

ug silver in the form of a simple salt, in solution by an acid, are easily treated; add to them an excess of common salt, or hydrochloric acid, the silver will be precipitated as chloride of silver, which, after washing, may be employed for the preparation of new baths, or reduced to the metallic form. Solutions of nitrate of silver, or desilverizing acids, belong to this class. Common salt, however, is without action upon the liquids which hold silver in the state of a double salt, and will rather aid the solution than the precipitation; such are the double tartrate of silver and potash, whitening bath, the double sulphite of soda and silver, and the bath for dipping. Before employing common salt, add sulphuric acid, which, displacing the other acids, restores the silver to the state of a simple salt, easily precipitated by common salt. Hydrochloric acid alone precipitates silver well from these solutions. Liquors containing silver, as cyanide, are also exceptions; to extract all the metal, use the process employed for similar combinations of gold, evaporate to dryness, and reduce the mass in a crucible, with an addition of carbonate of soda and powdered charcoal. The metallic silver remains at the bottom of the crucible. To reduce chloride of silver—1. Put well-washed chloride of silver into an iron ladle, with a little pure water above the chloride. The greater affinity of iron for chlorine determines its departure from the silver; and, after standing 24 to 30 hours, throw the contents of the ladle upon a filter, and wash thoroughly with pure water, to remove the soluble chloride of iron; the residue will be pure silver in a minute state of division. This method is rarely employed on account of the length of time required. 2. Well-washed chloride of silver, water does not dissolve a trace of it, is put into a stoneware pan with two or three times its weight of zinc, and the whole is covered with water rendered acid by sulphuric acid. As soon as they are in contact, these substances react upon each other; the sulphuric acid and the zinc decompose the water, the oxygen of

which oxidizes the zinc, which then combines with the acid, and forms sulphate of zinc, a very soluble salt; the hydrogen transforms the chlorine of the silver into hydrochloric acid, which is also very soluble in water. Before filtering, wait until all the zinc is dissolved. The remaining silver is in impalpable powder, and cannot pass through the filter. Wash the silver thoroughly with pure water, and it may then be dissolved in pure nitric acid to form a pure nitrate of silver. This process is seldom employed, as it is difficult to find zinc without lead, which will unite with and follow the silver in subsequent manipulations. 3. The chloride of silver, freed from foreign metallic salts by washing, is mixed with four times its own weight of crystallized carbonate of soda, and half of its weight of pulverized charcoal. Make into a homogeneous paste, dry thoroughly in an iron pan, and then place in a red-hot crucible. After fusion the heat is raised, in order to allow the smallest globules to reach the bottom of the crucible. Should the crucible be moved at the time of the solidification, the silver will be of a very irregular shape. To obtain granulated silver, pour it in a small stream, and from a height, into a large volume of water.

Extraction of Platinum.—1. Render any kind of platinum bath acid by hydrochloric acid, unless it is already so, and then plunge cleansed iron into it. The platinum is reduced to a black powder, wash, and calcine to a white heat. Dissolving it in aqua regia reconstitutes the chloride of platinum necessary for the preparation of the baths. 2. Reduce by evaporating the bath to dryness, strongly calcine the residue, then wash upon a filter to remove the soluble salts, and again heat to a white heat. The platinum thus obtained is soluble in aqua regia.

Extraction of Copper Salts.—Collect all the liquids holding copper in a large cask filled with wrought or cast iron scraps; a chemical reaction immediately takes place, the iron is substituted for

the copper to make a soluble salt, and copper falls to the bottom of the cask in the shape of a brown powder. The cask should be large enough to hold all the liquids employed in a day's work. The iron scrap should be suspended in willow baskets on the top of the liquor, and, by stirring now and then the liquid with them, the metallic powder of copper will alone fall to the bottom of the cask. The same method may be employed for recovering the copper from old cleansing acids, or from worn out galvanoplastic baths. The copper thus obtained is quite pure; calcining it in contact with the air, gives a black bioxide of copper for neutralizing too acid galvanoplastic baths.

Ashes.—Sweepings, saw-dust, residues from the bottoms of scratch-brushing tubs, filters, papers, and rags, must be collected, mixed, and burned in a furnace constructed for the purpose. The ashes are finely pulverized, sifted, and thoroughly mixed with a quantity of mercury, which combines with the gold and silver. The amalgams, separated by washing, are then distilled in cast-iron retorts of a peculiar shape. The mercury volatilizes, and the gold and silver remain in the retort. For separating these metals, granulate the solid mass and treat with pure nitric acid, which dissolves the silver, and is without action upon the gold. The latter metal collects at the bottom of the vessel in a black or violet powder, and is pure, after having been washed in distilled water. If an ingot contains only a little silver and much gold, melt previously with a certain proportion of the former metal, in order to more easily dissolve in nitric acid. The ingots of silver and copper should be boiled in cast-iron kettles with concentrated sulphuric acid, which transforms the copper into soluble sulphate of copper, and silver into sulphate of silver, only slightly soluble. The separation of the two may be partly effected by washing, but, generally, the silver is precipitated by plates of copper. The alloy, previous to its solution, should be granulated.

Galvanoplasm. Thick Deposits.—Galvanoplasm consists of deposits with sufficient thickness to form a resisting body, which may be separated from the objects serving as moulds, and which will preserve the shape and dimensions of the model. A statue of plaster of Paris, wood sculpture, an impress in wax, fruit, and similar things, may, after certain preparations, be covered with electro-deposits, for instance, which will give a deposit representing the same shape and dimensions. In galvanoplastic operations copper is almost exclusively employed. It is possible to have the deposits entirely of silver and gold; but these are exceptions, on account of the cost of the materials and of the difficulties of the operation. The following is a summary of the usual requirements;—1. To apply upon a metallic surface conductor of electricity, a deposit of copper adhering to the metal underneath. 2. The above operation being completed, the two metals must be separated in such a manner that they will furnish two identical productions, one of which will be in relief, and the other hollow, for casts of medals, &c. 3. To apply the electro-deposits upon substances not naturally conductors of electricity, but rendered so by the process of metallization; upon ornaments of plaster of Paris, wax, glass, or porcelain, or upon leaves, fruits, and insects. 4. After the deposit to separate the non-metallic model to have a perfect copper copy of it. For reproduction of type in stearine, gutta-percha, gelatine. 5. Or, if it is impossible to apply the electro-deposit of copper directly upon the model, make moulds upon which a greater or less number of copies may be obtained. This is the general case;—The imprint of the model is taken with a plastic substance, which is rendered a conductor of electricity, and upon which the galvanoplastic deposit is effected.

THE BATHS.—1. Put into a vessel, made of glass, stoneware, porcelain, gutta-percha, or lead, a certain quantity of water, to which is added from 8 to 10 per cent. of sulphuric acid. If

in a glass vessel, or one lined with gutta-percha, pour in the acid slowly and stir all the time, otherwise the acid, which is much denser than water, falls to the bottom, and slowly combining with the surrounding water, may cause an increase of temperature sufficient to break the glass or melt the gutta-percha. 2. Dissolve in this liquor as much sulphate of copper as it will absorb at the ordinary temperature. Stir frequently with a glass or wooden rod, to mix the solution; or the sulphate of copper may be put into a perforated ladle of copper or stoneware, or into a bag of cloth, fixed near the surface of the liquid. When the liquid refuses to absorb any more crystals, it is saturated, and marks about 25° of Baumé's hydrometer. Baths of sulphate of copper, while they are working, must always be kept saturated; new sulphate of copper must be introduced to replace that decomposed and forming the metallic deposit; for this purpose suspend to the top of the vessel, and in the upper portion of the liquid, bags always filled with crystals of sulphate of copper. It is necessary to use good sulphate of copper; the best is in crystals, semi-transparent, and of a fine blue colour. Its solution is also a pure blue. These baths are always used cold, and are kept in vessels of shapes adapted to the wants of the operator. Stoneware, porcelain, and glass are the best materials for the purpose; but as it is difficult to find vessels sufficiently large, wooden troughs covered inside with coats of gutta-percha, marine glue, or with a sheet of lead, are used, painted with resist varnish.

Deposits by Separate Batteries.—After proper preliminary operations, the object which is to receive the deposit is connected with the conducting wire attached to the negative pole of the battery, zinc generally, and immersed in the solution; and the conducting wire starting from the positive pole, carbon or copper, is attached to a foil or plate of copper, and this anode is placed in the liquor parallel to the object connected with the other pole. This plate should have a surface at least equal to that of the article to be covered. The deposit will begin imme-

diately, and its progress may be seen by removing the object from the solution. If upon a clean metallic substance, the deposit of copper will be instantaneous on every part of it; if, on the contrary, the surface only moderately conducts the electricity, as plumbago or graphite, the deposits will begin at the points touched by the conducting wire, and then proceed forward. With a little practice it is easy to ascertain whether the intensity of the current corresponds to the surfaces to be covered. The operation will be slow with a weak current, but there is no other inconvenience, unless the substance of the mould is alterable, like gelatine. Too intense a current results in a granular deposit, of which the particles have little cohesion between themselves, and no adherence to the mould.

Simple Apparatus for Amateurs.—Place the solution of sulphate of copper in a stoneware, earthenware, or porcelain vessel, in the centre of which stand a porous cell filled with water with 2 or 3 per cent. of sulphuric acid, and 1 per cent. of amalgamating salts. This liquid must surround an inner cylinder of zinc, upon the top of which rests a circle of brass wire, by two crossed bars soldered, or fixed in four notches on the top of the zinc cylinder. Suspend from this circular framework, projecting over the copper solution, a certain number of objects or moulds, immersed in the liquid in such a way as to have their faces to be covered near and opposite to the cell. Two small hair bags filled with sulphate of copper crystals, should be attached to the upper edge of the vessel.

Large Apparatus.—To cover large surfaces, use a bath contained in a large wooden trough, lined inside with gutta-percha, or lead, or other substance unacted upon by the bath. In the middle of the trough dispose a row of cells close to each other, and each with its zinc cylinder. Connect a thin metallic ribbon with all the binding screws of the cylinders, in contact at its extremities with two metallic bands on the ledges of the trough. The metallic rods to support the moulds are placed in contact with the metallic bands of the ledges, and there-

fore in connection with the zincs. If the objects are in high relief, use a circular trough, place the cells in a circle, and the mould to be covered in the centre. Whatever the shape of the mould, its position should now and then be changed, because the lower layers of the bath give more abundant deposits, owing to the difference of specific gravity of the layers more or less charged with sulphate. As far as practicable, maintain the liquids in the bath and in the cells at the same level; or it is better to have that of the bath slightly above that of the cell, to prevent the solution of zinc from mixing with the copper bath.

Porous Cells.—Pipeclay, pasteboard, bladder, gold-beater's skin, and parchment, sail-cloth, and certain kinds of wood may be employed, but nothing equals porcelain clay, submitted to a certain heat, which hardens the paste without destroying its porosity. Vases made with this material are just porous enough, and resist the action of concentrated acids.

Batteries.—The battery, charged as has been described, will work well for 24 hours; and, for four consecutive days, it will only be necessary to add small quantities of acid and amalgamating salt, in proportion to the volume of the cells. Stir the mixture each time with a glass rod. The fifth day, throw away all the exciting liquors, and substitute fresh ones, otherwise the zinc salt will be so abundant as to crystallize upon the zincs and the cells. A cell will be clogged in two ways,—by the sulphate of zinc which having an insufficiency of water, crystallizes in the pores. In this case boil the cells in water acidulated by sulphuric acid. Or by deposits of copper caused by bad working; dip the cells in aquafortis until all the copper is dissolved, and rinse in plenty of water afterwards. It is also possible to clean cells by keeping them filled with water, which, escaping through the pores, pushes out the salts and the acids with which they are clogged. Cast zinc will work, but is far inferior to laminated zinc, which will be uniformly corroded instead of being perforated. It sometimes happens that zinc is scarcely attacked, even by concentrated liquors,

and that a multitude of small cavities are engraved on its surface. It also becomes covered with a blackish-grey crust, and no electricity is disengaged. These inconveniences occur when the zinc is too rich in lead.

Amalgamating Salt.—To avoid the solution of the zinc when the apparatus is not at work, cleanse it in diluted hydrochloric acid, and then amalgamate it by rolling the cylinders in a trough filled with mercury.

Acid Baths.—When a bath contains too weak a solution of sulphate of copper, the electro-deposit is pulverulent, black and irregular. The same inconvenience occurs when the liquors become too acid, because then they do not dissolve enough of sulphate of copper. When the bath is too acid, add carbonate of copper to it until effervescence no longer takes place. The bath should then be acidified anew to increase its conducting power. The carbonate of copper may be replaced by the oxide of the metal, which dissolves without effervescence. If, after very long use, a bath becomes overloaded with free acid and sulphate of zinc, there is no remedy but to start a fresh one.

Placing the Pieces in the Bath.—The depth of the bath should be sufficient to have a little liquor above and below the moulds. If the moulds are lighter than the solution of sulphate of copper sink them with lead pieces covered with varnish, with stones, or other non-conductors of electricity. When the object to be covered is metallic, and unacted upon by the solution of sulphate of copper, attach the conducting wire to any part of its surface, and it will be rapidly covered with a uniform deposit; if the mould is a non-conductor of electricity, and has been covered with some conducting substance, such as plumbago, bronze powder, or reduced silver, multiply the points of contact, as much as practicable, of the electrode, by uniting the connecting wire with a number of fine copper wires, and making their beat extremities touch the mould at various places. This method gives a greater rapidity of operation, and a uniform thickness of deposit. It is especially necessary for

moulds having deeply indented surfaces. As soon as the surface is entirely covered remove the supplementary wires. If only one face of the mould is to receive the deposit protect the other surfaces by a resist varnish, melted yellow wax, or softened gutta-percha.

Adhesive Deposits upon Metals.—Metals are unequally qualified to receive the galvanoplastic deposit; and some are naturally unfit for it. For instance, wrought and cast iron, steel, and zinc, as soon as immersed in the solution of sulphate of copper, and without the aid of electricity, decompose the salt, and are coated with a muddy precipitate of copper without adhesion. It is necessary to give them previously a thick coat of copper in the bath of double salts before submitting them to the action of the sulphate of copper. Tin, although presenting these inconveniences in a much less degree, should also be copper electroplated in the solutions of double salts before going into the bath. When the metal to be covered is unacted upon by the bath, cleanse it well, and submit it to the action of the current, which will give a rapid and uniform deposit; this should not be too thick, otherwise the surfaces may have a coarse appearance, which impairs the fineness of the lines of the mould. With a good bath, and a well-regulated electric current, the delicacy of the pattern will not be defaced by a copper coat having the thickness of stout writing paper. A bright lustre may be obtained by scratch-brushing or burnishing; or by a passage through aquafortis and soot, and afterwards through the compound acids for a bright lustre.

Dead Lustre Gilding by Galvanoplastic Deposit.—Adhering galvanoplastic deposits give a very cheap and handsome gilding with a dead lustre, which, although not equal in durability, has the appearance of that obtained with mercury, already described. Having cleansed the mould if metallic, or rendered it a conductor if non-metallic, immerse it in the solution of sulphate of copper, and allow the deposit to acquire a dead lustre slightly in excess of that desired. After this operation, which may last from 2

to 6 hours, remove the article from the bath, rinse it in plenty of water, and pass it rapidly through the compound acids for a bright lustre, which diminish the previous dullness of the appearance. Next rinse in fresh water; steep in a mercurial solution similar to that employed for gilding by dipping; rinse again; and immerse in an electro-gilding bath made of;—Distilled water, $2\frac{1}{2}$ galls.; phosphate of soda, 21 oz.; bisulphite of soda, $3\frac{1}{2}$ oz.; cyanide of potassium, $\frac{2}{3}$ of an ounce; gold, for neutral chloride, $\frac{1}{3}$ of an ounce. At first, the current is rendered sufficiently intense by dipping the platinum anode in deeply; afterwards the intensity is diminished by partly withdrawing the anode until the entire shade of gold is obtained. This gilding requires but little gold, as the frosty dead lustre comes from the copper. When the lustre of the copper is very fine and velvety, dispense with the dipping into the compound acids, but the rapid passage through the mercurial solution is always desirable. If the deposited gold is not uniform, or appears cloudy, it is proof of an imperfect deposit in the bath, or of an insufficient steeping in the compound acids. The piece should then be removed from the bath, washed in a tepid solution of cyanide of potassium, rinsed in fresh water, dipped in the solution of nitrate of biniodide of mercury, and electro-gilded anew. This gilding bears burnishing well; avoid acid waters and soap, which will produce a red polish, and use only the fresh solutions of linseed, or of marsh-mallow root. The tone of gold thus obtained is richer, deeper, and more durable than that produced upon frosted silver, the latter being recognized by the green colour of the burnished parts. This kind of deposit may be employed for binding substances together, because the covering coat will be continuous.

Galvanoplastic Deposits without Adhesion.—After thoroughly cleaning the pattern, rub it with a brush charged with plumbago, or with a soft brush slightly greased by a tallow candle. The film of fatty substance should not be seen at all. The deposit obtained

represents an inverted image of the pattern, and the raised parts become hollow. Remove the mould, and perform the same operation upon the deposit, and this second deposit is the accurate reproduction of the first pattern.

DEPOSITS UPON NON-METALLIC SUBSTANCES.—By this process porcelain, crystal, plaster of Paris, wood, flowers, fruits, animals, and the most delicate insects may be coated. These substances have no conductive power for electricity; it is, therefore, necessary to metallize them.

Metallization.—This coat should be so thin as not to alter the shape or the minutest parts of the model.

Plumbago, or graphite, is generally preferred, and in most cases its conducting power is sufficient; and it may be applied in films thin enough not to impair the sharpness of the mould. The plumbago found in the trade is rarely pure. Remove the impurities by digesting for 24 hours a paste made of plumbago and water, with hydrochloric acid. Several washings with water, and slow drying in a stove, finish the operation. If the plumbago is in large lumps, it should be powdered and passed through a silk sieve. The conducting power of this substance is sufficient when the surfaces are not deeply indented; but the mould should be rough enough for the plumbago to stick to it.

Gold Plumbago has a conducting power much greater than that of the ordinary substance. Prepare as follow:—In $1\frac{1}{2}$ pint of sulphuric ether dissolve $\frac{1}{2}$ of an ounce of chloride of gold, and thoroughly mingle with it from 18 to 20 oz. of good plumbago. Then pour into a shallow porcelain vessel, and expose to the action of air and light. After a few hours the ether completely volatilizes; stir the powder now and then with a glass spatula. Finish the drying in a stove.

Silvered Plumbago.—Dissolve 3 oz. of crystallized nitrate of silver in 3 pints of distilled water; mix this solution with 2 lbs. of good plumbago. Dry in a porcelain dish, and then calcine at a red heat in a covered crucible. After cool-

ing, powder and sift. Plumbago thus metallized conducts electricity nearly as well as a metal, although it is very expensive. Bronze powder mixed with plumbago is also used.

Rendering Moulds Impervious to Liquids.—Porous substances, before being coated with plumbago, are submitted to a previous operation, to render them impervious, by covering them with a coat of varnish, or by saturating them with wax, tallow, or stearine. For instance, with a plaster cast, cut a groove on the rim of the mould, place in it a brass wire, twist the ends, which must be long enough to hold the cast by. The cast, having been previously dried, is then dipped into a bath of stearine kept at a temperature of from 180° to 212° Fahr., and a number of bubbles of air will escape from the mould to the surface. When the production of air-bubbles is considerably diminished, remove the cast from the bath. When the cast is tepid, cover it with powdered plumbago, and let it get quite cold. Then, after breathing upon it, rub thoroughly with a brush covered with plumbago; and be careful that the surfaces are completely black and bright, without grey or whitish spots. When the mould is very undercut, it is difficult to employ plumbago. In such cases metallize the whole, or the deep parts only, by the wet way. Soft brushes should not be used for rubbing plumbago. When the substances to be metallized are not porous, such as glass, porcelain, stoneware, horn, and ivory, cover them with a thin coat of varnish, which, when nearly dry, receives the plumbago.

Metallization of Ceramic Articles.—After having varnished the portions of the piece to be coppered, cover them with very finely laminated foils of lead, which bend to all desired shapes; then connect a brass conducting wire with the lead, and dip the whole into the bath; copper is immediately deposited upon the metallic parts. Thus glass vases may be entirely covered with copper, upon which deposit layers of gold or silver. The chaser may penetrate with his tool to different depths,

and uncover one after the other, first the layer of silver, next that of copper, and at last the crystal itself. The vase will appear as if set in a net of various colours. For very fine work, the gold ornament first painted with the pencil, and fixed in the usual manner by heating in a muffle, is put in contact with a very thin conducting wire, and the whole immersed in a copper, silver, or gold bath, where the deposit takes place in the same manner as upon an ordinary metal, and the adherence is as perfect as that of the film of gold upon the porcelain. The deposit is afterwards polished, chased, or ornamented on the lathe.

Metallization by the Wet Way.—Silver, gold, and platinum, reduced from their solutions, have an excellent conducting power. Silver is generally preferred, and its nitrate is dissolved in certain liquids, variable with the substances to be covered. Apply the solution with a pencil upon the mould, and let it dry; repeat the operation two or three times. Lastly, expose the mould to the action of the sunlight, or of hydrogen, or fix it to the top of a box which closes hermetically, and at the bottom of which is a porcelain dish holding a small quantity of a concentrated solution of phosphorus in bisulphide of carbon. After a few hours this solution completely evaporates, and reduces to the metallic state the nitrate of silver covering the mould, which becomes black, and is then ready for the bath. When used to metallize wood, porcelain, and other resisting substances, dissolve 1 part of nitrate of silver in 20 parts of distilled water. With fatty or resinous materials, which water will not wet, use aqua ammonia. With very delicate articles, which will not bear a long manipulation, make the solution in alcohol, which evaporates rapidly. Concentrated alcohol dissolves nitrate of silver but slightly; but enough will be dissolved for metallizing flowers, leaves, and similar articles, if the solution is aided by grinding in a mortar. If the conducting wire is fixed to the mould before the metallization, the wire must be of gold, silver, or platinum, as

the other metals rapidly decompose the solution of nitrate of silver; but brass and copper wires may be employed when the metallization is completed, after the reduction by phosphorus.

Solution of Phosphorus in Bisulphide of Carbon.—Half fill a glass stoppered bottle with a large neck with bisulphide of carbon, then gradually introduce the phosphorus gently dried with blotting paper, and shake the bottle now and then. Phosphorus is added until no more dissolves. This preparation requires great care in the handling, because in drying upon combustible materials it takes fire spontaneously.

Plaster of Paris Moulds.—After the original model, say a medal, has been thoroughly rubbed with soap or plumbago, wrap round the rim a piece of stout paper, or thin lead foil, and band it in such a manner that the article to be copied, face upwards, is at the bottom of the box thus formed. Then in a vessel filled with a sufficient quantity of water, sprinkle fine plaster of Paris until the last portions reach the level of the water. After waiting for one or two minutes, stir, and the thin resulting paste must be employed immediately. With a painter's brush give a thin coat of this paste, and press into all the recesses; this is to expel the air; then pour the remainder of the paste up to a proper height, and allow it to set. After a few minutes the plaster hardens, and may be separated from the paper. Scrape off what has run between the paper and the rim of the medal, and the plaster cast will separate from the model. Plaster of Paris moulds cannot be introduced into the bath without having been previously rendered impervious.

Moulding with Stearine and Wax.—Stearine is melted and poured upon the model when it is going to set. When stearine is too new or dry, it crystallizes in cooling, and this impairs the beauty of the cast: In such case it should be mixed with a few drops of olive oil, or with tallow, or suet; if it is made too fat, it will remain soft and difficult to separate from the mould. It should then be mixed with virgin wax or sper-

maceti. As stearine contracts considerably by cooling, its employment must be avoided when the copies are required to be perfectly accurate. When it is desired to make a cast with stearine of a plaster model, the latter should be thoroughly saturated with water or stearine beforehand, and should also be perfectly coated with plumbago before the melted substance is poured upon it, otherwise the two will stick together, and it will not be possible to separate the cast from the model. Wax may also be employed in the same manner, but its price and want of hardness interfere with its application.

Moulding with Fusible Metal.—This metal is a perfect conductor of electricity, and therefore well adapted to the production of homogeneous deposits of equal thickness; it is, however, seldom employed, on account of the difficulty of the operation, of its crystalline texture, and of the presence of air-bubbles.

1. Pure lead, 2 parts in weight; tin, 3; bismuth, 5; fusible at 212° Fahr. 2. Pure lead, 5 parts in weight; tin, 3; bismuth, 8; fusible from 180° to 190° Fahr. 3. Pure lead, 2 parts in weight; tin, 3; bismuth, 5; mercury, 1; fusible at 158° Fahr. 4. Pure lead, 5 parts in weight; tin, 3; bismuth, 5; mercury, 2; fusible at 125° Fahr. For those alloys without mercury, the component metals may be melted together; when mercury is employed, it should be added when the three other melted metals have been removed from the fire. To obtain a thorough mixture the alloy should be stirred with an iron rod, or melted over and cast several times. 1. Run the metal into a small dish, remove the oxide with a card, and then apply the model, give it a few taps when the setting takes place; or put the model into the dish, and pour the clear alloy upon it. 2. Put the medal at the bottom of a small box of iron or copper, and bury half of its thickness in plaster of Paris; then, cover the medal with the cold fusible alloy, and apply heat until it is melted, when it is allowed to cool off. It is easy to separate the medal from the fusible alloy, as the portion protected by the plaster of

Paris may then be grasped. A well-made cast of fusible alloy is the best mould for galvanoplastic operations with silver and gold. Alloys containing mercury should not be used for taking casts from metallic medals, iron excepted, which would be amalgamated and injured. Copper deposits obtained upon such alloys are very brittle. Melted sulphur produces very neat and sharp casts; it is, however, very difficult to get it metallized, and it transforms the deposit of copper into sulphide.

Moulding with Gelatine.—In certain conditions, the elasticity of gelatine and gutta-percha allows of removing them from undercut or highly-wrought parts, and they reacquire the shape and position they had before the removal. This property is found in gelatine to a higher degree than in gutta-percha, but it requires a very rapid deposit, otherwise it will swell and be partly dissolved by too long an immersion in the solution of sulphate of copper. Put a sufficient quantity of colourless plates of gelatine in cold water, and let it swell there for about 24 hours; then drain off the water, and heat the gelatine upon a water bath until it has become of a syrupy consistency; it is then ready to be poured upon the object, which must be encased in a box of pasteboard or of thin lead. After cooling for about 12 hours, separate the cast from the object. To enable the gelatine to remain longer in the bath without alteration, use one of the following mixtures;—1. Dissolve the best gelatine in hot water, and add $\frac{1}{4}$ th of the weight of gelatine in tannic acid and the same quantity of rock candy; then mix the whole thoroughly, and pour upon the model in its box. After a few hours the gelatine may be easily separated from the object. 2. A mould having been made with gelatine alone, pour on it a solution of water holding 10 per cent. of bichromate of potash, and after draining, expose the mould to the action of the sun. 3. Beat, in 2 pints of distilled water, the whites of 3 eggs, filter, and cover the entire surface of the gelatine mould with this liquid. After drying, operate with the

solution of bichromate of potash, as in No. 2. 4. Pour some varnish upon the gelatine mould, drain carefully, and let it dry. The best varnish for the purpose is a solution of india-rubber in benzole, or in bisulphide of carbon. The mould must be metallized, and, when in the bath, submitted to a galvanic current of great intensity at the beginning. When the entire surface is covered with the copper deposit, and swelling is no longer to be feared, the intensity may be reduced.

