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[FOR THE USE OF MEMBERS.]

Royal Institution of Great Britain.

1851.

WEEKLY EVENING MEETING,

Friday, January 24.

SIR R. I. MURCHISON, Vice-President, in the Chair.

PROFESSOR FARADAY

On the Magnetic Characters and Relations of Oxygen and Nitrogen.

IN a Friday Evening discourse on the diamagnetic condition of flame and gases, delivered on the 14th April, 1848, Mr. Faraday called attention to the singular condition of oxygen gas in its relation to the magnet. It was then demonstrated that this gas was magnetic by its carrying a cloud of muriate of ammonia (itself diamagnetic) to the poles of the magnet, around which it seemed to gyrate in vortices. A more elaborate paper on the same subject had previously appeared in the Phil. Mag. for December, 1847.

Last year M. Becquerel, not aware of these researches, had rediscovered the high magnetic character of oxygen, made some independent investigations, and derived numerical results from them. These inquiries Mr. Faraday does not consider to interfere with, but strongly to confirm his own.

Oxygen is one of the most remarkable of known bodies: it forms one half of the aggregate of all matter. Important as are its magnetic properties, it seems incapable of receiving permanent magnetism like steel or the natural loadstone. — By a series of elementary experiments the audience were led to discriminate between these bodies, and soft iron, nickel, cobalt; which unless while under an extraneous magnetic influence, have no attractive force. Oxygen being of the latter class, it is not certain that, even while it possesses an attractive power, it is in the exact condition of the permanently magnetical body from which it derives it.

Were oxygen highly magnetic in the same extent as iron is, the immense quantity of magnetic power which would in that case be constantly undergoing variation by combustion, respiration, &c., would cause the most serious disturbances in nature. It is necessary to the conservation of the present state of things that the magnetic power in a given bulk of oxygen should be comparatively small. The audience were therefore told to expect no great demonstration of magnetism; but the extent to which that power does exist in oxygen and air, was proved by the following experiments: —

A double cone of iron (the apices of the cones meeting in a point, and the cones being equal and similar,) was fabricated of such a length as to complete the magnetic circuit when placed between the poles of the large electro-magnet in possession of the Royal Institution. Mr. Faraday directed attention to this hourglass-shaped piece, and showed how, by such an arrangement, extreme power is exerted at the place without any chance of change in the form of the parts. Very small soap-bubbles were blown by means of a glass tube drawn to a fine point, from a bladder filled with oxygen. It was observed that these bladders so filled were drawn forcibly inwards to the apices of the cones, but that no such effect followed when bubbles were filled with nitrogen. Another experiment, which was visible all over the room, at once demonstrated the same fact, and illustrated a differential mode of measuring the magnetic force of oxygen. A delicately balanced wire was suspended from its centre of gravity by 10 fibres of the cocoon of the silk-worm; from the extremities of a small cross bar at one end of this wire were hung small glass bubbles; and the whole was so adjusted that the bubbles were on opposite sides of the apices first described, each hanging near to it but not in contact with the iron, and each equidistant from it. Therefore any difference of magnetic influence on the bubbles or their contents would be indicated by the bubble so affected being drawn inwards. In order to render such motion widely visible, the other arm of the balance just described was converted into a long indicating lever, constructed of a straw for the sake of lightness. To the extremity of the longer end a slip of silk was attached to catch the eye, and the lever was shielded from the currents in the room by being placed within a glass balloon two feet in diameter. By the motion of the lever it was seen, when one of the bubbles was filled completely or partially with oxygen and the other with nitrogen, that nitrogen, whether dense or rare, was totally unaffected by the magnet, and that oxygen was magnetic in direct proportion to its density in the bubble; and that the force required to set the bubble of oxygen (one atmosphere) in motion towards the magnet was one-tenth of a grain for one-third of a cubic inch of oxygen.

Certain peculiarities in the exertion of the power which is here in action, not as a central, but as an axial force, were then referred to.

The inference from the experiment, supported by other experiments on bubbles containing air, is — that as oxygen enters into the atmosphere in a constant proportion, and as the magnetic power of oxygen varies directly with its density, definite variation must take place in the magnetic power of the atmosphere in different states.

