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The young man's book of amusement

Halifax, 1848

Galvanism

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The Electrified Camphor.

A beautiful experiment of the same nature is made with camphor. A spoon holding a piece of lighted camphor is made to communicate with an electrified body, as the prime conductor of a machine; while the conductor continues electrified by keeping the machine in motion, the camphor will throw out ramifications, and appear to shoot like a vegetable.

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GALVANISM.  
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A LONG time prior to the establishment of galvanism as a science, it had been observed, that if two different metals were placed in contact under water, they were subject to a rapid oxidation, though the water had no perceptible action upon them, when they were alone.

When metals have been soldered by means of other metals, they were found to tarnish about the places where they were joined; and the copper sheathing of ships when fastened by means of iron nails, soon corrodes about the place where the different metals touch each other.

It had been generally affirmed, that porter drunk

out of a pewter vessel, has a taste different from that drunk out of glass or earthenware.

*Galvanic Battery.*

(Refer to Frontispiece, Fig. 14.)

The zinc plates are made by casting that metal in an iron or brass mould; they may be about an eighth of an inch thick. The copper need not exceed twelve or fourteen ounces to the square foot, and may be soldered to the zinc at one edge only, the other three being secured by cement in the trough. The trough must have as many grooves in its sides as the number of plates it is intended to contain, which should be fewer in proportion to their size, otherwise the apparatus will be inconvenient from its weight. When the plates are not more than three inches square, their number in one trough may be fifty, and the distance of the grooves from three-eighths to half an inch. The trough must be made of very dry wood, and put together with white lead. The plates being placed at the fire, the trough is to be well warmed, and placed horizontally on a level table, with its bottom downwards; very hot cement is then to be poured into it, until the bottom is covered to the depth of a quarter of an inch. During this process the plates will have become warm, and they are then to be quickly slid into the grooves and pushed firmly to the bottom, so as to bed themselves securely in the ce-

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ment. In this way the plates are very perfectly cemented at the bottom, and when this cement is sufficiently cool, a slip of thin deal is to be slightly nailed on the top edge of one of the sides of the trough, so as to overhang the inner surface about a quarter of an inch. The trough being about three quarters of an inch deeper than the diameter of the plates, there will be an interval between their top edges and the deal slip; and when the side of the trough to which the slip is attached is laid flat on the table, this interval forms a channel into which very hot cement is to be poured, and it will flow between each pair of plates, so as to cement one side of all the cells perfectly. As soon as the channel is quite full of fluid cement, the strip of deal is to be torn off, and the trough inclined so as to admit of the superfluous cement to run out. When this is effected, and the cement cool, a slip of deal is to be nailed on the opposite side, and the same process pursued with that. The instrument will then be cemented in the most perfect manner, and it may be cleaned off and varnished.\*

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#### *Voltaic Pile.*

The Voltaic Pile was invented towards the close of

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\* The zinc end of a battery is considered to be plus or positive: the silver end, (or copper end, when copper is used with the zinc,) is considered to be minus or negative.

The effect of the galvanic battery is considered much greater in oxygen than in atmospheric air, and it ceases entirely in azote or hydrogen.

the last century, and since that period, the science of Voltaic electricity has done more towards the progress of chemical research, than any other apparatus yet discovered. The Voltaic Pile consists of a series of plates composed of zinc and copper, in alternate layers; it is found that when a pile is thus raised, each alternate pair of plates being separated by a piece of moistened flannel, that smart shocks will be received by any person who may make a communication between the top and bottom of the pile. An electrical arrangement of this kind usually consists of about fifty pair of plates.

#### *Vegetable Galvanic Pile.*

A galvanic pile has been constructed by a scientific gentleman, entirely of vegetable substances. For this purpose, he cut discs of horse-radish and beet-root of two inches in diameter. He then prepared equal discs of walnut-tree wood, which were raised at their edges, to contain a little solution of acidulous tartrate of potash in vinegar, in which they had been previously boiled, to free the wood from rosin. Sixty pairs of discs were employed in the following order; viz. horse radish, beet root, discs of wood. The spinal marrow of a prepared frog was connected with the pile, by means of a leaf of *cochlearia*; the muscles of the frog were connected with the top of the pile by means of a double band of grey paper, wetted with vinegar; and, as often as this circuit was completed, contortions were excited in the animal.

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*Galvanic Experiment with Frogs.\**

Frogs have been found the most convenient subjects for galvanic operations. Galvani prepared these animals by skinning their legs when recently dead, (they are usually killed by decapitation,) and leaving the legs attached to a small part of the spine, but separated from the rest of the body. Any other limb may be prepared in a similar manner, viz. the limb is deprived of its integuments, and the nerve which belongs to it is partly laid bare. The strongest contractions are produced when the galvanic electricity is caused to pass through the nerve to the muscles. Frogs which have been galvanized, very quickly become putrid.