Moulding with Gutta-percha.—Gutta-percha is entirely insoluble in water, in weak acids, and in the solution of sulphate of copper. After purification in boiling water, plates of various thicknesses or lumps are formed. A quantity sufficient for the intended mould is cut and put in cold water, which is gradually heated, until it is soft enough to be kneaded with the fingers like dough. After having pulled the gutta-percha in every direction, the edges are turned in so as to form a kind of half ball, the convex and smooth surface of which is then applied upon the middle of the model. Then the gutta-percha is spread over and forced to penetrate the details of the object. The kneading is continued so long as the material remains sufficiently soft, when it is allowed to cool. As soon as it is lukewarm, the gutta-percha is separated from the model, and dipped into cold water, when it hardens, and may then be handled without danger of impairing its accuracy.

Moulding with the Press.—After the object has been carefully coated with plumbago or tallow, it is put square and firm upon the table of the press, and surrounded with a ring or frame of iron, which should be a little higher than the most raised parts of the object. A piece of gutta-percha at least double the thickness of the pattern, is cut so as to fill the ring or frame of iron, and then heated, on one of its faces only, before a bright fire. When about two-thirds of its thickness have been softened, it is to be placed, soft portion downwards, in the iron ring or frame, and the whole covered with a block of metal exactly fitting. The screw to the press is made to act slowly at first,

but with gradually increased force, as the gutta-percha becomes harder and more resisting.

Moulding with a Counter-mould.—Cast a thick block of lead upon sand, hollow out approximately with a graver the places corresponding to the reliefs of the pattern, bearing in mind the desired thickness of the gutta-percha. Spread over the pattern a plate of gutta-percha of the same thickness all through, upon this place the lead block, compress by the screw press. This process produces excellent results.

Moulding in the Stove.—This is convenient for brittle articles of plaster of Paris, marble, or alabaster. The pattern is put upon a dish of iron or earthenware, a ball of gutta-percha is placed in the middle of the object to be moulded, and the whole is placed in a stove, where the temperature is just sufficient to melt the gutta-percha, which softens and penetrates all the details; when it has sunk completely, remove it from the stove, and allow to cool off until it still retains sufficient elasticity to be separated from the pattern.

Moulding by Hand.—The foregoing process does not suit objects which will not bear the heat of the stove; for such articles heat the gutta-percha slowly until it becomes a semi-fluid paste; pour a sufficient quantity of it upon the pattern previously placed in an iron frame or ring. After a few minutes, knead it, with wet or oiled fingers, to make it penetrate all the details of the pattern until it scarcely yields to the pressure. In removing the mould from the pattern, cut off all the useless parts of the gutta-percha, and especially those which may have passed under the pattern and bind it. Then the proper position and shape of the covered pattern must be ascertained, so as not to break the model, or tear the gutta-percha. In moulding with the press, gutta-percha of the best quality is generally employed. For moulding by sinking or kneading, gutta-percha should be mixed with certain substances to increase its fusibility, such as linseed oil, lard, tallow, or yellow wax. Their proportions should never be over

one-third of the total weight. The mixture with linseed oil is made by heating in a kettle 1 part of linseed oil, and when its temperature has reached from 190° to 212° Fahr., add gradually, and stir in 2 parts of gutta-percha cut into small pieces. When the whole is in a pasty form, and begins to swell up with the production of thick fumes, remove the kettle from the fire, and throw its contents into a large volume of cold water, where, without loss of time, the paste must be well kneaded. While still hot, place it upon a slab of marble or stone; it may afterwards be rolled between middling warm rollers. Gutta-percha may be used for an indefinite length of time. Moulds of plaster of Paris, from which moulds of fusible metal or of gelatine are to be taken, will stand the operation much better if they have been hardened by being saturated with boiled linseed oil, to which a certain proportion of dryer has been added. They must be oiled again just before pouring the gelatine over them.

Deposits on Undercut Patterns which are Sacrificed.—A cast of a human head in plaster of Paris may be rendered impervious, and then metallized. After a deposit of copper has been effected on its surface, remove the plaster by boiling, and breaking it through the opening of the neck. The copper mould thus obtained, after being slightly greased inside, serves as a galvanoplastic trough, which is to be filled with the solution of sulphate of copper. Suspend bags filled with crystals of blue vitriol to the edges, and with a separate battery and soluble anode, or with a porous cell placed inside the mould, which is connected with the zinc, another deposit of copper takes place in the cavity. When the thickness of the metal is sufficient, strip off the mould or first deposit. This process is expensive, but gives sure results with large patterns having large raised parts. With small or narrow, or very crooked objects, moulds in several parts must be used, although the seams require mending.

Method for Articles in High Relief with Gutta-percha Moulds.—If it is required

to imitate a statue, or other large article, commence by making with gutta-percha a mould in several pieces, which, by means of proper marks, may be united together, and form a perfect hollow mould of the pattern. Cover all these parts carefully with plumbago. Make a skeleton with platinum wires, to represent the outline of the pattern; this must be smaller than the mould, as it has to be suspended in it without any point of contact. The skeleton is to be enclosed in the metallized gutta-percha mould, and the whole immersed in the galvanoplastic bath; connect the inner surface of the mould with the negative pole of the battery, and the skeleton, which should have no point of contact with the metallized surface of the mould, of platinum wires with the positive pole; this decomposes the solution of sulphate of copper, which must be placed in the mould. When the deposit has reached the proper thickness, remove the gutta-percha mould, inside which will be found the statue, which may be finished at a very small expense. Lead wires may be substituted for the platinum, they are cheaper, and may easily be removed, when done with, by melting. But the execution of the process is not easy, as it is very difficult to ascertain that the skeleton anode is nowhere in contact with the enclosing mould; to avoid such contact, wrap all the external parts of the platinum anode with a spiral of india-rubber thread. As the increase of the deposit of copper reduces the distance between the mould and the anode, the latter and the deposit may come in contact, and stop the operation without any exterior sign to attract attention. Thus, if in a trough holding many moulds, our point of contact were established between the two poles, mould and skeleton, all the electricity of the battery would escape at that place, and the working of the bath would stop entirely. To obviate this inconvenience, support all the moulds of the same bath by hooks suspended to a metallic rod. These hooks must have no contact with the metallized surfaces of the moulds, which must be connected with the negative pole by

metallic wires terminated above the liquid by very fine iron wires. The connecting wires of the skeleton anode are to pass through the same opening as the negative electrodes, but without contact, and are united to the positive pole. So long as there is no contact between the skeleton and the interior of the mould, the electric fluid finds sufficient passage through the several fine iron wires which connect the moulds with the battery; but, if any contact takes place, the whole of the electricity rushes to that point, and, being too abundant for the small iron wire, it heats and burns it out rapidly. The work is thus instantaneously stopped for this mould, and continues for the others; and the broken wire shows where the defect is. The iron wire should be very short, so as to burn rapidly. In closed moulds and with an insoluble platinum anode, the solution of sulphate of copper will be rapidly transformed into sulphuric acid and water. Therefore make two holes at the lower part of the mould, through which and the opening at the head left for the passage of the electrode a free circulation of the liquor in the bath may take place. When the operation is completed, remove the gutta-percha mould, and the skeleton anode must be pulled out. Close the three holes in the statue, and file off the seams left at the junction of the different parts of the mould.

Filling the Hollow Deposit with Brass Solder.—First cover the exterior with clay, plaster of Paris, or Spanish white mixed with charcoal dust, and dry in a stove-room. This coat is to prevent the copper deposit from losing its shape and being oxidized by the heat. The interior of the article is then to be filled with the softest brass solder, and powdered borax, which are melted by a gas or turpentine blowpipe. All the hollow parts are soon filled with the solder, which imparts to them as much firmness and durability as is to be found in cast articles.

Removing the Mould.—With a metallic mould, after having removed the useless portions of the deposits, pass a card or a blade of ivory between the model and the deposit. The operation is the same with

moulds of plaster of Paris, porcelain, marble, glass, or wood; but it is difficult to save a plaster mould which has been in the bath, and which is nearly always sacrificed. Moulds of wax, stearine, fusible metal, gelatine, or gutta-percha are softened in boiling water, and their separation presents no difficulty whatever.

Finishing up the Articles.—The articles when separated from the moulds are generally spotted with plumbago, grease, or other substances from the moulds. It is usual to heat them, so as to burn out the impurities, and to cleanse them by immersion in a pickle of diluted sulphuric acid. The heating renders the copper deposit softer and more malleable; but it may result in injury to the minute details and the fineness of the copy. Therefore, for delicate works, it is preferable to clean with alcohol, turpentine, or benzole, and to rub the surface with a stiff brush; finish with a paste of Spanish white in water, which let dry upon the object before it is wiped out. Should any Spanish white remain in the hollows, it may be dissolved in water holding one-tenth of its volume of hydrochloric acid, which does not corrode the copper. Complete the operation by rinsing in fresh water, and drying in sawdust or otherwise. When it is desired to anneal the articles without injury to their surface, plunge them into boiling colza or linseed oil, or simply grease, which will bear a heat sufficient for annealing, and will prevent the oxidizing action of the air. This annealing in fatty substances is to be recommended in the case of highly undercut moulds of gutta-percha, which may have left part of their substance in the deep recesses of the copy. The gutta-percha is first softened, and then dissolved in the fatty material.

GALVANOPLASTIC OPERATIONS WITH GOLD OR SILVER.—The processes are more difficult and less effective than those for copper. In the case of non-conducting and deeply-wrought moulds, after having deposited by the ordinary process a thin coating of copper, the whole is plunged into the silver bath,

which then works very well. After the separation of the copy from the mould, allow it to rest in a solution of ammonia or of very dilute nitric acid, which, after a time dissolves the copper, and leaves the silver deposit. This reproduction must be imperfect, as there is, between the mould and the precious metal, an intermediate layer of copper of unequal thickness. When the surfaces are but slightly in relief, employ moulds of lead, tin, or fusible metal, upon which silver or gold will deposit well and without adherence. Lead is preferable to the other metals, especially when the mould may be obtained by pressure. Cover the pattern with a very thin foil of lead larger than the object, the gutta-percha is applied upon it, and pressed, as before explained. The lead foil, without being torn, will follow all the details of the pattern, and may be separated afterwards with the gutta-percha which it has metallized. Instead of lead, silver or gold foils may be used, and are so thin that the seams disappear by simple pressure. A somewhat thick sheet of very pure lead may be employed for taking moulds of engravings upon copper or steel. The lead and the engraved plate are to be passed between rollers, or simply pressed under a screw press.

Baths for Silver and Gold.—The bath for silver is composed of distilled water, 1½ pint; cyanide of potassium, 7 oz.; nitrate of silver, fused, 2½ oz. The gold bath is made of distilled water, 2 pints; cyanide of potassium, 6 oz.; neutral chloride of gold, 2 oz. In this case, the weight of the chloride of gold, and not that of the metal employed for its preparation. These baths generally work with separate batteries, and with anodes of the metal used in the solution, or the porous cells and zincs may be put into the bath itself, provided that the exciting liquor be a more or less concentrated solution of cyanide of potassium. The zincs must not be amalgamated, unless in separate batteries. Green gold is obtained by mixing 10 parts of gold bath with 1 of silver bath, or by employing for a time a silver anode in the gold solution. The deposits of gold and silver,

after their separation from the mould, should be heated and scratch-brushed; and a proper shade may be given to them by a short sojourn in ordinary electro-gilding or silvering baths.

GALVANIC ETCHING.—The most simple process consists in covering entirely a copper plate, with an insulating varnish, which is not acted upon by the bath, and then in tracing the drawing with a graver, which must penetrate through the coat of varnish, and expose the copper. By using this plate as the soluble anode of a bath of sulphate of copper, and suspending another copper plate at the negative pole, the latter will receive the deposit, whereas the former will become hollow at the places uncovered by the graver. The engraving produced will only need a slight finishing up. Instead of using varnish as an insulating material, a metallic film, which cannot be dissolved in the bath, may be used. If the copper plate is strongly gilt with the battery, the gilt portions will remain entirely unacted upon, as the acid of the sulphate of copper does not dissolve gold. It is equally easy to produce a drawing in relief, by making the drawing with some insulating material like varnish or a lithographic pencil. The uncovered portions around the lines of the drawing will become hollow, and the image will be in relief. The baths employed generally hold in solution the same metal as that to be engraved; thus, baths of sulphate of copper are used for etching copper plates, solutions of sulphate of zinc for zinc plates, and gold or silver baths for the corresponding metals. Copper and zinc plates may be engraved by the battery, in a simple bath of water with a little sulphuric, acetic, or nitric acid. Upon a varnished plate of copper, a drawing is traced; this plate is dipped into a weak solution of nitrate of bioxide of mercury, and then set perfectly level. By covering it with metallic mercury, this becomes fixed upon the lines traced by the graver, and all the drawing is reproduced in relief by the mercury. Cover the plate with a thin paste of plaster of Paris, and when the latter has set the two moulds are separated,

and the mercury still adheres to the copper. The plaster mould may be treated either for getting a counter-mould from it, or for directly obtaining a galvanoplastic deposit after its metallization.

2. The copper plate is varnished as above, and with the graving tool the parts which will produce the blacks of the engraving are uncovered. A solution of neutral protochloride of zinc is poured upon the plate, and a quantity of fusible metal, fusible at from 190° to 212°, is melted by means of an alcohol lamp moved about under the copper plate. The same result is obtained as with the mercury, except that the mould may be immediately reproduced by galvanoplastic methods.

COMPOSITION FOR RENDERING THE DECOMPOSING BATHS IMPERVIOUS.—A well-joined and screwed, or bolted, oak bath will last from 12 to 15 years, if coated with a mixture composed of;—Burgundy pitch, 6 parts; gutta-percha, old and cut into small pieces, 1; finely-powdered pumice-stone, 3. Melt the gutta-percha, and mix it, by kneading, with the pumice-stone, then add the Burgundy pitch. When these three substances are thoroughly mixed and in the liquid state, several coats must be spread over the inside of the trough. The angles and corners require a greater proportion of material, which is run in by means of an iron ladle. These various coats are at first coarse and irregular; an even surface is obtained by a heated flat-iron and a soldering iron for the angles. The heat increases the adherence and the penetration of the wood. The exterior of the trough and the iron parts are varnished, either with a fat varnish or the residuum of some turpentine varnish. A trough thus prepared will resist galvanoplastic baths at 28° Baumé, composed of sulphuric acid and sulphate of copper, and even pure nitric or sulphuric acid, provided that neither of these latter remain long in it; but it will not stand the cyanides.

DEPOSITS TO IMITATE MOSAIC WORK.
—Cut an open pattern upon a sheet of copper, spread it even upon another metallic plate, and dip the whole into a

bath of silver or gold, the empty spaces will be filled with the new metals; or a pattern may be hollowed out with a graver from a plate of ivory or mother-of-pearl, and the whole metallized and immersed in the galvanoplastic bath. When the whole surface is covered with the metallic deposit, grind and polish it until the reliefs of ivory or mother-of-pearl reappear, and the metal will form the relief.

BRONZE FOR MEDALS.—This operation is to give to new metallic objects the appearance of old ones, by imitating the characteristic appearance imparted by age and atmospheric influences to the metals or metallic compounds, and especially to copper and its alloys.

1. The most simple bronze is, obtained by applying upon the cleansed object a thin paste made of water with equal parts of plumbago and peroxide of iron, with a certain proportion of clay. Then heat the whole, and when the object is quite cold, brush in every direction for a long time with a middling stiff brush, which is frequently rubbed upon a block of yellow wax, and afterwards upon the mixture of plumbago and peroxide of iron. This process gives a very bright red bronze, suitable for medals kept in a show case.

2. This bronze may also be produced by dipping the article into a mixture of equal parts of perchloride and nitrate of sesquioxide of iron, and heating until these salts are quite dry. Then rub with the waxed brush as described.

3. Cleanse the article, and cover it with hydrosulphate of ammonia, which allow to dry, then brush with peroxide of iron and plumbago, and afterwards with the waxed brush. If the piece impregnated with hydrosulphate of ammonia is gently heated a black bronze is obtained, which being uncovered at certain places produces a good effect.

Bronze for Zinc.—The zinc to be bronzed must receive an electro-deposit of brass, which is then dipped into a weak solution of sulphate of copper for a red tinge. When dry, wet with a rag dipped into hydrosulphate of ammonia, or a solution of polysulphide of potas-

sium, or protochloride of copper dissolved in hydrochloric acid. After another drying, the surface is brushed over with a mixture of peroxide of iron and plumbago, according to the tint desired. The brush may be slightly wetted with essence of turpentine, which aids the adhesion of the powders. The raised parts are strongly rubbed to uncover the brass. Afterwards give a coat of colourless varnish.

Antique Bronze.—Dissolve in 20 parts by weight of ordinary strong vinegar 3 parts of carbonate or hydrochlorate of ammonia, and 1 each of common salt, cream of tartar, and acetate of copper, and add some water. When an intimate mixture has been obtained, smear the copper object with it, and let it dry at the ordinary temperature for nearly 48 hours. After that time the object is entirely covered with verdigris of various tinges. Then brush the whole, and especially the reliefs, with the waxed brush. If necessary, the raised parts are set off with chrome yellow, or other suitable colours. Light touches with ammonia give a blue shade to the green portions, and carbonate of ammonia deepens the colour of the parts on which it is laid.

Black Bronze.—A steel bronze is obtained by wetting the copper articles with a diluted solution of chloride of platinum, and slightly heating. This bronze will sometimes scale off by friction. It may also be obtained by dipping the cleaned copper into a weak warm solution of chloride of antimony in hydrochloric acid. But sometimes the colour is violet instead of black.

Bronze Powders.—Bronze powders made of impalpable brass are applied upon metals to imitate bronze, and also upon articles of plaster of Paris, and ceramic wares. After the object has been cleaned, it receives a thin coat of fatty drying varnish, which is allowed to become nearly dry. The bronze powder is then laid on with a brush, and adheres strongly. After drying, cover it with a coat of transparent colourless varnish. This process is only suited to large pieces which are

imperfectly finished, and will not do for reproductions intended to respect the small details.

Acetate of Copper, Neutral.—It is found in the trade either in dark green crystals, or as a bright green powder soluble in water, which becomes green; very soluble in ammonia, and the solution is of a sky-blue colour; it is used for preparing electro-baths of copper and brass; manufactured with copper corroded by fermenting grape-mash, and by other processes.

Acetate, or Sugar, of Lead.—This is usually in masses formed of needle-like crystals; white; light, although having lead for its base; very soluble. Obtained by dissolving litharge or protoxide of lead in an excess of vinegar or acetic acid. Its solution forms, with caustic potash or soda, a white precipitate which is soluble in an excess of alkali, and then constitutes the bath for coloured rings.

Acetic Acid.—It is more or less concentrated and pure, according to the mode of manufacture. Wood vinegar or pyroigneous acid is employed in large quantities, and is colourless or more or less yellow. It often possesses an empyreumatic smell, and generally marks 8° of the hydrometer for acids. Wine vinegar is more or less coloured, and may be concentrated. Crystallizable acetic acid is obtained by the distillation of perfectly dry acetate of soda, or acetate of lead, with concentrated sulphuric acid. The vapours are condensed in a glass receiver, which should be surrounded by ice, sometimes mixed with common salt.

Nitrous and Hyponitric Acids.—These two acids are of an orange-yellow colour, more or less deep, and are always produced by the action of nitric acid upon a metal. The smell is flat and nauseous, and it is dangerous to inhale much of these gases. They colour aquafortis yellow, and also impart a greenish tinge to metallic solutions, those of silver for instance, which may appear as holding copper. This colouration disappears by heating, which it will not do if copper be present. They are abundantly pro-

duced during the cleansing of copper and its alloys in aquafortis.

Nitric Acid.—Called also aquafortis or spirit of nitric. It is bought at 40° Baumé, colourless or dark yellow; and at 36° Baumé, colourless or more or less deep yellow. This colouration is generally due to the presence of nitrous gases, and is perfectly satisfactory for cleansing copper; but it sometimes results from the presence of hydrochloric acid, thus forming aqua regia, or, what is worse, of iodine, bromine, or chlorine, and then the cleansing processes with it are unsuccessful. Pure nitric acid is absolutely necessary for the preparation of nitrate of silver. The presence of chlorine, hydrochloric acid, or sulphuric acid will transform a part of the metal into insoluble, or scarcely soluble, compounds. A pure nitric acid is obtained;—1. By distilling in a large glass retort the commercial article, and collecting the product only when it no longer produces a precipitate or turbidity in a solution of nitrate of silver. The distillate is then collected into a glass receiver and cooled with fresh water or ice. The operation is terminated when about five-sixths have been distilled, otherwise the sulphuric acid will also pass over. 2. By precipitating with nitrate of silver and nitrate of baryta, the hydrochloric and sulphuric acids of commercial aquafortis, and then distilling the whole nearly to dryness. The residuum in the retort is composed of sulphate of baryta, chloride of silver, and the excess of the nitrates of these two bases. 3. By distilling in a glass retort a mixture of 100 parts of pure nitrate of potash with 60 of pure concentrated sulphuric acid and 40 of distilled water. The heat is gradually raised, and stopped when, after having disappeared, the yellow vapours reappear. The acid thus obtained is slightly yellow, and is bleached, by heating it to near the boiling point.

Boracic Acid is obtained in the form of scales by decomposing, with a powerful acid, a concentrated and boiling solution of borax; the boracic acid crystallizes by cooling. It is used for making platinum adhere, by the heat of

a muffle, to ceramic wares; thus causing the metallization of surfaces which were not naturally conducting. It is also employed for increasing the whiteness of silver alloys, and for the decomposition of the subsalts deposited in electro-baths containing cyanide of potassium.

Hydrocyanic Acid, or Prussic Acid.—Diluted hydrocyanic acid is colourless, although it is often coloured by a small proportion of Prussian blue, which does not change its properties, with a bitter taste, and the characteristic smell of bitter almonds or peach-tree flowers, although less aromatic, more pungent and deleterious. It is prepared by introducing into a large retort fixed to a receiver, which is cooled by ice, 2½ lbs. of the double cyanide of iron and potassium, yellow prussiate of potash, 1½ pint of water, and 3½ lbs. of concentrated sulphuric acid. The acid and water should be mixed beforehand and allowed to cool. The distillation is effected in a sand bath, and the condensed liquid is clear and colourless. The operation must be stopped when the substances in the retort begin to swell up, otherwise a certain proportion of cyanide of iron and sulphate of potash will pass into the receiver. Avoid inhaling the vapour produced during this preparation. Hydrocyanic acid may also be obtained by passing a stream of washed sulphuretted hydrogen through a tall glass vessel holding water and cyanide of mercury. The latter compound is transformed into the insoluble sulphide of mercury, whereas the hydrocyanic acid remains in solution. After filtering, the liquor is gently heated in order to expel the remaining sulphuretted hydrogen, which is more volatile than hydrocyanic acid. This method is not so simple as the preceding one, and is open to the inconvenience of often having the acid contaminated with undecomposed cyanide of mercury or sulphuretted hydrogen. Hydrocyanic acid is employed for maintaining the metal strength of gold dipping baths with pyro-phosphates, and for decomposing the alkaline carbonates formed in baths with cyanide of potassium.

Hydrochloric Acid, Spirit of

Salt.—During the preparation of this acid, it is gaseous, and emits abundant and thick fumes in contact with the air. Water, at the temperature of 70° Fahr., dissolves 460 times its own volume of this acid. This solution is always employed in the arts, and is generally contaminated with sulphurous and sulphuric acids, and by perchloride of iron, imparting a yellow colour to it. It is employed for preparing the chlorides of certain metals, for instance that of zinc; it enters into the composition of aqua regia; and the common salt, added to certain cleansing acids, is intended to form a small quantity of hydrochloric acid. It is prepared by introducing common salt into a glass balloon, and an excess of commercial sulphuric acid. A gentle heat is gradually applied, and the gas is collected and dissolved in a series of tubulated bottles. These receivers should be constantly cooled by a stream of water or by ice, because the elevation of temperature caused by the combination of the water and acid, would prevent the liquid from becoming thoroughly saturated. The first bottle contains but little water, and is intended to arrest the impurities mechanically carried by the gas. The glass balloon, after the operation, contains acid sulphate of soda.

Hydrofluoric Acid.—Hydrofluoric acid is prepared by decomposing in a lead retort a paste of fluoride of calcium and sulphuric acid. The various joints of the retort are carefully luted with clay or plaster of Paris, and the receiver is a bent tube of lead plunged into a mixture of 3 parts of broken ice, and 2 of common salt, or more simply, into ice alone. The end of the receiver is perforated with a small hole, in order to aid the condensation by a small pressure. A gentle heat is applied at the bottom of the retort. This acid must be kept in lead bottles which are but slightly acted upon, or in platinum vessels, upon which it has no action whatever; gutta-percha bottles have been substituted for the metallic ones, and appear to stand the acid well when it is not too concentrated. Avoid any contact with

the vapours of hydrofluoric acid, otherwise after a few hours the skin will be covered with painful blisters.

Stearic Acid.—This acid is white, and more or less greasy to the touch; it melts at a temperature from 140° to 150° Fahr. into a clear liquid, which again solidifies by cooling. It is this property which renders stearic acid valuable for taking casts. If too greasy it will stick to the pattern, and especially to plaster of Paris coated with plumbago; in this case it should be mixed with a certain proportion of wax or spermaceti. When too dry it contracts considerably by cooling, often breaks, and the galvanoplastic deposits have a crystalline surface. This defect is corrected by tallow or olive oil.

Hydrosulphuric Acid.—Generally in the gaseous form, but may be dissolved in water, which absorbs two or three times its own volume of it at the ordinary temperature, and then acquires the same properties as the gas itself. Hydrosulphuric acid is obtained by the reaction of hydrochloric acid, or diluted sulphuric acid, upon many sulphides, such as those of antimony, iron, barium, or strontium. The gas is collected under receivers filled with mercury, or is dissolved in an apparatus such as that described in the manufacture of hydrochloric acid. The distilled water employed should be deprived of air by boiling, otherwise the solution will be milky from the partial decomposition of the acid. Be careful not to bring in contact with this gas metallic salts, gilt or silvered articles, or even pure gold and silver, which are rapidly blackened by it.

Tannic Acid.—This acid is generally prepared by digesting powdered gall-nuts, at a temperature of about 90° Fahr., in commercial ether, and in closed vessels. After about eight days the settled liquid, which is quite syrupy, is decanted and spread upon many dishes, which are put into a stove. The ether is evaporated, and the nearly pure tannic acid remains in uncrystallized scales, which are light, thin, yellowish, and with the lustre of mother-of-pearl. It is purified by solution in boiling

water, which, by cooling, allows it to deposit in the shape of needle-like crystals. Tannic acid possesses the singular property of rendering insoluble certain gums, gluten, and gelatine especially, the latter being transformed into a kind of leather which will not putrefy.

Gold Amalgam.—Amalgam is the name given to alloys of metals with mercury, but the latter must absolutely be one of the component parts. Whatever be the proportions of gold and mercury put together, an amalgam is always formed; but there are certain proportions which are more or less favourable for obtaining a certain result. The gold amalgam for gilding by stirring should be more fluid, and therefore contain more mercury, than that prepared for gilding by fire for a dead lustre, or for ornolu. The latter should be of the consistency of hard cold butter, a little rough to the touch, and with a crystalline texture which causes the production of a noise when the amalgam is pressed between the fingers. That for gilding by stirring should be of the consistency of honey and quite soft. An amalgam is generally prepared by heating distilled mercury to a temperature of about 390° F., and adding to it foils or ribbons of gold, which readily incorporate. The whole is then thrown into cold water. If the proportion of mercury has been too great, the amalgam may be heated over the fire, until part of the mercury is volatilized, and the proper consistency is reached. Should the amalgam be too hard, an addition of mercury will soon mix with the mass. When an amalgam is heated at a dull red heat, all the mercury is volatilized, and the gold remains in the form of a spongy and crumbling mass.