Mr. Faraday was led to inquire whether any separation of oxygen from nitrogen in a mixture of these gases could take place, as happens when a magnet is presented to a mixture of iron filings and sand. To test this idea he applied to the conical angle (so often described as the centre of magnetic force,) a glass tube drawn to a point (as in the apparatus used for blowing the delicate soap-bubbles,) and filled with water ; by slowly withdrawing the water, the air could be drawn into the tube from any desired spot and tested. This was done; and it was found that even when the magnetic action was most intense, the proportions of the magnetic oxygen and of the non-magnetic nitrogen were undisturbed. — The following experiment proved that no condensation was produced on oxygen by the magnetic power, *i. e.* that it is not aggregated, as happens with iron filings when under the influence of the magnet. The flat-faced poles of the magnet were separated the 60th of an inch by a copper plate with an aperture in the middle, so that when the whole was clamped together a chamber was formed. By gauges attached to this chamber it was found that no trace of condensation occurred, however great was the magnetical force brought to bear on the oxygen.

The loss of magnetical power occasioned by heat was then noticed. This was shown first in the case of iron heated to redness; then in that of nickel raised to the temperature of boiling oil ; and lastly, in the case of the air (*i. e.* of the oxygen in this air) by the following experiment : — Two conical poles a little separated were employed ; above was placed a piece of phosphorus on paper, and below a helix of platinum wire heated to redness by a small Grove's battery independent of that used to excite the electro-magnet. The heated air, rising upwards from the helix, speedily inflamed the phosphorus above it whilst the electro-magnet was unexcited ; but when rendered active, the oxygen in the heated air becoming less magnetic, was displaced by the current of colder (and consequently more magnetical) oxygen, and the phosphorus in consequence remained unaffected by the mass which glowed beneath it, until the electro-magnet was deprived of its power ; and then the natural laws of specific gravity came again into operation, the heated air rose, and the phosphorus was lighted.

In conclusion, Mr. Faraday announced his intention of applying, on a future evening, the reasoning deducible from these and other experiments, to the variation of magnetic lines on the earth's surface. His purpose then will be to compare the records of this varying force with the variations of temperature occasioned by the annual revolution of the earth, the varying pressure of the atmosphere, storms, &c. with the hope of supplying a true theory of the cause of the annual and diurnal, and many of the irregular variations of the terrestrial magnetic power.

For the papers in which these results are described more at large, see Philosophical Magazine, 1847, Vol. xxxi. p. 401 ; and Philosophical Transactions for 1851, p. 1.

Among the objects exhibited in the Library, were — a water-worn Lump of Gold, (weight 219 oz. 8 dwt. 12 gr. ; value about £826,) from Carson's creek, California [by the Governor of the Bank of

England]—an Ingot (weighing 324 oz.) and a cup of chemically pure Palladium [by Mr. G. Matthey]— Specimens of Printing in Colours, by Wood-blocks and Lithography [by Messrs. C. and G. Leighton]— Henley's Magneto-Electric Telegraph, &c. &c.

WEEKLY EVENING MEETING,

Friday, January 31.

W. Pole, Esq. F.R.S. Vice President, Treasurer, in the Chair.

Professor Brande

On Peat and its Products.

Referring with commendation to an article entitled "The Irish California" in Dickens's Household Words, No. 41, p. 348, Professor Brande disclaimed any purpose of predicting the result of the great enterprize which is described in that able paper. He proposed to confine himself to a statement of what had been done, and what was doing, to make the products of peat commercially valuable.

A peat bog was described as a superficial stratum of vegetable matter, which at different depths is undergoing, or has undergone, various stages of change and decomposition. Its superficial appearance is that of a mass of half-decayed mosses, rushes, heath, and grass; the roots having successively died away, though the plants continued to vegetate. The mass is ligneous, and imbued with humus and humic acid, among other products of slow decay; and the abundance of moisture pervading the bog affects the character at once of the peat and of the district. The upper layers of the bog are usually loose and fibrous, and of a pale brown colour. Beneath the surface the density is found to increase, sometimes to a great extent. At last, the distinctive characters of the vegetables cease to be discernible, and the mass appears nearly homogeneous, and of a dark brown, or blackish colour. Trunks of trees, and some curious geological phenomena, occasionally present themselves. A peat district may be regarded therefore as the consolidated produce of enormous forests and fields of vegetation, amounting in the aggregate to millions of acres. In Ireland alone $\frac{1}{10}$th of the surface is covered by peat bog, which if removed would exhibit a soil fit for the operations of agriculture.

Professor Brande then invited attention to different samples of peat taken from the upper, middle, and lower portions of the bog. He particularly noticed the tallow peat of the banks of Lough Neagh, which, from the brilliant flame attending its combustion, is sometimes used as a source of light as well as of heat.

Peat may be rendered valuable, either

1. From the charcoal which may be obtained from it; — or