ARTICLE IX.

Contributions to Electricity and Magnetism. By Joseph Henry, Professor of Natural Philosophy in the College of New Jersey, Princeton, late of the Albany Academy.

No. I.—Description of a Galvanic Battery for producing Electricity of different Intensities. Read before the American Philosophical Society, January 14*th*, 1835.

THE following account of a Galvanic Battery, constructed under my direction for the Physical Department of the College of New Jersey, is submitted to the American Philosophical Society with the intention of referring to it in some communications which I purpose making on the subject of Electricity and Magnetism. It is hoped, however, that the arrangement and details of the instrument, in themselves, will be found to possess some interest, since they have been adopted in most cases after several experiments and much personal labour.

The apparatus is intended to exhibit most of the phenomena of Galvanism and all those of Electro-Magnetism, on a large scale, with one battery. It was constructed to illustrate the several facts of these branches of science to my class, and also to be used as a convenient instrument of research in all cases where no very great degree of intensity is required.

The several parts of this battery are not soldered together forming one permanent galvanic arrangement, but are only temporarily connected by means of movable conductors and cups of mercury. The whole is constructed in reference to the principle well understood of producing electricity of greater or less intensity, by a change in the method of uniting the several elements with each other.

The apparatus consists of eighty-eight elements or pairs, composed of plates of rolled zinc nearly one eighth of an inch thick, nine inches wide, and twelve inches long, inserted into copper cases open at top and bottom. Eleven of these elements are suspended together from two cross pieces of wood, and the whole number is thus arranged in eight sets, of eleven in each. These are supported by the ends of the cross-pieces in a strong wooden frame, so as to be immersed in eight separate troughs: they thus form as many independent batteries, which can be used separately or together as the occasion may require. Each trough is divided into eleven cells by wooden partitions coated with cement. If one of the cells be charged with dilute acid, a single element may be excited without producing action in any other part of the battery. Each set or battery may also be lifted separately from the frame by its cross pieces, without disturbing the other parts of the apparatus.

The elements remain stationary, while the troughs are raised to them on a movable platform by the common application of a wheel and pinion.

The general arrangement of the whole may be seen at once by a reference to the perspective drawing, fig. 1, Plate XXII. *a a*, &c. represent the cross pieces resting on the upper part of the frame of the machine; *c c* is the movable platform.

A perspective view of one of the elements on a larger scale is given in fig. 3. *a a* are two cups of cast copper, with a broad stem on the bottom; one soldered to the zinc plate, and the other to the copper case. The cavity in these cups is about three eighths of an inch wide, a little more than an inch long, and half an inch deep. The cups being well amalgamated and partially filled with mercury, receive the ends of the copper conductors which unite the several elements.

For the purpose of suspension, a slip of copper, *b b*, with a hole in it, is soldered to each upper corner of the copper case; these fit loosely into a mortice or narrow groove in the cross pieces, and are secured by a pin of copper wire. When the pins are withdrawn, a single element may be removed from any part of the series, without disturbing the remainder.

The zinc plate is fastened into its copper case, without touching, by a piece of wood at each corner, with a groove in it to receive the edge of the plate. The grooves in the two lower pieces of wood terminate at about a quarter of an inch from the lower end, and thus form shoulders, which prevent the plate from slipping down; while the wood itself is supported by a flange, formed by bending in the lower edges of the corner of the copper case.

There are two principal sets of connectors; the first is formed of bars of cast copper thirteen inches long, an inch wide, and about an eighth of an inch thick. On the lower side of these are eleven broad projections, which fit loosely into a row of cups on the plates of zinc or copper. Fig. 4 represents one of these connectors with a thimble soldered on the upper side for the purpose of attaching a conductor, which may serve as a pole.

There are two of these for each of the eight batteries, and when in their places, one unites all the zinc, and the other all the copper, so that the battery becomes a calorimotor of a single element or pair. If with this arrangement the several batteries be connected, zinc to zinc and copper to copper, by conductors reaching from one to the other, the whole apparatus of eighty-eight elements becomes a large calorimotor of a single pair; but if the copper of the first be united to the zinc of the second, and so on, it then forms a calorimotor of eight elements, and by a simple change may be reduced to one of four, or of two, elements.

The other set of connectors consists of short pieces of thick copper plate, the ends of which are bent down at right angles, so as to dip into the cups of mercury: they connect the copper of one element with the zinc of the next. Ten of these, intended to unite the elements of one battery, are shown in fig. 5. They are attached crosswise to a slip of harness leather, which, by its pliability, permits them to fit loosely into the cups, while it enables the whole set to be removed as one piece. When these connectors are in their places, and the several batteries united, the copper pole of the one, with the zinc pole of another, and so on, the whole series forms a deflagrator of eighty-eight elements.

