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THE VACUUM AN ABSOLUTE NON-CONDUCTOR OF ELECTRICITY.

The passage of electricity through rarefied air constitutes a well known experiment in the lecture room of physical science. The oldest style of performing it is to attach, by means of a stopcock connection, a long glass tube to the air pump, each end of the tube being provided with brass caps. The electricity may be made to flow through its interior as soon as the exhaustion of the air has proceeded to a certain extent; then a most beautiful exhibition is produced in the dark, resembling the aurora borealis; hence such a tube is called an aurora tube, and the aurora borealis has been ascribed to a discharge of electricity from the polar regions to the equator, through the stratum of rarefied air above the clouds. Another form of this experiment is the so-called electric egg, which differs from the preceding in nothing but that, in place of a long tube, an egg-shaped glass globe is employed, into which brass knobs or points project from both ends.

Lately this same experiment has been modified, so that the vessel filled with rarefied air is always ready for the experiment. Gassiot and Geissler first conceived the idea of manufacturing small and large glass tubes, melting pieces of platinum wire into their extremities, so as to introduce the electric current, exhausting the air in them to the proper degree, and then sealing them hermetically.

As it had been found that rarefied gases of different natures produce different colors of light in the dark when the electric current was passed through them, and later that different kinds of glass and liquids, when illuminated in this way, produced a great variety of effects (due to fluorescence), a very extensive assortment of these tubes was soon in the market; and they may now be bought, under the name of Geissler tubes, from the dealers of philosophical instruments in our large cities, at different prices, varying according to their size and the elaboration of their construction.

Experiments prove that electricity is retained on the surface of bodies by the presence of the atmosphere, which is an isolating substance; and that when its pressure decreases, the escape of electricity becomes easier; while, in a good vacuum, the resistance to escape becomes zero, and the electricity flows off and cannot be retained at all. This has for a long time been the accepted theory, and is still taught in most text books on physics, and is believed in by most electricians; but that it is an error was proved by Bécquérél, Hawksbee, Gray, and Snow Harris, as they showed that even the weakest electric discharges could be retained in vacuo. Bécquérél even went so far as to show that the charge was retained for fifteen days, provided that the vacuum was so perfect as to be equal to a mercurial pressure of one millimeter (the twenty-fifth part of an inch); and he concluded that, in a perfect vacuum, the body would retain the charge forever: in other words, that electricity could not be transmitted through an absolute vacuum.

Du Moncel, in his lately published French work on the Ruhmkorff coil, gives an account of his experiments in passing a powerful electric current through a tube in which the air was being more and more rarefied, and states that, when the vacuum was made very nearly perfect by the continued operation of a good air pump, the passage of electricity through the tube continually diminished; so that at last, when the pressure had decreased to less than a half millimeter (one fiftieth of an inch), the light had almost disappeared, while tests proved that very little electricity passed; when, however, a little air was gradually admitted into the tube, the electric current was re-established, and the light appeared again.

Gassiot was the first who attempted to make an absolute vacuum, deprived of all traces of air or gas. He first made a barometer of the easily fusible alloy made of lead, tin, bismuth, and cadmium, which melts below 150° Fah., contains no mercury, and which would not contaminate the vacuum with mercurial vapors. He did not, however, succeed in this way, as the vacuum thus made always contained traces of air or gas. He tried then another method; he filled the vacuum with pure carbonic acid gas; and after exhausting by the air pump, he left the remnant to be absorbed by caustic potassa, which, by its well known great affinity for this gas, removed the last traces. He produced in this way a vacuum much more perfect than any one ever did before; while his manner of procedure allowed the experiment to be extended over several days, and even weeks. When the vacuum had been made with the air pump on carbonic acid, an electric discharge, which, in the air, would not pass over a distance of half an inch, traversed twenty inches with the greatest ease. In proportion as the vacuum became more perfect by the absorption of the carbonic acid, the discharge tended to fill the tube with a more and more pale luminous vapor. The vacuum becoming more perfect in the course of several days, the luminosity became confined to the sides, where the platinum wires, which conducted the electricity, entered into the vacuum; and a certain space, half way, became dark, and this darkness extended itself, so that, in a tube of twenty inches length, it occupied nearly ten inches. When a galvanometer was placed in the circuit, it indicated that there was no longer a constant discharge as before, but occasionally alternate discharges: when also the tube showed light flashes, and the so-called stratification of the light. When at last the absorption went on, and formed a perfect vacuum, perfect darkness was obtained in the tube, and no trace of light showed itself, even with strong electric charges, while neither the galvanometer nor an ordinary vacuum tube, when introduced into the circuit, would manifest a trace of any current, notwithstanding that this other ordinary vacuum tube showed luminosity with feeble currents. From all this, it is therefore evident that it is practically demonstrated that the absolute vacuum is not only a non-conductor, but that it is absolutely impenetrable by electric discharges.