Ammonia.—Ammonia is obtained by treating any kind of ammoniacal salt by a fixed alkali. Sulphate or hydrochlorate of ammonia is generally employed, and is heated in a stoneware retort with slaked lime. The gas produced is received either under glass bells or tubes filled with mercury, if we desire to keep it in the gaseous state; or is dissolved in the water contained in tubu-

lated bottles if its solution is desired. After the operation there remains in the retort sulphate of lime or chloride of calcium. Ammonia is employed for aiding the solution of the copper salts entering into the composition of the baths for electro-deposits of copper or brass, for ageing freshly-made silver baths, for precipitating gold ammonium from the chloride of gold, and for dissolving the film of copper deposited at the beginning of galvanoplastic operations with silver, &c.

Silver.—The silver found in the trade, even under the name of virgin silver, retains traces of copper. Silver is purified by several methods;—1. The impure metal is dissolved by nitric acid, and the solution being largely diluted with water, add to it an excess of a filtered solution of common salt. An abundant white precipitate of chloride of silver is produced, which rapidly settles to the bottom of the vessel. All the silver salt is decomposed when the clear liquid is not rendered turbid by a further addition of common salt. The chloride of silver is collected, and washed several times, until the liquors are no longer coloured brown by yellow prussiate of potassa. This is the proof that all the copper has been washed out. The washed chloride of silver is mixed with two or three times its own weight of carbonate of soda, dried, and melted in a crucible. After cooling, the metal is found in a conical button at the bottom of the crucible. To granulate it, the molten silver is poured from a certain height, about 3 ft., into a large volume of water. 2. The alloy of copper and silver is dissolved in nitric acid, and the solution evaporated until the salts fuse. After cooling, the fused mass is gradually thrown into a red-hot crucible, when the nitric acid escapes, leaving behind the silver in the metallic state, and the copper as oxide. The separation of the two takes place naturally, and is aided by the addition of dry borax, which dissolves the oxide of copper. Silver is easily dissolved in pure nitric acid, but not so rapidly in one contaminated by chlorine or hydrochloric acid, which produces a coat of chloride of silver around the

metal, and therefore forms an obstacle to its solution. Sulphuric acid also combines with silver, and the resulting salt is but slightly soluble. Pure silver is employed for the preparation of the nitrate and other silver salts, and for soluble auode in silver baths.

Nitrate of Silver, or Lunar Caustic.—This salt is found in the trade under three forms; either as crystallized nitrate of silver in thin transparent plates; or in amorphous, opaque white plates of fused nitrate; or in small cylinders, which are white, or grey, or black, according to the nature of the mould employed, and constitute the lunar caustic for surgical uses. The crystallized nitrate of silver still retains a small proportion of nitric acid and water; the white fused one is pure when it has not been fraudulently adulterated by nitrate of potash or soda. The third kind, or lunar caustic, generally has its surface coated with a film of reduced silver and of oxide of copper from the moulds; its colour may also be due to the inferior quality of the silver employed. Nitrate of silver is prepared by dissolving pure silver in double its own weight of pure nitric acid at 40° Baumé, in a glass flask or in a porcelain capsule. Abundant nitrous vapours are disengaged, and the metal soon disappears to form a colourless liquid, blue or green if there be copper. After cooling, and a rest of a few hours, a mass of crystals of nitrate of silver is found, which is drained and washed with a little distilled water already saturated with nitrate of silver, in order to remove the excess of acid. The crystals are dried in a stove, and kept away from solar light. If, instead of cooling the liquid after the silver has been dissolved, the evaporation be continued, the mass will become spongy, and then fuse by a greater heat into a greyish liquid which may be run into moulds. The fused mass, obtained by the fusion of the separated crystals of nitrate of silver, is whiter. This salt, whatever be its mode of preparation, should be kept in black or blue bottles; it is employed for preparing baths, metallizing moulds, and many other purposes.

Nitrate of Binoxide of Mercury.—This salt is used for slightly amalgamating the pieces which are to be silvered or gilt. It is obtained by dissolving at the temperature of about 212° F. some mercury in double its own weight of nitric acid at 40° Baumé, and continuing the heat until yellow fumes no longer appear.

Nitrate of Potash, or Saltpetre.—Nitrate of potash is colourless, and has a salt taste; it is very soluble in water, and a concentrated solution deposits, on cooling, fine prismatic crystals, which are more or less translucent. Distilled in closed vessels with more or less diluted sulphuric acid, nitrate of potash produces nitric acid, or aquafortis of various degrees of concentration. Saltpetre is used for producing a dead lustre upon objects gilt by fire, and for desilverizing baths.

Bicarbonate of Potash.—This is white and colourless, and crystallizes either like nitrate of silver, or like common salt or iodide of potassium. It is soluble in tepid water, without decomposition; but at the boiling-point it loses one-fourth of its carbonic acid and becomes a sesquicarbonate. This is employed for the preparation of certain gilding baths by dipping, and for that of the ordinary cyanide of potassium, is obtained by conducting a stream of carbonic acid through a concentrated solution of carbonate of potash, until the liquor is no longer rendered turbid by the addition of sulphate of magnesia or nitrate of lime.

Bitartrate of Potash, Cream of Tartar.—This salt is nearly pure in wine, from which it separates in the shape of small white or red crystals, according to the colour of the liquid. It is gathered on the sides of wine casks, and purified by bone black. The price of cream of tartar varies with that of wine. This substance is often adulterated with alum, saltpetre, &c. It is therefore preferable to buy it in the crystallized form, and to pulverize it in the shop. It is employed for the preparation of the whitening silver baths, for those of tin, and for the silvering paste by rubbing.

India-rubber.—This substance is white when pure; but its colour is generally brown or red, caused by the smoke of the fires employed for drying it. Water, alcohol, and acids do not dissolve india-rubber; ethers, bisulphide of carbon, essential oils, and benzole dissolve and abandon it after their volatilization. These solutions give the means of obtaining very delicate moulds. Apply it in very thin and successive coats, otherwise the exterior surface being the first to solidify, will prevent the drying of the intermediate coats.

Chloride of Silver.—This substance turns black if exposed to the light, it must therefore be kept in blue or black bottles. It melts at a high temperature, and acquires the appearance of horn. When chlorine water, hydrochloric acid, or a soluble chloride is introduced into a solution of a silver salt, there is immediately produced an abundant white precipitate of chloride of silver, which is insoluble in water and in concentrated acids, but soluble in ammonia, cyanides, and the hyposulphites and sulphites of alkaline or earthy bases. This precipitate is but slightly soluble in the bromides, iodides, chlorides, and fluorides of the alkaline or earthy metals. Chloride of silver is employed in the preparation of the baths for electro-silvering, and for whitening, and for the pastes for silvering in the cold by rubbing.

Protochloride of Tin, or Tin Salt.—This salt is greasy to the touch, and melts easily. Protochloride of tin is soluble in water, but is partly precipitated in the state of a white subsalt, which is easily dissolved in a slight excess of acid. Alums, pyrophosphates, tartrates and bitartrates precipitate at first the aqueous solution of this salt, but an excess of the reagent redissolves the precipitate. The protochloride of tin is prepared by dissolving granulated zinc, in excess, in hot hydrochloric acid, evaporating the solution, and letting it crystallize. If the crystals are heated, they first melt in their water of crystallization, which soon evaporates, carrying off a small proportion of hydro-

chloric acid. This operation is completed when thick, white fumes begin to be evolved, which are proof that the salt itself volatilizes. The melted chloride of tin thus obtained is preferable for tinning with alkaline liquors.

Chloride of Gold.—This salt is in yellow, red, or brown-red needle-like crystals, according as it has been more or less deprived of acid. Chloride of gold is decomposed by light into the metal and chlorine; it should be kept in black bottles, with ground-glass stoppers. Cork, like other organic substances, decomposes this salt. Chloride of gold absorbs the dampness of air, and resolves into a liquid of a fine yellow colour. It produces violet stains on the skin, and is very soluble in water. A diluted solution of chloride of gold is decolorized by sulphurous acid; after a time the metal is precipitated as a powder, which is green by transparency, and red by reflected light. Chloride of gold may be prepared by dissolving the finely-divided metal in aqua regia, formed of 2 parts of pure hydrochloric acid to 1 of pure nitric acid. The operation is effected in a glass flask, and with the aid of a gentle heat, until all the gold is dissolved into a yellow liquid, which retains a great excess of acid. The heat is then slightly increased, and continued until the liquid is a hyacinth-red. After cooling, a crystallized mass of a fine yellow colour remains, which is well adapted to the preparation of the gilding baths by dipping. If for baths working with a battery, continue the action of the fire until the liquid in the flask appears a dark blackish red, without ceasing to be fluid. By cooling, the crystals are brown-red. The flask should stand upon a plate of sheet iron perforated in the centre with a hole, the diameter of which is not larger than the layer of liquid after evaporation. This is to avoid the reduction by an excess of heat of a portion of the chloride of gold. It is preferable to make the aqua regia just before using it.

Bichloride of Platinum.—This salt is amorphous, reddish yellow, or blackish red, according to the degree of

evaporation of the acids in excess. It resembles chloride of gold in appearance and in its deliquescent property, when acid, but it is not so easily decomposed by light and organic substances. Its diluted solution is gold-yellow, and dark yellow when concentrated; but never wine-red, unless it contains palladium, iridium, or rhodium. The chloride of platinum resists the action of the fire better than that of gold; however, at first it becomes protochloride of platinum, and lastly metal. When a brass article is rubbed with chloride of platinum, it acquires the colour and lustre of steel, and this coat is often quite durable. Perfectly neutral chloride of platinum, mixed under a muller with certain fatty and essential oils, furnishes a paste for applying thin coats of metal upon stoneware, pottery, glass, and porcelain. Chloride of platinum is easily soluble in caustic soda, and in the carbonate and phosphate of this base, and thus furnishes more or less satisfactory baths for platinum deposits. This salt is prepared like the chloride of gold; but the aqua regia is composed of 5 parts of hydrochloric acid to 3 of nitric acid. The product is evaporated nearly to dryness in a porcelain dish, and then removed after cooling. If it be desired to have it more acid, and therefore more easy to dissolve, it is poured still fluid, but emitting little fumes, into a porcelain plate, from which it is easily separated after cooling.

Chloride of Zinc.—This substance is grey or white according as it has been prepared in iron or porcelain vessels, and has been more or less dried. It is caustic, greasy, and hot to the touch. It absorbs moisture very rapidly. It may be distilled, and then possesses the appearance of butter. Chloride of zinc is employed for aiding soldering, brazing, or welding operations, and in this case it should be as neutral as possible, in order not to act as an acid upon the metals. It enters into the composition of the brass or zinc baths. It is prepared by dissolving zinc in hydrochloric acid, filtering the solution left for a few days in contact with

an excess of zinc, and evaporating it down to igneous fusion. At that moment abundant and thick white fumes are disengaged. The mass is then cast into plates, which are put into well-closed vessels immediately after cooling.

Cyanide of Silver.—This substance is white, becomes slowly black when exposed to the light, and is insoluble in water and in cold acids, which, however, will dissolve it on the temperature being raised sufficiently. It is dissolved and decomposed by the sulphites, hyposulphites, and chlorides; the cyanides and prussiates form with it double salts. A cyanide of silver is always formed when any kind of soluble silver salt is treated by a small proportion of cyanide. Cyanide of silver is prepared by adding hydrocyanic acid to a cold solution of nitrate of silver. The precipitate formed is thoroughly washed, and kept wet in blue or black bottles.

Cyanide of Copper.—This salt, as a powder of a brown colour, is obtained by the precipitation of a soluble copper salt by yellow prussiate of potash, or may be obtained of a dirty white with a greenish-yellow tinge, from the precipitation of a soluble copper salt by cyanide of potassium. Whatever its mode of production, it is easily soluble in all the alkaline cyanides, and even in yellow prussiate of potash, if it has been recently prepared. By solution in an excess of cyanide it forms the double cyanide of potassium and copper for electro-coppering.

Cyanide of Calcium.—This is employed for decomposing the carbonates formed in the baths of cyanide of potassium. A solution of cyanide of calcium is obtained by adding prussic acid to a paste of caustic lime in excess. By filtration, the excess of lime remains behind, and the cyanide of calcium is in the liquor. This salt cannot be obtained in the solid state, is decomposed by heat, and it is better to use it when recently prepared.

Cyanide of Gold.—It is of yellow colour, and acts with reagents very much like the cyanide of silver. Cyanide of gold is prepared by pouring a concen-

trated solution of cyanide of potassium into a concentrated one of chloride of gold. An excess of alkaline cyanide will dissolve the precipitate and form an electro-gilding bath holding a double cyanide of gold and potassium. This salt may be employed for the preparation of gold baths; but it is more expensive, and does not seem to give better results than any other good salt, and particularly the gold ammonium.

Cyanide of Potassium.—No other product is more important to the electroplater than the cyanide of potassium, which is the basis of most of the baths employed, and the purity of which is necessary for the success of the operation. To obtain the cyanide pure, several operations are necessary. 1. The recrystallization of the commercial yellow prussiate of potash until it is entirely free from sulphates. 2. The thorough drying of the pure crystals at a temperature of from 212° to 250° F. 3. The melting at a white heat of the dried prussiate in thick iron crucibles with their covers on. 4. Keeping the contents for some time in a state of quiet fusion, to permit the settling of the iron at the bottom of the crucible. 5. When the surface of the molten cyanide appears transparent withdraw the crucible with iron tongs, and pour its contents, without shaking, upon a polished iron pan, the bottom of which is immersed in water. The iron generally remains in a spongy mass at the bottom of the crucible; but, as a further precaution, the molten cyanide is sometimes passed through a fine metallic sieve, which has been previously raised to a red heat. An iron ladle, perforated with numerous holes, may also be filled with the iron of the previous operations, and the whole being raised to a red heat, the molten cyanide is filtered through it. During the fusion of the cyanide, now and then plunge into it a dry glass rod; if the cyanide gathered upon it is perfectly white and clean, the moment has arrived to pour the contents out. The cyanide manufactured in this manner is cyanide No. 1; it is of a milky white, more or less translu-

cent, and its fracture is crystalline and vitreous. It is completely odourless, when perfectly dry, but if it has absorbed the least quantity of water, it possesses the characteristic smell of the bitter almond. Exposed to the damp air, it soon deliquesces, and is decomposed into carbonates and formiates of potash and ammonia. When a cyanide is to be kept for a long while, it is prepared with a pure yellow prussiate of soda, and the product is rather efflorescent, that is to say, repels dampness instead of attracting it like the cyanide of potassium.

Ordinary Cyanide of Potassium.—Sometimes it is advantageous to substitute for pure cyanide marking 98° or 100° one not so rich, which owes to free potash the property of improving the conducting power of freshly-made baths. The facility of its manufacture allows of a much lower price. The second quality, which contains 75 per cent. of real cyanide, is intended for freshly-made baths, and for those of brass and copper; the third quality, having 55 per cent. of real cyanide, is applied to photographic uses. The following is mixture for No. 2:—8 parts of purified and dried yellow prussiate of potash, and 4 parts of bicarbonate of potash, or 3 parts of pure carbonate of potash; and for No. 3, equal parts in weight of yellow prussiate and pure carbonate of potash. Place in a covered iron crucible and bring to a red heat. The remainder of the operation is the same as has been described for the pure cyanide, except that the temperature does not require to be so high. The trial coating upon the glass rod should be porcelain white. The fracture of these cyanides is more or less crystalline or granular, according as the cooling has been sudden or gradual. The presence of sulphates in the yellow prussiate, or the carbonate of potash employed, will impart a pink, green, or blue colour to the cyanide.

Ferrocyanide of Potassium, or Yellow Prussiate of Potash.

—This is in fine yellow, and semi-transparent, crystals, which break gradually and without noise. The fracture is jagged, and filled with a multitude of

small bright spots. The solution of ferrocyanide of potassium is straw yellow, and like the simple cyanide of potassium, precipitates and redissolves afterwards nearly all metallic salts. However, its dissolving power is much less energetic. The soluble anodes are but little dissolved, in baths composed of this yellow prussiate, which renders their use expensive. This cyanide is scarcely poisonous, and does not emit any smell or absorb dampness. It is prepared by carbonizing animal residue, such as blood, horn, hair, &c., with a mixture of carbonate of potash and iron scraps. The mass is then lixiviated with water, and the solution crystallized. For the manufacture of white cyanide of potassium, avoid those crystals of yellow prussiate which, when viewed obliquely, present other small bright crystals of sulphate of potash, as they are injurious to the operation.

Cyanide of Zinc.—This article is costly, and does not present any real advantage over the other zinc salts. It is white or dirty white, according as the zinc salt was without or with iron. It is insoluble in water, but soluble in ammonia, and in the earthy or alkaline sulphates and cyanides, with which it forms double salts, suitable for zinc electro-baths. Its solution is the more easy as it has been more recently prepared. Cyanide of zinc is obtained by incompletely precipitating with cyanide of potassium, a solution of sulphate, nitrate, chloride, or acetate of zinc. The precipitate is drained upon a filter of paper or calico, and washed to remove the remaining soluble zinc salt.

Gelatine or Isinglass.—This article is extracted by acids, or superheated water, from bones, skin, cartilage, and similar substances; it is more or less coloured, according to its degree of purity. The common sorts, or glue, are employed for making galvanoplastic moulds. The least coloured are preferred, because the casts are more delicate. Cold water swells and softens gelatine, but hot water will dissolve it. This property is very useful for the production of the moulds, but is disadvantageous when the

mould is in the bath. This inconvenience may be partly remedied by adding to the gelatine, before pouring it upon the pattern, a few hundredths of tannic acid, which with it forms a kind of leather, and resists the action of the liquids better. Gelatine moulds should be rapidly coated with the metallic deposit, otherwise they will give very imperfect copies. Although hot water dissolves gelatine, which sets by cooling, this property disappears after too long a boiling, and the liquid that remains will not coagulate.

Benzine.—Benzine dissolves all the oils, resins, gum resins, varnishes, and fats, and is therefore very useful. It is much superior to alcohol and essence of turpentine, formerly employed for removing resist varnishes, and may be used in the cold, which is a great advantage with inflammable substances. A small quantity of naphthaline gives a pink, red, or brown tinge to benzine; but this is of no consequence.

Phosphate of Ammonia.—Necessary for the composition of baths for thick platinum deposits; it is obtained by the exact saturation of phosphoric acid with ammonia. The liquid is then evaporated at a gentle heat; add a few drops of ammonia now and then to compensate for that removed by the decomposition of small quantities of the salt. When the liquid becomes syrupy it is set aside to crystallize in a cool place. It may also be prepared by decomposing, with carbonate of ammonia, the biphosphate of lime resulting from the digestion in sulphuric acid of ground and calcined bones.

Phosphate of Soda.—This salt crystallizes in fine, transparent, colourless prisms; it effloresces by losing part of its water of crystallization. It is soluble in distilled water without producing any precipitate, but causes a deposit of white phosphate of lime in calcareous waters. This salt is formed of 1 part of phosphoric acid, saturating 2 of soda, and 1 of water acting a base. Phosphate of soda is used for hot electro-gilding baths, and is prepared by treating calcined and powdered bones with

sulphuric acid, and letting the mixture rest for several days. The acid phosphate of lime is then removed by washing the residue, and the filtered liquid is saturated by carbonate of soda until carbonic acid is no longer disengaged. The clear settled liquor is then concentrated until it marks 33° Baumé, and is allowed to crystallize once or several times.

Pyrophosphate of Soda.—The commercial salt is generally in a white powder, soluble in water, but not so soluble as the preceding salt; it requires distilled water, as it produces precipitates in calcareous waters. The pyrophosphate of soda gives a white precipitate with nitrate of silver, whereas that of the ordinary phosphate is yellow. It is employed for the preparation of gilding baths by dipping; and is obtained by fusing the ordinary dried tribasic phosphate, which by this operation loses an equivalent of combined water, and becomes bibasic. The temperature required is high, and few crucibles will stand the heat and the fluxing action of this substance.

Plumbago, or Black Lead.—Nearly pure carbon, black, with a certain lustre, soft to the touch, without smell or taste, and difficult to burn. Plumbago, in the natural state, is generally mixed with a proportion of oxide or sulphide of iron and earths, which should be removed by washing with hydrochloric acid. The best plumbago is very black, and without much lustre, except after rubbing; it should not adhere to wax and plaster of Paris articles, and should not detach from them by being immersed into a liquid. The best way to ascertain its quality is to apply a deposit upon it; the sooner it is regularly coated the better it is. It is employed for rendering conducting certain substances which are not naturally so, and for preventing the adherence between two superposed metals. Plumbago is also used for bronzing; but in this case it is useless to purify it with hydrochloric acid. When plumbago is moistened with a solution of chloride of gold in ether, and then allowed to dry

in a shallow vessel exposed to solar light, a gilt plumbago is obtained, which is much more conducting than plumbago alone.

Amalgamating Salt.—This is a mercury salt with three acids, and is composed of the sulphate, nitrate, and bichloride of this metal. It is liquid, more or less coloured, very dense, and gives its water a yellow precipitate, which is dissolved by an excess of acid. It produces a violet stain on the skin, and amalgamates copper and its alloys thoroughly and rapidly. It is used for amalgamating the zincs of batteries, and dispenses with the metallic mercury; it is more easily applied, and prevents much trouble in gilding works. It is prepared by boiling the nitrate of bioxide of mercury upon an excess of a powder composed of equal parts of bisulphate and bichloride of mercury; the liquor only, remaining after cooling, is used.

Sulphate of Copper, or Blue Vitriol.—Easily soluble in water, especially when the latter contains some free acid, and the solution is blue. Hot water dissolves much more of this salt than cold, and it crystallizes by cooling. The solution of sulphate of copper constitutes the galvanoplastic baths, which are rendered more conducting by the addition of $\frac{1}{10}$ th in volume of sulphuric acid. Many kinds of commercial sulphate of copper are impure, and have variable proportions of the sulphates of iron and zinc, which are injurious when their amount is too great. Sulphate of zinc is detected by passing through the acid solution a current of sulphuretted hydrogen gas. The sulphide of copper produced is separated by filtration, and the clear liquor is treated by ammonia, which produces a white precipitate of oxide of zinc, soluble in an excess of alkali. The iron remains also in the acid liquor filtered from the copper, and its presence is ascertained by the red prussiate of potash, which gives a blue colour. Another process for the detection of iron is to add to a small quantity of the solution of sulphate of copper

enough ammonia to dissolve all the oxide of copper precipitated at first, and the brown oxide of iron will be seen floating in the blue liquor. The best sulphate of copper comes from the refining of silver coin by sulphuric acid, or from the solution in the same acid of the scales of copper oxide produced in rolling sheets of this metal. Avoid cheap copper sulphates extracted from old acid dipping liquors, as they contain zinc and other metals, and also nitrate of copper with free nitric acid. These sulphates are generally very wet, and in small crystals.

Sulphate of Protoxide of Iron, or Green Copperas.—This salt crystallizes like the preceding one, and is of a fine green colour. It is very soluble in water, and is rapidly oxidized by contact with the air. The sulphate of protoxide of iron is employed for precipitating gold from its acid solutions. It is prepared either by evaporating and crystallizing the liquors used for cleansing iron, or by the oxidation in the air of iron pyrites. The salt obtained by this latter process generally contains some copper, which is precipitated by iron scraps put in the solution.

Sulphate of Mercury.—Prepared by heating in a porcelain dish 1 part of mercury with 2 parts of concentrated sulphuric acid, and completely drying the product. Great quantities of sulphurous acid, and then of sulphuric acid, are disengaged during the operation; when nearly dried the paste should be constantly stirred with a glass rod.

Sulphate of Zinc is either in white or opaque plates, in large transparent crystals, or in a mass formed of a quantity of crystals, it is very soluble in water, which remains colourless. Sulphate of zinc is employed for zinc and brass electro-baths, in the preparation of acids for a dead lustre, and for a frosted lustre upon clocks and jewellery.

Sulphite and Bisulphite of Soda.—The former forms white crystals, which are rapidly transformed into an amorphous powder by efflorescence.

It is very soluble in water, and is gradually transformed into sulphate by the absorption of the oxygen of the air. Sulphite of soda, and generally all the soluble sulphites, dissolve the salts of gold, silver, or copper, and transform them into double colourless salts, which possess more or less stability, and are employed for electro-baths. The sulphite of soda may absorb an excess of sulphurous acid, and thus become a bisulphite, which should always be preferred to the neutral salt. The neutral sulphide of soda is prepared by passing a stream of sulphurous gas through a solution of carbonate of soda until the liquor neither turns red litmus paper blue, nor reddens a blue one. If the solution is very concentrated, a quantity of small crystals of bicarbonate of soda precipitate during the operation, and should be stirred to prevent them from obstructing the gas tube. An excess of sulphurous acid decomposes them with abundant production of carbonic acid. The saturated liquor crystallizes by cooling if concentrated; in the other case it should be evaporated to a certain point. The bisulphite of soda is produced by continuing the passage of the sulphurous gas until the solution reddens, and even destroys the colour of blue litmus paper. This salt in the air loses its excess of sulphurous gas, then becomes neutral sulphite, and, after a long time, sulphate of soda, by the absorption of oxygen.

Sulphide of Ammonium.—This is prepared by saturating ammonia with sulphuretted hydrogen gas. It is generally used with an excess of sulphur, that is to say, after it has been kept for a few hours with an excess of flowers of sulphur, and at a temperature of about 160° Fahr. The liquid is then of a dark reddish-yellow. It may also be prepared by the decomposition of the sulphide of barium, calcium, or strontium, by carbonate of ammonia. Avoid opening a bottle of sulphide of ammonium in silver-plating rooms.

Sulphides of Calcium, Potassium, and Sodium.—These salts are obtained in solution by boiling the

alkali and the flowers of sulphur in, a certain quantity of water. They are produced in the dry way by projecting powdered quicklime or potash or soda into melted sulphur, and then casting the mixture on a marble slab. The dry sulphides are generally in plates, which are greenish or whitish at the surface and reddish yellow inside. They are soluble in water, which is coloured yellow or red, according to the degree of concentration. Their uses are the same as those of sulphide of ammonium.

Bisulphide of Carbon.—Bring to a red heat a stoneware or porcelain tube filled with charcoal and in connection with a condensing receiver, and then introduce fragments of sulphur into it, and immediately close the aperture, the liquid which results from the combination of the sulphur and carbon is condensed at the bottom of the water in the receiver, and, after a distillation in another vessel, is a pure bisulphide of carbon. It is a colourless transparent liquid, which is very dense, and possesses the double refraction. Bisulphide of carbon dissolves many kinds of resins, fats, and gum resins, such as india-rubber and gutta-percha, and also sulphur and phosphorus. This last solution is employed for reducing the nitrate of silver to the metallic state upon certain moulds, which thus become conducting. Sulphide of carbon is now obtained in the trade at a very low price; when pure it should volatilize without leaving any residue.

Stirring Rods.—These are made of various substances, and are employed for mixing; those made of glass, stoneware, or porcelain are the best in most cases. Wood and most metals should be avoided, because the former is absorbing, and the latter are corroded and easily oxidized.

Anodes.—These are the plates or wires of different metals, placed at the end of the connecting wire starting from the positive pole of a battery. The anodes are soluble or insoluble, that is, they either dissolve under the influence of the galvanic current to partly maintain the metallic strength of the bath,

or they simply bring the current into the bath without being dissolved. Generally the soluble anodes are of the same metal with which the bath is composed; and the insoluble anodes are of platinum, graphite of gas retorts, carbon, or any other conducting and insoluble substance. Soluble anodes are generally completely immersed in the solution, and connected with the conducting wire by other platinum wires. Insoluble anodes are rarely completely immersed; dipping them more or less increases or diminishes the amount of electricity.

