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Mois, a people who inhabit the mountains to the weſt, and who often make incurſions into their territories, the Cochineſe general marched with an army towards the mountains; but as he was not able to get at the enemy, on account of their inacceſſible ſituation, he ordered two priſoners he had taken to be put to death, and their fleſh to be devoured by his ſoldiers.

In the year 1777, being on board an Engliſh ſhip of war in Turon harbour, in order to return from Cochin-china to Europe, a party arrived there who had joined a powerful rebel named *Nbae*. This leader and his party had taken ſome of the king's confidential friends, and one in particular who had formerly done him a great deal of injury. The latter they put to death; and in order to gratify their revenge, they tore out his liver and ate it. The Cochin-chineſe, in general, when violently incenſed againſt any one, are accuſtomed to expreſs a wiſh that they may be able to devour his liver or his fleſh.

IX. *Deſcription of an improved Diſcharging Electrometer. Read before the Royal Society of Copenhagen. By* A. W. VON HAUCH, *Marſhal of the Court, &c. to his Daniſh Majeſty* *.

NO branch of natural philoſophy can boaſt of having attracted ſo much attention as the doctrine of electricity; and indeed there are few which ſeem more worthy of inveſtigation. When we conſider the diſtinguiſhed part which electricity apparently performs in the grand operations of nature; the aſtoniſhing, and, on the firſt view, ſo inexplicable effects produced by this power of nature ſo different from thoſe of any other, and its ſecret and concealed mode of action, which the moſt acute obſervers have not hitherto been able to penetrate, it will not ſeem ſurpriſing that both the

* From the *Tranſactions of the Royal Society of Copenhagen.*

the learned and the unlearned ſhould, with unabated zeal, have employed their attention on this phenomenon, as important to ſpeculative philoſophy as it is by its influence in ſociety. Without this inceſſant attention our knowledge would not have made ſuch rapid progreſs as it has done in the laſt forty years; and there might have been little difference between Otto von Guerick's balls of ſulphur, or Hauſen's glaſs globes, which were ſeventy years later, and the electric machine now in the Teylerian Muſeum at Haerlem. The former were ſcarcely ſufficient to attract the lighteſt bodies, whereas the latter approaches near to nature in its ſtrength, in its awful and wonderful effects; and ſeems to favour the poſſibility of the idea, that there are natural powers capable of impelling heavy bodies with prodigious force; and which, conducted by the hand of man, may, ſome centuries hence, baniſh the uſe of gunpowder, as the latter, a few centuries ago, baniſhed bows and arrows.

Franklin conveyed electricity from the atmoſphere, loaded a battery with it, and directed its mighty power with the ſame eaſe as that weak power excited by an electric machine. On account of the above-mentioned poſſibility of exhibiting the electric power in a certain degree and of a certain ſtrength, it was found more and more neceſſary to have inſtruments proper for aſcertaining theſe, and by which it might be determined with preciſion when and how a required effect could be produced.

Though theſe inſtruments have undergone many variations and improvements, and though there is an eſſential difference between Stephen Gray's or Du Fay's threads and the electrometers of Achard and Brooks *, they are all to be conſidered rather as announcers of electricity than as accurate gauges or meaſures, as they are all incapable of ſhewing its intenſity. Another inſtrument, hitherto equally imper-

* A deſcription of theſe Electrometers may be ſeen in Adams's and Cavallo's Treatiſes of Electricity, and in other works of the like kind. Edit.

fect,

ect, though no less important in electric experiments, is a discharging electrometer; for, as it is believed that the laws of electricity can be defined with mathematical certainty *, it must be of importance to be able to employ, with the same certainty, the electric power which has been excited; and every instrument tending to promote this object, though still imperfect, must be of some utility, and be not unacceptable to those fond of electrical experiments. All the discharging electrometers hitherto known, perform their effect either by spontaneously discharging, as that of Lane, or as Henley's general discharger, &c. and in this case are affected by the greater or less conducting property of the air, which must necessarily be changed on each change of the atmosphere, and therefore must render the instrument very imperfect and incorrect; or the effect is produced by introducing a conducting body between two electric atmospheres, and by these means uniting them. But as this must depend on the greater or less dexterity of the person who performs the experiment to determine the proper moment for discharging, and as another electrometer is at the same time necessary, this method of discharging is as uncertain as the first.

I have endeavoured, therefore, to construct an instrument to supply this deficiency; and I hope it will not be found unworthy of attention. It is an electrometer which, though founded on the same principles as that of Brooks, that is, on comparing the effect of the repulsive power of electricity between two bodies of a given size with the known weight requisite to produce that effect, has, in my opinion, some improvements which are wanting in the other; for the state of the barometer has no influence upon this electrometer, as it has on that of Brooks; nor does friction, which is far from being unimportant, here take place. But as this in-

* See Lord Stanhope's *Principles of Electricity*, 3d, 4th, and 5th parts; and Coulomb's description of an instrument by which it is proved that the effect of the electric matter is in the inverse ratio of the square of the distance.

strument

ſtrument is intended to be uſed as a diſcharging electrometer, and muſt be examined as ſuch, no compariſon can properly be made between it and any of the other electrometers hitherto employed.

