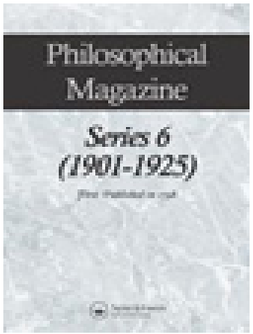

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XLIX. How air subjected to X-rays loses its discharging property, and how it produces electricity

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In addition to the above tabulated values the following also have been obtained :—

v = 285·64	302·65	293·26	344·83	366·32	393·94
R= 1·790	2·286	2·182	2·925	3·473	4·405
v = 426·00	461·92	531·33	562·82	582·35	628·09
R= 5·306	6·784	9·087	10·411	11·586	15·473
v = 655·56	669·53	677·42	691·32	723·18	
R= 18·164	19·998	20·419	21·085	23·896	

The curve is steeper than the nearest one of the family $R=av^2$, and more nearly coincides with a curve of the family $R=av^3$; but more nearly still with a curve represented by the equation $R=av^2+bv^3$, as manifested by fig. 3, which is the exact graph of the equation

$$R=0{\cdot}000008v^2+0{\cdot}000000049v^3.$$

Thus the law of resistance so earnestly maintained by Col. Duchemin, early in this century, and controverted by nearly all later experimenters, seems to be corroborated by the measurements made in this research, as far as they go. It would be most interesting, therefore, to have records at higher and lower velocities.

I hope later to use a vertical gun of greater power, to determine the resistance at all speeds from zero to 1400 feet a second, in order to discover how Duchemin's equation accords with the data of experiment throughout this range of velocities.

XLIX. *How Air subjected to X-rays loses its Discharging Property, and how it produces Electricity.* *By* Prof. Emilio Villari (Honorary Fellow of the Physical Society) *.

THE apparatus used in my experiments is indicated by the figure here adjoined (p. 536).

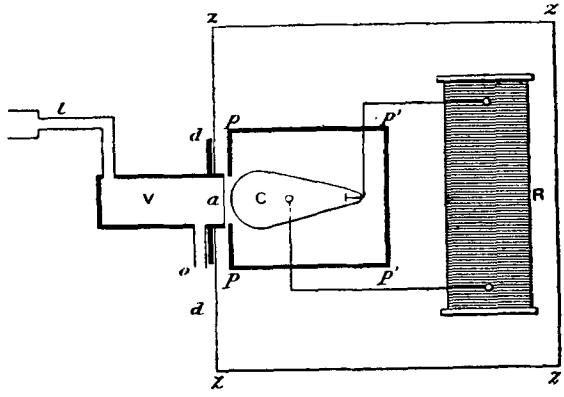
A Crookes's tube C (fig. 1), enclosed in a small lead case pp' with thick walls, was excited by a powerful inductorium R, which, along with the small case pp', was enclosed in a large case of zinc zz', connected to earth by means of the gas-pipes.

The walls of the cases opposite to the anticathode had two large openings through which there entered a vessel V quite close to the Crookes's tube. This vessel, of cylindrical form (30 centimetres by 11), was made of a thick sheet of lead, with the exception of its base a, turned towards C, which was

* Communicated by the Physical Society: read Feb. 22nd, 1901.

formed of a thin leaf of aluminium. Two tubes, *o* and *t*, served, with the aid of a constant-pressure bellows, to drive a current of air across the vessel V. A large sheet of lead *d* soldered to the vessel hindered the radiations from escaping;

Fig. 1.



and for the same purpose the tube *t* was formed with an elbow. The air which had been rendered active by the X-rays in the vessel V passed out through tubes joined on at *t* and was directed against one of my electroscopes, having a single gold leaf, protected by a metallic box connected to the earth. The gold leaf, by means of two slits cut in the walls of the box and closed by a metallic gauze, was illuminated by a glow-lamp and observed by means of a telescope having a divided-scale micrometer.

Air made active by X-rays, in the vessel V, in passing through a long tube, coiled in many turns, loses much more of its discharging power than it does in passing through the same tube if straight. The experiments were executed with tubes of copper, lead, glass, and caoutchouc. The material of the tubes does not influence the phenomena.

The air which has been made active with X-rays loses a great part of its discharging properties, by streaming upon pencils, or rather bundles, of many long and flexible wires of brass contained in surrounding tubes of glass or metal.