Mixtures employed in gilding by fire or by the wet processes.

Red Ormolu.—Potash alum, nitrate of potash, 30 parts of each; sulphate of zinc, 8; common salt, 3; red ochre, 28; sulphate of iron, 1. Add to it a small proportion of annatto, madder, cochineal, or other colouring matter, ground in water or in weak vinegar.

Yellow Ormolu.—Red ochre, 17 parts; potash alum, 50; sulphate of zinc, 10; common salt, 3; nitrate of potash, 20.

Dead Lustre for Jewellery.—Sulphate of iron, sulphate of zinc, potash alum, nitrate of potash, equal parts of each. All the salts are melted in their water of crystallization.

Hard Dead Lustre for Cloths.—Water, 5 parts; nitrate of potash, 37; potash alum, 42; common salt, 12; pulverized glass and sulphate of lime, 4. The whole is thoroughly ground and mixed.

Soft Dead Lustre for Smooth Surfaces and Figures.—Water, 5 parts; nitrate of potash, 46; potash alum, 46; common salt, 3. The same treatment as the preceding mixture.

Green for Red Lustre.—Bitartrate of potash, 65 parts; common salt, 25; acetate of copper, 10. The whole is ground together.

Wax for Gilding.—Oil, 25 parts; yellow wax, 25; acetate of copper, 13; red ochre, 37. The whole is melted, and stirred until cold.

Photography.—*The Operating Room* should be in an elevated position, the south side entirely closed, the north side being glazed with tolerably thick glass, as free from colour as possible,

out preferably of a blue tint, to anything at all approaching green or yellow, as these colours, by neutralizing the light, tend to prolong the photographic operations. If possible the length of the room should run from east to west, and the ends be protected from the morning and afternoon sun. A room lighted only from the north side has the softest and most uniform light that can be obtained. Part of the roof may be glassed, and curtains of a bluish colour should be fixed, with an arrangement of cords and pulleys, by which they may easily be adjusted to admit light, or cast a shadow in the required direction. The colours of the wall must be carefully chosen, avoiding red, yellow, or green; a bluish grey is the safest, and may be used of several tints to give variety. Movable backgrounds painted in different depths of colour are useful to modify the result of any ill-chosen colours worn by the sitter. Oil colour must be avoided for walls or backgrounds; a mixture of slaked lime, litmus, or lampblack may be employed, varying the quantity of lampblack to give the required shade. In the choice of dress, the sitter must remember that cold colours, such as blue or violet, come out white in photographs, whilst the warm colours, red, orange, or yellow, give various shades of black. Articles of dress with vertical stripes tend to give an appearance of increased height to the portrait. The sitter should assume an easy natural position, avoiding a direct vertical light, which falling on the top of the head gives to dark glossy hair the appearance of greyness, and throws very heavy shadows under the eyes, nose, and chin. The best position is a little back from under the skylight, with the head slightly retiring from the side light. The whole figure is then well illuminated; the deepest shadow on the face will be on the retiring cheek, in a three-quarter view, which is generally the best to take. The partial profile will be clearly defined on the shadowed cheek. The position of the body in relation to the head is a matter of taste. The distance of

the figure from the background, and its height on the plate, are points which must be regulated by the artistic skill of the operator. If the sitter is placed several feet in front of the screen, the picture will have greater relief, and the apparent height of a person is much affected by the position of the portrait on the plate. Avoid overcrowding the background with vases, columns, and curtains, or anything which will divert the attention from the principal object; as a rule a plain background is the best, the introduction of superfluous furniture and ornamentation most frequently gives a photograph an unpleasant tone of vulgarity. If the head-rest is used, it must be carefully adapted to the head, which should only lightly press on it. When the position is settled and the focus arranged, the sitter should not alter his attitude, though perfect immobility is unnecessary. When the operator has the plate ready to expose, he should caution the sitter to keep the eyes fixed in one direction, and to remain perfectly steady; he may then uncover the lens. The nearer the camera is brought to the sitter, the longer the exposure; thus the time of exposure may be varied from one second to 300 seconds. As a general rule, for a full length figure, in summer, the plate should be exposed 20 seconds; a sitting portrait will require 30 seconds. In winter the exposure must be increased in duration one-half.

Dark Room.—During certain parts of the process it is imperative that the operator should work in a room into which not a ray of direct light is admitted. This is usually effected by closing every window but one, and that is carefully obscured by yellow or orange coloured curtains, or calico cloth, or a second window-sash may be glazed with dark yellow glass. Lamps or candles, provided with yellow screens, may also be used. The dark room should not be too small, as in several important operations have to be performed; it should be fitted up with shelves for chemicals, a sink and tap, with a good supply of water, several

pails for refuse slops, jugs, and draining stands for the plates. The room should be well ventilated, the door and window being kept open as much as possible when the room is not in use, provided that the weather is not too cold, as an even and tolerably warm temperature is necessary for the proper working of the photographic chemicals. In winter the room must be kept warm; gas or charcoal stoves for this purpose should, however, be avoided. Keep the room as clean and free from dust as possible, and place over the bottles of chemicals small covers of paper, twisted round like an extinguisher, to keep the dust from the necks and stoppers.

The Camera.—This consists of 2 square wooden boxes, the one sliding, like a telescope, within the other. On the front of this is screwed an arrangement of lenses, capable of adjustment; and at the other end is a movable screen of ground glass.

Lens.—There are two descriptions of lenses in use, the single lens which is used for views and photographs of inanimate subjects. This lens requires a longer exposure of the plate than the double lens, but the resulting photograph is very clear in the details. The compound lens used for portraits consists of two pairs of lenses, mounted in a telescopic brass frame, having diaphragms or stops, and provided with a turnscrew to regulate the focus to a nicety, after it has been roughly obtained by adjusting the camera. The interior of the brass tubes holding the lenses must be kept of a dull black colour; should this wear off, a coating of gum-water and lampblack should be applied when cleansing the lenses. It is important to replace the glasses in the lens in exactly the same order and position, after having removed them to clean, which is to be done with a piece of very soft wash-leather. The single lens is composed of an achromatic lens mounted in a brass tube, fixed with diaphragms or stops of various sizes. These diaphragms are simply flat disks of brass, each having in the centre a circular opening, and upon the size of the opening of the diaphragm used, depends

the length of exposure necessary, and the sharpness of the resulting picture. The larger the opening of the stop, the shorter will be the time necessary to expose the plate in the camera, but if a stop be used with a smaller opening the picture will be sharper and more distinct in the details. Thus, in working with the view, or single lens, the operator can choose which point is most material for the particular picture he desires. The plate is of course more rapidly affected in proportion to the brilliancy of the light striking upon it. It is sometimes necessary to use a diaphragm with the compound lens, as for instance in photographs of groups, but the openings in these stops are much larger than those used with the single lens. Portrait lenses are usually provided with central diaphragms.

How to arrange the Lenses in a Portrait Combination.—The lenses in a portrait combination are occasionally removed from their cells for the purpose of cleaning. When the lenses are taken out of their cells they may be variously transposed, and thus rendered incapable of producing good pictures. In a portrait combination there are four lenses in all, the so-called front and back lenses being really each formed of a pair. The front ones are always cemented together, and may thus be easily taken for one lens; the back pair are distinct, and are usually separated from each other by a narrow ring. Take the front lens—the pair cemented together—and observe that one surface is considerably curved, and the other almost flat; place the lens in its cell, so that when screwed into the tube the curved side will be to the sitter. The two glasses forming the back lens are very unlike each other; one is thick at the centre and thin at the edge, the other thick at the edge and thin at the centre; put the thin-edged one first into the cell, resting on the least curved side; next put in the ring, and then the thick-edged glass, concave side towards the other lens; fix them in their places with the part provided, and screw the cell in its place. With many per-

trait lenses there is an arrangement whereby the front lens may be used as a landscape lens; to use it for this purpose proceed as follows;—Unscrew the back lens and lay it aside altogether, as it is only required in the double combination; then remove the brass hood before the front lens; next unscrew the front lens, and rescrew it in the place where the back lens was. In doing this the flat surface will be presented to the object. The lens tube may be now put on the camera, and the central stops will be in their proper place for use. As the focus of the front lens, when thus used singly, is much longer than when used in combination with the back lens, the picture it will yield is proportionately larger, but a much smaller stop must be employed than when the lens is used for portraiture. The exposure must be considerably longer than when the double combination lens is used.

Focus.—An object is said to be in focus when its image is clearly and sharply reflected on the ground-glass screen at the back of the camera. The ground glass usually has the sizes of the various plates marked on it, and having decided what size the picture is to be, move the camera to or from the object until its reflexion occupies the proper position, and is of the size required for the picture. The nearer the camera is to the object the larger will be the picture. The next step is one upon which the chief beauty of the photograph depends, the exact adjustment of the focus, so as to bring out quite clearly those points which are considered essential. Having roughly settled the distance, lay the black focussing cloth on the camera, put your head under it, slide the body of the camera gently in or out, until the reflexion is clearly seen on the ground glass. As different portions of an object are necessarily at varying distances from the camera, some will come into focus earlier than others. In portraits, to make the features show distinctly is generally the chief point aimed at. For views no rules can be given, but it is advisable to so place the camera

and adjust the focus that the photograph shall not distort or confuse the natural lines of perspective. A little practice is required to adjust the focus satisfactorily, as the image reflected on the ground glass is upside down.

The Glass Frame.—This is always sold with the camera; it consists of a wooden frame, with two shutters, the one opens on hinges, and allows the plate, which has been just removed from the nitrate of silver bath, to be inserted, with its collodionized face placed towards the sliding shutter, which must be kept closed. The frame is provided at the corners with pieces of wire, which prevent the plate from coming in contact with the sliding shutter. Close and fasten the hinged shutter, and the frame is then ready for use. Remove the ground-glass screen, place the glass frame in its place, with the collodion side towards the object, then on raising the sliding shutter the time must be noted in seconds for the desired exposure. Close the sliding shutter, remove the frame to the dark room, and take out the plate by opening the hinged shutter.

Cleaning the Glasses.—The glasses for photography are sold in certain fixed sizes. When new, the sharp edges must be smoothed over with a corundum file, then carefully wash, rub with a soft rag, finish with chamois leather. When the glasses have been used they are more difficult to clean. If they have been varnished they must be soaked in a solution of common soda, or carbonate of potash, till the varnish peels off. If the carbonate of potash or common soda does not bring off the varnish quickly enough, use a solution of an ounce of nitric acid to every half-pint of water. Apply this to the glasses with a piece of cotton wool, fixed on a handle, so as to avoid contact with the nitric acid, which stains the hands. When the plates have been well covered with any of these solutions, let them stand to drain in a rack, then rub and wash well with a sponge and water. Dry. The side intended for the collodion must next be polished with Tripoli powder and a few drops of spirit of wine, rubbed over with cotton woo.,

wipe off the excess of Tripoli, and polish with a dry chamois leather. Place the cleaned plates into a properly grooved box, with all the faces prepared for the collodion turned one way. It is advisable to wash all glasses as soon as possible after use, as by not doing so the varnishes dry on very firmly and are difficult to remove. Waste collodion may be utilized for cleaning glasses; it removes all grease. When glasses have once been cleaned, avoid touching them with the naked hand, as it is sure to leave stain. There are various holders in use; the india-rubber pneumatic is one of the best. Before using a plate dust it carefully with soft silk or a piece of clean old rag. Perfect cleanliness is imperative.

Sizes of Photographic Glasses.— $2\frac{1}{2}$ in. \times 2 in., ninth plate; $3\frac{1}{2} \times 2\frac{3}{4}$, sixth; $4\frac{1}{2} \times 3\frac{1}{4}$, quarter, carte de visite; 5×4 , third; $6\frac{1}{2} \times 4\frac{3}{4}$, half; $8\frac{1}{2} \times 6\frac{1}{2}$, whole. All plates above whole size are denoted by dimensions only, $6\frac{3}{4}$ in. \times $3\frac{1}{2}$ in stereoscopic plate. The following are the diameters and focal lengths of lenses suitable for portraits of the usual sizes:—

Diam. of Lens.	Focal length.	Size of picture.
Ins.	Ins.	Ins.
$1\frac{1}{2}$	$3\frac{1}{4}$	$2\frac{1}{2} \times 2$
$2\frac{3}{4}$	5	$4\frac{1}{4} \times 3\frac{1}{4}$
$3\frac{1}{4}$	7	5×4
$4\frac{1}{4}$	7	$6\frac{1}{2} \times 4\frac{3}{4}$
$5\frac{1}{4}$	$9\frac{1}{2}$	$8\frac{1}{2} \times 6\frac{1}{2}$
For groups;—		
$3\frac{1}{2}$	11	9×7
$4\frac{1}{2}$	13	10×8
$4\frac{3}{4}$	15	12×10
$5\frac{1}{2}$	19	15×12
For views;		
$1\frac{3}{4}$	8	6×5
2	10	7×6
$2\frac{1}{2}$	14	9×7
3	16	12×10
4	24	16×12

The dimensions of pictures given are maximum sizes, and to ensure a thoroughly good picture, it is best to use a lens of a larger size than is absolutely necessary. Patent plate glasses are the best for

negatives, although flatted crown and sheet glass may be used. Positives are sometimes taken on deep red or purple coloured glass. Whatever kind of glass is chosen, it should be as flat as possible, otherwise it will be difficult to place in the dark slide.

The Argentometer.—This very useful instrument is for ascertaining the strength of the nitrate of silver solution; which becomes weakened to a certain extent, after the immersion of every plate. To use the argentometer, fill the glass jar to within about two inches of the top with the liquid to be tested, and then insert it; the degree on the scale that floats on a level with the surface of the fluid will indicate the number of grains of nitrate of silver contained in each ounce of the solution. There must be sufficient liquid to prevent the argentometer resting on the bottom of the jar. For strengthening a bath to the required standard, it is generally found more convenient to have a stronger prepared bath to add to the weak one, than to add the nitrate of silver direct.

Positives and Negatives.—With the exception of the collodion used, there is very little difference between the chemicals used, or the manipulation required, for the production of a positive or negative. A positive is simply a glass plate coated with a thin film of collodion, rendered sensitive to the light, which receives the image thrown upon it by the lens. The ether and alcohol evaporate, leaving a dry, very thin film of gun-cotton upon the glass. This film constitutes the picture, and may be kept upon the glass, or removed if desired. Positives are now less used than negatives; they are generally kept upon the glass, with a backing of black varnish, and are in fact the result, whereas negatives are only taken as a medium for printing from afterwards.

THE COLLODION PROCESS.—Plain collodion is a mixture of alcohol, sulphuric ether, and gun-cotton, which is made suitable for negative photographic purposes by an iodide, or bromide; it is then termed sensitized collodion.

The Spirits of Wine must be perfectly

clear, transparent, and free from any floating impurities. Should it contain any impurities, they must be removed by filtration through a sheet of filtering paper, properly supported in the mouth of the bottle. Should it not run clear and bright the first time, it must again be filtered. The specific gravity of the alcohol should be about '810, and is not suitable for photography, if stronger than '819.

Ether.—Care must be taken to procure the sulphuric ether free from foreign substances, and to keep it, and liquids containing it, particularly the collodion, in well-filled and closely-stoppered bottles. The chemical action which takes place when the ether is exposed to the air is very injurious to its photographic utility; it is very volatile, and as the vapour it gives off is explosive when mixed with atmospheric air, care must be taken not to pour it from one vessel to another near a fire or artificial light; as the vapour is heavier than air, it will have a tendency to fall; the artificial light, if used, should therefore be considerably above the vessel from which the ether or collodion is being poured. The specific gravity of the ether may vary from '720 to '750; its strength is ascertained by the hydrometer. If the ether obtained is not sufficiently pure for photographic purposes, it must be rectified. Place it in a tall bottle, with about a quarter of its bulk of water, cork the bottle tightly, and shake it for some minutes. When left to settle, the pure ether will float on the water; remove the water by passing a small siphon-pipe, filled with water, through the cork and nearly to the bottom of the liquid in the bottle, holding the thumb over the longer end of the tube. Remove the thumb; the water in the lower part of the bottle will then flow up the siphon, leaving the washed ether in the bottle. This operation should be repeated, and the ether must then be dried and distilled, by placing it in a glass retort, with about a quarter of its bulk of quicklime. Connect a tube to the retort, and arrange a supply of very cold water to fall upon the tube, so as to cool its contents. The

end of this tube must be placed over, or into, a bottle; the retort being fixed in a water-bath; a small charcoal fire is lit underneath it, and the heat of the water acting upon the ether causes it to evaporate. In passing along the tube it is condensed and falls into the bottle. The water falling on the condensing tube must be very cold, or the vapour will not be properly condensed. Remove the fire when all the ether is distilled, and clean out the retort at once, as it will be more difficult to clean afterwards. Keep the heat of the fire from the vessel containing the distilled ether, and cork the bottle immediately the operation is completed. A double-stoppered glass bottle is best suited to contain this liquid. As ether boils at a very low temperature, about 96° Fahr., it will commence to evaporate very quickly; and the water in the water-bath should not be allowed to rise in temperature much beyond 110° Fahr., if pure ether is desired. As the first small portion of the ether will probably contain some impurities, that should be rejected.

Gun-Cotton.—Ordinary gun-cotton is used, which is soluble in a mixture of ether and spirits of wine. The proportion of gun-cotton regulates the density of the liquid obtained and materially affects the action of the mixture, when poured on the glass plate.

Weights and Measures used in Photography.—Most chemicals are sold by avoirdupois weight, but all photographic receipts are given either in troy weight, or fluid measure. The pound is the same in both troy and avoirdupois, but in the former it consists of 12 oz., in the latter of 16. Consequently, for an ounce of chemical required by the receipts, more than an ounce must be purchased.

Fluid Measure.—69 minims = 1 dram or 1 $\frac{1}{3}$; 8 drams = 1 ounce or, 1 $\frac{1}{3}$; 20 ounces = 1 pint; 8 pints = 1 gallon. Glass measures graduated for these quantities are used, and wherever fluids are spoken of, this measure is intended.

COLLODION POSITIVES.—The articles required are positive collodion, nitrate of silver, developing and fixing solutions, black and crystal varnishes.

Positive Collodion.—Pyrotiline, and iodide of cadmium, or ammonium, 15 grains each; ether, 3½ oz.; alcohol, 1½ oz. Place the two first in a dry bottle, then pour on the spirits of wine, shake the mixture well, then add the ether, shake again, and let it stand for 12 hours. Decant the clear portion into a wide-mouthed bottle, keep well stoppered, and in the dark. Avoid shaking the bottle when about to use the collodion, and never use quite all the bottle contains, as the sediment which will accumulate at the bottom, would spoil the picture. The glass plates used for this process need not be so carefully chosen as for the negative process; they should be as flat as is necessary for them to go into the camera back, but the colour is not material.

Nitrate of Silver Bath.—Re-crystallized nitrate of silver, 5 drams, dissolved in 10 oz. of distilled water. Filter the solution until it is quite clear, then add 3 drops of nitric acid, and 10 drops of collodion. Shake well together and filter. Blue litmus paper should slightly redden in this bath; should it turn very red add a little ammonia or oxide of silver should it not redden at all, add a little acid carefully, drop by drop. It is preferable to have a slight excess of acid.

Developing Solution.—Protosulphate of iron, 2 drams, dissolved in 8 oz. of distilled water, add 2½ drams glacial acetic acid, 2½ drams alcohol, and 5 minims nitric acid. Filter, and pour into a well-stoppered bottle; this solution will keep good for several weeks if not exposed to the air. When about to use this solution, nearly fill a vertical glass bath with it; the plate is immersed in the liquid by means of hooks, called dippers.

Fixing Solution.—50 grams of cyanide of potassium dissolved in 5 oz. of distilled water, that is to say, for every fluid ounce of solution required, mix 10 grains of cyanide of potassium in 1 oz. of distilled water. Filter, and keep in a well-stoppered bottle, which, from the dangerous nature of the solution, should be labelled poison.

Coating the Plate with Collodion.—Hold the plate, which must be perfectly clean

and dry, in the left hand, or supported by a pneumatic holder, then pour on very steadily about as much collodion as will half cover the plate. Incline the plate, so that the collodion flows from one corner to the other, until the whole of the plate has been coated; then pour back the superfluous collodion into its bottle, from one of the corners of the plate. Now exclude all but yellow light from the dark room. When the collodion has been on the plate a few seconds it will set and have a dull appearance, the plate must then be immersed in the nitrate of silver bath. Lift the dipper, lay the back of the plate on it, plunge them both steadily into the bath, move the plate about in the solution for a few seconds, then put the cover on the bath. The time the plate must be kept in the nitrate of silver varies with the temperature, from 2 minutes in warm weather, to 10 in cold weather. As soon as the collodion film assumes a creamy appearance, remove the plate from the bath, being cautious to hold it as much as possible by the sides; let it drain on blotting paper, then lay it in the dark slide, collodion side downwards; close the slide. Have a little blotting paper in the dark slide, to absorb any little of the nitrate solution which remains on the plate. Have some of the developing and fixing solutions ready in separate glasses, and clean water handy. The action of the nitrate of silver bath transforms the iodide of cadmium into iodide of silver, which is sensitive to light; the plate is then ready for exposure in the camera. If the plate is placed in the bath before the collodion film has set properly it will peel off, and it will be necessary to filter the nitrate of silver bath to remove it. The film must not be allowed to get too dry, before immersion in the bath, as it will then turn white at once, and will not produce a good photograph. It is important, in first placing the plate in the nitrate of silver bath, to do so steadily and continuously, so as to avoid marking the plate with wavy lines and stains. Cover the bath when not in use.

Exposure.—Having arranged the focus

and finally adjusted the sitter, remove the focus screen from the camera, and put the dark slide in its place, cover the lens with the cap, draw up the shutter, which will turn down on the camera. Up to this point any little movement of the sitter is of no consequence, but having now given the final caution, gently remove the lens-cap, so as not to shake the camera, and note the time in seconds. The time for exposure varies considerably, on a bright day a shorter period suffices than on a dull day, but no certain rules can be laid down, as the nature of the light, the time of day, and the qualities of chemicals employed, are all elements in the calculation—a little practice will soon give an approximation; the usual failing with beginners is too long an exposure. Replace the cap, close the sliding shutter, and take the slide into the dark room.

Developing.—The plate must be immersed in the developing bath, by means of dippers, for about 15 seconds, gently moving it about in the solution. On removing the plate, it must be well washed with clean water; for this purpose a siphon washing bottle is very handy. This is a bottle, through the neck of which two glass tubes are passed. One of these tubes reaches nearly to the bottom of the bottle, the other only just passes through the cork; by blowing through this short tube the water passes up the long one, and is projected with more or less force in the desired direction. After the process of developing and washing, the plate is no longer affected by light, which may therefore be admitted if desired.

Fixing.—The iodide of silver, which gives the creamy appearance to the collodionized plate, must be dissolved, by pouring some of the fixing solution on and off the plate. As soon as those parts of the plate which should represent the black parts of the picture are quite clear, pour off the fixing solution, and wash the plate thoroughly. Dry over a spirit lamp. At this stage examine the plate, it should have a glossy appearance, and the blacks be very pure. If there is a foggy appearance, this may

be removed by washing the plate, immediately after the fixing, in a solution composed of 15 grains of iodine, to an ounce of spirits of wine. When the fogging has disappeared, wash away the iodine, use the fixing solution again, wash and dry. If the plate is now satisfactory, varnish the film side with crystal varnish, or a very clear solution of gum arabic; apply in the same manner as the collodion, but run the surplus varnish off the plate quickly, as an excess of varnish injures the effect. The glass side should be coated with black varnish, applied in a smooth layer, by a camel-hair brush. Place the plate in its mount, with a clean glass in front, and close in the back and sides, to prevent dust from getting in.

Crystal Varnish.—Dissolve 1 oz. of white lac in 10 oz. of warm spirits of wine. Let the varnish settle for several weeks, then carefully decant the clear portion into a bottle for use.

Black Varnish for Backing, see p. 72.

General Instructions for Glass Positives.—If the picture is very dark it has not been exposed long enough; if, on the contrary, the shadows are weak, and the dark parts are not dark enough, the plate has been exposed too long. Fogging is a very common and troublesome occurrence; there are many things likely to cause it, and it is sometimes difficult to find which of them it is. Impure air in the rooms, such as from an escape of gas, or from new paint, will sometimes cause it, but usually it arises from some error in the manipulation, or defect in the chemicals. Try the nitrate of silver bath with litmus paper; add a little acid if the paper does not turn slightly red. Examine the window in the dark room, to see that the light admitted is of a sufficiently dark yellow or orange tinge, and see that no light enters at any other place—also make sure that there is no crevice in the camera through which light can pass. Collodion should not be used too soon after it is made. It should be of a golden sherry colour; this may be obtained by adding a little of an old bottle of collodion, which is of a dark colour, or by pouring in a few drops of

tincture of iodine. The principal causes of defects arising from faulty manipulation are, leaving the developing solution too long upon the plate; this results in a bright silvery deposit. When the developing solution has not been properly washed off before fixing; there will be green stains, especially at the edges. If the collodion is allowed to get too dry before being placed in the nitrate of silver bath, there will be transparent spots on the plate. If the developing solution does not flow readily over the plate, and the operator does not perform the developing steadily and carefully, there will be stains or wavy lines on the picture. Any floating dust in the air, or impurities in the solutions used, will cause spots and marks. If a picture, which is brilliant when wet, turns dull on drying, with misty blue shadows, the cause is bad collodion.

COLLODION NEGATIVES.—The principal difference between the processes of negative and positive photography is, that the negative plate requires about three times longer exposure than the positive. The plates used may be the same, but certain modifications are necessary in the bath, chemicals, and collodion. The developing solution must be kept on as long as the details of the picture continue to come out, then wash off. When the plate is held up to the light it should present the appearance of a much over-exposed positive, there being very little clear glass, and that only where the shadows are quite black, while those parts which represent the white parts of the picture should be quite opaque. It only happens under the most favourable conditions, in portraiture, that the first developing of the negative renders it sufficiently dense to produce good prints, hence the necessity of the subsequent operation called intensifying; this is a kind of second developing, by which the density is increased to the required degree. The process is as follows:—Put four or five drops of intensifying solution No. 2 into a clean glass; then flood the plate with intensifying solution No. 1, and when it has covered the whole surface, pour it

off into the glass containing the No. 2 solution, and shake the glass round so as to mix them, then immediately pour the mixture upon the plate in the same manner as the developer, pouring it off into the glass every few seconds, and holding the negative up to the light each time until it appears sufficiently dense. By careful printing a fairly good proof may be got from an over-exposed negative, but with an under-exposed negative no good result can be obtained. Great care must be taken not to continue the intensifying too long, or a deposit of red fog will take place, and the negative will be spoiled. While the intensifying is proceeding, the liquid gradually assumes a dark claret colour, and if kept on too long will become turbid and cause fogging. The point to which intensifying can be safely carried may be known, after a little experience; by a peculiar change of colour in the high lights of the picture which takes place just before fogging commences. When this change is observed the solution must be quickly washed off. It is important that the intensifier should not be poured on at the same part of the plate each time, or that part will become denser than the rest. The fixing is the same as in the positive process; but a rather longer washing should be given. When dry, the film should be very slightly brushed with a soft camel-hair brush, made for the purpose, to remove any dust or loose particles of silver; the plate must then be warmed until it is as hot as can be borne upon the back of the hand, and the negative varnish poured over the film in the same manner as the collodion; it should not be drained off too rapidly, but allowed to flow slowly over the plate, so as not to leave too thin a coating. If only a few prints are required from the negative, crystal varnish will answer the purpose; but if it is desired to preserve the negative, and to get many prints from it, the crystal varnish will not give sufficient protection, and a spirit varnish must be used, which gives a much harder surface. When the surplus varnish has run off, the plate must

oo again gently heated until the varnish is dry. Experience alone will indicate the proper heat to use when applying the varnish; if the plate be not warm enough the varnish will dry dull, and if too hot it will run into streaks and be liable to blister. If any varnish should get upon the wrong side of the glass it can be cleaned off with a little alcohol. As soon as the plate is cold it is ready for printing from.

