PHYSICS

Franklin and The Electric Phial

"A Classic of Science"

The Leyden Jar, Though Invented Accidentally in Holland, Owes its Explanation to America's Ubiquitous Scientist

EXPERIMENTS AND OBSERVATIONS ON ELECTRICITY, made at Philadelphia in America by Mr. Benjamin Franklin, and communicated in several letters to Mr. P. Collinson, of London. London: Printed and sold by E. Cave, at St. John's Gate, 1751.

July 28, 1747.

SIR,

The necessary trouble of copying long letters, which perhaps when they come to your hands may contain nothing new, or worth your reading (so quick is the progress made with you in Electricity) half discourages me from writing any more on that subject. Yet I cannot forbear adding a few observations on M. *Muschenbroek's* wonderful bottle.

1. The non-electric contain'd in the bottle differs when electrified from a non-electric electrified out of the bottle, in this: that the electrical fire of the latter is accumulated *on its surface,* and forms an electrical atmosphere round it of considerable extent: but the electrical fire is crouded *into the substance* of the former, the glass confining it.

2. At the same time that the wire and top of the bottle, &c. is electrified *positively* or *plus,* the bottom of the bottle is electrified *negatively* or *minus,* in exact proportion: *i.e.* whatever quantity of electrical fire is thrown in at top, an equal quantity goes out of the bottom. To understand this, suppose the common quantity of Electricity in each part of the bottle, before the operation begins, is equal to 20; and at every stroke of the tube, suppose a quantity equal to 1 is thrown in; then, after the first stroke, the quantity contain'd in the wire and upper part of the bottle will be 21, in the bottom 19. After the second, the upper part will have 22, the lower 18, and so on 'till after 20 strokes, the upper part will have a quantity of electrical fire equal to 40, the lower part none: and then the operation ends: for no more can be thrown into the upper part, when no more can be driven out of the lower part. If you attempt to throw more in, it is spued back thro' the wire, or flies out in loud cracks thro' the sides of the bottle.

3. The equilibrium cannot be restored in the bottle by *inward* communication or contact of the parts; but it must be done by a communication form'd *without* the bottle, between the top and bottom, by some non-electric, touching both at the same time; in which case it is restored with a violence and quickness inexpressible: or, touching each alternately, in which case the equilibrium is restored by degrees.

4. As no more electrical fire can be thrown into the top of the bottle, when all is driven out of the bottom, so in a bottle not yet electrified, none can be thrown into the top, when none *can* get out at the bottom; which happens either when the bottom is too thick, or when the bottle is placed on a electric *per se.* Again, when the bottle is electrified, but little of the electrical fire can be *drawn out* from the top, by touching the wire, unless an equal quantity can at the same time *get in* at the bottom. Thus, place an electrified bottle on clean glass or dry wax, and you will not, by touching the wire, get out the fire from the top. Place it on a non-electric, and touch the wire, you will get it out in a short time; but soonest when you form a direct communication as above.

So wonderfully are these two states of Electricity, the *plus* and *minus,* combined and balanced in this miraculous bottle! situated and related to each other in a manner that I can by no means comprehend! If it were possible that a bottle should in one part contain a quantity of air strongly comprest, and in another part a perfect vacuum, we know the equilibrium would be instantly restored *within.* But here we have a bottle containing at the same time a plenum of electrical fire, and a *vacuum* of the same fire; and yet the equilibrium cannot be restored between them but by a communication *without!* though the *plenum* presses violently to expand, and the hungry vacuum seems to attract as violently in order to be filled.

5. The shock to the nerves (or convulsion rather) is occasion'd by the sudden passing of the fire through the body in its way from the top to the bottom of the bottle. The fire takes the shortest course, as Mr. *Watson* justly observes: But it does not appear, from experiment, that, in order for a person to be shocked, a communication with the floor is necessary; for he that holds the bottle with one hand, and touches the wire with the other, will be shock'd as much, though his shoes be dry, or even standing on wax, as otherwise. And on the touch of the wire (or of the gun-barrel, which is the same thing) the fire does not proceed from the touching finger to the wire, as is supposed, but from the wire to the finger, and passes through the body to the other hand, and so into the bottom of the bottle.

Experiments Confirming the Above

EXPERIMENT I.

Place an electrical phial on wax; a small cork-ball suspended by a dry silk-thread held in your hand, and brought near to the wire, will first be attracted, and then repelled: when in this state of repellency, sink your hand, that the ball may be brought towards the bottom of the bottle; it will there be instantly and strongly attracted, 'till it has parted with its fire.

If the bottle had an electrical atmosphere, as well as the wire, an electrified cork would be repelled from one as well as from the other.

EXPERIMENT II.

Fig. 1. From a bent wire (*a*) sticking in the table, let a small linen thread (*b*) hang down within half an inch of the electrified phial (*c*). Touch the wire of the phial repeatedly with your finger, and at every touch you will see the thread instantly attracted by the bottle. (This is best done by a vinegar cruet, or some such belly'd bottle). As soon as you draw any fire out from the upper part by touching the wire, the lower part of the bottle draws an equal quantity in by the thread.

