dust it over the surface. Rub smoothly with a soft cloth. When dry, cover with copal varnish.

Bronze for Leather.—Aniline violet mixed with a little water and applied with a brush gives a beautiful bronze luster.

To Bronze Paper.—Apply a size of glue or gum arabic in water, and dust the powder over the surface.

Lettering may be done by dipping the brush in the size, lettering quickly, and dusting on the powder before the size is dry.

Printing is done in the same manner. Afterwards the letters should be burnished by going over them with a smooth flatiron as hot as can be without scorching the paper.

Bronze for Medals. — Mix crocus powder with water to a thin paste and apply with a brush. Afterwards heat the metal, and when cool polish. The depth of color depends upon the degree of heat. Heat the metal over an open fire.

Or use powdered black lead instead of crocus powder.

Or apply sulphuret of potassium.

ELECTROPLATING AND ELECTROTYPING

Electroplating.—This process consists in covering, by means of an electric current, the surface of articles composed of cheaper metals with more costly metals, as gold, silver, platinum, nickel, copper, etc. The process is the same as that employed in electrotyping.

German silver is perhaps the best metal to use as a basis in electroplating; but iron, zinc, pewter, and other metals may also be plated. Articles to be plated must first be cleaned and scoured to free them from rust or other impurities, then dipped in a solution of nitrate of mercury to give them a thin film of mercury, which causes the plating to adhere. They are then suspended in a bath containing a suitable solution, and treated by means of the electric current as in electrotyping. After being removed, they are brushed and burnished.

Electrotyping. — This is a process of making the cast or image of an object by gradually depositing metal from a solution by means of an electric current. Electroplating is done on the same principle.

Electrotyping or electroplating requires very little apparatus, and can be done very cheaply. It is a practical, useful, and instructive art or amusement. The principle is very simple. If, for example, two strips of clean platinum are suspended in a solution of sulphate of copper, no action takes place; but if these platinum plates be connected with the opposite poles of an electric battery the sulphate of copper solution will be decomposed, and the metallic copper will be deposited upon the plate or surface by which the electric current leaves the solution. This is the negative pole of the electric battery. By reversing the direction of the current the copper will be sent back to the other plate, and it can thus be sent backward and forward indefinitely if the current be continually reversed.

By adding more sulphate of copper to the solution and continuing the electric current, a metallic film of copper may be made of any required thickness, which may afterwards be peeled off the platinum plate if desired.

The best conditions for copperplating or electrotyping are a rather strong solution of sulphate of copper slightly acidulated with sulphuric acid and at a temperature of not less than 60°, with an electric current of low intensity. Gold and other metals may be substituted for copper by suitable solutions, as described under electroplating.

If an object having raised surfaces, as a coin or medal, be substituted for the strip of platinum at the negative pole of the battery, it will be covered with metal to any desired depth. This may afterwards be stripped off, thus giving an exact inverted impression of the object, corresponding to a die.

If this die or a cast taken from the object by means of plaster of Paris or wax be substituted for the platinum plate at the negative pole of the battery, the depressions in its surface will be filled. Thus a solid casting or image of the object will be secured, and this is the usual method of electrotyping.

Hence, to make a cast of an object by electrotyping, it is first necessary to make an impression of the object in wax or plaster of Paris. If plaster of Paris is used, the mold must be soaked in oil, tallow, or melted wax so that it will be impervious to water. The surface of the mold must then be brushed with a coating of black lead to make it a conductor of electricity. Or if a cast of the object itself is to be made, only half of its surface can be electrotyped at one time, and the remainder must be covered with sealing wax, varnish, or shellac.

Molds for Electrotyping.—To make a mold for electrotyping, lay the model on a flat surface and cover it with a coat of sweet oil or olive oil. Mix a little plaster of Paris with water to a thin paste and pour it over the model. Before the plaster of Paris sets, insert in it a wire ring from which the wire extends an inch or two to form a hook from which to suspend the mold in the solution. When the plaster sets, carefully remove the model and paint the back of the mold and the edges, except where it is desired to have the metal deposited, with melted sealing wax, varnish, or shellac. Now brush black lead thoroughly into the mold so as to cover every portion of the surface and extend upward to the wire on which the mold is to be suspended.