Faults in Negatives.—In addition to the faults which occur in positives, there are some others to which negatives are liable. If the negative is deficient in density, and has somewhat the appearance of a positive, it is the result of under-exposure, or may be caused by washing off the developer too soon. If the deep shadows, which should be clear glass, are veiled by a grey deposit, and the whole picture is wanting in vigour and contrast, it is caused by over-exposure. Red or brown fog, generally beginning at one corner of the plate, is caused by keeping the intensifier on too long. The film tears and leaves the glass while being washed. This will sometimes occur when the negative has been much intensified. Remedy—longer exposure and less intensifying. The film splits and peels off the plate when dry. Cause—imperfectly cleaned glass or bad collodion. Numerous minute transparent spots, called pinholes, indicate that the bath is out of order. Small crystals which form under and upon the film when dry are from traces of the fixing solution which has not been completely washed off.

Softening of Photographic Pictures.—The likenesses produced by photograph have, in many cases, a harshness which is extremely disagreeable. The camera will tell the truth, but its effects may be toned down so as to give the features something of that softness which is generally imparted by the portrait painter. For this purpose use a lace curtain stretched between the sitter and the camera—the nearer it is to the latter, the more softness it imparts. The grain of a chalk drawing is produced by the threads, and characteristics

of the model which would not bear prominence are pleasingly softened down.

PRINTING PROCESS.—The copies taken from the negative are printed upon paper containing a salt which forms chloride of silver by decomposing the nitrate of silver in the sensitizing solution.

Positive Paper.—Specially prepared paper for positives is easily obtained. The size is 22 in. by 17 in.; the weight varies, but should not be less than 24 lbs. to the ream for paper to be albumenized, and for salted paper about 18 lbs. a ream will be heavy enough. Reject any sheets having black spots or blemishes, and those that are uneven in texture. Select the most even side for the chemicals, by examining each sheet in a reflected light, marking the wrong side with a pencil. Always hold the paper by the extreme edge, as a slight stain is sure to be found where the fingers have touched it. For portraits, and most other uses, the paper is albumenized on one side, the resulting print then having a more or less glazed surface, according as to whether or not the albumen has been diluted. When photographs are printed to be afterwards coloured, so-called *plain* paper is used, which gives a dull surface like an engraving. Positive paper, when treated with a solution of nitrate of silver, has the property of rapidly darkening on being exposed to the sunlight; if, therefore, a sheet of it is placed behind a negative and exposed to the light, where the clear portions of the negative allow the light to pass through, the paper will become dark, whilst the dark parts of the negative which obstruct the light will remain white on the positive paper. When the positive print is obtained, it has to be soaked in the fixing solution to remove all the chloride of silver which has not been affected by the light. A careful washing in clean water completes the process of printing.

Albumenized Paper.—There are several well-known papers sold; Rive, which is a French paper, has a high glaze and fine surface; the Saxe, which is more uniform in its texture, is made in Germany;

and that made by Towgood. Positive paper is albumenized by placing it in a mixture composed of the white of eggs and salt. To the white of each moderate-sized egg use 15 grains of common salt reduced to a fine powder; whisk until the albumen is all white froth. Leave this froth in a glazed earthen pan for about 12 hours, by which time most of it has settled into clear albumen; pour the clear portion into a flat porcelain tray. This tray should be somewhat larger than the sheets of paper to be albumenized. Lift the paper up by the ends, and lay it carefully on the albumen, keeping the side marked as inferior uppermost and dry. The paper should be slightly damp before it is thus treated, as it then takes the albumen more regularly, and is not so liable to air-bubbles. The paper must be lifted at each end, and should any air-bubbles appear, brush them off with a card or small brush, replacing the paper in the bath. Whenever the albumen does not come into actual contact with the paper, a white mark will appear in the print. Remove the paper from the bath, and place it to dry on a cardboard frame, or suspended at the corners by clips. Paper glazed with pure albumen acquires too brilliant a glaze for portraits; the albumen may be diluted with from $\frac{1}{4}$ to $\frac{1}{2}$ of its bulk of water. Albumenized paper is not sensitive to light, but absorbs moisture from the atmosphere very rapidly, it should therefore be kept in tin or zinc cases.

Plain Paper.—Albumenized paper may be used as plain paper, if instead of sensitizing the glazed side, the plain side is placed in the sensitizing solution. Or place some sheets of Saxe paper in a salting bath of 100 grains each of chloride of barium and chloride of ammonium, and 20 grains of citrate of soda dissolved in 20 oz. of water. Leave the paper in the bath for about 5 minutes, carefully removing all air-bubbles. Then hang the sheets to dry. The pictures produced on this latter paper are not so rich in appearance as those printed on albumenized paper.

Preparing the Paper.—This operation must be performed in the dark room, or it may be done by candlelight, as the prepared paper is not so sensitive as the glass plates. The paper must be cut into pieces of a convenient size, at least a quarter of an inch smaller than the dish which is used to contain the sensitizing nitrate of silver solution. The dish must be perfectly clean, and contain solution at least half an inch deep. The piece of paper is then to be laid gently upon the surface of the solution, with the albumenized, or the selected, side, if plain paper, downwards, and allowed to float upon it without wetting the back; after about 30 seconds the paper should be raised from the solution at one end, and if any air-bubbles appear they must be broken, either by blowing on them or by touching them with a piece of clean blotting paper, and the paper being again laid upon the solution, the other end must be raised and treated in a similar manner. The paper must not be entirely removed from the bath, or it will curl up, and the back come in contact with the prepared side. After floating from 4 to 5 minutes the paper may be removed from the bath, being lifted slowly by one corner with ebony forceps, and held over the dish until it ceases to drip, when it should be hung up to dry, either by suspending it with a pin through one corner, to the edge of a shelf, or by hanging it by a glass clip to a line. Carefully prevent any of the solution from running on the back of the paper. When the paper is thoroughly dry it should be cut into pieces rather smaller than the negative to be used, and placed in a portfolio or a book. Good paper will keep two or three days after being sensitized if carefully excluded from light and air; but it should always be used as soon as possible, as recently-sensitized paper always yields better prints than that which has been kept for some time. If it is required to keep the sensitized paper for any length of time, it must be placed in an air-tight zinc or tin box, with a little saucer containing some dry crystals of

chloride of calcium. This substance absorbs any moisture there may be in the air in the box, and thus keeps the paper dry.

Printing.—The negative being placed in the printing frame, plain side downwards, the paper is to be laid upon it, with the prepared side in contact with the varnished side of the negative; the back of the frame is then put into its place and the springs closed; if it has screws, these should be tightly screwed down to prevent the paper from shifting; it is then ready to be exposed to the light. With good dense negatives the printing may be conducted in direct sunshine, but weak negatives are best printed from in diffused light. The print must be examined at intervals to see how it proceeds; this is done by raising one side of the hinged back of the frame and turning back the paper from the negative, being careful always to keep the other end of the frame closed, so that the paper may not be displaced, and not allowing any strong light to fall upon the paper while the frame is open. The printing must be allowed to go on until the picture has become rather darker than it is intended ultimately to be, as the subsequent operations of toning and fixing exercise, to a certain extent, a kind of bleaching effect upon it. The back of the printing frame must be quite flat, otherwise the paper will not be in perfect contact with the negative. A passable print may be got from a weak negative, if the exposure to the light be prolonged, but diffused, not direct sunlight, should be used in this case. For vignettes, or other photographs, where white or graduated backgrounds are desired, glasses for the printing frame are used, having yellow borders, which prevent the passage of the pure white rays of light. The resulting print will only be black under the unobscured portions of the glass. The same course may be adopted when the background of a negative is in any way defective. If a recently varnished negative is exposed to the direct action of the sun's rays, it will probably stick to the paper; in

such cases it is preferable to use diffused light, or to cover the face of the frame with thin white paper. As a general rule, the printing should proceed until those parts which are to be white assume a slight tint; this will take from ten minutes to a whole day, according to the quality of the negative and the amount of light. When the prints are finished they must be kept in the dark until all that are required the same day are done; the toning and fixing should then be proceeded with as soon as possible, as if delayed many hours the prints will not tone readily, and if kept long not at all.

Toning.—The toning and fixing may be carried on in diffused light, as it is difficult to judge of the colour in toning by artificial light; but not more light than is necessary should be admitted to the room, and the prints shielded from it as much as convenient. If too much light be admitted, the prints will acquire a pink colour while toning. The prints must first be washed for 10 or 15 minutes in at least three changes of rain or distilled water, and then immersed in the toning bath, which should be poured into a glass or porcelain dish; while in the toning bath the prints must be moved about from time to time, so that it may act equally on all parts of them, and only a few prints should be in the bath at one time. After being in the toning bath a few minutes, the red brick colour which the prints usually present after washing will begin to change, and gradually become darker until they are a purple black, at which point they should be removed from the bath and placed in clean water until all are ready. If it is desired that the prints should be of a brown or sepia tone, they must be taken from the bath when they reach the required tint, which will be rather lighter after fixing. If the prints are left too long in the bath they will acquire a cold inky tone, which is very undesirable. Prints on albumenized paper require more gold in the toning bath than those on plain salted paper.

Fixing.—The quantity of fixing solu-

tion required will be in proportion to the number of prints to be fixed; for one dozen, or less, of the $\frac{3}{4}$ -plate size, 5 oz. will be sufficient, and for a larger number the quantity must be proportionally increased. The prints must remain in it for 20 minutes, and during that time must be frequently moved about and separated, and from time to time turned over, so that the solution shall act equally on every part of the paper. If this is not carefully attended to the pictures will soon become discoloured and fade. After 20 minutes' immersion in the fixing bath, the prints must be lifted out, one at a time, held up by one corner for a few seconds to drain, and then plunged into a vessel of clean water. The hyposulphite solution should be used slightly warm.

Washing.—The object of this process is to secure the stability of the picture by removing all traces of the fixing solution with which the paper is saturated. One of the chief causes of the fading of prints is insufficient washing. The water in which the prints are placed must be changed at least six times, at intervals of about an hour, and each time the water is changed the prints should be taken out separately and drained before being put into the fresh water. In the last change they may remain all night. The more capacious the vessel used in this process, and the oftener the water is changed, the more permanent the prints will be. An earthenware pan will be found convenient. Wooden or metallic vessels must be carefully avoided. A convenient way of washing prints is to place them in a large pie-dish or a photographic dish, and place this in a sink, under a tap turned on only sufficiently to run a small stream continuously, which should run in at the higher end of the dish, this being slightly tilted. The prints will thus be kept in continual motion by the water, and in one night be perfectly washed. Another method is to pin the prints by their edges in a row to a long slip of wood, such as a lath, and set them afloat in a water cistern for 12 hours.

Mounting.—When the prints have been thoroughly washed and drained they should be laid between sheets of clean blotting paper, to absorb the superfluous water, and afterwards dried. As they usually curl up when dry, they may be flattened by drawing the back of the paper over any blunt-edged instrument, such as a paper knife, or the back may be pressed with a warm flat-iron; they are next to be cut to the proper size by means of a glass cutting shape and a sharp knife, and then mounted on cards with a newly-made cold paste of dextrine or starch. The appearance of the finished prints is greatly improved by having them rolled.

Good photographers usually cover small defects in likenesses by touching them with a small brush dipped in colour the same tone as the print.

To Varnish Cartes de Visite.—The mounted photograph must first be sized with a warm solution of 10 grains of gelatine dissolved in 1 oz. of water. Hot-press, or burnish with a burnisher. Then apply crystal enamel, by means of a small piece of cotton wool saturated with the enamel, and wrapped in a perfectly clean piece of white calico rag, slightly moistened with linseed oil. Gently rub this over the picture with a circular motion, until it becomes brilliant, then finish by applying a little spirits of wine, and lastly linseed oil, in the same manner.

Crystal Enamel.—Dissolve 1 oz. of white lac in 10 oz. of warm alcohol. Let the mixture stand for some weeks, then decant the clear portion for use.

Defects in Paper Prints.—A marbled appearance on the surface of the paper indicates that it has been removed from the sensitizing solution too soon, or else that the solution is too weak. As the strength of the solution is decreased each time it is used, it should be tested occasionally with the argentometer, and sufficient nitrate of silver added to bring it to its original strength of 60 grains to the ounce. White spots are the result of air-bubbles which have not been detected and dispersed while the paper was being sensitized. Red spots

which will not change colour in the toning bath are caused by touching the face of the print with the finger, which has left a greasy impression on the albumen. If the prints are weak and slaty in colour, either the negative is in fault, the paper is bad, or the sensitizing solution is too weak. If the prints become yellow or spotted after they are finished it is because the fixing and washing processes have not been properly carried out.

Plain Collodion.—Mix in a bottle, gun-cotton, 450 grains; ether, 25 oz.; spirits of wine, 7 oz. Shake these well together, and leave to settle for several days. If well corked, this mixture may be kept for any length of time.

Sensitized Collodion.—Add to 1 oz. of the plain collodion, 6 drams spirits of wine, $1\frac{1}{2}$ oz. ether, and 3 drams of iodide of bromide solution. Shake the bottle well; the mixture is then ready, but is improved by being kept 4 or 5 hours before using. In hot weather a little more alcohol and less ether, in very cold weather more ether and less alcohol must be used. As sensitized collodion does not preserve its qualities well, it is better not to mix the plain collodion, and the iodide and bromide solution until shortly before required for use.

Iodide and Bromide Solution.—Iodide of cadmium, 154 grains; bromide of cadmium, 54 grains; spirits of wine, $3\frac{1}{2}$ oz. Pound the iodide and bromide very fine in a mortar, adding the spirits gradually; when the iodide and bromide are dissolved, pass the solution through a filter paper into a bottle. This solution will not deteriorate if kept in a closely-stoppered bottle.

Iodide of Cadmium.—Put 4 oz. of iodine into a pint of water, add 2 oz. of cadmium, broken small. Warm gradually, and keep the water at about 190° Fahr. for several hours; when the liquid becomes colourless, let it cool, and then filter. The remaining cadmium may be again used. Evaporate the solution down to crystals, which must be pounded in a mortar to a fine powder. Keep in a stoppered bottle.

Bromide of Cadmium.—Pour 3 oz. of bromide into 1 pint of water, then add 2 oz. cadmium, broken small; put into a stoppered flask. Let the ingredients stand for several days, shaking the flask occasionally. When the solution becomes discoloured, filter and evaporate, reduce to powder, and keep in a stoppered bottle.

Iodized Collodion may be made at one operation; it should be kept 2 days before being used, but is less reliable, if kept for any length of time, than is sensitized collodion which has been made as above described, as the iodide will decompose the other ingredients. Place 16 grains of gun-cotton in a bottle, add 18 grains of iodide of cadmium in powder, and 6 grains of bromide of cadmium in powder, and $1\frac{1}{2}$ oz. of spirits of wine, sp. gr. .805. Shake the bottle until the iodide and bromide are dissolved, then add 3 oz. ether, sp. gr. .720, and shake until the cotton is dissolved. After settling for 24 hours decant the clear portion into small well-stoppered bottles.

Nitrate of Silver Bath for Negatives.—Recrystallized nitrate of silver, $\frac{1}{2}$ oz.; distilled water, 7 oz.; collodion, 7 drops. Shake well together until the crystals have dissolved, then filter. The purity of the negative bath is a matter of great importance; none but the best recrystallized nitrate of silver must be used, and the introduction of foreign matter of every kind must be carefully guarded against. When the bath gets out of order, which will not occur very soon if it is properly used, it should be diluted with an equal bulk of distilled water, and exposed to the sun for a few days in a white glass bottle, then filtered, and sufficient nitrate of silver added to restore the strength to 35 grains an ounce, as indicated by the argentometer.

Developing Solution for Negatives.—Protosulphate of iron, 75 grains; glacial acetic acid, 2 drams; alcohol, 2 drams; distilled water, 5 oz. Dissolve the crystals in the water, then add the acid and alcohol, and filter. This solution will keep good for several weeks. In hot weather a little more acetic acid

may be added, and if it does not flow readily the alcohol may be increased.

Intensifying Solution, No. 1.—Pyrogallie acid, 10 grains; citric acid, 10 grains; distilled water, 5 oz. This solution will not keep long; when it becomes brown it should be thrown away. *No. 2.*—Recrystallized nitrate of silver, 40 grains; distilled water, 1 oz. Dissolve and filter. This solution will keep for any length of time.

Another Intensifying Bath.—A saturated solution of bichloride of mercury in water. Powder the bichloride of mercury, place in a bottle, add the water, and shake. Place the negative plate in a bath of the solution, remove when the film assumes a milky white appearance, wash, and then plunge in a solution of 1 oz. of liquid ammonia to 20 oz. of water, which immediately darkens the plate. Remove the plate, wash, and place to dry. This mode of intensifying may be regulated by leaving the plate in the bichloride of mercury a shorter time, when it will require a weaker ammonia bath than that above given.

Fixing Solution for Negatives.—Hypo-sulphite of soda, 5 oz.; distilled water, 5 oz. Dissolve and filter. This solution will keep good for many months.

Sensitizing Solution for Paper.—Nitrate of silver, 5 drams; distilled water, 5 oz.; nitric acid, 2 drops; kaolin, 1 oz. Dissolve the nitrate of silver in the water, and then add the acid and kaolin; the kaolin will not dissolve, its use being to prevent the solution becoming discoloured after using. This solution will not require filtering; it must be allowed to settle until quite clear, and when required for use decanted carefully, leaving the kaolin in the bottle; after using, it should be returned to the bottle and well shaken with the kaolin, which will carry down all the colouring matter as it subsides. As this solution rapidly becomes weaker by using, it should be tested with the argentometer occasionally, and sufficient nitrate of silver added to restore it to its proper strength, which is 60 grains to the ounce.

Another Negative Collodion.—Ether, $\frac{1}{2}$ oz.; alcohol, $\frac{1}{2}$ oz.; cotton, 7 grains; bromide of cadmium, $\frac{1}{2}$ grain; bromide of ammonium, $1\frac{1}{2}$ grain; iodide of cadmium, $2\frac{1}{2}$ grains; iodide of calcium, 1 grain; iodide of potassium, 1 grain; iodide of ammonium, 1 grain. For intensifying, flood with chloride of gold, 1 grain; water, 15 oz.; then wash and flood with pyrogallie acid, 2 grains; water, 3 oz.

Toning Baths.—1. Chloride of gold, 4 grains; acetate of soda, $\frac{1}{2}$ oz.; distilled water, 10 oz. Dissolve and filter. In purchasing chloride of gold in small quantities it will be found best to have it in solution containing 4 grains to each ounce of water. This solution improves by keeping, but will require a little chloride of gold added to it occasionally. A black deposit will form in it after using, which should be removed by filtering.

2. To produce black to bright sepia tones, according to length of immersion;—Take carbonate of soda sufficient to cover a threepenny-piece; dissolve it in a teaspoonful of cold water in a cup; add 2 grains chloride of gold; then add 3 oz. of boiling water; use in 15 minutes. After toning, pour it into a stock bottle, adding a particle of acetate of soda to give it keeping qualities. The next batch to tone, commencing in same manner, but using half the above quantities. Add it to the stock, and tone immediately, and so keep on, omitting the acetate of soda, which should be used but once in twenty times. It is well known that one formula will suit one paper but not another. This will suit Hart's albumenized paper.

Fixing Solution for Paper Prints.—Hypo-sulphite of soda, 8 oz.; distilled water, 1 pint. This solution must only be used once, as it is useless afterwards.

Stopping-out Negatives.—Small round transparent spots are frequently found on glass negatives, which if not stopped-out, occasion corresponding black spots on the print. Lay the plate on a slab of glass, having either direct or reflected light shining up through it. Then cover the spots with a mixture com-

posed of 10 parts ivory black, 2 parts saturated solution gum arabic, 2 parts white honey, 1 part sugar-candy; well mix, and apply with a fine camel-hair brush. Should the spots on the negative be black, or opaque, white spots will be formed on the print, these are easily tinted with a little water colour, to match the other portions of the print, it is seldom necessary therefore to alter the negative on this account.

Albumen Varnish for Negatives.—Remove the cords and yolks from several eggs, whisk the albumen to a froth, let it settle. Decant the clear portion, add half its bulk of distilled water, and one dram of liquid ammonia for each pint of the varnish. After having washed the plate, and whilst the film is still damp, apply the varnish in the same way that collodion is poured on. Repeat the operation, then place the plate to dry, with the film side protected from dust.

Amber Varnish for Negatives.—Fill three-fourths of a bottle with small pieces of yellow amber, pour upon it a mixture of equal parts of chloroform and ether, in sufficient quantity to just cover the amber. After standing several days filter the liquid; use closely-stoppered bottles. Pour the varnish over the collodion film of the negative, drain and let dry. This varnish is more easily applied than the crystal varnish, as it does not require artificial heat to dry it, but it does not give such a firm varnish to the negatives. The amber which remains in the bottle, after the liquid varnish has been poured off, may be used again and again for the same purpose.

VIEWS AND LANDSCAPES.—In taking views, the process is exactly the same as in the case of portraits, except that the exposure is very much less. Views can be taken with the ordinary portrait lens, although distant objects are generally produced by it on too small a scale; this difficulty may be overcome by removing the back pair of lenses from the tube and using the front combination only, provided the camera will open to a sufficient length for focussing.

COPYING PICTURES.—Pictures and engravings can be easily reproduced by photography. If framed the glass must be removed, or the reflected light will interfere with the image formed by the lens. The picture must be placed in a good light, and the front of the camera must be parallel with it, or the copy will be distorted. A small stop should be used, and the negative rather underexposed than otherwise. Copies of photographs, except on a reduced scale, are seldom as satisfactory as the original, for the grain of the paper gives a peculiar mottled effect to the picture.

Toning Bath.—To produce rich purple tones;—30 grains acetate of soda, 10 oz. water, 5 grains carbonate of soda. This to be mixed some hours before wanted, and chloride of gold sufficient to tone the prints in hand added just before required for use. The bath works quickly hot and slowly when cold; the solution may be used over and over again.

Toning and Fixing in one Bath.—The following formula yields a fine, rich, warm, black tone, with somewhat rosy half. Water, 2 oz.; sulphocyanide of ammonium, 50 grains; hyposulphite of soda, 240 grains; acetate of soda, 15 grains; chloride of gold, 1 grain. Dissolve the gold in a small quantity of water, and add it to the other solution. The bath may be used immediately after preparing. The prints are not washed before putting them into the bath. They become yellow at first, but afterwards recover their force. The toning and fixing takes about 10 or 15 minutes, but can be continued for some hours. The acetate may be substituted by the benzoate, the phosphate, borate, citrate, or any other such salt, for the purpose of modifying the tint desired.

To quickly obtain Positive Prints.—In dull weather it is sometimes necessary to expose the paper for a whole day before a positive print can be obtained, and although albumenized paper prints more rapidly than plain paper, the time necessary is still often inconveniently long. This trouble may be avoided by the following process;—

Cut plain paper to the required size, let it float on the surface of a solution composed of 10 grains of iodide of potassium dissolved in every $3\frac{1}{2}$ oz. of the water required for the bath. When it has remained in this solution about one minute, remove and drain. Then float it for about one minute, in the dark, on a sensitizing bath composed of $3\frac{1}{2}$ oz. of water, 30 grains of fused nitrate of silver, and 300 grains of glacial acetic acid. Withdraw, drain, and press carefully between several folds of pure white blotting paper. Then place the paper, still slightly damp, upon the negative. The exposure, in diffused light, necessary in this case, will only be from about 5 to 15 seconds. Remove the paper from the negative, and place it on a glass plate, with the sensitized side of the paper uppermost. Then spread some of the following developing solution over it, with a fine soft brush;—15 grains of gallic acid, dissolved in 35 oz. of warm water, $3\frac{1}{2}$ drams glacial acetic acid; mix and filter. As soon as the picture is sufficiently developed, place it in water, to stop the action of the developing solution. Tone in a weak solution of chloride of gold, with a small quantity of carbonate of soda. Then soak for several hours in plenty of clean water.

THOMAS SUTTON'S WET COLLODION PROCESS.—The old process has one weak point, which renders it unfit for long exposures to dark subjects, such as interiors,—the free nitrate which must be left upon the film in order to render it sensitive gradually attacks the iodide of silver, and combines with it to form iodo-nitrate. From this Sutton's wet collodion process is free, whilst all the good qualities of the old method are retained. The process consists in using a bromized collodion containing no iodide, exciting the plate in a nitrate bath, washing off the free nitrate, pouring an organifier over the film, exposing it wet in the camera, and developing it by the alkaline method, after which it may be fixed, washed, and varnished in the usual way. After making the plate visibly clean, and wiping it dry, put it

upon a wooden French plate-holder with a screw, and pour upon it a little tripoli made into a cream with a mixture of equal parts of alcohol and ammonia. After rubbing this all over the plate with a tuft of cotton wool, polish it with a clean dry tuft of the same wool, and carefully wipe the edges. The mere cleaning of the plate may be done with nitric acid or aqua regia, followed by copious washing. The collodion film adheres best to a plate which has been finally polished with tripoli rendered alkaline in the manner described. It is a good plan to use a coating fluid made by dissolving india-rubber in any of its solvents, such as mineral naphtha, chloroform, or kerosene. Three grains of india-rubber paste dissolved in a dram of chloroform, add kerosene to make up the ounce. The solution is then left to settle, and the upper part is carefully decanted for use. It is poured over the dry polished plate in the same way as collodion; the film sets in a minute or two, and then the collodion may be poured on. A slight opalescence in the rubber film is of no consequence, as this does not show after the collodion has been applied to it. The advantage of the coating fluid is, that it fills up holes and scratches in the plate, and renders them comparatively harmless. It is a great safeguard against splitting and blistering of the film in the various operations, where these are protracted. Albumen must not be used as a coating fluid in this process, because it would injure the bath. For the collodion any good pyroxyline will do; it need not be especially powdery. The collodion should not be anhydrous. The ether should be absolute, but the alcohol may lie between 808 sp. gr. and 812 sp. gr., according to the proportion in which it is added. In summer, and particularly in a hot climate, the alcohol should be in excess of the ether; but in winter there may be 5 parts of ether to 3 of alcohol. The more alcohol, the stronger it should be. When alcohol 805 sp. gr. is used, with the thermometer at 90° Fahr., there may be three times as much alcohol as ether in the collo-

tion, but the film is then very subject to mbs. The collodion should be bromized with bromide of cadmium, because that is so soluble in alcohol that a larger dose of it may be introduced with facility. There are two kinds of cadmium bromide—one anhydrous, the other containing four equivalents of water. The latter is preferable, as being the least trouble to dissolve, but the water may be expelled by heating the crystals in a capsule. The quantity of bromide to an ounce of collodion is a matter of some importance, because the sensitiveness of the film, and the density of the negative, depend upon there being plenty of bromide of silver upon the plate. Twelve grains of hydrated cadmium bromide to an ounce of collodion will be found a good proportion. Less than this is liable to give thin negatives, which require to be intensified with silver. Films thinly bromized are also less sensitive than those of the full density. According to Sutton a good test for the mechanical quality of collodion is to pour a little upon a glass plate, and examine the film a few minutes after, when it has become perfectly dry. If it appears opalescent, or if it shows structure, the collodion is bad, and useless for any purpose. The best solvents to employ are pure alcohol, and methylated ether which has been redistilled with quick lime. The fresher they are, the better apparently. The bromized collodion will keep indefinitely; but when great sensitiveness is required it is better to use it fresh. The nitrate bath should not be less than 80 grains to the ounce. It should be made with pure neutral nitrate of silver. A minim of nitric acid may then be added to every 5 oz. of solution, in order to neutralize any free oxide of silver which it may contain. This bath is costly in the first instance, but as there is subsequently no waste of silver it is economical in the long run. No silver is used in developing, and all that clings to the back and front of the plate on its removal from the bath goes into the washing waters, and is eventually restored to the bath without having to

be reduced. It is immaterial how long the plate remains in the bath, provided it remains long enough, about 3 minutes in summer, and 5 minutes in winter. Too short an immersion in the bath is proved by the film not possessing its maximum of sensitiveness, and the negative being bright, dense, and hard. The appearance of the film is a sure guide to the full time of immersion in the bath; but as it matters not how much the proper time is exceeded, no mistake need be made in this matter. This strong bath does not produce pinholes. These proceed in general from particles of dust which stick to the film. The film is so thoroughly washed in this process that any crystals of bromonitrate which might adhere to it would be decomposed and removed by the washing water. This immunity from pinholes produced by double salts is one of the advantages of Sutton's method. The nitrate bath does not seem to get out of order so quickly in this as in the common wet process. It does not require treatment with bicarbonate of soda, and sunning every now and then, to keep it in good working condition. It is necessary, however, to keep it always up to the right strength. The vessel in which it is kept should be left open in order that the ether and alcohol may evaporate. There should be a series of at least three vertical washing baths, placed side by side, and filled with distilled or clean rain water. The plate, on its removal from the nitrate bath, is to be placed in each of these for 2 or 3 minutes, and then transferred to a large pan of rain water, with a lid, in which it may remain until required for use. Washing bath No. 1 soon acquires a quantity of silver nitrate, and this solution should be used instead of water for making fresh nitrate bath to replenish with. The gap thus made in No. 1 must be filled up by water from No. 2, and so on. By proceeding thus, not a single grain of nitrate of silver is wasted, but the whole of it is utilized in forming the sensitive film of bromide upon the plate. It is absolutely necessary to remove all the free nitrate from the

film, for, if any should remain, it would at once be darkened by the contact of the alkaline developer. Five minutes in the three baths is the least time that can, with safety be allowed for the removal of the free nitrate. A plate which has been left for 30 hours in the nitrate bath may afterwards be left for 3 days in the pan of rain water, and still give a bright and beautiful negative. Portrait photographers will find it a great advantage to be able thus to prepare their plates beforehand, ready for use at a moment's notice when a sitter arrives.

