Note on Hall's Phenomenon

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VII. *Note on Hall's Phenomenon.**By* HERBERT TOMLINSON, B.A.*

IN a paper entitled "The Influence of Stress and Strain on the Action of Physical Forces" †, I drew attention to the fact that there is a marked resemblance between the table of "rotational coefficients" drawn up Prof. Hall and that laid down by myself from the results of experiments on the effects of mechanical stress on the specific electrical resistance of metals. A comparison of the two tables given below shows that, with the exception of platinum, the metals stand in nearly the same order in both, and that iron and nickel are very conspicuous, the one at the top and the other at the bottom of the lists. The last-named metal is especially worthy of notice, because in it longitudinal traction, when not carried beyond a certain limit, diminishes the electrical resistance in spite of the increase of length and diminution of section which ensues.

Name of Metal.	Rotational coefficient ‡.	Temporary alteration of specific resistance per unit produced by temporary increase of length per unit. + signifies increase of resistance on application of stress.
Iron	+ 78.0	+2.618
Zinc	+ 15.0	+2.113
Tin	- 0.2	+1.630
Lead	0	+1.613
Platinum	- 2.4	+2.239
Silver	- 8.6	+1.617
Copper	- 10.0	+1.005
Aluminium	- 50.0	-0.420
Nickel.....	-120.0	-8.860

It might then be suspected that the results obtained by Hall are capable of receiving an explanation, in the fact that the

* Read March 22, 1884.

† Phil. Trans. Part I. 1883, p. 168.

‡ A + sign attached to a metal signifies that the effect is in a direction the same as that which the conductor itself bearing the current would follow if free to move across the lines of magnetic force under the action of the ordinary "ponderomotive" force

electrical resistance of the strips of metal used by him would be altered by the mechanical strain consequent on their endeavour to move across the lines of magnetic force. Mr. Shelford Bidwell has, however, in his recent interesting communications to the Royal Society and the Physical Society, pointed out that "Hall's phenomenon" cannot be thus accounted for. Nevertheless, as it seems not improbable that there is some indirect connexion between the alteration of electrical resistance produced by mechanical stress and the "Hall effect," I have little doubt but that experiments on the "rotational coefficient" of nickel, in which the temperature is varied up to 100° C., or in which the strips are subjected to mechanical traction of varied amount, would assist in deciding the question as to whether purely mechanical stresses are to be regarded as producing the phenomenon. For it has been shown* that with this metal the maximum diminution of resistance following from longitudinal traction is at 100° C. *less than one half* of that at 15° ; and, further†, that whilst traction not exceeding a certain limit produces diminution of resistance, increase of stress beyond this limit is followed by increase of resistance. Hall has remarked, in the 'Philosophical Magazine' for September 1881, that the transverse current obtained with a nickel strip is much *increased*, other conditions remaining unchanged, by rise of temperature. But his experiments in this direction are, I think, hardly conclusive; and, indeed, an examination of the numbers given in the column in which the values of the "rotational coefficient" are recorded shows, in the first *ten out of the eighteen* experiments, evidence that rise of temperature causes a *decrease* of the transverse current. Should Hall's phenomenon prove to result from mechanical strain, I incline to the belief that a rise of temperature from 15° to 100° C. will produce decrease in the transverse current.

The experiments of Mr. Bidwell tend very largely to prove that the "Hall effect" can be explained by the joint action of mechanical strain and certain "Peltier effects." Should this be so, we ought, I think, to be able, by means of two thermo-elements connected with each other and with a delicate gal-

* *Loc. cit.* p. 125.

† *Loc. cit.*

vanometer, one element being in a cooled region and the other in a heated region, to put this theory to the test. Or, again, we might cover the strip with some material of bad thermal conductivity and watch for a gradual increase of transverse current with time when the electromagnet is excited, and gradual decrease when the electromagnetic stress is removed. Indeed in the actual arrangement adopted by Hall and Bidwell, it would seem that this gradual increase or decrease should occur ; for though the strips themselves would rapidly cool if unmounted and exposed to the air, the nonconducting material of the mounting would take some little time both to gain and lose the heat imparted to it by the strip.