Or soften wax or gutta percha with gentle heat and knead it over the model. Treat the impression thus formed in the same manner.

Plaster Casts for Electrotyping.—To use plaster as a mold for electrotyping, dry it in an oven and boil it in a mixture of equal quantities of beeswax and rosin until it is saturated. Cool, and cover evenly with a thin coating of black lead.

Experiment for Electrotyping.—Take an ordinary leaf, lay it on a hard surface, and knead over it a bit of soft gutta percha or wax to make a mold. A little experimenting will secure a perfect impression. Remove the leaf, heat the end of a wire, and thrust it through the mold; brush the face of the mold with black lead, varnish the back as above, and attach to the negative pole of a battery. Attach a piece of copper to the opposite pole, facing but not touching it, and cover both with a saturated solution of copper sulphate slightly acidulated with sulphuric acid. Thus a beautiful model may be taken which will show every detail of the leaf.

Gold-plating Solution. — Mix 4 ounces of muriatic acid and 2 ounces of nitric acid; add 10 pennyweights of gold coin, 10 grains of pure copper, and 8 grains of pure silver. Shake until all is dissolved except a silver sediment. Add 1 ounce of pulverized borax, 2 ounces of pulverized sulphate of iron, 50 grains of salt, and 2 quarts of hot distilled water. Mix or shake vigorously.

Let this mixture stand until all the metals have settled. When they have fully settled, pour off the liquor and wash the sediment perfectly clean, or until it ceases to be acid to the taste. This may be done by adding hot water, shaking, allowing it to settle, and pouring off the water as often as necessary. The sediment consists of the chloride of gold of about 18 karats fineness. Add 2¼ ounces of cyanuret of potassium, 2 quarts of boiling distilled water, shake well, and let stand a day or two, when it will be ready for use.

Silver-plating Solution.—Shave 1 ounce of silver and cover with 2 ounces of pure nitric acid. Add distilled water slowly, ½ ounce or less at a time, as the silver dissolves. Use as little water as possible, and when all dissolved stir in 3 ounces of salt dissolved in 3 pints of water. Stir or shake and let the solution settle.

Wash the sediment until it is no longer acid to the taste, add 1⅛ ounces of cyanuret of potassium and 16 ounces of distilled water, and let stand a day or two before using.

To Test Plated Metals.—To test silver plating on metals, dissolve ½ ounce of bichromate of potassium in nitric acid. Rub the surface to be tested with pure alcohol or ether to kill grease or varnish. Apply a drop of this mixture, and rinse the article in cold water. Pure silver is indicated by a blood-red stain; German silver by a brown stain which washes off; Britannia metal by a black stain; mercury by specks of red, which wash off; lead and bismuth by yellow stains; tin by a brown stain which turns yellow in water; and zinc by the active action of the liquid, the stain of which is soluble in water.

Gold Plating without Electricity.—Dissolve 1½ ounces of gold amalgam in a mixture of 1 ounce of nitric acid and 2 ounces of muriatic acid. Add 6 ounces of alcohol and immerse the articles in this for about 15 minutes; apply the solution with a soft brush or cloth. The articles must first be cleaned by dipping them in dilute nitric acid or potash lye to remove grease and rust and to give an absolutely clean surface; otherwise the amalgam will not adhere. Rinse, dry in sawdust or prepared chalk, wipe clean with tissue paper, and polish with chamois skin.

Or clean the articles as before, and apply gold amalgam with a fine, stiff brush. Set them in the oven and heat them until the mercury evaporates, when their color will be a dull yellow. Mix equal parts of powdered saltpeter and alum to a paste with water, and go over the gold coating with this mixture, using a brush. Apply heat until this solution is melted, then plunge the articles into cold water and afterwards polish.

Or dissolve ½ ounce of gold in 1 ounce of aqua regia, or a mixture of nitric and muriatic acids. Add 1 quart of soft water, and throw in gradually hyposulphite of soda in crystals. A brown sediment will form which will again dissolve if additional hyposulphite is added. When this has dissolved, add a little more hyposulphite and immerse small articles, or apply the solution by means of a brush or sponge.

Or use this solution to touch up gilded articles where the gilding has worn or been taken off by accident. Apply by means of a brush, and at the moment touch the spot with the bright side of a piece of shaving whittled from a piece of zinc.

