plaster casts, and various other works of art, may be copied in copper and other metals by the above process.

3. *On the Multiplication of Engraved Copper Plates.* The difficulty of procuring good and pure copper plate for engraving, has been entirely removed by this new art. A prepared copper plate with a good surface may have copper deposited on its surface, so that the deposited plate has the same perfect surface, with the additional advantage of con­sisting of pure copper. It is advisable, however, to ham­mer and prepare with charcoal the deposited plate to give it elasticity, &c., and such plates have been found superior to all others for the purposes of engraving.

The method of copying *engraved* copper plates, of the most delicate execution, is shewn in fig. 48, where D is a vessel, a gallipot for example, about eight inches high and six inches in­ternal diameter. The dotted line, E E, is a copper cy­linder six and a half inches high and five in diameter, and Ο Ο O is a porous cylinder, which may be made of brown paper when a quick action is wanted, but, in general, a thin unglazed gallipot is preferable. A cylinder of zinc, Z Z, as large as possible, is then placed within the porous cylinder without touching it, nearly at the dis­tance of one-8th of an inch. A perforated cover, S S of earthenware, is made to rest either on the copper cylinder EE, or upon a rim in the gallipot about an inch from its top. The object of it is to hold crystals of sulphate of cop­per for keeping the solution in a state of saturation. Wires X, Y, are soldered to the cylinders of copper and zinc, and these are connected with the wires in the other vessel by a binding screw *s*, fig. 49, used by Mr Spencer, uniting the two wires M, N. The square cell A B, contains the engraved plate *b,* to be copied, and connected by the wire, *b x,* with the zinc cylinder of the battery ; and *c b* is the plate to be oxydised and to be attached to the zinc cylinder of the battery. The second­ary cell, or precipitating trough, which may be made of earthenware, wood, or glass, is fill­ed with a saturated solution of sulphate of copper. In this way a reverse copy of the plate itself is obtained in relief, and from this copy, or relief, another copy in intaglio is to be taken by the same method. It is considered prefer­able, however, to take a perfect mould from the engraved plate in white wax or plaster of Paris. When this mould is rubbed with black lead, an electrotype plate is then de­posited upon it. In like manner steel plates may be copied by first taking moulds from them in lead, wax, or plaster. It is a curious fact, that the deposited plate is always superior to the engraved plate. Mr Palmer has succeeded in thus copying the works of our finest engravers. For farther information on this subject, see Spencer’s *Instructions for the Multiplication of Works of Art in Metals,* &c., in Griffin’s Miscellany, Glasgow, 1840; *Jacobi's Die Galvanoplastik,* Petersburgh, 1840; *Annales de chimie et de Physique,* September 1840, tom. lxxv. p. 24; and Smee’s Elements of Electro-Metallurgy, Lond. 1841.

3. *Voltaic Etching.* In this new art, which is fully described by Mr Smee, the copper plate having the design drawn upon the etching ground, as in ordinary etching, and having its back and sides coated with wax, is connected, by means of a wire, with the silver plate of one of Mr Smee’s batteries. “ A piece of copper,” says Mr Smee. “ of the same size as the plate, should then be connected to the zinc, when both the copper plate and the piece of zinc are to be placed in a solution of sulphate of copper. Immedi­ately copper will be reduced from the solution on the nega­tive plate, and copper from the etching plate will be dis­solved to keep up the strength of the solution. Whatever is favourable to the increase of electricity causes the cop­per to be more quickly acted upon, and whatever dimin­ishes the galvanic current retards the solution of the metal; so that the nearer the etching plate, forming the positive pole, and the piece of copper, forming the negative, are ap­proximated, the more rapid will be the action. In the same way the intensity of the battery also affects the rate at which the plate is bitten in. The negative plate of cop­per, however, should not exceed in size the copper plate on which the etching is executed, or else there is a risk of some of the lines being more deeply bitten in ; and, in like manner, if any considerable part of the plate has a great deficiency of lines, compared with other parts, that part must be stopped out rather before the other, to ensure a uniformity of depth, or else the negative copper opposite the part must be so bent, that it is at a greater distance. The advantages of galvanism for etching are, the absence of poisonous nitrous fumes, which are evolved in the ordi­nary process ; the greater uniformity of action which takes place than when acids are used, and that the rapidity of biting may be regulated to the greatest nicety. The lines may be made of any depth, and are sharper and clearer than when acid is used ; and lastly, no bubbles are evolved, which the engraver well knows are apt to tear up the ground, or to cause unequal action.”@@1

4. *Voltaic Gilding arid Plating.* We owe the art of gilding upon *silver* and *brass,* by electricity, to M. de Larive, who was led to it by witnessing the dreadful effects which are produced at Geneva by the use of mercury in gilding. Gold, platinum, palladium, silver, copper, and carbon, when their surfaces are smooth and chemically clean, and freed from adhering air, may be gilt by means of a feeble voltaic current which deposits the gold from a weak nitro-muriate solution of that metal, and in this way a coating of any thickness can be obtained. By a similar process, metals may be platinated or palladinated by using the nitro-muriate solution of those metals. Metals may, in like manner, be covered with nickel by means of its nitrate.

By similar means fruit, vegetables, leaves, seeds may be coated with copper ; and crystallised copper may be depo­sited on wicker work, baskets, &c., after they are blackleaded, or upon articles of earthenware. Mr Smee has succeed­ed in coating copper with almost every other metal ; but for an account of De Larive’s and Mr Smee’s processes we must refer to the *Bibliotheque Universelle,* April 1840, the *Comptes Rendus,* &c., 1840, No. 14, p. 578, and to the work of Mr Smee, already quoted, book iii.

PART II—ON ELECTRO-MAGNETISM.

Various insulated facts and experiments, observed and made by Franklin, Van Marum, Cavallo, Ritter, Mojon. and Maschmann, led to the belief that electricity produced magnetical effects; and this opinion was strengthened by the magnetical changes which had been repeatedly ob­served in compass needles struck by lightning. It was not however, till 1820, that electro-magnetism was discovered by Professor H. C. Oersted of Copenhagen. In the month of July of that year, after obtaining several feeble magne­tical effects from wires conducting the galvanic current, he at last succeeded, by using larger wires, in establishing the

@@@1 Smee’s Electro-Metallurgy, p. 138, 139.