The different arrangements of the several connectors will be readily understood by a reference to the plan drawing, fig. 2, which exhibits one half of the whole apparatus arranged as a deflagrator of forty-four elements, and the other half as a calorimotor of four pairs. By closely inspecting the drawing, it will be seen that the connexion in the upper half of the figure is from the copper of the first element to the zinc of the next, and so on through the entire series of forty-four elements. In the lower half the union of copper and zinc takes place only between the poles of the different batteries; the several elements of which are united so as to act as one plate of copper and one of zinc. The four batteries therefore will act together as a calorimotor of four elements. The arrangement, as given in the drawing, is intended to illustrate by one figure the two sets of connectors; but such an arrangement becomes interesting in practice in determining the effect of the conjoined actions of batteries producing electricity of different intensities.

The circuit of the connexions as given in the figure is complete except at *a b*; the two plates at this point form the poles of the battery. A set of poles, however, may be formed at any other point of the circuit, by making an interruption at that place. In the same way two or more sets may be formed. It furnishes an interesting and instructive experiment to place a pair of large decomposing plates at *a b* and another at *c d*. When only one of these is plunged into a saline solution, the circuit being interrupted at the other pair, no effect is produced; but as soon as this other is plunged into a similar solution, a copious decomposition simultaneously takes place at both. Also the contemporaneous action in each element of the battery is pleasingly shown by placing at the same time several large magnetic needles on the different parts of the apparatus. These instantly change their direction when the second pair of decomposing plates touch the solution.

At first sight it might be supposed that there would be some difficulty in entering the several plates into their respective cells, but this is obviated by the precise movement of the platform on which the troughs stand. Its horizontal position is adjusted by four screws (*c c* fig. 1), and its corners slide in grooves in the upright posts of the large frame. Besides this, when the plates are once entered, they are not required to be entirely withdrawn from the cells until the end of the series of experiments; since the acid descends as the plates are withdrawn, and finally fills but little more than three-fourths of the capacity of the cells. When a plate accidentally catches on the side of the cell, the battery to which it belongs is gently raised in its place and the plate adjusted.

This apparatus readily furnishes the means of making comparative experiments on the difference produced by partial and perfect insulation. When no higher degree of intensity is required than that afforded by eight pairs of plates, perfect insulation is obtained by the eight separate troughs. In higher degrees of intensity the partitions in the troughs furnish the means of perfectly insulating forty-eight of the elements: this is effected by simply charging with acid every other cell in each of the troughs, and connecting the corresponding element by conductors, which pass over the intermediate elements without touching them: with this arrangement we have six cells in each trough separated from one another by a cell without acid, or in effect by a stratum of air. For comparison with these a set of troughs has been constructed without partitions.

The want of perfect insulation is not very perceptible in the common experiments of the deflagration of large and perfect conductors; but where the decomposition of a liquid is attempted, or the battery required to act on a small or imperfect conductor, the loss of power is very great, the apparatus partially discharging itself through its own liquid, and the intensity at the poles does not increase with a short interruption of the current.

There is also considerable loss on account of imperfect insulation even in the case of low intensity, and when the poles are connected by a perfect conductor. In one experiment with an arrangement of five pairs, and the poles united by a conductor composed of thirty strands of copper bell wire, each forty feet long, the loss was found to be at least one seventh, as measured by the quantity of zinc surface required to be immersed in order to produce the same magnetic effect. I would infer from this that the most perfect of all Dr Hare's ingenious galvanic arrangements is that in which the elements dip into separate glass vessels, as this combines perfect insulation with the power of instantaneous immersion.

A variety of experiments have been made during the past year with this instrument on several points of Galvanism and Electro-Magnetism, which will be communicated to the society as soon as my engagements will permit me to repeat and arrange them for publication.

Fig 1.