The above are suitable for silver, copper, or brass.

Solutions for German-silver Plating.—To make a solution for electroplating German silver and other metals, take the plate of German silver of a known composition and prepare a mixture of chlorides of the metals in the same proportion that they are found in the alloy. If, for example, the German silver consists of 1 part nickel, 1 part zinc, and 2 parts copper, dissolve 1 ounce of nickel, 1 ounce of zinc, and 2 ounces of copper in hydrochloric acid, and evaporate the excess of acid by gentle heat. Dissolve this solution in the water for the bath, and add slowly potassium cyanide. The metals will be first precipitated, but as the cyanide solution is gradually added and the bath stirred, the metals will be redissolved. The solution will then be ready to apply, but to obtain the best results it should be raised to a temperature of at least 60°. The plate of German silver is suspended from the positive pole, and the article to be plated, suitably cleaned, from the negative pole.

Brass Plating.—Prepare separate solutions of cyanide of potassium and neutral tartrate of ammonia in water, mix the two solutions for the bath, and add the cyanide of copper and zinc in the proportions desired for the alloy until the bath is saturated, or until they commence to precipitate. Then add black oxide of copper and pure zinc white until the

bath has dissolved all it can. This admits of the use of a weak galvanic current. If the color of the brass is too light, a little more copper salt may be added, or if too dark, a little more zinc salt. A brass plate of the composition desired is connected with the positive pole of the battery, and the zinc or other metal to be coated, with the negative pole. The latter must, of course, be thoroughly cleaned with acids and by scrubbing to give a chemically clean surface for the deposit.

Hints for Electroplating. — The process of electroplating with single metals, as copper, silver, gold, and the like, on various solid metals is very simple, but electroplating with alloys, as German silver, brass, and the like, is somewhat more difficult on account of the fact that the electric current shows a tendency, if the bath is not properly prepared, to deposit one of the metals contained in the alloy in preference to the others; hence some little experimenting will be required to succeed in electroplating with alloys.

A weak current gives the best results with single metals, but with alloys it tends to favor one of the metals at the expense of the others. A strong current tends to deposit a rough, thick film which is not tenacious and does not adhere well to the article; hence care should be taken to prepare the solution for alloys exactly according to instruction.

The cyanide solution, which is always used for the precious metals, will give better results with alloys than the sulphate solution used in copperplating. All objects to be electroplated must be carefully cleaned before they are put in the bath; hence they should be dipped in the mixture of nitric and muriatic acids to remove any oxides, rinsed in water, and, if necessary, scoured with pure water and sand. On removal from the bath after plating, they may be dried in sawdust, cleaned, and polished.

Electroplating Silver on Iron.—To plate iron or steel, dissolve cyanide of potassium in soft water, using 1 pound of the cyanide to 1 quart of water. Dip the articles in pure sulphuric acid, scrub with fine sand and a scouring brush, rinse with pure water, and suspend them in the cyanide solution until it becomes white. Remove and suspend in the silver solution.

Or first coat the steel or iron with sulphate of copper by suspending it in a bath of sulphate of copper, and deposit the silver solution on this coating.

To Plate Iron without Electricity.—To plate iron with silver without electricity, clean and smooth the surface with a burnisher, heat it to blueness, lay the silver leaf upon it and burnish it down. Continue adding silver leaf until the proper thickness is secured.

Or apply soldering liquid to the iron, and thin sheets of solder. Lay the silver over this, and heat gently until the solder melts.

Or tin the iron. First lay tin foil over it, and silver leaf or thin sheets of silver over all, and melt the tin with gentle heat.

Solution for Nickel Plating.—A pure solution of the double sulphate of nickel and ammonia gives a thick deposit with a smooth surface capable of taking a high polish, but this solution must be chemically pure and free from foreign ingredients, especially nitric acid, alkalies, and lime. If these are used to clean articles to be nickel plated, the utmost care must be used in rinsing them, as a drop of nitric acid will ruin the solution by causing the nickel plate to become black and streaked. Potash or soda gives a deposit of green oxide of nickel. Other metals, as copper, zinc, and arsenic, must also be avoided. Instead of a pure nickel plate at the positive pole of the battery, better results are obtained by a plate composed of nickel combined with carbon, and such casting nickel plates are now obtainable on the market.