Plate VI contains a repreſentation of the electrometer, and the different parts of which it conſiſts. OP is a board of dry mahogany, twelve inches in length and four in breadth, which ſerves as a ſtand for the inſtrument. In this board are faſtened two maſſy glaſs pillars, M and N, which ſupport the two braſs capes or rings GG, with the two forks of tempered ſteel KK ſcrewed into them. The two rings GG are well covered with varniſh.

In the ring G is faſtened a braſs rod, which terminates in a ball E of the ſame metal, and an inch in diameter. The length of the rod and ball together is four inches and a half.

A very delicate beam, AB, the arms of which are of unequal length, moves on a ſharp triangular axis (a knife edge) of well tempered ſteel on the fork K of the pillar M. It is ſeventeen inches in length, and ſo conſtructed that the ſhort arm forms a third and the long one two-thirds of the whole beam. The ſhort arm of braſs furniſhed with the ball B, exactly of the ſame ſize as the ball E, is divided into forty-five parts equivalent to grains. The long arm A is of glaſs covered with copal varniſh, and ends in an ivory ball A, into which is fitted an ivory hook R, deſtined to ſupport the ivory ſcale H. In order to render the inſulation more complete, this ſcale is ſuſpended by three hairs.

A very delicate beam, CD, eleven inches in length, moves on an axis, like the former, on the pillar N, though not here ſhewn. This beam is proportioned in the ſame manner, one arm being a third and the other two-thirds of the whole length. The long arm of braſs is furniſhed at the end with a ball D, and divided into thirty parts correſponding to grains. The ſhort arm of glaſs terminates in a long roundiſh plate C, covered with copal varniſh. The ſteel forks are ſhewn by the ſections of the two braſs caps FF, as are alſo the two knife edges LL. By theſe caps the eſcape of the electric matter is partly prevented.

A braſs ring Q, capable of being moved along the ſhort arm of the upper beam AB, ſhews, by means of marks determined by trial and cut out on the beam, the number of grains which muſt be placed in the ſmall ſcale to reſtore the equilibrium of the beam at each diſtance of the ring Q from the point of ſuſpenſion.

On the long arm CD of the lower beam there is alſo a moveable ring S, which, like the ring Q, ſhews in grains, by its diſtance from the point of ſuſpenſion, the power requiſite to overcome the preponderance of LD in regard to LC.

The power neceſſary for this purpoſe will be found if the ſhell H, which weighs exactly fourteen grains, be ſuffered to ſink down on the glaſs plate C, and the ring S be puſhed forwards till both the arms of the beam are in equilibrium. The part of the beam on which the ring S has moved is divided into fourteen parts, ſo that *o* marks the place where the ring S muſt ſtand when the beam, in its free ſtate, is in equilibrium; and 14 ſtands at the place where the ring S again reſtores a perfect equilibrium when the ſhell H is laid on the glaſs plate C. Each of theſe parts, which are divided into quarters, indicates a grain. The lower diviſions of the ſcale will be found with more accuracy if quarters of a grain be put, in ſucceſſion, into the ſhell H (after it has been laid on the plate C), and the ring S be moved between each quarter of a grain until the perfect equilibrium be reſtored. This place on the beam is then to be marked, and you may continue in this manner until the 30th part of a grain be given. Both ſcales, for the ſake of diſtinctneſs, are divided only ſo low as quarters of a grain; though the inſtrument is ſo delicate, and muſt abſolutely be ſo, that 1-20th of a grain is ſufficient to deſtroy the equilibrium.

The two glaſs pillars M and N, together with the ſteel forks

forks affixed to them, are so fitted into the stand that both the beams lie parallel to each other as well as to the rod GE. In this position of the beams AB, the balls B and E are just in contact. The smallest glass pillar N is of such a height that the ball of the beam CD stands at the distance of exactly four lines from the ring G, and cannot move without touching the latter. The small shell H is suspended in such a manner that there is a distance of exactly two lines between it and the shell C. In each of the brass rings GG is a small hole, that the instrument may be connected with the two sides of an electric jar. I is a brass wire, with a hollow bit of ivory *a* destined to support the beam CD, which is necessarily preponderant at D, in order to prevent oscillation between the discharges to be examined by the instrument.

It may be readily comprehended that, when the beam AB has moved, A must pass over twice the space that B does; and that, in the beam CD, the case is the same in regard to C and D. If AB therefore be connected with the external side, and CD with the internal side of a battery, but in such a manner that the instrument is at a sufficient distance beyond the electric atmosphere; and if the battery be charged, the repulsive effect of the electric power will oblige the ball B to separate from the ball E; the shell H must therefore naturally sink down with double velocity, so that when the ball B rises a line, the shell H must sink two: when it reaches this depth it will touch the shell C, and the latter, by the power excited in it, will be obliged to sink, by which D must naturally again ascend in a double proportion to the sinking of C; so that when C has fallen two lines, D must have ascended four, and D that moment touches the ring by which the two sides of the battery are connected with each other, and discharges the battery.