EXPERIMENT III

Fig. 2. Fix a wire in the lead, with which the bottom of the bottle is armed, (*d*) so as that bending upwards, its ring-end may be level with the top or ring-end of the wire in the cork (*e*), and at three or four inches distance. Then electricise the bottle, and place it on wax. If a cork suspended by a silk thread (*f*) hang between these two wires, it will play incessantly from one to the other, 'till the bottle is no longer electrised; that is, it fetches and carries fire from the top to the bottom of the bottle, 'till the equilibrium is restored.

EXPERIMENT IV

Place an electricised phial on wax; take a wire (*g*) in form of a *C*, the ends at such a distance when bent, as that the upper may touch the wire of the bottle, when the lower touches the bottom: stick the outer part on a stick of sealing wax (*h*) which will serve as a handle. Then apply the lower end to the bottom of the bottle, and gradually bring the upper-end near the wire in the cork. The consequence is, spark follows spark till the equilibrium is restored. Touch the top first, and on approaching the bottom with the other end, you have a constant stream of fire, from the wire entering the bottle. Touch the top and bottom together, and the equilibrium will soon be restored, but silently and imperceptibly; the crooked wire forming the communication.

EXPERIMENT V.

Let a ring of thin lead or paper surround a bottle (*i*), event at some distance from or above the bottom. From that ring let a wire proceed up, 'till it touch the wire of the cork (*k*). A bottle so fixt cannot by any means be electrised: the equilibrium is never destroyed: for while the communication between the upper and lower parts of the bottle is continued by the outside wire, the fire only circulates: what is driven out at bottom, is constantly supply'd from the top. Hence a bottle cannot be electrised that is foul or moist on the outside.

EXPERIMENT VI.

Place a man on a cake of wax, and present him the wire of the electrified phial to touch, you standing on the floor, and holding it in your hand. As often as he touches it, he will be electrified *plus*: and any one sttanding on the floor may draw a spark from him. The fire in this experiment passes out of the wire into him; and at the same time out of your hand into the bottom of the bottle.

EXPERIMENT VII

Give him the electrified phial to hold; and do you touch the wire; as often you touch it he will be electrified *minus,* and may draw a spark from any one standing on the floor. The fire now passes from the wire to you, and from him into the bottom of the bottle.

EXPERIMENT VIII

Lay two books on two glasses, back towards back, two or three inches distant. Set the electrified phial on one, and then touch the wire; that book will be electrified *minus;* the electrical fire being drawn out of it by the bottom of the bottle. Take off the bottle, and holding it in your hand, touch the other with the wire; that book will be electrised *plus;* the fire passing into it from the wire, and the bottle at the same time supply'd from your hand. A suspended small cork-ball will play between these books 'till equilibrium is restored.

EXPERIMENT IX

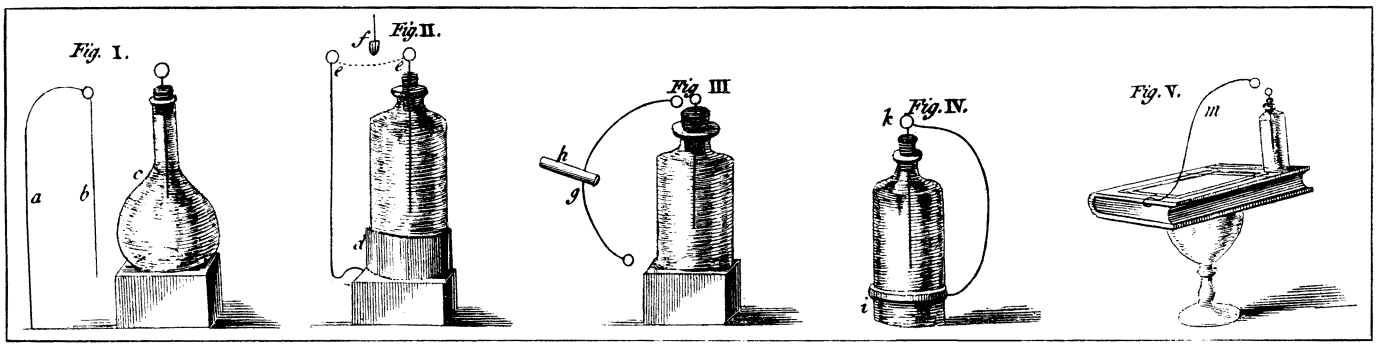
When a body is electrised *plus* it will repel an electrified feather or small cork-ball. When *minus* (or when in the common state) it will attract them, but stronger when *minus* than when in the common state, the difference being greater.

EXPERIMENT X.

Tho', as in Exper. VI. a man standing on wax may be electrised a number of times, by repeatedly touching the wire of an electrised bottle (held in the hand of one standing on the floor) he receiving the fire from the wire each time: yet holding it in his own hand, and touching the wire, tho' he draws a strong spark, and is violently shock'd, no Electricity remains in him; the fire only passing thro' him from the upper to the lower part of the bottle. Observe, before the shock, to let some one on the floor touch him to restore the equilibrium in his body; for in taking hold of the bottom of the bottle, he sometimes becomes a little electrised *minus,* which will continue after the shock; as would also any *plus* Electricity, which he might have given him before the shock. For, restoring the equilibruim in the bottle does not at all affect the Electricity in the man thro' whom the fire passes; that Electricity is neither increased nor diminish'd.