De la Rive studied the phenomena observed. As soon as, during the attempts to pass the electric current, a small amount of gas is introduced, corresponding with a mercurial pressure of $\frac{1}{4}$ millimeter ($\frac{1}{100}$ inch), he found that the phenomena vary, according as the gas is admitted near the positive or the negative side; and he gives a very detailed description of the so-called stratification, the succession of colors, the rose-colored mist, etc., phenomena which are always repeated under the similar circumstances, depending, of course, upon certain laws governing the relation between the electric and luminous vibrations.

The writer of this article possesses a strong glass tube in which, after the method of Gassiot, the vacuum has been produced by the absorption of carbonic acid. The ends of the platinum wire intended to introduce the electric current are only one quarter inch distant from each other. But notwithstanding this short space, the strongest possible charge cannot be made to traverse this distance of vacuum, while the same charge will pass through a distance of six inches in common air, and of as many feet through a glass tube in which the air is rarefied. In the Stevens Institute, Hoboken, the experiment with a similar tube can be shown to any visitor, and excites the surprise of many who still persist in the faith in an electric fluid, notwithstanding they have abandoned the doctrine of a caloric fluid, being advanced enough in their ideas to be satisfied that heat is a mere mode of motion of ponderable matter.

Now the fact is that the whole science of thermotics cannot produce a single experiment upsetting the old doctrine of a caloric fluid, so conclusive as the experiment above described. Nobody has ever succeeded in producing an empty space or vacuum through which heat could not pass; but having done so for electricity, it proves conclusively that this subtle agent cannot be of the nature of a fluid, as a fluid would not be arrested by a vacuum. It proves that electricity must be a mode of motion (wave vibration or molecular rotation) of ponderable matter, which cannot be propagated except by such matter, and will be as effectively arrested in its propulsion, when ponderable matter is absent, in the same way as is the case with the sound waves when the medium by which they can be transmitted is wanting.

DON'T KISS THE BABY!

The promiscuous kissing of children is a pestilent practice. We use the word advisedly, and it is mild for the occasion. Murderous would be the proper word, did the kissers know the mischief they do. Yes, madam, *murderous*; and we are speaking to you. Do you remember calling on your dear friend Mrs. Brown the other day, with a strip of flannel round your neck? And when little Flora came dancing into the room, didn't you pounce upon her demonstratively, call her a precious little pet, and kiss her? Then you serenely

proceeded to describe the dreadful sore throat that kept you from prayer meeting the night before. You had no designs on the dear child's life, we know; nevertheless you killed her! Killed her as surely as if you had fed her with strychnin or arsenic. Your caresses were fatal.

Two or three days after, the little pet began to complain of a sore throat too. The symptoms grew rapidly alarming; and when the doctor came, the single word *diphtheria* sufficed to explain them all. To-day a little mound in Greenwood is the sole memento of your visit.

