an earlier paper, "New Experiments by Dr. Seebeck on Electromagnetic Effects", also 1823, Oersted stated:

"Dr. Seebeck has also succeeded in producing a thermelectric (sic) current in a single metal, but this succeeded only with metals that have a quite perceptible crystalline texture so that the various parts of a crystal then seem to play the role of different metals."

I wonder if this may have been the first ever recognition of the fact that the thermoelectric effect is much more pronounced in a material which has an inhomogeneous internal structure.

And it may also be interesting to note that the first use of dental amalgam, which is a highly inhomogeneous metallic material when compared with pure metals or with any true alloy of metals, is credited to the French dentist Auguste Taveau at around the same period.

Finally, at least for now, it appears that by 1830 either Seebeck or Oersted had succeeding in confirming that a thermoelectric
circuit was capable of exciting neurological activity in a dissected frog's leg:

"It is very remarkable that, notwithstanding all that has been mentioned, the thermo-electric circuit makes a prepared frog's leg palpitate, like the hydro-electrical circuit. The communication between the extremities of the circuit and the nerves of the frog were made by means of platina wire, in order to guard against the influence of unequally oxidated surfaces." (Well who would have thought of that?! - KPW)

This last quote is taken from Oersted's paper, "Thermo-electricity", of 1830. Unfortunately he does not mention the level of temperature differential that was required to produce the palpitation's in the frog's leg - although since he would have been using a thermoelectric circuit constructed of more than one metal, presumably it would have been significantly less than that from the "boiling water" that Volta had needed to apply to one end of his single-metal rod when he did it (see http://bookbootusers.co.uk/Anat_P2.pdf).

Maybe there's still a PhD in it for some gifted experimental thermoelectrician who's curious enough to find out.

Best regards,

Keith P Walsh

PS, Don't worry about "The Wind in the Willows" by the way. It's just make-believe.

All content on this site © 2006-19 by each individual author, All Rights Reserved.

Source URL: http://www.its.org/content/oersted-confirmed-frogs-leg-convulsions-thermoelectric-effect-1830