VI.—*On Thermo-Electric Joints formed with the metals Antimony, Bismuth, and Palladium.*

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EXPERIMENT I.—A bar of antimony 8 inches long was broken in the centre, and soldered together again with pure bismuth; while the solder was fluid, the two pieces of antimony were pressed firmly together, so that the coating of bismuth in the joint should be as thin as possible. When the right side of the joint was heated, the left became the positive thermo-electric element; and when the left side was heated, the right side stood positive. This effect, where the bismuth has no sensible thickness, is the same as if a long bar of that metal had intervened between the two pieces of antimony.

EXPERIMENT II.—A slip of palladium cut into two, had a bismuth joint prepared as thin as possible, like the experiment No. I. When the right side of the joint was heated, the left in this case became negative; and when the left side was heated, the right became negative.

EXPERIMENT III.—The same two pieces of palladium as in the last experiment, with a bismuth joint one-tenth of an inch in thickness. When heat was applied on the right side of the joint, the left side was positive, the result showing that the increase in the thickness of the bismuth joint had rendered the effect similar to that which would have been produced by a long bar.

EXPERIMENT IV.—A slip of palladium and a bar of antimony formed the couple for this experiment, joined together by a thin bismuth joint. The recognised action of these metals, when heated together, is that palladium becomes positive. When heat was applied to the antimony side, palladium was positive; and when heat was applied to the palladium, antimony stood positive for fifteen seconds; but as the heat penetrated through the joint, the palladium assumed the positive position, which it retained. The result of this experiment I consider as valuable, for illustrating the action of the first and second surface of a joint; for when the heat is applied to the palladium, we have for a short space the first surface in action, with antimony positive, then a reversal of the current when the heat reaches the second surface.

EXPERIMENT V.—A bar of antimony was tied firmly down to a bar of bismuth, with a small scale of sulphuret of silver inserted between them for a joint. When the antimony was heated to near 400° ,

an attached galvanometer indicated the passage of a feeble current with the bismuth positive, or in its natural thermo-electric position; and when the heat was applied to the bismuth bar near the joint, the galvanometer showed bismuth the negative metal, with a feeble current passing. This experiment is not so satisfactory as the one with a sulphuretted silver wire connected with the bismuth, being more liable to fail from the couple becoming active at too low a temperature, or from the temperature required approaching near the melting-point of bismuth; but it has the advantage of exhibiting the two most opposite thermo-electric elements in an inverted position.

My object in giving the results of these experiments is to show cases where a thin coating of bismuth in a joint acts in several ways.

1st. The same as if it had been a bar of that metal in Experiment I. Instances of this kind are numerous among thermo-electric couples where the antagonistic negative and positive properties of the two elements are not strongly marked, as in the single metals, in zinc and silver, in gold and in many of its combinations, copper, &c.

2nd. Where a thin bismuth joint did not act as if it were a bar, and yet the direction of the flow of heat across the joint governed that of the electrical current generated. Cases of this kind are rare. With lead and tin I have met with very feeble currents of a like character, but the arrangement given is the most certain form of the experiment.

3rd. Where a thin bismuth joint acted for a brief period of time, as if it had been a long bar, and then acted like a couple in its recognised thermo-electric position, independent of the method of applying the heat. I have noticed this property in other thermo-electric couples, where palladium formed one of the elements.

The permanent action of the joint, after a lapse of fifteen seconds, where the recognised thermo-electric relation of the elements is maintained, notwithstanding the thin bismuth joint or the direction in which the heat is made to cross it, is one of frequent occurrence: we meet it in the combination of metals which have decided antagonistic thermo-electric positions, such as palladium, platinum, zinc, iron, antimony, &c.; but Experiment V. shows that such elements may have their natural thermo-electric position inverted by a joint offering greater resistance.