The Organiser must be applied after the removal of the plate from the rain-water pan. It is only necessary first to give it a rinse with a little clean rain or distilled water. Spring water should on no account be employed for rinsing the plate. For the usual organiser employ albumen, 1 part; distilled water, from 3 to 6 parts. For the highest attainable degree of sensitiveness use Nelson's neutral gelatine, 3 grains; sub-carbonate of soda, 1 grain; distilled water, 1 oz. The albumen and water should be beaten up together and then allowed to settle. The clear liquid should be filtered through a piece of cambric folded twice. The gelatine should be dissolved by heat, and the solution filtered after the alkali is added. Neither of the above organisers keep well. They ferment and become putrid in a few days. It is important to use pure neutral gelatine. When the plate is not to be exposed immediately after it is organised, but has to be kept for some hours before the exposure or development, one-half of the water which the organiser contains should be replaced by pure glycerine. This will keep the film moist and in good condition for at least a day and a night. By the use of glycerine in the organiser a landscape photographer may prepare his plates in the morning, expose them during the day, and develop them at night. Such plates cannot well be prepared in a tent, but they may be carried for a whole summer's day ready prepared, and be developed in a light and portable tent soon after their exposure.

This method is less troublesome than the preparation of dry plates. The plates are much more sensitive than common wet ones; yet the exposure is by no means a critical matter; certainly not more so than in the common wet process. It is always well to put a sheet of damp red blotting paper at the back of the plate, in order to prevent blurring from internal reflection. There are two methods of development—one a quick, the other a slow one. The quick method takes about 2 minutes, the slow method about 5. The plate is then washed and fixed, no intensification with silver being in general required, or, if required, being done after fixing. The following is the slow method of development, the quick method only differing from it in doubling the strength of the solution. Make a solution of bromide of potassium 5 grains to the oz.; and a solution of ammonia fortis and water, equal parts. Keep these in 1-oz. wide-mouthed bottles, each of which is provided with a dropping tube. Now take a glass measure, and put it into 2 minims of potassium bromide solution, 1 oz. of water, spring water will do, and 3 grains of pyrogallic acid. This done, proceed quickly with what follows, for the developer should be used fresh. Wash the organiser off the plate with some clean water, then add a minim of the ammonia solution to the developer, and pour it over the plate in the usual way with one sweep, and not too violently upon any particular spot, or that will begin to develop before the rest. Keep the developer flowing backwards and forwards upon the plate for about a minute, up to all the edges and corners, and then the image may begin to show of a pale red tint. Now add another drop of bromide of potassium solution and another of ammonia. Repeat this from time to time until the negative is dense enough; but although ammonia intensifies it and brings out the details, be extremely careful not to add a drop too much, or the image may be suddenly veiled and the picture be irreparably lost. The development, whether slow or quick, is always gradual and under command, and the image does not

flash out as with iron in the common process, but by degrees, as when pyro-gallic acid is used. The film must now be washed, and fixed with weak hypo-sulphite of soda, and then be washed thoroughly again. It will then be seen that the image is of a yellow colour, and although thin, possibly, will yield a vigorous print.

The Varnish should be made with lac only, and should contain neither sandarac nor benzoin. Purified seed lac is the best. Mix alcohol, 820 sp. gr., 1 oz.; lac, 50 grains. Dissolve without heat, and decant from the sediment. This varnish may be partially decolorized by mixing animal charcoal with it. Do not heat the plate much before varnishing, but heat it as much as desired afterwards. The negative is now finished, and may be kept in a paper envelope.

For the conversion of a Negative into a Positive, a full exposure should be given, in order that the light may act entirely through the film in the sky and other spaces which are to be eventually clear glass; and the development should be pushed to the very verge of fog. The film should now be washed, and instead of fixing it with hypo. some strong nitric acid should be poured over it. This will quickly dissolve all the blacks, leaving them bare glass, whilst the half-tones and real shadows of the view will be represented by the pale yellow bromide of silver in layers of different thickness, so as to produce a beautiful kind of positive transparency. In order to blacken this, the bromide image must be converted into one composed of metallic silver. This is effected by removing the bromine from the bromide of silver by means of redevelopment. The best plan is, after washing off the nitric acid very thoroughly, to pour some alkaline developer over the image and expose it to the light; then add more ammonia to the developer, and thus blacken the image as much as you can. Of course no fixing with hypo. is required. These positives are very perfect in their details, and although of an ugly colour, are suitable for the multiplication of negatives by copying, or for producing an enlarged

negative, without having recourse to a print. The only trouble in this operation consists in the high lights not coming out clear glass, as they ought to do under treatment with the nitric acid. To make a good positive the sky of the negative should look very nearly as black on the back as on the face of the film. For Sutton's process there must not be too much light in the operating room or tent, and the colour of the light should be orange, and not yellow. The main difficulty in the process is to get the negatives to intensify sufficiently without silver; but, when all else is right, feebleness can only proceed from a deficiency of bromide of silver in the film. With 12 grains of cadmium bromide to the ounce of collodion, and an 80-grain bath, this difficulty ought never to occur, unless the plate is much under-exposed. For common subjects, where great sensitiveness is not required, the quantity of bromide may be reduced to 8 grains, and 2 grains of chloride of cadmium may be added. The negatives will then be very bright and dense. This is recommended for copying paintings, engravings, and maps. Where very thin, delicate negatives are required, full of harmony and detail, use less bromide in the collodion, and give a longer exposure. In working by candlelight, inclose the candle within a screen made of orange-coloured paper, or of Solomon's orange-coloured oiled muslin.

DR. RYLEY'S MODIFIED COLLODIO-ALBUMEN PROCESS.—The plate has to be sensitized as usual, and thoroughly well washed. Coat with the following solution;—Albumen, 1 oz.; water, 2 oz.; ammonia, 30 minims. Beat well up to a froth, allow it to settle, and filter before use. Pour sufficient of this over the plate to cover it; let it flow backwards and forwards to soak into the film. Pour the solution away, and thoroughly wash the plate, the last rinsing being with distilled water. Let the plate dry. When perfectly dry, moisten the plate with distilled water, and pour over the following;—Gallic acid, 2 grains; water, 1 oz. Filter the solution before using. Pour it on and off the plate to well per-

meats the film, then set the plate up to drain, and dry without washing off the gallic acid solution. When surface-dry, finish by the heat of a dull fire. These plates retain their sensitiveness well. The development of the plates may be by the plain or alkaline pyro method. The peculiarity of this process consists in the final wash of gallic acid after the prepared plate has dried from its albuminous coating.

ENGLAND'S MODIFIED COLLODIO-ALBUMEN PROCESS.—The plate having been coated with bromo-iodized collodion, and sensitized as usual in a 40-grain bath, should be washed till all greasy lines are removed; next float over the film an albuminous solution formed of one white of egg to 3 oz. of water and 2 drops of ammonia. These require to be well beaten together and filtered. When this solution has been poured over the film backwards and forwards to well permeate it, the plate has to be washed again under a gentle stream, ending with a little distilled water. The plate has now to be resensitized by flowing off and on a 30-grain solution of nitrate of silver, slightly acidulated with acetic acid. Again wash well and dry. This latter sensitizing gives increased vigour and sensitiveness to the plate. The exposure should be about three times longer than for a wet plate. Either plain or alkaline pyro may be used to develop, and intensify with acid silver and pyro.

COLLODIO-BROMIDE PROCESS.—The peculiarity of this process mainly consists in dispensing with the nitrate bath and using a collodion which contains the sensitive salt. The greatest care is required in preparing the collodion. It is composed of—Pyroxyline, 6 grains; ether, $\frac{1}{2}$ oz.; alcohol, $\frac{1}{2}$ oz.; bromide of calcium, 6 grains; bromide of ammonium, 2 grains. Mix as much of this as may be required, as it will keep indefinitely. It should stand a week before being employed. When ready for use, pound nitrate of silver to the finest possible powder in a glass mortar, and add 11 grains to every ounce of the above bromized collodion. Add gradually, and

shake so as to get it well combined. Allow this sensitized collodion to rest for 3 hours before use. The mixing must be made in a non-actinic light, and the collodion must be kept in the dark. In this state the collodion will not keep for many days, therefore not much more should be sensitized than will be speedily required. Varnish the edges of the glasses a quarter of an inch with india-rubber and benzole varnish, and coat the plate with the sensitive collodion. Allow it to set well, and immerse in a dish of water till all greasiness disappears; next put the plate in a dish containing a solution of tanning, 15 grains to the ounce of water, or use the following solution;—Tannin, 10 grains; gallic acid, 3 grains; grape sugar, 5 grains; alcohol, 10 minims; water, 1 oz. Prepare as follows;—Dissolve the gallic acid first in the water, using heat; next add the tannin, then the grape sugar. Filter, and, when cold, add the alcohol. Allow the plate to remain in this solution 3 minutes. Let the plate dry evenly and quickly in any convenient manner, and it is ready for use. Expose three times the time required for a wet plate. Use the alkaline pyro developer, adopting all the precautions described in the use of the bromide of potassium. If there be any difficulty in obtaining the ultimate intensity, the acid pyro and silver may be used. The fixing may be done with cyanide, as it counteracts any splitting of the film on drying. When experience is gained in working the process, the quantity of nitrate of silver in the collodion may be increased to 12 or even 13 grains, accompanied with increased sensitiveness in the plate. A very simple method of using up the residues of sensitized collodion is to add an equal quantity of plain bromized collodion, reserving the necessary addition of nitrate of silver until a few hours before it is required for using the next time. This prevents deterioration and loss of material.

THE AUTOTYPE PROCESS, or Carbon Printing.—Johnson's process is adapted to supply the place of albumenized paper and silver, gold, and hypo. solu-

tions; the manipulations are more simple than silver printing, and less skill is required for producing prints by this method than by the usual silver one. The most troublesome portion of any carbon process is the preparation of the tissue, that is, the sheet consisting of the layer of gelatine and carbon or pigment. This carbon tissue consists of a layer of gelatine containing the carbon or other permanent pigment spread on paper. As sold it is not sensitive to light, but requires the action of a solution of bichromate of potash to render it sensitive. So far the process resembles the silver printing one—the tissue corresponding with albumenized paper, the bichromate sensitizing solution with the silver one. When the paper is dry, the coloured surface is placed in contact with the negative and exposed to light; the exposure should be about one-third the time required for silver printing. The pigmented paper is prepared in long rolls, so that much larger sheets can be obtained than of albumenized paper. It should be cut into convenient sized sheets for sensitizing. A solution, 20 grains to the ounce, of bichromate of potash is provided in a flat dish. The sheets may be placed in the solution one at a time until all are immersed. Each should be turned over to see that no air-bubbles form. They must remain in for one minute, but may stay longer without injury. They should then be taken out, and hung to dry. This sensitizing and drying must be done in chemical darkness, like sensitizing silvered paper; more caution must, however, be taken, as the carbon paper is so much more sensitive. When the paper is dry it must be placed in contact with the negative to be printed. It is advisable for carbon printers to classify their negatives. Let those negatives that print the quickest be called No. 1; those that require longer printing, No. 2; and those still denser, No. 3. By the use of an actinometer the amount of printing given in a certain time can be measured. This simple little apparatus consists of a round japanned tin box, with a slot in the lid about $\frac{1}{4}$ of an inch wide and

an inch long, like a money-box. Inside the box is a strip of Carrier's sensitized albumenized paper, about $\frac{1}{4}$ an inch wide, coiled up in a roll. The lid of the box is painted a chocolate colour, like the tint that sensitized albumenized paper quickly takes when exposed to the light. By a simple means a portion of this paper is pulled out of the box, and in doing so a portion is exposed to light through the slot in the lid, the rest of the strip being screened from light. The paper when exposed begins to darken, and presently arrives at the same tint as that surrounding it on the lid of the box. Let us suppose a negative to have sensitized pigmented paper placed under it, and the actinometer to have a piece of the white sensitive silver exposed through the slot, then let the actinometer and the negative be both exposed simultaneously to the same light; by the time the light has darkened the silver paper to the standard tint, the actinometer and the negative will both be said to have received one tint, that is, they will both have received that amount of action from the light necessary to produce on the silvered paper that particular tint. In the first instance each negative, or each class of negative, will have to be tested by the actinometer, how many tints have to be darkened before the carbon print is made, and the negatives may then be marked accordingly. When a negative has been once tried and marked the number of tints it requires, no mistakes will be made afterwards as to the exposure that will be required. The next operation is to attach the print to a temporary support during the development, or removal of the unacted-on pigmented gelatine. Plain gelatine is not sensitive to light, but is easily soluble in hot water. The bichromate of potash makes it sensitive to light, and the change effected in the gelatine by light renders it insoluble in hot water, but the rest of the gelatine still remains soluble. The insoluble portion constitutes the picture, and it is necessary to dissolve everything but that which light has rendered insoluble. The print has

to be attached for this purpose to a temporary support. Almost any substance impermeable by water will answer, but some substances are more convenient than others, such as the surface of ground opal glass, or zinc plates that have a finely-ground surface. To facilitate the removal of the print from this slightly-roughened surface, rub the support over with a dilute solution of resin and wax in turpentine, using a soft rag, and leaving only a very thin film of the solution on the surface. The pigment print is first immersed in cold water, gelatine side downwards; the print at first curls inwards as the paper on the back expands with the water, but in a few seconds it flattens and shows signs of curling outwards; at this juncture take it out, and previously wetting the glass or zinc that you are going to develop it on, lay it on gelatine side downwards, and with an india-rubber scraper, or squeegee, press the print in close contact to the support to expel the water. Sweep the squeegee backwards and forwards once or twice to get rid of all moisture that can be driven out. Allow the print to remain thus for a few minutes, and if you have other prints ready to go on with, you may serve them all the same until you have several ready. This pressure ensures the perfect adhesion of the print to the surface of the support through all the subsequent hot and cold water washings. The glass or zinc with the print thus firmly attached by atmospheric pressure may now be immersed in hot water at say 100° Fahr. Let it remain for a few minutes. When the coloured gelatine begins to show itself oozing from the edge of the paper, try one of the corners of the paper if it will lift easily; if so, lift it slowly and steadily from the support, and it will come off, bringing with it a great deal of the unaltered gelatine. If it does not lift off easily, allow it to remain until it will do so. On no account force it up. The time it takes for the paper to come freely away depends on the temperature of the water it is immersed in; the water need not be hotter than the hands can bear.

When the paper is removed the rest of the unaltered gelatine will speedily flow away, and the picture will gradually emerge from the dirty mass that envelops it. Allow it to remain in the hot water till all the soluble gelatine is removed; this is known by the ceasing of the dirty or coloured streams that previously have come from the picture. There is no fear of the print itself being dissolved away, for the altered gelatine that forms it is insoluble. When all that will come away has come away, remove the glass from the warm water, and well wash in cold water; the picture may then be set aside to dry, still adhering to the glass or zinc. When the print is in this state it can easily be seen if the exposure to light under the negative has been too little or too much. If it has been too little, the print will be too light, that is, there will not be enough pigmented gelatine left on the glass to properly represent the negative, showing that sufficient time was not given for the light to render enough of the gelatine insoluble. The print will betray the deficiency of exposure by the absence of the half-tones. If the print is too dark, then the exposure has been too great, and too much of the gelatine has been rendered insoluble. If either error has been committed a mark should be made on the margin of the negative showing the greater or lesser number of tints that the negative should receive in future printings. Gelatine prints never look sharp when they are wet; they will be sharp enough when the gelatine is hard and dry. After the print is dry, proceed to transfer it to the permanent paper base to which it is to remain. Ordinary plain paper, or even paper slightly gelatinized, is not sufficient for finally attaching to the image on the glass or zinc. If such papers be attached to the gelatine image the finer parts of the high lights and half-tones are so attenuated that this kind of paper will be sure to leave them behind. There is, however, a paper provided with a coating of insoluble gelatine that readily attaches itself to the image, and brings it all off the glass

perfectly. Pour boiling water in a flat dish and immerse the transfer paper supplied by the Autotype Company; many sheets may be immersed at a time. One side of the paper is covered with a gelatinous layer that softens but is not soluble in even boiling water. Allow it to remain in the hot water until it thoroughly softens and becomes pulpy. When it has arrived at this condition, lay it on the image on the glass or zinc, and with the squeegee smooth it down so as to be in close contact, and, by stroking the paper, expel superfluous moisture. Allow the paper to dry. When thoroughly dry the paper may be stripped from the glass, bringing the print with it. In some cases it will come off spontaneously, but usually it may be started at the corners and will come off freely. Sometimes it may be dry at the corners and damp in the middle; wait till it is quite dry all over, as it will not be forced. Occasionally it may happen that even when it is quite dry it will not freely come away; a little heat may then be applied to the glass, and the print will almost fly off. In such instances there has been rather too much resin in the waxing solution that was applied to the support; remedy, add a little more wax. If, on the other hand, there be too much wax and not enough resin, the print will come away too easily before it is even quite dry. A little turpentine or benzole should be rubbed over the surface of the print, to remove any of the wax and resin that may show on the face. In every stage of the process many prints may be carried on simultaneously, more particularly in the development. If the prints are considered too dull, increased glaze may be given—thereby increasing the brilliancy—by the use of varnish, collodion, or other glazing materials. This may be done before the pictures are finally mounted on cardboard, or afterwards. There is one point of great importance in carbon printing, the edges of the pigmented paper must never be exposed to light. It is not sufficient that the carbon paper is smaller than

the negative, but all around the margin of the negative a safe edge of a band of dark paper, or black varnish, must be put to protect from light for a $\frac{1}{4}$ of an inch the edges of the pigmented paper. If the margin of the print has been protected from light it remains soluble, and it retains its adhesive property, and thus the whole print is securely attached by the edges, and the water cannot get between the film and the support, but can only act on the face of the print. There is a method by which the pigmented tissue is attached at once, after coming from the printing frame, on to paper, instead of to a temporary support; when development is finished the picture is complete without any further transferring. The prints so produced are all reversed; it is therefore necessary in working by this method to either take reversed negatives in the camera, or to strip the negatives off the glass so as to use them from the contrary side. It will be seen that the entire principle of this printing process depends upon obtaining an image in insoluble gelatine, and the colour of the image will chiefly depend on the colouring substance, or pigment, that is held imprisoned in the insoluble image.

GUM AND GALLIC ACID PROCESS.—Any good collodion may be used, but commercial ones may be improved by the addition of 2 grains to the ounce of bromide of cadmium. The nitrate bath should be as nearly neutral as possible, and not of less strength than 40 grains an ounce. Allow the plate coated with collodion to remain from 10 minutes to a quarter of an hour in the bath, so as to sensitize thoroughly; wash in distilled water in two successive dipping baths, then under the tap, and finish with distilled water; then flood the plate, still wet, with the following solution;—1. Picked gum arabic, 20 grains; sugar-candy, 5 grains; distilled water, 1 oz. 2. Gallic acid, 3 grains; hot water, 1 oz. Dissolve these two solutions separately, and mix in equal proportions, filter at the time of using. The first portion of the solution should be allowed to freely flow off, carrying with it the water on

the film. A second portion should be allowed to soak into the film for about a minute, and then be poured off, and the plate put away to drain and dry in a dark place. The plates must be edged with india-rubber solution, or dilute albumen, or varnish, before development. The exposure in summer time with good light will be about twice that of wet plates, but in winter, or a dull light, the exposure will be proportionately longer. The backs of the plates should be painted with some yellow, green, or red colour, to prevent the light passing through, and causing blurring. This paint must be removed after exposure and before developing. The plates will keep for a considerable time before exposure, but in this, as in all dry processes, develop as soon after exposure as convenient.

PHOTO-CRAYON PORTRAITS.—This is a method of producing a delicate style of portrait, consisting of a transparency on glass, the lights of the portrait being formed by a tinted paper backing. The picture is made from an ordinary portrait negative, which should be soft, sharp, and clean. Place the negative in a copying camera for transparencies, or in the window of a darkened room, and proceed to make a transparency from the negative. An ordinary carte-de-visite vignette, or a cabinet-sized head, is most suitable. Provide a screen outside the camera, and in advance of the negative, of a somewhat oval shape, and allow the light to pass through this aperture on to the negative so that only the head and shoulders are visible, the rest being vignetted gradually away. Make the image to yield a head of about an inch and a half in size. Any ordinary good bromo-iodized collodion will do if half a grain of chloride of ammonium to the ounce is added. The nitrate bath should be as nearly neutral as can be worked without fogging. The developer should be—Pyrogalllic acid, 2 grains; citric acid, $\frac{1}{2}$ grain; glacial acetic acid, 30 minims; water, 1 oz. The exposure should be abundant, so that the image rapidly appears when the developer is applied. Very little development is

required, as the imago must be a thin one and of a purple-brown colour. If the image is under-exposed, or too much developed, it will be a disagreeable colour, and be deficient in delicate definition, as only a very thin transparency is required. During development the action must be carefully watched, something like developing a glass positive, and directly the details are visible—without washing off—saturated solution of hyposulphite must be flooded over the plate to fix it. When fixed the plate must be well washed and dried, and, if the operation is perfect, the transparency will show, when laid on white paper, as a portrait with a white vignetted margin, the whites in all cases being supplied by the paper backing. Much of the beauty of these pictures is due to the tinted backing not being in absolute contact with the image. These pictures can be produced by the magnesium light.

DIAPHANOTYPES.—Produce a good photograph on plain paper, with all the delicate half-tones of the negative well preserved. Let it be deeply printed, as when it is rendered transparent by the balsam its force is considerably reduced. Do not attach the print to cardboard; retouch the unmounted print in the shadows of the drapery, but do not interfere with the face. Place the print in contact with a piece of the best white plate glass, using the following solution;—Canada balsam, 2 oz.; turpentine, 1 oz. Pour this over the glass in much the same manner as collodion, and lay the print down on it, and with the finger or a soft pad commence from one corner carefully to press out all air-bubbles. When the picture is sufficiently set to paint upon, work in the local colours of the face, drapery, and accessories in oil colours, having a careful regard to the general outlines. It is not necessary to paint in all the shadows as carefully as an artist would do, as the transparent photograph supplies these. When the work is done the effect is very rich and mellow, with the certainty of retaining all the fidelity of the photograph.

THE IVORYTYPE.—Make a good print on plain paper; if the portrait is that of a fair person let the tone of the print be warm, if of a dark person let it be a cold tone. The print has to be coloured on the surface as an ordinary coloured miniature, only colouring it stronger to allow for the toning down it will presently receive. In this stage it will look like an ordinary photograph overcoloured. The next point is to communicate to it the softness, creamy delicacy, and transparency of an ivory miniature. This is effected by attaching it to white plate glass by white wax and gum dammar. Melt in a jar by gentle heat 2 oz. of the best white wax, and add a piece of gum dammar about the size of a hazel nut. When these are thoroughly mixed, place a little on the clean glass plate which is to receive the picture. Heat the plate gently, and when the gum and wax melts and flows over the plate, the coloured photograph must be carefully laid down on the melted wax, the greatest care being taken to avoid air-bubbles and to preserve an equal layer of wax all through. Should air-bubbles show when the plate is cold, or the wax appear unequally thick, the plate can be rewarmed, and with a warm palette knife remove the irregularities by gentle pressure.