A flexible tube of copper 3 metres or more in length and 1 centimetre in diameter, coiled in 8 or 10 turns, and well insulated with paraffin and with a stem of glass, charges itself to a positive potential of about 30 volts when it is traversed by active air *. It is necessary to insulate the

* To avoid repetition the term "active" air is here used for air which has been rendered active by being exposed to X-rays. The term used by Prof. Villari is "aria ixata." [TRANSL.]

copper tube from the rest of the apparatus, not only with the paraffin, but also with a glass tube of 30 to 40 centimetres in length, to lessen the discharge of the tube of copper, as happens through convection, by means of the same active air.

Filters made with brass tubes ($10 \times 2{\cdot}5$ centimetres) closed with 30 to 60 disks of strong gauze of brass, copper, or aluminium, when traversed by a current of active air, take a positive charge to a potential of 15 volts, increasing a little with the number of the disks, and perhaps with the fineness of the meshes of the gauze adopted.

Square pieces of not very fine gauze of brass, 20 to 25 or more centimetres in the side, rolled and wrapped round themselves, and introduced into suitable tubes of glass or of metal, take positive charges from 15 to 20 volts when they are traversed by a current of active air.

Some metallic leaves equal in size to the pieces of gauze, and rolled up in a similar manner, all took from the current of active air negative charges with a potential of about 10 volts. The experiments were made with leaves of copper, iron, zinc, brass, tinned iron, platinum, aluminium, and tin. The charges varied principally with the way in which the leaves were rolled up.

Strips of the metals mentioned, 51 centimetres long by 2·7 centimetres broad, introduced into a tube of glass or metal and subjected to streams of active air, charged themselves at least to a potential of 3 to 5 or more volts. The strip of polished aluminium often took a lesser charge than the others. The strips of gauze equal in size to those of sheet metal took negative charges, similar, but sensibly superior to those assumed by the sheet metal strips.

Finally, the closed tubes and the brass wires introduced into tubes of glass or metal charged themselves negatively when they were subjected to streams of active air.

It seems that the metals, independently of their nature, take a positive or a negative charge according to whether the active air rubs against them with force or lightly; and this result is confirmed by the following experiments.

Tubes of copper or of lead, if short, and particularly if straight, traversed by active air take a negative charge; but if long, and particularly if coiled upon themselves, take positive charges which may attain sufficiently high potentials.

Coarse turnings of copper well rammed into a tube of glass or metal take a positive charge from active air; but if inserted in small quantity and sparsely, they take a negative charge.

Cylinders of diverse sizes, made with leaves of gauze of a

moderate breadth, put into tubes of glass or metal traversed by active air, take positive charges if they are long, and negative if they are short. In my researches the positive charges grew with the length of the cartouches, beginning at about 15 centimetres; and the negative grew with a diminution of the length of the same from about 12 centimetres down to 2 centimetres.

Ribbons of gauze 2 centimetres wide and of various lengths (from 20 to 60 centimetres), rolled up into a cylinder 2 centimetres high, and placed in a tube of glass or brass, took a positive or a negative charge from the active air according as the air was blown more or less gently through the cylinder.

It is to be noted that the charges received are not always of the same intensity, and to obtain them energetically it is necessary to insulate the tubes perfectly with paraffin, and also always with a glass stem.

The phenomena indicated above cannot be attributed to chemical actions, but on the contrary seem to be produced by a special rubbing of the active air upon metallic surfaces, as the result of which these assume one of the charges, while the other charge ought to manifest itself in the air. But from my very numerous measurements made upon the discharge of the electrometer produced by active air which has streamed against metallic cartouches connected to the soil, it results: (1) that the air had not lost all its discharging virtue, and (2) that it had a little of the charge of the cartouches (instead of having a charge of contrary sign to them) which it transported or conducted from them to the electrometer.

I have shown in another place * that active air by streaming against an electrified body is reduced either to ordinary air or to air charged with the electricity which disappears. Hence it may be supposed that the active air in rubbing upon the metallic surfaces develops the two electricities, one of which manifests itself upon these surfaces, and the other goes to reduce the active air to ordinary air, and therefore does not become manifest. Thus it might be explained also how active air streaming against these metallic surfaces is transformed into ordinary air. Therefore this is simply a hypothesis relative to phenomena which require further study.

* Dell' azione dell' elettricità sulla virtù scaricatrice dell' aria ixata.—*Rendiconti dell' Accademia di Bologna*, 1899–1900.