PROCEEDINGS

OF

THE ROYAL SOCIETY.

1838. No. 32.

February 15, 1838.

DAVIES GILBERT, Esq., Vice-President, in the Chair.

A paper was in part read, entitled "Experimental Researches in Electricity," Twelfth Series, by Michael Faraday, Esq., D.C.L., F.R.S., &c.

February 22, 1838.

FRANCIS BAILY, Esq., V.P. and Treas., in the Chair.

William Thomas Denison, Esq., R.E., and Joseph Locke, Esq., were elected Fellows of the Society.

The reading of a paper, entitled, "Experimental Researches in Electricity," Twelfth Series, by M. Faraday, Esq., D.C.L., F.R.S., was resumed.

March 1, 1838.

The Right Honourable the EARL of BURLINGTON, Vice-President, in the Chair.

Alexander Wilson, Esq., was elected a Fellow of the Society.

The reading of a paper, entitled "Experimental Researches in Electricity," Twelfth Series, by Michael Faraday, Esq., D.C.L., F.R.S., &c., was resumed and concluded.

Experimental Researches in Electricity: Twelfth Series. By Michael Faraday, Esq., D.C.L., F.R.S., Fullerian Professor of Physiology in the Royal Institution of Great Britain.

The object of the present series of researches is to examine how far the principal general facts in electricity are explicable on the theory adopted by the author, and detailed in his last memoir, relative to the nature of inductive action. The operation of a body charged with electricity, of either the positive or negative kind, on other bodies in its vicinity, as long as it retains the whole of its charge, may be regarded as *simple induction*, in contradistinction to the effects which follow the destruction of this statical equilibrium, and imply a transit of the electrical forces from the charged body to

those at a distance, and which comprehend the phenomena of the *electric discharge*. Having considered, in the preceding paper, the process by which the former condition is established, and which consists in the successive polarization of series of contiguous particles of the interposed insulating dielectric; the author here proceeds to trace the process, which, taking place consequently on simple induction, terminates in that sudden, and often violent interchange of electric forces constituting *disruption*, or the electric discharge. He investigates, by the application of his theory, the gradual steps of transition which may be traced between perfect insulation on the one hand, and perfect conduction on the other, derived from the varied degrees of specific electric relations subsisting among the particular substances interposed in the circuit: and from this train of reasoning he deduces the conclusion that *induction* and *conduction* not only depend essentially on the same principles, but that they may be regarded as being of the same nature, and as differing merely in degree.

The fact ascertained by Professor Wheatstone, that electric conduction, even in the most perfect conductors, as the metals, requires for its completion a certain appreciable time, is adduced in corroboration of these views; for any retardation, however small, in the transmission of electric forces can result only from induction; the degree of retardation, and, of course, the time employed, being proportional to the capacity of the particles of the conducting body for retaining a given intensity of inductive charge. The more perfect insulators, as lac, glass and sulphur, are capable of retaining electricity of high intensity; while, on the contrary, the metals and other excellent conductors, possess no power of retention when the intensity of the charge exceeds the lowest degrees. It would appear, however, that gases possess a power of perfect insulation, and that the effects generally referred to their capacity of conduction, are only the results of the carrying power of the charged particles either of the gas, or of minute particles of dust which may be present in them: and they perhaps owe their character of perfect insulators to their peculiar physical state, and to the condition of separation under which their particles are placed. The changes produced by heat on the conducting power of different bodies is not uniform; for in some, as sulphuret of silver and fluoride of lead, it is increased; while in others, as in the metals and the gases, it is diminished by an augmentation of temperature.

One peculiar form of electric discharge is that which attends *electrolyzation*, an effect involving previous induction; which induction has been shown to take place throughout linear series of polarized particles, in perfect accordance with the views entertained by the author of the general theory of inductive action. The peculiar feature of this mode of discharge, however, is in its consisting, not in a mere interchange of electric forces at the adjacent poles of contiguous particles, but in their actual separation into their two constituent particles; those of each kind travelling onwards in contrary directions, and retaining the whole amount of the force they had ac-

quired during the previous polarization. The lines of inductive action which occur in fluid electrolytes are exemplified by employing for that purpose clean rectified oil of turpentine, containing a few minute fibres of very clean dry white silk; for when the voltaic circuit is made by the introduction into the fluid of wires, passing through glass tubes, the particles of silk are seen to gather together from all parts, and to form bands of considerable tenacity, extending between the ends of the wires, and presenting a striking analogy to the arrangement and adhesion of the particles of iron filings between the poles of a horse-shoe magnet.

