



XXV. On the inflammation of gunpowder by electricity

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deferred till the return of summer shall afford me an opportunity of continuing them.

From the results which have been stated, I am induced to believe that the more refrangible rays of the solar spectrum have a magnetic influence even in this country.

XXV. *On the Inflammation of Gunpowder by Electricity.*
By Mr. THOMAS HOWLDY.

To the Editor of the Philosophical Magazine and Journal.

Sir,

THROUGH the medium of your very useful Magazine and Journal, your ingenious correspondent Mr. Sturgeon has communicated to the public, some observations and experiments concerning the ignition of gunpowder by the charge of a Leyden jar. But as Mr. Sturgeon's method of performing the experiment is not so certain in its effect, nor more simple than Cavallo's, and as a better than Cavallo's* does not seem to have been yet made public, you will, perhaps, sir, favour me by communicating to the cultivators of electrical science, a method which I contrived more than twelve years ago, of inflaming with ease and certainty, either loose or confined gunpowder by electricity; especially as it saves the experimenter time, labour, and power.

By describing the manner in which the original experiment was conducted, the method will immediately be understood, and may be readily practised by any electrician. A jar, containing about 160 square inches of (interior) coated surface, was placed at the prime conductor, and the points of the wires of the universal discharger were set upon the table of that instrument, at the distance of one inch and a quarter from each other. A chain, which was laid upon the bare surface of the table supporting the machine and apparatus, had one of its extremities placed at the distance of four inches from the bottom or outside of the jar; while its other extremity was annexed to the negative end of the universal discharger. By this arrangement, two interruptions were made in the electrical circuit; the first or that between the points of the

* See his *Elements of Natural or Experimental Philosophy*, vol. iii. page 411. It may be here stated, likewise, that both Mr. Tatum and Mr. Lewthwaite, in their lectures on electricity delivered at the London Mechanics' Institution, had recourse to Cavallo's "water tube," as it is called by the reporter of the lectures, in order to effect the experiment in question. See the *London Mechanics' Register*, vol. i. p. 84, and vol. ii. p. 36.

wires

wires was, as usual, intended to receive the substance which was to be subjected to the action of the charge; and the second, or that between the end of the chain and the outside of the jar, was intended to diminish the intensity of the charge, so as to *prevent the electrical explosion* from occurring in the first interruption. A little heap of gunpowder was then laid at the point of each wire, so as to surround and cover it; a small train of the same being laid to connect the heaps.

A moderate charge was then transmitted through the circuit, and the gunpowder was instantly inflamed by its transmission.

Having repeated the experiment several times, the distances in the interruptions being the same, the desired effect was always produced with the same intensity of the charge; and in pursuing the subject further, it was likewise found that the experiment succeeded when the distances were varied within certain limits, unless the intensity of the charge was considerably too great or too small. When the charge, in a few instances, was too intense, on its transmission a spark was seen darting between the two points, which disturbed, in a small degree, some of the gunpowder, without inflaming it; but when, in the subsequent experiment, the charge was less intense, its transmission caused the immediate inflammation of the gunpowder. Hitherto the gunpowder had been invariably disposed of in the interruption, as described in the original experiment; but I now wished to ascertain whether it would be inflamed when placed in a *single heap in any part* of the interruption, every other part being free from it. On trial it was discovered that whether the gunpowder was placed in a heap at either the positive or negative wire, or in the middle of the interruption, or in any other part of it, the passage of the charge, through the interruption, always inflamed it, though in each instance the rest of the interruption was entirely free from gunpowder.

During the performance of the preceding and many other experiments of the kind, which it is unnecessary to detail, it was observed on several occasions, that only a small portion of the charge was transmitted through the circuit, and consequently that a considerable portion of it remained in the jar; and yet the gunpowder in such cases was always inflamed. This circumstance led me to infer that the charge of a smaller jar might be successfully employed for the experiment. In consequence of which a jar whose coated surface measured half a square foot was placed at the conductor, and the transmission of its charge inflamed the gunpowder as readily as
that

that of the larger jar, the whole circuit being thirty-one feet nine inches. A similar effect was produced by the charge of a phial containing forty-seven square inches of coating, the extent of the circuit remaining the same as in the above experiment. A phial containing only twenty-eight square inches of coating was next employed, and its charge when transmitted, produced the immediate inflammation of the gunpowder, the whole circuit being seven feet nine inches. This is the smallest phial in my possession, but there is no doubt that the experiment might be effected, by this method, with the charge of a phial still smaller.

