milar to the natural crystals of this substance. In this manner, by a skilful combination of solutions and metallic arcs, and a profound knowledge of the reactions which arise from the contact of these different substances, he succeeded in obtaining, in a crystalline state, compounds which had never been procured under that form.

Μ. Becquerel has been equally successful in reducing the bases of certain oxides, and in obtaining immediately from their solutions, in their metallic, and even crystallised state, iron, zirconium, glucium, and magnesium. In 1832, he also obtained crystals of metallic oxides, such as those of the anhydrous black oxide of copper, of the red oxide, of the protoxide and peroxide of lead, and the oxide of cobalt.

The same distinguished philosopher has employed the effects of weak electric forces to explain the process of ce­mentation, by which iron is converted into steel, by the combination of carbon with all the interior molecules of the iron ; and that remarkable mineralogical process by which the elements of many rocks are transferred from within to without, and replaced by others without any disintegration. The process of cementation is the consequence of the op­posite electric state of the carbon and the iron, which, with the aid of high temperature, produces electric currents that convey the atoms of carbon from molecule to molecule to the very interior of the iron. In like manner, pieces of iron, which have been buried in the metallic state, are al­most wholly oxidated; and ancient copper medals have been found changed entirely into the protoxide of copper.

By studying this class of phenomena, Μ. Becquerel has been led to an explanation of the phenomena of phospho­rescence, which he ascribes to the recomposition of the na­tural electricities of each molecule, which have been sepa­rated by heat or some other cause. The restoration of phosphorescence to bodies that have lost this property, or that never possessed it, by repeated electrical discharges, as ascertained by Mr Pearsal, confirms the ingenious expla­nation of M. Becquerel.@@'

Our countryman, Mr Andrew Crosse of Bromfield, by processes differing from those of Becquerel, arrived at simi­lar results, not long after the publication of the discoveries of the French philosopher. There can be no doubt, however, that Mr Crosse was unacquainted with these discoveries; and that his results were entirely independent of them. By means of voltaic electricity, he obtained the following sub­stances, namely, calcareous spar, arragonite, quartz, red oxide of copper, arseniate of copper, blue carbonate of copper, phosphate of copper, sulphuret of copper, carbonate of lead, sulphuret of silver, carbonate of zinc, chalcedony, oxide of tin, yellow oxide of lead, the sulphurets of antimony and zinc and iron, protoxide of iron, and crystals of sulphur.

Sect. VI *On the coloured Bings formed on Polished*

*Metallic Plates by Voltaic currents.*

This new class of phenomena are remarkable from their beauty and singularity, as discovered by Μ. Nobili. They may be produced by a small battery like that of Wollaston, with twelve elements of an inch square, in the manner shown in fig. 46. A small apparatus, not shown in the figure, is construct­ed so as to move up and down the pincers R S, which hold two pieces of large platinum wire P N, pointed at their extremity, the one communicating with the po­sitive, and the other with the ne­gative pole of the battery. A polished metallic plate A B, intended to receive the coloured rings, is placed horizontally in a saucer or plate which contains the fluid to be used, suppose a solution of sulphate of copper.

When the solution of copper is poured into the saucer above the silver plate AB, and the point of one of the wires N brought as near as possible to *n,* while the other point *p* is plunged in the solution, there will be formed round the point *n, four* or *five* concentric circles, alternately bright and dark. When the point *ρ* is used, there will be formed round it *three* small circles of copper. The *two* extreme circles are of a deep red colour, and the middle one of a higher colour ; sometimes *four* or *five* are formed, which al­ternate like the preceding.

When a solution of *acetate of lead* is used, and the plate of gold or silver is positive, while the point is negative, the concentric rings are as brilliant as the coloured rings of Newton. When we increase the number of negative points, there are formed as many systems as there are points of concentric wires or rings which never cross each other, but which, when they meet, extend outwards so as to form only one exterior ring.

The effects are the reverse with a solution of *acetate of copper,* that is, the concentric rings are formed only when the plates are negative, while positive plates exhibit nothing remarkable.

When the fluid is *urine* and the plate silver and posi­tive, several orders of very brilliant-coloured rings are form­ed round a dark centre. Μ. Nobili has obtained very re­markable effects of colour by using different animal sub­stances, such as milk, white and yoke of an egg, saliva, &c. and vegetable substances, such as the juice of carrots, onions, parsley, grapes, apples, &c. Animal and vegetable substances yield colours more beautiful and brilliant than ordinary chemical solutions. The colours produced by the leaves of plants are more marked than those arising from the decomposition of the roots. In some chemical solu­tions the phenomena are equally beautiful on the positive as on the negative plate; but when the circles meet, the two figures experience, as it were, a sort of compression, and when the coloured rings are impressed only on one plate, they may be made to disappear, if not wholly, at least in part, by inverting the direction of the current.

Μ. Nobili has drawn the following conclusions from a great number of experiments:—1. Certain electro-negative sub­stances possess the property, in some circumstances, of attach­ing themselves to the surface of some of the less oxidable metals, in layers so thin and regular as to exhibit under an infinity of varied forms, the beautiful phenomena of coloured rings. 2. That when electro-negative substances do not de­posit themselves in thin layers on polished metals, they at­tack their surface, not uniformly, but at regular intervals.

The most varied and remarkable appearances were ob­tained by Μ. Nobili when the polished metal was positive; but he succeeded in obtaining equally remarkable pheno­mena when the metal was negative, either by augmenting the force of the current, or by using compound solutions.

He took, for example, a mixture of acetate of copper and nitrate of potash, and upon a negative plate of silver he formed a series of concentric rings, the centre of which retained the metallic brilliancy. The two next circles were green, then came rings of white, red, and green, then a zone of copper of a fine red colour. This zone was surrounded with a blue circle, marked with radiating lines, like a gra­duated circumference. Its rays extending even to the circle of copper : Then came a second copper zone wider than the first, but equally brilliant, surrounded with a circle of beau­tiful green, which terminated the figure. The same appear­ances were obtained on gold and platina.@@2

@@@1 See Ann. de Chimie et de Phys. tom. xxxiv. p. 152; xxxv. 126 ; xlii. 225 ; xliii. 131 ; xlvii. 5, 13 ; xlviii. 337 ; lii. 181 ; liii. 105, 243. See also Becquerel’s Traité de l’Electricité, &c. tom. iv. v.

@@@\* See Ann. de Chim. &c. tom. xciv. p. 210, and Becquerel s Traité, &c. tom. iii. pp. 274—287.