HELIOTYPE.—When a layer of varnish composed of gelatine and bichromate of potash is spread upon a suitable surface, and is then dried in the dark, it forms a sensitive compound upon which the light exercises such action as to cause it to resist water, the parts unacted on being capable of absorbing water. An ordinary photographic negative is then placed upon the film, those parts through which the light passes are rendered insoluble, whilst those parts unacted upon by the light, are capable of absorbing moisture, when the negative has been removed, and the film slightly damped. Thus when a roller charged with greasy ink is passed over the surface, the ink adheres to those parts only on which the light acted, the water with which the other parts are charged preventing the adhesion of the

ink. The proofs are then obtained by means of the usual printing press—a typographic being preferred to a lithographic press. The details of the process are as follows;—A plate of glass, the surface of which is ground and not polished, having received a coating of wax, and been carefully levelled, a sufficient quantity of a mixture of gelatine, bichromate of potash, and chrome alum is poured over it to form, when spread out and subsequently dried, a film of the thickness of very thin card or thick paper. The coating and drying must be done in a dark room, or one into which only a *yellow* light is admitted. The use of the chrome alum is to prevent the subsequent solubility of the film, this substance having the property of preventing gelatine from becoming again liquid after it has once set; without it the portions of the film that had not been acted on by the light would be at the mercy of the water, which would cause it to become so soft and swollen as to seriously interfere with the successful working of the process, which depends for good results on its firmness and uniformity of condition. The proportion of bichromate of potash to the gelatine is about 5 per cent., but this may be varied to any extent to suit the requirements of the negative, much in the same way as the strength of a silver bath for positive printing is altered for special purposes. After the glass plate has been coated, it is retained in its level position for a few minutes until the film has set sufficiently to permit its being lifted up on its edge, when it is stored away in the drying room, where the temperature is tolerably high, and the atmosphere dry. The drying and store rooms must be dark. In about 24 hours the film has become thoroughly dry, when it is removed from the glass—an operation which is effected with ease, the previous substratum of wax conducing to this end. The advantages derived from the removal of the film from the glass are very great. One of these is, that whereas formerly, when the film remained on the thick plate of glass on which it was printed, it was

difficult to secure perfect contact between the negative and the sensitive surface, and any hollow or inequality in the negative caused a separation to take place between the two plates, loss of sharpness in the printed gelatinous surface being the result. But now that the system of removing the film from the glass has been adopted, its flexibility permits it to be pressed in intimate contact with the negative, no matter whether the latter be flat or not. The next operation is to attach the film to a plate of zinc. This is effected by first placing the plate in a flat vessel of water, and then immersing the gelatine film, bringing both in contact without allowing air-bubbles to intervene. With one or two strokes of a squeegee is secured the intimate union of the sheet of gelatine with the metallic plate, on the sucker principle. After the plate becomes surface-dry—which is the case in a few minutes—a brush charged with india-rubber solution is passed round the margin, which has the effect of preventing the ingress of air when the plate is being printed from. To prevent the film from shifting during subsequent operations, the zinc plate, previous to the laying down of the film, is usually coated with india-rubber varnish. The plate is now ready for furnishing impressions. These are obtained by treating it in much the same way as is a lithographic stone; it is first of all sponged with water; the surplus water is removed by the squeegee, which is followed by pressing over the surface of the plate a sheet of blotting paper. The ink rollers are then passed over it, the ink adhering according to the action of the light. It is in the printing that the great value of the stripping off of the film and transferring it to the zinc plate is seen. In the Albortype process, so long as a plate of glass was used for printing from, an element of extreme danger and uncertainty was present—danger, because any particle of granular matter getting under the plate would ensure its being fractured under the pressure of the printing press. Experience has proved that a greater degree of pressure

must be applied to obtain the finest effects of certain subjects than a glass plate can safely bear. The degree of pressure to which a zinc plate may be subjected, compared with that which glass will bear, forms a feature of value in the recent modifications of the heliotype process. When the desired number of prints have been obtained, the film is detached from the zinc plate and placed away in a portfolio, ready for future use. This, also, is an improvement, for, previously, the reserving of some hundreds or thousands of printing films, each of them permanently attached to a large, very thick, and costly piece of plate glass, entailed both expense and inconvenience. As the printing pressure is direct, a considerable number of proofs can be obtained from one film; 1500 uniformly good prints have been thus got. Of course, as the preparation of the printing plate or film involves so little trouble and expense, when a large order has to be executed a number of plates are prepared, and the uniformity of these is ensured by exposing them all to the same actinometric figure. Another point in the process is the adaptation of it to chromotypic printing; by printing upon a sheet of paper previously coloured in broad masses by lithographic or other means. The effect of a heliotype when printed upon such a base is very good. There is no other way by which the peculiar effect of photographs on albumenized paper can be so well obtained as by using paper with an enamelled face. We have stated that the sensitive film of gelatine was formed upon a plate of ground glass. For subjects requiring great delicacy, the upper or shining side of the film is invariably placed next to the negative; but if a granular texture in the finished print be desired—such a texture as would be obtained from a grained lithographic stone—it is only necessary to print upon the granular instead of the smooth side of the film, the degree of granularity depending upon that of the surface of the glass on which the film was prepared. It is found that the stiffness of the ink exercises a marked influence on the image.

A stiff ink adheres only to the deepest shadows, while, on the contrary, a thin ink attaches itself to the demi-tints. Taking advantage of this property, the plates are rolled over with ink or inks to suit the particular kind of work, or the effect wanted. One consequence of this is that, if a very soft picture be required, a thin transparent ink will give the desired quality, while, if the opposite quality be desired, it is only requisite to use a stiff opaque ink. Both can advantageously be combined in one picture. In printing by the heliotype process, the pictures do not require to be mounted like other photographs, for the margin is left clean and white. This renders the process specially applicable for book illustration.

SWAN'S PROCESS.—PHOTOGRAPHS IN PIGMENTS.—The tissue is prepared by machinery, by which a perfect and uniform coating is secured. Each piece of paper is made into an endless band revolving round rollers, which keep it stretched, and repeatedly pass it over a surface of melted gelatine, sugar, and pigment, until a perfectly even coating of the right thickness is applied to the whole length. The trough of gelatine is kept at a proper temperature by means of steam. By repeated contact with the gelatine, a thin coating being applied each time it passes over it, a more perfect surface and even thickness of the gelatine is secured than could be obtained by any plan which applied the full thickness at once. By the arrangement adopted, waves of irregular draining are entirely avoided. These lengths of gelatine are then cut up to specific sizes, and will keep ready for sensitizing when required. The paper employed must possess a fine surface, and be free from inequalities and imperfections, so that it may receive an even layer of the gelatine, as any imperfection in this layer may result in a blemish in the picture. It is desirable that the paper shall be sufficiently permeable by the water to facilitate its removal from the gelatine prior to development. The tissue is prepared in three varieties of colour; and in each there are three

gradations of intensity to suit negatives of various kinds. The colours are indian ink, sepia, and photographic purple. The indian ink tissue is a pure black, nearly neutral in tone, inclining to warmth. The sepia tissue is of a warm sepia tint. The photographic purple tissue is of a tint resembling that common in gold-toned silver prints, of a purple-brown, in its extreme depths a purple-black. In this pigment printing, although the best picture will result from the best negative, it is possible with a very intense hard negative, possessing abrupt contrasts, to produce extremely soft and harmonious prints; whilst brilliant prints may also be obtained from a feeble negative possessing very little contrast or intensity. It will be seen, then, that by forming the picture in a thin film of insoluble matter of intense colour, vigorous contrasts and perfect gradations from light to dark may be secured with a thin negative; and that by using a thicker film of insoluble matter, less intense in colour, the excessive contrasts of a hard negative may be softened, thus materially ameliorating the faults of bad negatives in either direction. The kind of negative which suits best for Swan's process is a negative of average density, with full detail in the shades, such as is got by ample exposure and development. There should be some, although little, absolutely bare glass; but whatever deposit of silver there is on the deepest shades should be a pure photographic deposit, and not "fog." The tissue is prepared in each tint to suit negatives of three qualities, numbered 1, 2, and 3. No. 1 possesses the smallest proportion of colour, and is suited to the production of harmonious prints from negatives in which, from the nature of the subject, from under-exposure or over-intensifying, the contrasts are abrupt. No. 2 is suited to good negatives of normal character, in which the densest parts are not absolutely opaque. No. 3 possesses a large proportion of colour, and is suited to thin, soft negatives, a little lacking in force and intensity. By a classification of the negatives, and

the use of a suitable quality of tissue for each, it will be found possible to secure more complete control over the character of the prints, and a more perfect uniformity of result than is possible in ordinary silver printing. The tissue should be kept in a cool, dry place, packed flat, and kept under a weight. If exposed to the atmosphere, it will in hot weather curl up and become unmanageably horny; whilst in damp weather it would absorb moisture.

Sensitizing the Tissue, and other subsequent operations, will be conducted in the dark room. A nearly saturated solution of bichromate of potash is employed. As the strength of a saturated solution varies with temperature, make a solution of definite strength, by dissolving such a quantity of bichromate of potash as will not during cold weather crystallize. Such a solution is formed by dissolving 1 lb. of bichromate of potash in 12 lbs. of water. The tissue is immersed by drawing it face upwards, under the solution, contained in a dish 2 or 3 inches deep, care being taken to avoid the formation of air-bubbles. After immersion, the sheet is turned, and with a flat camel-hair pencil remove the bubbles that form on the back; it is then again turned, and drawn repeatedly through the solution. Then attach American clips along one of the edges, and slowly withdraw, so that the solution drains off without being repelled from the face of the tissue, and running off in streams. If the sheet is large, a thin lath of wood may be laid along the edge of the tissue that is first withdrawn from the trough, the tissue and lath being clipped together with American clips. The time of immersion may vary from 1 to 3 minutes, according to the temperature and the facility with which the tissue absorbs the solution. As a rule, as soon as it is quite limp it should be removed. The longer the immersion, within certain limits, the more sensitive will be the tissue; but if too much prolonged, there is a danger of the paper becoming rotten, the gelatine also loses toughness, and the large quantity of water absorbed renders it

liable to tear with its own weight. Long immersion in a saturated solution is also apt to produce a crystallized surface in drying, which renders the tissue quite useless. The tissue should be placed to dry in a dark room, through which a current of dry air is constantly passing. In the first stage of drying, the temperature of the air must not be above 70° Fahr., otherwise the gelatine would melt. During damp weather, the air of the drying room may be raised 10° after the tissue has become half dry. If the drying is slow, the development of the image afterwards will be extremely slow or altogether impossible. After complete drying, the sensitive tissue may be kept for several days. By keeping it too long, a discolouration of the print results, and the print develops tardily, and the lights are not clear. As a rule, by sensitizing in the evening, a supply of paper may be prepared for printing next day; 12 hours' suspension in a dry atmosphere being sufficient for the necessary drying. Should the tissue by accident be rendered too dry and horny, it is desirable to hang it for a few minutes in a damp place, when it will quickly become just sufficiently pliant to permit easy manipulation.

Exposure under the Negative.—As the prepared side of the tissue is placed in contact with the negative, if it retained the slightest adhesiveness of surface, it would be dangerous to bring them together. Care must be taken not to use damp tissue. Before placing the tissue in contact with the negative, apply to its surface, with a flat camel-hair brush, some powdered French chalk. This material prevents the risk of the gelatine film adhering to the negative, and serves other useful purposes. On applying it to the gelatine surface, it indicates if any spot is not perfectly dry by adhering there in a patch instead of spreading in a scarcely perceptible coating; it also prevents an excessive absorption of light at those points of the tissue which are in such perfect contact with the negative as to destroy the reflection from its second surface. Although the gloss of the tissue

is slightly deadened by the trace of powder attached, it does not in any degree interfere with the progress of printing, or cause any imperfection in the print. The negative is also rubbed over in the same way; and all risk of the tissue sticking to the negative is removed. For the exposure it is not necessary to use pressure frames with hinged backs, as the print is not examined in progress, the sole guide as to time being the actinometer. The back pressure should be comparatively light, and the backing should be smooth and level. Fine cloth forms an excellent backing. Where the padding of the back is coarse, a piece of smooth cardboard may be placed at the back of the tissue. If the tissue is quite dry, there can be no objection to sun printing; but if the slightest moisture is left in the gelatinous film, prolonged exposure to a hot sun with a dense negative would soften the film, and cause it to adhere. As this tissue is much more sensitive than albumenized paper, printing in diffused light will generally be more convenient, as well as safer. As a rule, the exposure is from one-third to one-half of that required for albumenized paper. In direct sunlight, it may vary from 1 to 10 minutes; in diffused light from 10 minutes to an hour, or even more. In using the actinometer, it must be exposed to the same light as the prints, the progress of which it is to indicate.

Mounting and Preparing for Development of the Image.—As the washing away of the superfluous compound must be effected at the side opposite to that which was in contact with the negative, before commencing development, the tissue must be mounted on another piece of paper with a material which is not affected by water, in order that the paper upon which the compound has rested up to the present time may be removed, so as to expose the hitherto protected surface to the water. As the paper upon which the tissue has to be supported, during future operations, is placed in contact with the surface which will be the surface of the finished print, it should be smooth and free from blemish; and it should be sufficiently tough to bear the

treatment necessary in hot water. Fine Saxe paper answers well. A solution of india-rubber is used for mounting the tissue. Pure india-rubber should be cut up into fine shreds, and dissolved in pure benzole at the rate of about 10 grains to 1 oz. of the solvent. When properly prepared, it forms a thin varnish, but it leaves a palpable film of india-rubber on the paper to which it is applied. When desirable to hasten the complete solution, covering the shreds of india-rubber with a little chloroform will quickly reduce them to a pasty mass, readily dissolved by the addition of benzole. The india-rubber solution is poured into a flat dish, and the paper drawn over it, so as to secure an even coating on the whole surface. The paper is then hung up by American clips to dry. The tissue, removed from the negative, having been wiped to remove the French chalk, is floated over the surface of the india-rubber solution in the same manner, care being taken not to allow it to sink below the surface; it is then hung up to dry for about an hour. When the india-rubber on both the paper and the tissue is dry, the extreme edge of the tissue is cut off, and the two coated surfaces are carefully brought into contact, and in order to secure perfect contact and cohesion, they must be submitted to heavy rolling pressure. The coated surfaces should be preserved from dust and from contact with anything which could impair the cohesion of the india-rubber surfaces. In bringing the tissue into contact with the india-rubber coated paper, the tissue should be bent back, so that contact is first made with the middle of the print; the ends of the tissue being then allowed to fall after first contact. After being placed, the back of the tissue may be lightly rubbed with the hand or a pad, the rubbing being from the centre outwards. Several prints may be attached to one piece of paper. In rolling, the india-rubber coated paper is laid on the steel plate, and a blanket of thick felt is laid over the tissue, which is uppermost, whilst it passes through the press. Although the prepared surface of the sensitive tissue must be always carefully

shielded from light, when once that has been covered up by mounting, it may be submitted to a dull, diffused light with impunity, care being taken that the back of the original tissue is uppermost. This permits the rolling of the mounted tissue to be effected in a moderately light room. The back of each print should be examined, and any india-rubber solution removed by rubbing with a piece of india-rubber. The print is now ready for development. To effect this a plentiful supply of warm water is necessary. Three large wooden troughs should be used, provided with hot and cold water taps and waste-pipe. Into these troughs pass the prints in succession. But the same result could be obtained on a more limited scale in photographic dishes, and by having at hand a large vessel of hot water, as well as the ordinary cold water supply. The prints must be first immersed in cold water, all air-bubbles being carefully removed. Here they are left for half an hour or more, as may be convenient, to permit the water to penetrate and soften the gelatine; after this, place them one by one in water of from 80° to 100° Fahr. This immediately loosens the backing paper upon which the tissue compound was originally coated, which must be stripped off. It is separated from the tissue at one edge, and lifted gently away. If it should still adhere, a little longer soaking in the warm water will be necessary to effect the removal of the paper; but this is always a bad sign. The back surface of the tissue, opposite to that which was exposed, is now uncovered; and the next operation is to remove all gelatine, pigment, and chromic salt which have not been rendered insoluble. As the sensitive surface is now exposed, strong white light should be avoided until the bichromate has been washed out of the film. A large portion has been removed whilst the print was soaking; and now that the gelatinous compound is exposed, the salt is rapidly diffused in the water. The process of clearing may be accelerated by allowing a gentle stream of warm water to fall on the surface of the print, but if the print is left face down in the warm

water, in from five minutes to a quarter of an hour it will have parted with nearly all the superfluous gelatine and colour, presenting the image in its proper gradations, and only requiring a little further washing to complete the operation. If, from over-exposure, the picture appears too dark, or the image appears slowly, the temperature may be raised, when necessary, to 150° Fahr.; but high temperature must not be used until all the development has been effected that can be effected by water of a lower temperature. The development is best commenced at as low a temperature as possible; and, as soon as the image is fully made out, the print should be removed to cold water, in which the residue of bichromate will be washed away without injury to the delicate half-tones, which would, with an under-exposed print, disappear in hot water. After 2 or 3 hours' immersion in cold water, the prints are one by one re-immersed in water at 80° or 90°. Those which show signs of under-exposure are very carefully rinsed in merely tepid water, say 80°, to clear away the soluble gelatine and adherent colour; after which they are suspended to dry. The more fully-exposed prints remain in the warm water until they become light enough. Any that are over-exposed are put into hot water, and are allowed to remain until the depth is sufficiently reduced. By using merely tepid water at the commencement of the operation, any under-exposed prints are discovered and saved. Then, by the use of hot water to the more fully-exposed prints, these are speedily lightened to the required degree, and very few prints are lost from under or over exposure. When sufficient gelatine and colouring matter have been removed, and the prints are fully developed, they are hung up to dry. It is most important to preserve uniformity of action. It is desirable to keep the face downwards until the development is completed, and to remove air-bubbles whenever they form. It should be remembered, in observing the depth of the picture, that it is seen on a ground covered by the coating of india-rubber, which gives the paper a brown tint,

and that when transferred to pure white paper, it will possess much greater brilliancy. The picture up to the present time presents an image in which right and left are reversed. It is now necessary to transfer it from the paper which has supported it temporarily for manipulation, to its final resting place, in which operation right and left will resume their proper relations. The image may be transferred to a sheet of cardboard, so as to require no further mounting, or to paper; in the latter case, it is simply in the position of an ordinary print, and will require subsequent mounting.

Transferring to Cardboard.—The face of the dried print is very evenly coated, by floating, or by means of a flat camel-hair brush, with the following preparation;—Gelatine, 2 oz.; glycerine, $\frac{1}{2}$ oz.; water, 1 pint. The gelatine should be melted and carefully cleared of air by long heating, and skimming the froth; after which the glycerine is added. It will always require melting by heat, and straining through wet flannel or muslin before use; it is then applied evenly to the surface, by floating, and hung up to dry. When dry the print is trimmed to the required shape. A piece of stout cardboard of the required size, pure in colour and fine in surface, is passed through clean water, and drained. Upon the moistened surface the print is laid, face downwards, exactly in the position it is to occupy, and the card is taken to the rolling press and placed on the polished steel plate, print side downwards, the side on which the print is placed being in contact with the plate, and a felt blanket on the back of the card; it is submitted to a heavy rolling pressure, and put aside to dry. The cardboard must be perfectly moistened all over, as, if any point is omitted, the adhesion of the print in that place would not be secured. As each part is submitted to the rolling pressure, a wave, infinitely small however, is driven before the pressure, effectually displacing air, and securing perfect contact. There should be no delay in applying the pressure after the print has been placed in contact with the

moistened surface, as the image, by absorbing moisture, might, under the heavy pressure, lose something in sharpness. As each print is passed through the rolling press, it is placed upon the last, and when the pile is completed, a weight is placed upon the whole heap, the prints then dry without warping; and at the expiration of about 24 hours they are ready for the final operation. This is, removing the paper which has supported the image during the operations of developing and washing. The picture must be quite dry before the operation is attempted. A piece of clean cotton wool is saturated with pure benzole, and the india-rubber coated paper which covers the print is rubbed pretty hard with it. An edge of the paper is then gently raised with the point of a blunt knife, care being taken to commence at a black part of the picture where the film of the image is thickest. The raised edge is then taken hold of, and pulled so as to tear it gently and steadily off the print. Instead of removing the paper with an upward or lifting motion, it is better to turn it backwards, as there is less danger to the surface of the print at any point in which the adhesion in mounting is imperfect. As a general rule, especially when the benzole is used sparingly, the paper brings away with it all the india-rubber coating; but any traces remaining may be rubbed away with india-rubber. Under ordinary circumstances, the picture is now finished. If required for colouring, the print may be coated with plain collodion, or a suitable sizing preparation. The manipulations in transferring to paper are very similar to those just described, but are a little more easy. It is not necessary to trim the print to its proper size or shape, as this will be done in the final mounting. The mounting papers are carefully immersed in water, air-bubbles being brushed away, and then laid one upon another while in the water; they are then drawn out in a pack, and suspended to drain for some hours, or pressed to remove the superfluous water; a perfectly even film of moisture is thus secured. Place the print, face upwards, on the steel plate of the press,

and over the print is laid the moistened paper, and on that a felt blanket. The press is then pulled. The print is next immersed for an hour in a bath, containing 5 per cent. of alum, and is afterwards well washed in water and dried, after which it is uncovered as when mounted on cardboard. By transferring to paper it will be observed that facility is afforded for performing the last-mentioned operation, by which an additional source of stability is secured. A solution of common alum has, to a certain extent, the power of waterproofing the prints, and generally fixture with alum is quite sufficient. Where, however, more thorough waterproofing is required, the prints, after transfer, should be treated with a 1 per cent. solution of chrome alum. Prints intended for colouring in water colour should be chrome-fixed.

Sensitive Collodio-Gelatinous Tissue.—

To prepare the sensitive collodio-gelatinous tissue, take a sheet of plate glass, free from blemishes or scratches, and clean it perfectly, finally rubbing the surface with a saturated solution of beeswax in ether. This is wiped off with a clean cloth, leaving a scarcely perceptible coating of the wax. This coating tends to facilitate the future removal of the tissue from the glass. Now coat the glass with plain collodion, giving a thick, tough, transparent film. The pyroxyline should be of the kind which yields a film free from opacity. About ten grains in an ounce of solvent, consisting of equal parts of ether and alcohol, will answer the purpose. This film must be dry before applying the tissue compound. Make a solution of pure gelatine 2 oz., white sugar $\frac{1}{2}$ oz., water 8 oz. The kind of pigment to be employed, and the proportion in which it is to be added, will depend on circumstances, but it is especially important in the preparation of this tissue, that the pigment employed should be so finely divided that no subsidence will take place during the period the tissue compound remains in the fluid state upon the glass. The preparation in this state may be kept ready for use. It should be kept in a well-corked, wide-mouthed

bottle; in hot weather it is apt to decompose if kept long. It may be poured into a flat dish to the depth of about half an inch, and when nearly dry cut into shreds, and thoroughly dried; in which state it may be kept without risk of injury. When required for use it must be soaked again in eight parts of water. The proportion of gelatine and of sugar will be influenced by the quality of the gelatine, the temperature, and other conditions, in which experience must be the guide. In very dry weather the proportion of sugar may be increased. To prepare the tissue compound for use, heat must be applied until it is quite fluid, when one part of a saturated solution of bichromate of ammonia must be added to every ten parts of the gelatinous compound, after which the whole should be strained through flannel. It is desirable, after the chromic salt has been added to the gelatine, to avoid applying a greater heat than is necessary to preserve fluidity, as excess of heat tends to produce insolubility. About 100° Fahr. will generally answer the purpose. It must be remembered that frequent application of heat to gelatine destroys its setting powers, and renders the preparation useless. If the tissue is too thin the finished picture will not possess its proper depth of shade in its darkest parts, unless it has had an unusually large proportion of colouring matter. If too thick, drying is retarded, and it is intractable in manipulation; it will also require a longer time in development. As a general rule, about 2 oz. will be required for each superficial foot. Immediately previous to the preparation of a sheet of tissue, the piece of patent plate glass should be placed in a perfectly horizontal position, a spirit-level being used in the adjustment. The tissue compound, warmed to 100°, should be strained through a piece of moist flannel or muslin, and when ready the plate should be warmed until it is of the same temperature as the compound. The proper amount is then poured on the collodionized plate, and caused to flow over its surface, a glass

rod being used to spread the solution. The coated plate is then left on the stand until it is quite set. When once thoroughly set, the plates may be placed away in an upright position to dry. The more quickly the drying is effected, provided heat is not applied, the better. The temperature should not exceed 60° or 70° Fahr., as a higher temperature may cause the gelatine to run and form uneven waves. In a dry, well-ventilated dark room, kept at a temperature of about 60° Fahr., drying will generally take place within twelve hours, and without any danger to the solubility of the tissue. It is desirable in damp weather to use a drying box, containing chloride of calcium, or other substance having great affinity for water. When the tissue is dry it is ready for printing, it is removed from the glass and placed in the pressure frame, with the collodion surface in contact with the negative. The proper exposure is ascertained by the actinometer. Before development, the tissue is coated with india-rubber solution in the same manner as the paper tissue, and is mounted on paper coated with india-rubber. It is then developed, washed, dried, and transferred as already described; the film of collodion in this instance forming the surface of the finished print. Instead of coating the glass plate with collodion, it may be rubbed with ox-gall, or with the solution of wax before mentioned, and coated with the sensitive tissue compound. When this is dry it may be coated with collodion, removed from the glass, and treated in the manner already described. Or it may, instead of being coated with collodion, have a sheet of wet paper applied to it, and pressed in contact so as to adhere. It is then sullered to dry, and treated as the paper tissue in all respects, its only difference consisting in the fine surface communicated by the plate glass, which becomes finally the surface of the transferred picture, and possesses more delicacy of effect than that produced by the ordinary paper tissue.

The Pigment employed.—Where effects resembling artists' drawings are required, which, in reproductions will often be

valuable, it is quite possible to produce them. The effect of a drawing in light pencil may be imitated by using graphite as the pigment; red chalk may be imitated by Venetian red; for sepia and bistre effects these pigments themselves may be used. For most purposes, however, a fine black, either neutral, or inclining to brown or purple, will be preferred. Fine lamp-black, or good indian ink, in such case will generally form the basis of the colouring matter. If the colour required is a pure neutral black, the addition of a blue pigment is necessary, to neutralize the brown tint of indian ink; and, where necessary, coldness is corrected by the addition of some warm colour. The selection of this colour will be governed by the tint desired, and by the permanency. Many of the most beautiful tints are most fugitive. Carmine, for instance, is unstable. Crimson lake is a valuable colour, but it is not strictly permanent. Indian red is a very powerful and very permanent colour. Venetian red is also permanent. Ultra-marine blue is satisfactory as regards permanence. In judging colours it must be remembered that the actual effect of colour employed is chiefly seen in middle tint. It is difficult to distinguish much difference between a blue-black, a brown-black, or a purple-black, in the extreme darks of a picture; but the tone is easily distinguished in middle tint, and, as a rule, warm half-tones are the most pleasing. By the addition of a large proportion of colour to the gelatine, a vigorous print may be obtained from a feeble negative, and by the use of a small proportion of colour a hard and intense negative may be made to yield soft prints. As a normal proportion for good negatives 2 per cent. of carbon is sufficient. The proportion of pigment required varies with different pigments, and depends upon the power of the colour employed.

Colouring Carbon Prints.—Carbon photographs admit of colouring in oil, water, or powder colours, without risk of damage; the manipulation is easier than that upon albumenized silver prints,

Powder colours adhere very readily to the surface of these prints. By breathing on the picture a still more adherent surface is obtained.

Water Colours.—The water colours take kindly without any preparation, washing well, and permitting tint to be worked over tint without difficulty, and the surface may be made more pleasant for working on by the application of a coating of sizing preparation. The plain carbon print so treated acquires an even, clear surface, losing all gloss without any loss of depth or transparency.

Oil Colours.—The best mode of preparing a carbon print for the reception of oil colours is by sizing it with isinglass. A solution of about 2 per cent. of isinglass in equal parts of hot water and spirits of wine, carefully applied, not too hot, to the surface of the carbon print, with a flat camel-hair brush, yields a surface upon which oil colours work admirably.

Re-touching Carbon Prints.—In the ordinary process of re-touching carbon prints, to remove small imperfections, it is only necessary to use the proper colour in the usual way; if a little gelatine, with a trace of a chromic salt, is employed with the colour, it will, when dry, become insoluble like the rest of the picture. If the re-touching is effected with the same materials before transferring the print, it will, when the picture is finished, be under the image, and no inequality of surface, usually apparent after touching, will be seen.

Failures, Faults, and Remedies.—**Spontaneous Insolubility of the Tissue.**—This arises chiefly from slow drying, or long keeping in a damp place. The addition of substances to give elasticity, such as glycerine, which retard the drying of the gelatine film, also tend to produce spontaneous insolubility. Heat in conjunction with the moisture increases the tendency. The use of too much bichromate of potash, or too prolonged immersion in the solution of bichromate, will produce spontaneous insolubility. Immersion in very hot water, prior to development, is at times conducive to insolubility, also drying the tissue in an

impure atmosphere, and especially one vitiated by the burning of gas.

Tardy Solution of the Superfluous Gelatine Development.—The same causes which produce spontaneous insolubility when present in less degree, cause tardy solution of the unaltered gelatine, and slow development. The more rapidly the tissue has dried, and the more horny it appears, the more readily, as a general rule, the superfluous gelatine and pigment are removed by warm water, and complete development is effected. When the development is slow, hotter water may be employed; but care should be taken that the free soluble bichromate has first been removed by tepid water.