After practising for several years the above simple and efficacious method of performing an experiment which has so much embarrassed electricians, another method was suggested by considering the following well-known fact; namely, that a very imperfect conductor of the electric fluid, if it has a *sharp point* and is not too extended, will convey the electricity from the prime conductor, or even from the ball of a charged jar, when presented to either of them, almost as rapidly as a metallic point. It was therefore concluded that if a sharp-pointed piece of wood was substituted for one of the pointed wires, it would convey a portion of the charge adequate to produce the intended effect. Accordingly, a small piece of very dry wood was taken, about three inches long, and a part of it was formed into a very tapering point. This was attached to the negative wire of the universal discharger, in such a manner that the wooden point projected beyond the end of the metallic point one inch and a half. The wooden point and the metallic point of the *positive wire* were then placed at the distance of half an inch from each other, and some gunpowder was laid in the interval between them. The extremity of the chain, instead of being placed so as to make a second interruption, as in the former method, was now put *in contact* with the outside of the jar. A pretty strong charge was then communicated to the jar; and as soon as the ball of the discharging rod touched that of the jar, the gunpowder was inflamed, and *nearly* at the same instant the residue of the charge passed through the flame of the gunpowder with a *smart explosion*. This unexpected and curious phenomenon very much surprised me; and the experiment was repeated several times, in order to ascertain the certainty of the fact; and with a view to render it more evident, the points were placed further from each other, and by carefully noticing and adjusting the intensity of the charge to the distance between the points, the inflammation of the gunpowder, when the *first portion* of the charge was transmitted, was seen to take place

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a perceptible time before the explosion of the residual charge was heard.

As the electric explosions in these experiments do not occur till the gunpowder is in a state of combustion, it appears evident that either the product of the combustion, or the rarefaction of the air by it, is the cause of this interesting phenomenon. For the conducting power of the interval is so augmented, as to enable a *portion* of the charge having a lower intensity, to pass with explosion over a distance which the *whole charge*, having even a higher intensity, was incapable of passing over, in the same time either with or without explosion. This mode of inflaming gunpowder is related principally on account of the interesting fact which was discovered in thus conducting the experiment; for it does not possess the facility of the former, because it requires a nicer adjustment of the distance forming the interruption with respect to the intensity of the charge; and the wooden point is generally so much burned after two or three experiments have been made with it, as to be rendered useless; but as different ways of producing the same effect are sometimes desirable and pleasing as well as instructive, it may be recommended to the student in electricity who wishes to become well acquainted with the varieties of electrical action.

The latest experiments which I have made to ascertain any fact relative to the inflammation of gunpowder by electricity, were made during the severe frost which occurred here last winter. Previous to leaving the room in which the machine and apparatus are kept and employed, one night during the frost a saucer was placed upon the window-sill, and filled with pure water, which was there left to be frozen. On the following morning before any fire was lighted in the apartment, the saucer, then containing a very hard mass of ice, was put in the electrical circuit, and the interruption in which the gunpowder was placed, was made upon the surface of the ice. And when the charge of the *small phial* before described was transmitted through the circuit, the gunpowder was immediately inflamed. The experiment was repeated, under similar circumstances, the next morning, and the same effect ensued. A small Fahrenheit's thermometer denoted the temperature of the room, when these experiments were made, to be 30°.

Mr. Sturgeon supposes that the velocity with which the electric fluid moves, when the discharge passes through the circuit with explosion, is the cause of the non-ignition of the gunpowder placed in the circuit.

"Hence," says he, "my first object now was to devise some means of retarding the velocity of the electric fluid; for

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I considered that if this could be accomplished, *more time* would be afforded for the fluid and gunpowder *to be in contact*, and the latter, in consequence, more likely to be ignited." But this is not the case; the electric fluid does not come at all into contact with the gunpowder when it is not ignited by the explosive discharge. For this substance is a non-conductor of electricity, and the scattering and dispersing of it is not caused by any direct impetus or action of the electric fluid itself on the gunpowder, but by the rapid expansion and displacement of the air, which is driven in every direction with considerable force by the electric fluid from the point whence it explodes. This is, I believe, the true solution of the difficulty which has been so long experienced of inflaming loose or slightly confined gunpowder by the explosive discharge; and it is confirmed by the circumstance, that if a portion of any quantity of gunpowder be bruised and mixed with the rest, and the whole be well and closely confined so as to exclude the air as much as possible, an explosive charge of moderate strength on its transmission through the circuit will be found to inflame the gunpowder.

I have pleasure in perceiving that Mr. Sturgeon has realized an experiment which I had long contemplated, but had not time and opportunity to execute,—the discharge of guns by electricity; and I hope he will be successful in his attempt to render the decomposition of water by the same agent more easily practicable. I am, sir,

Your obliged servant,

Hereford, Aug. 7, 1826.

THOMAS HOWLDY.

XXV. *Atmospheric Refraction at very low Temperatures and Altitudes.* By J. Ivory, Esq. A.M. F.R.S.*

THE 42nd Number of the Quarterly Journal of Science, published in July last, contains a great number of refractions observed at small altitudes and very low temperatures. Such observations are of great value, and throw considerable light upon some important questions relating to the tables in the hands of astronomers. We may inquire; 1st, Whether any table hitherto published represents the refractions within 2° or $1^{\circ}\frac{1}{2}$ of the horizon with tolerable regularity and certainty. 2dly, Whether the tables, which, at altitudes above 2° or $1^{\circ}\frac{1}{2}$, are known to approach near the truth at the usual temperatures, continue to preserve the same degree of accuracy,

* Communicated by the Author.