EXPERIMENT XI

The passing of the electrical fire from the upper to the lower part of the bottle, to restore the equilibrium is render'd strongly visible by the following pretty experiment. Take a book whose cover is filletted with gold; bend a wire of eight or ten inches long in the form (*m*) Fig. 5, slip it on the end of the cover of the book over the gold line, so as that the shoulder of it may press upon one end of the gold line, the ring up, but leaning towards the other end of the book. Lay the book on a glass



ILLUSTRATIONS IN BENJAMIN FRANKLIN'S ACCOUNT OF HIS LEYDEN JAR EXPERIMENTS

or wax; and on the other end of the gold lines, set the bottle electrised: then bend the springing wire, by pressing it with a stick of wax till its ring approaches the ring of the bottle wire; instantly there is a strong spark and a stroke, and the whole line of gold, which completes the communication between the top and bottom of the bottle, will appear a vivid flame, like the sharpest lightning. The closer the contact between the shoulder of the wire, and the gold at one end of the line, and between the bottom of the bottle and the gold at the other end, the better the experiment succeeds. The room should be darkened. If you would have the whol filletting round the cover appear in fire at once, let the bottle and wire touch the gold in the diagonally opposite corners. *I am,* &c.

B. FRANKLIN.

Science News Letter, August 1, 1931

METALLURGY

Atoms Are Wanderers Even In Most Solid Metal

ATOMS, even the heavy atoms of lead, are wanderers. Prof. J. G. von Hevesy, of the University of Freiburg in Breisgau, has been investigating their properties. Lead atoms are constantly in motion, even in solid metal, he believes. In an alloy of lead and gold, at a temperature half again as high as that of boiling water, the atoms wander through a space of a hundredth of a cubic inch in a day. When there is nothing but lead in the lump, however, moving about is not nearly so easy.

Science News Letter, August 1, 1931

MEDICINE

Father Gives Baby Malaria By Blood Transfusion

THE DANGER of giving malaria by blood transfusion or by injections of whole blood for other purposes such as the prevention of measles was called to the attention of physicians by Dr. I. R. Jankelson of the Boston City Hospital in a report to the American Medical Association.

Dr. Jankelson described the case of a father who unwittingly gave malaria to his new-born baby in this way.

The father, an Italian, who had been living in Boston for the last twenty years, had been complaining of stomach trouble for nine or ten years. He was being treated for stomach ulcer with more or less success, careful examination having ruled out any other cause of his trouble.

At about that time his wife had a baby. This infant suffered from hemorrhages and in the course of treatment was given several ounces of the father's blood. The child developed malaria. Careful examination of the father's blood revealed the presence of the malaria parasite.

The father recalled that at the age of five, when he was living in Italy, he had had malaria, and that about once or twice a year he had a chill, lasting about one hour and followed by profuse perspiration.

Because a recipient of blood is usually in a precarious state of health, he is entitled to every safeguard against transmission of disease from the donor, Dr. Jankelson pointed out.

Science News Letter, August 1, 1931

(From page 71) and the frequency of rainfall is not much greater if immeasurable amounts, or traces, are also included. In January, February and March, measurable rainfall occurs on the average one day each month while in practically all other months the average number of rainy days is considerably less than one-half. The greatest number of rainy days in one year was in 1913 when measurable rainfall occurred on 16 days and the least in 1929 when no rain, not even a trace, was recorded. The greatest number of rainy days in any one month was five in March, 1918, but the total monthly precipitation was only 0.75 inch.

"A daily rainfall of one inch or more has been recorded at Greenland Ranch only four times in nearly twenty years and the greatest amount ever recorded in 24 hours is 1.40 inches."

Old Tales Exaggerated

With so much heat and so little water, one would naturally expect to see the valley an absolute, staring desert, with no leaf or stem of plant life and not so much as an insect to speak for the animal kingdom. Such were the descriptions published by early California writers, who never took the trouble to visit the region, but relied on the tales of horror told by survivors of trapped pioneer trains, added to by their own imaginations.

But the fact is, that most of the floor of the valley is covered with vegetation. Several botanists have worked in the place, and their lists total somewhere in the neighborhood of 200 species, ranging from short-lived annuals to the tough and useful mesquite. Some of these, like sedges and cattails, live along the edges of streams that run down from the mountains and wander out, losing themselves in flat, marshy meadows. Others, however, bravely live on the dry upland, holding their gray-green leaves like defiant banners.

And where there are plants there are also animals. There is a special variety of the bighorn or mountain sheep that is found only in Death Valley and on its bordering mountain ranges. Threatened with extinction a few years ago, these animals are now given the benefit of an absolute closed season and are staging a hopeful come-back. There is an astonishing development of rodent life, including two most interesting fellows, the trade-rat or pack-rat and the long-legged, leaping kangaroo rat.

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