Of course the mother does not suspect, and would not dare to suspect, you of any instrumentality in her bereavement. She charges it to a mysterious Providence. The doctor says nothing to disturb the delusion; that would be impolitic, if not cruel: but to an outsider he is free to say that the child's death was due directly to your infernal stupidity. Those are precisely his words: more forcible than elegant, it is true; but who shall say, under the circumstances, that they are not justifiable? Remember

"Evil is wrought by want of thought
As well as by want of heart."

It would be hard to tell how much of the prevalent sickness and mortality from diphtheria is due to such want of thought. As a rule, adults have the disease in so mild a form that they mistake it for a simple cold; and as a cold is not contagious, they think nothing of exposing others to their breath or to the greater danger of labial contact. Taking into consideration the well established fact that diphtheria is usually if not always communicated by the direct transplanting of the malignant vegetation which causes the disease, the fact that there can be no more certain means of bringing the contagion to its favorite soil than the act of kissing, and the further fact that the custom of kissing children on all occasions is all but universal, it is not surprising that, when the disease is once imported into a community, it is very likely to become epidemic.

It would be absurd to charge the spread of diphtheria entirely to the practice of child-kissing. There are other modes of propagation, though it is hard to conceive of any more directly suited to the spread of the infection or more general in its operation. It stands to diphtheria about the same relation that promiscuous hand-shaking formerly did to the itch.

It were better to avoid the practice. The children will not suffer if they go unvisited; and their friends ought for their sake to forego the luxury for a season. A single kiss has been known to infect a family; and the most careful may be in condition to communicate the disease without knowing it. Beware, then, of playing Judas, and let the babies alone.

POSTAL DETECTIVE SERVICE.

It is rather more the custom to abuse the officials of the post office, for losses, irregularities, and other difficulties happening in the mails, than to give them credit for their skill in the detection of crime and recovery of missing property. We hasten, therefore, to put on record a recent instance of a prolonged search for lost money in which we have been directly interested, and which has resulted in a remarkable and praiseworthy success on the part of the post office detectives. On the first of May last, a correspondent in a village in Louisiana mailed a registered letter to this office, and enclosed therein the sum of sixteen dollars. The missive failed to reach us, and we notified both our correspondent and the post office authorities. The latter placed the case in the hands of special agents, and for the past seven months the detective officials have been actively at work tracing the lost missive. We, and doubtless the sender of the money, had given up hope of its recovery, and hence our astonishment was all the greater at the reception, a few days ago, of a terse communication, signed L. M. Terrell, Superintendent Railway Mail Service, Fourth Division, and dated from Chattanooga, Tenn., citing the above facts, and stating that the writer had arrested the guilty party, and recovered the funds, which we found enclosed. When the immense number of letters which pass through the mails is considered, this regaining of a single missive, the abstraction of which had probably been carefully concealed, exhibits a brilliant piece of detective ability, which redounds highly to the credit of our postal service.

TEMPERATURE OF IGNITION OF CHARCOAL.

Some months ago, as our readers will remember, an interesting discussion arose in our columns in reference to the possibility of igniting charcoal or over-seasoned wood, by the heat radiated from steam pipes. A well known engineer stated that he had collected conclusive evidence, proving the possibility of fires occurring in consequence of the ignition of wooden beams by contact with steam pipes, in cases where the wood had lain for a long time in contact with the pipe, and had thus been submitted to a process of charring at a very low temperature. We stated at the time that we were not convinced of the possibility of such action by any evidence which had then been given, and asked for more proof.

It is a well known fact that the lower the temperature at which charring occurs, the lower the temperature of ignition. The question is, however, whether the temperature of charring can ever become so low as to cause the temperature of ignition to become equally low, or nearly as low. In such cases as were above referred to, it was supposed that the wood lay in contact with the steam pipe for months, or even years, and that finally the wood, having become thoroughly charred, actually took fire at steam heat.

We have some evidence which has just been received, which may assist in settling the question, and in setting at rest the apprehensions of the authorities of our insurance companies, who are now acting upon the assumption that the possibility of this source of fire is so well supported by evi-