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*The Effect of Galvanism upon Living Animals.*

*The following Experiments, which are not attended with any circumstances that can wound the feelings of humanity, may be easily made to shew the action of voltaic electricity on living animals.*

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\* Perhaps most of those who try galvanic experiments merely for the purpose of amusement, would choose to dispense with the operations of decapitating and skinning frogs. It may therefore be observed, that an ample proof of the power of galvanism over the dead animal muscle, may be obtained by galvanizing any animal killed for domestic use. It will only be necessary to point the wires from the battery, and to penetrate the skin with them, at the two parts between which a communication is intended to be made.

*Experiment on a Frog.*

Place a living frog upon a plate of zinc wetted with water, and paste a slip of tin-foil, or a shilling, also wetted with water, upon the back of a frog. If now a communication be formed between the zinc and the tin-foil, by means of a wire, or other piece of metal, the frog will be violently convulsed, and jump off the plate.

*Experiment with a Leech.*

Those animals can only be convulsed by galvanism which possess distinct limbs and muscles; yet reptiles may be shewn to be affected by it: thus if a leech or a worm be laid upon a plate of zinc, and surrounded at a little distance by pieces of silver, for example half-crowns, every time the animal touches one of the pieces of silver, it will be observed to draw itself back.

*Experiment on a Flounder.*

Take a live flounder, and put it on a pewter plate, or upon a large piece of zinc, wetted with water, upon its back; or place the fish upon its back, and apply the coin to its cheek or breast, then touch the plate or zinc with a wire, and apply the other extremity of the wire to a piece of silver, violent contractions will

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be immediately excited in the fish, which may be renewed at pleasure by forming a connection between the two metals. The animal, therefore, is quiet, until a communication be made between the silver and the zinc, by means of a third metal, to the edges of the others. The galvanic agency then takes place, because a galvanic circle is formed.

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*Besides these effects produced by the influence on the muscles, the sensations which it excites in some of the organs of sense are equally evinced in the following manner.*

Place a thin plate of zinc upon the upper surface of the tongue, and half a crown, or piece of silver or tea-spoon, on the under surface. The metals ought to be allowed to remain for a little time in contact with the tongue before they are made to touch each other, that taste of the metals themselves may not be confounded with the sensation produced by their contact. When the edges which project beyond the tongue are then made to touch, a sensation is produced which it is difficult accurately to describe. It takes place suddenly, like a slight electrical shock, and a subacid taste, somewhat resembling dilute nitric acid, is perceived confounded with an evident metallic taste.



*Another.*

Place a silver tea-spoon as high as possible between the gums and the upper lip, and a bar of zinc between the under lip: on bringing the extremities into contact, a very vivid sensation, resembling a flash of light, will be perceived. It is singular, that this light is equally vivid in the dark with the strongest light, and whether the eyes be shut or open.

*Another.*

Place a cup of silver, filled with water, on a plate of zinc, standing upon a table, and touch the water with the tip of the tongue, it will be tasteless as long as the zinc plate is not touched, for the body does not form a voltaic circle with the metals. Moisten well the hands, and lay hold of the plate of zinc, whilst the tongue is brought to touch the water, a peculiar sensation, and an acid taste will be immediately experienced.

*Galvanic Shock.*

Several persons may receive the shock together, by joining hands, in the same manner as in receiving the shock from a Leyden phial. Their hands should

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be well moistened; but the strength of the shock diminishes as it proceeds, in consequence of which the last person feels it much less violently than the first. After receiving the galvanic shock, a slight numbness of the part that has been exposed to it remains for some time.

The galvanic shock may also be conveniently given by immersing the hands or the feet into vessels containing a solution of salt, and bringing wires from each end of the battery into the liquid. If any other part of the body is intended to be operated upon, a sponge, moistened with salt-water and fastened to a metal plate connected with one end of the battery, may be applied to the part, and the hand or foot put into a vessel of the same liquid, connected by a wire with the other end of the battery. Small bits of sponge, or bits of leather, may be fastened to the end of the connecting wires, and made more or less moist as the delicacy of the part may require.

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*The Decomposition of Water by Galvanism.*

The most simple mode of performing this experiment, is to bring the wires coming from each end of the battery into a vessel of water. A profusion of bubbles of gas will appear to be given out from each wire, as far as they are immersed in the liquid. The nearer the wires are brought together, so as not to touch, the more rapidly the decomposition goes on. The gas produced from the wire coming from the

zinc end of the battery, if the wire be of gold or platina, is found as before mentioned, to be oxygen; but if the wire be of any more oxidable metal, no gas will appear, but the wire will be oxidated. The gas furnished by the wire from the copper end of the battery, of whatever kind of metal the wire may be, is pure hydrogen. If the immersed part of this, however, be previously oxidated, no gas will be observed for some time, the hydrogen being employed in reducing the oxide upon the surface. Both the gases are furnished by the decomposition of the water.

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#### *Powerful Batteries.*

Sir H. Davy's great voltaic battery consisted of two thousand double plates of copper and zinc of four inches square.

Each plate of Mr. Children's large galvanic battery consists of thirty-two square inches, and produced intense heat. Iron was instantaneously converted by it to blister steel, and diamond powder disappeared.

