XXIX.—*On some of the Thermo-electric Properties of the Metals
Zinc and Silver.*

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A zinc and silver thermo-electric couple is known to reverse the direction of the current of electricity generated by heating it, when the temperature of the joint is raised above 248° , as described by the late Professor Daniell in his *Introduction to Chemical Philosophy*, p. 468. This peculiar property I have made the subject of the following experiments, which I hope may prove interesting, for they

show how completely thermo-electrical currents are governed by resistance to conduction in the joints of the couples.

EXPERIMENT I.—A piece of zinc wire was soldered to a piece of silver by pure bismuth for a solder, and the joint was made strong with a large surface of bismuth in contact with the metals. On heating this couple by dipping the joint in oil raised to different temperatures, the reversal of the current alluded to above was observed; for temperatures under 250° , zinc was positive, and for temperatures above that point, silver was the positive element.

EXPERIMENT II.—The same zinc and silver as in the last experiment, with bismuth surface in contact with the metals, made as small as practicable. The heat was applied by dipping the joint in oil raised to various temperatures from 100° to 360° , and in all the silver was the positive metal. The peculiar property of the reversal of the current, as the temperature passed a certain point, had disappeared with a change in the joint, which had only increased its resistance to conduction.

EXPERIMENT III.—The same zinc and silver couple employed with a joint formed without solder. The two surfaces of the metals were cleaned, and bound firmly together with thread, with only small portions of each element in contact. The result of this experiment was the same as No. 2; the silver stood positive for all temperatures.

EXPERIMENT IV.—The same zinc and silver were joined by a bismuth soldering, so as to form a continuous straight wire, with a bismuth joint in it, of which the surface in contact with the metals was nearly equal to the section of the wires. When heat was applied to the zinc wire, about two-tenths of an inch from the joint, silver was positive for all temperatures. And when heat was applied in a similar manner to the silver wire, the zinc became the positive metal for all temperatures. In this experiment, *the direction of the flow of heat across the joint governed that of the thermo-electric current generated*; it is a result which I have met with in many other thermo-electrical couples tested in like manner.

EXPERIMENT V.—A piece of zinc wire cut in two halves formed the couple for this experiment, with the joint formed by tying them firmly together; for temperatures under 300° , this arrangement showed very slight thermo-electrical effects; for higher temperatures more decided evidence of electrical action was obtained, but the direction of the currents generated was not regular.

EXPERIMENT VI.—The same pieces of zinc as for the last experiment, No. 5, with a bismuth joint, formed in the same manner as for experiment No. 4. This formed a delicate thermo-electrical couple.

When the right side of the joint was heated, the left wire was positive; and when the left side was heated, the right became positive: these effects could be readily shown by grasping the wires in the fingers. A similar experiment was made with a silver wire cut in two.

EXPERIMENT VII.—A piece of silver wire and a bar of bismuth formed the couple for this experiment. It may be premised that bismuth is a metal strongly positive to every other, and that the object in view was to endeavour to exhibit it as a negative element. For the joint, the point of the silver wire was heated in sulphur until it was thickly coated with a sulphide of silver, and the sulphuretted portion was tied firmly down to the bismuth. On heat being applied to the silver, the couple did not become active* till the temperature was near 400° , when the bismuth showed itself the positive metal. On heat being applied to the bismuth bar, near the joint, the couple became active as before, at a high temperature, *and silver stood as a positive thermo-electric element to bismuth*. The experiment was tried with a thin coat of sulphide on the silver, when the couple became active at a lower temperature; but bismuth then stood positive to silver when heat was applied on its side, as well as when heat was given on the silver side.

Experiments like these, showing the direction of thermo-electrical currents to be under control, can be multiplied in great variety.