But, as the attractive electric power between unlike atmospheres, under like circumstances, is at least as strong as its repulsive power between like atmospheres, it would thence follow that the electric power, instead of repelling the ball B from

from the ball E would rather attract D, and, by its contact with G, promote the difcharging; by which the inftrument would fail of its object, and be fubjected to the temperature of the atmofphere like all other electrometers; and befides this, the electric power could no longer be determined by weight. To obviate this inconvenience, the inftrument, in all electrical experiments, muft be applied in fuch a manner that the power with which the ball D is attracted by AB may exceed in ftrength the power required to repel the ball B from the ball E. For this purpofe the ring S muft always be removed two divifions farther on CD, towards D, than the ring Q is fhifted on AB towards B. If, for example, an electric force were required equal to eight grains, according to this electrometer, the ring Q muft be removed to the place where 8 ftands, and the ring S to the place marked 10. The repulfive power will then naturally repel the balls B and E before G is in a condition to attract the ball D, as a power of two grains would be neceffary for this purpofe, befides that of the eight already in action. The fhell H, with its weight of fourteen grains, will eafily overcome the preponderance of LD over LC, as it amounts only to ten grains, and therefore nothing exifts that can impede the difcharging.

When the ring S, according to the required power, is removed fo far towards D that the fhell H is not able by its weight to deftroy the preponderance of LD in regard to LC, the active power of the fhell H muft be fo far increafed by the addition of weights that it can act, with a preponderance of four grains, on the plate C. If, for example, an electric power of fourteen grains be required, the ring S muft be removed to 16, by which LD refts upon *a*, with a preponderance of fixteen grains in regard to LC. Now to make H act on the plate C with a preponderance of four grains, it muft be increafed to twenty grains, that is, fix grains weight more muft be added, as it weighs only fourteen; which fix grains are again laid upon LB; and therefore the ring Q is fhifted to 20, as the

 ftrength

ſtrength of the repulſive power is pointed out by fourteen grains.

If an electric power of twenty-five grains be required, the ring S muſt be removed to 27, and the weight of ſeventeen grains be put into the ſhell H in order to produce a preponderance of four grains in regard to S. Theſe ſeventeen grains are added to the required power of twenty-five grains, and the ring Q is puſhed to 42, &c. In this manner the repulſive power always acts before the attractive power can.

It may be readily perceived that the faults and inconveniences common to all the electrometers hitherto employed, and which have been already mentioned, cannot take place here; becauſe the diſcharging is performed by immediate connection between the poſitive and negative electricity in the inſtrument itſelf, without any external means being employed.

One of the moſt eſſential advantages of this inſtrument is, the certainty with which the ſame reſult may be expected when the experiment is repeated. For the ſame degree of electric power, whatever be the temperature of the atmoſphere, will always be neceſſary to commence the ſeparation of the two balls B and E from each other, the quantity of coated glaſs and the diſtance of the ring Q from the axis L being the ſame.

Another no leſs important advantage of this inſtrument is, that in an experiment where the ſame electric power, often repeated, is neceſſary to aſcertain the reſult with accuracy; ſuch, for example, as the charging a battery through acids, water, &c.; the ſame degree of precaution is not neceſſary as is indiſpenſibly ſo in any other electrometer, as the perſon who puts the machine in motion has nothing to do but to count how often the electrometer diſcharges itſelf; and the inſtrument may be incloſed in a glaſs caſe, or prevented in any other manner from external contact, or any other circumſtances which might render the experiment uncertain.

I flatter

I flatter myfelf that the fimplicity of the conftruction of this inftrument, the facility with which it may be made at a very fmall expence, and the certainty that two inftruments, prepared according to the fame fcale, with a like quantity of coated glafs, muft exactly correfpond with each other; but, above all, that the certainty and accuracy by which experiments may be made with it, and by thefe means be accurately defcribed, are advantages which will not be found united in any of the electrometers hitherto invented.

X. *Obfervations on the Tones produced by an Organ-pipe in different Kinds of Gas.* By C. F. F. Chladni *.

Air, it is well known, is the moft common conductor of found; but it can become a fonorous body alfo. The latter is the cafe in regard to a pipe, as the pipe itfelf does not emit found, but the column of air included in it, and which, being feparated from the reft of the atmofphere, is obliged, by blowing, to vibrate in fuch a manner that it contracts and expands longitudinally in various ways; and thefe vibrations are then conducted to a diftance by the furrounding air. It is not neceffary that I fhould here farther explain the different kinds of vibration of which the air in a pipe is fufceptible. Thofe who are defirous of information on this fubject may confult Daniel Bernoulli's papers in the Memoirs of the Academy of Paris for 1762; thofe of Lambert, in the Memoirs of the Academy of Berlin for 1775; and of Euler, in the Sixteenth Volume of the New Tranfactions of the Imperial Academy of Peterfburgh.

The conducting of found through the air, and the vibrations of air in a pipe, depend on the fame laws. This will readily appear from the following obfervation, befides others, that the velocity of the vibrations, under like circumftances,

* From *Voigt's Magazin für den neueften zuftand der Naturkunde*, Vol. I. part 3.