NOTES ON ELECTRICITY AND MAGNETISM.

BY PROF. W. GARNETT.

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On sending a current through the bars from antimony to bismuth, the junction will be heated, and the air expand; on sending the current in the opposite direction, the junction will be cooled, and the air contract. If a very strong current be employed, the Peltier effect will be concealed by the heating of the metals, on account of the resistance they offer to the passage of the current. It may also be shown by means of the Peltier cross, which consists of a bar of bismuth and a bar of antimony made to cross one another, and soldered at their point of contact. One end of the bismuth bar and one end of the antimony bar are connected to a galvanometer, while the other ends are connected with a battery. When the current flows the junction becomes heated or cooled according to the direction of the current, and an electromotive force is set up in the galvanometer circuit, producing a current which continues after the battery has been removed.

If a circuit be formed by soldering together a bar of bismuth and a bar of antimony, and one of the junctions be heated, the current will flow from bismuth to antimony across the hot junction, and from antimony to bismuth across the cold junction. The hot junction will thereby be cooled, and the cold junction heated, but more heat will be abstracted from the hot junction than will be supplied to the cold junction, and the difference will provide the energy which enables the current to flow in opposition to the resistance of the circuit, and will appear as heat diffused through the mass of the metals. The source of the energy of the current is in this case readily recognized in the Peltier effect.

In the case of a pair of metals in which the hot junction is at the *neutral* temperature, no Peltier effect can there occur, so that no heat can be supplied from the hot junction. At the cold junction heat may be developed. Hence the Peltier effect is insufficient to explain the source of the energy of the current. Sir Wm. Thomson pointed out that in this case heat must be absorbed by the current from one or both of the metals. Taking the case of a copper-iron circuit, with the junction at the neutral temperature, and the other below it, Sir Wm. Thomson showed that heat must be absorbed when electricity passes from hot to cold in iron, or else when it flows from cold to hot in copper, or both of these effects may take place. He afterwards showed experimentally that both these effects do take place, and that a current flowing from hot to cold in iron cools the iron, while a current flowing from cold to hot in copper cools the copper. If the direction of the current be reversed, the metals will be heated, the heating and cooling being proportional to the strength of the current. This effect is called the Thomson effect. In lead the Thomson effect is zero. It is the reason why lead is selected as the zero of thermo-electric power.

A thermo-electric pile is generally constructed by soldering together a number of bars of antimony and bismuth, in such a manner that the alternate junctions occur at opposite faces of the pile. When the faces are exposed to different temperatures, the electromotive forces of the several couples are added together.

The Claymond thermo-electric battery consists of alternate strips of tin plate (charcoal iron tinned) and lozenge shaped masses of an alloy of antimony and zinc. These are united so that the alternate junctions appear on the inside and outside of a ring and several rings so formed are built into a cylinder. The interior junctions are heated by a gas flame or charcoal fire, while the alternate (exterior) junctions are exposed to the cooling action of the air.

Galvani's discovery in 1790 of the effect of the contact of dissimilar metals in producing contractions of a frog's leg was followed in 1800 by the construction by Volta of the Voltaic pile.

The Voltaic pile consisted of a series of disks of copper, zinc, and flannel, which were placed on above the other so as to form a pile. The flannel disks were moistened with a zinc disk at the bottom the order in which the plates were arranged was zinc, flannel, copper, zinc, flannel, &c., the same order being maintained throughout. and the pile terminating with a copper plate. To prevent the liquid running between the copper and zinc plates they were soldered together where they were in contact. On connecting the zinc and copper terminals of the pile a current flawed from the copper to the zinc terminal through the were.

The "crown of cups" of Volta and the early batteries of Wollaston and others consisted of plates of two dissimilar metal, (generally copper and zinc) placed in vessels, or cells, containing dilute acid or solution of salt, and connected alternately so that the copper of one cell was connected with the zinc of the next, and ao on. On connecting the final copper and zinc plates by a wire a current flowed round the circuit as in the Voltaic pile. In Wallaston's battery the copper and zinc plates were immersed in cells containing dilute sulphuric acid.

In 1830 Sturgeon introduced the improvement of amalgamating the zinc plates, thus preventing "local action" and preserving the zinc from the action of the acid, except when the current is flowing in the circuit. This improvement obviated the necessity of lifting the plates out of the acid when the battery is not in use.

The followers of Volta maintained that the electric current in the Voltaic cell was due entirely to differences of potential produced at the three places of contact of the metals with the acid, and with each other. They held that although in the case of three metals in contact at the same temperature the difference of potential between the metuls at the three points of contacl balance one another so that there is no resultant electro motive force round the circuit, yet this is not the case when one of the metals is replaced by a liquid which can act chemically upon one or both of the remaining metals. Thus, supposing the potentials of zinc and of copper to be both lower than that of sulphuric acid when the metals are in contact with the acid, and in electrical equilibrium, and the potential of zinc to be higher than that of copper when the metals are in equilibrium, the supporters of the Voltaic or contact theory maintained that the difference of potential between the sulphuric acid and the zinc necessary for equilibrium was greater than the sum of the differences of potential between the acid and the copper, and between the copper and the zinc, the difference being the resultant electro-motive force which urges electricity from the zinc through the acid to the copper and back to the zinc through the metallic junction, when the three subtances are connected as in the Voltaic cell.—*(To be continued.)*