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#### *Galvanic Experiments on the Dead Body of a Criminal.*

The following interesting experiments, illustrative of the amazing powers of Galvanic operations, will be highly acceptable to the reader. The subject of these

experiments was a middle sized, athletic, and extremely muscular man, about thirty years of age. He was a murderer, and after hanging nearly an hour, underwent the experiments about to be detailed.

*Experiment 1.* A large incision was made into the nape of the neck, close below the occiput. The posterior half of the atlas vertebra was then removed by bone forceps, when the spinal marrow was brought into view. A profuse flow of liquid blood gushed from the wound, inundating the floor. A considerable incision was at the same time made in the left hip, through the great gutteal muscle, so as to bring the sciatic nerve into sight, and a small cut was made in the heel; the pointed rod connected with one end of the battery was now placed in contact with the spinal marrow, while the other rod was applied to the sciatic nerve. Every muscle of the body was immediately agitated with convulsive movements resembling a violent shuddering from the cold; the left side was most powerfully convulsed at each renewal of the electric contact. On moving the second rod from the hip to the heel, the knee being previously bent, the leg was thrown out with such violence as nearly to overturn one of the assistants, who in vain attempted to prevent its extension.

*Experiment 2.* The left phrenic nerve was now made bare at the outer edge of the *sternothyroidhus* muscle, from three to four inches above the clavicle, the cutaneous incision having been made by the side of the *sternocleffo mastoideus*. Since this nerve is distributed to the diaphragm, and since it communicates with the heart through the eighth pair, it

was expected, by transmitting the galvanic power along it, that the respiratory process would be renewed. Accordingly a small incision having been made under the cartilage of the seventh rib, the point of the one insulating rod was brought into contact with the great head of the diaphragm, while the other point was applied to the phrenic nerve in the neck. This muscle, the main agent of respiration, was instantly contracted, but with less force than was expected. Satisfied from ample experience on the living body, that more powerful effects can be produced in galvanic excitation, by leaving the extreme communicating rods in close contact with the parts to be operated on, while the electric chain or circuit is completed by running the end of the wires along the top of the plates, in the last trough of either pole, the other wire being steadily immersed in the last cell of the opposite pole, I had immediate recourse to this method. The success of it was truly wonderful. Full, nay, laborious breathing, instantly commenced. The chest heaved, and fell; the belly was protruded, and again collapsed, with the relaxing, and retiring diaphragm. This process was continued without interruption, so long as I continued the electric discharges.

In the judgment of many scientific gentlemen who witnessed the scene, this respiratory experiment was perhaps the most striking ever made with a philosophical apparatus. Let it also be remembered, that for full half an hour before this period, the body had been well nigh drained of its blood, and the spinal marrow severely lacerated. No pulsation could be

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perceived meanwhile at the heart or wrist; but it may be supposed, that but for the evacuation of blood, the essential stimulus of that organ, this phenomenon might also have occurred.

*Experiment 3.* The supra-orbital nerve was laid bare in the forehead, as it issues through the supra-ciliary foramen in the eye-brow: the one conducting rod being applied to it, and the other to the heel, most extraordinary grimaces were exhibited every time that the electric discharges were made, by running the wire in my hand along the edges of the last trough, from the 220th, to the 270th pair of plates: thus fifty shocks, each greater than the preceding one, were given in two seconds. Every muscle in his countenance was simultaneously thrown into fearful action: rage, horror, despair, anguish, and ghastly smiles united their hideous expression in the murderer's face; surpassing far the wildest representation of a Fuseli or a Kean. At this period several of the spectators were forced to leave the apartment from terror or sickness, and one gentleman fainted.

*Experiment 4.* The last galvanic experiment consisted in transmitting the electric power from the spinal marrow to the ulnar nerve, as it passes by the internal condyle to the elbow: the fingers now moved nimbly, like those of a violin performer: an assistant, who tried to close the fist, found the hand to open forcibly, in spite of his efforts. When the one rod was applied to a slight incision in the tip of the forefinger, the fist being previously clenched, that finger extended instantly; and from the convulsive agitation of the arm, he seemed to point to

the different spectators, some of whom thought he had come to life. About an hour was spent in these operations.

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### PNEUMATICS.

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#### *The Air Pump.*

It will be advisable in the first place to describe the way in which the Air Pump is usually constructed. In the frontispiece, Fig. 15, represents the cheapest form, and in its action it exactly resembles the common sucking pump. Within each of the two strong brass barrels in front is fixed (at the bottom) a valve, opening upwards; these valves communicate with a concealed pipe leading to the hole under the glass receiver. The barrels also include moveable pistons, with valves opening upwards. To the upper parts of the pistons are attached rack-work, (part of which is elevated in the cut,) these racks are moved up and down by means of a little cog wheel turned round by a handle affixed. A little beneath the pistons is a small screw which serves to re-admit air into the receiver when it is in a state of exhaustion. When the Air-Pump is to be used, *a slip of wet leather should be placed under the edge of the receiver*, be-