The fact that water acquires greater power of electrolytic induction by the addition of sulphuric acid, which not being itself decomposed, can act only by giving increased facility of conduction, is adduced as confirming the views of the author.

The phenomena of the disruptive electric discharge are next examined with reference to this theory: the series of inductive actions which invariably precede it are minutely investigated: and reference is made to the accurate results obtained by Mr. Harris, as to the law of relation between the intensity of a charge, and the distance at which a discharge takes place through the air.

The theory of Biot and others, which ascribes the retention of a charge of electricity in an insulated body to the pressure of the surrounding atmosphere, is shown to be inconsistent with various phenomena, which are readily explained by the theory adopted by the author.

The author then enters into an inquiry relative to the specific conducting capacities of different dielectrics.

With a view of determining the degrees of resistance to the transit of electricity excited by different kinds of gases, he constructed an apparatus, in which an electric discharge could be made along either of two separate channels; the one passing through a receiver filled with the gas, which was to be the subject of experiment, and the other having atmospheric air interposed. By varying the length of the passage through the latter, until it was found that the discharge occurred with equal facility through either channel, a measure was afforded of the relative resistances in those two lines of transit, and a determination consequently obtained of the specific insulating power of the gas employed.

The circumstances attending the diversified forms of the disruptive discharge, such as the vivid flash or spark, the brush or pencil of light, and the lucid point or star, which severally represent different conditions of the sudden transit of electrical forces through an intervening dielectric, are minutely investigated in their various modifications. The spark is the discharge, or reduction of the polarized inductive state of many dielectric particles, by the particular action of a few of those particles occupying but a small and limited space, leaving the others to return to their original or normal condition in the inverse order in which they had become polarized: and its path is determined by the superior tension which certain particles have acquired, compared with others, and along which the action is accord-

ingly conducted in preference to other lines of transit. The variety in the appearance of the electric spark taken in different gases may be ascribed partly to different degrees of heat evolved, but chiefly to specific properties of the gas itself with relation to the electric forces. These properties appear also to give occasion to diversities in the form of the pencil or brush, which takes place when the discharge is incomplete, and is repeated at short intervals, according to the shape of the conductor on either side, and according to the species of electricity conveyed. The diverging, converging, bent and ramified lines presented in these different forms of electric discharge, strikingly illustrate the deflexions and curvilinear courses taken by the inductive actions which precede the disruption; these lines being not unlike the magnetic curves in which iron filings arrange themselves when under the action of opposite magnetic polarities.

March 8, 1838.

FRANCIS BAILY, Esq., V.P. and Treas., in the Chair.

Colonel Andrew Leith Hay, K.H., who had at the last Anniversary ceased to be a Fellow from the non-payment of his annual contribution, was at this meeting re-elected by ballot into the Society.

A paper was read, entitled, "Proposal for a new method of determining the Longitude, by an absolute Altitude of the Moon," by John Christian Bowring, Esq. Communicated by John George Children, Esq., F.R.S.

The method employed by the author for determining the longitude by the observation of an absolute altitude of the moon, was proposed, many years ago by Pingré and Lemmonier; and the principal difficulty which stood in the way of its adoption, was its requiring the exact determination of the moon's declination reduced to the place of observation. This difficulty the author professes to have removed by supposing two meridians for which the altitudes are to be calculated: and the only remaining requisite is the accurate determination of the latitude, which presents no great difficulty, either on land or at sea. Examples are given of the practical working of this method; showing that if the latitude of a place of observation be obtained within a few seconds, the longitude will be found by means of a single observation of the altitude of the moon.

A paper was also read, entitled, "An Inquiry into a new Theory of earthy Bases of Vegetable Tissues," by the Rev. J. B. Reade, M.A., F.R.S.

The author, after briefly noticing the results of some of his experiments described in two papers which appeared in the Philosophical Magazine for July and November, 1837, and also those of Mr. Robert Rigg in a paper read to the Royal Society, next adverts to the theory of M. Raspail, detailed in his *Tableau Synoptique*, and *Nouveau Système de Chimie*. In opposition to some of the views enter-