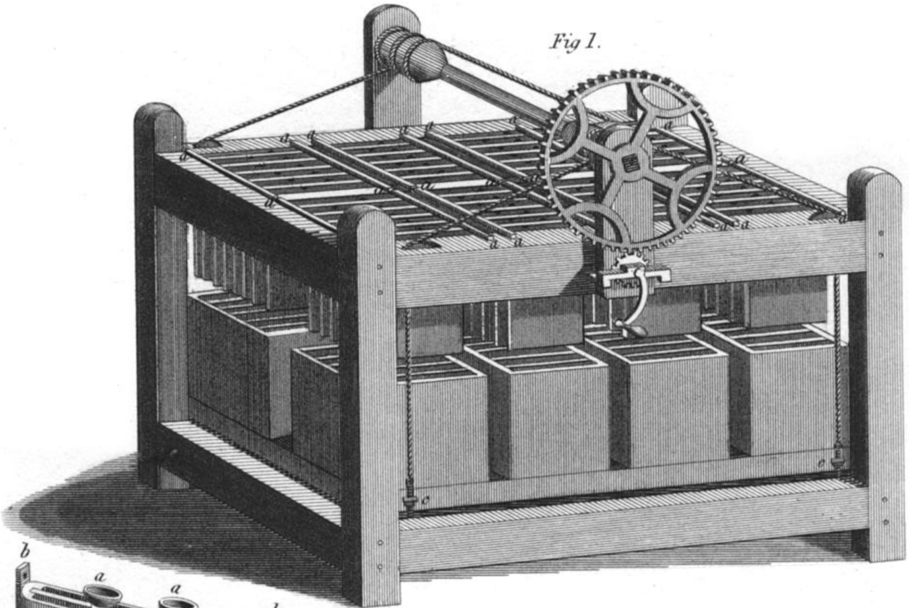


Fig 5.

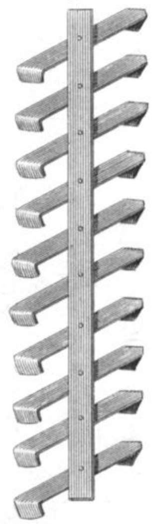


Fig 3.

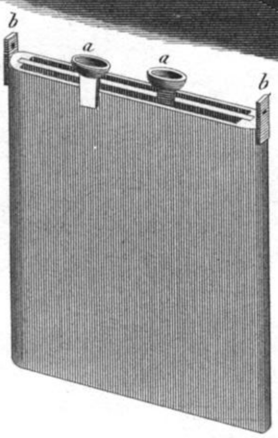


Fig 4.

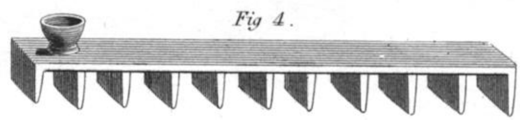
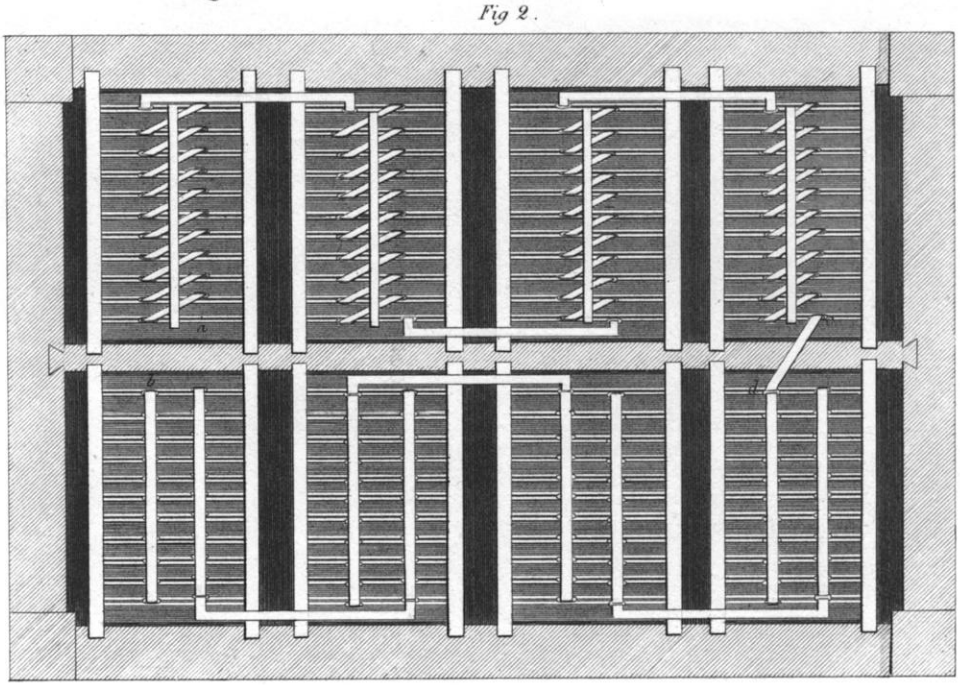


Fig 2.



Drawn by S. Rufus Mason. Engraved by J. Yeager.