Article IX.

New Electromagnetic Experiments. By Prof. Oersted.

Since the publication of my first experiments on the magnetic action of the galvanic battery, I have multiplied my researches on that subject as much as a multitude of other important avocations put it in my power.

The magnetic effects do not seem to depend upon the intensity of the electricity, but solely on its quantity. The discharge of a strong electric battery transmitted through a metallic wire produces no alteration in the position of the magnetic needle. A series of interrupted electric sparks acts upon the needle by the ordinary electric attractions and repulsions, but as far as can be perceived, the sparks produce no electromagnetic effect. A galvanic pile composed of 100 discs of two inches square each metal, and of paper moistened with salt water to serve as a fluid conductor, is likewise destitute of sensible effect upon the needle. On the other hand we obtain the effect by a single galvanic arc of zinc and copper having for a conductor a liquid possessed of great conducting power; for example, of one part sulphuric acid, as much of nitric acid, and 60 parts of water. We may even double the quantity of water without much diminishing the effect. If the surface of the two metals is small, the effect is likewise small. But it augments in proportion as we augment the surfaces. A plate of zinc, of six inches square, plunged into a vessel of copper containing the liquid conductor of which I have spoken, produces a considerable effect. But an arrangement of this kind in which the zinc plate has a surface of 100 inches square acts upon the needle with such force that the effect is very sensible at the distance of three feet, even when the needle is not very moveable. I have not observed greater effects from a galvanic apparatus composed of 40 similar troughs; indeed the effect seemed less great. If this observation, which I have not investigated expressly, is just, I shall be of opinion that the small diminution of the conducting power produced by increasing the number of the elements of the apparatus weakens its electrochemical effect.

To compare the effect of a single galvanic arc with that of an apparatus composed of several arcs or elements, let us make an observation. Let fig. 9 (Pl. CIX), represent a galvanic arc composed of a piece of zinc *z*, of copper *c*, of a metallic wire *a b*, and of a liquid conductor *l*. The zinc always communicates a portion of its positive electricity to the water as the copper does of its negative electricity. This would occasion an accumulation of negative electricity in the upper part of the zinc, and of positive electricity in the upper part of the copper, unless the communication *a b* re-established the equilibrium by affording a free passage for the negative electricity from *z* to *c*, and for the positive electricity from *c* to *z*. We see then that the wire *a b* receives the negative electricity of the zinc, and the positive electricity of the copper, while a wire that constitutes the communication of the two poles of a pile, or of another compound galvanic apparatus, receives the positive electricity of the zinc pole, and the negative electricity of the copper pole.

By attending to this distinction, we may, with a single galvanic arc, repeat all the experiments which I had at first made with a compound galvanic apparatus. Employing a single galvanic arc gives this great advantage, that it enables us to repeat the experiments with little preparation and expense. But it presents another advantage still more considerable; namely, that we may establish a galvanic arc sufficiently powerful for the electromagnetic experiments, and yet sufficiently light to be suspended to a small metallic wire, in such a manner that the small apparatus may be made to turn round the prolonged axis of the wire. We may in this way examine the action which a magnet exerts on the galvanic arc. As a body cannot put another in motion without being moved in its turn, when it possesses the requisite mobility, it is easy to foresee that the galvanic arc must be moved by the magnet.

I made use of different arrangements of the simple galvanic apparatus to examine the motion impressed on it by the magnet. One of these arrangements is represented in fig. 10, which represents a perpendicular section of it in the direction of the breadth. *c c c c* is a trough of copper, three inches high, four inches long, and half an inch broad. These dimensions doubtless may be varied to infinity. It is only necessary to observe that the breadth ought not to be great, and thus the trough should be made of plates as thin as possible. *z z* is a plate of zinc. *l l* are two pieces of cork which keep the plate in its position. *c f f f f z* is a brass wire, of a quarter of a line at least in diameter. *a b* is a brass wire as fine as possible, so as to be able to bear the weight of the apparatus. *c a c* is a linen thread uniting the wire to the apparatus. The trough contains the liquid conductor. The conducting wire of this apparatus will attract the north pole of the needle when it is placed on the left side of the plane *c f f f f z*, considered in the direction *f z*. On the same side the south pole will be repelled. On the other side of this plane, the north pole will be repelled, and the south pole attracted. That this effect may take place, we must not place the needle above *f f*, nor below *f z* or *f c*. If instead of presenting a small moveable needle to the conducting wire we present near one of the extremities *f f* one of the poles of an energetic magnet, the attraction or repulsion indicated by the needle will put the galvanic apparatus in motion, and will turn it round the prolonged axis of *a b*.

If instead of the conducting wire we take a large ribbon of copper of the same breadth as the plate of zinc, the effect differs from that which we have just mentioned only in being much feebler. On the other side we increase the effect a little by making the conductor very short. Fig. 11 represents the perpendicular section of this arrangement in the direction of the breadth of the trough. Fig. 12 exhibits the same arrangement in perspective. It is obvious that *a c b d e f* represents the conducting plate, and *c z z f* the plate of zinc. In this arrangement the north pole of the needle will be attracted towards the plane of *a b c*, and the south pole will be repelled from the same plane. *e d f* will have contrary effects. Here we have an apparatus whose extremities act like the poles of the needle. But it must be acknowledged that only the faces of the two extremities, and not the intermediate parts, have this analogy.

We may likewise make a moveable galvanic apparatus of two plates, one of copper and oue of zinc, twisted into a spiral, and suspended in the fluid conductor. This apparatus is more moveable; but more precautions are necessary not to be deceived when we make experiments with it.

I have not yet found a method of making a galvanic apparatus capable of directing itself towards the poles of the earth. For this object it would be necessary to possess apparatus much more moveable.

Article X.

Observations on the Ventilation of Mines.

By Joseph M'Sweeny, M.D.

(To Dr. Thomson.)

SIR, *July* 21, 1280.

The safety lamp of Sir H. Davy has enabled miners to descend into an explosive atmosphere with impunity; but when we reflect that only a wire gauze liable to accident screens so many from destruction, we must admit that every precaution should be taken to prevent the accumulation of noxious gas. I am not aware that water blowing engines* have been proposed for ventilating mines. The water escaping from crevices of a mine could be conducted by pipes to supply these engines, the air extricated could be conveyed from them up the shaft by tubes, and atmospheric air would descend to occupy its place. In this way even carbonic acid gas may be got out. It is well known that gas can be got out of a mine by a tube communicating with the under valve of a large bellows; but if by the act of getting out gas we could raise the water out of the mine, it

* Vide Ferguson's Lectures by Brewster.