Bichromate of Potash Crystallizing on the Tissue in Drying.—If the tissue is allowed to remain too long in a saturated solution of bichromate of potash, the salt will crystallize on the surface during drying, and the tissue will be useless. The remedy of course is the employment of a weaker solution, or a shorter immersion in the full-strength solution.

Uneven Development.—If the print is allowed to float to the surface of the warm water, allowing portions to become dry; or if some portions of the paper forming the original basis of the gelatine are allowed to become detached long in advance of the remainder, so that the warm water acts directly on the soluble matter in patches, the result will be uneven development, the portions last uncovered remaining darker than the rest of the print; and it will be difficult to equalize the tint, even by long-continued development.

Blisters during Development.—If, in mounting the tissue with the india-rubber solution, perfect contact in all parts is not secured, blisters will arise in the course of development, which will show as marks or defects in the finished print. Passing the combined sheets of tissue and india-rubber coated paper through a powerful rolling press prevents this.

Over-Exposure.—An over-exposed print will develop tardily, and continue, under ordinary treatment, too dark. After all the soluble chromic salts are removed, the temperature of the water

may be raised, and by long soaking in hot water the depth may be reduced considerably. Immersion for a short time in a very weak solution of chloride of lime, or of hypochlorite of soda, or in chlorine water, or peroxide of hydrogen, rapidly reduces a print, by decomposing a portion of the insoluble chromogelatine compound, and restoring it to its original condition of solubility. Protracted immersion in hot water is the best remedy.

Under-Exposure.—An under-exposed print develops rapidly, the lighter half-tones quickly disappearing. When this is seen, quickly remove the print to cold water, and by skilful manipulation and attention, and the after-use of almost cold water, say under 20°, a brilliant print may be secured.

Weak and Flat Prints.—When a feeble print is obtained from a good negative, it may arise from the use of a tissue containing too small a proportion of colour, or from the tissue being old and partially decomposed by slow drying. If the negative is weak, the use of a tissue containing a large proportion of colour will yield a vigorous image. Increased vigour may be obtained from an ordinary sample of tissue, by sensitizing it on the paper side of the tissue only, instead of immersing the whole. Printing in direct sunshine aids in obtaining a vigorous print.

Hardness and Excessive Contrast.—This may arise from an unsuitable negative, or from the injudicious use of too hot water on a lightly exposed print, or from the use of tissue containing an excessive proportion of colour, especially in conjunction with under-exposure. Sensitizing the tissue on the prepared side will tend to produce softness, even with a dense negative.

An Uneven Texture in the Finished Print arises from unequal and insufficient pressure in transferring. This unequal pressure may arise from the coating of india-rubber being uneven, or, more probably, from the coating of clear gelatine being applied in uneven streaks, or from uneven texture of blanket, or uneven pressure.

Portions of the Image wearing off in Transferring arises from the face of the print being imperfectly coated with gelatine, or from the paper or board to which the print is transferred having an imperfectly moistened surface, or from not being dry when the paper is removed, or soiled by fingering or dust.

A Green Tint pervading the Blacks is caused by imperfect washing of the print, by which traces of soluble chromic salt are left in the image.

Unequal Sensitiveness.—This arises from the tissue having imbibed the bichromate solution unequally. If, in immersing the tissue, one portion remains dry while the rest is wet, that portion will be least sensitive, and will form a light patch in the picture. If the tissue is raised out of the bichromate in such a manner that streams of the solution run down the sheet, there will be in the print patches or streaks of a darker colour.

The Gelatinous Coating will Run in Sensitizing, if the bichromate solution is too warm, and the tissue kept too long immersed. During summer it is necessary to keep the bichromate solution as cool as possible, and to sensitize in the coolest place that can be procured.

Dark Spots.—If a piece of tissue is printed under too heavy a pressure, dark spots or patches appear in the half-tones. This is most apt to occur if the tissue is limp, and the pressure of the back of the printing frame not only strong, but uneven from coarse padding.

A Sparkling Appearance in the Print after final Transfer.—This arises from the transfer process being imperfectly performed, the paper being either too wet, or too slight pressure used, or the blanket not sufficiently yielding to diffuse the pressure equally over all the surface of the print.

DRY COLLODION PROCESS.—The wet collodion process is found very inconvenient for photographs of scenery, and buildings, when the operator is away from his base of operations. He must either carry a tent, to use as a dark room, an awkward addition to his lug-

gage, or he must treat his collodionized plates so as to preserve their sensibility for a longer or shorter period. There are many well-known processes in use, by which the plates are prepared and sensitized before starting on a journey, exposed at the desired situation, and developed on return home. In all the processes the plates are coated with iodized collodion, washed, and sensitized in the nitrate of silver bath, in the same manner as in the wet collodion process, but the means taken to preserve the sensitiveness of the plates vary greatly. If an ordinary negative plate, when removed from the nitrate of silver bath, be allowed to dry, it loses nearly all sensibility, and cannot be developed, as the nitrate of silver crystallizes on the glass. The dried collodion film, when wetted, does not return to its former soft porous condition, but is apt to peel off. It has been found that dilute spirits of wine poured over the dried plate prior to developing, will to a certain extent restore the collodion to its proper condition. When the alcohol has well soaked in, wash the plate, and develop as with wet collodion plates. This simply washed and dried plate is the easiest form of dry collodion process, but is unreliable. By the addition of half per cent. of resin to the collodion, or a few drops of amber varnish, the chances of failure are lessened, as the film is more likely to adhere to the glass. Treat the plates as with ordinary collodion; when taken out of the nitrate of silver bath, wash and place to dry in the dark. Varnish the edges of the film, and when about to use the plate dip it in a nitrate of silver bath. These plates must be used the day after preparation. The time of exposure in the camera must be about three times as long as for the wet process; develop with a solution of gallic acid. Another simple operation is to coat an ordinary wet plate with a solution of dextrine. Dissolve one part by weight of dextrine in ten parts water, allow to settle, pour off the clear portion. Remove plate from nitrate of silver bath, wash, pour

some of the dextrine evenly over the plate, drain and dry in the dark. Thus prepared, plates may be preserved several days; exposure three times as long as for wet collodion. Before developing, wash in clean water, develop with pyrogallic acid.

Preservative Solution for Sensitive Plates.—Honey, 3 oz.; distilled water, 5 oz. This mixture is to be poured over the sensitive plate after it has been removed from the silver bath and well drained upon blotting paper. The solution should be filtered before use and poured over the plate several times; it should be then drained for a few minutes and kept in the slide or dark box; it will keep sensitive for several days. The following dry processes, though less simple, are far more efficient and trustworthy than the washed plates. For open-air views, a careful consideration of the size of diaphragm to be used is necessary; the smaller the opening the more brilliant will be the picture, but a longer exposure will be necessary than with a diaphragm having a large opening.

COLLODIO-ALBUMEN PROCESS.—Coat the plate with ordinary bromo-iodized collodion, pour it on as usual, let it set well before placing the plate in the nitrate of silver bath, and use a pneumatic holder, so that the collodion may completely coat the plate. Place the plate in the nitrate of silver bath, remove and wash with several waters, place it in a pan half filled with a solution of 3 grains of iodide of potassium to an ounce of water, in which let it remain whilst preparing the next plate. Then remove, wash well, and pour over the collodion surface some of the iodized albumen solution, letting it float backwards and forwards on the plate so as to saturate the film; pour off the solution, and repeat the operation with a fresh quantity of the iodized albumen; pour off, and set the plate to drain on blotting paper. The final drying may be done by artificial heat. Plates thus prepared must be kept dry; they are almost insensitive to light, and will remain good for a long time. To

sensitize, heat the plate over a spirit lamp or before a fire; when cool, immerse it in the aceto-nitrate bath for one minute, using only a yellow light, then wash thoroughly, and stand to dry in the dark. The plates should not be sensitized the second time too long before they are to be used, although they will keep for a few weeks in warm weather, and even longer in cold weather. Exposure about six times as long as ordinary wet collodion. A little over-exposure is better than under-exposure, as the great point is to bring out all the details, even in the darkest shadows. Develop with plain pyrogallic acid, and intensify with acid silver solution. After developing, fix with the hyposulphite of soda solution as used for wet collodion plates.

Nitrate of Silver Bath.—1 oz. recrystallized nitrate of silver, 12 oz. distilled water, $\frac{1}{2}$ oz. glacial acetic acid, and 2 grains iodide of potassium. Dissolve and filter.

Iodized Albumen.—2 $\frac{1}{2}$ oz. distilled water, 10 oz. albumen, 50 grains iodide of potassium, 10 grains bromide of ammonium, 120 minims strong liquor ammonia. Beat to a froth, allow to settle. Filter before use. This mixture will keep good a considerable time.

Aceto-Nitrate Bath.—30 grains nitrate of silver, $\frac{1}{2}$ dram glacial acetic acid, 1 oz. distilled water. After using this bath for sensitizing the plates, it will be discoloured; pour it into a bottle containing about 2 oz. of kaolin, shake, and stand to settle; the kaolin in subsiding will carry down the colouring matter.

Plain Pyrogallic Developer.—Two grains pyrogallic acid to every ounce of water. Let the film on the dry plate be well wetted with clean water, then pour on the solution; as soon as all the details of the picture have come out, add a few drops of the following solution to that on the plate;—

Intensifying Solution.—15 grains nitrate of silver, 10 grains citric acid, 1 oz. water.

Alkaline Pyrogallic Developer.—Make the following mixtures, and keep in 3

separate bottles;—1. 96 grains pyrogallic acid, and 1 oz. alcohol. 2. 96 grains carbonate of ammonia in 1 oz. water. 3. 10 grains bromide of potassium in 1 oz. water. When about to use, mix 10 minims of No. 1, 5 minims No. 3, with 1 oz. water; pour over the wetted plate, let it remain on a few seconds, pour the solution back into the cup, and add to it 5 minims of No. 2, pour on to the plate again. More of No. 2 may be added, if the details do not come out well; but if too much is used, fogging may occur before the development is completed. The solution of bromide of potassium is to check fogging; but as it also checks development, the less of it that is used the better. Pour off the developer, wash and intensify with pyrogallic acid and the acid silver solution.

COLLODIO-ALBUMEN PROCESS, adapted for preparing a large number of plates, and especially for obtaining stereoscopic positives. Glasses having all been cleaned beforehand, by the following method a hundred plates, not exceeding 9 in. by 7 in., may be prepared in a few hours. A gutta-percha or porcelain dish must be placed in the dark room, containing a bath composed of 1050 grains fused nitrate of silver in 35 oz. water. Use a mixture of $\frac{3}{4}$ ordinary negative collodion, and $\frac{1}{4}$ of ether and alcohol, in the proportion of 2 parts ether to 1 of alcohol. Have a large tub of distilled water in the dark room—near the nitrate of silver bath. Coat a plate with the collodion, and place it in the nitrate of silver bath; as soon as it is sensitized remove it to the water trough, then coat another plate, and follow the same process, taking care that the plates have sufficient water to remove the nitrate of silver. The plates should remain in the water about 10 minutes, and should be placed upright, and not touching each other. If the tub is small, change the water frequently, throwing it into a waste-liquor vessel. When all the plates have been well washed, pour a solution of common salt into the waste; this will cause a precipitate of chloride of silver, which can be

reduced to metallic silver by fusion with some carbonate of soda, in a crucible. By having two nitrate of silver baths, and two washing troughs, much greater rapidity can be obtained, as whilst the plate in one bath is being sensitized, another can be collodionized and placed in the other bath; then remove the sensitized plate to the water trough, and proceed with another plate. When sufficiently washed, draw the plates, and stand them on blotting paper, collodion side to the wall. Before they are quite dry, pour a small quantity of albumen over the collodion, to remove the remaining water, drain this albumen into a separate bottle; then pour a fresh quantity of albumen on the plate, letting it flow over every part of the collodion film, return the surplus albumen to the bottle, stand the plate to dry, coated side to the wall to avoid dust, and resting on blotting paper as before. Avoid letting the albumen run round to the back of the plate; if a little should accidentally do so, let it dry, and then remove with damp bibulous paper. Keep the dark room as free as possible from floating dust whilst the plates are drying, which will take about 12 hours. When dry, pack the plates in a grooved box; and, if protected from damp or direct light, they can be preserved a considerable time.

Albumen.—To the white of each egg add $7\frac{1}{2}$ grains iodide of potassium dissolved in $7\frac{1}{2}$ grains water. Beat to a froth, stand to settle, pour the clear portion into a wide-mouthed bottle, and keep in a cool place.

Sensitizing the Plates for Use.—This operation must only be performed the day before the plates are required, and in the dark room.

Nitrate of Silver Solution.—16 oz. distilled water, 1 oz. glacial acetic acid, $1\frac{1}{2}$ oz. fused nitrate of silver. Filter. When discoloured by use, shake up with kaolin and allow to settle. Place the plate in a bath of the above for about 15 seconds, wash well, stand to dry. When dry it is ready for exposure in the camera; time twice or thrice that required for ordinary collodion plates.

After exposure, a few days may elapse before developing, but the shorter the period the better will be the result.

Developing.—To 15 grains gallic acid in a porcelain capsule, add 3 oz. hot water, mix well. When the gallic acid is dissolved, add 13 oz. cold water, filter for use. Then make a solution composed of 230 grains fused nitrate of silver, and 9 minims glacial acetic acid dissolved in 35 oz. water. Add $\frac{1}{4}$ of a dram of the latter solution to every 3 oz. of the former; the whole must be thoroughly incorporated; pour into a porcelain dish, a little larger than the plates, about an inch of depth of the mixture. Immerse the plate in the bath, and agitate it a little at first. The time necessary for development varies with the temperature, which should be about 70° Fahr.; a little more nitrate of silver solution will hasten it, but if too much is added fogging will take place. With proper solutions about 4 hours is usually sufficient. If the gallic acid bath turns muddy, remove and wash the plate, and place in a fresh solution of gallic acid, containing less of the nitrate of silver mixture than was previously added. When well developed, wash the plate, and fix with hyposulphite of soda, as described in the wet process, then wash and dry.

Causes of Failures.—Under-exposure of a plate is fatal. If, after long standing in the developing solution, only the sky is well marked, the plate is useless. An over-exposed plate develops rapidly, and if removed from the bath before the whole picture turns grey, a passable result may be obtained. If the sky begins to show about an hour after the plate is placed to develop, and gradually turns to an intense black, and the dark shadows remain perfectly transparent, the plate is successful.

To Prevent Film Splitting.—In all dry processes the film when wetted has a tendency to loosen from the glass and split; this may be avoided either by painting for about $\frac{1}{4}$ inch round the edge of the plate with a solution of india-rubber 2 grains, benzole 1 oz., or by applying to the whole of the plate a substratum of albu-

men 1 oz., water 20 oz., liquid ammonia $\frac{1}{2}$ dram, to be well shaken together and allowed to stand until clear. These also prevent water getting under the film during preparation. It is essential that the collodion should be allowed to set well before immersion in the silver bath.

THE HONEY PROCESS.—Clean, coat, and sensitize the plate in the usual manner; then place it in a bath of distilled water, washing more or less as it may be required to be kept for a longer or shorter time. Pour on the plate a solution made of equal parts of honey and distilled water, and applied in the same manner as the collodion; throw away the first portion, and repeat the operation, letting the solution soak in for one or two minutes; pour back the honey solution to its bottle, drain the plate on blotting paper, keep it in the dark and free from dust. Exposure about double for the ordinary wet process. Previous to developing, soak the plate in distilled water, to soften or remove the film of honey; the older the plate, the more soaking will be required; then dip the plate into the silver bath and develop in the usual way.

THE TANNIN PROCESS.—Clean the glasses with a mixture of tripoli powder, spirits of wine, and solution of ammonia, applied by a tuft of cotton. Wash in clean water, and dry with a soft cloth, previously warmed. Coat one side of the plate with the following gelatine solution, applied in the same manner as collodion.

Gelatine Solution.—20 grains Nelson's patent gelatine, dissolved in 10 oz. of water, and $\frac{1}{2}$ oz. spirits of wine. Filter. After coating the plate, pour back the superfluous gelatine into the bottle, stand the plate to drain on a piece of blotting paper, when dry, warm slightly, and pack in a grooved box. A number of plates may be thus coated at one time, as if they are carefully packed they will keep any length of time. Do not let any of the gelatine solution get on the back of the plate. Coat the plate with old iodized collodion in the usual way, and place in a similar nitrate of

silver bath to that used in the wet collodion process, in which it must remain 4 or 5 minutes. Then wash with plenty of water.

Tannin Preserving Bath.—To every ounce distilled water required in the bath, add 15 grains tannin. Filter. Pour out two separate portions of about 4 drams each, one to be used for the first coating of the plate, which removes the water remaining on it after washing; the second portion is then poured on and off the sensitized side of the plate several times. Stand the plate in a warm dark room resting on blotting paper; when dry, it is ready for use in the camera. The necessary time for exposure varies from one minute on a very favourable day, to eight minutes in dull weather.

Developing Solutions.—1. 72 grains pyrogallic acid in 1 oz. spirits of wine; keep in a stoppered bottle. 2. 20 grains each of nitrate of silver and citric acid, dissolved in 1 oz. distilled water. Filter. Add $\frac{1}{2}$ dram of No. 1 to 3 oz. distilled water, then take say 3 drams of this diluted pyrogallic solution, and add to it from 10 to 15 minims of the nitrate of silver and acid solution, moisten the exposed plate with water, quickly and evenly applied, then pour on the developing solution, and let it flow gently to and fro over the plate. If the sky comes out quickly and strongly, but the details do not, it is a proof of under-exposure, which a little more pyrogallic acid added to the developer will remedy. If, however, the picture appears to come out at once, a proof of over-exposure, add a few drops of No. 2 solution to the developer. When developed fix with hyposulphite of soda, wash and varnish, as described for wet collodion.

ENLARGEMENT OF NEGATIVES.—The negative to be enlarged must be absolutely perfect as regards definition, slightly dense, and full of detail, possessing as little granularity as possible. From the negative, either by contact printing on a dry plate, or copied by the wet process in camera, a transparency should be obtained, the development to be effected by the application of a weak solution of

pyrogallic acid, to which a few drops of an acid solution of nitrate of silver, 10 grains to the oz., has been added. The contrasts should not be too decided, nor the shadows too dense. From such transparency the enlargement may be produced by the usual studio process up to six or eight diameters without any visible diminution in the excellency of its definition; or the transparency may be enlarged to the required size at once, and a negative obtained from it on a dry plate as before, or upon carbon tissue, each of which possesses its advantages.

STEREOSCOPIC VIEWS.—The appearance of high relief given by the stereoscope, is obtained by placing side by side two prints representing the same object, but photographed from slightly different positions, whilst the glass prisms of the stereoscope so direct the visual rays as to superpose the views, and but one picture is seen, although it is in reality a combination of both; thus the same object is seen from two different points of view at the same time, as is always the case when both eyes are looking at one thing, as they, with the object seen, of course form a kind of triangle. Views for the stereoscope are frequently taken simultaneously by two cameras, placed at certain angles and distances from each other, varying with the size and distance of the object to be photographed; but for portraits less trouble is involved by the use of a properly constructed twin camera. For views, or groups, situated some distance from the operator, two distinct cameras must be used (or one camera moved from place to place); the distance they must be placed apart, and the relative angle in which they should stand to each other, require careful consideration. For portraits or other objects, to which the cameras can be brought rather close, the angle should not be too great, otherwise the effect of relief will be distorted. In such cases an angle of about 2° must be used. For landscapes, as large an angle as 4° may generally be safely employed. To reckon the angles, suppose the nearest point of the view to be taken to represent the apex of a triangle, from

each camera produce an imaginary straight line to the apex, these lines must represent the desired angle. As lines diverging from a centre may be indefinitely produced without altering their relative angle to each other, so the distance between the cameras will not affect the angles they should stand in, except that, for pictorial effect, distant objects may be a little distorted with good results, as will be the case when a large angle is used; whereas for subjects close to the camera, such distortion does not give a pleasing picture. Supposing an angle of 2° to be used, the distance required between the cameras will be about $1\frac{1}{2}$ in. for 1 yard, $2\frac{1}{2}$ in. for 2 yards, $3\frac{1}{2}$ in. for 3 yards, 5 in. for 4 yards, 6 in. for 5 yards, $7\frac{1}{2}$ in. for 6 yards, 9 in. for 7 yards, 10 in. for 8 yards, $11\frac{1}{2}$ in. for 9 yards, $12\frac{1}{2}$ in. for 10 yards, 13 in. for 15 yards, 25 in. for 20 yards. These remarks apply equally whether two cameras are used simultaneously, or whether only one camera is used, being moved from one position to the other as required.

Twin Lens Camera.—This is a camera having two double achromatic combinations of the same focal length, in other respects like an ordinary camera, except that it has two folding shutters at the back. Before focussing the object to be photographed, it is necessary to ascertain that the two lenses are in focus with each other. For this purpose, focus a statuette, or other convenient article, and when a perfectly sharp image is obtained with each of the lenses, upon the ground-glass slide, do not again alter the rack and pinion which adjust the lenses; any further adjustment necessary for portraits to be taken subsequently must be obtained by drawing in or out the expanding body of the camera, as when once the glasses are of the exact focal length, their relative positions to each other will not require any alteration, although the body of the camera will. As the two lenses are necessarily rather close to each other, the twin camera will only answer for photographs taken at a very short distance, otherwise the effect of relief will not be

obtained. The glasses used are longer than they are wide, as two negatives are taken at the same time. All the operations are the same as before described for negatives; when the positive prints are obtained, their position must be reversed in mounting, the left-hand half of the print being pasted on the right-hand side of the card, and the right side of the print on the left side of the card.

Stereoscopic Views with One Ordinary Camera.—The camera must be placed on a board, having a movable slip of wood at each side which can be adjusted to the desired angle, against which the camera must be placed, first on one side to take one view, and then on the other side to take the other view. Mark cross lines on the ground-glass plate, to intersect a central point of the view from whichever side of the board the camera is standing; this is to ensure correct centres for the proofs. Two separate negatives are then taken; when mounting the prints, transpose their position from right to left. Dark slides are made for this process, to hold a glass sufficiently long to contain both views, and fitted with two shutters, by which each half of the glass can be exposed alternately. Having exposed the right-hand half, close its shutter, move the camera the required distance to the left, and expose the left-hand half of the glass.

Stereoscopic Views with Two Ordinary Cameras.—For instantaneous views of any landscape containing animate figures, it is necessary to use two quarter-plate cameras, with lenses of exactly equal focal length; they must be placed on a board provided with movable stops to regulate angle and distance. Great care is necessary in manipulation; the two shutters must be opened and closed at the same time, otherwise the two proofs will develop unequally. The plates should be collodionized and sensitized in the same baths, and to the same extent. For the developing bath, employ a vessel into which the two plates can be placed side by side, so that the same pyrogallie acid may effect both

simultaneously. When mounting the positives, transpose the two views, left to right, as before described.

PHOTOGRAPHY BY ARTIFICIAL LIGHT.
—Negatives may be obtained by the aid of light given by burning magnesium wire, care being taken that the direct light does not fall on the lens, and that the object is well illuminated. Transparent positives on glass may be printed by the light of a gas-burner, or of an argand oil lamp.

TRANSPARENT POSITIVES.—These are taken from negatives, and may be obtained of the same size, or larger, or smaller than the original, as desired. For copies of the same size as the negative, the operation can be effected by placing the negative in a printing frame, in contact with an ordinary dry collodion plate. The negative used should be very clear in the lights, and have transparent shades. To obtain a good negative for this process use a more acid nitrate of silver bath than for ordinary negatives, and do not continue the development so long. By daylight the exposure required will be a few seconds, but gaslight may also be used, when the exposure must be extended over several minutes. In developing, pyrogallie and citric acid give a blue-black tint; pyrogallie and acetic acid a brown-black tint. If intended to be hung up as a transparency, varnish and protect the collodion side with a ground-glass backing, bind round the edges to keep out dust. If the transparency is required of a different size to the negative, the camera and lens must be used. One means of doing this is to work in a dark room, allow the light to enter through the negative only, and proceed as usual with the exposure and developing.

Copying Camera.—This is a kind of double-bodied camera, one part of which is provided with holders for the negatives, and has no lens; the other portion has a lens which can be moved so as to approach or recede from the negative, and has the usual ground-glass plate. The negative must be placed in its holder, screw on the lens, and adjust

the lens to its proper distance from the negative. If the copy is wished to be larger than the negative, approach the lens to it, and farther from the ground glass; if it is required to be smaller, remove the negative farther from the lens. The light passing through the negative will show its image on the ground glass in the usual way. When the desired size is obtained, remove the ground glass, and replace by a frame having an ordinary wet sensitized plate. Use a diaphragm, with a small stop, and proceed as if for an ordinary negative. It is necessary sometimes, when considerable enlargements are required, to use a camera with a long body opening out like an accordion; the operations are similar when once the proper focal distances have been adjusted. The power of a lens is determined by its shape and diameter. The larger it is in diameter, the more light it will admit; whilst the degree of curvature it has regulates its focal length, and determines the size of the image it will produce. It is the focal length of a lens, and not its diameter, which regulates the size of the image, and the distance it has to be from the ground-glass screen determines the length of body required in the copying camera.

To calculate Length of Camera required.—Calculate the distance the ground glass must be from the back lens thus; multiply the focal length of the lens used by the number of times of enlargement required, add the focal length to the product. The focus of a quarter-plate lens is generally 6 in. Say the negative is to be enlarged 3 times, $6 \times 3 = 18 + 6$ in. focal length = 24 in., the distance required between the ground glass and the lens. The distance the negative is to be in front of the lens is always more than the focal length, but less than twice the focal length.

MAGIC-LANTERN SLIDES.—If the transparent positives obtained are intended for the magic lantern, they need not be varnished; if varnish is used, the crystal varnish is better adapted for the purpose than spirit varnish, which would

probably show streaks when magnified on the screen. Mount on another piece of glass of the same size to protect the collodion film, and bind round the edges like a passe-partout.

The Solar Camera.—This is a copying camera with a condensing lens to concentrate the sun's light on the negative, so as to allow the focus of the lens to be at a considerable distance, to obtain an enlargement of a picture. The magnified image of the transparent negative may be received upon either sensitized glass or paper. For use with ordinary albumenized paper, sensitize it in the usual way; the development required will however be longer. Or thin Saxony paper may be used, after being floated for one minute on the following solution;—chloride of ammonium and citric acid, 4 drams each; 25 oz. of distilled water, saturated with sesquicarbonate of soda. To prepare this bath, dissolve the citric acid in part of the water, and add the soda until the acid is neutralized; add the resulting citrate of soda to the solution of chloride of ammonium; add a little citric acid in solution, with a small quantity of boiled arrowroot. Remove the paper from this bath, and hang to dry.

Sensitizing Bath.—Nitrate of silver, 1 oz., in 18 oz. distilled water; add a few drops of citric acid to dissolve the first precipitate. Lay the paper on this solution, prepared side downwards, for half a minute, dry in a dark room. Expose the paper until it takes a pale lilac tinge, which will occur in a few minutes, remove and immerse in the following.

Developing Bath.—Dissolve 15 grains gallic acid in 1 dram alcohol; and $7\frac{1}{2}$ grains acetate of lead in $1\frac{1}{2}$ oz. water. Pour these solutions into 5 pints of water, adding a few drops of glacial acetic acid to redissolve the slight precipitate which will form. Several prints may be developed at once; when developed, remove and wash in clean water.

Fixing.—6 oz. of hydrosulphite of soda dissolved in 1 pint water. Leave the prints in the bath for about four minutes, then wash very thoroughly in